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CISCO VALIDATED DESIGN

IWAN Security for Remote Site Direct Internet Access and Guest Wireless

Technology Design Guide (ISR4K)

March 2015

CISCO VALIDATED DESIGN

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Preface

Cisco Validated Designs (CVDs) present systems that are based on common use cases or engineering priorities. CVDs incorporate a broad set of technologies, features, and applications that address customer needs. Cisco engineers have comprehensively tested and documented each design in order to ensure faster, more reliable, and fully predictable deployment.

CVDs include two guide types that provide tested design details:

- **Technology design guides** provide deployment details, information about validated products and software, and best practices for specific types of technology.
- **Solution design guides** integrate existing CVDs but also include product features and functionality across Cisco products and sometimes include information about third-party integration.

Both CVD types provide a tested starting point for Cisco partners or customers to begin designing and deploying systems.

CVD Foundation Series

This CVD Foundation guide is a part of the *January 2015 Series*. As Cisco develops a CVD Foundation series, the guides themselves are tested together, in the same network lab. This approach assures that the guides in a series are fully compatible with one another. Each series describes a lab-validated, complete system.

The CVD Foundation series incorporates wired and wireless LAN, WAN, data center, security, and network management technologies. Using the CVD Foundation simplifies system integration, allowing you to select solutions that solve an organization's problems—without worrying about the technical complexity.

To ensure the compatibility of designs in the CVD Foundation, you should use guides that belong to the same release. For the most recent CVD Foundation guides, please visit the CVD Foundation web site.

Comments and Questions

If you would like to comment on a guide or ask questions, please use the feedback form.

CVD Navigator

The CVD Navigator helps you determine the applicability of this guide by summarizing its key elements: the use cases, the scope or breadth of the technology covered, the proficiency or experience recommended, and CVDs related to this guide. This section is a quick reference only. For more details, see the Introduction.

Use Cases

This guide addresses the following technology use cases:

- **Use Case: DIA for Remote-Site Internal Employees**– Remote-site users directly access the Internet for cloud-based applications and user web access without having to route their traffic through a central site over the WAN.
- **Use Case: DIA from Remote-Site Guest Wireless Users**– Remote-site guest users directly access the Internet for cloud-based applications and user web access without having to route their traffic through the central site and traverse the internal network.

For more information, see the "Use Cases" section in this guide.

Scope

This guide covers the following areas of technology and products:

- Secure remote-site direct Internet access for employees
- Remote-site wireless guest networking with secure direct Internet access

For more information, see the "Design Overview" section in this guide.

Proficiency

This guide is for people with the following technical proficiencies or equivalent experience:

- CCNP Routing and Switching
- CCNP Security
- CCNP Wireless

Related CVD Guides

Intelligent WAN Technology Design Guide

MPLS WAN Technology Design Guide

VPN WAN Technology Design Guide

To view the related CVD guides, click the titles or visit the CVD Foundation web site.

Introduction

Security is an essential component of Cisco Intelligent WAN (IWAN). Cisco IWAN delivers an uncompromised user experience over any connection, allowing an organization to right-size their network with operational simplicity and lower costs while reducing security risks.

This guide describes how to reduce WAN bandwidth and improve user experience by enabling secure direct access to the Internet at each remote site, without routing employee and guest traffic to central network locations.

Related Reading

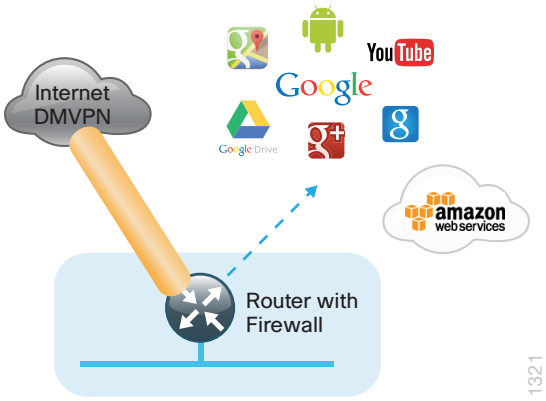
The Intelligent WAN Technology Design Guide provides configuration and deployment guidance for IWAN routing with enhanced interior gateway routing protocol (EIGRP) named mode, dynamic multipoint virtual private network version 3 (DMVPNv3), public key infrastructure (PKI), and performance routing version 3 (PfRv3) for Cisco IWAN.

Technology Use Cases

For remote-site users to effectively support the business, organizations require that the wide-area network (WAN) provide sufficient performance, reliability, and security.

Although remote-site workers use many centrally location applications and services, there are also benefits in providing direct Internet access (DIA) at each remote-site location. Offloading Internet browsing and providing direct access to public cloud service providers can significantly reduce traffic on the private WAN, saving costs and improving overall survivability. Leveraging the cloud in the remote office can also greatly increase performance and the overall cloud experience.

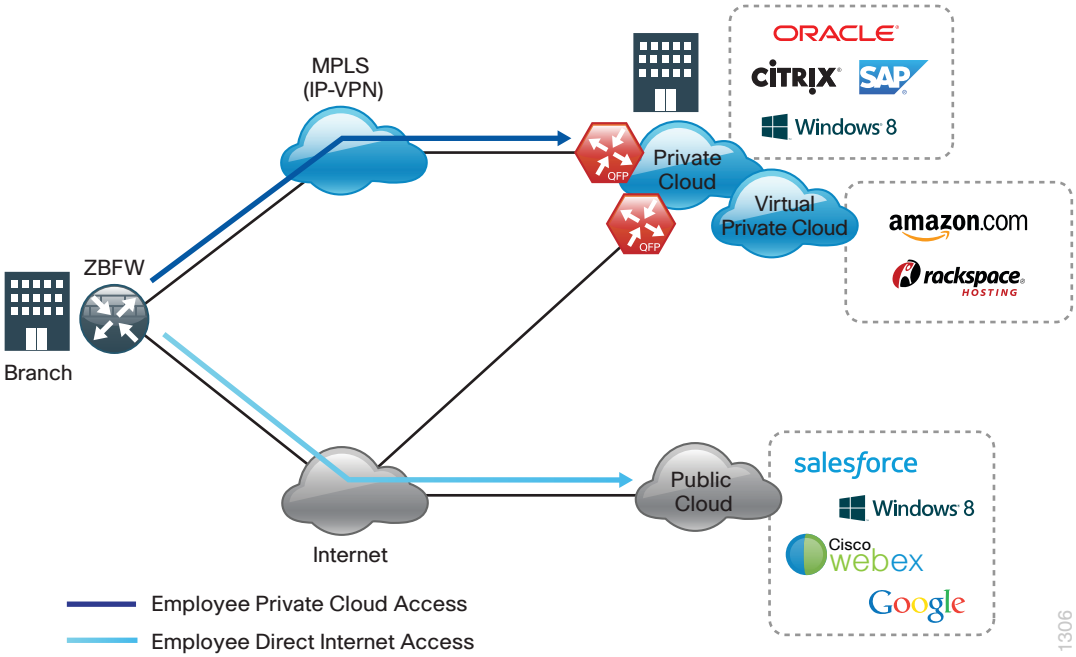
Figure 1 - IWAN remote site with DIA



Use Case: DIA for Remote-Site Internal Employees

Remote-site users directly access the Internet for cloud-based applications and user web access without having to route their traffic through a central site over the WAN.

Figure 2 - Employee DIA



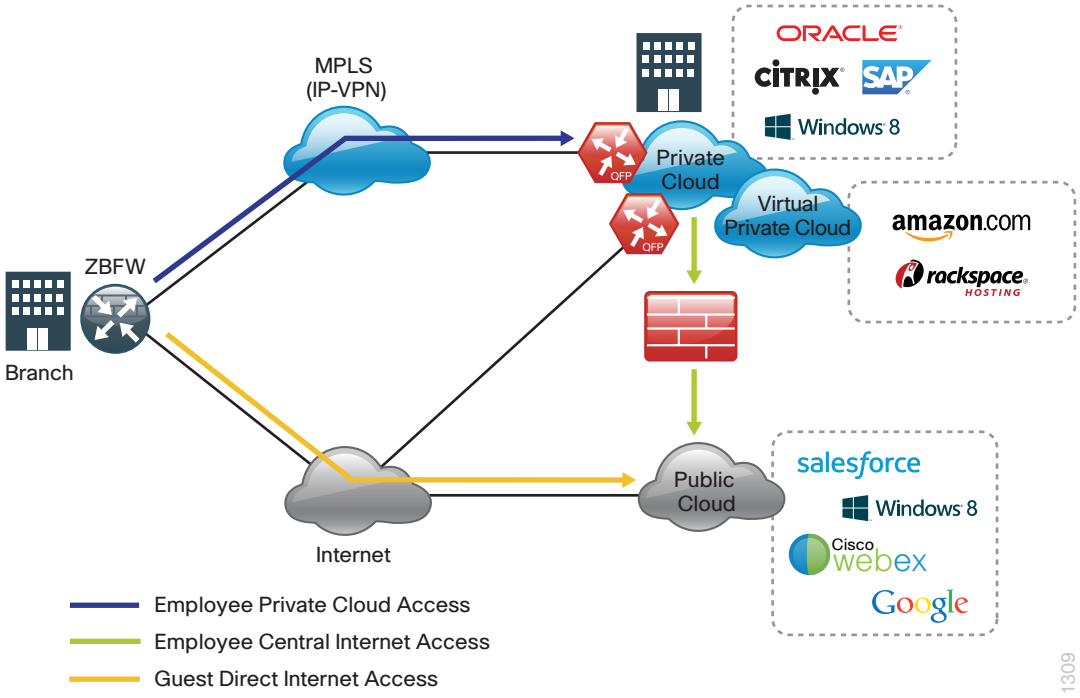
This design guide enables the following network capabilities:

- Offloading Internet traffic from the WAN, thereby reducing bandwidth utilization
- Improving user experience by providing DIA for employees at IWAN remote-site locations
- Deploying Cisco IOS security services for remote users and applications that leverage zone-based firewall (ZBFW), network address translation (NAT), and other integrated network security features
- Resilient routing of local Internet, such as rerouting with local fall back or accessing the Internet through the central site during local Internet failure conditions

Use Case: DIA from Remote-Site Guest Wireless Users

Remote-site guest users directly access the Internet for cloud-based applications and user web access without having to route their traffic through the central site and traverse the internal network.

Figure 3 - Guest DIA



This design guide enables the following network capabilities:

- Offloading Internet traffic from the WAN by providing isolated secure direct Internet access for guest network users independent of employee Internet access
- Deploying remote-site wireless guest access with acceptable use policies (AUP) and guest authentication services by using Cisco Identity Services Engine (ISE) and integrated wireless controller functionality with local and central web authentication.
- Deploying Cisco IOS security services for remote guest users by leveraging ZBFW, NAT, and other network security features to isolate and secure guest user traffic
- Integrating with existing central site guest deployment solutions

Overview of Cisco IWAN and Secure DIA

This guide provides designs that enable highly available and secure local Internet connectivity for Cisco IWAN remote sites. It shows you how to deploy the network and services in order to enable the following IWAN configurations:

- Secure remote-site direct Internet access for employees
- Remote-site wireless guest networking with secure direct Internet access

While the Internet is quickly becoming a more stable platform with better price to performance and improved reliability, it can still fall short of meeting standards for many businesses. With Cisco IWAN, IT has the security and application services to deliver the highest levels of resiliency and reliability over a variety of WAN transports.

IWAN Remote-Site Design

The modular nature of IWAN allows you to replicate common design elements throughout the network. All of the IWAN remote-site elements are standard building blocks in the overall design, providing a flexible, consistent, and scalable WAN deployment methodology.

Ethernet WAN

Ethernet has traditionally been a local-area network (LAN) technology primarily due to the distance limitations of the available media and the requirement for dedicated copper or fiber links. Ethernet is becoming a dominant carrier handoff in many markets and it is relevant to include Ethernet as the primary media in the tested architectures. Much of the discussion in this guide can also be applied to non-Ethernet media (such as T1/E1, DS-3, OC-3, and so on), but those media are not explicitly discussed.

Private MPLS as IWAN Transport

Cisco IOS software multiprotocol label switching (MPLS) enables enterprises and service providers to build next-generation, intelligent networks that deliver a wide variety of advanced, value-added services over a single infrastructure. You can integrate this economical solution seamlessly over any existing infrastructure, such as IP, frame relay, asynchronous transfer mode (ATM), or Ethernet.

MPLS Layer 3 VPNs use a peer-to-peer VPN model that leverages the border gateway protocol (BGP) in order to distribute VPN-related information. This peer-to-peer model allows enterprise subscribers to outsource routing information to service providers, which can result in significant cost savings and a reduction in operational complexity for enterprises.

Reader Tip

For more information about the implementation and design of MPLS VPN transport technologies as a building block of IWAN, see the MPLS WAN Technology Design Guide.

Layer 2 WAN transports are now widely available from service providers and are able to extend various Layer 2 traffic types (for instance, frame relay, point to point, ATM, or Ethernet) over a WAN. The most common implementations of Layer 2 WAN are used to provide Ethernet over the WAN by using either a point-to-point or point-to-multipoint service.

Service providers implement these Ethernet services by using a variety of methods. MPLS networks support both Ethernet over MPLS (EoMPLS) and Virtual Private LAN Service (VPLS). You can use other network technologies, such as Ethernet switches in various topologies, to provide Ethernet Layer 2 WAN services.

Reader Tip

For more information about the implementation and design of L2 transport technologies as a building block of IWAN, see the Layer 2 WAN Technology Design Guide.

Public Internet as IWAN Transport

The IWAN uses the Internet for VPN site-to-site connections. The Internet is essentially a large-scale public WAN composed of multiple interconnected service providers. It can provide reliable, high-performance connectivity between various locations, although it lacks any explicit guarantees for these connections. Despite its best effort nature, the Internet is a sensible choice for a primary transport when it is not feasible to connect with another transport option. Additional resiliency is provided by using the Internet as an alternate transport option.

Internet connections are typically included in discussions relevant to the Internet edge, specifically for the primary site. Remote-site routers commonly have Internet connections that can be used for local web browsing, cloud services, and private WAN transport. For security, Internet access at remote sites is maintained by using integrated security features such as Cisco IOS zone-based firewall (ZBFW). All remote-site traffic must be encrypted when transported over public IP networks such as the Internet.

Reader Tip

For more information, see the VPN WAN Technology Design Guide.

Dynamic Multipoint VPN

Dynamic multipoint VPN (DMVPN) is a solution for building scalable site-to-site VPNs that support a variety of applications. DMVPN is widely used for encrypted site-to-site connectivity over public or private IP networks and can be implemented on all IWAN routers referenced in this design guide.

DMVPN makes use of multipoint generic routing encapsulation (mGRE) tunnels to interconnect the hub to all of the spoke routers. These mGRE tunnels are also sometimes referred to as DMVPN clouds in this context. This technology combination supports unicast, multicast, and broadcast IP, including the ability to run routing protocols within the tunnels.

DMVPN is used for the encryption solution for the IWAN transport because it supports on-demand full mesh connectivity with a simple hub-and-spoke configuration and a zero-touch hub deployment model for adding remote sites while maintaining transport independence from the providers.

DMVPN also supports spoke routers that have dynamically assigned IP addresses and are configured with NAT. It is common for firewalls to be configured between the DMVPN routers and the Internet. In many cases, designs also require NAT configurations in conjunction with DMVPN.

Reader Tip

This guide does not cover the configuration details for DMVPN. For information about DMVPN, see the Intelligent WAN Technology Design Guide.

Routing Protocols

Enhanced Interior Gateway Routing Protocol

Cisco chose EIGRP as the primary routing protocol for IWAN because it is easy to configure, does not require a large amount of planning, has flexible summarization and filtering, and can scale to large networks. As networks grow, the number of IP prefixes or routes in the routing tables grows as well. You should program IP summarization on links where logical boundaries exist, such as distribution layer links to the wide area or to a core. By performing IP summarization, you can reduce the amount of bandwidth, processor, and memory necessary to carry large route tables and reduce convergence time associated with a link failure.

With the advances in EIGRP, this guide uses EIGRP named mode. The use of named mode EIGRP allows related EIGRP configurations to be centrally located in the configuration. Named mode EIGRP includes features such as wide metrics, supporting larger multi-gigabit links. For added security, EIGRP neighbor authentication has been implemented to prevent unauthorized neighbor associations.

> **Tech Tip**
>
> Direct Internet access configurations in this CVD are based on the use of a single process EIGRP for all of the WAN transports as well as over the remote-site LAN.

DNS Considerations

When deploying remote site IWAN with direct Internet it is important to consider domain name system (DNS) configuration requirements and impacts to network redundancy and performance. Remote sites are often geographically diverse and many cloud services have localized resources within the regions of remote-site locations that are optimal for user and application traffic. Using centralized DNS will result in sub-optimal routing, poor application performance, and failure if private WAN connections are unavailable.

For example, compare a cloud storage application moving data across the country for storage versus resolving to a local cluster. For these reasons, split DNS designs are recommended for optimal routing and application performance.

> **Tech Tip**
>
> This design guide uses a centralized DNS service from the primary site for internal employee DIA. The use of local DNS services in each remote site to resolve for Internet resources based on proximity is recommended. This guide does include public DNS for guest users.

IWAN Remote-Site LAN

IWAN designs with DIA support both Layer 2 access and Layer 3 distribution layer switching designs at the remote site.

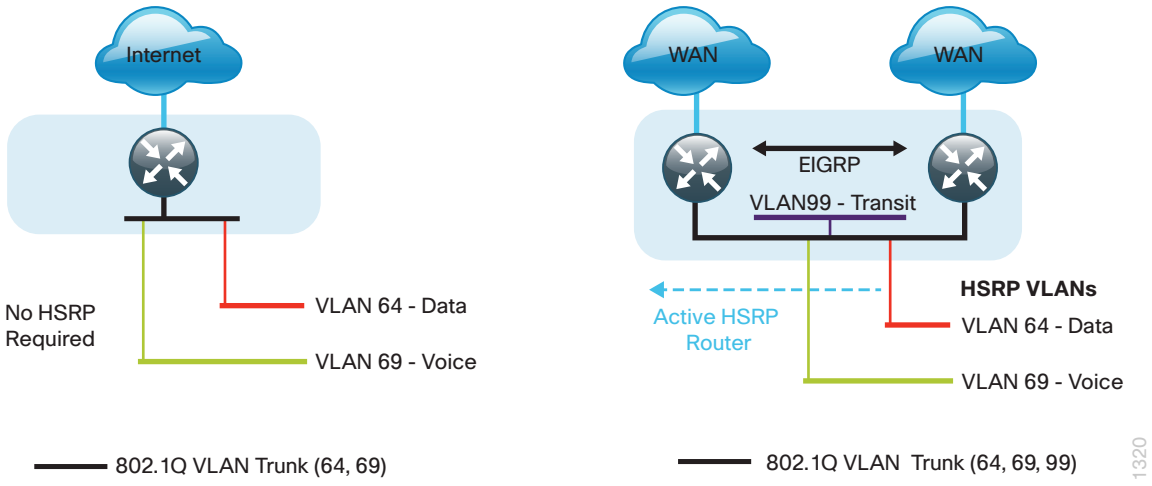
Layer 2 Access Sites

Many IWAN remote sites will not require additional distribution layer routing devices. These more typical environments are considered to be flat or, from a LAN perspective, they are considered un-routed Layer 2 sites. In these designs, all Layer 3 services are provided by the attached IWAN routers.

Access switches, through the use of multiple VLANs, support data, voice, and guest services. The design shown in the following figure illustrates the standardized IWAN remote site with Layer 2 access.

> **Reader Tip**
>
> Access switches and their configuration are not included in this guide. For information about the various access switching platforms, see the Campus Wired LAN Technology Design Guide. Configuration of the IWAN foundation is covered in the Intelligent WAN Technology Design Guide.

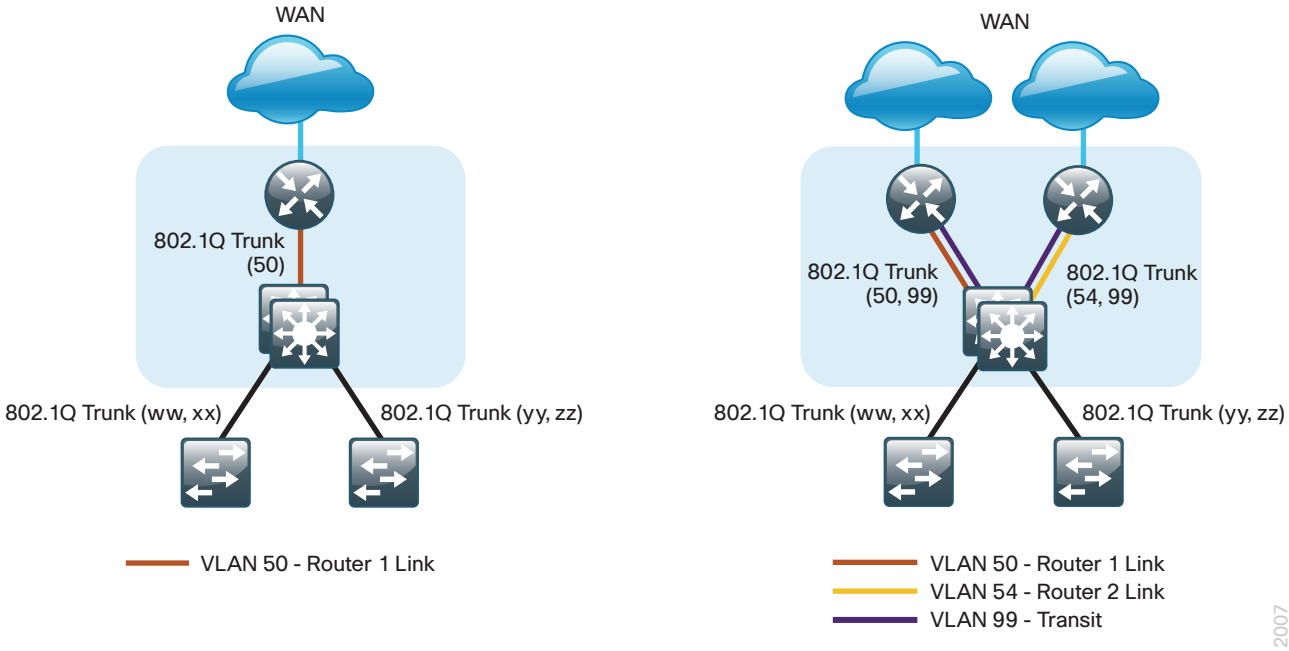
Figure 4 - Single- and dual-router IWAN remote site—Layer 2 access



Layer 3 Distribution Sites

Larger IWAN remote sites may require a LAN environment similar to that of a small campus LAN that includes a distribution layer and access layer. This topology works well with either a single- or dual-router IWAN edge design. The distribution switch handles all access-layer routing, with VLANs trunked to access switches. IWAN configurations in this guide address the DIA routing configurations required for all Layer 3 distribution design options.

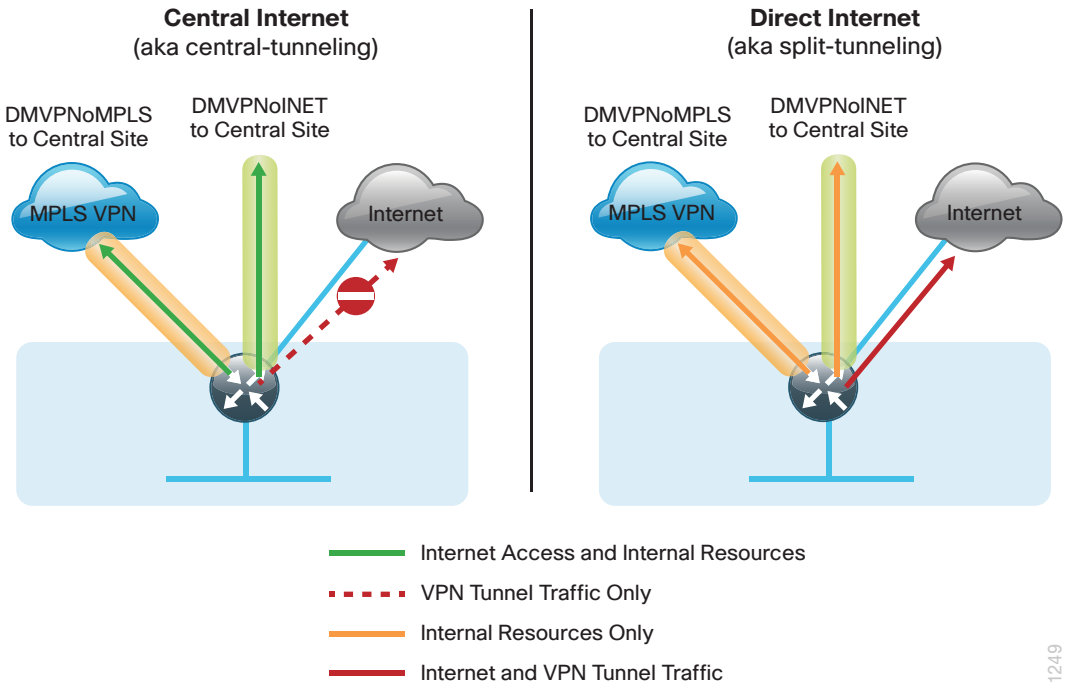
Figure 5 - WAN remote site—Connection to distribution layer



IWAN Remote-Site Design with DIA

The remote-site design provides the remote office with DIA solutions for web browsing and cloud services. This is commonly referred to as the *local or direct Internet model* where traffic accesses Internet services directly without traversing the WAN. With the direct Internet model, user web traffic and hosted cloud services traffic are permitted to use the local Internet link in a split-tunneling manner. In this model a default route is generated locally, connecting each remote site directly to the Internet provider. Private WAN connections using DMVPN over Internet or MPLS-based WAN services provide a transparent WAN service for internal routes to data center and campus resources.

Figure 6 - Central Internet and local Internet comparison



This guide documents secure, direct Internet-enabled WAN remote-site designs based upon combinations of IP WAN transports, which are mapped to site-specific requirements around service levels and resiliency. WAN transport is transparent and made uniform by using DMVPN tunnels with front door virtual routing and forwarding (FVRF), irrespective of the service from the provider.

Figure 7 - IWAN direct Internet access models

The primary focus of the design is to allow usage of the following commonly deployed remote-site IWAN configurations with local Internet access:

- Single-router remote site with MPLS WAN services and Internet connectivity, known as the *IWAN single-router hybrid* design model.
- Dual-router remote site with MPLS WAN services and Internet connectivity, known as the *IWAN dual-router hybrid* design model.
- Single remote site with dual-Internet connections to different Internet service providers (ISPs), known as the *single-router dual-Internet* design model
- Dual-router remote site with dual-Internet connections to different ISPs, known as the *single-router dual-Internet* design model

Reader Tip

The choice to use locally routed or direct Internet is locally significant to the remote site. No changes are required to the primary site.

The remote-site designs documented in this guide can be deployed in parallel with other remote-site designs that use centralized Internet access.

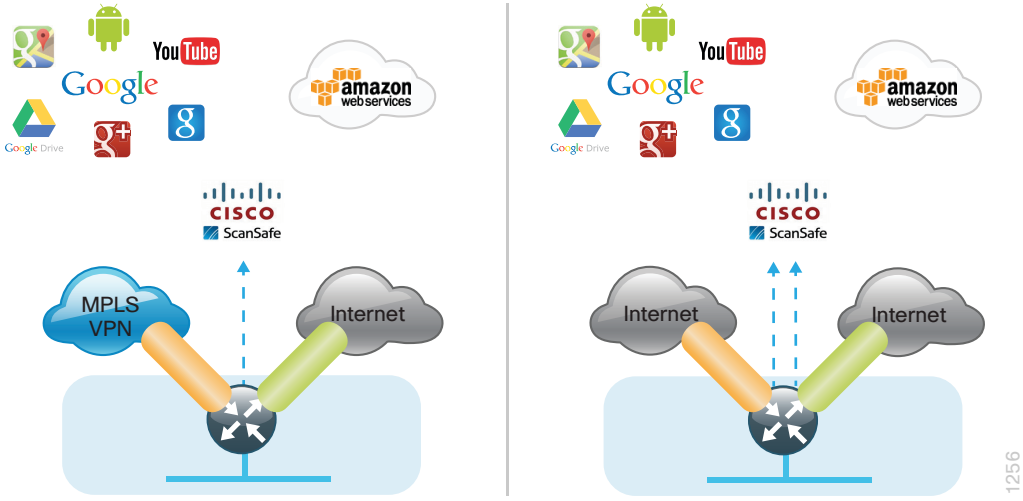
This guide does not address the primary aggregation site design and configuration details. This solution is tested and evaluated to work with the design models and WAN-aggregation site configurations as outlined in Intelligent WAN Technology Design Guide.

IWAN High Availability

The majority of remote sites are designed with a single-router WAN edge; however, certain remote-site types require a dual-router WAN edge. Dual-router candidate sites include regional office or remote campus locations with large user populations, or sites with business critical needs that justify additional redundancy to remove single points of failure.

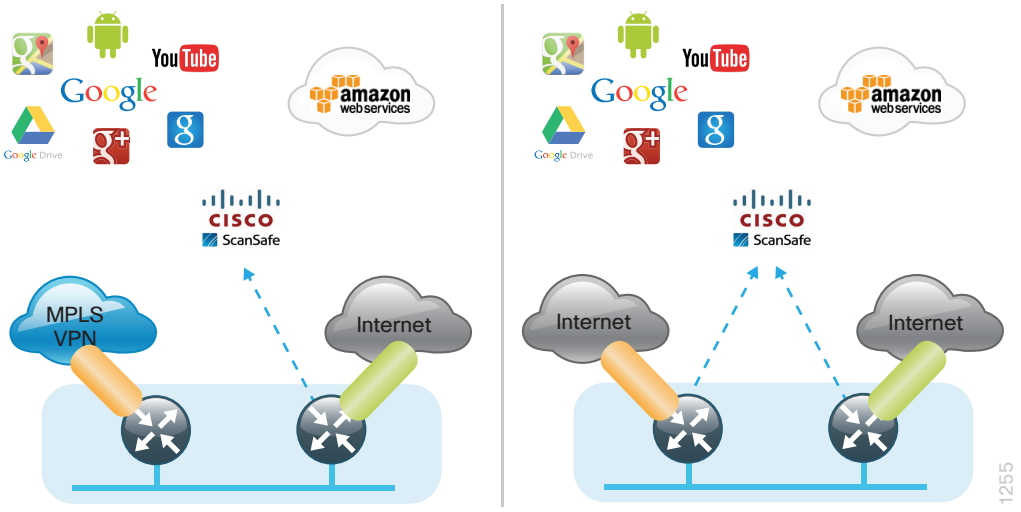
The network must tolerate single failure conditions, including the failure of any single WAN transport link or any single network device at the primary remote site. IWAN remote-site designs provide the following high availability options for direct Internet access.

Figure 8 - Single-router IWAN remote sites with DIA



Remote sites classified as single router may provide Internet failover in the event of local Internet link failure. Hybrid IWAN configurations may fail over to the central Internet model. Single-router dual-Internet IWAN configurations provide redundancy for local Internet connectivity by failing over to the secondary local Internet connection.

Figure 9 - Dual-router IWAN remote sites with DIA



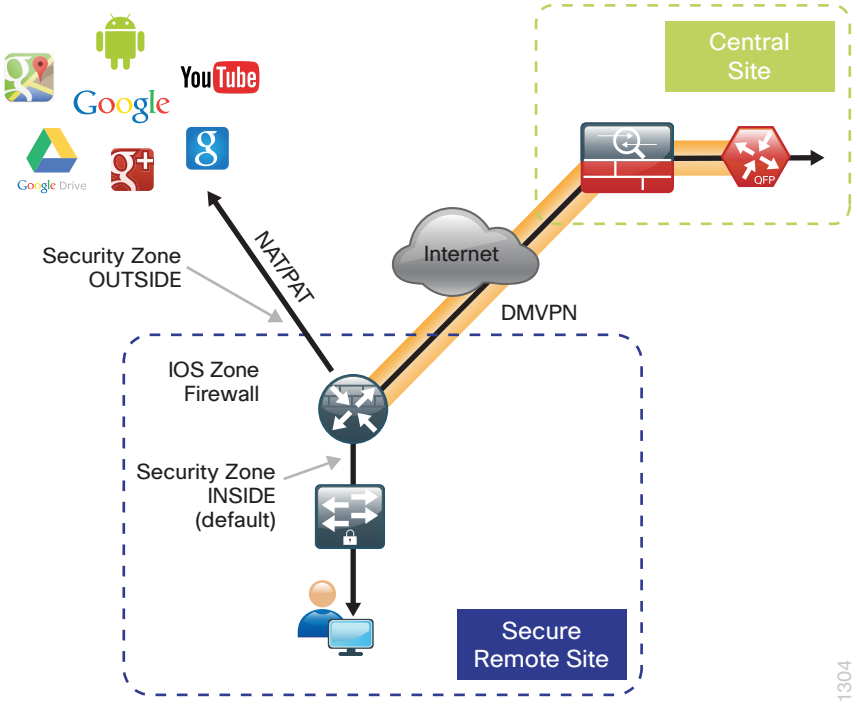
Remote sites classified as dual router may provide Internet failover in the event of local Internet link or router failure. Hybrid IWAN configurations may fail over to the central Internet model. IWAN dual Internet configurations provide redundancy for local Internet connectivity by failing over to the secondary local Internet connection.

Securing DIA

Network security is an essential component of this design. In a large network, there are many entry points and you need to ensure they are as secure as possible without making the network too difficult to use. Securing the network not only helps keep the network safe from attacks but is also a key component to network-wide resiliency.

To help organizations address concerns with cloud security, this guide addresses the implementation of several key integrated security features. As organizations leverage local Internet in the remote site, considerations for securing access at each remote location is necessary. This guide provides general recommendations and guidelines for implementing stateful firewalling, NAT, and basic router security and hardening.

Figure 10 – IWAN secure remote site



Network Address Translation

With the growing adoption of distributed cloud applications, NAT plays an integral role in enabling organizations to deploy and secure public and private cloud services.

NAT enables private IP networks that use unregistered IP addresses (as specified in RFC 1918) to connect to the Internet. NAT is used to translate the private addresses defined on internal networks into legal routable addresses because ISPs cannot route RFC 1918 addresses.

Primarily designed for IP address conservation and network design simplification, NAT can also serve as a security mechanism by hiding a host's IP address and application ports.

NAT operates on a firewall and routers connecting two network segments and translating the internal private addresses to a public address on the external network. It can be configured to show only one IP address externally. This provides additional security by effectively hiding the entire internal network behind a single IP address. This capability is called port address translation (PAT), also referred to as *NAT overload*.

NAT provides the following benefits:

- Security, providing an added layer of defense from external attackers by hiding IP addresses and application ports
- Scalability through the reuse of IP addresses, and by using IP address overloading capabilities
- Simplified provisioning and troubleshooting by enforcing consistent network design across network locations

NAT is typically implemented at the edge of the network wherever an organization connects to the Internet. Today, this may be in central or large aggregation sites or in remote sites providing localized Internet services.

Cisco IOS Zone-Based Firewall

With the adoption of remote-site local Internet for user web browsing and cloud services, the deployment of firewall services at the remote office Internet edge is critical to maintaining an organization's security posture.

Zone-based firewall (ZBFW), also called *zone policy firewall*, is a Cisco IOS-integrated stateful firewall implemented on the Cisco Integrated Services Routers (ISR) and Cisco Aggregation Services Routers (ASR) routing platforms.

Firewall zone policies are configured by using the Cisco Common Classification Policy Language (C3PL), which employs a hierarchical structure to define inspection for network protocols and the groups to which the inspection will be applied. Users familiar with the Cisco IOS modular quality of service CLI (MQC) will recognize the use of class maps to specify which traffic will be affected by the action applied in a policy map.

Within this model, router interfaces are assigned to security zones, which establish the security borders of your network. A security zone defines a boundary where traffic is subjected to policy restrictions; this policy is called a *zone policy*. Zone policies define what traffic is allowed to flow between security zones. Zone policies are unidirectional firewall policies applied between two security zones, called a *zone pair*. A zone pair is defined as two security zones between which a zone policy is applied.

Router interfaces assigned to configured security zones are subject to the default policies and rules:

- An interface can be a member of only a single security zone.
- A security zone can contain only member interfaces that are all in the same virtual routing and forwarding (VRF); interfaces in different VRFs may not be part of the same security zone.
- When an interface is placed into a security zone, traffic is implicitly allowed to flow between other interfaces assigned to the same security zone.
- Traffic flow to interfaces in different security zones is denied with an implicit deny all zone policy.
- Traffic cannot flow between an interface that is a member of a security zone and any interface that is not a member of a security zone. Instead, the traffic is dropped. If the default zone configuration is implemented as is described in this guide, traffic can flow between interfaces without security zone configurations because all interfaces automatically become part of the default zone.
- To allow traffic to flow between different security zones, policies must be configured between any two security zones.
- Pass, inspect, and drop actions can only be applied between two zones.
- By default, traffic (for instance, a routing protocol) that flows to and from the router itself is permitted. The router (as a source and destination) is defined as the self-zone by the Cisco IOS firewall. Traffic to and from the self-zone on any interface is allowed until traffic is explicitly denied by a user-defined zone security policy.

Design Detail

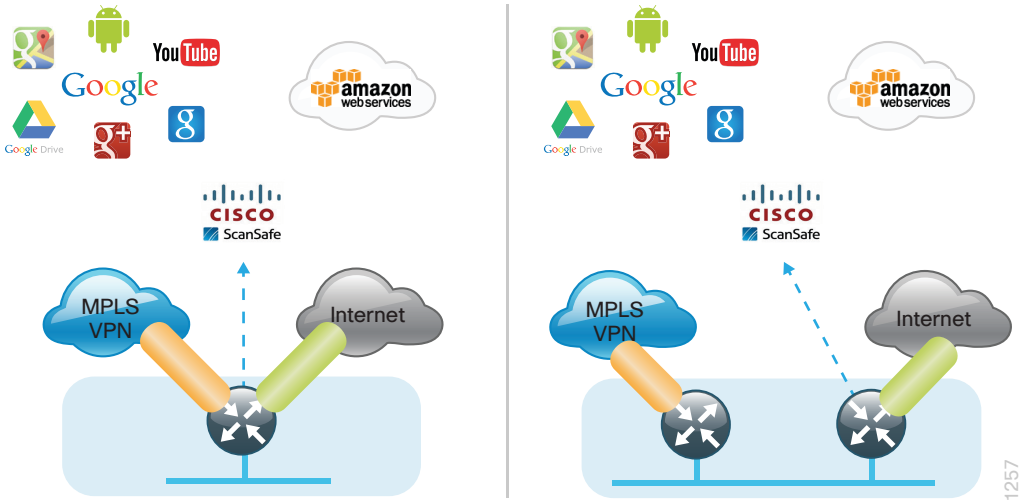
This guide focuses on four remote-site designs with DIA. These designs provide configurations and guidance for enabling secure localized Internet access in remote office locations.

Each of the Cisco IWAN remote-site design options support DIA and internal network communications with the central site. All designs support resilient routing.

The IWAN hybrid direct Internet access designs are:

- Single-router hybrid designs, MPLS and Internet
- Dual-router hybrid designs, MPLS and Internet

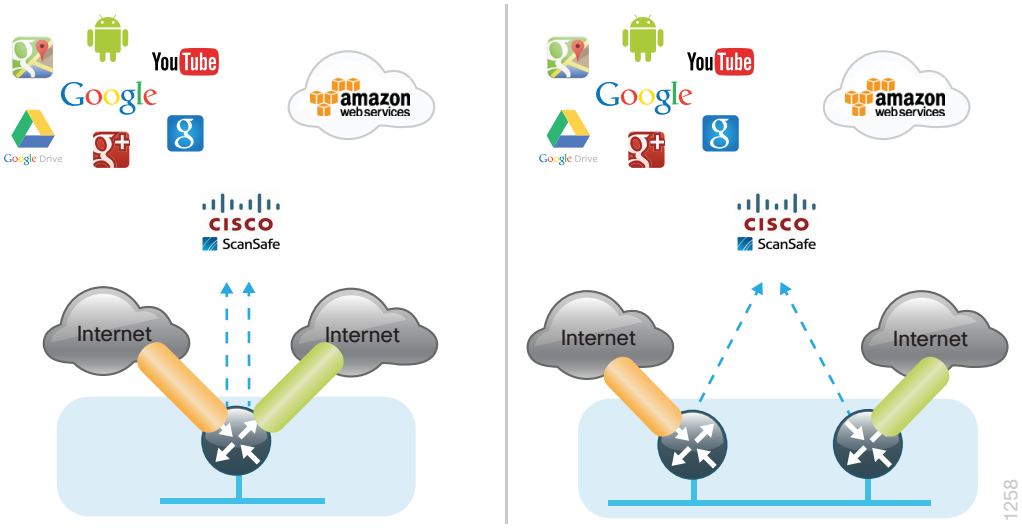
Figure 11 - IWAN hybrid design models with DIA



The IWAN dual-Internet direct Internet access designs are:

- Single-router, dual-Internet design
- Dual-router, dual-Internet design

Figure 12 - IWAN dual-Internet design models with DIA



Local Internet traffic is forwarded directly to the Internet by using the default route. This default route is directed at the next-hop router in the ISP's network. Because RFC-1918 addresses are used for internal networks, all Internet-bound traffic is translated to a public address by using PAT on the ISP-connected interface. The ZBFW is enabled to provide stateful inspection and to enforce a policy that only allows return traffic for sessions initiated by internal users and for DMVPN tunnel traffic between the remote-site router and the DMVPN hub router.

