White Paper

IP Address Management: Smoothing the Way to Cloud-Based Services

What You Will Learn

Cloud computing offers many operational advantages to service providers. An important element of successful cloud-based offerings is fast, efficient provisioning and service delivery. However, as IP addressing becomes much more complex, providers will need a new, easier way to manage IP addressing and multitenant services. This paper will describe how Cisco Network Registrar can help providers:

- Simplify Domain Name Service (DNS), Dynamic Host Configuration Protocol (DHCP), and IP address management (IPAM)
- Ease the transition from IPv4 to IPv6
- Address privacy regulations
- Reduce management costs for cloud-based services

Cloud Computing—A Breakthrough for Delivering Innovative Services

Cloud computing promises many advantages for delivering innovative services without boundaries. Many service providers are looking to cloud computing for increasing efficiency and simplifying service management. By abstracting IT resources and services from the underlying infrastructure, service providers are achieving highly elastic, multitenant environments *and* savings. For example, cloud-based environments facilitate provisioning in minutes; time-to-market reductions of more than 50 percent; high server and storage utilization; 50 percent reductions in capital costs; and 25 to 30 percent reductions in operational costs.[1]

At the same time, cloud-based services are highly attractive to providers' enterprise customers. Service provider-based cloud services offer greater scalability and performance without requiring premises-based infrastructure and management. Self-service, scale-on-demand, and pay-per-use features increase user convenience and IT flexibility, while automated recovery and cloud-based backup significantly enhance risk management.

Positioned to Benefit

The good news is that service providers today are uniquely positioned to take advantage of cloud computing. Infrastructure as a service (IaaS)—a cloud utility architecture—provides an easy entry point for many service providers who are already expert at provisioning, managing, and scaling infrastructure-based services for multiple customers. IaaS offers a highly attractive, cost-effective solution, helping to enable service providers to increase return on investment through existing infrastructure to deliver high-margin multitenancy services and support new competitive offerings. According to the Cisco® Internet Business Systems Group, a 2009 study has forecast IaaS service revenues to be approximately $15.6 billion by 2013.

[1] Cisco Services Cloud Enablement White Paper for Service Providers, 2010.

Moving to cloud-based IaaS has different implications for different groups within the service provider organization:

- **Service provider CEOs:** Seek competitive advantage and improved time to revenue for their services. The full benefits of a cloud model allow the company to scale, globalize, and deliver new services as a competitive response.
- **Service provider CIOs and IT managers:** Want to keep the IT organization cost-effective and relevant within the business. Cloud-based services can affect infrastructure and security.
- **Service provider CIOs and business unit leaders:** Look to the cloud to accelerate time-to-service revenue while reducing or avoiding costs.
- **Service provider IT and data center architects:** Network, storage, and computing teams need expertise to help accelerate design and implementation of cloud-based architectures and solutions.
- **Architects and solution designers:** This group is interested in gaining assistance to implement and operate cloud-based services models.
- **Service provider IT program managers:** These individuals are focused on maintaining existing services and supporting infrastructures, as well as working with non-cloud-based vendors and partners.

Moving from Here to There

Achieving the full benefits of a cloud model requires addressing the significant challenge of managing access and privileges for millions of customer IP devices. The number of IP addresses that must be managed is growing exponentially as new devices and technologies are introduced into the service provider network. Everything—from computing devices, networking systems, and virtualized servers to IP telephones, smartphones, and video devices—uses IP addressing. And today, most individuals use multiple devices and frequently switch between them multiple times a day, making it even more important to be able to manage IP addresses effectively for a high-quality customer experience.

The Internet Protocol itself is changing in order to support rapid IP address expansion. Many network operators and web companies, such as Facebook, Google, and others, have already begun the transition of their networks from IPv4 to IPv6, which supports vastly more addresses and simplifies some aspects of address assignment and network renumbering. A recent global test, in which these companies enabled IPv6 on their sites for 24 hours, was deemed a success with no significant issues or problems for users (source: *World IPv6 Day Ends, Everyone Goes Back to IPv4*, eWeek.com, June 9, 2011).

