How Cisco IT Simplified Network Growth with EIGRP

EXECUTIVE SUMMARY

CHALLENGE

- Simplify global expansion
- Add tens of thousands of home offices to network
- Provide high-quality voice and video experience

SOLUTION

- Implemented EIGRP in conjunction with Dynamic Multipoint VPN (DMVPN)

RESULTS

- Minimized operational costs by reducing effort to add new offices to network
- Summarized ~83,000 routes to just 1240 core routes, an 83 percent reduction
- Added 25,000 teleworker home offices without manually adjusting routing tables
- Eased transition to IPv6, upgrading WAN to support dual-stack operations with a few simple commands

LESSONS LEARNED

- Be diligent about route summarization

NEXT STEPS

- Enable IP Fast-Reroute (FRR) feature
- Evaluate EIGRP Over-the-Top (OTP) to simplify multicarrier IP WAN designs

Easy-to-use protocol minimized effort to provision 25,000 teleworker offices and simplified transition to IPv6

Challenge

As the Cisco enterprise grew rapidly in the late 1990s, Cisco IT reevaluated its approach to routing. “We needed a different routing protocol that would make it easier to scale,” says John Cornell, IT architect for Cisco Network Services.

At the time, Cisco IT used Interior Gateway Routing Protocol (IGRP) within regions and Internal Border Gateway Protocol (iBGP) between regions. But these protocols had two major liabilities for a growing organization.

First, the then-current version of BGP did not allow route summarization, which meant that geographic expansion required time-consuming, manual changes to routing tables. “We had to do a lot of design work every time we expanded into a new region, like Asia,” Cornell says.

Second, BGP cannot quickly find an alternate path if a network link goes down. This capability, called fast convergence, is critical for the high-quality voice and video experience that brings together the globally distributed Cisco workforce. Even 50 milliseconds of packet loss is noticeable for voice and video.

The need for a scalable routing protocol would become more urgent as Cisco IT prepared to connect tens of thousands of teleworker offices to the network. “We don’t have the resources to manually revise routing tables every time one of the company’s 68,000 employees requests a connection to a home office,” says Tom Wojciaczyk, Cisco IT network engineer. “This is the same challenge faced by retail and restaurant chains, financial institutions, and other organizations with hundreds or thousands of branches.”

The Open Shortest Path First (OSPF) protocol would do little to simplify expansion. “Rapidly expanding our global network might require reconfiguring the OSPF areas,” Cornell says. “We wanted a very simple protocol that would allow a network administrator to make changes without changing our WAN routing design.”

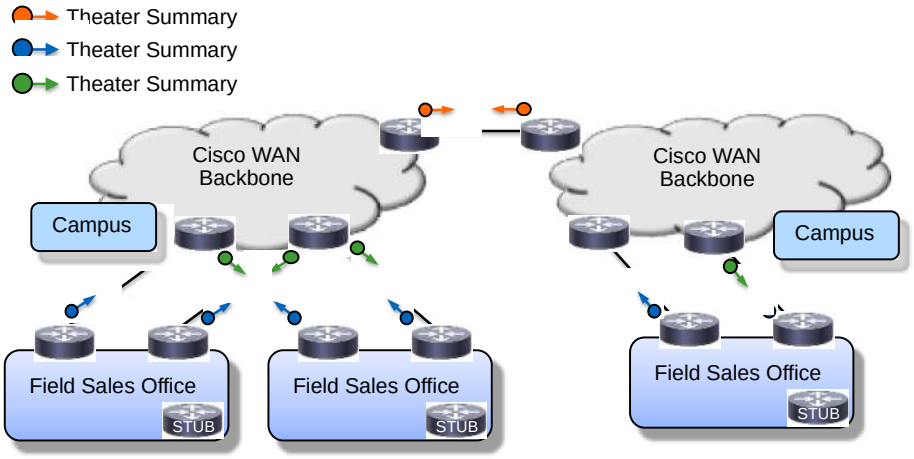
Solution

Cisco IT simplified scaling in a global enterprise by developing Enhanced Interior Gateway Routing Protocol

(EIGRP), a standard that became an IETF Information Draft in June 2013. “With EIGRP, we can expand the network without having to repeatedly redesign the routing domain,” says Shawn Shafai, member of the technical staff for Cisco IT. “We summarize whenever we assign addresses in a new area, representing the addresses as a contiguous block.”

When planning the EIGRP implementation, Cisco IT summarized address spaces at the site level, sub-region level, and region level (Figure 1). The team has summarized an estimated 83,000 routes to just 1240 core routes, an 83 percent reduction. “The fewer routes on the core, the more stable the network,” Cornell says. “Now, an unreliable link to a small office doesn’t affect users in Cisco headquarters or other branch offices.”