Reader Tip

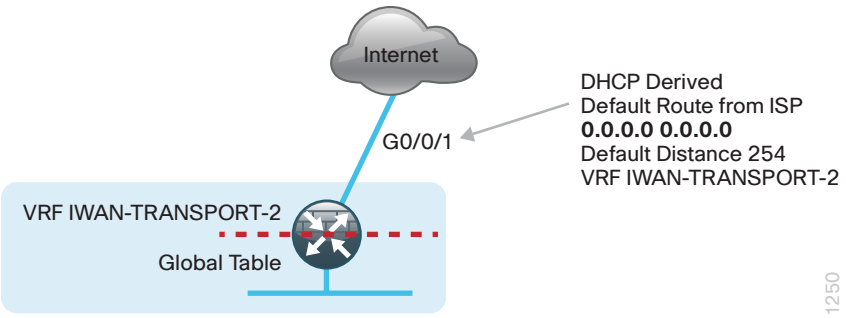
For more information about the different IWAN deployment models, see the Intelligent WAN Technology Design Guide.

IWAN DIA Routing with Front Door VRF

All IWAN designs are based on the use of front door virtual routing and forwarding (FVRF) with DMVPN to segment the routing table, thus allowing two default routes to exist on the same router.

With FVRF, the default route from the ISP is contained within the Internet facing VRF and is only used for DMVPN tunnel formation. A default route is obtained from the local ISP by using DHCP and is added to the outside VRF with a default administrative distance (AD) value of 254.

Figure 13 - IWAN FVRF routing–VRF default route

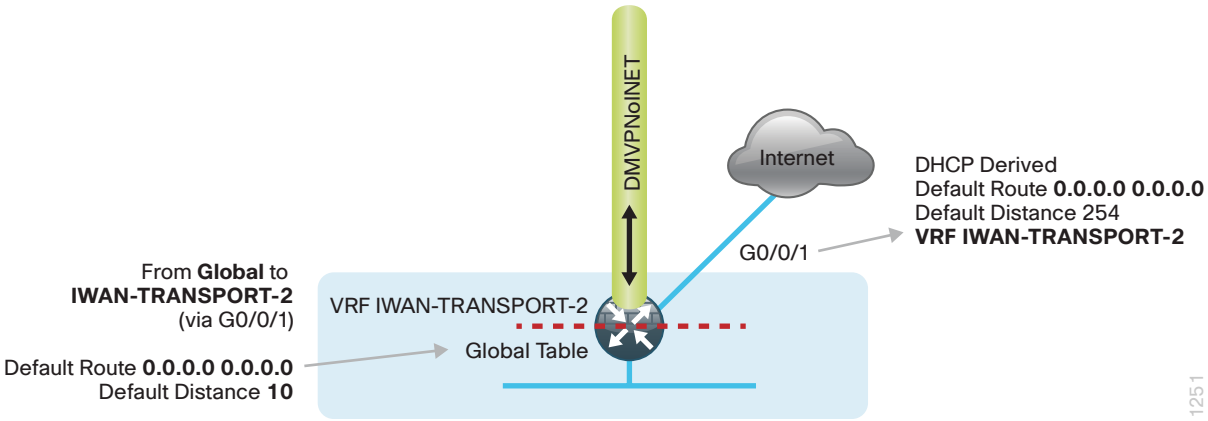


In the foundation IWAN configuration, a second default route is contained in the global table. In this central Internet model, the global table default route directs traffic over the tunnel interfaces.

When a remote site is converted to use a local or direct Internet model, the global default route needs to direct traffic outside the Internet facing DMVPN tunnel to the Internet.

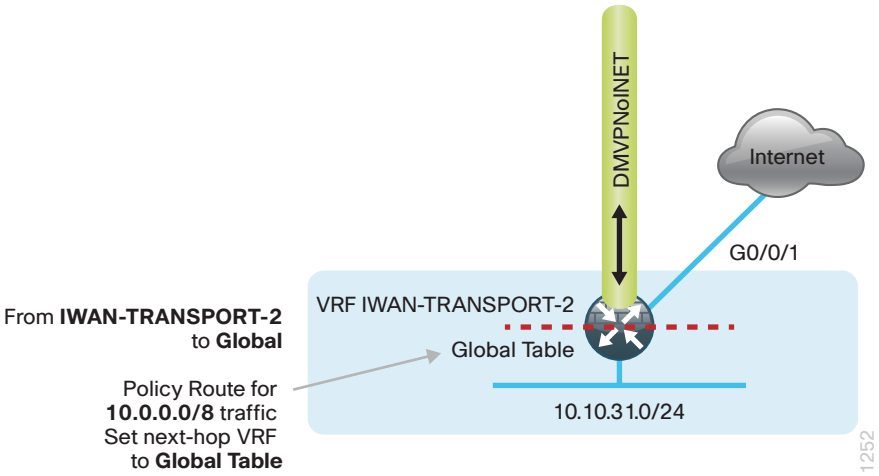
In the direct Internet model, a default route over Internet-based VPN tunnels cannot be allowed. In this case, because backup Internet routing is not possible over these VPN tunnels, the recommended best practice is to filter the central-site default route.

Figure 14 - IWAN FVRF routing–global to VRF outbound



When FVRF is used, the return traffic from the Internet to the remote site router needs to traverse from the outside facing Internet VRF to the global routing table. In IWAN configurations, a local policy route must be used to move return traffic from the outside VRF into the global table that is destined to the internal remote site network.

Figure 15 - IWAN FVRF routing–return VRF to global routing

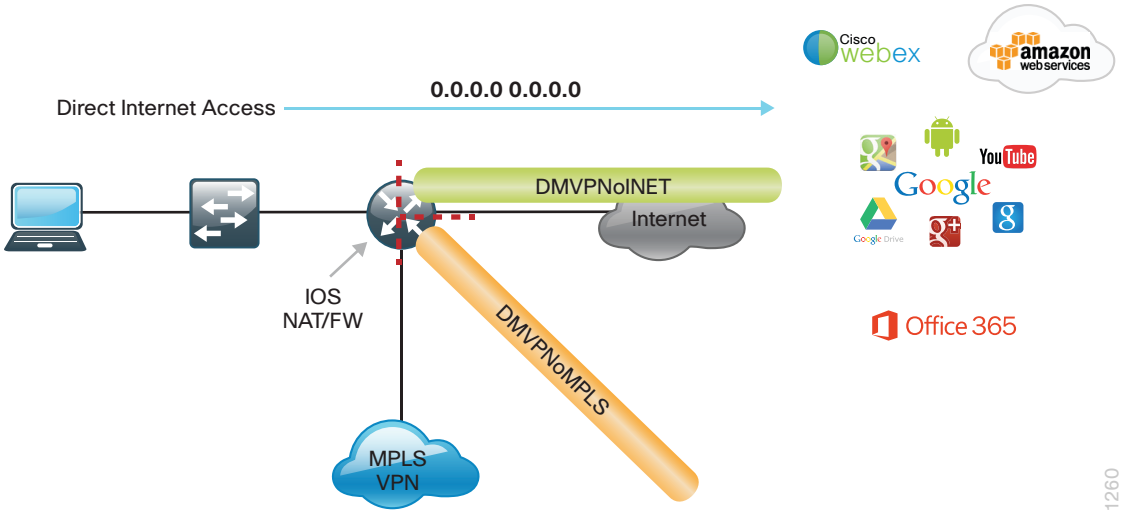


IWAN Single-Router Hybrid Remote-Site Routing

In this design, the remote site is configured with a single router by using DMVPN over MPLS as the primary connectivity for internal traffic. This site also uses an Internet connection on the same router for DMVPN over the Internet as an alternate path.

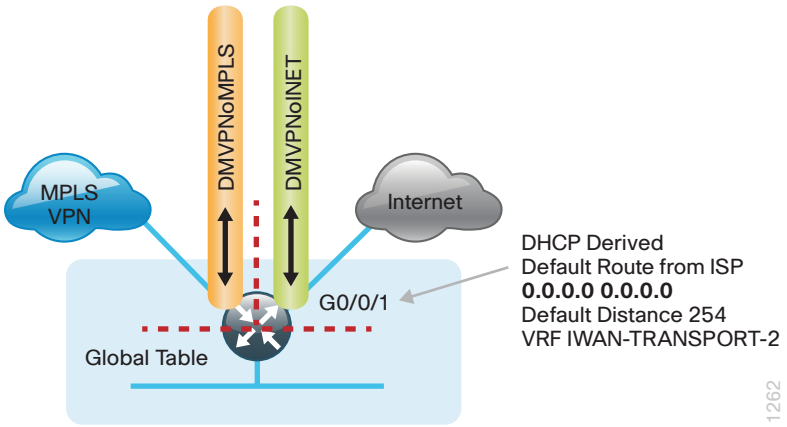
In the hybrid design with DIA, Internet traffic is routed outside the DMVPN tunnel for local Internet access. In this configuration, the local path is primary with failover to the central site Internet connectivity by using the MPLS-based DMVPN tunnel.

Figure 16 - IWAN single-router hybrid with DIA



With IWAN, internal networks are advertised using EIGRP over the DMVPN tunnels, preferring the MPLS-based path. Based on performance routing (PfR) policy, critical internal traffic or traffic that stays within the organization is routed primarily over the MPLS-based WAN tunnel and alternatively over the Internet-based DMVPN tunnel. If the MPLS-based DMVPN tunnel fails, all internal traffic is routed to the central site by using DMVPN over the Internet.

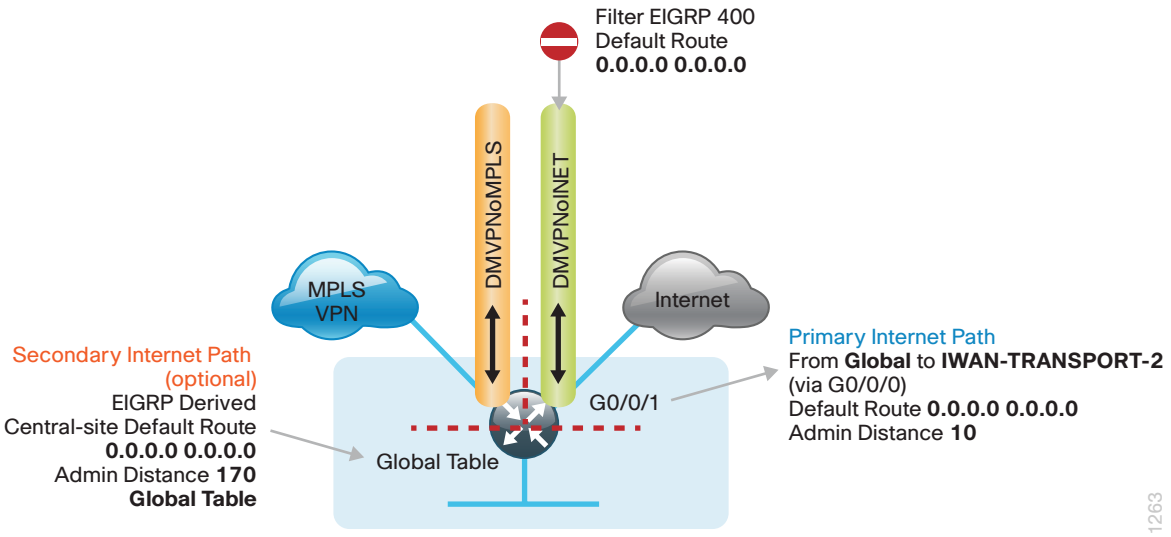
Figure 17 - IWAN single-router hybrid design–routing



In this example, the Internet facing Ethernet interface on the router is using DHCP to obtain an IP address from the ISP. The router is also using DHCP to install a default route into the outside VRF routing table. By default, this DHCP-installed static route has an AD value of 254.

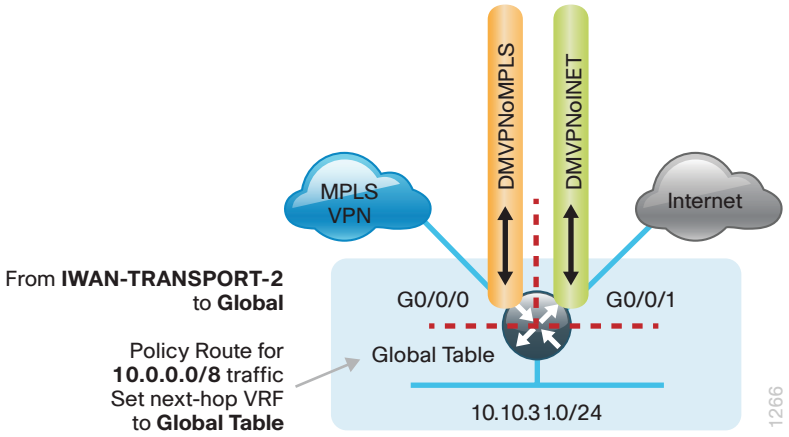
In this case, the default route to the local ISP is isolated in the VRF IWAN-TRANSPORT-2 and used for DMVPN tunnel setup and to route traffic from the outside VRF to the Internet. The default route is used for both Internet protocol service-level agreement (IPSLA) and DIA traffic.

Figure 18 - IWAN single-router hybrid–global default



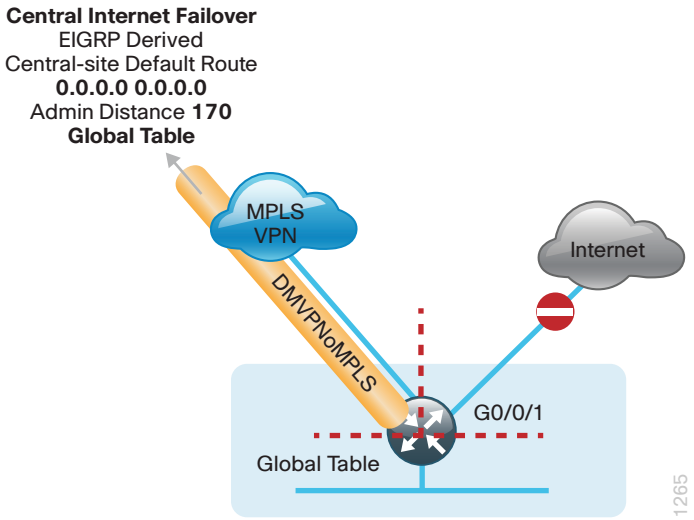
For DIA, the central default route must be filtered inbound on the Internet-based DMVPN tunnel interface. A default static route with an AD of 10 is configured in the global table.

Figure 19 - IWAN single-router hybrid–Internet return routing



A local policy routing configuration is also added for return traffic from the Internet. In this configuration, a route map is used to move the traffic from the outside facing VRF to the global routing table.

Figure 20 - IWAN single-router hybrid–central failover



In this configuration, the MPLS-based tunnel can be used as a backup path for Internet if the local Internet connection fails. The central-site default route is advertised over the MPLS-based tunnel via EIGRP with an AD value of 170 and is used only if the local connection fails.

Tech Tip

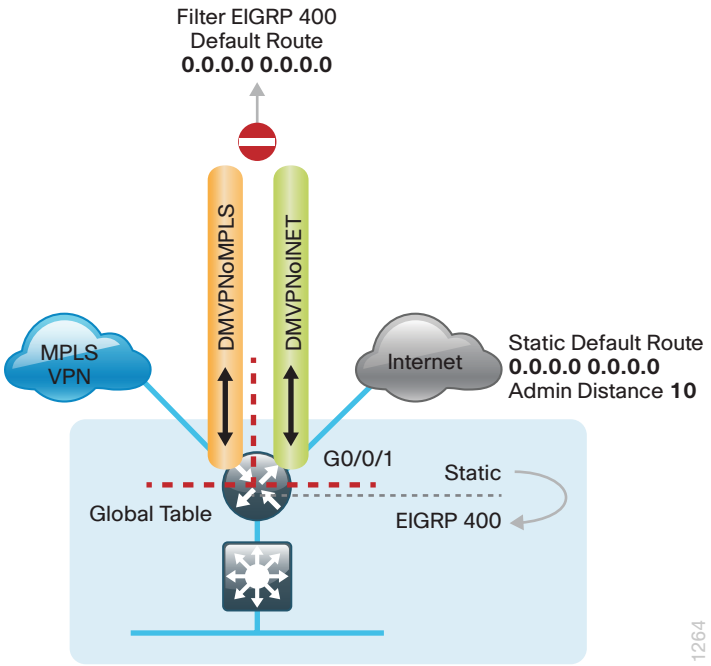
This configuration requires you to turn off Performance Routing (PfR) load-balancing on the Hub Master Controller. If PfR load-balancing is not turned off, the traffic will fail over to the central site Internet path, but it will not return to the local DIA interface after the failure condition is resolved.

DMVPN tunnel state and IPSLA probes are used to determine the availability of the primary local Internet connection. If a failure is detected, an Embedded Event Manager script removes the default static route. Instead, the EIGRP central default route via the MPLS-based DMVPN tunnel is used.

Single-Router Layer 3 Distribution Site

When a remote-site IWAN router is connected to a Layer 3 distribution switch, additional configurations are required to advertise the local Internet default route via EIGRP (example: autonomous system 400).

Figure 21 - IWAN single router hybrid–Layer 3 distribution



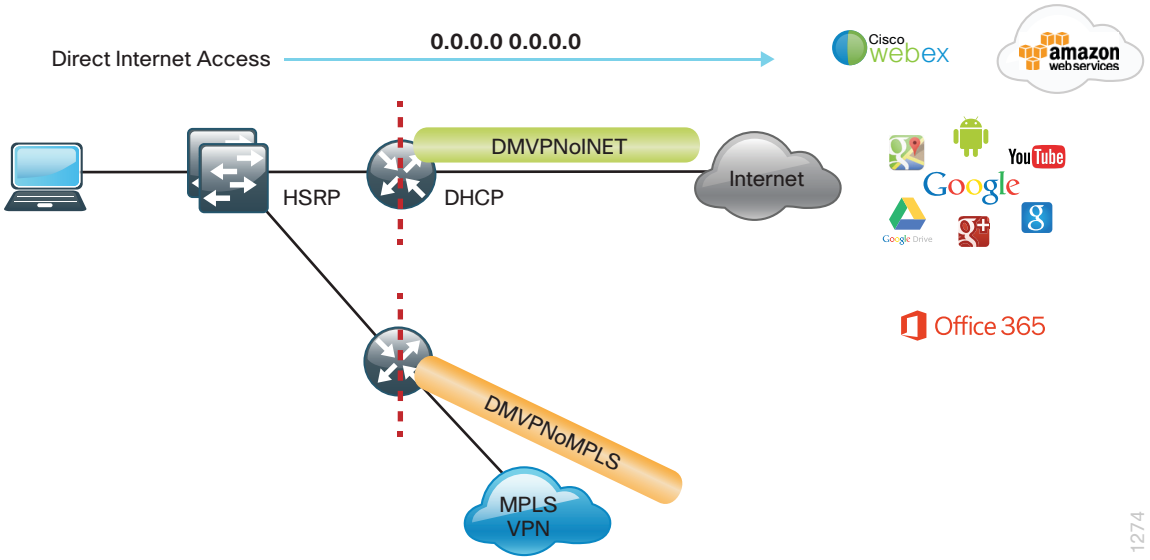
For simplicity IWAN uses a single EIGRP autonomous system (AS). On the IWAN router, two things must be accomplished to correctly advertise the local default route. First, to ensure the local default route is not advertised to the WAN, filter outbound on both DMVPN tunnel interfaces. Second, static default route must be distributed into EIGRP so the IWAN router can advertise the default route to the distribution switch.

IWAN Dual-Router Hybrid Remote Site Routing

In this design, the remote site is configured with dual routers. The primary router uses DMVPN over MPLS as the primary connection for internal traffic. This site also uses a secondary router with an Internet connection for DMVPN over the Internet as an alternate path.

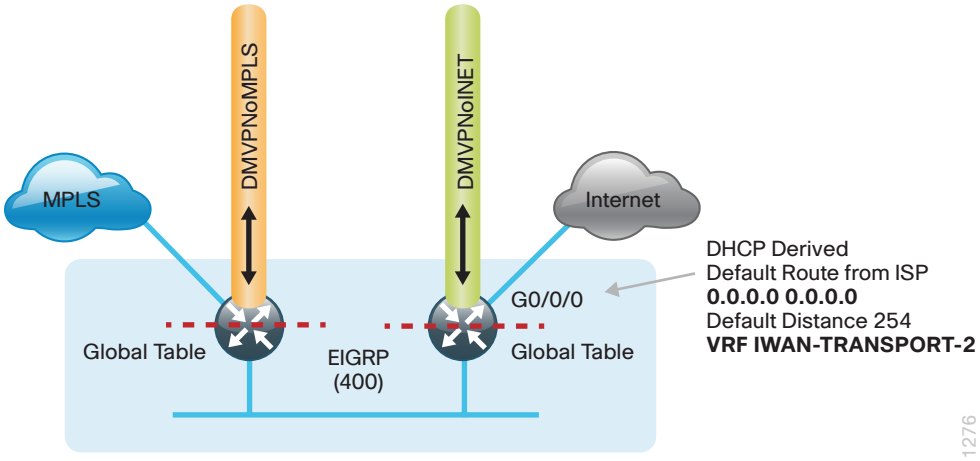
In the hybrid design with DIA the Internet traffic is routed outside the DMVPN tunnel for local Internet access on the secondary router. In this configuration the local path is primary with failover to the central site Internet connectivity by using the MPLS-based DMVPN tunnel on the primary router.

Figure 22 - IWAN dual-router hybrid with DIA



With IWAN, internal networks are advertised by using EIGRP over the DMVPN tunnels, preferring the MPLS-based path on the primary router. Based on PfR policy, critical internal traffic or traffic that stays within the organization is routed primarily over the MPLS-based WAN tunnel and alternatively over the Internet-based DMVPN tunnel on the secondary router. In the case of a failure on the primary router, all internal traffic is routed to the central site by using DMVPN over the Internet on the secondary router.

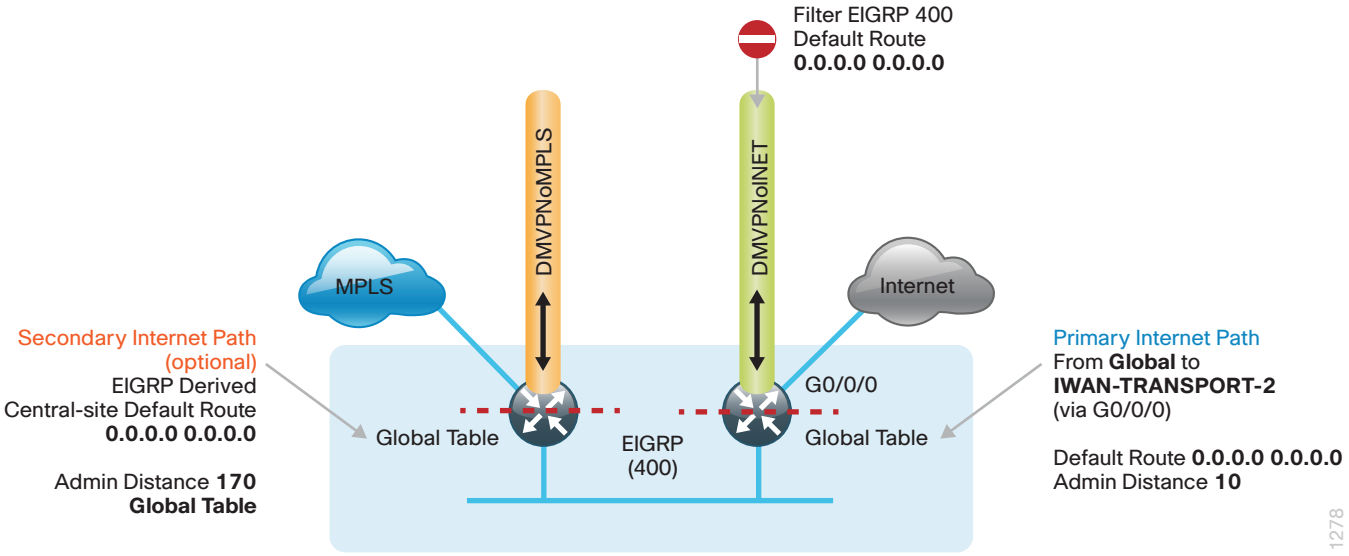
Figure 23 - IWAN dual-router hybrid–VRF routing



In this example, the Internet-facing Ethernet interface on the secondary router is using DHCP to obtain an IP address from the ISP. The secondary router is also using DHCP to install a default route into the local table. By default, this DHCP installed static route has an AD value of 254.

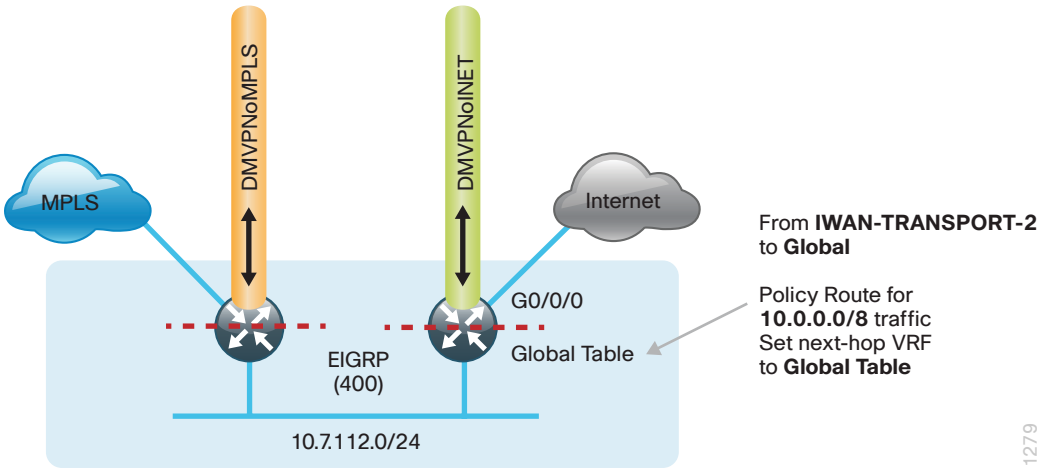
In this case, the default route to the local ISP is isolated in the VRF IWAN-TRANSPORT-2 and used for DMVPN tunnel setup and to route traffic from the outside VRF to the Internet. The default route is used for both IPSLA and DIA traffic.

Figure 24 - IWAN dual-router hybrid–global default



For DIA, the central default route must be filtered inbound on the Internet-based DMVPN tunnel interface on the secondary router. A default static route with an administrative distance of 10 is also configured in the global table on the secondary router.

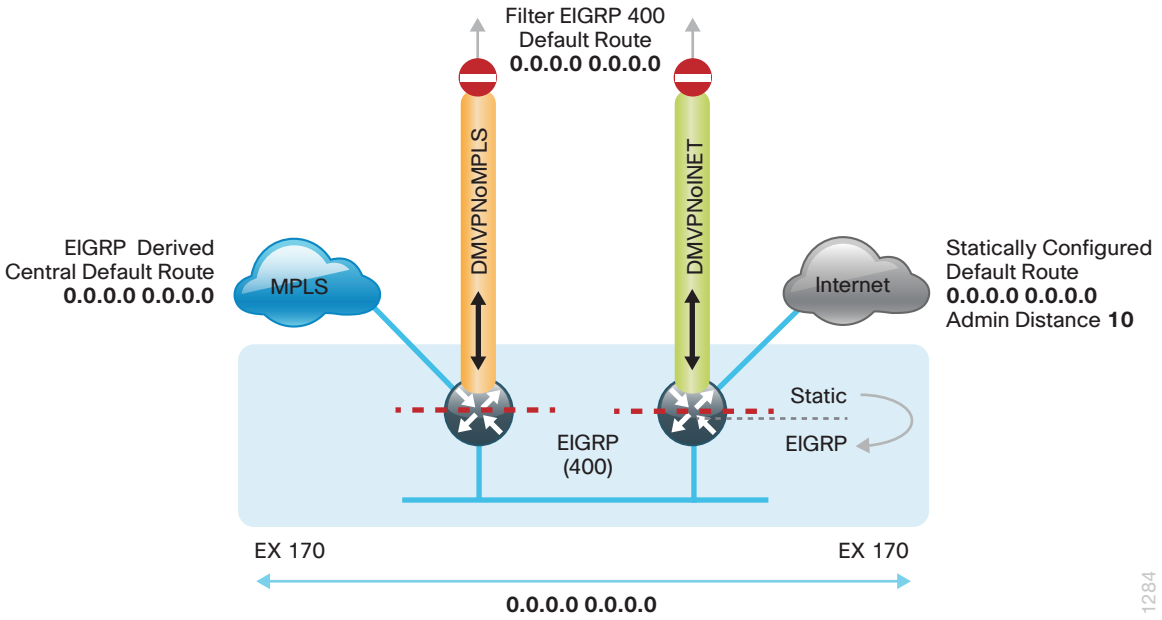
Figure 25 - IWAN dual-router hybrid–Internet return routing



A local policy routing configuration is also added to the secondary router for return traffic from the Internet. In this configuration a route map is used to move the traffic from the outside facing VRF to the global routing table.

With dual-router sites, additional configurations are required to advertise the local Internet default route via EIGRP (example: AS400) from the secondary to the primary IWAN router. This also advertises the route to a Layer 3 distribution switch if needed.

Figure 26 - IWAN dual-router hybrid–Routing

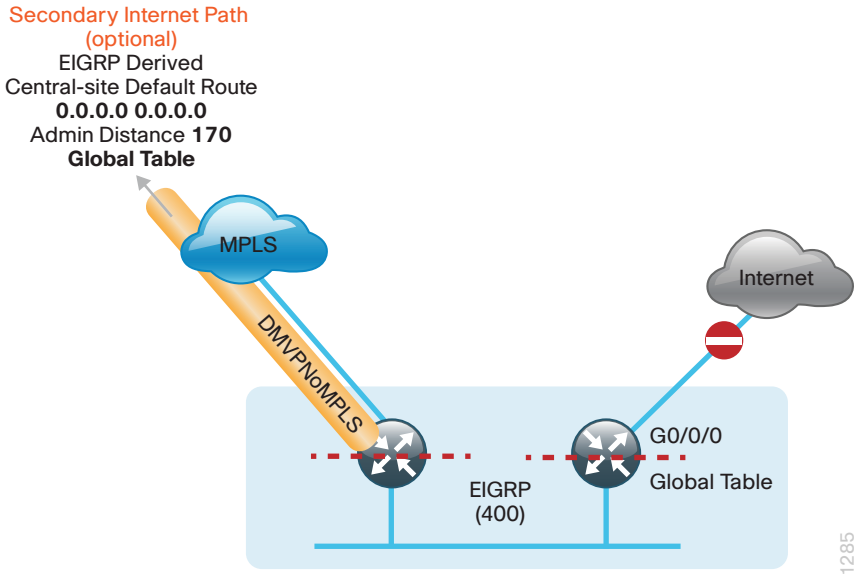


For simplicity, IWAN uses a single EIGRP AS. On the IWAN routers, two things must be accomplished in order to correctly advertise the local default route between the WAN edge routers and optionally with a Layer 3 distribution switch.

First, to ensure the local default route is not advertised to the WAN, filter outbound on both routers' DMVPN tunnel interfaces.

Second, the static default route must be redistributed into EIGRP on the secondary router so it can advertise the default route via EIGRP to the primary router. When the primary router receives the redistributed default route from the secondary IWAN router, it has an administrative distance of 170 and shows as an external EIGRP route. This route is preferred over the existing MPLS-based tunnel central route.

Figure 27 - IWAN dual-router hybrid–central site failover



In this configuration, the MPLS-based tunnel on the primary router can be used as a backup path for Internet if the local Internet connection or the secondary router fails. The central-site default route is advertised over the MPLS-based tunnel via EIGRP with an AD value of 170 and is used only if the local connection fails. In this condition, the secondary router and Layer 3 distribution switch also receive the central EIGRP route from the primary router.

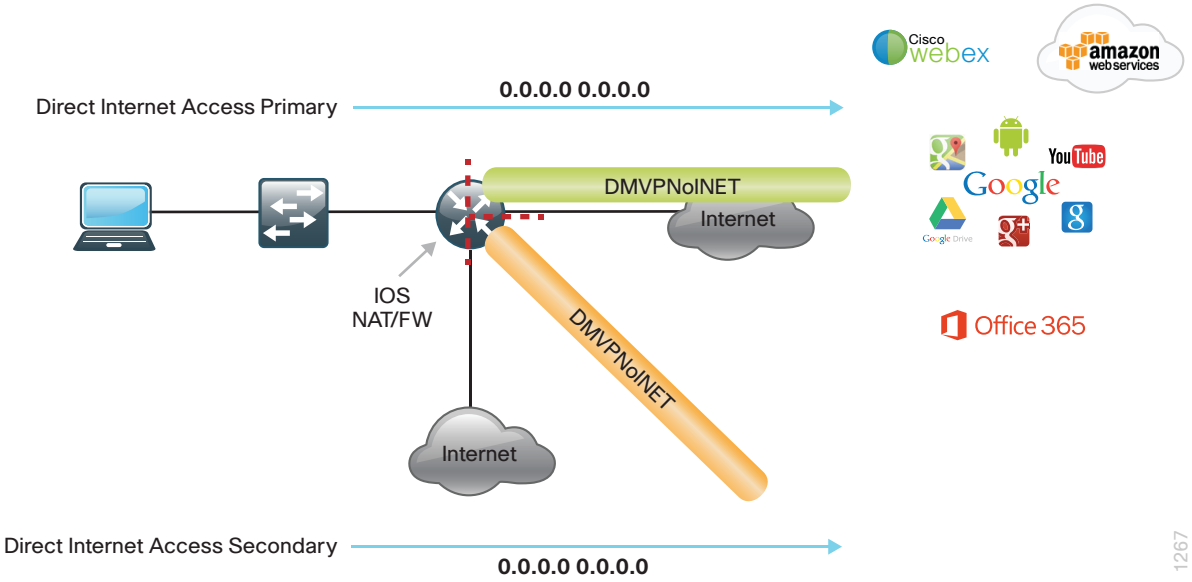
> **Tech Tip**
>
> This configuration requires you to turn off Performance Routing (PfR) load-balancing on the Hub Master Controller. If PfR load-balancing is not turned off, the traffic will fail over to the central site Internet path, but it will not return to the local DIA interface after the failure condition is resolved.

DMVPN tunnel state and IPSLA probes are used to determine the availability of the primary local Internet connection on the secondary router. If a failure is detected, an EEM script removes the default static route from the secondary router and the EIGRP central default route via the primary router is used.

IWAN Single-Router, Dual-Internet Remote-Site Routing

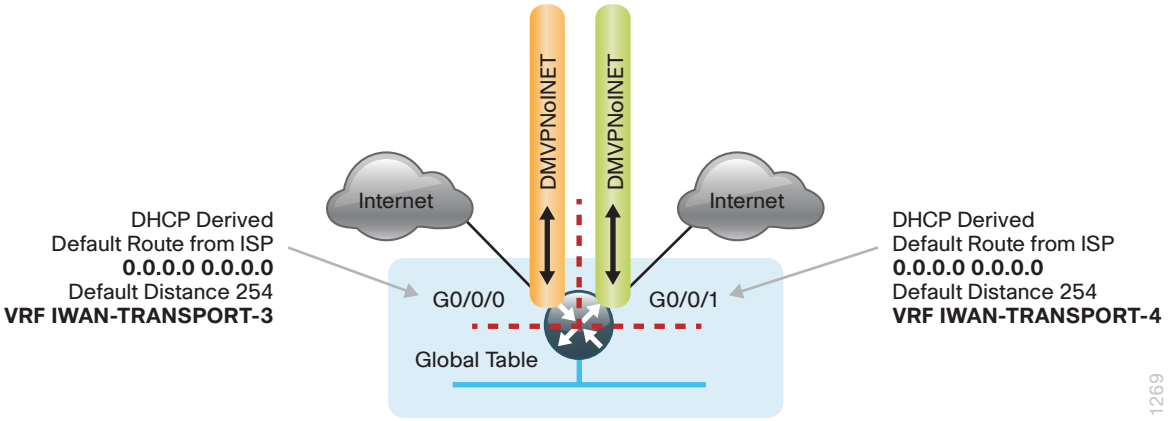
In this design, the remote site is configured with a single router using dual-Internet connections. Traffic is balanced over these connections by using PfR policy.

Figure 28 - IWAN single router, dual-Internet with DIA



With IWAN, internal networks are advertised using EIGRP over the DMVPN tunnels, preferring the primary path. Based on PfR policy, critical internal traffic or traffic that stays within the organization is routed over the first ISP and alternatively over the second. In the case of primary tunnel failure, all internal traffic is routed to the central site by using the remaining DMVPN tunnel interface.

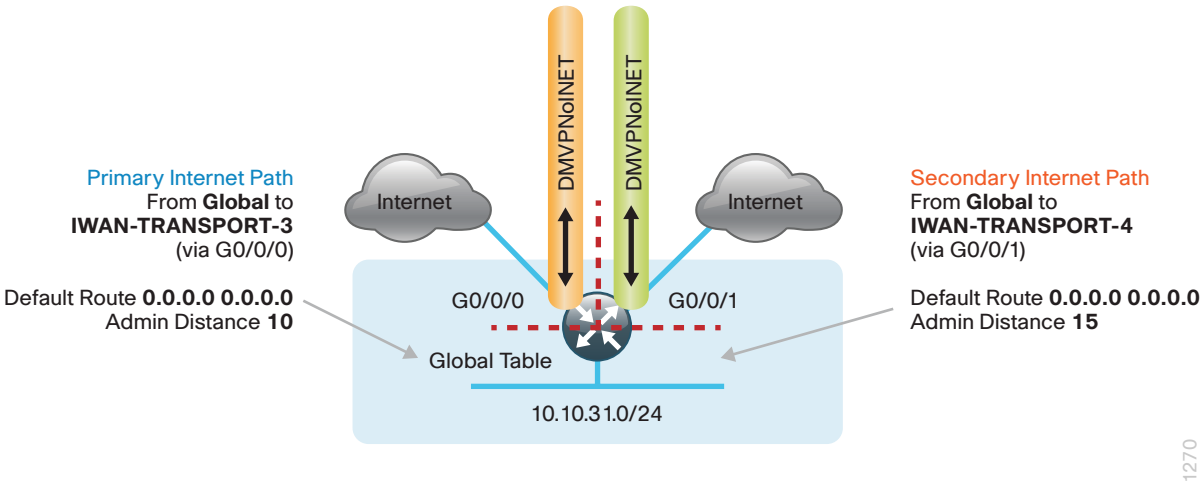
Figure 29 - IWAN single router, dual-Internet–routing



In this example, the Internet facing Ethernet interfaces on the router are both using dynamic host configuration protocol (DHCP) in order to obtain an IP address from the ISP. The router is also using DHCP to install a default route into each VRF routing table. By default, this DHCP-installed static route has an AD value of 254.

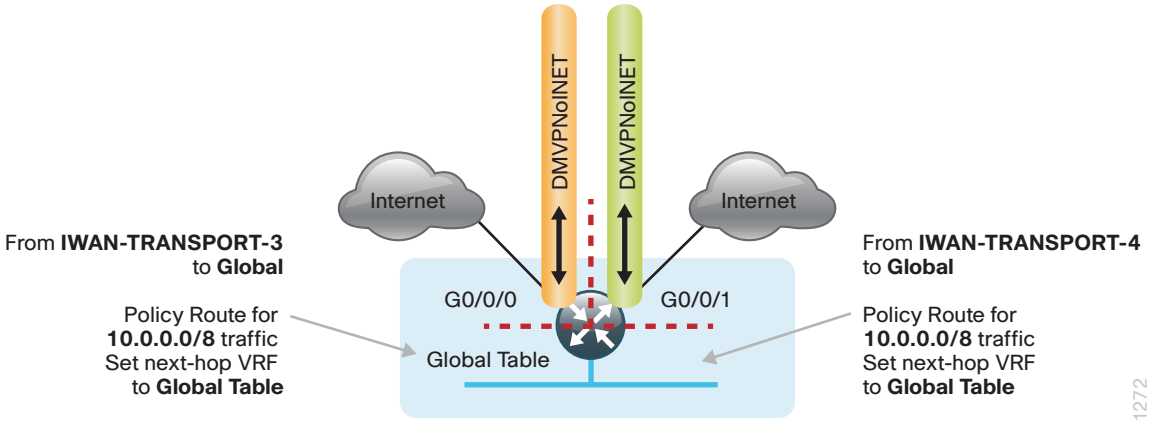
In this case, the default routes to the Internet are isolated in the outside VRFs IWAN-TRANSPORT-3 and IWAN-TRANSPORT-4 and are used for DMVPN tunnel setup and to route traffic from the outside VRF to the Internet. The default routes are used for both IPSLA and DIA traffic.

Figure 30 - IWAN single router, dual-Internet–global default



For DIA, the central default route must be filtered inbound on the Internet-based DMVPN tunnel interfaces. A default static route with an administrative distance of 10 is configured in the global table for the primary ISP and another with a distance of 15 for the secondary ISP connection.