However, IPv4 and IPv6 are not interoperable. IPv6 requires network hardware and software modifications, which will require migration of critical infrastructure and management tools. During the transition from IPv4 to IPv6, which could take several years, service providers will essentially have to operate parallel networks with dual-protocol access software and tunneling to accommodate all customers.

The migration to IPv6 greatly complicates service providers' IPAM tasks today and increases IPAM costs. As the size of the network grows, so do the number of IP addresses per user and the cost of IPAM per IP address.

Also affected by migration to IPv6 are Domain Name System and Dynamic Host Configuration Protocol, which play critical roles in IP addressing. DNS translates domain names to numerical identifiers for all networking equipment in order to locate and address these devices worldwide. Domain names help enable Internet resource and user information to remain consistent, regardless of their physical locations. Without a fast, reliable, and secure DNS service, subscribers' broadband Internet access will be compromised. If DNS fails, the Internet will fail. In addition,

many service providers have created a dynamic service delivery infrastructure based on DNS to help ensure high service quality and competitive service delivery.

DHCP is an automatic configuration protocol used in IP networks. It allows a computer to be configured automatically and maintains a database for keeping track of computers that have been connected to the network, which prevents two computers from accidentally being configured with the same IP address. Without DHCP, every device must be manually assigned a unique address, which today is a virtually impossible task. With highly mobile users, converged third- and fourth-generation (3G/4G) networks, and the growing number of end-user network-capable devices, high-capacity DHCP servers are indispensable.

DNS and DHCP services must be automated and managed centrally if a service provider can even hope to cope with increasing addressing complexity. This can be achieved through integration with an easy-to-use, reliable IPAM solution.

When combined with market requirements for instant provisioning and service activation, rising costs, and fixed management budgets, IP addressing complexity is a serious problem. Current operational processes, which are largely manual, are no match for the coming onslaught of IP addresses. In addition, most existing DNS and DHCP environments do not support multitenancy, which would allow a provider to securely support and manage multiple customer environments in one hardware system or software instance. Having to manage separate systems and software instances for high numbers of customers simply is not a scalable approach.

Virtualized environments, such as cloud computing, will soon be the only feasible way to quickly provision and deliver services securely and cost-effectively. And service providers will need a single solution that integrates IPAM with DNS and DHCP services to manage their dynamic IP address requirements across converged IPv4/IPv6 networks.

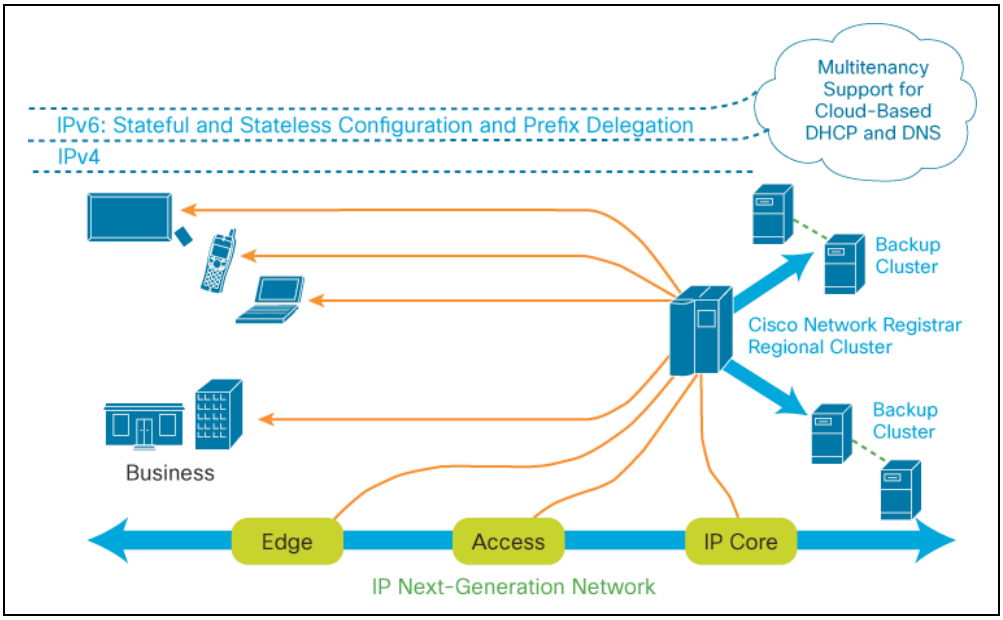
Enhanced, Integrated Management with Cisco Network Registrar

With IPv6, service providers face increasing complexity in managing IP address space; managing IP addresses in spreadsheets is nearly impossible. Maintaining and understanding IPv6 network information in an IPv6 or hybrid IPv4/IPv6 network requires an automated DNS, DHCP, and IPAM (DDI) solution. Therefore, virtualized DDI platforms for cloud-based services must be able to support automated, centralized IP address management for IPv4 and IPv6 simultaneously.

