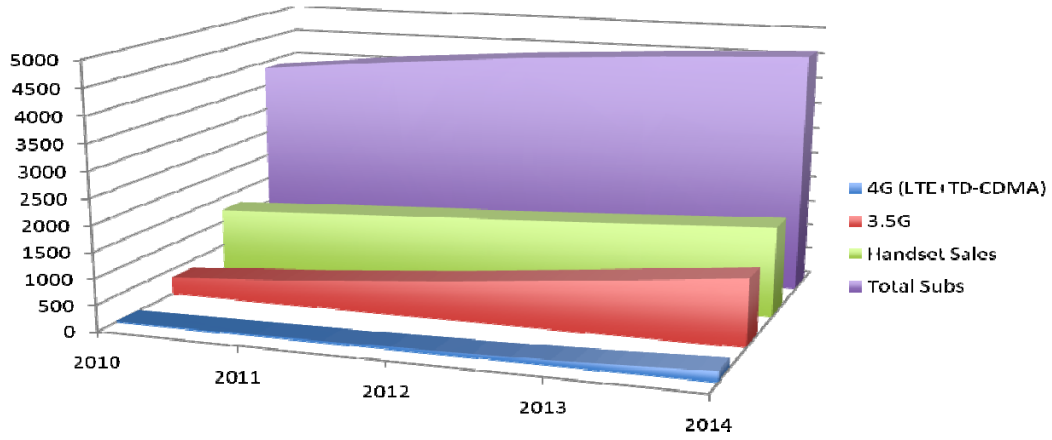
White Paper

Deploy CGN to Retain IPv4 Addressing While Transitioning to IPv6

The IANA ran out of IPv4 addresses to allocate in February 2011, and the Regional Internet Registries (RIR) will have assigned most of their addresses by the end of 2011. The world is faced with the fundamental problem of IPv4 address space exhaustion. There is a huge demand for IP addresses resulting from the explosive growth of mobile devices, including smartphones, portable gaming consoles, tablets, laptops and netbooks, and machine-to-machine modules.

Figure 1 shows the expected growth in mobile phones alone. The number of mobile subscribers is expected to be 4.5 billion by 2014.

Figure 1. Expected Mobile Phone Growth (in Millions) (Source: IDC)



Preserve IPv4 Addressing with CGN

Service providers are looking for ways to extend the use of the IPv4 addresses they have during their transition to IPv6. IPv4 addresses are still valid and ubiquitous, and not everyone is using IPv6 yet, so the two addressing schemes will coexist for a long time. Although new IPv4 addresses are not available, there is a short-term alternative that ensures your business continuity.

That alternative is Carrier Grade NAT (CGN), a solution that service providers can employ today to extend their use of IPv4 addresses. The extension is achieved in two ways: IPv4 addresses are extended because they are translated from many private addresses to one public address. The extension is also a time extension—service providers can continue using IPv4-only networks for a while. Cisco's approach to help customers as they transition to IPv6 is to "Preserve, Prepare and Prosper." CGN helps customers "Preserve" the present mode of operation.

CGN can also be used in a dual stack environment or with a 6rd tunnel if SPs have IPv6 addressing in place, so CGN does not preclude the use of IPv6.

Need More Time Before Implementing a Dual Stack or IPv6 Network?

The current economic model of free IP addresses and an almost limitless IP address space is a model that service providers want to preserve. Incorporating IPv6 addressing into a network takes time, planning, and resources. Using both IPv4 and IPv6 (a dual stack environment) requires those same elements. With the implementation of CGN, service providers can continue to use IPv4 addresses while they plan their move and indeed move to IPv6. This strategy allows them to incrementally transition to IPv6 at a pace that suits their environment.

CGN is Based on NAT

CGN's predecessor, Network Address Translation (NAT), was created primarily for network administrators of small networks who used private, nonregistered IPv4 addresses, yet needed to access the public Internet. NAT made such access possible without users needing unique, globally routable IPv4 addresses. NAT translates one or more private (inside) addresses into one or more public addresses using network address and port translation techniques before forwarding packets onto another network.

NAT can be configured to advertise only one address for the entire private network to the outside world. This functionality not only preserves IPv4 addresses, it also provides additional security by effectively hiding the private network behind that one address. NAT has been in use for over ten years, allowing private home and enterprise networks to use private IPv4 addresses for intranet connectivity while using NAT-enabled routers and public IPv4 address for external, public Internet connectivity.