Figure 31 - IWAN single router, dual-Internet–Internet return routing



A local policy routing configuration is also added for return traffic from the Internet. In this configuration, a route map is used to move the traffic from the outside facing VRF to the global routing table inbound on both Internet facing interfaces.

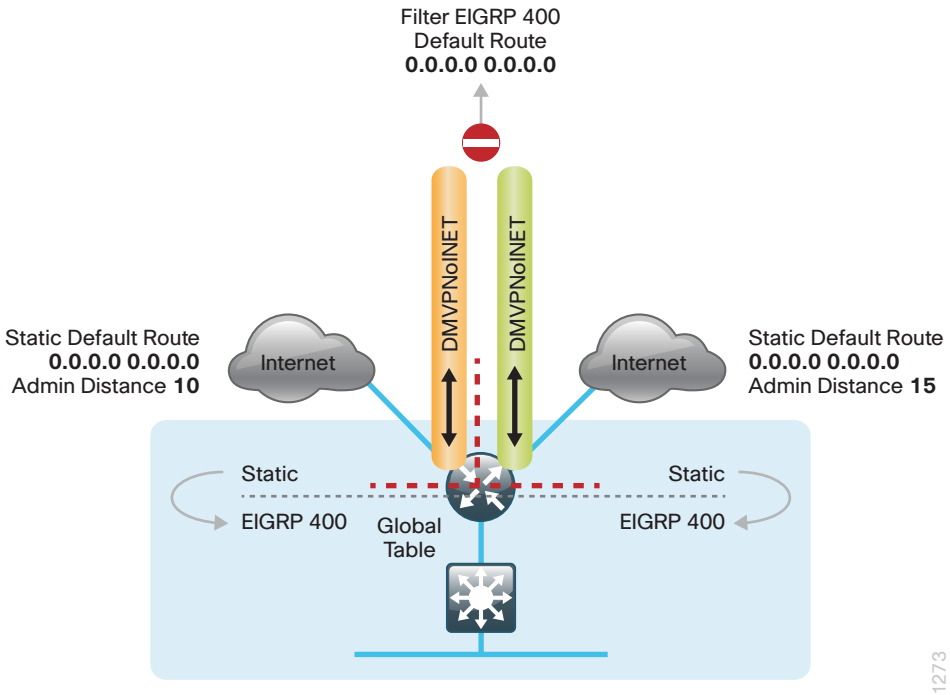
In this configuration, if the primary ISP connection fails, all locally routed Internet traffic is routed to the secondary ISP.

DMVPN tunnel state and IPSLA probes are used to determine the availability of the primary local Internet connection. If a failure is detected, an EEM script removes the primary default static route and the secondary static default route with an administrative distance of 15 is used instead.

Single-Router, Layer 3 Distribution Site

When a remote site IWAN router is connected to a Layer 3 distribution switch, additional configurations are required to advertise the local Internet default route via EIGRP (example: AS400).

Figure 32 - IWAN single router, dual-Internet–Layer 3 distribution



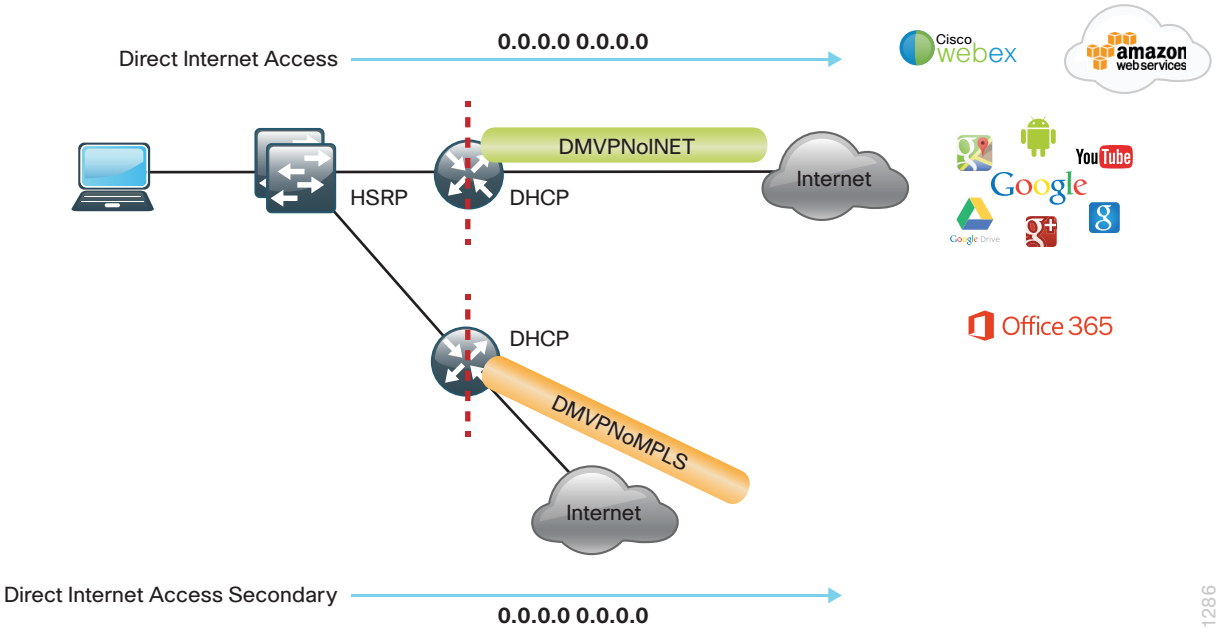
For simplicity, IWAN uses a single EIGRP AS. On the IWAN router, two things must be accomplished to correctly advertise the local default route. First, to ensure the local default route is not advertised to the WAN, filter outbound on both DMVPN tunnel interfaces. Second, redistribute the static default routes into EIGRP so the IWAN router can advertise the default route to the distribution switch.

IWAN Dual-Router, Dual-Internet Remote Site Routing

In this design, the remote site is configured with dual routers. Both routers connect to the Internet. The primary router provides a primary connection for internal traffic. The secondary router provides an alternate path via DMVPN over the Internet.

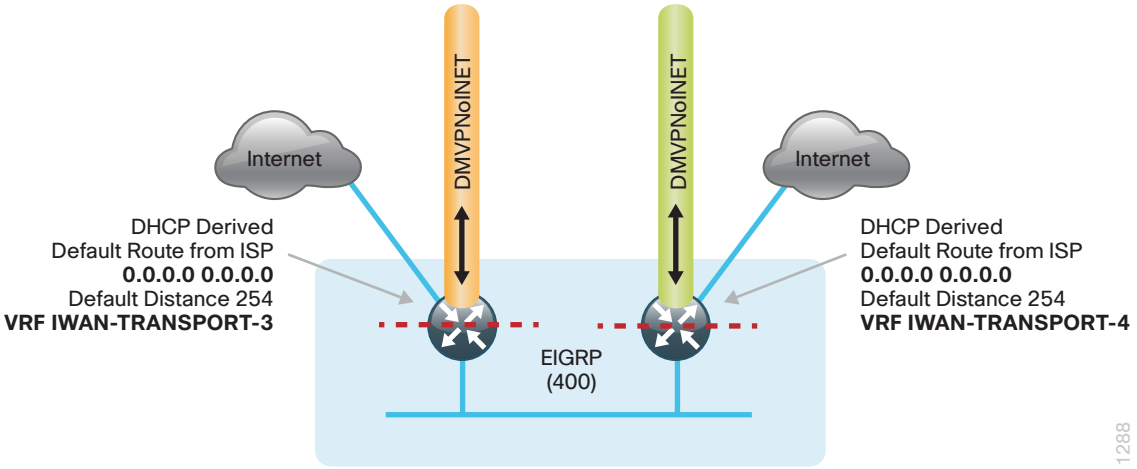
In the dual-Internet design with DIA, Internet traffic is routed outside the DMVPN tunnels for local Internet access on both routers. In this configuration the local Internet path is primary on the primary router with failover to the secondary router's ISP.

Figure 33 - IWAN dual router, dual-Internet with DIA



With IWAN, internal networks are advertised by using EIGRP over the DMVPN tunnels, preferring the path on the primary router. Based on PfR policy, critical internal traffic or traffic that stays within the organization is routed primarily over the primary router's WAN tunnel and alternatively over the DMVPN tunnel on the secondary router. In the case of a failure on the primary router, all internal traffic is routed to the central site by using DMVPN over the Internet on the secondary router.

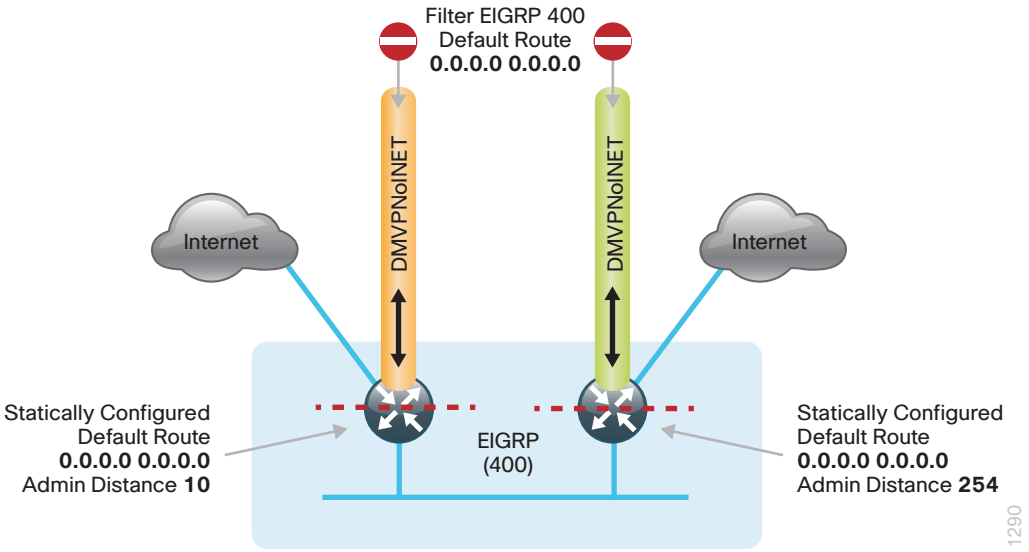
Figure 34 - IWAN dual router, dual-Internet–VRF routing



In this example, the Internet facing Ethernet interfaces on both routers are using DHCP to obtain an IP address from each ISP. The routers are also using DHCP to install default routes into the outside VRF routing table on each router. By default, this DHCP installed static route has an AD value of 254.

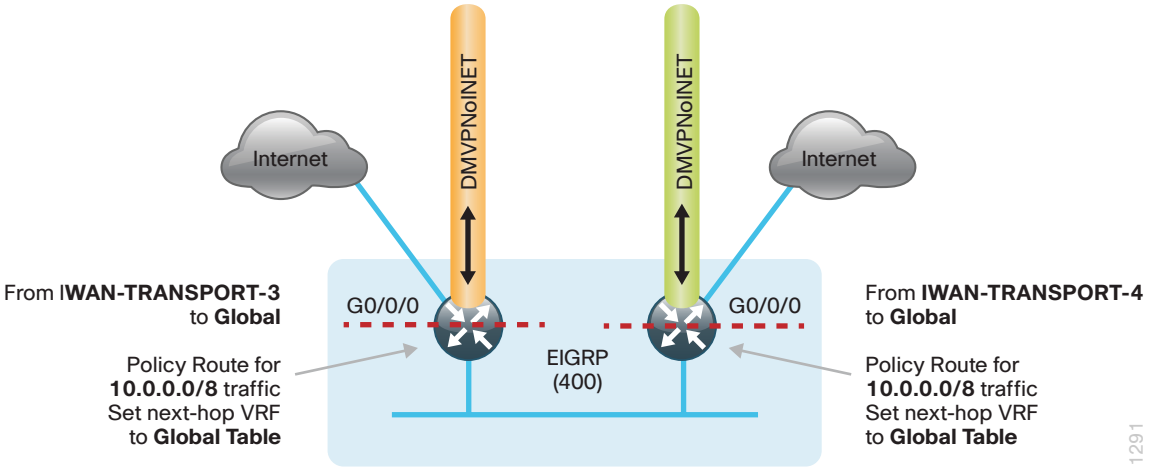
In this case, the default route to the local ISPs are isolated in the VRF IWAN-TRANSPORT-3 on the primary router and IWAN-TRANSPORT-4 on the secondary router. These default routes are used for DMVPN tunnel setup and to route traffic from the outside VRF to the Internet. These default routes are also used for both IPSLA and DIA traffic.

Figure 35 - IWAN dual router, dual-Internet–global default



For DIA, the central default route must be filtered inbound on the Internet-based DMVPN tunnel interfaces on both the primary and secondary routers. A default static route with an administrative distance of 10 is also configured in the global table on the primary router and a static default with an administrative distance of 254 on the secondary router. The value of 254 is used so EIGRP is preferred.

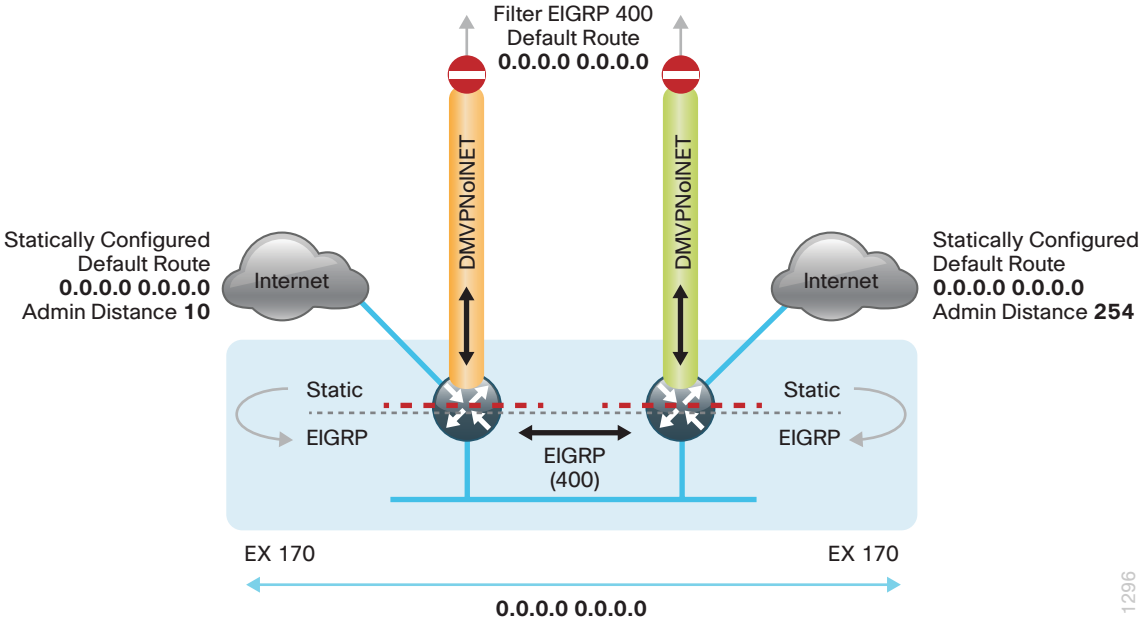
Figure 36 - IWAN dual router, dual-Internet–Internet return routing



A local policy routing configuration is also added to the routers for return traffic from the Internet. In this configuration, a route map is used to move the traffic from the outside facing VRFs to the global routing tables on each router.

With dual-router sites, additional configurations are required to advertise the local Internet default routes via EIGRP (example: AS400) between the primary and secondary IWAN routers. This also advertises the route to a Layer 3 distribution switch if needed.

Figure 37 - IWAN dual router, dual-Internet–routing



For simplicity, IWAN uses a single EIGRP AS. On the IWAN routers, two things must be accomplished in order to correctly advertise the local default route between the WAN edge routers and optionally with a Layer 3 distribution switch.

First, to ensure the local default route is not advertised to the WAN, filter outbound on both routers' DMVPN tunnel interfaces.

Second, redistribute the static default route into EIGRP on both the primary and secondary routers so they can advertise the default route via EIGRP between them and with a Layer 3 distribution switch.

The primary router advertises the redistributed static default route to the secondary router and distribution switch with an administrative distance of 170; this will be preferred over the static default route configured on the secondary router with a distance of 254. The secondary router also advertises a redistributed default static route to the primary router and distribution switch with a less preferred EIGRP metric.

In this configuration, the DMVPN tunnel on the secondary router can be used as a backup path for Internet if the local Internet connection or the primary router fails. In the case of a primary ISP failure, the secondary router advertises the secondary ISP default with an administrative distance of 170 via EIGRP and becomes the Internet path for the remote site network.

DMVPN tunnel state and IPSLA probes are used to determine the availability of the primary router's local Internet connection. If a failure is detected, an EEM script removes the default static route from the primary router and the redistributed static route on the secondary router via EIGRP is used instead.

Deploying Direct Internet Access

How to Read Commands

This guide uses the following conventions for commands that you enter at the command-line interface (CLI).

Commands to enter at a CLI prompt:

```
configure terminal
```

Commands that specify a value for a variable:

```
ntp server 10.10.48.17
```

Commands with variables that you must define:

```
class-map [highest class name]
```

Commands at a CLI or script prompt:

```
Router# enable
```

Long commands that line wrap are underlined. Enter them as one command:

```
police rate 10000 pps burst 10000
packets conform-action
```

Noteworthy parts of system output (or of device configuration files) are highlighted:

```
interface Vlan64
  ip address 10.5.204.5 255.255.255.0
```

The successful deployment of secure DIA with IWAN includes a number of components that ensure proper DIA functionality within each remote-site design. All of these tasks are covered in this section:

- Configuration of remote site default routing including any necessary filtering and redistribution
- Configuration of NAT
- Configuration of zone-based firewall
- Configuration of additional router security
- Configuration of ISP black hole routing detection

Using This Section

This guide is organized into sections focused on each IWAN remote-site design, with detailed procedures for the implementation of direct Internet access. The configurations in each section are specific to each design model.

To configure direct Internet access, use the section appropriate for your remote site design requirements:

- "IWAN Single-Router Hybrid Remote Site with DIA"
- "IWAN Dual-Router Hybrid Remote Site with DIA"
- "IWAN Single-Router Dual-Internet Remote Site with DIA "
- "IWAN Dual-Router Dual-Internet Remote Site with DIA"

Reader Tip

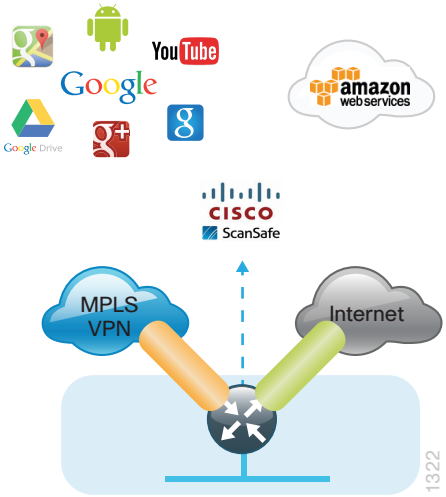
The configurations that follow are remote-site configurations only. These configurations assume each remote site has been configured based on the IWAN foundation. For information about configuring the remote-site routing and primary site WAN-aggregation routers, see the Intelligent WAN Technology Design Guide.

IWAN Single-Router Hybrid Remote Site with DIA

This section describes configuring DIA for the single-router hybrid IWAN design. These configurations assume the single-router hybrid site with centralized Internet access is configured and functional, as described in the Intelligent WAN Technology Design Guide.

In this section, you convert a remote site from centralized Internet access for employees to a secure DIA configuration.

Figure 38 - IWAN single-router hybrid design



PROCESS

Configuring DIA Routing

1. Configure Internet interface
2. Filter EIGRP learned central default route
3. Configure local default routing for outbound local Internet traffic
4. Configure local policy-routing for return Internet traffic

In the following procedures, you enable DIA routing, NAT, and zone-based firewall configurations for the single-router hybrid IWAN design. In this configuration, you route local Internet traffic by using split-tunneling outside the DMVPN tunnel. All configurations are specific to this design model.

Procedure 1 Configure Internet interface

For security, disable the ISP interface before configuring DIA. You will not restore this interface until you complete all of the configurations in this section.

> **Tech Tip**
>
> If you are remotely connected to the remote-site router via SSH, you will be disconnected from the router console. Shutting down the Internet interface will drop the existing DMVPN tunnel.

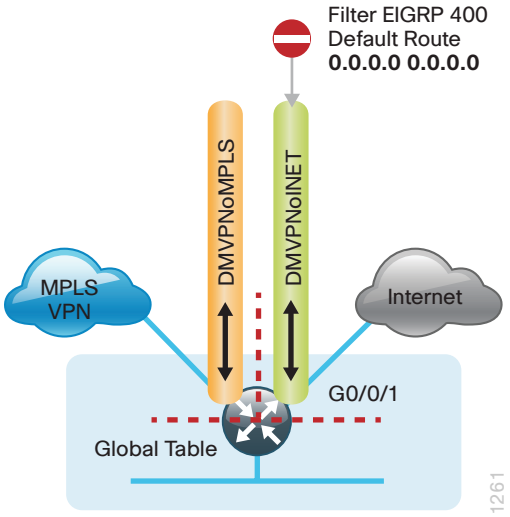
Step 1: Verify that the Internet-facing interface is disabled.

```
interface GigabitEthernet0/0/1
 shutdown
```

Procedure 2 Filter EIGRP learned central default route

With DIA routing, the default route is locally configured for the global routing table. It is important to filter the default route originating over the Internet-facing DMVPN tunnel from the central site. Failover to the central site is optional over the MPLS-based DMVPN tunnel. In the single-router hybrid design with DIA, all Internet traffic is routed directly to the local ISP interface; it is not feasible to failover to central Internet by using an Internet based DMVPN tunnel.

Figure 39 - Filter inbound EIGRP default route from the central site



Step 1: Create an access list to match the default route and permit all other routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Create a route-map to reference the access list.

```
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
  match ip address ALL-EXCEPT-DEFAULT
```

Step 3: Apply the policy as an inbound distribute list for the Internet-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel11
exit
```

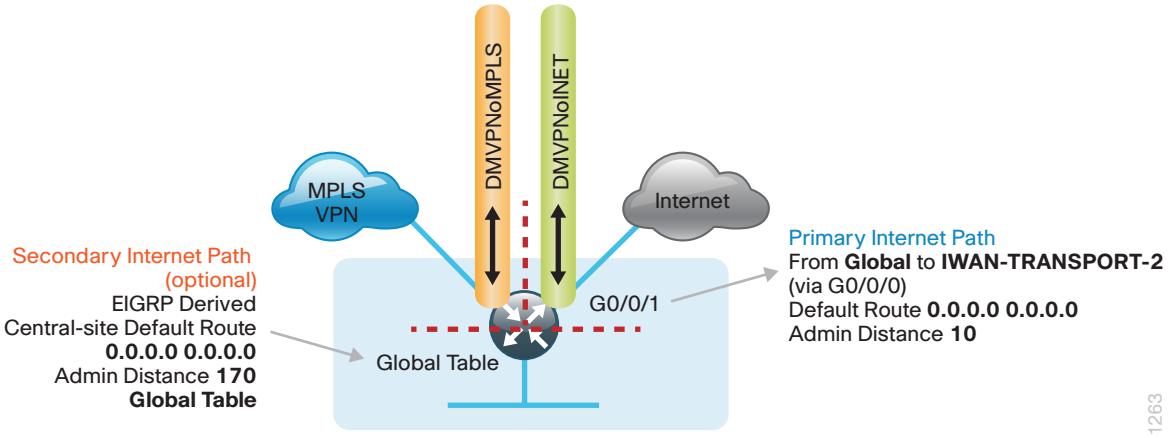
Step 4: If you do not want fallback to centralized Internet, also apply the policy as an inbound distribute list for the MPLS-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel10
exit
```

Procedure 3 Configure local default routing for outbound local Internet traffic

Internal employee traffic is in the global table and needs to route to the Internet via the ISP interface in the IWAN-TRANSPORT-2 VRF. This configuration allows traffic to traverse from the global to the outside VRF in DMVPN F-VRF configurations used for IWAN.

Figure 40 - IWAN single-router hybrid–egress default routing



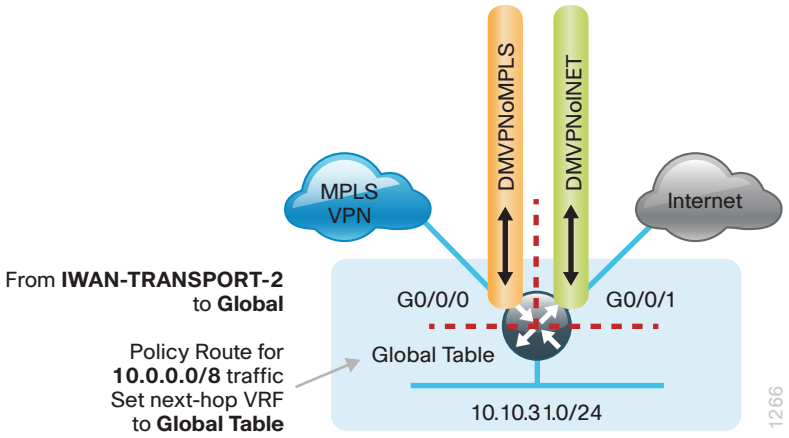
Step 1: Configure a default route in the global table that allows traffic into the outside transit VRF and set the administrative distance to 10.

```
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10
```

Procedure 4 Configure local policy-routing for return Internet traffic

Traffic returning to the outside NAT address of the router ISP interface will be contained inside the IWAN-TRANSPORT-2 VRF. The local policy configuration allows this traffic to be routed back to the global table.

Figure 41 - IWAN single-router hybrid–return routing



Step 1: Configure an ACL that matches the summary range of the internal IP networks.

```
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
```

Step 2: Create a route map that references the ACL and changes the traffic to the global table.

```
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
```

Step 3: Apply the local policy routing configuration to the Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 ip policy route-map INET-INTERNAL
```

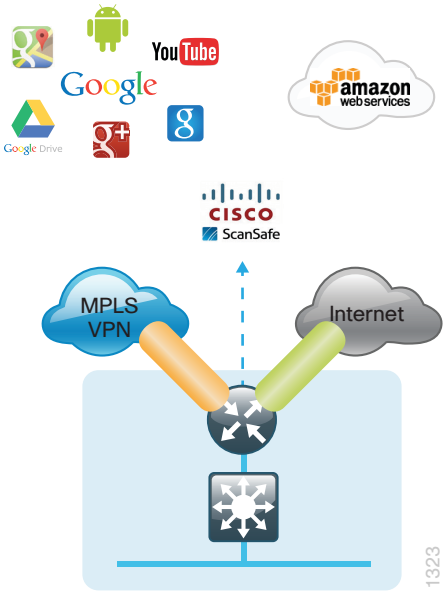
PROCESS

Configuring Single-Router Remote Site with Layer 3 Distribution

1. Configure outbound filtering of the default route to the WAN
2. Configure static default route redistribution into EIGRP

Use this process when a single-router IWAN site requires connectivity to a Layer 3 distribution switch as outlined in the Intelligent WAN Technology Design Guide. Here, you need to redistribute the local default route into EIGRP for advertisement to the Layer 3 switch and filter the default route from being advertised to the WAN.

Figure 42 - IWAN single-router hybrid–Layer 3 distribution



Procedure 1 Configure outbound filtering of the default route to the WAN

Perform these steps when connecting a single router to a Layer 3 distribution switch.

Step 1: Configure an access list to deny the default route and permit all over routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Add an instance after the existing route map named "ROUTE-LIST" and reference the access list that denies the default route and permits all other routes. There should be an instance of this route map from the IWAN foundation configuration. This statement should go between the existing statements.

```
route-map ROUTE-LIST deny 20
 description Block Local Internet Default route out to the WAN
 match ip address DEFAULT-ONLY
```

Step 3: On both routers, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel10
   distribute-list route-map ROUTE-LIST out Tunnel11
  exit-af-topology
exit-address-family
```

Procedure 2 Configure static default route redistribution into EIGRP

Perform these steps when connecting a single router to a Layer 3 distribution switch.

Step 1: Configure an access list to match the default route for redistribution.

```
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
```

Step 2: Configure a route map for static redistribution, referencing the access list that matches the static default route.

```
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
```

Step 3: Redistribute the static default route installed by DHCP into EIGRP AS400 by using the route map.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   redistribute static route-map STATIC-IN
  exit-af-topology
exit-address-family
```

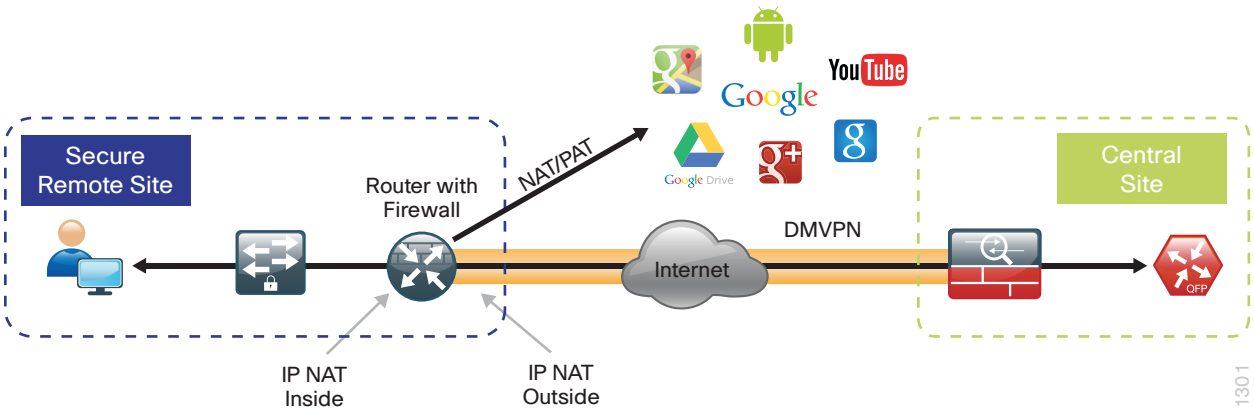
PROCESS

Configuring Network Address Translation for DIA

1. Define and configure Cisco IOS NAT policy

In this design, inside hosts use RFC 1918 addresses, and traffic destined to the Internet from the local site needs to be translated to public IP space. The Internet-facing interface on the remote-site router uses DHCP to acquire a publically routable IP address; the NAT policy here will translate inside private IP addressed hosts to this DHCP address by using PAT.

Figure 43 - NAT for Internet traffic



Procedure 1 Define and configure Cisco IOS NAT policy

Use this procedure if you want to configure NAT for single-router, hybrid remote-site configurations.

Step 1: Define a policy matching the desired traffic to be translated. Use an ACL and include all remote-site subnets used by employees.

```
ip access-list extended NAT-LOCAL
 permit ip 10.7.128.0 0.0.7.255 any
```

Step 2: Configure route map to reference the ACL and match the outgoing Internet Interface.

```
route-map NAT permit 10
 description Local Internet NAT
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/1
```

Step 3: Configure the NAT policy.

```
ip nat inside source route-map NAT interface GigabitEthernet0/0/1 overload
```

Step 4: Enable NAT by applying policy to the inside router interfaces. Apply this configuration, as needed, to internal interfaces or sub-interfaces where traffic matching the ACL may originate, such as the data and transit networks and any service interfaces such as Cisco UCS-E or Cisco Services Ready Engine (SRE) interfaces.

```
interface GigabitEthernet0/0/2.64
 ip nat inside
```

Step 5: Configure the Internet-facing interfaces for NAT.

```
interface GigabitEthernet0/0/1
 description ISP Connection
 ip nat outside
```

> **Tech Tip**
>
> When you configure NAT on IOS router interfaces, you will see **ip virtual-reassembly in** added to the configuration. This is automatically enabled for features that require fragment reassembly, such as NAT, Firewall, and IPS.

Step 6: Verify proper interfaces are configured for NAT.

```
RS31-4451X#sh ip nat statistics
Total active translations: 33 (0 static, 33 dynamic; 33 extended)
Outside interfaces:
  GigabitEthernet0/0/1
Inside interfaces:
  GigabitEthernet0/0/2.64
Hits: 119073  Misses:
Expired translations:
Dynamic mappings:
-- Inside Source
[Id: 1] route-map NAT interface GigabitEthernet0/0/1 refcount 0
nat-limit statistics:
 max entry: max allowed 0, used 0, missed 0
In-to-out drops: 0  Out-to-in drops: 0
Pool stats drop: 0  Mapping stats drop: 0
Port block alloc fail: 0
IP alias add fail: 0
Limit entry add fail: 0
```

Step 7: Verify NAT translations for intended sources that are using local Internet services.

```
RS31-4451X#sh ip nat translations
Pro  Inside global     Inside local         Outside local      Outside global
tcp 172.18.98.205:2223 192.168.192.21:49569 93.184.215.200:443 93.184.215.200:443
tcp 172.18.98.205:2202 192.168.192.21:49548 66.235.132.161:80  66.235.132.161:80
tcp 172.18.98.205:2178 192.168.192.21:49512 74.125.224.114:80  74.125.224.114:80
tcp 172.18.98.205:2181 192.168.192.21:49527 23.203.236.179:80  23.203.236.179:80
```

PROCESS

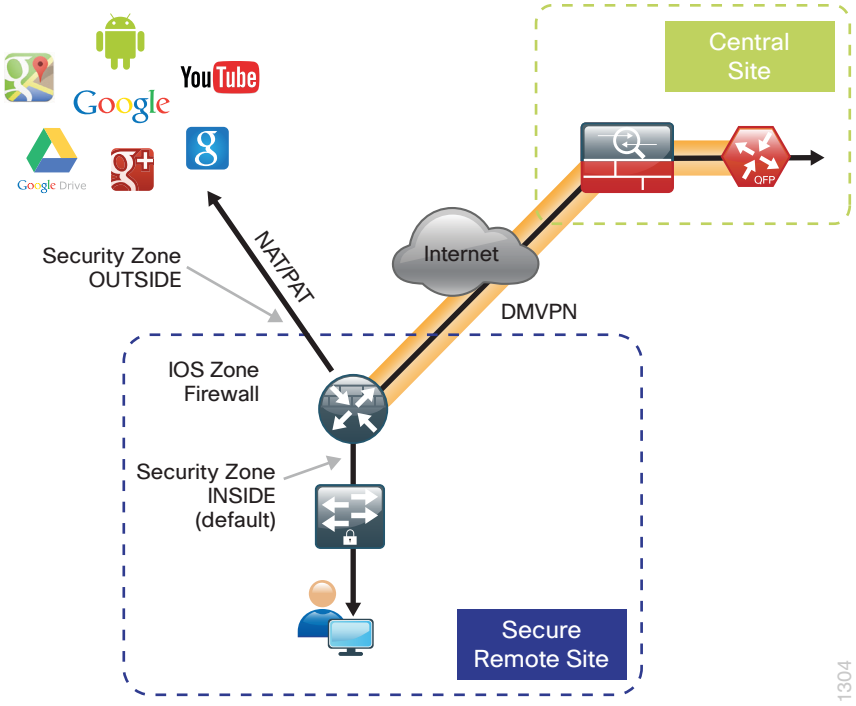
Configuring Zone-Based Firewall for DIA

1. Configure base Cisco IOS zone-based firewall parameters
2. Restrict traffic to the router
3. Enable and verify zone-based firewall configuration

The following Cisco IOS firewall configuration is intended for use on Internet-facing remote-site routers that provide secure local-Internet access. This configuration assumes DHCP and DMVPN are also configured to use the outside interface. To configure the required base firewall policies, complete the following procedures.

Follow these procedures to secure a remote-site router with direct Internet configurations.

Figure 44 - Zone-based firewall for DIA



Procedure 1 Configure base Cisco IOS zone-based firewall parameters

Step 1: If it is configured, remove the inbound ACL from the Internet-facing router interfaces, and then shut down the interface before continuing. This prevents unauthorized traffic while the ZBFW is configured.

```
interface GigabitEthernet0/0/1
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
```

Step 2: Define security zones. A *zone* is a named group of interfaces that have similar functions or security requirements. This example defines the names of the two basic security zones identified. For simplicity this design uses the "default" security zone for inside interfaces. Once the default zone has been defined, all interfaces not explicitly configured as members of a security zone will automatically be part of the default security zone.

```
zone security default
zone security OUTSIDE
```

Tech Tip

This design uses the "default" zone for all inside interfaces; traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Be aware that any interface that is removed from a defined security zone will be automatically placed into the default zone. In this configuration, that interface will be treated as an "inside" zone and have access to the internal routing domain.

Step 3: Define a class map to match specific protocols. Class-maps apply **match-any** or **match-all** operators in order to determine how to apply the match criteria to the class. If **match-any** is specified, traffic must meet at least one of the match criteria in the class-map to be included in the class. If **match-all** is specified, traffic must meet all of the match criteria to be included in the class.

```
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol tcp
 match protocol udp
 match protocol icmp
```

Tech Tip

Protocols that use single ports (such as HTTP, telnet, SSH, etc.) can be statefully allowed with tcp inspection alone by using the **match protocol tcp** command.

Protocols such as **ftp** that use multiple ports (one for control and another for data) require application inspection in order to enable dynamic adjustments to the active firewall policy. The specific TCP ports that are required for the application are allowed for short durations, as necessary.

Step 4: Define policy maps. A policy is an association of traffic classes and actions. It specifies what actions should be performed on defined traffic classes. In this case, you statefully inspect the outbound session so that return traffic is permitted.

```
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
```

Tech Tip

An *action* is a specific functionality that is associated with a traffic class. **Inspect**, **drop**, and **pass** are actions.

With the **inspect** action, return traffic is automatically allowed for established connections. The **pass** action permits traffic in one direction only. When using the **pass** action, you must explicitly define rules for return traffic.

Step 5: Define the zone pair and apply the policy map. A zone pair represents two defined zones and identifies the source and destination zones where a unidirectional firewall policy-map is applied. This configuration uses only one zone pair because all traffic is inspected and thus allowed to return.

```
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
```

Procedure 2 Restrict traffic to the router

Cisco IOS defines the router by using the fixed-name self as a separate security zone. The self-zone is the exception to the default deny-all policy.

All traffic destined to or originating from the router itself (local traffic) on any interface is allowed until traffic is explicitly denied. In other words, any traffic flowing directly between defined zones and the router's IP interfaces is implicitly allowed and is not initially controlled by zone firewall policies.

This default behavior of the self-zone ensures that connectivity to the router's management interfaces and the function of routing protocols is maintained when an initial zone firewall configuration is applied to the router.

Specific rules that control traffic to the self-zone are required. When you configure a ZBFW rule that includes the self-zone, traffic between the self-zone and the other defined zones is immediately restricted in both directions.

Table 1 - Self-zone firewall access list parameters

Protocol	Stateful inspection policy
ISAKMP	Yes
ICMP	Yes
DHCP	No
ESP	No
GRE	No

The following configuration allows the required traffic for proper remote-site router configuration with DMVPN. ESP and DHCP cannot be inspected and need to be configured with a **pass** action in the policy, using separate ACL and class-maps. ISAKMP should be configured with the **inspect** action and thus needs to be broken out with a separate ACL and class-maps for inbound and outbound policies.

> **Tech Tip**
>
> More specific ACLs than are shown here with the "any" keyword are recommended for added security.

Step 1: In the following steps, define access lists.

Step 2: Define an ACL allowing traffic with a destination of the router itself from the OUTSIDE zone. This includes ISAKMP for inbound tunnel initiation. This traffic can be inspected and is identified in the following ACL.

```
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
```

Step 3: Identify traffic for IPSEC tunnel initiation and other traffic that will originate from the router (self-zone) to the OUTSIDE zone. This traffic can be inspected.

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
```

> **Tech Tip**
>
> The Internet control message protocol (ICMP) and domain entries here are for IPSLA probes that originate from the router.
>
> ```
> permit icmp any any
> permit udp any any eq domain
> ```

Step 4: Configure the DHCP ACL to allow the router to acquire a public IP address dynamically from the ISP. This traffic needs to be defined separately for server and client and cannot be inspected.

```
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc

ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
```

Step 5: Configure the ESP ACL to allow the router to establish IPSEC communications for DMVPN. ESP needs to be explicitly allowed inbound and outbound in separate ACLs. ESP cannot be inspected.

```
ip access-list extended ESP-IN
 permit esp any any

ip access-list extended ESP-OUT
 permit esp any any
```

Step 6: Configure the GRE ACL to allow GRE tunnel formation. GRE needs to be explicitly allowed inbound only.

```
ip access-list extended GRE-IN
 permit gre any any
```

> **Tech Tip**
>
> GRE needs to be permitted inbound for GRE on IOS-XE platforms due to a difference in interface order of operations. This is not required on IOS ISRG2 platforms.

Next, you define class maps for traffic to and from the self-zone. Separate class-maps are required for inbound and outbound initiated flows as well as for traffic that can be inspected by the router.

Step 7: Define the class-map matching inbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
```

Step 8: Define the class-map matching outbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
```

Step 9: Define the class-map matching inbound traffic that is not able to be inspected.

```
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
```

Step 10: Define the class-map matching outbound traffic that cannot be inspected.

```
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
```

Next, you define policy maps. Create two separate policies, one for traffic inbound and one for traffic outbound.

Step 11: Define the inbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
```

Step 12: Define the outbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
```

Tech Tip

Inspection for Layer 7 applications is not allowed for traffic going to and from the self-zone to other zones. Cisco IOS firewalls support only inspection of TCP, UDP, and H.323 traffic that terminates on or originates from the router itself.