As service providers move to cloud-based services, their IP addressing management solutions must work well in the virtualized environments characteristic of cloud computing. Cisco® Network Registrar supports cloud environments by providing a full-featured solution with centralized capabilities for managing DNS, DHCP, IPv4, and IPv6 in one IP management system, which can be deployed as a virtual appliance. Cisco Network Registrar delivers scalable, high-performance DNS and DHCP services, robust IPAM features, and full lifecycle management for IPv4 and IPv6.

Cisco Network Registrar is based on a scalable, distributed architecture that delivers high-performing DNS and DHCP services. Regional clusters manage local clusters deployed throughout network. A typical DNS deployment is one regional cluster at the network operations center (NOC) with local backup clusters at remote locations to provide DHCP and DNS. The System Configuration Protocol (SCP) communicates configuration changes between servers. See Figure 1.

Figure 1. Cisco Network Registrar provides consolidated IP address management across the full IP next-generation network.



Standards-Compliant DNS Server

With Cisco Network Registrar, a single DNS server supports both IPv4 and IPv6. The server is standards-compliant and reliable with support for high availability DNS. High performance delivers query throughput of:

- 170,000 queries per second (qps) cache
- 100,000 qps authentication

Compared to competing solutions, Cisco Network Registrar delivers a significant performance advantage. See Table 1.

Table 1. DNS Server Performance Comparison for Dynamic Update Speed and Maximum Query Throughput Estimates[2]

	Cisco Network Registrar	BIND	Competitive Solution
Maximum dynamic update rate	5838.80 updates/second	32.67 updates/second	127.50 updates/second
Maximum query throughput	40,000 queries/second	35,000 queries/second	22,000 queries/second

Fast DHCP

Cisco Network Registrar is the industry's most scalable DHCP server, able to support more than 50 million devices in a single customer deployment. It also provides best-in-class speed with its ability to assign more than 14,000 DHCP leases per second. It can assign up to 18,000 new clients in a test environment with features such as failover, updates, and logging turned off. Using Cisco Unified Computing System™ hardware, the Cisco Network Registrar DHCP server can assign 47,000 leases per second for returning clients with features turned off. This exceptional performance helps ensure that the DHCP server can handle particularly heavy loads, including the surge of demand that typically follows a power failure. Additional features that provide high DHCP reliability include support for DHCP failover and a patent-pending discriminating rate limiter for avalanche protection to limit downtime after network outages.

[2] Based on independent testing with results available upon request.

The full-featured DHCPv6 server provides support for address assignment, both stateless and stateful configuration, and prefix delegation for full IPv6 address management. Cisco Network Registrar's powerful extension support for customizing DHCP server processing allows providers easily to create new solutions for billing, security, lawful interception, and other applications.

High-Performance IPAM

IPAM features are integrated with DNS and DHCP for configuration, automation, integration, and administration of servers, as well as reporting and IPv4 and IPv6 management.

Future-Ready Capabilities

DNS, DHCP, and IPAM capabilities are basic requirements for cloud-based service delivery. Cisco Network Registrar includes additional capabilities that ease the transition to secure, virtualized services in both IPv4 and IPv6 environments.

Multitenancy with Data Security

Cisco Network Registrar's multitenancy feature allows managed service providers to consolidate many small customers on a limited number of local clusters. Providers can segment data stored on regional and local clusters by tenant. Any given local cluster can be associated with one or more tenants residing on that cluster. Within a local cluster, the address pools and domain names assigned to a given tenant are separated, allowing multiple tenant environments to coexist on a single instance of Cisco Network Registrar.