Figure 1. Three Levels of Address Space Summarization



In 2002, Cisco IT deployed Multiprotocol Label Switching (MPLS) in Europe, selecting a service provider that supported EIGRP. “By working with a service provider that supports EIGRP, we don’t lose routing information such as minimum bandwidth, delay, and route type, which happens when you have to redistribute routes between routing protocols,” says Roel Bernaerts, network design engineer for Cisco IT. “Preserving routing information leads to better routing decisions at the edge, which creates a better user experience for Cisco employees and partners.”

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Results

The main benefits of EIGRP in the Cisco environment include increased availability, high quality of experience for voice and video, reduced costs, simpler scalability, and a simplified transition to IPv6.

Increased Availability through Faster Convergence

Cisco IT provides at least one feasible successor for each link, avoiding business disruption in the event of a link outage. “After an earthquake took down several main cable systems in 2006, EIGRP gave us the flexibility to evenly spread load over our remaining international circuits, enabling the business to continue without disruption,” Bernaerts says. EIGRP is the first protocol to use the feasible-successor design technique, which OSPF has since borrowed.

Cisco also took advantage of the feasible-successor technique to deploy a dynamic disaster recovery (DDR) solution for the WAN that Cisco used for several years.

Improved Quality of Experience for Voice and Video

EIGRP influences routing decisions at every layer in the Cisco enterprise network, resulting in almost immediate convergence of routing tables around problematic links. “By providing fast convergence, EIGRP has been instrumental in our use of video to improve collaboration, communications, training, customer interaction, and physical security,” Wojciaczyk says.

Another way that EIGRP increases bandwidth efficiency is by only transmitting Hello messages during normal operations, and by only propagating changes to routing tables, not the entire table.

Finally, EIGRP has helped to avoid routing loops that might otherwise degrade the voice and video experience for Cisco employees. Routing loops occur when a router incorrectly identifies the next-hop router. “IT teams ordinarily don’t find out about routing loops until employees open a ticket,” says Dipesh Patel, Cisco IT network architect. “The Site of Origin feature in EIGRP avoids routing loops inside our MPLS VPN, helping Cisco IT to meet service-level agreements.”

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Simplified Operations and Lowered Operational Costs

EIGRP is easier to understand and deploy than OSPF, which reduced staff time and training costs. “When we add a new office to the Cisco network, engineers don’t need to take time to configure the routing protocol, which can save several days,” Cornell says. “Engineers follow standard processes for planning, designing, implementation, and operations.”

Simplified Addition of Tens of Thousands of Teleworker Offices

Used in conjunction with the Cisco Dynamic Multipoint VPN (DMVPN), EIGRP enabled Cisco IT to support a large number of home offices, the same challenge faced by large retail chains with thousands or tens of thousands of stores. Approximately 25,000 Cisco employees work from home offices over a VPN connection at least one day a

week, and EIGRP is the only protocol that can scale in a DMVPN network. “With a DMVPN and EIGRP, we can scale to tens of thousands of connections without having to redesign the network,” Cornell says.

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Eased Transition to IPv6

EIGRP supports both IPv4 and IPv6. In 2011, Cisco IT upgraded the backbone WAN to EIGRP v6 to support dual-stack (IPv4 and IPv6) operations. Cisco IT engineers did not need to learn another routing protocol as the company began its transition to a dual-stack network, and the upgrade was as simple as issuing a few commands. “It’s a good idea to use the same routing protocol for IPv4 and IPv6 to simplify support activities for operational teams,” says Jon Woolwine, chief architect for the Cisco IT’s IPv6 program.

Next Steps

Cisco IT plans to enable the IP Fast Re-Route (FRR) feature in EIGRP, which can repair the network in 20 milliseconds, more than twice as fast as today’s 50-millisecond repairs. This capability will even further improve the voice and video experience for Cisco employees, partners, and customers.

Cisco IT is also evaluating EIGRP Over-the-Top (OTP) to simplify the company’s multi-carrier IP WAN design. OTP would eliminate the need for peering and exchanging private routing tables with WAN providers.

Lessons Learned

Cisco IT engineers emphasize the importance of proper network design to optimize EIGRP performance. Design principles include using address summarization to limit query scope, and providing at least one feasible successor for each link. “The downside of EIGRP’s scalability is that initially, we weren’t diligent in summarizing address blocks,” Cornell says. “The core ended up with a larger routing table that experienced lots of updates. Now we’re disciplined about summarization.”

Cisco IT also observed that more than four backup links can slow performance.

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