Traffic such as DHCP and ESP cannot be inspected and must be configured as **Pass** in the associated policy-map.

Next, you define the zone pair and apply policy maps to them.

Step 13: Define the zone pair for traffic destined to the self-zone of the router from the outside and associate the inbound policy-map defined in the previous step.

```
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
```

Step 14: Define the zone pair for traffic destined from the self-zone of the router to the outside and associate the outbound policy-map defined in the previous step.

```
zone-pair security FROM-ROUTER source self destination OUTSIDE
 service-policy type inspect ACL-OUT-POLICY
```

Procedure 3 Enable and verify zone-based firewall configuration

Step 1: Assign the Internet-facing router interface to the outside security zone. All other interfaces are assigned to the default zone and do not need to be defined.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 zone-member security OUTSIDE
```

Tech Tip

By default, traffic is allowed to flow between interfaces that are members of the same zone, while a default "deny-all" policy is applied to traffic moving between zones.

This design uses the "default" zone for all inside interfaces; traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Loopback interfaces are members of the "self" zone and are not assigned to a defined security zone or the default zone.

Step 2: Verify the interface assignment for the zone firewall and ensure that all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS31-4451X#show zone security
zone self
  Description: System defined zone

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically

zone OUTSIDE
  Member Interfaces:
    GigabitEthernet0/0/1
```

Step 3: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS31-4451X#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        50 packets, 13824 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
```

```
    Match: access-group name ESP-OUT
      0 packets, 0 bytes
    Match: access-group name DHCP-OUT
      8 packets, 2680 bytes
    Pass
      8 packets, 2680 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: IN_OUT
Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
  Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
    Match: protocol ftp
      0 packets, 0 bytes
    Match: protocol tcp
      0 packets, 0 bytes
    Match: protocol udp
      0 packets, 0 bytes
    Match: protocol icmp
      0 packets, 0 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: TO-ROUTER
Service-policy inspect : ACL-IN-POLICY
  Class-map: INSPECT-ACL-IN-CLASS (match-any)
    Match: access-group name ACL-RTR-IN
      52 packets, 14040 bytes
    Inspect
  Class-map: PASS-ACL-IN-CLASS (match-any)
    Match: access-group name ESP-IN
      0 packets, 0 bytes
    Match: access-group name DHCP-IN
      8 packets, 2736 bytes
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      1697 packets, 332091 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
```

Step 4: Add the following command to the router configuration in order to identify traffic dropped by the Cisco IOS-XE zone firewall.

```
parameter-map type inspect global
 log dropped-packets
```

Tech Tip

In IOS, when you configure the command **ip inspect drop-pkt**, the following is automatically added to the router configuration:

```
parameter-map type inspect global
 log dropped-packets enable
```

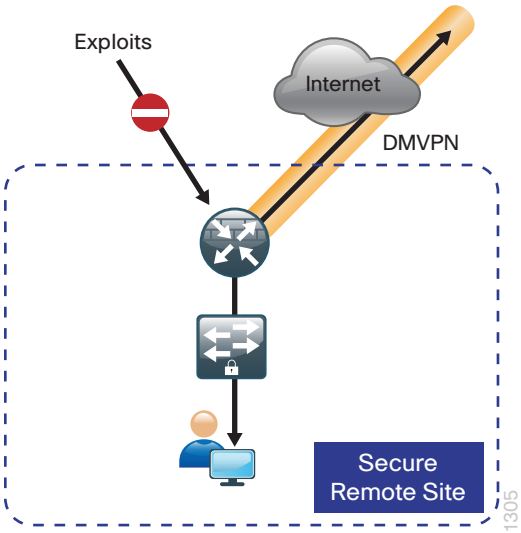
PROCESS

Configuring Additional Router Security

1. Disable IP ICMP redirects
2. Disable ICMP unreachable messages
3. Disable proxy ARP
4. Disable unused router services
5. Disable CDP and LLDP
6. Enable keepalives for TCP sessions
7. Configure internal-network floating static routes
8. Enable Internet interfaces

In addition to the security measures already taken in prior configuration tasks, this section introduces best practices recommendations for securing Internet-facing routers. Disabling unused services and features for networking devices improves the overall security posture by minimizing the amount of information exposed. This practice also minimizes the amount of router CPU and memory load that is required to process unneeded packets.

Figure 45 - Additional router security



Tech Tip

These are general security guidelines only. You may take additional measures to secure remote-site routers on a case-by-case basis. Take care to ensure that the disabling of certain features does not impact other functions of the network. For added security in hybrid IWAN designs, you can also apply these additional security configurations to MPLS provider interfaces.

Procedure 1 Disable IP ICMP redirects

Routers use ICMP redirect messages to notify that a better route is available for a given destination. In this situation, the router forwards the packet and sends an ICMP redirect message back to the sender advising of an alternative and preferred route to the destination. In many implementations, there is no benefit in permitting this behavior. An attacker can generate traffic, forcing the router to respond with ICMP redirect messages, negatively impacting the CPU and performance of the router. You can prevent this by disabling ICMP redirect messages.

Step 1: Disable ICMP redirect messages on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no ip redirects
```

Procedure 2 Disable ICMP unreachable messages

When filtering on router interfaces, routers send ICMP unreachable messages back to the source of blocked traffic. Generating these messages can increase CPU utilization on the router. By default, Cisco IOS ICMP unreachable messages are limited to one every 500 milliseconds. ICMP unreachable messages can be disabled on a per interface basis.

Step 1: Disable ICMP unreachable messages on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no ip unreachables
```

Procedure 3 Disable proxy ARP

Proxy address resolution protocol (ARP) allows the router to respond to ARP request for hosts other than itself. Proxy ARP can help machines on a subnet reach remote subnets without configuring routing or a default gateway as defined in RFC 1027. Disadvantages to using proxy ARP:

- An attacker can impact available memory by sending a large number of ARP requests.
- A router is also susceptible to man-in-the-middle attacks where a host on the network could be used to spoof the MAC address of the router, resulting in unsuspecting hosts sending traffic to the attacker.

You can disable proxy ARP by using the **interface** configuration command.

Step 1: Disable proxy ARP on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no ip proxy-arp
```

Procedure 4 Disable unused router services

As a security best practice, you should disable all unnecessary services that could be used to launch denial of service (DoS) and other attacks. Many unused services that pose a security threat are disabled by default in current Cisco IOS versions.

Step 1: Disable maintenance operation protocol (MOP) on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no mop enabled
```

Step 2: Disable Packet Assembler/Disassembler (PAD) service globally on the router.

```
no service pad
```

Step 3: Prevent the router from attempting to locate a configuration file via trivial file transfer protocol (TFTP) globally on the router.

```
no service config
```

Procedure 5 Disable CDP and LLDP

Attackers can use Cisco Discovery Protocol (CDP) and link layer discovery protocol (LLDP) for reconnaissance and network mapping. CDP is a network protocol that is used to discover other CDP-enabled devices. CDP is often used by network management systems (NMS) and for troubleshooting networking problems. LLDP is an IEEE protocol that is defined in 802.1AB and is very similar to CDP. You should disable CDP and LLDP on router interfaces that connect to untrusted networks.

Step 1: Disable CDP on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no cdp enable
```

Step 2: Disable LLDP on Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no lldp transmit
 no lldp receive
```

Procedure 6 Enable keepalives for TCP sessions

This configuration enables TCP keepalives on inbound connections to the router and outbound connections from the router. This ensures that the device on the remote end of the connection is still accessible and half-open or orphaned connections are removed from the router.

Step 1: Enable the TCP keepalives service for inbound and outbound connections globally on the router.

```
service tcp-keepalives-in
service tcp-keepalives-out
```

Procedure 7 Configure internal-network floating static routes

In the event the DMVPN tunnel to the hub site fails, you will want to ensure traffic destined to internal networks does not follow the local Internet default route. It's best to have the network fail closed to prevent possible security implications and unwanted routing behavior.

Configuring floating static routes to null zero with an AD of 254 ensures that all internal subnets route to null0 in the event of tunnel failure.

Step 1: Configure static route for internal network subnets.

```
ip route 10.0.0.0 255.0.0.0 null0 254
```

Tech Tip

Configure the appropriate number of null 0 routes for internal network ranges, using summaries when possible for your specific network environment. Depending on the networking environment more specific statements may be required.

Procedure 8 Enable Internet interfaces

Now that the security configurations are complete, you can enable the Internet-facing interfaces.

Step 1: Enable the Internet-facing router interface.

```
interface GigabitEthernet0/0/1
 description Internet Connection
 no shutdown
```

PROCESS

Configuring ISP Black-Hole Routing Detection

1. Configure ISP black-hole routing detection

In many cases you will need to ensure connectivity issues with your ISP does not cause black-hole routing conditions. Failure conditions can exist where the DHCP address and routes are not removed from the remote-site router when connectivity issues exist with the broadband service or local premise equipment. There may also be circumstances if certain services are unreachable within via the local ISP connection that you want to reroute to a secondary Internet service.

Tech Tip

This configuration requires you to turn off Performance Routing (PfR) load-balancing on the Hub Master Controller. If PfR load-balancing is not turned off, the traffic will fail over to the central site Internet path, but it will not return to the local DIA interface after the failure condition is resolved.

If central Internet fallback is required, configure one or more of the following options.

Procedure 1 Configure ISP black-hole routing detection

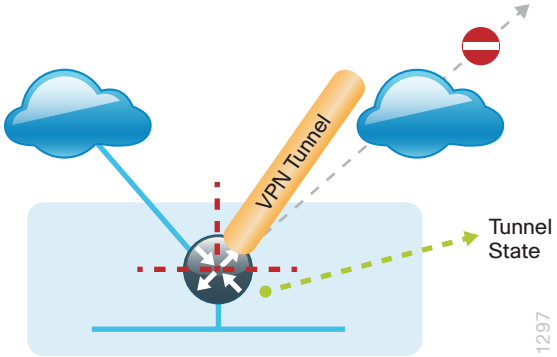
Option 1: DMVPN Tunnel State Tracking

In this solution, the DMVPN tunnel state is used to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, a "down" state of the tunnel interface triggers the removal of the default route via an EEM script. If tunnel state is "up," the route will remain.

Tech Tip

With this method, a failure or maintenance at the central site can cause a failover event where the route is removed due to tunnel state change and the local Internet connection remains active at the remote site. In hybrid configurations, this can cause failover to Central Internet for multiple sites. It is recommended that you use the other options presented in this guide for hybrid DIA configurations.

Figure 46 - IWAN tunnel tracking with EEM



Step 1: Ensure that state tracking is configured for the DMVPN tunnel interface.

```
interface Tunnel11
 if-state nhrp
```

Step 2: Configure the tracking parameters and logic for the IPSLA probes.

```
track 80 interface Tunnel10 line-protocol
```

Step 3: Configure the EEM script to remove the route when the tunnel line protocol transitions to a "down" state.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 DISABLED"
```

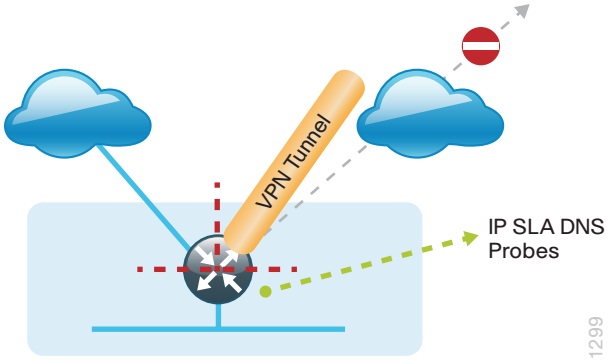
Step 4: Configure the EEM script to restore the local default route when the tunnel line protocol transitions to an "up" state.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 ENABLED"
```

Option 2: DNS-Based IPSLA Probes

In this solution, you use DNS-based IPSLA probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of DNS probes to two or more root DNS servers triggers the removal of the default route via an EEM script. If any DNS probe is active, the route will remain.

Figure 47 - IPSLA with DNS probes



Tech Tip

For DNS-based IPSLA probes to function, you need to ensure that DNS or "domain" is permitted in the ZBFW outbound ACL, from the self-zone to the OUTSIDE zone.

Example:

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq domain
```

Step 1: Configure the VRF-aware IPSLA DNS probes.

```
ip sla 118
 dns d.root-servers.net name-server 199.7.91.13
 vrf IWAN-TRANSPORT-2
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 118 life forever start-time now

ip sla 119
 dns b.root-servers.net name-server 192.228.79.201
 vrf IWAN-TRANSPORT-2
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 119 life forever start-time now
```

Tech Tip

When configuring DNS probes, you should specify the hostname of the DNS server itself. That asks the DNS server to resolve for itself, allowing the use of root DNS servers.

Step 2: Configure the tracking parameters and logic for the IPSLA probes.

```
track 73 ip sla 118 reachability
track 74 ip sla 119 reachability
!
track 100 list boolean or
 object 73
 object 74
```

Step 3: Configure an EEM script to remove the route in the event of DNS probe failure.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 DISABLED"
```

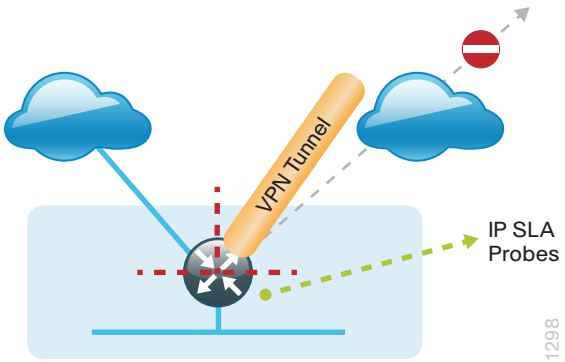
Step 4: Configure an EEM script to also restore the local default route when the DNS probes are active.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 ENABLED"
```

Option 3: IPSLA ICMP Probes

In this solution, you use IPSLA ICMP probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of ICMP probes to two different IP hosts triggers the removal of the default route via an EEM script. If either ICMP probe is active, the route will remain.

Figure 48 - IPSLA with ICMP probes



Tech Tip

For ICMP-based IPSLA probes to function, you need to ensure ICMP is permitted in the outbound ACL, from the self-zone to the OUTSIDE zone.

Step 1: Configure the VRF-aware IPSLA ICMP probes.

```
ip sla 110
 icmp-echo 172.18.1.253 source-interface GigabitEthernet0/0/1
 vrf IWAN-TRANSPORT-2
 threshold 1000
 frequency 15
ip sla schedule 110 life forever start-time now

ip sla 111
 icmp-echo 172.18.1.254 source-interface GigabitEthernet0/0/1
 vrf IWAN-TRANSPORT-2
 threshold 1000
 frequency 15
ip sla schedule 111 life forever start-time now
```

Step 2: Configure the tracking parameters and logic for the IPSLA ICMP probes.

```
track 60 ip sla 110 reachability
track 61 ip sla 111 reachability
track 62 list boolean or
 object 60
 object 61
```

Step 3: Configure an EEM script to remove the route when the ICMP probes are down.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 DISABLED"
```

Step 4: Configure the EEM script to also restore the local default route when the ICMP probes are active.

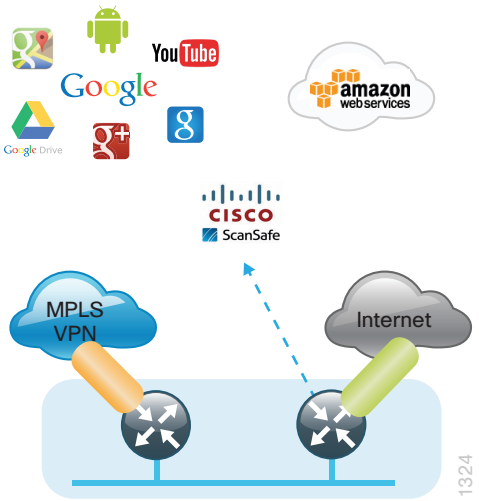
```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 ENABLED"
```

IWAN Dual-Router Hybrid Remote Site with DIA

This section describes configuring of DIA for the dual-router hybrid IWAN design. These configurations assume the dual-router hybrid site with centralized Internet access is configured and functional, as outlined in the Intelligent WAN Technology Design Guide.

In this section, you convert a remote site from centralized Internet access for employees to a secure DIA configuration.

Figure 49 - IWAN dual-router hybrid with DIA



PROCESS

Configuring DIA Routing

1. Configure Internet interface
2. Filter EIGRP learned central default route
3. Configure local default routing for outbound local Internet traffic
4. Configure local policy routing for return Internet traffic
5. Filter default route outbound to WAN
6. Redistribute DHCP default route into EIGRP

In the following procedures, you enable DIA routing, NAT and zone-based firewall configurations for the dual-router hybrid IWAN design. In this configuration, you route local Internet traffic by using split-tunneling outside the DMVPN tunnel on the secondary router. All configurations are specific to this design model.

Procedure 1 Configure Internet interface

For security, disable the ISP interface before configuring DIA. You will not restore this interface until you complete all of the configurations in this section.

Tech Tip

If you are remotely connected to the remote-site router via SSH, you will be disconnected from the router console. Shutting down the Internet interface will drop the existing DMVPN tunnel.

Step 1: Verify that the Internet-facing interface is disabled.

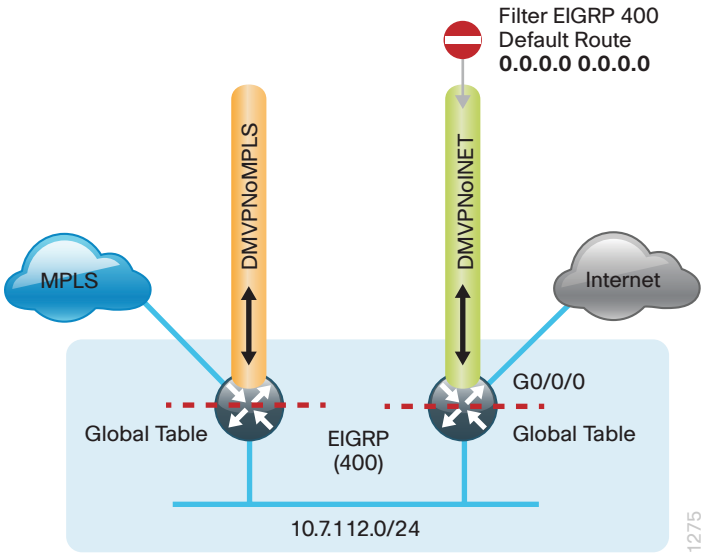
```
interface GigabitEthernet0/0/0
 shutdown
```

Procedure 2 Filter EIGRP learned central default route

With DIA routing, the default route is locally configured for the global routing table. It is important to filter the default route originating over the Internet-facing DMVPN tunnel from the central site. Failover to the central site is optional over the MPLS-based DMVPN tunnel. In the single-router hybrid design with DIA, all Internet traffic is routed directly to the local ISP interface; it is not feasible to failover to central Internet by using an Internet-based DMVPN tunnel.

Configurations are on the secondary router.

Figure 50 - Filter inbound EIGRP default route from the central site



Step 1: Create an access list to match the default route and permit all other routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Create a route-map to reference the access list.

```
route-map BLOCK-DEFAULT permit 10
 description Block only the default route inbound from the WAN
  match ip address ALL-EXCEPT-DEFAULT
```

Step 3: Apply the policy as an inbound distribute list for the Internet-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel11
exit
```

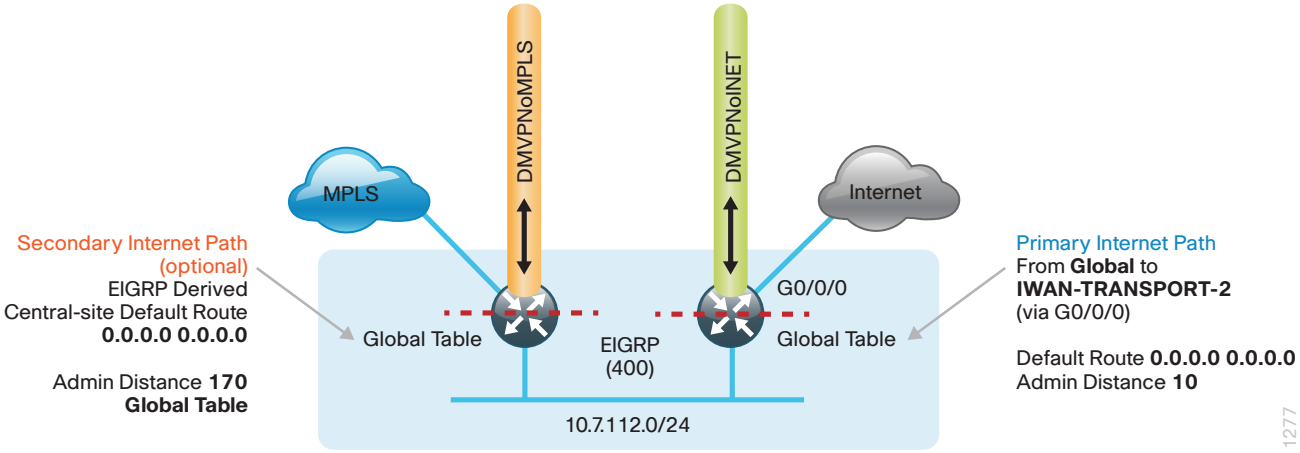
Step 4: If you do not want fallback to centralized Internet, also apply the policy as an inbound distribute list for the MPLS-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel10
exit
```

Procedure 3 Configure local default routing for outbound local Internet traffic

Internal employee traffic is in the global table and needs to route to the Internet via the ISP interface in the IWAN-TRANSPORT-2 VRF. This configuration allows traffic to traverse from the global to the outside VRF in DMVPN F-VRF configurations used for IWAN.

Figure 51 - IWAN dual-router hybrid–egress default routing



Step 1: Configure a default route in the global table that allows traffic into the outside transit VRF and set the administrative distance to **10** on the secondary router

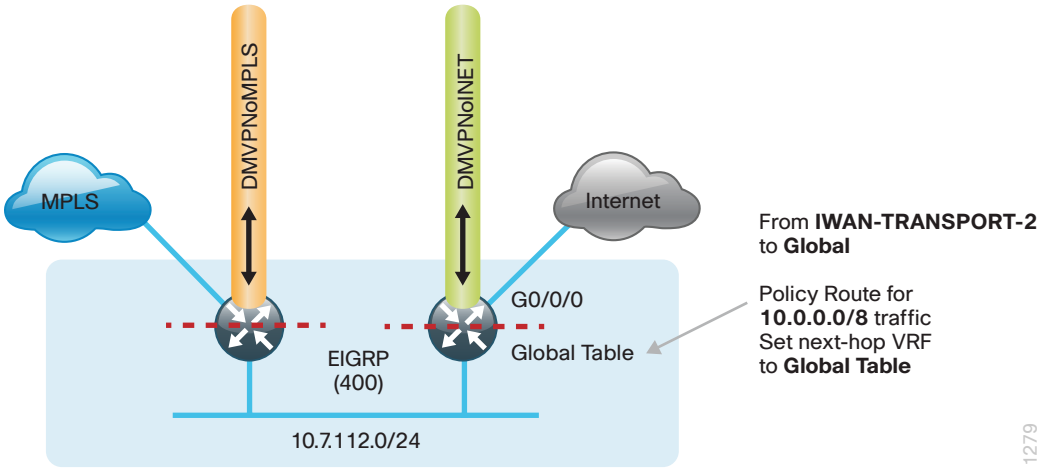
```
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
```

Procedure 4 Configure local policy routing for return Internet traffic

Traffic returning to the outside NAT address of the router ISP interface will be contained inside the IWAN-TRANSPORT-2 VRF. The local policy configuration allows this traffic to be routed back to the global table.

Configurations are on the secondary router.

Figure 52 - IWAN dual-router hybrid–local policy return routing



Step 1: Configure an ACL that matches the summary range of the internal IP networks.

```
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
```

Step 2: Create a route map that references the ACL and changes the traffic to the global table.

```
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
```

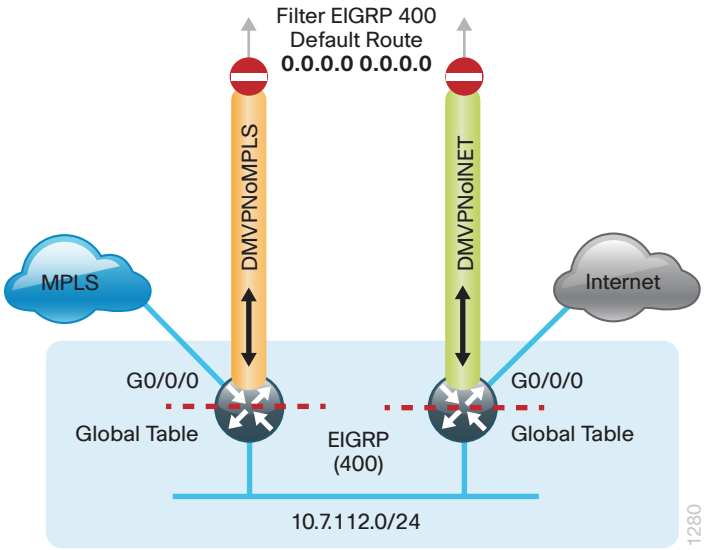
Step 3: Apply the local policy routing configuration to the Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 ip policy route-map INET-INTERNAL
```

Procedure 5 Filter default route outbound to WAN

With IWAN, you are using a single EIGRP process over the WAN and between the remote site routers. When you redistribute the default route into EIGRP in the next procedure, it would by default be sent out the WAN interfaces to the central site location. This is not the desired behavior, so you must first configure an outbound filter.

Figure 53 - IWAN dual-router hybrid–egress default route filtering



Step 1: On both routers, configure an access list to deny the default route and permit all over routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: On both routers, add an instance after the existing route map named "ROUTE-LIST" and reference the access list that denies the default route and permits all other routes. There should be an instance of this route map from the IWAN foundation configuration. This statement should go between the existing statements.

```
route-map ROUTE-LIST deny 20
 description Block Local Internet Default route out to the WAN
 match ip address DEFAULT-ONLY
```

Step 3: On the primary router, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel10
  exit-af-topology
exit-address-family
```

Step 4: On the secondary router, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

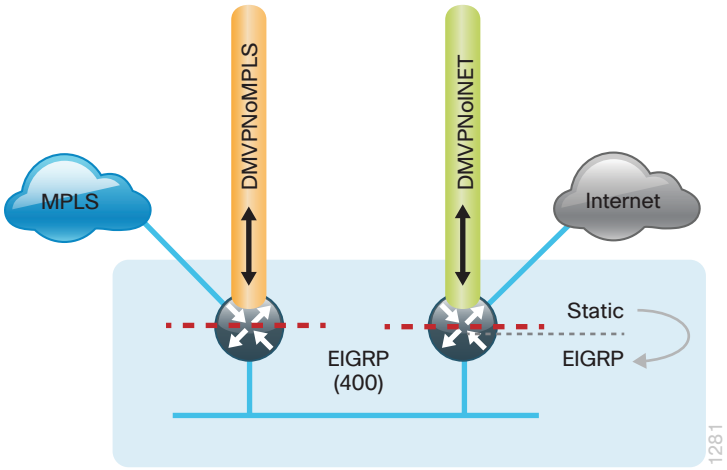
```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel11
  exit-af-topology
exit-address-family
```

Procedure 6 Redistribute DHCP default route into EIGRP

For dual-router configurations, you need to redistribute the statically configured default route into EIGRP AS400 for reachability on both WAN routers.

Configurations are on the secondary router.

Figure 54 - IWAN dual-router hybrid–route redistribution



Step 1: Configure an access list to match the default route.

```
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
```

Step 2: Configure a route-map instance for static redistribution referencing the access list that matches the static default route.

```
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
```

Step 3: Redistribute the static default route installed by DHCP into EIGRP AS400 by using the route map.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   redistribute static route-map STATIC-IN
  exit-af-topology
exit-address-family
```

PROCESS

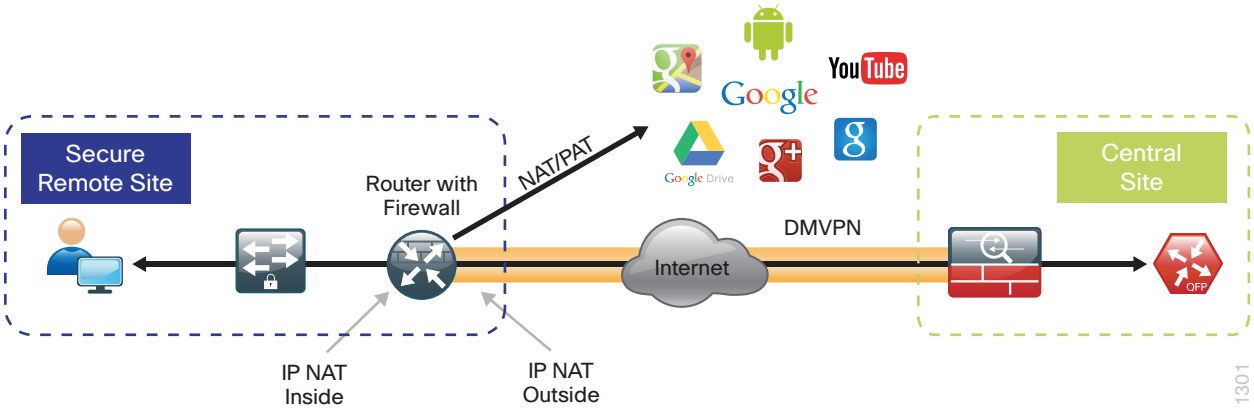
Configuring Network Address Translation for DIA

1. Define and configure Cisco IOS NAT policy

In this design, inside hosts use RFC 1918 addresses, and traffic destined to the Internet from the local site needs to be translated to public IP space. The Internet-facing interface on the remote-site router uses DHCP to acquire a publically routable IP address; the NAT policy here will translate inside private IP addressed hosts to this DHCP address by using PAT.

Perform these configurations on the secondary router.

Figure 55 - NAT for Internet traffic



Procedure 1 Define and configure Cisco IOS NAT policy

Use this procedure to configure dual-router hybrid remote-site configurations.

Step 1: Define a policy matching the desired traffic to be translated. Use an ACL and include all remote-site subnets used by employees.

```
ip access-list extended NAT-LOCAL
 permit ip 10.7.144.0 0.0.7.255 any
```

Step 2: Configure route map to reference the ACL and match the outgoing Internet Interface.

```
route-map NAT permit 10
 description Local Internet NAT
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/0
```

Step 3: Configure the NAT policy.

```
ip nat inside source route-map NAT interface GigabitEthernet0/0/0 overload
```

Step 4: Enable NAT by applying policy to the inside router interfaces. Apply this configuration as needed to internal interfaces or sub-interfaces where traffic matching the ACL may originate, such as the data and transit networks and any service interfaces such as Cisco UCS-E or Cisco SRE interfaces.

```
interface Port-channel 2.64
description data network
 ip nat inside

interface Port-channel 2.99
description transit network
 ip nat inside
```

Step 5: Configure the Internet-facing interfaces for NAT.

```
interface GigabitEthernet0/0/0
 description ISP Connection
 ip nat outside
```

> **Tech Tip**
>
> When you configure NAT on the router interfaces in IOS, you will see **ip virtual-reassembly in** added to the configuration. This is automatically enabled for features that require fragment reassembly, such as NAT, Firewall, and IPS.

Step 6: Verify proper interfaces are configured for NAT.

```
RS32-4451X-2#show ip nat statistics
Total active translations: 33 (0 static, 33 dynamic; 33 extended)
Outside interfaces:
  GigabitEthernet0/0/0
Inside interfaces:
  Port-channel2.64
Hits: 119073  Misses:
Expired translations:
Dynamic mappings:
-- Inside Source
[Id: 1] route-map NAT interface GigabitEthernet0/0/0 refcount 0
nat-limit statistics:
 max entry: max allowed 0, used 0, missed 0
In-to-out drops: 0  Out-to-in drops: 0
Pool stats drop: 0  Mapping stats drop: 0
Port block alloc fail: 0
IP alias add fail: 0
Limit entry add fail: 0
```

Step 7: Verify NAT translations for intended sources that are using local Internet services.

```
RS32-4451X-2#sh ip nat translations
Pro Inside global        Inside local         Outside local       Outside global
tcp 172.18.98.250:2223 192.168.192.21:49569 93.184.215.200:443 93.184.215.200:443
tcp 172.18.98.250:2202 192.168.192.21:49548 66.235.132.161:80  66.235.132.161:80
tcp  172.18.98.250:2178 192.168.192.21:49512 74.125.224.114:80 74.125.224.114:80
tcp  172.18.98.250:2181 192.168.192.21:49527 23.203.236.179:80 23.203.236.179:80
```

PROCESS

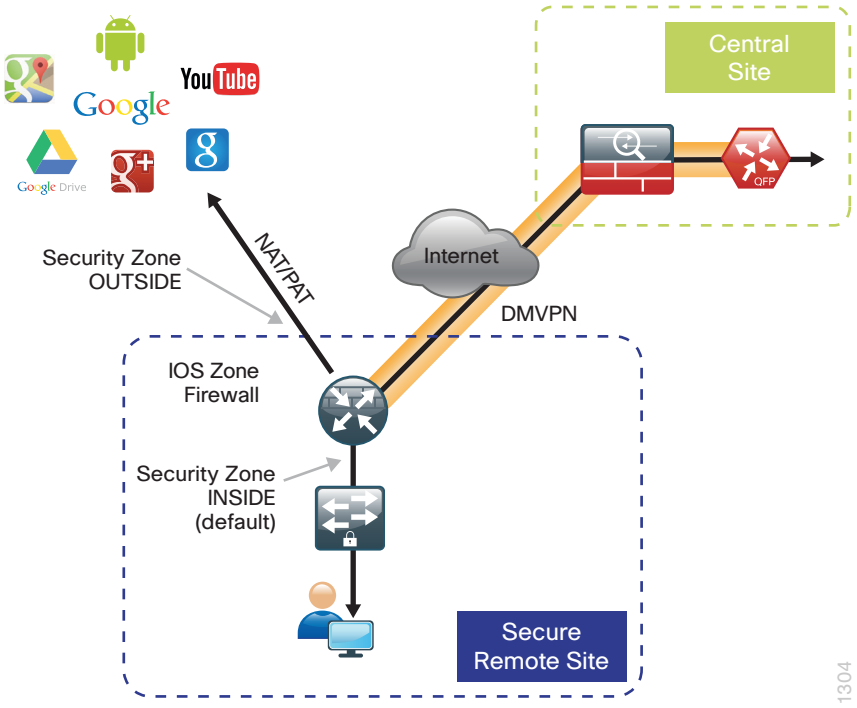
Configuring Zone-Based Firewall for DIA

1. Configure base Cisco IOS Zone-Based Firewall parameters
2. Restrict traffic to the router
3. Enable and verify zone-based firewall configuration

The following Cisco IOS firewall configuration is intended for use on Internet-facing remote site routers providing secure local-Internet access. This configuration assumes DHCP and DMVPN are also configured to use the outside interface. To configure the required base firewall policies, complete the following procedures on the secondary router.

Follow these procedures to secure a dual-router hybrid remote-site router with direct Internet configurations.

Figure 56 - Zone-based firewall for DIA



Procedure 1 Configure base Cisco IOS Zone-Based Firewall parameters

Step 1: If it is configured, remove the inbound ACL from the Internet-facing router interfaces, and then shut down the interface before continuing. This prevents unauthorized traffic while the ZBFW is configured.

```
interface GigabitEthernet0/0/0
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
```

Step 2: Define security zones. A zone is a named group of interfaces that have similar functions or security requirements. This example defines the names of the two basic security zones identified. For simplicity, this design uses the "default" security zone for inside interfaces. Once the default zone has been defined, all interfaces not explicitly configured as members of a security zone will automatically be part of the default security zone.

```
zone security default
zone security OUTSIDE
```

Tech Tip

This design uses the "default" zone for all inside interfaces; traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Be aware that any interface that is removed from a defined security zone will be automatically placed into the default zone. In this configuration, that interface will be treated as an "inside" zone and have access to the internal routing domain.

Step 3: Define a class map to match specific protocols. Class-maps apply **match-any** or **match-all** operators in order to determine how to apply the match criteria to the class. If **match-any** is specified, traffic must meet at least one of the match criteria in the class-map to be included in the class. If **match-all** is specified, traffic must meet all of the match criteria to be included in the class.

```
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol tcp
 match protocol udp
 match protocol icmp
```

Tech Tip

Protocols that use single ports (such as HTTP, telnet, SSH, etc.) can be statefully allowed with tcp inspection alone by using the **match protocol tcp** command.

Protocols such as ftp that use multiple ports (one for control and another for data) require application inspection in order to enable dynamic adjustments to the active firewall policy. The specific TCP ports that are required for the application are allowed for short durations, as necessary.

Step 4: Define policy maps. A policy is an association of traffic classes and actions. It specifies what actions should be performed on defined traffic classes. In this case, you statefully inspect the outbound session so that return traffic is permitted.

```
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
```

Tech Tip

An *action* is a specific functionality that is associated with a traffic class. **Inspect**, **drop**, and **pass** are actions.

With the **inspect** action, return traffic is automatically allowed for established connections. The **pass** action permits traffic in one direction only. When using the **pass** action, you must explicitly define rules for return traffic.

Step 5: Define the zone pair and apply the policy map. A zone pair represents two defined zones and identifies the source and destination zones where a unidirectional firewall policy-map is applied. This configuration uses only one zone pair because all traffic is inspected and thus allowed to return.

```
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
```

Procedure 2 Restrict traffic to the router

Cisco IOS defines the router by using the fixed name self as a separate security zone. The self-zone is the exception to the default deny-all policy.

All traffic destined to or originating from the router itself (local traffic) on any interface is allowed until traffic is explicitly denied. In other words, any traffic flowing directly between defined zones and the router's IP interfaces is implicitly allowed and is not initially controlled by zone firewall policies.

This default behavior of the self-zone ensures that connectivity to the router's management interfaces and the function of routing protocols is maintained when an initial zone firewall configuration is applied to the router.

Specific rules that control traffic to the self-zone are required. When you configure a ZBFW rule that includes the self-zone, traffic between the self-zone and the other defined zones is immediately restricted in both directions.

Table 2 - Self-zone firewall access list parameters

Protocol	Stateful inspection policy
ISAKMP	Yes
ICMP	Yes
DHCP	No
ESP	No
GRE	No

The following configuration allows the required traffic for proper remote-site router configuration with DMVPN. ESP and DHCP cannot be inspected and need to be configured with a **pass** action in the policy, using separate ACL and class-maps. ISAKMP should be configured with the **inspect** action and thus needs to be broken out with a separate ACL and class-maps for inbound and outbound policies.

Tech Tip

More specific ACLs than are shown here with the "any" keyword are recommended for added security.

Step 1: In the following steps, define access lists.

Step 2: Define an ACL allowing traffic with a destination of the router itself from the OUTSIDE zone. This includes ISAKMP for inbound tunnel initiation. This traffic can be inspected and is identified in the following ACL.

```
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
```

Step 3: Identify traffic for IPSEC tunnel initiation and other traffic that will originate from the router (self-zone) to the OUTSIDE zone. This traffic can be inspected.

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
```

> **Tech Tip**
>
> The ICMP and domain entries here are for IPSLA probes that originate from the router.
>
> ```
> permit icmp any any
> permit udp any any eq domain
> ```

Step 4: Configure the DHCP ACL to allow the router to acquire a public IP address dynamically from the ISP. This traffic needs to be defined separately for server and client and cannot be inspected.

```
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc

ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
```

Step 5: Configure the ESP ACL to allow the router to establish IPSEC communications for DMVPN. ESP needs to be explicitly allowed inbound and outbound in separate ACLs. ESP cannot be inspected.

```
ip access-list extended ESP-IN
 permit esp any any

ip access-list extended ESP-OUT
 permit esp any any
```

Step 6: Configure the GRE ACL to allow GRE tunnel formation. GRE needs to be explicitly allowed inbound only.

```
ip access-list extended GRE-IN
 permit gre any any
```

> **Tech Tip**
>
> GRE needs to be permitted inbound for GRE on IOS-XE platforms due to a difference in interface order of operations. This is not required on IOS ISRG2 platforms.

Next, you define class maps for traffic to and from the self-zone. Separate class-maps are required for inbound and outbound initiated flows as well as for traffic that can be inspected by the router.

Step 7: Define the class-map matching inbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
```

Step 8: Define the class-map matching outbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
```

Step 9: Define the class-map matching inbound traffic that is not able to be inspected.

```
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
```

Step 10: Define the class-map matching outbound traffic that cannot be inspected.

```
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
```

Next, you define policy maps. Create two separate policies, one for traffic inbound and one for traffic outbound.

Step 11: Define the inbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
```

Step 12: Define the outbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
```

Tech Tip

Inspection for Layer 7 applications is not allowed for traffic going to and from the self-zone to other zones. Cisco IOS firewalls support only inspection of TCP, UDP, and H.323 traffic that terminates on or originates from the router itself.

Traffic such as DHCP and ESP cannot be inspected and must be configured as **Pass** in the associated policy-map.

Next, you define the zone pair and apply policy maps to them.

Step 13: Define the zone pair for traffic destined to the self-zone of the router from the outside and associate the inbound policy-map defined in the previous step.

```
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
```

Step 14: Define the zone pair for traffic destined from the self-zone of the router to the outside and associate the outbound policy-map defined in the previous step.