What is CGN?

CGN evolved from NAT to be a service-provider class feature that provides scalability and performance. CGN is intended for service providers who want to extend their use of IPv4 addresses. There are still many IPv4 hosts that need to access the public IPv4 Internet. The service provider uses CGN to multiplex a large number of IPv4 subscriber flows through a much smaller set of public IPv4 addresses.

Today most customers are connected to the Internet using NAT at the CPE level, but providing a public IPv4 address to the uplink side of the customer premises equipment (CPE). An enterprise or home network deploys NAT44, which is proportioned in scale and performance to serve a fixed, known set of IPv4 endpoints.

CGN employs address sharing also, by sharing a single public IPv4 address across multiple CPEs, thereby saving IPv4 addresses. A CGN differs from a home or enterprise NAT44 router in several ways: CGN has a much larger scale and higher performance. CGN is configured and managed by the network operator, not the end customer. Finally, CGN logs NAT session information in an archive to comply with regulatory requirements.

CGN connects a private IPv4 network and a public IPv4 network. Figure 2 illustrates NAT44 and CGN.

Figure 2. Typical CGN Environment

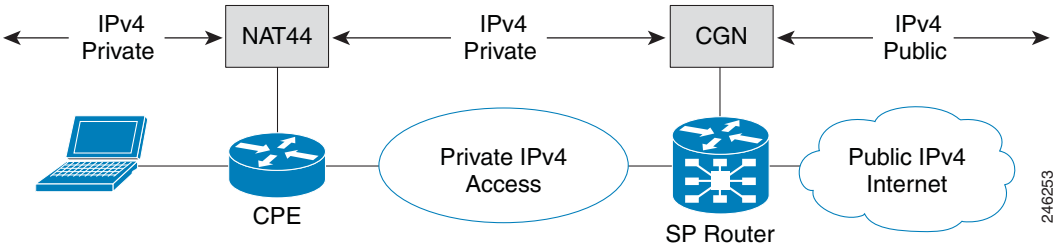


Figure 2 illustrates the CGN scenario. The CGN located on the SP at the border of the IPv4 address space and public IPv4 Internet provides high-performance, private-to-public IPv4 translation. The access network is private IPv4 and the CPE is required to perform a private-to-private IPv4 NAT. There is no IPv6 addressing in this scenario.

The key differences between a CGN and the classic home or enterprise NAT are performance, scale, and the fact that CGN is owned and managed by the service provider.

Why Scale Is Important

The performance and scale of CGN are crucial to accommodate very large numbers of users. Internet use has shown accelerating growth.

- China Mobile has surpassed 500 million subscribers–more than the population of North America. (China Mobile)
- The “Embedded Internet” will consist of over 15 billion devices by 2015. (Intel Embedded Internet Projections)
- Mobile data traffic will roughly double each year from 2008 through 2013. (Cisco VNI)
- Global IP traffic will increase by a factor of five from 2008 to 2013, approaching 56 exabytes per month in 2013, compared to approximately 9 exabytes per month in 2008. An exabyte is 1,000,000,000 gigabytes. (Cisco VNI)

Not only are there new Internet users, but many users have multiple devices requiring an IP address. CGN provides the scale and performance that service providers need in order to accommodate large numbers of IP hosts and network address translations.

Benefits of CGN to Extend the Use of IPv4 Addressing

- CGN can be deployed today to address the fact that IPv4 addresses will run out in a few months. It is low risk and does not have the long learning curve or implementation complexity of IPv6 addressing.
- Customer premise equipment (CPE), the access network, and home network remain using IPv4 addresses for the time being.
- Minimal OPEX: there is one IPv4 stack on hosts, one IPv4 network to manage and troubleshoot.
- CGN is compliant with standard NAT behavior (RFC 4787, RFC 5382, RFC 5508).
- CGN provides the scalability and performance that service providers need.
- CGN buys time for service providers to plan their move to IPv6 addressing incrementally.

- CGN is the precursor for a suite of SP-class IPv4 address-sharing solutions, including Stateful NAT64. NAT64 allows a move toward IPv6 adoption by enabling IPv6-only devices to connect to existing IPv4 servers.
- CGN can be used in a dual-stack environment (IPv4 traffic is translated) and is upgradable to support additional IPv6 transition methods, including NAT64 and 6rd.