At the same time, multitenant capabilities provide secure IP address management and self-service control for subscribers. Self-service capabilities are enabled by the service provider, allowing subscribers various levels of access, from viewing their own data through a read-only portal to managing their own address space.

Virtual Machine Support

A virtualized environment accelerates service provisioning and delivery, which reduces total cost of ownership. Cisco Network Registrar is available for deployment as a virtual machine (VM). This version of the product, called Cisco Network Registrar Jumpstart, is packaged as an Open Virtualization Format (OVF) virtual machine for VMware and includes CentOS and a preinstalled Cisco Network Registrar local cluster. A single package simplifies installation in an existing virtualized environment. There is a similar VM package for a Cisco Network Registrar regional cluster. These VMs will be available for download over the web. Cisco Network Registrar is supported for Red Hat 5 and Windows 2008 Server R2, running on VMware ESXi 4.1.

Dual-Stack Deployment

Because most service providers will be running both protocols concurrently for some time, Cisco Network Registrar allows dual-stack IPv4/IPv6 deployments on a single server. A single DHCP server supports both IPv4 and IPv6 for IP address translation and service delivery. A single DNS server can respond to and initiate queries over IPv4 and IPv6.

Operational Benefits

Privacy Protection and Regulatory Compliance

Service providers' customers want control and to make sure that their data, applications, and services in the cloud are still private and secure. Cisco Network Registrar is designed to meet data retention limits imposed by some regulatory agencies and to give providers granular control. It provides full visibility into lease history for IPv4 and IPv6 and offers exceptional privacy protection functionality, including compliancy with European Union privacy regulations that dictate how individuals' Internet addresses are stored. Providers can limit aging lease dates and times for both DHCPv4 and DHCPv6 environments. With Dynamic Lease Notification, customers can have external systems notified whenever Cisco Network Registrar issues a lease. This feature is used in lawful intercept solutions and long-term storage of customer data for regulatory compliance and operational efficiency.

Reduced Operational Costs

Installation and configuration wizards let providers quickly configure DNS and DHCP. Centralized control and configuration allow administrators to manage DNS and DHCP servers from a central location while eliminating manual, repetitive, error-prone tasks in configuring local servers

Service Provider Hosts DNS Services in the Cloud for Cable Operators

In the late 1990s, small and medium-sized cable television companies recognized that their future depended on offering high-speed data services to customers. However, with a lack of affordable provisioning software on the market, cable operators had few choices.

In 2001, IBBS, a provider of integrated data, voice, and technical support services for cable providers wrote software that automated provisioning and diagnostics for small and medium cable operators. However, IBBS needed a flexible way to deliver DNS and DHCP services that would accommodate its cable operator customers' diverse devices and business rules.

In 2001, IBBS chose Cisco Network Registrar and deployed it in a single, multitenant cluster. With Cisco Network Registrar's extensions, IBBS gained precise control over incoming DHCP requests and outgoing responses, based on detailed criteria. Cisco Network Registrar's full scripting capability also allows IBBS to quickly and easily add or extract information in a batch mode. For example, when IBBS acquires a new customer or when an existing customer purchases another cable operator, IBBS can easily convert the entire new subscriber base to its system, saving time.

The flexibility and scalability of Cisco Network Registrar has allowed IBBS to provide cable modem access services using a cloud model for the past 10 years with very little cost. A single cluster of Cisco Network Registrar servers supports 250 cable operators managing 1400 aggregation devices connecting more than one million cable modems across North and South America. All day, every day, Cisco Network Registrar reliably identifies each device and class of service and then provides IP addresses and the right configuration files and profiles to keep each modem up and running. Cisco Network Registrar's flexibility also lets IBBS accommodate the myriad business rules its customers request. Where a typical cable company may have three or four classes of service, IBBS is able to configure three or four different classes of service for each of 250 operators—for nearly 1000 classes of service.

Conclusion

Preparing to deliver cloud-based services can be made much easier with an integrated, scalable, reliable solution for DNS, DHCP, and IPAM. Cisco Network Registrar delivers the high performance and virtualization support required for simplifying address management and successfully navigating the transition to IPv6 and cloud-based, multitenant services.

For More Information

For more information about Cisco Network Registrar, visit www.cisco.com/go/cnr.

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