```
zone-pair security FROM-ROUTER source self destination OUTSIDE
 service-policy type inspect ACL-OUT-POLICY
```

Procedure 3 Enable and verify zone-based firewall configuration

Step 1: Assign the Internet-facing router interface to the outside security zone. All other interfaces are assigned to the default zone and do not need to be defined.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 zone-member security OUTSIDE
```

Tech Tip

By default, traffic is allowed to flow between interfaces that are members of the same zone, while a default "deny-all" policy is applied to traffic moving between zones.

This design uses the "default" zone for all inside interfaces, traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Loopback interfaces are members of the "self" zone and are not assigned to a defined security zone or the default zone.

Step 2: Verify the interface assignment for the zone firewall and ensure that all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS32-4451X-2#show zone security
zone self
  Description: System defined zone

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically

zone OUTSIDE
  Member Interfaces:
    GigabitEthernet0/0/0
```

Step 3: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS32-4451X-2#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        50 packets, 13824 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        8 packets, 2680 bytes
      Pass
        8 packets, 2680 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: IN_OUT
  Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
    Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
      Match: protocol ftp
        0 packets, 0 bytes
      Match: protocol tcp
        0 packets, 0 bytes
      Match: protocol udp
        0 packets, 0 bytes
      Match: protocol icmp
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: TO-ROUTER
  Service-policy inspect : ACL-IN-POLICY
    Class-map: INSPECT-ACL-IN-CLASS (match-any)
      Match: access-group name ACL-RTR-IN
        52 packets, 14040 bytes
      Inspect
    Class-map: PASS-ACL-IN-CLASS (match-any)
      Match: access-group name ESP-IN
        0 packets, 0 bytes
      Match: access-group name DHCP-IN
        8 packets, 2736 bytes
```

```
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      1697 packets, 332091 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
```

Step 4: Add the following command to the router configuration in order to identify traffic dropped by the Cisco IOS-XE zone firewall.

```
parameter-map type inspect global
 log dropped-packets
```

Tech Tip

In IOS, when you configure the command **ip inspect drop-pkt**, the following is automatically added to the router configuration:

```
parameter-map type inspect global
 log dropped-packets enable
```

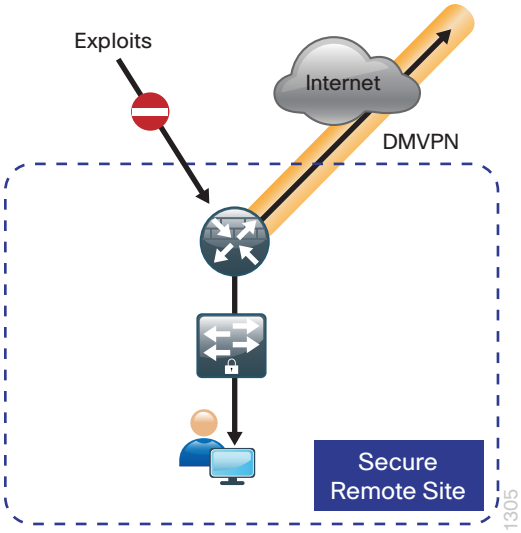
PROCESS

Configuring Additional Router Security

1. Disable IP ICMP redirects
2. Disable ICMP unreachable messages
3. Disable Proxy ARP
4. Disable unused router services
5. Disable CDP and LLDP
6. Enable keepalives for TCP sessions
7. Configure internal-network floating static routes
8. Enable Internet interface

In addition to the security measures already taken in prior configuration tasks, this section introduces best practices recommendations to secure Internet-facing routers. Disabling unused services and features for networking devices improves the overall security posture by minimizing the amount of information exposed. This practice also minimizes the amount of router CPU and memory load that is required to process unneeded packets.

Figure 57 - Additional router security



Tech Tip

These are general security guidelines only. You may take additional measures to secure remote-site routers on a case-by-case basis. Take care to ensure that the disabling of certain features does not impact other functions of the network. For added security in hybrid IWAN designs, you can also apply these additional security configurations to MPLS provider interfaces.

Procedure 1 Disable IP ICMP redirects

Routers use ICMP redirect messages to notify that a better route is available for a given destination. In this situation, the router forwards the packet and sends an ICMP redirect message back to the sender advising of an alternative and preferred route to the destination. In many implementations, there is no benefit in permitting this behavior. An attacker can generate traffic, forcing the router to respond with ICMP redirect messages, negatively impacting the CPU and performance of the router. You can prevent this by disabling ICMP redirect messages.

Step 1: Disable ICMP redirect messages on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip redirects
```

Procedure 2 Disable ICMP unreachable messages

When filtering on router interfaces, routers send ICMP unreachable messages back to the source of blocked traffic. Generating these messages can increase CPU utilization on the router. By default, Cisco IOS ICMP unreachable messages are limited to one every 500 milliseconds. ICMP unreachable messages can be disabled on a per interface basis.

Step 1: Disable ICMP unreachable messages on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip unreachables
```

Procedure 3 Disable Proxy ARP

Proxy ARP allows the router to respond to ARP request for hosts other than itself. Proxy ARP can help machines on a subnet reach remote subnets without configuring routing or a default gateway as defined in RFC 1027. Disadvantages to using proxy ARP:

- An attacker can impact available memory by sending a large number of ARP requests.
- A router is also susceptible to man-in-the-middle attacks where a host on the network could be used to spoof the MAC address of the router, resulting in unsuspecting hosts sending traffic to the attacker.

You can disable proxy ARP by using the **interface** configuration command.

Step 1: Disable proxy ARP on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip proxy-arp
```

Procedure 4 Disable unused router services

As a security best practice, you should disable all unnecessary services that could be used to launch DoS and other attacks. Many unused services that pose a security threat are disabled by default in current Cisco IOS versions.

Step 1: Disable MOP on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no mop enabled
```

Step 2: Disable PAD service globally on the router.

```
no service pad
```

Step 3: Prevent the router from attempting to locate a configuration file via TFTP globally on the router.

```
no service config
```

Procedure 5 Disable CDP and LLDP

Attackers can use CDP and LLDP for reconnaissance and network mapping. CDP is a network protocol that is used to discover other CDP-enabled devices. CDP is often used by NMS and for troubleshooting networking problems. LLDP is an IEEE protocol that is defined in 802.1AB and is very similar to CDP. You should disable CDP and LLDP on router interfaces that connect to untrusted networks.

Step 1: Disable CDP on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no cdp enable
```

Step 2: Disable LLDP on Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no lldp transmit
 no lldp receive
```

Procedure 6 Enable keepalives for TCP sessions

This configuration enables TCP keepalives on inbound connections to the router and outbound connections from the router. This ensures that the device on the remote end of the connection is still accessible and half-open or orphaned connections are removed from the router.

Step 1: Enable the TCP keepalives service for inbound and outbound connections globally on the router.

```
service tcp-keepalives-in
service tcp-keepalives-out
```

Procedure 7 Configure internal-network floating static routes

In the event the DMVPN tunnel to the hub site fails, you will want to ensure traffic destined to internal networks does not follow the local Internet default route. It's best to have the network fail closed to prevent possible security implications and unwanted routing behavior.

Configuring floating static routes to null zero with an AD of 254 ensures that all internal subnets route to null0 in the event of tunnel failure.

Step 1: Configure static route for internal network subnets.

```
ip route 10.0.0.0 255.0.0.0 null0 254
```

Tech Tip

Configure the appropriate number of null 0 routes for internal network ranges, using summaries when possible for your specific network environment.

Procedure 8 Enable Internet interface

Now that the security configurations are complete, you can enable the Internet-facing interface.

Step 1: Enable the Internet-facing router interface.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no shutdown
```

PROCESS

Configuring ISP Black-Hole Routing Detection

1. Configure ISP black-hole routing detection

In many cases you will need to ensure connectivity issues with your ISP does not cause black-hole routing conditions. Failure conditions can exist where the DHCP address and routes are not removed from the remote-site router when connectivity issues exist with the broadband service or local premise equipment. There may also be circumstances if certain services are unreachable within via the local ISP connection that you want to reroute to a secondary Internet service.

Tech Tip

This configuration requires you to turn off Performance Routing (PfR) load-balancing on the Hub Master Controller. If PfR load-balancing is not turned off, the traffic will fail over to the central site Internet path, but it will not return to the local DIA interface after the failure condition is resolved.

If central Internet fallback is required, configure one or more of the following options on the secondary router.

Procedure 1 Configure ISP black-hole routing detection

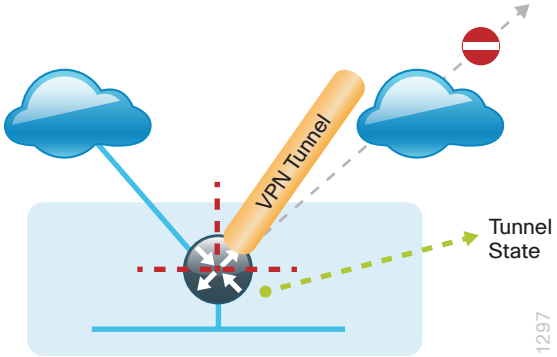
Option 1: DMVPN Tunnel State Tracking

In this solution, the DMVPN tunnel state is used to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, a "down" state of the tunnel interface triggers the removal of the default route via an EEM script. If tunnel state is "up," the route will remain.

Tech Tip

With this method a failure or maintenance at the central site can cause a failover event where the route is removed due to tunnel state change and the local Internet connection remains active at the remote site. In hybrid configurations this can cause failover to Central Internet for multiple sites. It is recommended that you use the other options presented in this guide for hybrid DIA configurations.

Figure 58 - IWAN tunnel tracking with EEM



Step 1: Ensure that state tracking is configured for the DMVPN tunnel interface on the secondary router.

```
interface Tunnel11
 if-state nhrp
```

Step 2: Configure the tracking parameters and logic for the IPSLA probes on the secondary router.

```
track 80 interface Tunnel10 line-protocol
```

Step 3: On the secondary router, configure an EEM script to remove the local default route when the tunnel line protocol transitions to a "down" state.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

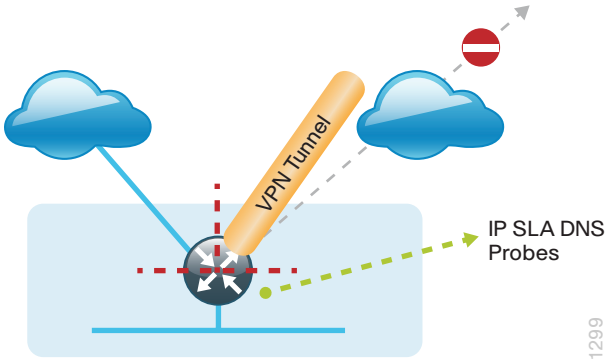
Step 4: On the secondary router, configure an EEM script to also restore the local default route when the tunnel state tracking object is "up".

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 2: DNS-Based IPSLA Probes

In this solution, you use DNS-based IPSLA probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of DNS probes to two or more root DNS servers triggers the removal of the default route via an EEM script. If any DNS probe is active, the route will remain.

Figure 59 - IPSLA with DNS probes



Tech Tip

For DNS-based IPSLA probes to function, you need to ensure that DNS or "domain" is permitted in the ZBFW outbound ACL, from the self-zone to the OUTSIDE zone.

Example:

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq domain
```

Step 1: On the secondary router, configure the VRF-aware IPSLA DNS probes.

```
ip sla 118
 dns d.root-servers.net name-server 199.7.91.13
 vrf IWAN-TRANSPORT-2
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 118 life forever start-time now

ip sla 119
 dns b.root-servers.net name-server 192.228.79.201
 vrf IWAN-TRANSPORT-2
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 119 life forever start-time now
```

Tech Tip

When configuring DNS probes, you should specify the hostname of the DNS server itself. That asks the DNS server to resolve for itself, allowing the use of root DNS servers.

Step 2: On the secondary router, configure the tracking parameters and logic for the IPSLA probes.

```
track 73 ip sla 118 reachability
track 74 ip sla 119 reachability
!
track 100 list boolean or
 object 73
 object 74
```

Step 3: On the secondary router, configure an EEM script to remove the route in the event of DNS probe failure.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

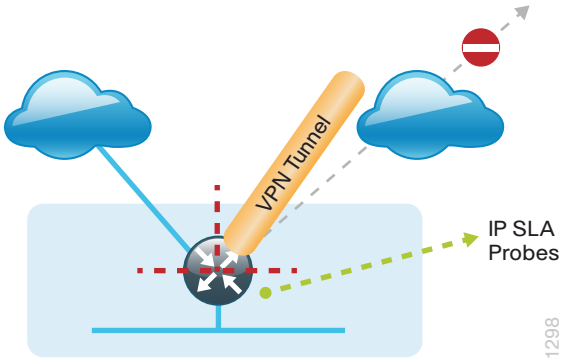
Step 4: On the secondary router, configure an EEM script to also restore the local default route when the DNS probes are active.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 3: IPLSA ICMP Probes

In this solution, you use IPSLA ICMP probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of ICMP probes to two different IP hosts triggers the removal of the default route via an EEM script. If either ICMP probe is active, the route will remain.

Figure 60 - IPSLA with ICMP probes



Tech Tip

For ICMP-based IPSLA probes to function, you need to ensure ICMP is permitted in the outbound ACL, from the self-zone to the OUTSIDE zone.

Step 1: Configure the VRF-aware IPSLA ICMP probes.

```
ip sla 110
 icmp-echo 172.18.1.253 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-2
 threshold 1000
 frequency 15
ip sla schedule 110 life forever start-time now

ip sla 111
 icmp-echo 172.18.1.254 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-2
 threshold 1000
 frequency 15
ip sla schedule 111 life forever start-time now
```

Step 2: Configure the tracking parameters and logic for the IPSLA ICMP probes.

```
track 60 ip sla 110 reachability
track 61 ip sla 111 reachability
track 62 list boolean or
 object 60
 object 61
```

Step 3: Configure the EEM script to remove the route when the ICMP probes are down.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

Step 4: Configure the EEM script to also restore the local default route when the ICMP probes are active.

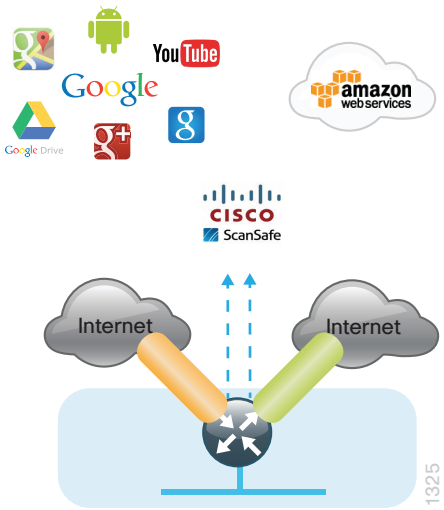
```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

IWAN Single-Router Dual-Internet Remote Site with DIA

This section describes configuring DIA for the single-router dual-Internet IWAN design. . These configurations assume that the single-router dual-Internet site with centralized Internet access is configured and functional, as described in the Intelligent WAN Technology Design Guide.

In this section, you convert a remote site from centralized Internet access for employees to a secure DIA configuration.

Figure 61 - IWAN single-router dual-Internet with DIA



PROCESS

Configuring DIA Routing

1. Configure Internet interfaces
2. Filter EIGRP learned central default route
3. Configure local default routing for outbound local Internet traffic
4. Configure local policy routing for return Internet traffic

In the following procedures, you enable AIA routing, NAT and zone-based firewall configurations for the single-router dual-Internet IWAN design. In this configuration, local internet traffic will be routed using split-tunneling outside the DMVPN tunnel. All configurations are specific to this design model.

Procedure 1 Configure Internet interfaces

For security, disable the ISP interface before configuring DIA. You will not restore this interface until you complete all of the configurations in this section.

Tech Tip

If you are remotely connected to the remote-site router via SSH, you will be disconnected from the router console. Shutting down the Internet interfaces will drop the existing DMVPN tunnel.

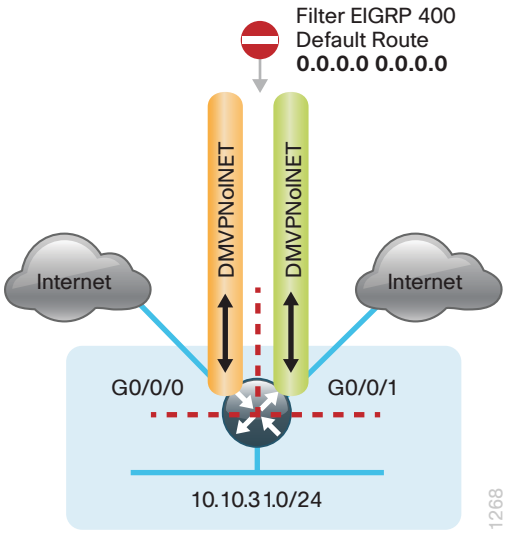
Step 1: Verify that the Internet-facing interfaces are disabled.

```
interface GigabitEthernet0/0/0
 shutdown

interface GigabitEthernet0/0/1
 shutdown
```

Procedure 2 Filter EIGRP learned central default route

With DIA routing, the default route is locally configured for the global routing table. It is important to filter the default route originating over both Internet-facing DMVPN tunnels from the central site. In the single-router dual-Internet design with DIA, all Internet traffic is routed directly to the local ISP interface; it is not feasible to failover to central internet using an Internet-based DMVPN tunnel. Internet failover is from the primary to the secondary Internet interface on the router.

Figure 62 - Filter inbound EIGRP default route from the central site



Step 1: Create an access list to match the default route and permit all other routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Create a route-map to reference the access list.

```
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
  match ip address ALL-EXCEPT-DEFAULT
```

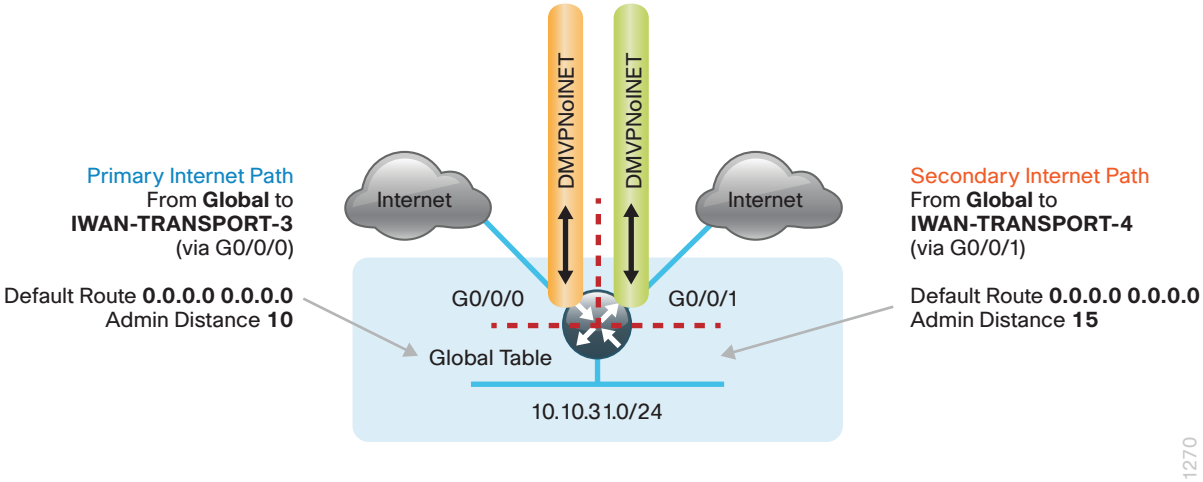
Step 3: Apply the policy as an inbound distribute list for the Internet-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel20
   distribute-list route-map BLOCK-DEFAULT in tunnel21
exit
```

Procedure 3 Configure local default routing for outbound local Internet traffic

Internal employee traffic is in the global table and needs to route to the Internet via the ISP interface in the IWAN-TRANSPORT-3 VRF. This configuration allows traffic to traverse from the global to the outside VRF in DMVPN F-VRF configurations used for IWAN.

Figure 63 - IWAN single-router dual-Internet–egress default routing



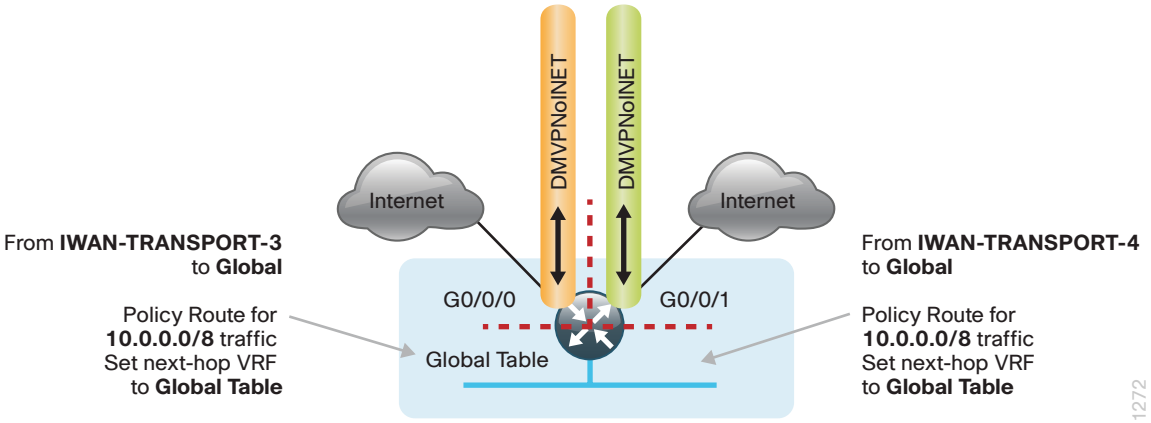
Step 1: Configure a default route in the global table that allows traffic into the outside transit VRF and set the administrative distances.

```
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 15
```

Procedure 4 Configure local policy routing for return Internet traffic

Traffic returning to the outside NAT address of the router ISP interface will be contained inside the IWAN-TRANSPORT-3 and IWAN-TRANSPORT-4 VRFs. The local policy configuration allows this traffic to be routed back to the global table.

Figure 64 - IWAN single-router dual-Internet–local policy return routing



Step 1: Configure an ACL that matches the summary range of the internal IP networks.

```
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
```

Step 2: Create a route map that references the ACL and changes the traffic to the global table.

```
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
```

Step 3: Apply the local policy routing configuration to the Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 ip policy route-map INET-INTERNAL

interface GigabitEthernet0/0/1
 ip policy route-map INET-INTERNAL
```

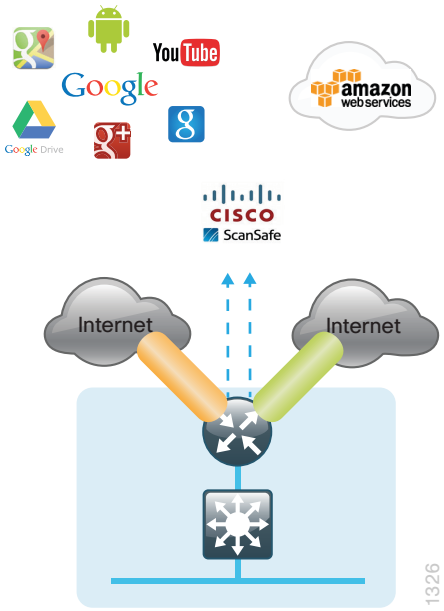
PROCESS

Configuring Single-Router Remote Site with Layer 3 Distribution

1. Configure outbound filtering of the default route to the WAN
2. Configure static default route redistribution into EIGRP

Use this process when a single-router IWAN site requires connectivity to a Layer 3 distribution switch as outlined in the Intelligent WAN Technology Design Guide. Here, you need to redistribute the local default route into EIGRP for advertisement to the Layer 3 switch and filter the default route from being advertised to the WAN.

Figure 65 - IWAN single-router dual-Internet–Layer 3 distribution



Procedure 1 Configure outbound filtering of the default route to the WAN

Perform these steps when connecting a single-router to a Layer 3 distribution switch.

Step 1: Configure an access list to deny the default route and permit all over routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Add an instance after the existing route map named "ROUTE-LIST" and reference the access list that denies the default route and permits all other routes. There should be an instance of this route map from the IWAN foundation configuration. This statement should go between the existing statements.

```
route-map ROUTE-LIST deny 20
 description Block Local Internet Default route out to the WAN
 match ip address DEFAULT-ONLY
```

Step 3: On both routers, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel20
   distribute-list route-map ROUTE-LIST out Tunnel21
  exit-af-topology
exit-address-family
```

Procedure 2 Configure static default route redistribution into EIGRP

Perform these steps when connecting a single router to a Layer 3 distribution switch.

Step 1: Configure an access list to match the default route for redistribution.

```
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
```

Step 2: Configure a route map for static redistribution, referencing the access list that matches the static default route.

```
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
```

Step 3: Redistribute the static default route installed by DHCP into EIGRP AS400 by using the route map.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   redistribute static route-map STATIC-IN
  exit-af-topology
exit-address-family
```

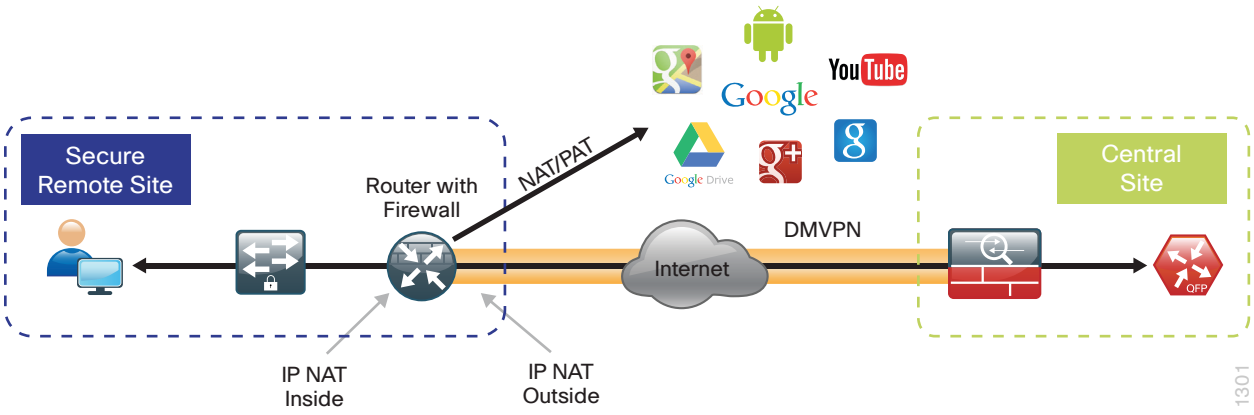
PROCESS

Configuring Network Address Translation for DIA

1. Configure NAT policy on a single router with dual-Internet links

In this design, inside hosts use RFC 1918 addresses, and traffic destined to the Internet from the local site needs to be translated to public IP space. The Internet-facing interface on the remote-site router uses DHCP to acquire a publically routable IP address; the NAT policy here will translate inside private IP addressed hosts to this DHCP address by using PAT.

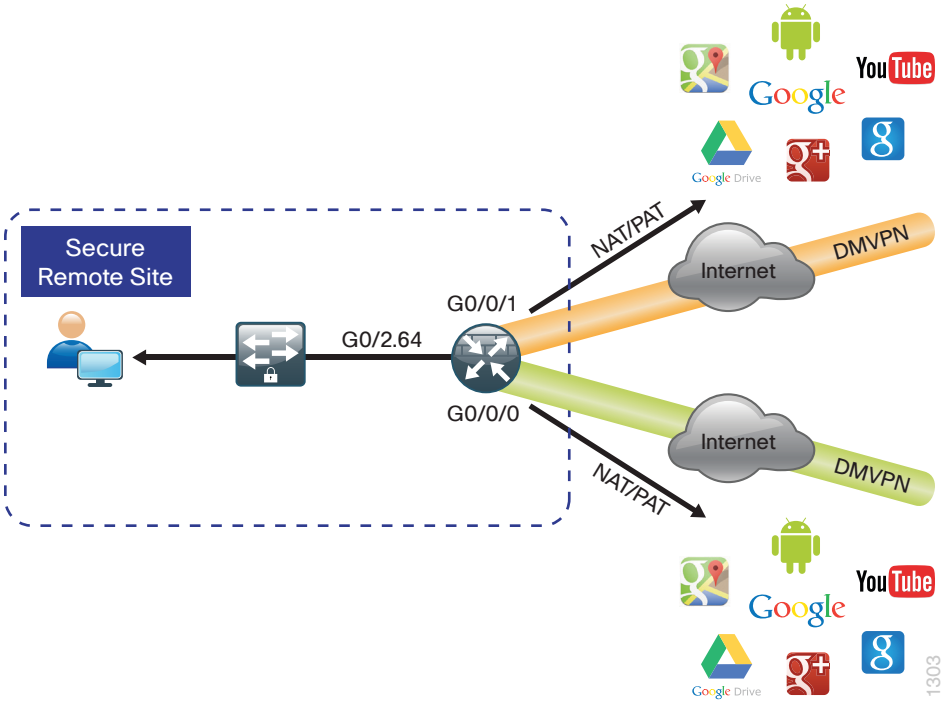
Figure 66 - NAT for Internet traffic



Procedure 1 Configure NAT policy on a single router with dual-Internet links

Use this procedure if you want to configure NAT for single-router dual-Internet configurations. This procedure provides the NAT configurations required when connecting a single router to two different ISPs.

Figure 67 - IWAN single-router dual-Internet–NAT



Step 1: Define a policy matching the desired traffic to be translated. Use an ACL and include all remote-site subnets.

```
ip access-list extended NAT
 permit ip 10.7.160.0 0.0.7.255 any
```

Step 2: Configure route maps matching the ACL and interfaces where NAT will be applied.

```
route-map ISP-A permit 10
 match ip address NAT
 match interface GigabitEthernet0/0/0

route-map ISP-B permit 10
 match ip address NAT
 match interface GigabitEthernet0/0/1
```

Step 3: Configure the NAT policies for PAT on both Internet interfaces.

```
ip nat inside source route-map ISP-A interface GigabitEthernet0/0/0 overload
ip nat inside source route-map ISP-B interface GigabitEthernet0/0/1 overload
```

Step 4: Enable NAT by applying the policy to the inside router interfaces. Apply this configuration, as needed, to internal interfaces or sub-interfaces where traffic matching the ACL may originate, such as the data network.

```
interface GigabitEthernet0/0/2.64
 ip nat inside
```

Step 5: Configure the Internet-facing interfaces for NAT.

```
interface GigabitEthernet0/0/0
 description Internet Connection (ISP-A)
 ip nat outside

interface GigabitEthernet0/0/1
 description Internet Connection (ISP-B)
 ip nat outside
```

> **Tech Tip**
>
> When you configure NAT on IOS router interfaces, you will see **ip virtual-reassembly in** added to the configuration. This is automatically enabled for features that require fragment reassembly, such as NAT, Firewall, and IPS.

Step 6: Verify proper interfaces are configured for NAT.

```
RS33-4451X#show ip nat statistics
Total active translations: 175 (0 static, 175 dynamic; 175 extended)
Outside interfaces:
  GigabitEthernet0/0/0, GigabitEthernet0/0/1
Inside interfaces:
  GigabitEthernet0/0/2.64
Hits: 587036  Misses: 5285
Expired translations: 5108
Dynamic mappings:
-- Inside Source
[Id: 1] route-map ISP-A interface GigabitEthernet0/0/0 refcount 175
[Id: 2] route-map ISP-B interface GigabitEthernet0/0/1 refcount 0
refcount 0
nat-limit statistics:
 max entry: max allowed 0, used 0, missed 0
In-to-out drops: 0  Out-to-in drops: 11
Pool stats drop: 0  Mapping stats drop: 0
Port block alloc fail: 0
IP alias add fail: 0
Limit entry add fail: 0
```

Step 7: Verify NAT translations for intended sources that are using local Internet services.

```
RS33-4451X#show ip nat translations
Pro Inside global       Inside local       Outside local       Outside global
tcp  172.18.99.11:5021  10.7.164.20:49678  69.25.24.26:80      69.25.24.26:80
tcp  172.18.99.11:5108  10.7.164.20:49765  23.203.221.156:443  23.203.221.156:443
tcp  172.18.99.11:4105  10.7.164.20:49786  23.204.109.42:80    23.204.109.42:80
tcp  172.18.99.11:4975  10.7.164.20:49632  23.204.109.48:80    23.204.109.48:80
```

PROCESS

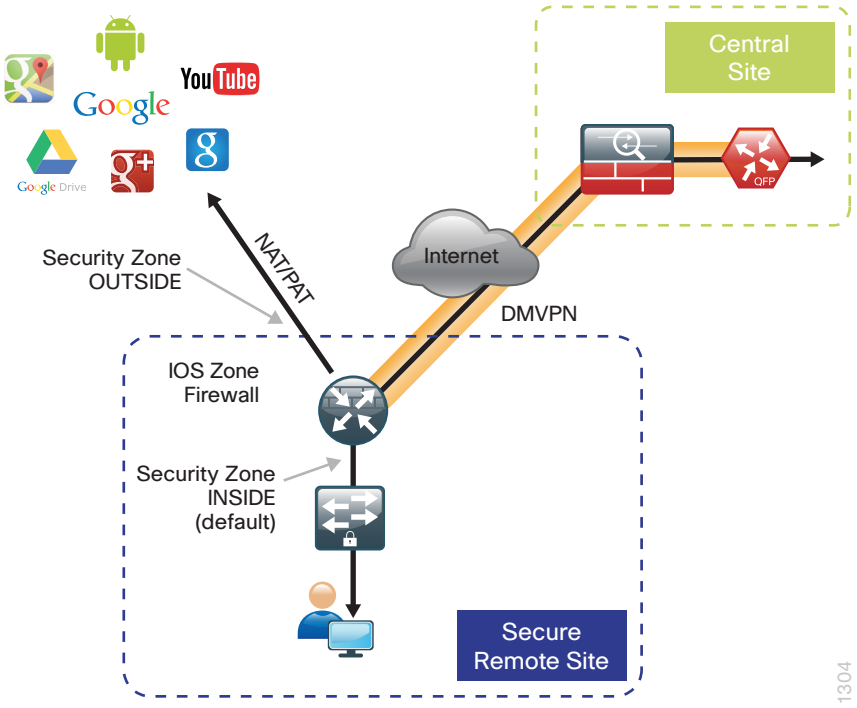
Configuring Zone-Based Firewall for DIA

1. Configure base Cisco IOS Zone-Based Firewall parameters
2. Restrict traffic to the router
3. Enable and verify zone-based firewall configuration

The following Cisco IOS firewall configuration is intended for use on Internet-facing remote site routers that provide secure local Internet access. This configuration assumes DHCP and DMVPN are also configured to use the outside interface. To configure the required base firewall policies, complete the following procedures.

Follow these procedures to secure a single-router dual-Internet remote-site router with direct Internet configurations.

Figure 68 - Zone-based firewall for DIA



Procedure 1 Configure base Cisco IOS Zone-Based Firewall parameters

Step 1: If it is configured, remove the inbound ACL from the Internet-facing router interfaces, and then shut down the interface before continuing. This prevents unauthorized traffic while the ZBFW is configured.

```
interface GigabitEthernet0/0/0
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
interface GigabitEthernet0/0/1
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
```

Step 2: Define security zones. A *zone* is a named group of interfaces that have similar functions or security requirements. This example defines the names of the three basic security zones identified.

Step 3: This example has two outside interfaces that are both in a unique VRF. In this situation, you must define two security zones; you cannot define a single security zones to interfaces in different VRFs.

Step 4: For simplicity, this design uses the "default" security zone for inside interfaces. Once the default zone has been defined, all interfaces not explicitly configured as members of a security zone will automatically be part of the default security zone.

```
zone security default
zone security OUTSIDE-A
zone security OUTSIDE-B
```

Tech Tip

This design uses the "default" zone for all inside interfaces; traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Be aware that any interface that is removed from a defined security zone will be automatically placed into the default zone. In this configuration, that interface will be treated as an "inside" zone and have access to the internal routing domain.

Step 5: Define a class map to match specific protocols. Class-maps apply **match-any** or **match-all** operators in order to determine how to apply the match criteria to the class. If **match-any** is specified, traffic must meet at least one of the match criteria in the class-map to be included in the class. If **match-all** is specified, traffic must meet all of the match criteria to be included in the class.

```
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol tcp
 match protocol udp
 match protocol icmp
```

Tech Tip

Protocols that use single ports (such as HTTP, telnet, SSH, etc.) can be statefully allowed with tcp inspection alone by using the **match protocol tcp** command.

Protocols such as **ftp** that use multiple ports (one for control and another for data) require application inspection in order to enable dynamic adjustments to the active firewall policy. The specific TCP ports that are required for the application are allowed for short durations, as necessary.

Step 6: Define policy maps. A policy is an association of traffic classes and actions. It specifies what actions should be performed on defined traffic classes. In this case, you statefully inspect the outbound session so that return traffic is permitted.

```
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
```

Tech Tip

An *action* is a specific functionality that is associated with a traffic class. **Inspect**, **drop**, and **pass** are actions.

With the **inspect** action, return traffic is automatically allowed for established connections. The **pass** action permits traffic in one direction only. When using the **pass** action, you must explicitly define rules for return traffic.

Step 7: Define the zone pair and apply the policy map. A zone pair represents two defined zones and identifies the source and destination zones where a unidirectional firewall policy-map is applied. This configuration uses only one zone pair because all traffic is inspected and thus allowed to return. In this case, you need to define two zone pairs: one for each outside zone and the default zone.

```
zone-pair security IN_OUT-A source default destination OUTSIDE-A
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY

zone-pair security IN_OUT-B source default destination OUTSIDE-B
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
```

Procedure 2 Restrict traffic to the router

Cisco IOS defines the router by using the fixed-name self as a separate security zone. The self-zone is the exception to the default deny-all policy.

All traffic destined to or originating from the router itself (local traffic) on any interface is allowed until traffic is explicitly denied. In other words, any traffic flowing directly between defined zones and the router's IP interfaces is implicitly allowed and is not initially controlled by zone firewall policies.

This default behavior of the self-zone ensures that connectivity to the router's management interfaces and the function of routing protocols is maintained when an initial zone firewall configuration is applied to the router.

Specific rules that control traffic to the self-zone are required. When you configure a ZBFW rule that includes the self-zone, traffic between the self-zone and the other defined zones is immediately restricted in both directions.

Table 3 - Self-zone firewall access list parameters

Protocol	Stateful inspection policy
ISAKMP	Yes
ICMP	Yes
DHCP	No
ESP	No
GRE	No

The following configuration allows the required traffic for proper remote-site router configuration with DMVPN. ESP and DHCP cannot be inspected and need to be configured with a **pass** action in the policy, using separate ACL and class-maps. ISAKMP should be configured with the **inspect** action and thus needs to be broken out with a separate ACL and class-maps for inbound and outbound policies.

Tech Tip

More specific ACLs than are shown here with the "any" keyword are recommended for added security.

Step 1: In the following steps, define access lists.

Step 2: Define an ACL allowing traffic with a destination of the router itself from the OUTSIDE zone. This includes ISAKMP for inbound tunnel initiation. This traffic can be inspected and is identified in the following ACL.

```
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
```

Step 3: Identify traffic for IPSEC tunnel initiation and other traffic that will originate from the router (self-zone) to the OUTSIDE zone. This traffic can be inspected.

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
```

Tech Tip

The ICMP and domain entries here are for IPSLA probes that originate from the router.

```
permit icmp any any
permit udp any any eq domain
```

Step 4: Configure the DHCP ACL to allow the router to acquire a public IP address dynamically from the ISP. This traffic needs to be defined separately for server and client and cannot be inspected.

```
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc

ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
```

Step 5: Configure the ESP ACL to allow the router to establish IPSEC communications for DMVPN. ESP needs to be explicitly allowed inbound and outbound in separate ACLs. ESP cannot be inspected.

```
ip access-list extended ESP-IN
 permit esp any any

ip access-list extended ESP-OUT
 permit esp any any
```

Step 6: Configure the GRE ACL to allow GRE tunnel formation. GRE needs to be explicitly allowed inbound only.

```
ip access-list extended GRE-IN
 permit gre any any
```

Tech Tip

GRE needs to be permitted inbound for GRE on IOS-XE platforms due to a difference in interface order of operations. This is not required on IOS ISRG2 platforms.

Next, you define class maps for traffic to and from the self-zone. Separate class-maps are required for inbound and outbound initiated flows as well as for traffic that can be inspected by the router.

Step 7: Define the class-map matching inbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
```

Step 8: Define the class-map matching outbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
```

Step 9: Define the class-map matching inbound traffic that is not able to be inspected.

```
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
```

Step 10: Define the class-map matching outbound traffic that cannot be inspected.

```
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
```

Next, you define policy maps. Create two separate policies, one for traffic inbound and one for traffic outbound.

Step 11: Define the inbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
```

Step 12: Define the outbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
```

Tech Tip

Inspection for Layer 7 applications is not allowed for traffic going to and from the self-zone to other zones. Cisco IOS firewalls support only inspection of TCP, UDP, and H.323 traffic that terminates on or originates from the router itself.

Traffic such as DHCP and ESP cannot be inspected and must be configured as **Pass** in the associated policy-map.

Next, you define the zone pair and apply policy maps to them.