What CGN Does

CGN enables private IP internetworks that use nonregistered IP addresses to connect to the Internet. CGN is placed at the edge of the service provider network.

CGN translates internal local addresses to globally unique IP addresses before sending packets to the outside network. A packet originating within a user network and forwarded through the CGN is translated twice, once by the CPE and again by the CGN.

Virtual Routing and Forwarding Instances (VRFs) and per-VRF interfaces can be used to separate the private and public traffic arriving at the CGN. Private packets arriving on one physical or logical interface can be diverted to the CGN for NAT44 translation, while public packets arriving on a different physical or logical interface are simply forwarded through the system based on destination IP address.

Applications That Work with CGN

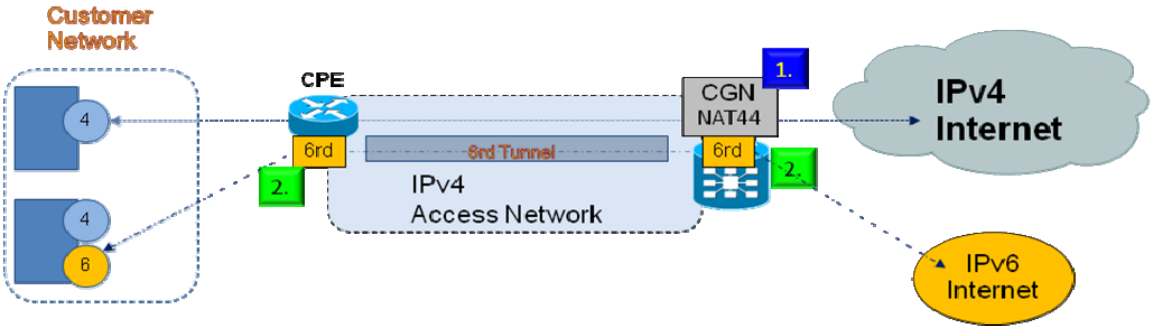
Our testing shows that many common applications, such as iTunes, Facebook, Twitter, BitTorrent, Skype, YouTube, gaming, and more, work with CGN. Most applications today have been built with NAT traversal mechanisms in place.

Use CGN and 6rd Tunnel to Access IPv6 Network

Service providers can use CGN and 6rd to address IPv4 exhaustion, support IPv4 customer connectivity to the public IPv4 Internet, and enable IPv6 customer connectivity to the IPv6 Internet, all performed over the existing IPv4 access network. IPv6 Rapid Deployment on IPv4 infrastructures is known as 6rd (RFC 5969). It basically supports a method to automatically tunnel IPv6 packets across an IPv4 access network.

In Figure 3, the CPE and CGN router are upgraded to support 6rd tunnel encapsulation and decapsulation and are connected by a 6rd tunnel for handling IPv6 packets. Thus IPv6 packets sent from the dual-stack host in the customer network are transported over the 6rd tunnel and then forwarded to the IPv6 Internet; IPv4 and dual-stack hosts use IPv4 and the CGN to reach the IPv4 Internet.

Figure 3. 6rd Tunnel Allows Access to IPv6 Networks



1. CGN addresses the IPv4 run-out; uses same IPv4 access network.

2. 6rd for IPv6 allows access to IPv6 Internet; uses same IPv4 access network

Thus, the combination of CGN and 6rd preserves legacy IPv4 connectivity to the public IPv4 Internet and supports dual-stack IPv6 subscriber connectivity to the IPv6 Internet, both done over the SP's existing broadband IPv4 infrastructure.

Conclusion

Service providers want to extend their use of IPv4 addressing during their transition to IPv6. CGN is a carrier-grade solution that service providers can employ today in an IPv4-only or dual stack environment. CGN provides SP-class performance and scale. CGN allows SPs to preserve IPv4 addresses and carry on with business while they plan and implement their transition to IPv6. CGN can be used in conjunction with IPV6 transition features such as 6rd and NAT64 to enable access to IPv6 networks.

For More Information

Read more about CGN and the Cisco Carrier-Grade IPv6 Solution at http://www.cisco.com/go/cgv6

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