Step 13: Define the zone pair for traffic destined to the self-zone of the router from the outside and associate the inbound policy-map defined in the previous step.

```
zone-pair security TO-ROUTER-A source OUTSIDE-A destination self
 service-policy type inspect ACL-IN-POLICY

zone-pair security TO-ROUTER-B source OUTSIDE-B destination self
 service-policy type inspect ACL-IN-POLICY
```

Step 14: Define the zone pair for traffic destined from the self-zone of the router to the outside and associate the outbound policy-map defined in the previous step.

```
zone-pair security FROM-ROUTER-A source self destination OUTSIDE-A
 service-policy type inspect ACL-OUT-POLICY

zone-pair security FROM-ROUTER-B source self destination OUTSIDE-B
 service-policy type inspect ACL-OUT-POLICY
```

Procedure 3 Enable and verify zone-based firewall configuration

Step 1: Assign the Internet-facing router interfaces to the outside security zone. All other interfaces are assigned to the default zone and do not need to be defined.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 zone-member security OUTSIDE-A

interface GigabitEthernet0/0/1
 description Internet Connection
 zone-member security OUTSIDE-B
```

Tech Tip

Interfaces in different VRFs cannot be assigned to the same security zone. In this case, each ISP interface must be in a different security zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Loopback interfaces are members of the "self" zone and are not assigned to a defined security zone or the default zone.

Step 2: Verify the interface assignment for the zone firewall and ensure that all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS33-4451X#show zone security
zone self
  Description: System defined zone

zone OUTSIDE-A
  Member Interfaces:
    GigabitEthernet0/0/0

zone OUTSIDE-B
  Member Interfaces:
    GigabitEthernet0/0/1

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically
```

Step 3: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS33-4451X#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER-A
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        1653936 packets, 103139556 bytes
      Inspect
        Established Sessions
         Session ID 0x001955D3 (172.18.99.11:8)=>(172.18.1.253:23626) icmp
SIS_OPEN
          Created 00:00:04, Last heard 00:00:04
          Bytes sent (initiator:responder) [36:36]
         Session ID 0x001955D2 (172.18.99.11:8)=>(172.18.1.254:23625) icmp
SIS_OPEN
          Created 00:00:04, Last heard 00:00:04
          Bytes sent (initiator:responder) [36:36]


    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        82 packets, 27470 bytes
      Pass
        82 packets, 27470 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
```

```
        0 packets, 0 bytes
  Zone-pair: FROM-ROUTER-B
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        676 packets, 169296 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        82 packets, 27470 bytes
      Pass
        82 packets, 27470 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: IN_OUT-A
  Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
    Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
      Match: protocol ftp
        0 packets, 0 bytes
      Match: protocol icmp
        0 packets, 0 bytes
      Match: protocol udp
        4 packets, 357 bytes
      Match: protocol tcp
        2541 packets, 156894 bytes
      Inspect
        Established Sessions
         Session ID 0x00195303 (10.7.164.20:50159)=>(199.59.148.12:80) tcp
SIS_OPEN
          Created 00:12:12, Last heard 00:12:11
          Bytes sent (initiator:responder) [333:748]
         Session ID 0x001955C3 (10.7.164.20:50250)=>(54.235.157.205:80) tcp
SIS_OPEN
          Created 00:00:23, Last heard 00:00:23
          Bytes sent (initiator:responder) [0:0]
         Session ID 0x001955C2 (10.7.164.20:50249)=>(54.235.157.205:80) tcp
SIS_OPEN
          Created 00:00:23, Last heard 00:00:22
          Bytes sent (initiator:responder) [518:213]
         Session ID 0x001951E5 (10.7.164.20:50062)=>(23.204.109.9:80) tcp
SIS_OPEN
          Created 00:15:45, Last heard 00:00:00
          Bytes sent (initiator:responder) [719288:33937120]
```

```
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: IN_OUT-B
Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
  Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
    Match: protocol ftp
      0 packets, 0 bytes
    Match: protocol icmp
      0 packets, 0 bytes
    Match: protocol udp
      0 packets, 0 bytes
    Match: protocol tcp
      0 packets, 0 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: TO-ROUTER-A
Service-policy inspect : ACL-IN-POLICY
  Class-map: INSPECT-ACL-IN-CLASS (match-any)
    Match: access-group name ACL-RTR-IN
      520 packets, 140828 bytes
    Inspect
  Class-map: PASS-ACL-IN-CLASS (match-any)
    Match: access-group name ESP-IN
      0 packets, 0 bytes
    Match: access-group name DHCP-IN
      82 packets, 28044 bytes
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      17880 packets, 3495146 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: TO-ROUTER-B
Service-policy inspect : ACL-IN-POLICY
  Class-map: INSPECT-ACL-IN-CLASS (match-any)
    Match: access-group name ACL-RTR-IN
      522 packets, 142292 bytes
    Inspect
  Class-map: PASS-ACL-IN-CLASS (match-any)
    Match: access-group name ESP-IN
```

```
      0 packets, 0 bytes
    Match: access-group name DHCP-IN
      82 packets, 28044 bytes
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      17888 packets, 3496154 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
```

Step 4: Add the following command to the router configuration in order to identify traffic dropped by the Cisco IOS-XE zone firewall.

```
parameter-map type inspect global
 log dropped-packets
```

Tech Tip

In IOS, when you configure the command **ip inspect drop-pkt**, the following is automatically added to the router configuration:

```
parameter-map type inspect global
 log dropped-packets enable
```

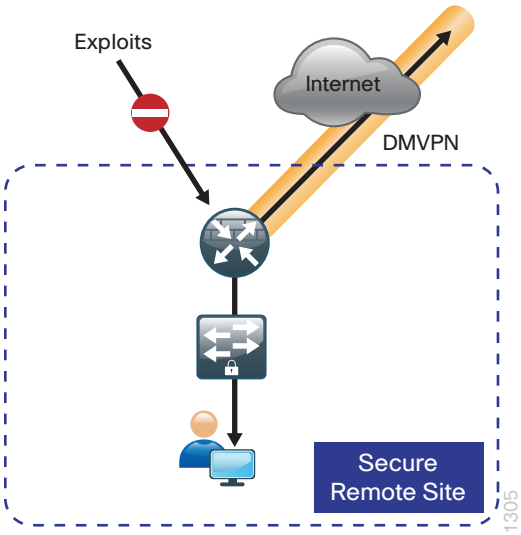
PROCESS

Configuring Additional Router Security

1. Disable IP ICMP redirects
2. Disable ICMP unreachable messages
3. Disable proxy ARP
4. Disable unused router services
5. Disable CDP and LLDP
6. Enable keepalives for TCP sessions
7. Configure internal-network floating static routes
8. Enable Internet interfaces

In addition to the security measures already taken in prior configuration tasks, this section introduces best practices recommendations for securing Internet-facing routers. Disabling unused services and features for networking devices improves the overall security posture by minimizing the amount of information exposed. This practice also minimizes the amount of router CPU and memory load that is required to process unneeded packets.

Figure 69 - Additional router security



Tech Tip

These are general security guidelines only. You may take additional measures to secure remote-site routers on a case-by-case basis. Take care to ensure that the disabling of certain features does not impact other functions of the network.

Procedure 1 Disable IP ICMP redirects

Routers use ICMP redirect messages to notify that a better route is available for a given destination. In this situation, the router forwards the packet and sends an ICMP redirect message back to the sender advising of an alternative and preferred route to the destination. In many implementations, there is no benefit in permitting this behavior. An attacker can generate traffic, forcing the router to respond with ICMP redirect messages, negatively impacting the CPU and performance of the router. You can prevent this by disabling ICMP redirect messages.

Step 1: Disable ICMP redirect messages on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no ip redirects

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no ip redirects
```

Procedure 2 Disable ICMP unreachable messages

When filtering on router interfaces, routers send ICMP unreachable messages back to the source of blocked traffic. Generating these messages can increase CPU utilization on the router. By default, Cisco IOS ICMP unreachable messages are limited to one every 500 milliseconds. ICMP unreachable messages can be disabled on a per interface basis.

Step 1: Disable ICMP unreachable messages on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no ip unreachables

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no ip unreachables
```

Procedure 3 Disable proxy ARP

Proxy ARP allows the router to respond to ARP request for hosts other than itself. Proxy ARP can help machines on a subnet reach remote subnets without configuring routing or a default gateway as defined in RFC 1027. Disadvantages to using proxy ARP:

- An attacker can impact available memory by sending a large number of ARP requests.
- A router is also susceptible to man-in-the-middle attacks where a host on the network could be used to spoof the MAC address of the router, resulting in unsuspecting hosts sending traffic to the attacker.

You can disable proxy ARP by using the **interface** configuration command.

Step 1: Disable proxy ARP on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no ip proxy-arp

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no ip proxy-arp
```

Procedure 4 Disable unused router services

As a security best practice, you should disable all unnecessary services that could be used to launch DoS and other attacks. Many unused services that pose a security threat are disabled by default in current Cisco IOS versions.

Step 1: Disable MOP on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no mop enabled

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no mop enabled
```

Step 2: Disable PAD service globally on the router.

```
no service pad
```

Step 3: Prevent the router from attempting to locate a configuration file via TFTP globally on the router.

```
no service config
```

Procedure 5 Disable CDP and LLDP

Attackers can use CDP and LLDP for reconnaissance and network mapping. CDP is a network protocol that is used to discover other CDP-enabled devices. CDP is often used by NMS and for troubleshooting networking problems. LLDP is an IEEE protocol that is defined in 802.1AB and is very similar to CDP. You should disable CDP and LLDP on router interfaces that connect to untrusted networks.

Step 1: Disable CDP on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no cdp enable

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no cdp enable
```

Step 2: Disable LLDP on Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no lldp transmit
 no lldp receive

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no lldp transmit
 no lldp receive
```

Procedure 6 Enable keepalives for TCP sessions

This configuration enables TCP keepalives on inbound connections to the router and outbound connections from the router. This ensures that the device on the remote end of the connection is still accessible and half-open or orphaned connections are removed from the router.

Step 1: Enable the TCP keepalives service for inbound and outbound connections globally on the router.

```
service tcp-keepalives-in
service tcp-keepalives-out
```

Procedure 7 Configure internal-network floating static routes

In the event the DMVPN tunnel to the hub site fails, you will want to ensure traffic destined to internal networks does not follow the local Internet default route. It's best to have the network fail closed to prevent possible security implications and unwanted routing behavior.

Configuring floating static routes to null zero with an AD of 254 ensures that all internal subnets route to null0 in the event of tunnel failure.

Step 1: Configure static route for internal network subnets.

```
ip route 10.0.0.0 255.0.0.0 null0 254
```

Tech Tip

Configure the appropriate number of null 0 routes for internal network ranges, using summaries when possible for your specific network environment.

Procedure 8 Enable Internet interfaces

Now that the security configurations are complete, you can enable the Internet-facing interfaces.

Step 1: Enable the Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 description Internet Connection ISP-A
 no shutdown

interface GigabitEthernet0/0/1
 description Internet Connection ISP-B
 no shutdown
```

PROCESS

Configuring ISP Black-Hole Routing Detection

1. Configure ISP black-hole routing detection

In many cases you will need to ensure connectivity issues with your ISP does not cause black-hole routing conditions. Failure conditions can exist where the DHCP address and routes are not removed from the remote-site router when connectivity issues exist with the broadband service or local premise equipment. There may also be circumstances if certain services are unreachable within via the local ISP connection that you want to reroute to a secondary Internet service.

If Internet fallback is required, configure one or more of the following options.

Procedure 1 Configure ISP black-hole routing detection

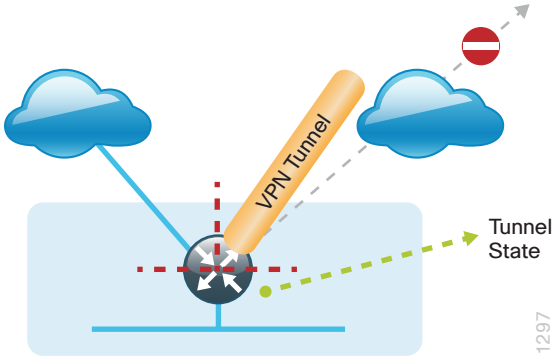
Option 1: DMVPN Tunnel State Tracking

In this solution, the DMVPN tunnel state is used to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, a "down" state of the tunnel interface triggers the removal of the default route via an EEM script. If tunnel state is "up" the route will remain.

Tech Tip

With this method, a failure or maintenance at the central site can cause a failover event where the route is removed due to tunnel state change and the local Internet connection remains active at the remote site.

Figure 70 - IWAN tunnel tracking with EEM



Step 1: Ensure that state tracking is configured for the DMVPN tunnel interface.

```
interface Tunnel20
 if-state nhrp
```

Step 2: Configure the tracking parameters and logic for the IPSLA probes.

```
track 80 interface Tunnel20 line-protocol
```

Step 3: Configure an EEM script to remove the local default route when the tunnel line protocol transitions to a "down" state.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

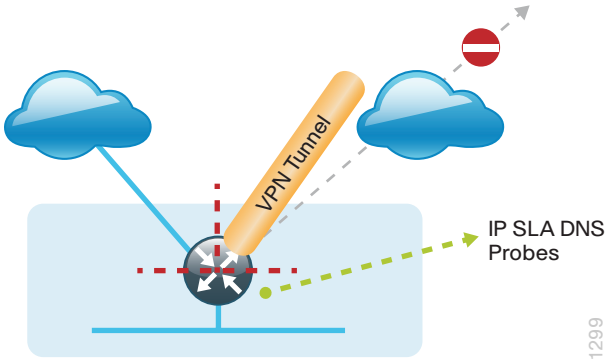
Step 4: Configure an EEM script to restore the local default route when the tunnel line protocol transitions to an "up" state.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 2: DNS-based IPSLA Probes

In this solution, you use DNS-based IPSLA probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of DNS probes to two or more root DNS servers triggers the removal of the default route via an EEM script. If any DNS probe is active, the route will remain.

Figure 71 - IPSLA with DNS probes



Tech Tip

For DNS-based IPSLA probes to function, you need to ensure that DNS or "domain" is permitted in the ZBFW outbound ACL, from the self-zone to the OUTSIDE zone.

Example:

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq domain
```

Step 1: Configure the VRF-aware IPSLA DNS probes.

```
ip sla 118
 dns d.root-servers.net name-server 199.7.91.13
 vrf IWAN-TRANSPORT-3
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 118 life forever start-time now

ip sla 119
 dns b.root-servers.net name-server 192.228.79.201
 vrf IWAN-TRANSPORT-3
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 119 life forever start-time now
```

Tech Tip

When configuring DNS probes, you should specify the hostname of the DNS server itself. That asks the DNS server to resolve for itself, allowing the use of root DNS servers.

Step 2: Configure the tracking parameters and logic for the IPSLA probes.

```
track 73 ip sla 118 reachability
track 74 ip sla 119 reachability
!
track 100 list boolean or
 object 73
 object 74
```

Step 3: Configure an EEM script to remove the route in the event of DNS probe failure.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

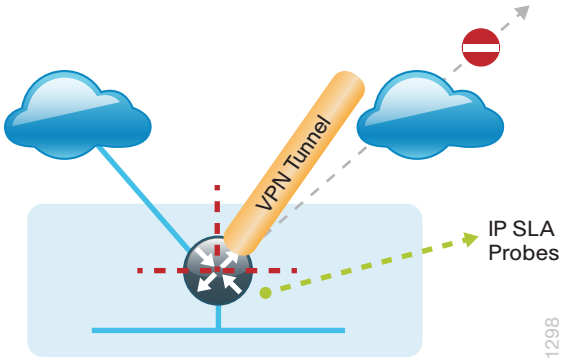
Step 4: Configure an EEM script to also restore the local default route when the DNS probes are active.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 3: IPSLA ICMP Probes

In this solution, you use IPSLA ICMP probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of ICMP probes to two different IP hosts triggers the removal of the default route via an EEM script. If either ICMP probe is active, the route will remain.

Figure 72 - IPSLA with ICMP probes



Tech Tip

For ICMP-based IPSLA probes to function, you need to ensure ICMP is permitted in the outbound ACL, from the self-zone to the OUTSIDE zone.

Step 1: Configure the VRF-aware IPSLA ICMP probes.

```
ip sla 110
 icmp-echo 172.18.1.253 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 110 life forever start-time now

ip sla 111
 icmp-echo 172.18.1.254 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 111 life forever start-time now
```

Step 2: Configure the tracking parameters and logic for the IPSLA ICMP probes.

```
track 60 ip sla 110 reachability
track 61 ip sla 111 reachability
track 62 list boolean or
 object 60
 object 61
```

Step 3: Configure the EEM script to remove the route when the ICMP probes are down.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

Step 4: Configure an EEM script to also restore the local default route when the ICMP probes are active.

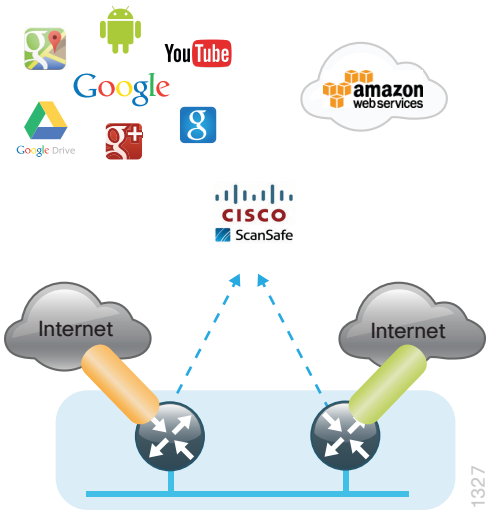
```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

IWAN Dual-Router Dual-Internet Remote Site with DIA

This process describes configuring DIA for the dual-router dual-Internet IWAN design. These configurations assume the dual-router dual-Internet site with centralized Internet access is configured and functional as outlined in the Intelligent WAN Technology Design Guide.

In this section, you convert a remote site from centralized Internet access for employees to a secure DIA configuration.

Figure 73 - IWAN dual-router dual-Internet with DIA



PROCESS

Configuring DIA Routing

1. Configure Internet interface
2. Filter EIGRP learned central default route
3. Configure local default routing for outbound local Internet traffic
4. Configure local policy-routing for return Internet traffic
5. Filter default route outbound to WAN
6. Redistribute DHCP default route into EIGRP

In the following procedures, you enable DIA routing, NAT, and zone-based Firewall configurations for the dual-router dual-Internet IWAN design. In this configuration, you route local Internet traffic by using split-tunneling outside the DMVPN tunnel on the secondary router. All configurations are specific to this design model.

Procedure 1 Configure Internet interface

For security, disable the ISP interface before configuring DIA. You will not restore this interface until you complete all of the configurations in this section.

Tech Tip

If you are remotely connected to the remote-site router via SSH, you will be disconnected from the router console. Shutting down the Internet interface will drop the existing DMVPN tunnel.

Step 1: Verify that the Internet-facing interface is disabled.

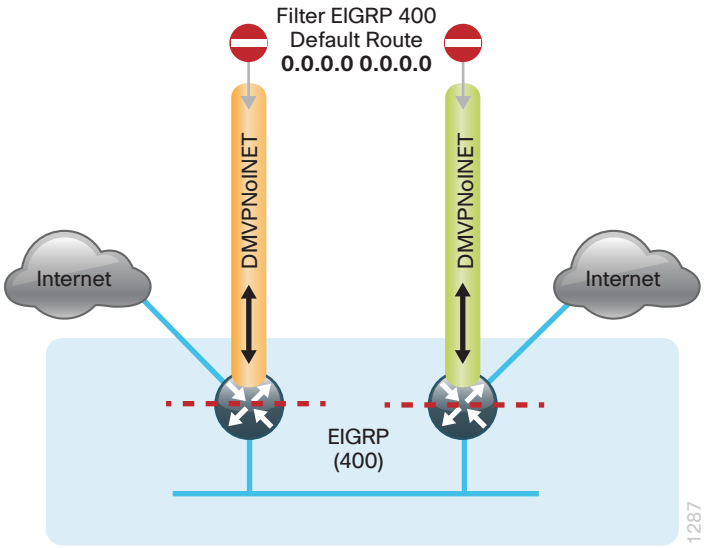
```
interface GigabitEthernet0/0/0
 shutdown
```

Procedure 2 Filter EIGRP learned central default route

With DIA routing, the default route is locally configured for the global routing table. It is important to filter the default route originating over the Internet-facing DMVPN tunnel from the central site. Failover to the central site is optional over the MPLS-based DMVPN tunnel. In the dual-router dual-Internet design with DIA, all Internet traffic is routed directly to the local ISP interface; it is not feasible to failover to central Internet by using an Internet-based DMVPN tunnel.

Configurations are on the both the primary and the secondary routers.

Figure 74 - Filter inbound EIGRP default route from the central site



Step 1: Create an access list to match the default route and permit all other routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: Create a route-map to reference the access list.

```
route-map BLOCK-DEFAULT permit 10
 description Block only the default route inbound from the WAN
  match ip address ALL-EXCEPT-DEFAULT
```

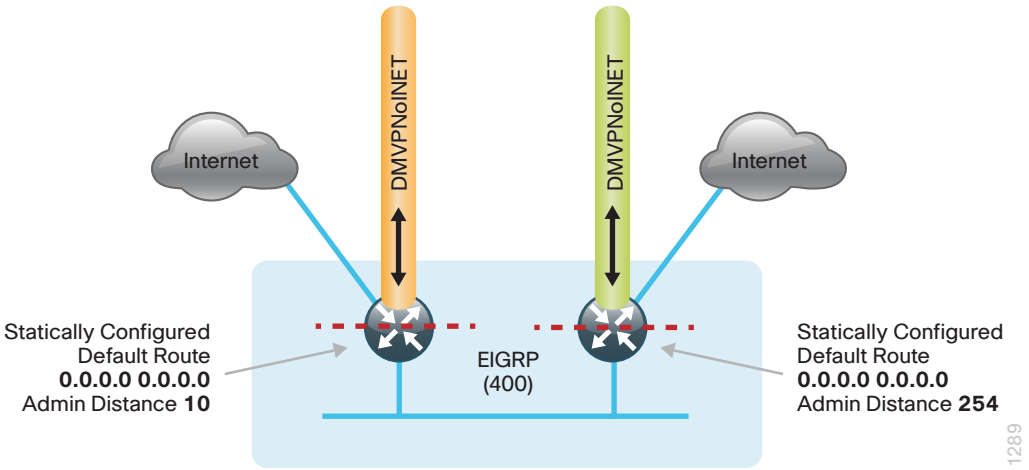
Step 3: Apply the policy as an inbound distribute list for the Internet-facing DMVPN tunnel interface.

```
router eigrp IWAN-EIGRP
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map BLOCK-DEFAULT in tunnel20
   distribute-list route-map BLOCK-DEFAULT in tunnel21
exit
```

Procedure 3 Configure local default routing for outbound local Internet traffic

Internal employee traffic is in the global table and needs to route to the Internet via the ISP interface in the IWAN-TRANSPORT-3 and IWAN-TRANSPORT-4 VRFs. This configuration allows traffic to traverse from the global to the outside VRF in DMVPN F-VRF configurations used for IWAN.

Figure 75 - IWAN dual-router dual-Internet–egress default routing



Step 1: Configure a default route in the global table of the primary router that allows traffic into the outside transit VRF and set the administrative distance to **10**.

```
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
```

Step 2: Configure a default route in the global table of the secondary router. Alllow traffic into the outside transit VRF and set the administrative distance to 254 so that this router prefers the external EIGRP route from the primary router.

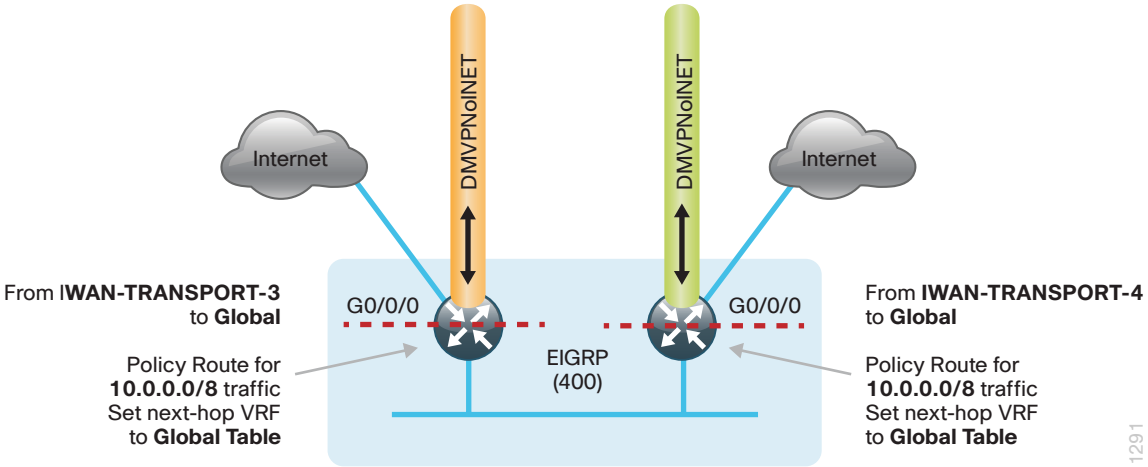
```
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 254
```

Procedure 4 Configure local policy-routing for return Internet traffic

Traffic returning to the outside NAT address of the router ISP interface will be contained inside the IWAN-TRANSPORT-3 and IWAN-TRANSPORT-4 VRFs. The local policy configuration allows this traffic to be routed back to the global table.

Configurations are on both routers.

Figure 76 - IWAN dual-router dual-Internet–local policy return routing



Step 1: Configure an ACL that matches the summary range of the internal IP networks.

```
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
```

Step 2: Create a route map that references the ACL and changes the traffic to the global table.

```
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
```

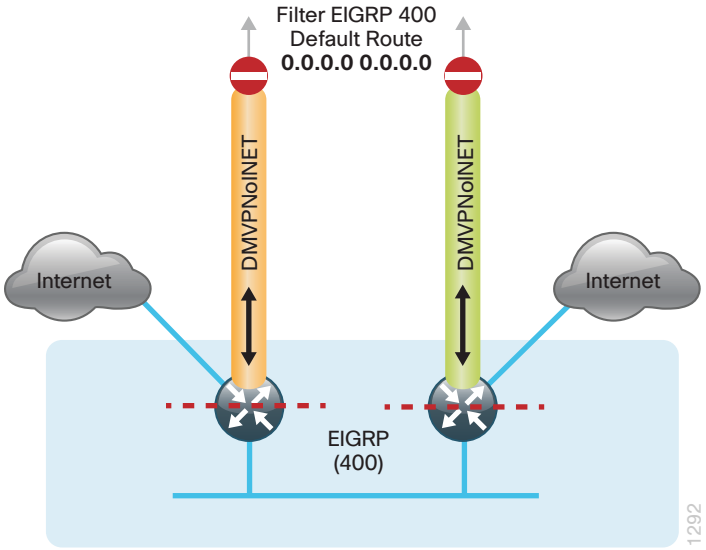
Step 3: Apply the local policy routing configuration to the Internet-facing router interfaces.

```
interface GigabitEthernet0/0/0
 ip policy route-map INET-INTERNAL
```

Procedure 5 Filter default route outbound to WAN

With IWAN, you are using a single EIGRP process over the WAN and between the remote site routers. When you redistribute the default route into EIGRP in the next procedure, it would by default be sent out the WAN interfaces to the central site location. This is not the desired behavior, so you must first configure an outbound filter.

Figure 77 - IWAN dual-router dual-Internet–egress default route filtering



Step 1: On both routers, configure an access list to deny the default route and permit all over routes.

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
```

Step 2: On both routers, add an instance after the existing route map named "ROUTE-LIST" and reference the access list that denies the default route and permits all other routes. There should be an instance of this route map from the IWAN foundation configuration. This statement should go between the existing statements.

```
route-map ROUTE-LIST deny 20
 description Block Local Internet Default route out to the WAN
 match ip address DEFAULT-ONLY
```

Step 3: On the primary router, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel20
  exit-af-topology
exit-address-family
```

Step 4: On the secondary router, ensure that the route map is applied as an outbound distribution list on the DMVPN tunnel interface. Apply this as part of the foundational configuration for dual-router egress filtering.

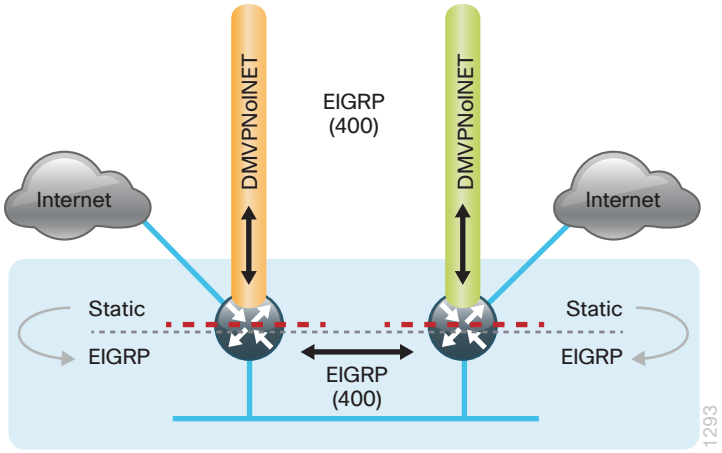
```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   distribute-list route-map ROUTE-LIST out Tunnel21
  exit-af-topology
exit-address-family
```

Procedure 6 Redistribute DHCP default route into EIGRP

For dual-router configurations, you need to redistribute the statically configured default route into EIGRP AS400 for reachability on both WAN routers.

Configurations are on both routers.

Figure 78 - IWAN dual-router dual-Internet–route redistribution



Step 1: Configure an access list to match the default route.

```
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
```

Step 2: Configure a route-map instance for static redistribution referencing the access list that matches the static default route.

```
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
```

Step 3: Redistribute the static default route installed by DHCP into EIGRP AS400 by using the route map.

```
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  topology base
   redistribute static route-map STATIC-IN
  exit-af-topology
exit-address-family
```

PROCESS

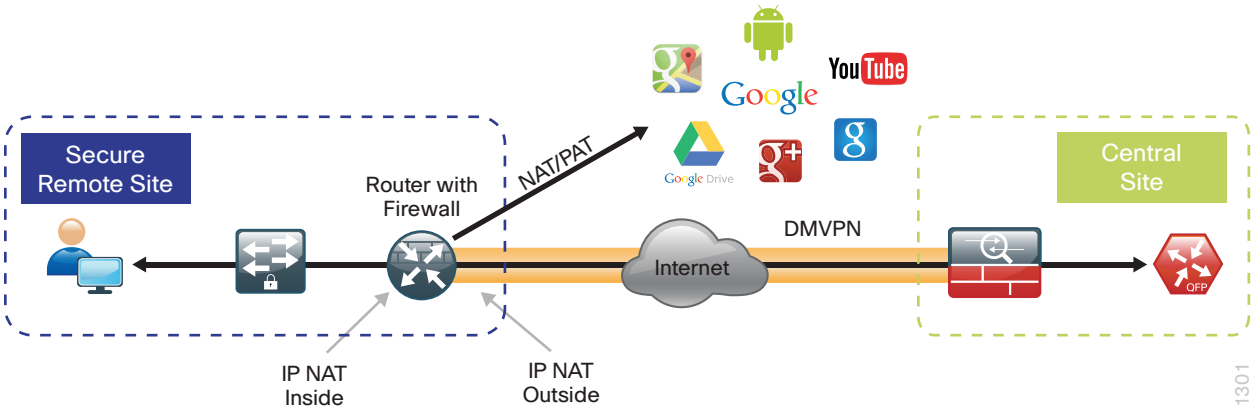
Configuring Network Address Translation for DIA

1. Define and configure Cisco IOS NAT policy

In this design, inside hosts use RFC 1918 addresses, and traffic destined to the Internet from the local site needs to be translated to public IP space. The Internet-facing interface on the remote-site router uses DHCP to acquire a publically routable IP address; the NAT policy here will translate inside private IP addressed hosts to this DHCP address by using PAT.

This configuration is done on both the primary and secondary routers.

Figure 79 - NAT for Internet Traffic



Procedure 1 Define and configure Cisco IOS NAT policy

Use this procedure to configure NAT for DIA for dual-router dual-Internet remote-site configurations.

Step 1: Define a policy matching the desired traffic to be translated. Use an ACL and include all remote-site subnets used by employees.

```
ip access-list extended NAT-LOCAL
 permit ip 10.7.176.0 0.0.7.255 any
```

Step 2: Configure route map to reference the ACL and match the outgoing Internet Interface.

```
route-map NAT permit 10
 description Local Internet NAT
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/0
```

Step 3: Configure the NAT policy.

```
ip nat inside source route-map NAT interface GigabitEthernet0/0/0 overload
```

Step 4: Enable NAT by applying policy to the inside router interfaces. Apply this configuration as needed to internal interfaces or sub-interfaces where traffic matching the ACL may originate, such as the data and transit networks and any service interfaces such as Cisco UCS-E or Cisco SRE interfaces.

```
interface Port-channel 1.64
description Data network
 ip nat inside

interface Port-channel 1.99
description Transit network
 ip nat inside
```

Step 5: Configure the Internet-facing interfaces for NAT.

```
interface GigabitEthernet0/0/0
 description ISP Connection
 ip nat outside
```

Tech Tip

When you configure NAT on an IOS router interfaces, you will see **ip virtual-reassembly in** added to the configuration. This is automatically enabled for features that require fragment reassembly, such as NAT, Firewall, and IPS.

Step 6: Verify proper interfaces are configured for NAT.

```
RS34-4451X-1#show ip nat statistics
Total active translations: 0 (0 static, 0 dynamic; 0 extended)
Outside interfaces:
  GigabitEthernet0/0/0
Inside interfaces:
  Port-channel1.64
Hits: 119073  Misses:
Expired translations:
Dynamic mappings:
-- Inside Source
[Id: 1] route-map NAT interface GigabitEthernet0/0/0 refcount 0
nat-limit statistics:
 max entry: max allowed 0, used 0, missed 0
```

```
In-to-out drops: 0  Out-to-in drops: 0
Pool stats drop: 0  Mapping stats drop: 0
Port block alloc fail: 0
IP alias add fail: 0
Limit entry add fail: 0
```

Step 7: Verify NAT translations for intended sources that are using local Internet services.

```
RS34-4451X-1#show ip nat translations
Pro  Inside global      Inside local       Outside local       Outside global
tcp  172.18.99.21:5021  10.7.164.20:49678  69.25.24.26:80      69.25.24.26:80
tcp  172.18.99.21:5108  10.7.164.20:49765  23.203.221.156:443  23.203.221.156:443
tcp  172.18.99.21:4105  10.7.164.20:49786  23.204.109.42:80    23.204.109.42:80
tcp  172.18.99.21:4975  10.7.164.20:49632  23.204.109.48:80    23.204.109.48:80
```

PROCESS

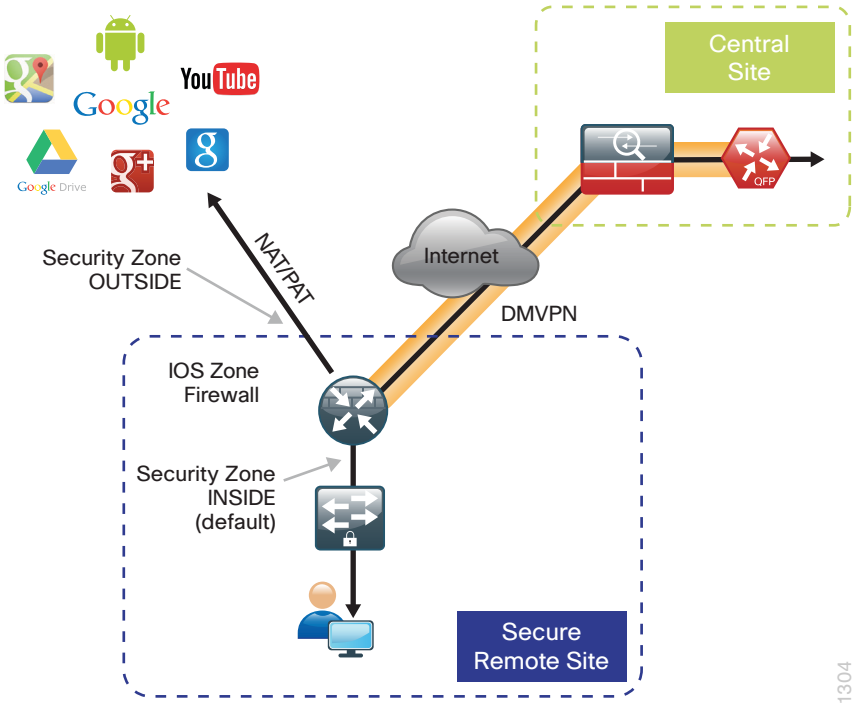
Configuring Zone-Based Firewall for DIA

1. Configure base Cisco IOS Zone-Based Firewall parameters
2. Restrict traffic to the router
3. Enable and verify zone-based firewall configuration

The following Cisco IOS firewall configuration is intended for use on Internet-facing remote site routers providing secure local-Internet access. This configuration assumes DHCP and DMVPN are also configured to use the outside interface. To configure the required base firewall policies, complete the following procedures on both routers.

Follow these procedures to secure a dual-router dual-Internet remote-site router with direct Internet configurations.

Figure 80 - Zone-based firewall for DIA



Procedure 1 Configure base Cisco IOS Zone-Based Firewall parameters

Step 1: If it is configured, remove the inbound ACL from the Internet-facing router interfaces, and then shut down the interface before continuing. This prevents unauthorized traffic while the ZBFW is configured.

```
interface GigabitEthernet0/0/0
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
```

Step 2: Define security zones. A zone is a named group of interfaces that have similar functions or security requirements. This example defines the names of the two basic security zones identified. For simplicity, this design uses the "default" security zone for inside interfaces. Once the default zone has been defined, all interfaces not explicitly configured as members of a security zone will automatically be part of the default security zone.

```
zone security default
zone security OUTSIDE
```

Tech Tip

This design uses the "default" zone for all inside interfaces; traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Be aware that any interface that is removed from a defined security zone will be automatically placed into the default zone. In this configuration, that interface will be treated as an "inside" zone and have access to the internal routing domain..

Step 3: Define a class map to match specific protocols. Class-maps apply **match-any** or **match-all** operators in order to determine how to apply the match criteria to the class. If **match-any** is specified, traffic must meet at least one of the match criteria in the class-map to be included in the class. If **match-all** is specified, traffic must meet all of the match criteria to be included in the class.

```
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol tcp
 match protocol udp
 match protocol icmp
```

Tech Tip

Protocols that use single ports (such as HTTP, telnet, SSH, etc.) can be statefully allowed with tcp inspection alone by using the **match protocol tcp** command.

Protocols such as ftp that use multiple ports (one for control and another for data) require application inspection in order to enable dynamic adjustments to the active firewall policy. The specific TCP ports that are required for the application are allowed for short durations, as necessary.

Step 4: Define policy maps. A policy is an association of traffic classes and actions. It specifies what actions should be performed on defined traffic classes. In this case, you statefully inspect the outbound session so that return traffic is permitted.

```
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
```

Tech Tip

An *action* is a specific functionality that is associated with a traffic class. **Inspect**, **drop**, and **pass** are actions.

With the **inspect** action, return traffic is automatically allowed for established connections. The **pass** action permits traffic in one direction only. When using the **pass** action, you must explicitly define rules for return traffic.

Step 5: Define the zone pair and apply the policy map. A zone pair represents two defined zones and identifies the source and destination zones where a unidirectional firewall policy-map is applied. This configuration uses only one zone pair because all traffic is inspected and thus allowed to return.

```
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
```

Procedure 2 Restrict traffic to the router

Cisco IOS defines the router by using the fixed name self as a separate security zone. The self-zone is the exception to the default deny-all policy.

All traffic destined to or originating from the router itself (local traffic) on any interface is allowed until traffic is explicitly denied. In other words, any traffic flowing directly between defined zones and the router's IP interfaces is implicitly allowed and is not initially controlled by zone firewall policies.

This default behavior of the self-zone ensures that connectivity to the router's management interfaces and the function of routing protocols is maintained when an initial zone firewall configuration is applied to the router.

Specific rules that control traffic to the self-zone are required. When you configure a ZBFW rule that includes the self-zone, traffic between the self-zone and the other defined zones is immediately restricted in both directions.

Table 4 - Self-zone firewall access list parameters

Protocol	Stateful inspection policy
ISAKMP	Yes
ICMP	Yes
DHCP	No
ESP	No
GRE	No

The following configuration allows the required traffic for proper remote-site router configuration with DMVPN. ESP and DHCP cannot be inspected and need to be configured with a **pass** action in the policy, using separate ACL and class-maps. ISAKMP should be configured with the **inspect** action and thus needs to be broken out with a separate ACL and class-maps for inbound and outbound policies.

Tech Tip

More specific ACLs than are shown here with the "any" keyword are recommended for added security.

Step 1: In the following steps, define access lists.

Step 2: Define an ACL allowing traffic with a destination of the router itself from the OUTSIDE zone. This includes ISAKMP for inbound tunnel initiation. This traffic can be inspected and is identified in the following ACL.

```
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
```

Step 3: Identify traffic for IPSEC tunnel initiation and other traffic that will originate from the router (self zone) to the OUTSIDE zone. This traffic can be inspected.

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
```

> **Tech Tip**
>
> The ICMP and domain entries here are for IPSLA probes that originate from the router.
>
> ```
> permit icmp any any
> permit udp any any eq domain
> ```

Step 4: Configure the DHCP ACL to allow the router to acquire a public IP address dynamically from the ISP. This traffic needs to be defined separately for server and client and cannot be inspected.

```
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc

ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
```

Step 5: Configure the ESP ACL to allow the router to establish IPSEC communications for DMVPN. ESP needs to be explicitly allowed inbound and outbound in separate ACLs. ESP cannot be inspected.

```
ip access-list extended ESP-IN
 permit esp any any

ip access-list extended ESP-OUT
 permit esp any any
```

Step 6: Configure the GRE ACL to allow GRE tunnel formation. GRE needs to be explicitly allowed inbound only.

```
ip access-list extended GRE-IN
 permit gre any any
```

> **Tech Tip**
>
> GRE needs to be permitted inbound for GRE on IOS-XE platforms due to a difference in interface order of operations. This is not required on IOS ISRG2 platforms.

Next, you define class maps for traffic to and from the self-zone. Separate class-maps are required for inbound and outbound initiated flows as well as for traffic that can be inspected by the router.

Step 7: Define the class-map matching inbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
```

Step 8: Define the class-map matching outbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
```

Step 9: Define the class-map matching inbound traffic that is not able to be inspected.

```
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
```

Step 10: Define the class-map matching outbound traffic that cannot be inspected.

```
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
```

Next, you define policy maps. Create two separate policies, one for traffic inbound and one for traffic outbound.

Step 11: Define the inbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
```

Step 12: Define the outbound policy-map that refers to both of the outbound class-maps with actions of **inspect**, **pass**, and **drop** for the appropriate class defined.

```
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
```

Tech Tip

Inspection for Layer 7 applications is not allowed for traffic going to and from the self-zone to other zones. Cisco IOS firewalls support only inspection of TCP, UDP, and H.323 traffic that terminates on or originates from the router itself.

Traffic such as DHCP and ESP cannot be inspected and must be configured as **Pass** in the associated policy-map.

Next, you define the zone pair and apply policy maps to them.

Step 13: Define the zone pair for traffic destined to the self-zone of the router from the outside and associate the inbound policy-map defined in the previous step.

```
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
```

Step 14: Define the zone pair for traffic destined from the self-zone of the router to the outside and associate the outbound policy-map defined in the previous step.

```
zone-pair security FROM-ROUTER source self destination OUTSIDE
 service-policy type inspect ACL-OUT-POLICY
```

Procedure 3 Enable and verify zone-based firewall configuration

Step 1: Assign the Internet-facing router interface to the outside security zone. All other interfaces are assigned to the default zone and do not need to be defined.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 zone-member security OUTSIDE
```

Tech Tip

By default, traffic is allowed to flow between interfaces that are members of the same zone, while a default "deny-all" policy is applied to traffic moving between zones.

This design uses the "default" zone for all inside interfaces, traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Loopback interfaces are members of the "self" zone and are not assigned to a defined security zone or the default zone.

Step 2: Verify the interface assignment for the zone firewall and ensure that all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS34-4451X-1#show zone security
zone self
  Description: System defined zone

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically

zone OUTSIDE
  Member Interfaces:
    GigabitEthernet0/0/0
```

Step 3: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS32-4451X-2#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        50 packets, 13824 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        8 packets, 2680 bytes
      Pass
        8 packets, 2680 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: IN_OUT
  Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
    Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
      Match: protocol ftp
        0 packets, 0 bytes
      Match: protocol tcp
        0 packets, 0 bytes
      Match: protocol udp
        0 packets, 0 bytes
      Match: protocol icmp
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: TO-ROUTER
  Service-policy inspect : ACL-IN-POLICY
    Class-map: INSPECT-ACL-IN-CLASS (match-any)
      Match: access-group name ACL-RTR-IN
        52 packets, 14040 bytes
      Inspect
    Class-map: PASS-ACL-IN-CLASS (match-any)
      Match: access-group name ESP-IN
        0 packets, 0 bytes
      Match: access-group name DHCP-IN
        8 packets, 2736 bytes
```

```
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      1697 packets, 332091 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
```

Step 4: Add the following command to the router configuration in order to identify traffic dropped by the Cisco IOS-XE zone firewall.

```
parameter-map type inspect global
 log dropped-packets
```

Tech Tip

In IOS, when you configure the command **ip inspect drop-pkt**, the following is automatically added to the router configuration:

```
parameter-map type inspect global
 log dropped-packets enable
```

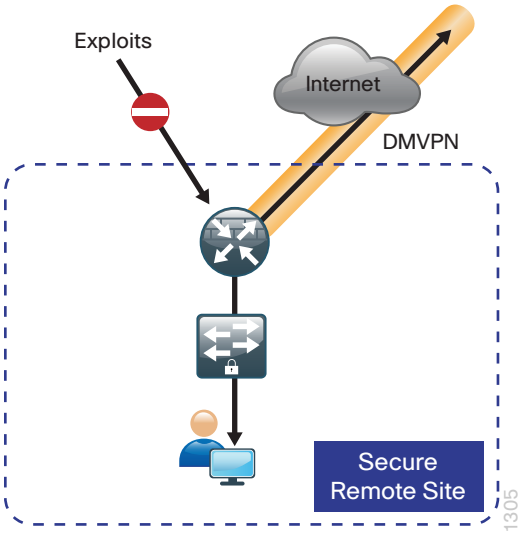
PROCESS

Configuring Additional Router Security

1. Disable IP ICMP redirects
2. Disable ICMP unreachable messages
3. Disable Proxy ARP
4. Disable unused router services
5. Disable CDP and LLDP
6. Enable keepalives for TCP sessions
7. Configure internal-network floating static routes
8. Enable Internet interfaces

In addition to the security measures already taken in prior configuration tasks, this section introduces best practices recommendations to secure Internet-facing routers. Disabling unused services and features for networking devices improves the overall security posture by minimizing the amount of information exposed. This practice also minimizes the amount of router CPU and memory load that is required to process unneeded packets.

Figure 81 - Additional router security



Tech Tip

These are general security guidelines only. You may take additional measures to secure remote site routers on a case-by-case basis. Take care to ensure that disabling certain features does not impact other functions of the network.

Procedure 1 Disable IP ICMP redirects

Routers use ICMP redirect messages to notify that a better route is available for a given destination. In this situation, the router forwards the packet and sends an ICMP redirect message back to the sender advising of an alternative and preferred route to the destination. In many implementations, there is no benefit in permitting this behavior. An attacker can generate traffic, forcing the router to respond with ICMP redirect messages, negatively impacting the CPU and performance of the router. You can prevent this by disabling ICMP redirect messages.

Step 1: Disable ICMP redirect messages on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip redirects
```

Procedure 2 Disable ICMP unreachable messages

When filtering on router interfaces, routers send ICMP unreachable messages back to the source of blocked traffic. Generating these messages can increase CPU utilization on the router. By default, Cisco IOS ICMP unreachable messages are limited to one every 500 milliseconds. ICMP unreachable messages can be disabled on a per interface basis.

Step 1: Disable ICMP unreachable messages on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip unreachables
```

Procedure 3 Disable Proxy ARP

Proxy ARP allows the router to respond to ARP request for hosts other than itself. Proxy ARP can help machines on a subnet reach remote subnets without configuring routing or a default Disadvantages to using proxy ARP:

- An attacker can impact available memory by sending a large number of ARP requests.
- A router is also susceptible to man-in-the-middle attacks where a host on the network could be used to spoof the MAC address of the router, resulting in unsuspecting hosts sending traffic to the attacker.

You can disable Proxy ARP by using the **interface** configuration command

Step 1: Disable proxy ARP on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no ip proxy-arp
```

Procedure 4 Disable unused router services

As a security best practice, you should disable all unnecessary services that could be used to launch DoS and other attacks. Many unused services that pose a security threat are disabled by default in current Cisco IOS versions.

Step 1: Disable MOP on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no mop enabled
```

Step 2: Disable PAD service globally on the router.

```
no service pad
```

Step 3: Prevent the router from attempting to locate a configuration file via TFTP globally on the router.

```
no service config
```

Procedure 5 Disable CDP and LLDP

Attackers can use CDP and LLDP for reconnaissance and network mapping. CDP is a network protocol that is used to discover other CDP-enabled devices. CDP is often used by NMS and for troubleshooting networking problems. LLDP is an IEEE protocol that is defined in 802.1AB and is very similar to CDP. You should disable CDP and LLDP on router interfaces that connect to untrusted networks.

Step 1: Disable CDP on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no cdp enable
```

Step 2: Disable LLDP on Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no lldp transmit
 no lldp receive
```

Procedure 6 Enable keepalives for TCP sessions

This configuration enables TCP keepalives on inbound connections to the router and outbound connections from the router. This ensures that the device on the remote end of the connection is still accessible and half-open or orphaned connections are removed from the router.

Step 1: Enable the TCP keepalives service for inbound and outbound connections globally on the routers. Configuration commands enable a device

```
service tcp-keepalives-in
service tcp-keepalives-out
```

Procedure 7 Configure internal-network floating static routes

In the event the DMVPN tunnel to the hub site fails, you will want to ensure traffic destined to internal networks does not follow the local Internet default route. It's best to have the network fail closed to prevent possible security implications and unwanted routing behavior.

Configuring floating static routes to null zero with an AD of 254 ensures that all internal subnets route to null0 in the event of tunnel failure.

Step 1: Configure static route for internal network subnets on both routers.

```
ip route 10.0.0.0 255.0.0.0 null0 254
```

Tech Tip

Configure the appropriate number of null 0 routes for internal network ranges, using summaries when possible for your specific network environment.

Procedure 8 Enable Internet interfaces

Now that the security configurations are complete, you can enable the Internet-facing interfaces.

Step 1: Enable the Internet-facing router interfaces on both routers.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 no shutdown
```

PROCESS

Configuring ISP Black-Hole Routing Detection

1. Configure ISP black-hole routing detection

In many cases you will need to ensure connectivity issues with your ISP does not cause black-hole routing conditions. Failure conditions can exist where the DHCP address and routes are not removed from the remote-site router when connectivity issues exist with the broadband service or local premise equipment. There may also be circumstances if certain services are unreachable within via the local ISP connection that you want to reroute to a secondary Internet service.

If Internet fallback is required, configure one or more of the following options on the primary router.

Procedure 1 Configure ISP black-hole routing detection

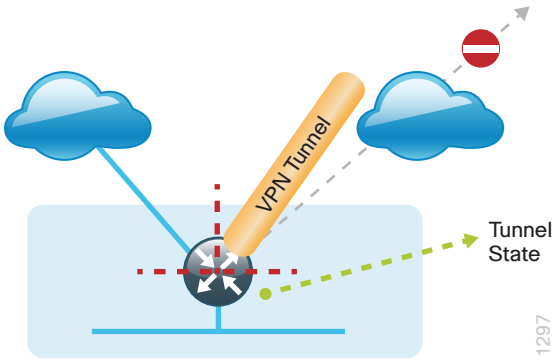
Option 1: DMVPN Tunnel State Tracking

In this solution, the DMVPN tunnel state is used to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, a "down" state of the tunnel interface triggers the removal of the default route via an EEM script. If tunnel state is "up" the route will remain.

Tech Tip

With this method, a failure or maintenance at the central site can cause a failover event where the route is removed due to tunnel state change and the local Internet connection remains active at the remote site.

Figure 82 - IWAN tunnel tracking with EEM



Step 1: Ensure that state tracking is configured for the DMVPN tunnel interface on the primary router.

```
interface Tunnel20
 if-state nhrp
```

Step 2: Configure the tracking parameters and logic for the IPSLA probes on the primary router.

```
track 80 interface Tunnel20 line-protocol
```

Step 3: On the primary router, configure an EEM script to remove the local default route when the tunnel line protocol transitions to a "down" state.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

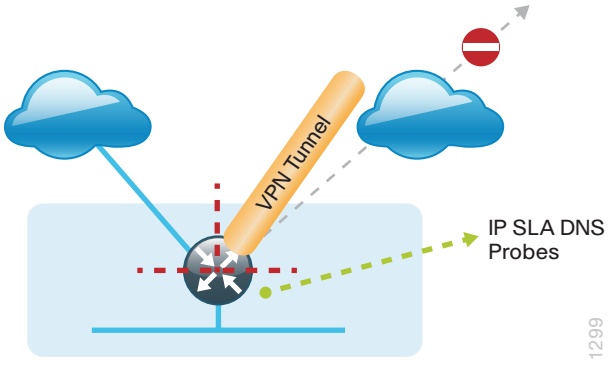
Step 4: On the primary router, configure an EEM script to also restore the local default route when the tunnel line protocol transitions to an "up" state.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 2: DNS-Based IPSLA Probes

In this solution, you use DNS-based IPSLA probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of DNS probes to two or more root DNS servers triggers the removal of the default route via an EEM script. If any DNS probe is active, the route will remain.

Figure 83 - IPSLA with DNS probes



Tech Tip

For DNS-based IPSLA probes to function, you need to ensure that DNS or "domain" is permitted in the ZBFW outbound ACL, from the self-zone to the OUTSIDE zone.

Example:

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq domain
```

Step 1: On the primary router, configure the VRF-aware IPSLA DNS probes.

```
ip sla 118
 dns d.root-servers.net name-server 199.7.91.13
 vrf IWAN-TRANSPORT-3
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 118 life forever start-time now

ip sla 119
 dns b.root-servers.net name-server 192.228.79.201
 vrf IWAN-TRANSPORT-3
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 119 life forever start-time now
```

Tech Tip

When configuring DNS probes, you should specify the hostname of the DNS server itself. That asks the DNS server to resolve for itself, allowing the use of root DNS servers.

Step 2: On the primary router, configure the tracking parameters and logic for the IPSLA probes.

```
track 73 ip sla 118 reachability
track 74 ip sla 119 reachability
!
track 100 list boolean or
 object 73
 object 74
```

Step 3: On the primary router, configure an EEM script to remove the local default route in the event of DNS probe failure.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

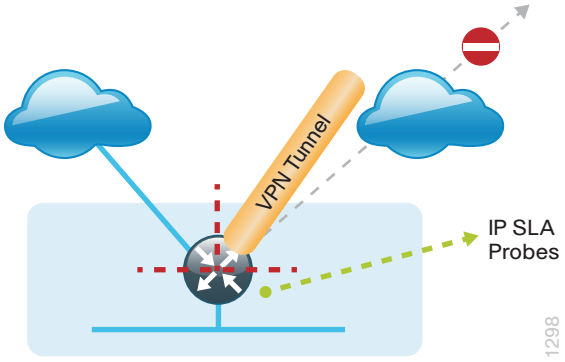
Step 4: On the primary router, configure an EEM script to also restore the local default route when the DNS probes are active.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 100 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Option 3: IPSLA ICMP Probes

In this solution, you use IPSLA ICMP probes to monitor the status of the ISP connection used as the primary path for local Internet traffic. In this example, the failure of ICMP probes to two different IP hosts triggers the removal of the default route via an EEM script. If either ICMP probe is active the route will remain.

Figure 84 - IPSLA with ICMP probes



Step 1: On the primary router, configure the VRF-aware IPSLA ICMP probes.

```
ip sla 110
 icmp-echo 172.18.1.253 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 110 life forever start-time now

ip sla 111
 icmp-echo 172.18.1.254 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 111 life forever start-time now
```

Step 2: On the primary router, configure the tracking parameters and logic for the IPSLA ICMP probes.

```
track 60 ip sla 110 reachability
track 61 ip sla 111 reachability
track 62 list boolean or
 object 60
 object 61
```

Step 3: On the primary router, configure an EEM script to remove the local default route when the ICMP probes are down.

```
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
```

Step 4: On the primary router, configure an EEM script to also restore the local default route when the ICMP probes are active.

```
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 62 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
```

Deploying Remote Site Guest Wireless Access

The ability to deploy secure guest access in remote site locations with locally routed Internet traffic is one of the primary use cases for DIA with IWAN.

The integration of IWAN guest access to the remote-site should provide the following benefits and capabilities:

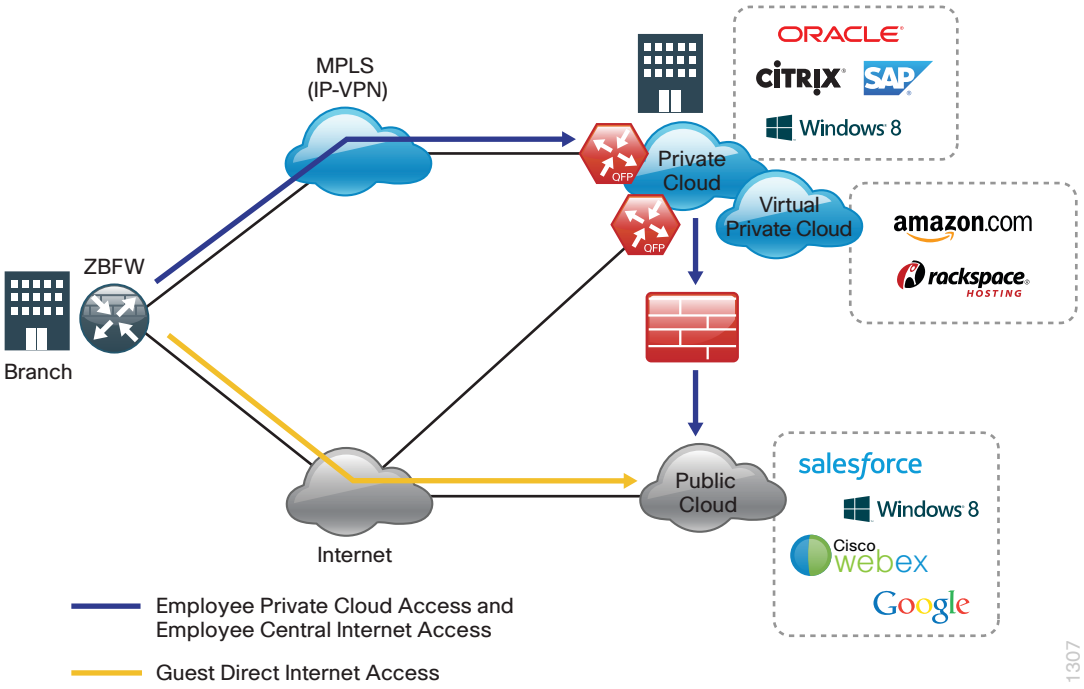
- DIA for guest users, reducing WAN use
- Integration with existing guest services using ISE and wireless controllers.
- Modular and scalable guest networking
- Secure isolation of guest traffic from internal employee traffic and resources

This section addresses the two primary deployment models for guest networking required by IWAN customers.

Deploying employee central Internet with guest local Internet access

The initial section of this guide addresses internal employee DIA. This section describes adding guest to these configurations.

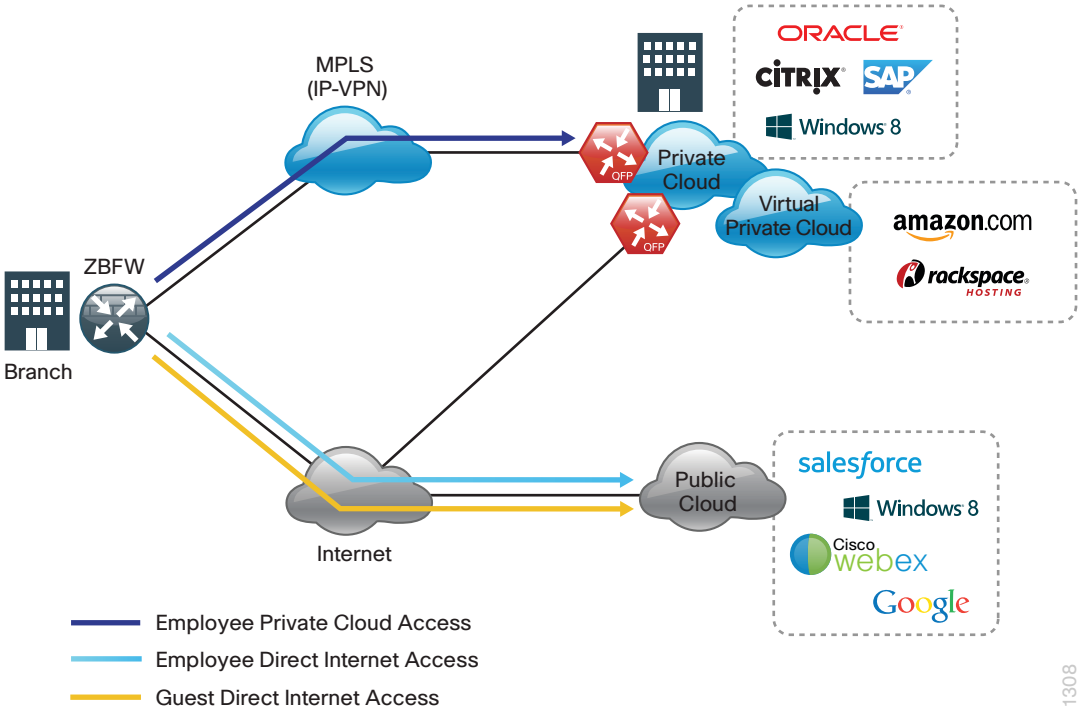
Figure 85 - Employee central Internet with guest DIA



Deploying employee and guest local Internet access

With the IWAN Foundation CVD configurations, remote site employee traffic uses central Internet for each IWAN design model. This section describes adding guest DIA to the Foundation IWAN design.

Figure 86 - Employee and guest DIA



Reader Tip

This guide does not address the deployment of guest access in the remote site with central Internet access.

The deployment of wireless guest access DIA with IWAN is composed of two primary tasks:

- Configuration of routing and security components fundamental to each design.
- Configuration of wireless networking to support remote site guest access.

IWAN Guest Access Routing

These configurations will enable guest DIA and secure guest authentication to internal demilitarized zone (DMZ) security resources over the WAN. These configurations are the foundation for all of the guest-access use-cases, and you can configure them on all of the IWAN remote site designs. The examples shown here assume a single-router hybrid remote site with employee DIA configured.

Tech Tip

The following configurations do not provide high availability for guest traffic. In the event of ISP failure or primary authentication link failure, guest access will be disabled. High availability for guest users, while possible, is not part of the configurations shown in this guide.

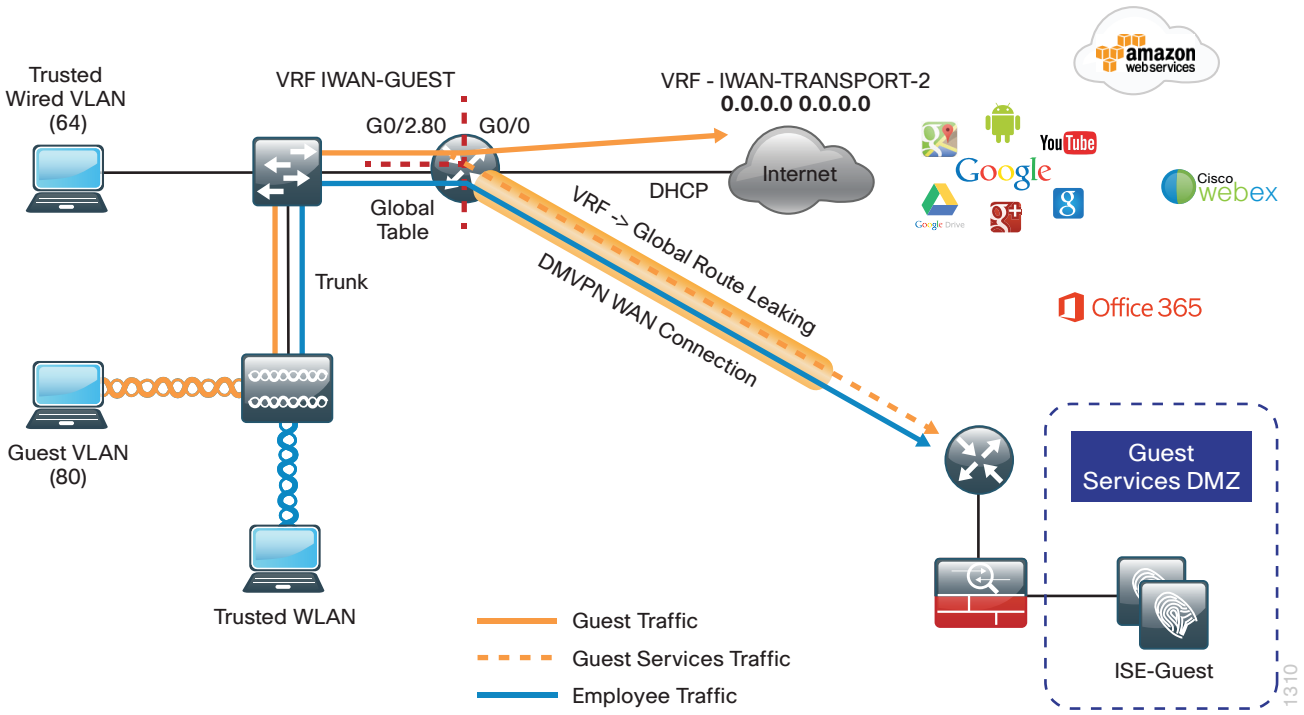
PROCESS

Configuring Guest Basic Network Connectivity

1. Configure the access or distribution layer switch
2. Configure the router for guest network connectivity
3. Configure guest network DHCP for guest users on the router

This process helps you configure basic network connectivity between the router and the access or distribution switch and the wireless networking equipment at the remote site location. This process also addresses creating the guest site VRF for guest segmentation and guest client DHCP and DNS configurations by using IOS-XE.

Figure 87 - IWAN guest networking



Procedure 1 Configure the access or distribution layer switch

Step 1: Configure the remote-site switch for the guest VLAN and enable trunking of this VLAN to the WAN router.

```
interface GigabitEthernet1/0/48
 description RS31-4451X
 switchport trunk allowed vlan 64,65,69,70,80
add 80 to the trunk
```

Step 2: Create VLAN for Guest

```
vlan 80
 name IWAN-Guest
```

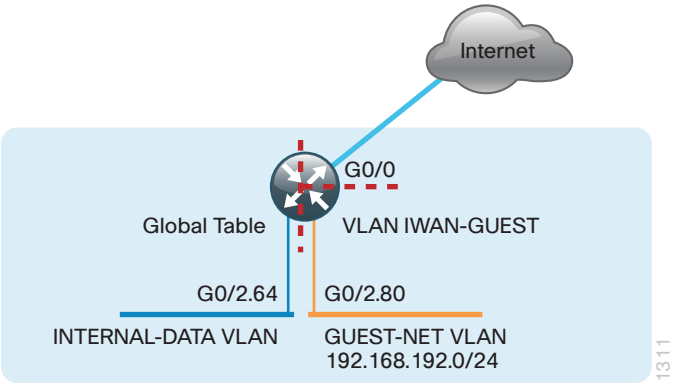
Step 3: Configure switchport for the remote site access point and enable the guest VLAN.

```
interface GigabitEthernet1/0/17
 description FlexConnect AP
 switchport trunk native vlan 99
 switchport trunk allowed vlan 64,65,70,80
 switchport mode trunk
 switchport nonegotiate
 switchport port-security maximum 255
 srr-queue bandwidth share 1 30 35 5
 priority-queue out
 mls qos trust dscp
 macro description EgressQoS
 spanning-tree portfast trunk
```

Procedure 2 Configure the router for guest network connectivity

To isolate guest networking traffic, you use a separate VRF to separate guest users from internal employees.

Figure 88 - IWAN guest VRF



Step 1: On the router, define a guest VRF.

```
vrf definition IWAN-GUEST
 address-family ipv4
 exit-address-family
```

Step 2: Define a guest sub-interface for the GUEST vlan and place this into the guest VRF.

```
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 encapsulation dot1Q 80
 vrf forwarding IWAN-GUEST
 ip address 192.168.192.1 255.255.255.0
```

Step 3: (Optional) Define a guest loop-back interface for testing and place into the guest VRF.

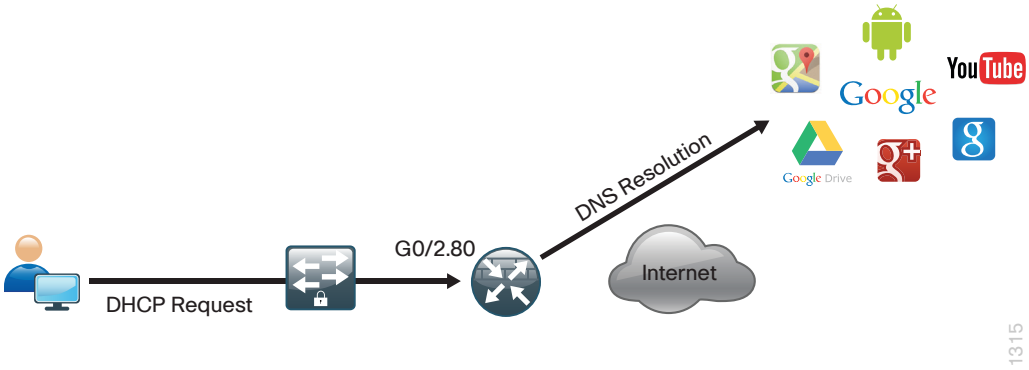
```
interface Loopback192
 description GUEST-NET LOOPBACK
 vrf forwarding IWAN-GUEST
 ip address 192.168.255.13 255.255.255.255
```

Procedure 3 Configure guest network DHCP for guest users on the router

(Optional)

Guest users can obtain IP configuration information from the router within secure guest VRF. This eliminates the need to use a local controller for this function or permit this over the WAN. This configuration provides the guest clients with IP addressing and a public DNS address so all DNS resolutions use the DIA path.

Figure 89 - IWAN guest DHCP and DNS



Step 1: On the router, define VRF-aware DHCP for guest clients. This should use a public DNS and not an internal/central DNS server.

```
ip dhcp excluded-address vrf IWAN-GUEST 192.168.192.1 192.168.192.19
!
ip dhcp pool IWAN-GUEST
 vrf IWAN-GUEST
 network 192.168.192.0 255.255.255.0
 default-router 192.168.192.1
 dns-server 8.8.8.8
```

PROCESS

Configuring Guest Authentication and DIA Routing

1. Configure guest authentication traffic leaking
2. Configure local Internet routing for guest traffic

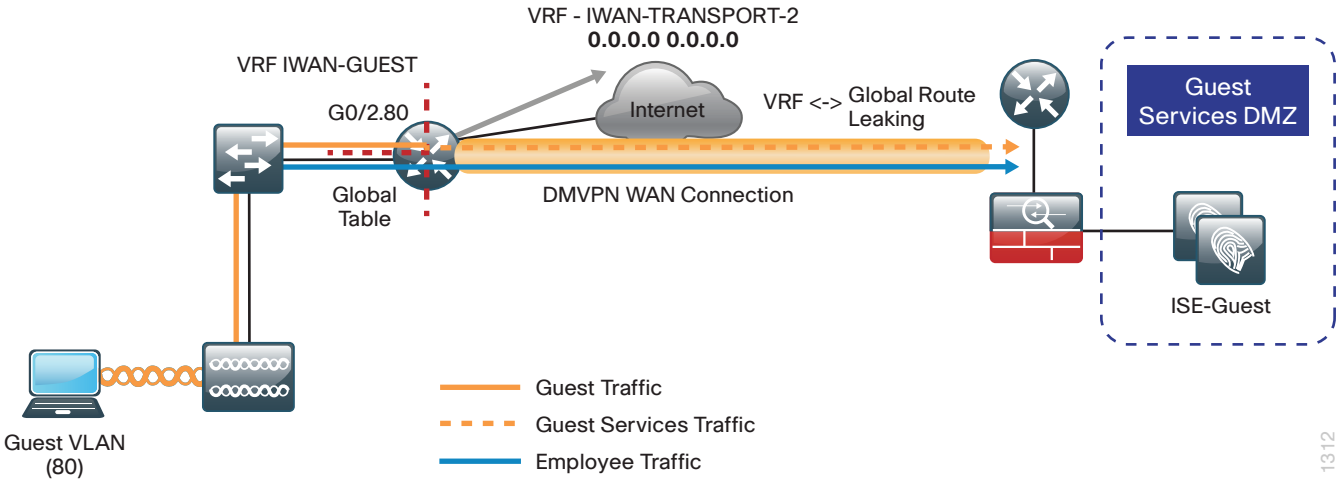
In this process, you configures secure guest authentication to a central site DMZ-based ISE and required security services. The guest user is isolated in a guest VRF and by default cannot access the internal WAN. These procedures securely allow only guest authentication traffic to defined internal resources. All other guest traffic is directly routed to the Internet at the remote site location.

Follow these procedures for all IWAN guest designs.

Procedure 1 Configure guest authentication traffic leaking

Here, you allow restricted guest authentication traffic to route between the guest VRF and the global routing table.

Figure 90 - Guest authentication route leaking



Step 1: Configure VRF to global traffic leaking for Authentication (ISE, AUP). Define the host routes to the ISE servers, etc. via the MPLS-based DMVPN tunnel interface.

```
ip route vrf IWAN-GUEST 192.168.144.0 255.255.255.0 Tunnel10 10.6.34.1 global
```

Tech Tip

Guest clients will only be able to reach authentication services when the primary tunnel is operational. In this configuration, there is no failover to the secondary tunnel.

Step 2: Configure Global to VRF routing for traffic returning from the global for Authentication traffic.

```
ip route 192.168.192.0 255.255.255.0 GigabitEthernet0/0/2.80
ip route 192.168.255.13 255.255.255.255 Loopback192
```

Step 3: Verify that guest hosts can get DHCP addresses and can reach the guest default gateway and loopback addresses.

> **Tech Tip**
>
> Clients will not be able to reach internal authentication services until NAT is properly configured.

Procedure 2 Configure local Internet routing for guest traffic

For guest DIA to work properly, you must add a static default route in the guest VRF to the IWAN router. This directs guest traffic directly to the outside transport VRF outside the DMVPN tunnel and to the Internet local to the remote site location.

Step 1: Configure an outbound default route in the guest VRF.

```
ip route vrf IWAN-GUEST 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10
```

> **Tech Tip**
>
> Clients will not be able to reach the Internet until VRF-aware NAT is properly configured. This NAT process is different from the employee DIA NAT configured in the global table.

PROCESS

Configuring Guest NAT for DIA

1. Configure VRF-aware NAT for Guest Authentication services
2. Configure guest NAT for DIA
3. Verify guest NAT

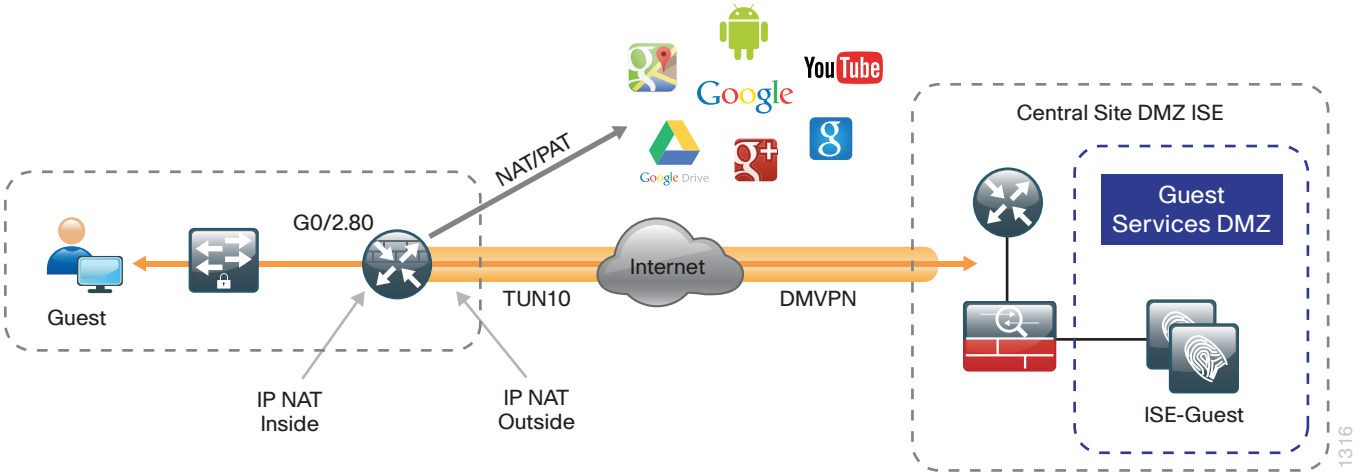
For guest traffic to flow properly, you need to configure VRF-aware policy based NAT for both authentication traffic to the central DMZ and for direct Internet traffic.

Follow these procedures for all guest DIA deployments.

Procedure 1 Configure VRF-aware NAT for Guest Authentication services

You must configure NAT to allow translation for guest traffic destined to authentication services in the central site DMZ network. In this design, there is not route reachability for the remote-site guest subnet from the central site. NAT is being used to allow all sites to use the same guest subnet and to eliminate unwanted guest traffic from being routed internally.

Figure 91 - Guest authentication NAT



Step 1: Define the traffic that will be matched for authentication traffic.

```
ip access-list extended GUEST-AUTH
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
```

Tech Tip

This example specifies the guest traffic leaving the guest VLAN and going to a DMZ subnet in the central site where the ISE servers reside. For added security, it's recommended that this NAT ACL be as restrictive as possible so that routing takes place only between central DMZ services and the remote-site guest clients.

Step 2: Configure the policy NAT route-map and reference the ACL matching guest traffic.

```
route-map GUEST-NAT-AUTH permit 10
 match ip address GUEST-AUTH
 match interface Tunnel 10
```

Step 3: Configure VRF-aware NAT statements referencing the route maps.

```
ip nat inside source route-map GUEST-NAT-AUTH interface Tunnel10 vrf IWAN-GUEST
overload
```

Step 4: Apply the NAT policy to the guest sub interface.

```
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 ip nat inside
```

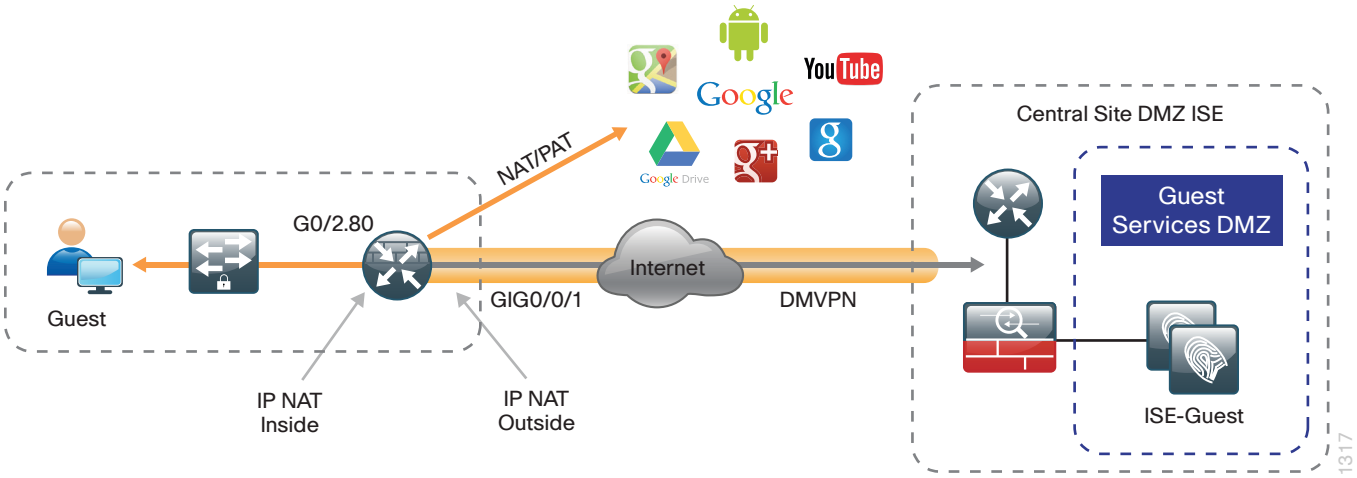
Step 5: Apply the NAT policy outbound for authentication services traffic on the MPLS-based DMVPN tunnel interface.

```
interface tunnel 10
ip nat outside
```

Procedure 2 Configure guest NAT for DIA

Configure NAT to allow translation for guest traffic to access the Internet locally.

Figure 92 - Guest NAT for DIA



Step 1: Define an ACL to match guest traffic destined to the Internet and exclude authentication traffic destined to the internal network.

```
ip access-list extended GUEST-INET
 deny   ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
 permit ip 192.168.192.0 0.0.0.255 any
```

Step 2: Configure policy NAT route-maps and reference the ACL that matches guest DIA traffic.

```
route-map GUEST-NAT-INET permit 10
 match ip address GUEST-INET
 match interface GigabitEthernet 0/0/1
```

Step 3: Configure VRF-aware NAT statements referencing the route map.

```
ip nat inside source route-map GUEST-NAT-INET interface GigabitEthernet0/0/1 vrf
IWAN-GUEST overload
```

Step 4: Apply NAT on the Internet-facing physical interface for guest Internet access.

```
interface GigabitEthernet 0/0/1
ip nat outside
```

Procedure 3 Verify guest NAT

Step 1: Verify NAT configuration for guest interfaces.

```
RS31-4451X#show ip nat statistics
Total active translations: 33 (0 static, 33 dynamic; 33 extended)
Outside interfaces:
  GigabitEthernet0/0/1, Tunnel10
Inside interfaces:
  GigabitEthernet0/0/2.64, GigabitEthernet0/0/2.80
Hits: 120911  Misses: 471
Expired translations: 438
Dynamic mappings:
-- Inside Source
[Id: 1] route-map NAT interface GigabitEthernet0/0/1 refcount 0
[Id: 2] route-map GUEST-NAT-AUTH interface Tunnel10 refcount 0
[Id: 3] route-map GUEST-NAT-INET interface GigabitEthernet0/0/1 refcount 33
nat-limit statistics:
 max entry: max allowed 0, used 0, missed 0
In-to-out drops: 0  Out-to-in drops: 0
Pool stats drop: 0  Mapping stats drop: 0
Port block alloc fail: 0
IP alias add fail: 0
Limit entry add fail: 0
```

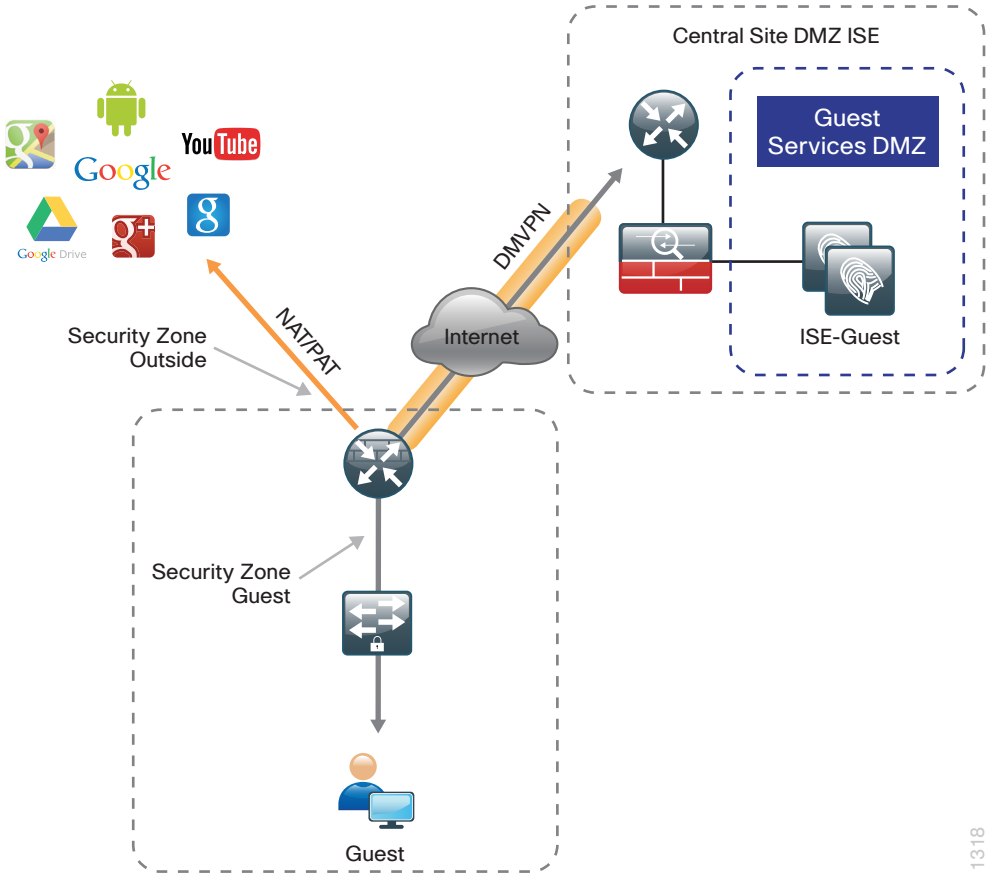
Step 2: Verify Guest VRF-aware NAT translations.

```
RS31-4451X#show ip nat translations vrf IWAN-GUEST
Pro  Inside global     Inside local         Outside local       Outside global
tcp 172.18.98.205:2223 192.168.192.21:49569 93.184.215.200:443 93.184.215.200:443
tcp 172.18.98.205:2202 192.168.192.21:49548 66.235.132.161:80  66.235.132.161:80
tcp 172.18.98.205:2178 192.168.192.21:49512 74.125.224.114:80  74.125.224.114:80
tcp 172.18.98.205:2181 192.168.192.21:49527 23.203.236.179:80  23.203.236.179:80
```

Configuring Zone-Based Firewall for Guest DIA Options

This section helps you configure zone-based firewall for guest DIA. This process assumes that zone-based firewall for employee DIA has been configured in a single-router hybrid IWAN configuration. These added configurations permit guest DIA in addition to providing additional security for guest authentication traffic to the central site DMZ.

Figure 93 - Guest zone-based firewall



PROCESS

Configuring Guest DIA, Option 1: Employee Central Internet

1. Configure base Cisco IOS zone-based firewall parameters
2. Restrict traffic to the router
3. Configure zone-based firewall for guest users
4. Configure guest self-zone security policy
5. Verify guest zone-based firewall configuration

This process describes configuring guest DIA with employee central access. For configuring guest DIA with employee DIA, skip to the process "Configuring Guest DIA, Option 2: Employee DIA."

This process assumes that you have not deployed the employee DIA configurations as shown in this guide. In this design, only guest traffic at the remote-site location accesses the Internet directly. Employee traffic follows the global default route to the central site location for Internet access.

These configurations allow you to add guest networking with DIA to an existing IWAN single-router hybrid remote site as described in the Intelligent WAN Technology Design Guide.

Procedure 1 Configure base Cisco IOS zone-based firewall parameters

Step 1: Remove the inbound ACL from the Internet-facing router interfaces, and then shut down the interface before continuing. This prevents unauthorized traffic while the ZBFW is configured.

```
interface GigabitEthernet0/0/0
  shutdown
  no ip access-list extended ACL-INET-PUBLIC
```

Step 2: Define security zones. A *zone* is a named group of interfaces that have similar functions or security requirements. This example defines the names of the two basic security zones identified. For simplicity, you are using the "default" security zone for inside interfaces. Once the default zone has been defined, all interfaces not explicitly configured as members of a security zone will automatically be part of the default security zone.

```
zone security default
zone security OUTSIDE
```

Tech Tip

This design uses the "default" zone for all inside interfaces. Traffic can flow between all interfaces in the default zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Be aware that any interface that is removed from a defined security zone will be automatically placed into the default zone. In this configuration that interface will be treated as an "inside" zone and have access to the internal routing domain.

Procedure 2 Restrict traffic to the router

Cisco IOS Software defines the router by using the fixed name self as a separate security zone. The self-zone is the exception to the default deny-all policy.

All traffic destined to or originating from the router itself (local traffic) on any interface is allowed until traffic is explicitly denied. In other words, any traffic flowing directly between defined zones and the router's IP interfaces is implicitly allowed and is not initially controlled by zone firewall policies.

This default behavior of the self-zone ensures that connectivity to the router's management interfaces and the function of routing protocols is maintained when an initial zone firewall configuration is applied to the router.

Specific rules that control traffic to the self-zone are required. When you configure a ZBFW rule that includes the self-zone, traffic between the self-zone and the other defined zones is immediately restricted in both directions.

Table 5 - Self-Zone firewall access list parameters

Protocol	Stateful inspection policy
ISAKMP	Yes
ICMP	Yes
DHCP	No
ESP	No
GRE	No

The following configuration allows the required traffic for proper remote-site router configuration with DMVPN. ESP and DHCP cannot be inspected and need to be configured with a **pass** action in the policy, using separate ACL and class-maps. ISAKMP should be configured with the **inspect** action and thus needs to be broken out with a separate ACL and class-maps for inbound and outbound policies.

Tech Tip

More specific ACLs than are shown here with the "any" keyword are recommended for added security.

Step 1: In the following steps, define access lists.

Step 2: Define an ACL allowing traffic with a destination of the router itself from the OUTSIDE zone. This includes ISAKMP for inbound tunnel initiation. This traffic can be inspected and is identified in the following ACL.

```
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
```

Step 3: Identify traffic for IPSEC tunnel initiation and other traffic that will originate from the router (self zone) to the OUTSIDE zone. This traffic can be inspected.

```
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
```

Tech Tip

The ICMP and domain entries here are for IPSLA probes that originate from the router.

```
permit icmp any any
permit udp any any eq domain
```

Step 4: Configure the DHCP ACL to allow the router to acquire a public IP address dynamically from the ISP. This traffic needs to be defined separately for server and client and cannot be inspected.

```
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc

ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
```

Step 5: Configure the ESP ACL to allow the router to establish IPSEC communications for DMVPN. ESP needs to be explicitly allowed inbound and outbound in separate ACLs. ESP cannot be inspected.

```
ip access-list extended ESP-IN
 permit esp any any

ip access-list extended ESP-OUT
 permit esp any any
```

Step 6: Configure the GRE ACL to allow GRE tunnel formation. GRE needs to be explicitly allowed inbound only.

```
ip access-list extended GRE-IN
 permit gre any any
```

> **Tech Tip**
>
> GRE needs to be permitted inbound for GRE on IOS-XE platforms due to a difference in interface order of operations. This is not required on IOS ISRG2 platforms.

Next, you define class maps for traffic to and from the self-zone. Separate class-maps are required for inbound and outbound initiated flows as well as for traffic that can be inspected by the router.

Step 7: Define class-map matching inbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
```

Step 8: Define class-map matching outbound traffic that can be inspected.

```
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
```

Step 9: Define class-map matching inbound traffic that is not able to be inspected.

```
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
```

Step 10: Define class-map matching outbound traffic that cannot be inspected.

```
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
```

Next, you define policy maps. Create two separate policies, one for traffic inbound and one for traffic outbound.

Step 11: Define the inbound policy-map that refers to both of the outbound class-maps with actions of inspect, pass, and drop for the appropriate class defined.

```
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
```

Step 12: Define the outbound policy-map that refers to both of the outbound class-maps with actions of inspect, pass, and drop for the appropriate class defined.

```
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
```

Tech Tip

Inspection for Layer 7 applications is not allowed for traffic going to and from the self-zone to other zones. Cisco IOS firewalls support only inspection of TCP, UDP, and H.323 traffic that terminates on or originates from the router itself.

Traffic such as DHCP and ESP cannot be inspected and must be configured as **Pass** in the associated policy-map.

Define the zone pair and apply policy maps to them.

Step 13: Define the zone pair for traffic destined to the self-zone of the router from the outside and associate the inbound policy-map defined in the previous step.

```
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
```

Step 14: Define the zone pair for traffic destined from the self-zone of the router to the outside and associate the outbound policy-map defined in the previous step.

```
zone-pair security FROM-ROUTER source self destination OUTSIDE
 service-policy type inspect ACL-OUT-POLICY
```

Procedure 3 Configure zone-based firewall for guest users

Configure zone-based firewall for guest DIA.

Step 1: Create the ACL for guest traffic destined to the central site DMZ for authentication.

```
ip access-list extended GUEST-IN
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
```

Tech Tip

In addition to the restrictive route leaking and NAT policies, this ACL can further restrict what traffic is allowed to access the central DMZ network. The best practice is to limit this to the hosts and protocols needed. The example used here for simplicity is not restrictive.

Step 2: Create an ACL for guest Internet traffic matching the guest VLAN source and destined to the Internet.

```
ip access-list extended GUEST-OUT
 permit ip 192.168.192.0 0.0.0.255 any
```

Step 3: Define the class maps that refer to the ACLs for the internal authentication and the Internet traffic.

```
class-map type inspect match-any GUEST-TO-INSIDE-CLASS
 match protocol tcp
 match protocol udp
 match protocol icmp
 match access-group name GUEST-IN

class-map type inspect match-any GUEST-TO-OUTSIDE-CLASS
 match protocol dns
 match protocol http
 match protocol https
 match protocol ftp
 match access-group name GUEST-OUT
```

Step 4: Define the policy maps that refer to the class maps for the authentication and Internet policies.

```
policy-map type inspect GUEST-TO-OUTSIDE-POLICY
 class type inspect GUEST-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop

policy-map type inspect GUEST-TO-INSIDE-POLICY
 class type inspect GUEST-TO-INSIDE-CLASS
  inspect
 class class-default
  drop
```

Step 5: Define the guest network security zone.

```
zone security GUEST
```

Step 6: Configure the zone pair and apply the policies.

```
zone-pair security GUEST-IN source GUEST destination default
 service-policy type inspect GUEST-TO-INSIDE-POLICY

zone-pair security GUEST-OUT source GUEST destination OUTSIDE
 service-policy type inspect GUEST-TO-OUTSIDE-POLICY
```

Step 7: Apply zone-based firewall to the router guest interface.

```
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 zone-member security GUEST
```

Step 8: Assign the Internet-facing router interface to the outside security zone. All other interfaces are assigned to the default zone and do not need to be defined.

```
interface GigabitEthernet0/0/0
 description Internet Connection
 zone-member security OUTSIDE
```

Tech Tip

By default, traffic is allowed to flow between interfaces that are members of the same zone. A default "deny-all" policy is applied to traffic moving between zones.

In this case, you are using the "default" zone for all inside interfaces. Traffic can flow between all interfaces in the default zone.

For this configuration, there is not a policy that allows default zone traffic to access the outside zone.

An interface not defined as part of a security zone is automatically part of the "default" zone. In this configuration, all undefined interface DMVPN tunnels, transit sub-interfaces, and service interfaces such as Cisco UCS-E, and SRE interfaces are included as part of the default zone.

Procedure 4 Configure guest self-zone security policy

After everything is working properly, add a guest self-zone policy in order to protect the router from unwanted traffic originating from the local guest network. This consists of additional ACLs, class-maps, a policy map, and the zone pair definition. This example allows only ICMP and DHCP. ICMP allows guest users to verify default gateway access and administrators to verify reachability from the router itself.

Step 1: Configure ACLs to allow DHCP and ICMP inbound from guest network to the router itself.

```
ip access-list extended GUEST-DHCP-IN
 permit udp any eq bootpc any eq bootps
!
ip access-list extended GUEST-ICMP-IN
 permit icmp any any echo
 permit icmp any any echo-reply
```

Step 2: Configure ACLs to allow DHCP and ICMP outbound from the router itself to the guest network.

```
ip access-list extended GUEST-DHCP-OUT
 permit udp any eq bootps any eq bootpc
!
ip access-list extended GUEST-ICMP-OUT
 permit icmp any any echo
 permit icmp any any echo-reply
```

Step 3: Configure additional class-maps that reference the inbound ACLs.

```
class-map type inspect match-any GUEST-RTR-DHCP
 match access-group name GUEST-DHCP-IN
!
class-map type inspect match-any GUEST-RTR-ICMP
 match access-group name GUEST-ICMP-IN
```

Step 4: Configure additional class-maps that reference the outbound ACLs.

```
class-map type inspect match-any RTR-GUEST-DHCP
 match access-group name GUEST-DHCP-OUT

class-map type inspect match-any RTR-GUEST-ICMP
 match access-group name GUEST-ICMP-OUT
```

Step 5: Configure policy maps that call the inbound class maps.

```
policy-map type inspect GUEST-SELF-POLICY-IN
 class type inspect GUEST-RTR-DHCP
  pass
 class type inspect GUEST-RTR-ICMP
  inspect
 class class-default
  drop
```

Step 6: Configure policy maps that call the outbound class map. This completes the policy definition.

```
policy-map type inspect GUEST-SELF-POLICY-OUT
 class type inspect RTR-GUEST-DHCP
  pass
class type inspect RTR-GUEST-ICMP
  inspect
class class-default
  drop
```

Step 7: Apply the policy by defining the zone pair for traffic between the guest zone and the router self-zone.

```
zone-pair security GUEST-RTR-IN source GUEST destination self
 service-policy type inspect GUEST-SELF-POLICY-IN

zone-pair security RTR-GUEST-OUT source self destination GUEST
 service-policy type inspect GUEST-SELF-POLICY-OUT
```

Procedure 5 Verify guest zone-based firewall configuration

Step 1: Verify the interface assignment for the zone firewall and ensure all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS31-4451X#show zone security
zone self
  Description: System defined zone

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically

zone OUTSIDE
  Member Interfaces:
```

```
    GigabitEthernet0/0/1

zone GUEST
  Member Interfaces:
    GigabitEthernet0/0/2.80
```

Step 2: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS31-4451X#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        52 packets, 14336 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        8 packets, 2680 bytes
      Pass
        8 packets, 2680 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: GUEST-IN
  Service-policy inspect : GUEST-TO-INSIDE-POLICY
    Class-map: GUEST-TO-INSIDE-CLASS (match-any)
      Match: protocol tcp
        0 packets, 0 bytes
      Match: protocol udp
        0 packets, 0 bytes
      Match: protocol icmp
        0 packets, 0 bytes
      Match: access-group name GUEST-IN
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: GUEST-OUT
  Service-policy inspect : GUEST-TO-OUTSIDE-POLICY
    Class-map: GUEST-TO-OUTSIDE-CLASS (match-any)
      Match: protocol dns
        39 packets, 3265 bytes
      Match: protocol http
```

```
      93 packets, 5946 bytes
    Match: protocol https
      8 packets, 560 bytes
    Match: protocol ftp
      0 packets, 0 bytes
    Match: access-group name GUEST-OUT
      0 packets, 0 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: GUEST-RTR-IN
Service-policy inspect : GUEST-SELF-POLICY-IN
  Class-map: GUEST-RTR-DHCP (match-any)
    Match: access-group name GUEST-DHCP-IN
      151 packets, 52258 bytes
    Pass
      151 packets, 52258 bytes
  Class-map: GUEST-RTR-ICMP (match-any)
    Match: access-group name GUEST-ICMP-IN
      1 packets, 118 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      68 packets, 6528 bytes
Zone-pair: IN_OUT
Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
  Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
    Match: protocol ftp
      0 packets, 0 bytes
    Match: protocol tcp
      0 packets, 0 bytes
    Match: protocol udp
      0 packets, 0 bytes
    Match: protocol icmp
      0 packets, 0 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: RTR-GUEST-OUT
Service-policy inspect : GUEST-SELF-POLICY-OUT

  Class-map: RTR-GUEST-DHCP (match-any)
```

```
    Match: access-group name GUEST-DHCP-OUT
      4 packets, 1384 bytes
    Pass
      4 packets, 1384 bytes
  Class-map: RTR-GUEST-ICMP (match-any)
    Match: access-group name GUEST-ICMP-OUT
      0 packets, 0 bytes
    Inspect
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
Zone-pair: TO-ROUTER
Service-policy inspect : ACL-IN-POLICY
  Class-map: INSPECT-ACL-IN-CLASS (match-any)
    Match: access-group name ACL-RTR-IN
      52 packets, 14040 bytes
    Inspect
  Class-map: PASS-ACL-IN-CLASS (match-any)
    Match: access-group name ESP-IN
      0 packets, 0 bytes
    Match: access-group name DHCP-IN
      8 packets, 2736 bytes
    Match: access-group name GRE-IN
      0 packets, 0 bytes
    Pass
      1730 packets, 338526 bytes
  Class-map: class-default (match-any)
    Match: any
    Drop
      0 packets, 0 bytes
```

PROCESS

Configuring Guest DIA, Option 2: Employee DIA

1. Configure zone-based firewall for guest users
2. Configure guest self-zone security policy
3. Verify guest zone-based firewall configuration

This process describes configuring guest DIA with employee DIA. For configuring guest DIA with employee central access, use the previous process, "Configuring Guest DIA, Option 1: Employee Central Internet."

This process assumes that you have configured employee DIA per the instructions in this guide. These configurations allow you to add guest networking with DIA to the employee DIA configuration.

Procedure 1 Configure zone-based firewall for guest users

Step 1: If the ACL is configured on the outside interface, remove it.

```
interface GigabitEthernet 0/0/1
 no ip access-group ACL-INET-PUBLIC in
```

Step 2: Create the ACL for guest traffic destined to the central site DMZ for authentication. .

```
ip access-list extended GUEST-IN
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
```

Tech Tip

In addition to the restrictive route leaking and NAT policies, this ACL can further restrict what traffic is allowed to access the central DMZ network. The best practice is to limit this to the hosts and protocols needed. The example used here for simplicity is not restrictive.

Step 3: Create an ACL for guest Internet traffic matching the guest VLAN source and destined to the Internet.

```
ip access-list extended GUEST-OUT
 permit ip 192.168.192.0 0.0.0.255 any
```

Step 4: Define the class maps that refer to the ACLs for the internal authentication and the Internet traffic.

```
class-map type inspect match-any GUEST-TO-INSIDE-CLASS
 match protocol tcp
 match protocol udp
 match protocol icmp
 match access-group name GUEST-IN

class-map type inspect match-any GUEST-TO-OUTSIDE-CLASS
 match protocol dns
 match protocol http
```

```
 match protocol https
 match protocol ftp
 match access-group name GUEST-OUT
```

Step 5: Define the policy maps that refer to the class maps for the authentication and Internet policies.

```
policy-map type inspect GUEST-TO-OUTSIDE-POLICY
 class type inspect GUEST-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect GUEST-TO-INSIDE-POLICY
 class type inspect GUEST-TO-INSIDE-CLASS
  inspect
 class class-default
  drop
```

Step 6: Define the guest network security zone.

```
zone security GUEST
```

Step 7: Configure the zone pair and apply the policies.

```
zone-pair security GUEST-IN source GUEST destination default
 service-policy type inspect GUEST-TO-INSIDE-POLICY

zone-pair security GUEST-OUT source GUEST destination OUTSIDE
 service-policy type inspect GUEST-TO-OUTSIDE-POLICY
```

Step 8: Apply the zone-based firewall to the router interfaces.

```
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 zone-member security GUEST
```

Use the **show zone security** command to verify each interface is in the correct zone.

Procedure 2 Configure guest self-zone security policy

After everything is working properly, add a guest self-zone policy in order to protect the router from unwanted traffic originating from the local guest network. This consists of additional ACLs, class-maps, a policy map, and the zone pair definition. This example allows only ICMP and DHCP. ICMP allows guest users to verify default gateway access and administrators to verify reachability from the router itself.

Step 1: Configure ACLs to allow DHCP and ICMP inbound from guest network to the router itself.

```
ip access-list extended GUEST-DHCP-IN
 permit udp any eq bootpc any eq bootps
!
ip access-list extended GUEST-ICMP-IN
 permit icmp any any echo
 permit icmp any any echo-reply
```

Step 2: Configure ACLs to allow DHCP and ICMP outbound from the router itself to the guest network.

```
ip access-list extended GUEST-DHCP-OUT
 permit udp any eq bootps any eq bootpc
!
ip access-list extended GUEST-ICMP-OUT
 permit icmp any any echo
 permit icmp any any echo-reply
```

Step 3: Configure additional class-maps that reference the inbound ACLs.

```
class-map type inspect match-any GUEST-RTR-DHCP
 match access-group name GUEST-DHCP-IN
!
class-map type inspect match-any GUEST-RTR-ICMP
 match access-group name GUEST-ICMP-IN
```

Step 4: Configure additional class-maps that reference the outbound ACLs.

```
class-map type inspect match-any RTR-GUEST-DHCP
 match access-group name GUEST-DHCP-OUT

class-map type inspect match-any RTR-GUEST-ICMP
 match access-group name GUEST-ICMP-OUT
```

Step 5: Configure policy maps that call the inbound class maps.

```
policy-map type inspect GUEST-SELF-POLICY-IN
 class type inspect GUEST-RTR-DHCP
  pass
 class type inspect GUEST-RTR-ICMP
  inspect
 class class-default
  drop
```

Step 6: Configure policy maps that call the outbound class map. This completes the policy definition.

```
policy-map type inspect GUEST-SELF-POLICY-OUT
 class type inspect RTR-GUEST-DHCP
  pass
class type inspect RTR-GUEST-ICMP
  inspect
class class-default
  drop
```

Step 7: Apply the policy by defining the zone pair for traffic between the guest zone and the router self-zone.

```
zone-pair security GUEST-RTR-IN source GUEST destination self
 service-policy type inspect GUEST-SELF-POLICY-IN

zone-pair security RTR-GUEST-OUT source self destination GUEST
 service-policy type inspect GUEST-SELF-POLICY-OUT
```

Procedure 3 Verify guest zone-based firewall configuration

Step 1: Verify the interface assignment for the zone firewall and ensure all required interfaces for the remote site configuration are assigned to the proper zone.

```
RS31-4451X#show zone security
zone self
  Description: System defined zone

zone default
  Description: System level zone. Interface without zone membership is in this
zone automatically

zone OUTSIDE
  Member Interfaces:
    GigabitEthernet0/0/1

zone GUEST
  Member Interfaces:
    GigabitEthernet0/0/2.80
```

Step 2: Verify firewall operation by reviewing the byte counts for each of the configured policies and classes.

```
RS31-4451X#show policy-map type inspect zone-pair sessions
  Zone-pair: FROM-ROUTER
  Service-policy inspect : ACL-OUT-POLICY
    Class-map: INSPECT-ACL-OUT-CLASS (match-any)
      Match: access-group name ACL-RTR-OUT
        52 packets, 14336 bytes
      Inspect
    Class-map: PASS-ACL-OUT-CLASS (match-any)
      Match: access-group name ESP-OUT
        0 packets, 0 bytes
      Match: access-group name DHCP-OUT
        8 packets, 2680 bytes
      Pass
        8 packets, 2680 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: GUEST-IN
  Service-policy inspect : GUEST-TO-INSIDE-POLICY
    Class-map: GUEST-TO-INSIDE-CLASS (match-any)
      Match: protocol tcp
        0 packets, 0 bytes
      Match: protocol udp
        0 packets, 0 bytes
```

```
      Match: protocol icmp
        0 packets, 0 bytes
      Match: access-group name GUEST-IN
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: GUEST-OUT
  Service-policy inspect : GUEST-TO-OUTSIDE-POLICY
    Class-map: GUEST-TO-OUTSIDE-CLASS (match-any)
      Match: protocol dns
        39 packets, 3265 bytes
      Match: protocol http
        93 packets, 5946 bytes
      Match: protocol https
        8 packets, 560 bytes
      Match: protocol ftp
        0 packets, 0 bytes
      Match: access-group name GUEST-OUT
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: GUEST-RTR-IN
  Service-policy inspect : GUEST-SELF-POLICY-IN
    Class-map: GUEST-RTR-DHCP (match-any)
      Match: access-group name GUEST-DHCP-IN
        151 packets, 52258 bytes
      Pass
        151 packets, 52258 bytes
    Class-map: GUEST-RTR-ICMP (match-any)
      Match: access-group name GUEST-ICMP-IN
        1 packets, 118 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        68 packets, 6528 bytes
  Zone-pair: IN_OUT
  Service-policy inspect : INSIDE-TO-OUTSIDE-POLICY
    Class-map: INSIDE-TO-OUTSIDE-CLASS (match-any)
      Match: protocol ftp
        0 packets, 0 bytes
```

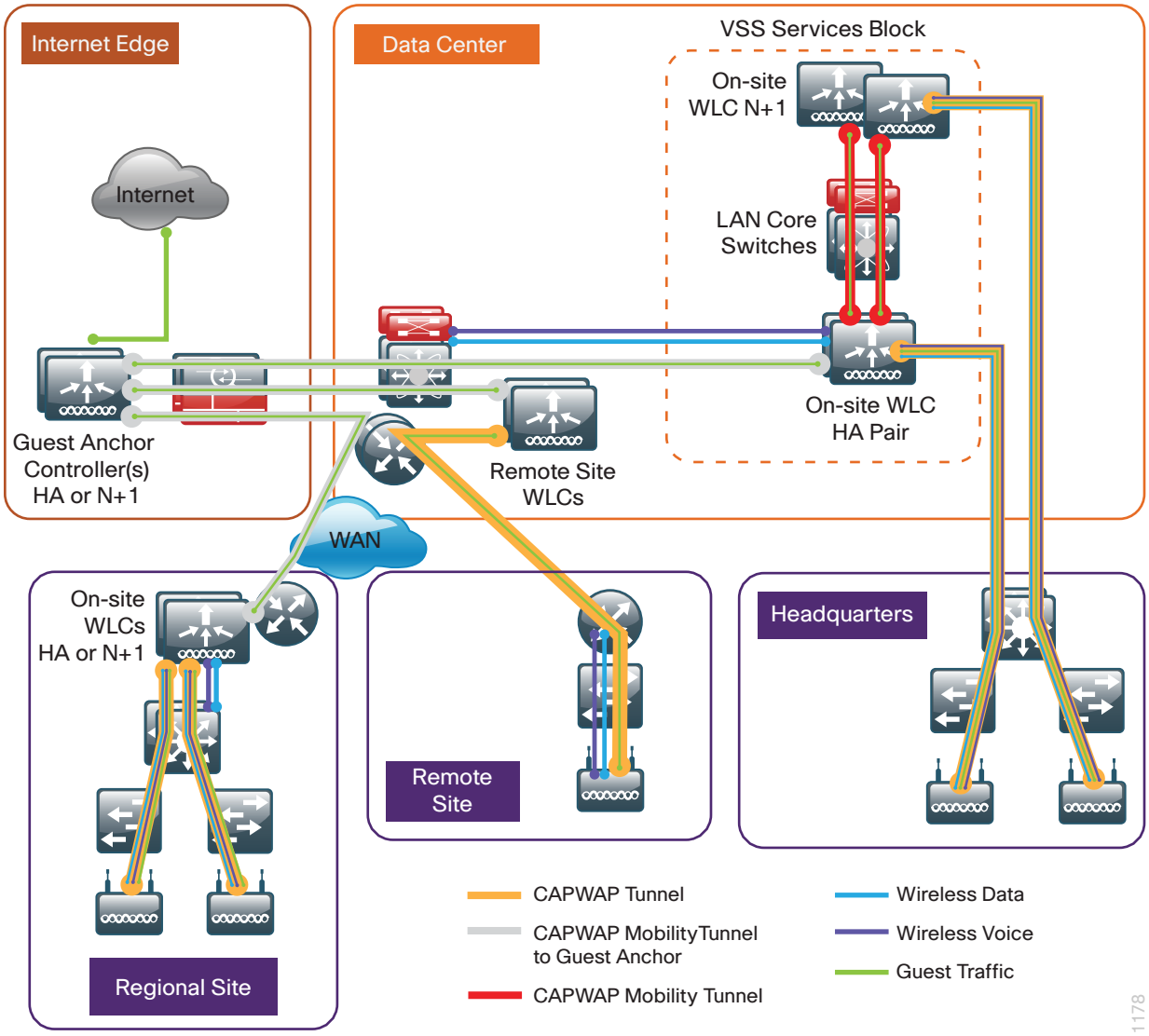
```
      Match: protocol tcp
        0 packets, 0 bytes
      Match: protocol udp
        0 packets, 0 bytes
      Match: protocol icmp
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: RTR-GUEST-OUT
  Service-policy inspect : GUEST-SELF-POLICY-OUT

    Class-map: RTR-GUEST-DHCP (match-any)
      Match: access-group name GUEST-DHCP-OUT
        4 packets, 1384 bytes
      Pass
        4 packets, 1384 bytes
    Class-map: RTR-GUEST-ICMP (match-any)
      Match: access-group name GUEST-ICMP-OUT
        0 packets, 0 bytes
      Inspect
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
  Zone-pair: TO-ROUTER
  Service-policy inspect : ACL-IN-POLICY
    Class-map: INSPECT-ACL-IN-CLASS (match-any)
      Match: access-group name ACL-RTR-IN
        52 packets, 14040 bytes
      Inspect
    Class-map: PASS-ACL-IN-CLASS (match-any)
      Match: access-group name ESP-IN
        0 packets, 0 bytes
      Match: access-group name DHCP-IN
        8 packets, 2736 bytes
      Match: access-group name GRE-IN
        0 packets, 0 bytes
      Pass
        1730 packets, 338526 bytes
    Class-map: class-default (match-any)
      Match: any
      Drop
        0 packets, 0 bytes
```

IWAN Guest Access Wireless

The deployment described here assumes that the wireless infrastructure was deployed as described in the Campus Wireless LAN Technology Design Guide.

IP addresses used in this section are examples; you should use addressing that is applicable to your architecture.

Figure 94 - Wireless overview



This CVD deployment uses a controller-based wireless design. Centralizing configuration and control on Cisco wireless LAN controllers (WLC) allows the wireless LAN (WLAN) to operate as an intelligent information network and support advanced services. This centralized deployment simplifies operational management by collapsing large numbers of managed endpoints.

Cisco Unified Wireless networks support two major campus design models: local mode and Cisco FlexConnect.

In a local-mode design model, the wireless LAN controller and access points are co-located. The wireless LAN controller can be connected to a data center services block as described in the Campus Wireless LAN Technology Design Guide or can be connected to a LAN distribution layer at the site. Wireless traffic between wireless LAN clients and the LAN is tunneled by using the control and provisioning of wireless access points (CAPWAP) protocol between the controller and the access point.

A local-mode architecture uses the controller as a single point for managing Layer 2 security and wireless network policies. It also enables services to be applied to wired and wireless traffic in a consistent and coordinated fashion. This controller can be a standalone controller like the Cisco 2500 Series Wireless LAN Controller or it can be embedded in the access switch like the Cisco Catalyst 3850 Series Switch.

Cisco FlexConnect is a wireless solution for remote-site deployments. It enables organizations to configure and control remote-site access points from the headquarters through the WAN, without deploying a controller in each remote site.

If all of the following are true at a site, deploy Cisco FlexConnect at the site:

- The site LAN is a single access-layer switch or switch stack.
- The site has fewer than 50 access points.
- The site has a WAN latency less than 100 ms round-trip to the shared controller.

The Cisco FlexConnect access point can switch client data traffic out its local wired interface and can use 802.1Q trunking in order to segment multiple WLANs. The trunk's native VLAN is used for all CAPWAP communication between the access point and the controller. This mode of operation is referred to as *FlexConnect local switching* and is the mode of operation described in this guide.

The other mode of operation, which is not discussed in this guide, is called *FlexConnect centrally switched*. In this mode, a majority of the traffic is tunneled back to the centrally located WLC, allowing the administrator to configure access control lists (ACLs) to selectively switch some local traffic.

There are two methods for deploying a guest portal described in this guide. The first is local web authentication (LWA). With LWA, the WLC provides the guest portal and guests are redirected to this portal for authentication when they attempt to use a browser. For LWA, each controller that supports guest users will need to have the portal configured.

The second method is centralized web authentication (CWA). With CWA, the guest portal is provided by a Cisco ISE that is deployed at a centralized location and used by multiple controllers.

There are several methods for deploying guest wireless at a remote site that were tested:

- Guest access with an acceptable use policy and no authentication
- Guest access using LWA with the guest user defined in the local database
- Guest access using LWA with the guest user defined on a centralized authentication server
- Guest access using CWA with the ISE server deployed in the data center at the central site
- Guest access using CWA with the ISE server deployed in a DMZ at the central site

In this guide, the deployments documented are LWA using a local database and CWA using ISE in the DMZ.

Deploying Guest Wireless by Using AireOS and FlexConnect

This section describes deploying guest wireless in an environment where the wireless LAN controller is deployed at a central location and the access point at each remote site is connected using FlexConnect with local switching.

PROCESS

Configuring Guest VLAN at Remote Site

1. Configure access switch at remote site

You need to configure the wired infrastructure at the remote site to support a guest VLAN that wireless users will use.

Procedure 1 Configure access switch at remote site

Step 1: Access the command-line interface (CLI) of the Cisco switch deployed at the remote site and configure the guest VLAN.

```
vlan 80
 name IWAN-Guest
```

Step 2: Configure the interface where the access point is connected.

```
interface GigabitEthernet1/0/17
 description FlexConnect AP
 switchport trunk native vlan 64
 switchport trunk allowed vlan 64,65,70,80
 switchport mode trunk
 switchport nonegotiate
 spanning-tree portfast trunk
```

Step 3: Add the guest VLAN to the trunk interface from the switch to the router.

```
interface GigabitEthernet1/0/48
 description Trunk to Remote Site Router
 switchport trunk allowed vlan add 80
```

Step 4: Configure the guest VLAN for DAI and DHCP snooping.

```
ip arp inspection vlan 80
ip dhcp snooping vlan 80
```

PROCESS

Configuring Local Web Authentication on WLC Running AireOS with FlexConnect

1. Configure guest login page
2. Create SSID for guest users
3. Configure SSID for guest users
4. Add SSID to FlexConnect group
5. Create guest users
6. Configure the guest anchor controller

The remote site access point is managed by the WLC in the main campus, and the guest portal is configured on this centralized controller.

Procedure 1 Configure guest login page

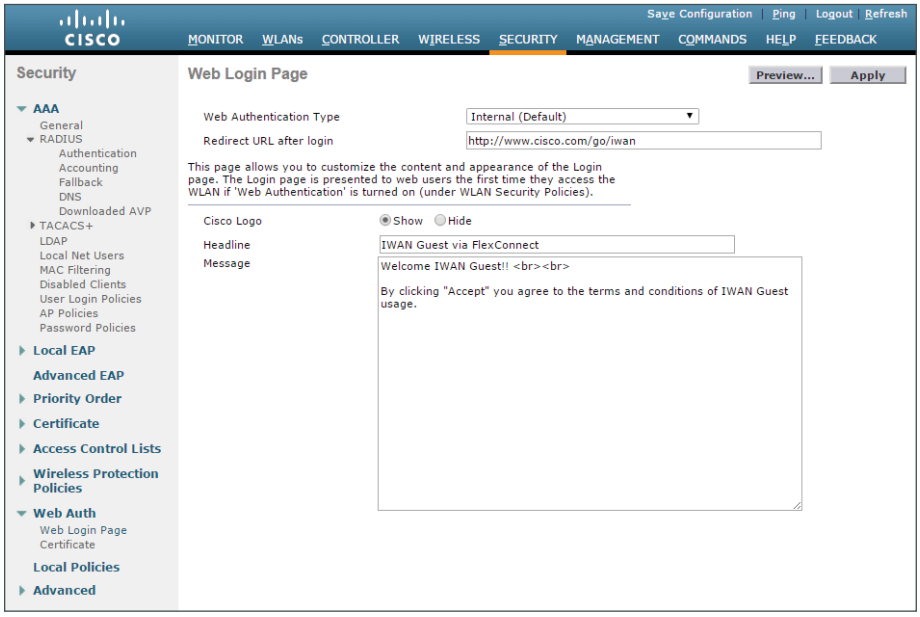
Step 1: Open a web browser and access the centralized WLC (Example: https://10.4.59.68).

Step 2: Log in using credentials that have administrative privileges.

Step 3: Navigate to **Security >Web Auth >Web Login Page**.

Step 4: In the **Web Authentication Type** box, choose **Internal (default)**.

Step 5: Fill out the remaining fields with values that adhere to your organization's policies and needs.



Procedure 2 Create SSID for guest users

Step 1: Navigate to **WLANs** and, in the list, choose **Create New**.

Step 2: Click **Go**.

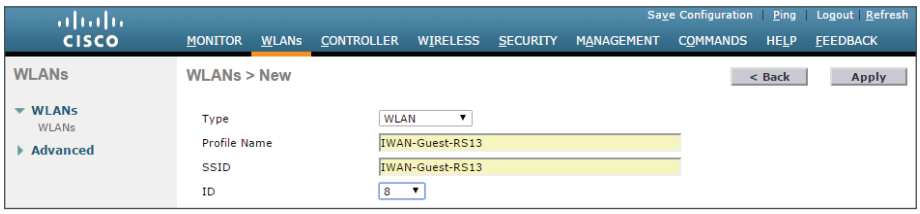
Step 3: In the **Type** list, choose **WLAN**.

Step 4: Name the profile. (Example: **IWAN-Guest-RS13**)

Step 5: In the SSID box, enter the SSID you wish to advertise for wireless guest users. (Example: **IWAN-Guest-RS13**)

Step 6: In the **ID** list, choose an ID for this WLAN.

Step 7: Click **Apply**.



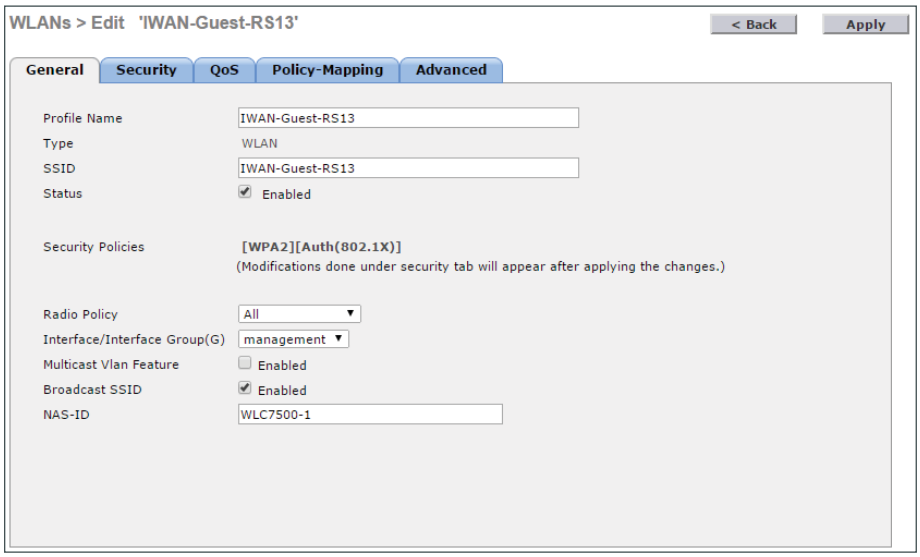
Procedure 3 Configure SSID for guest users

After you create the SSID, you now configure the options for the SSID.

Step 1: On the General tab, **next to Status**, select **Enabled**.

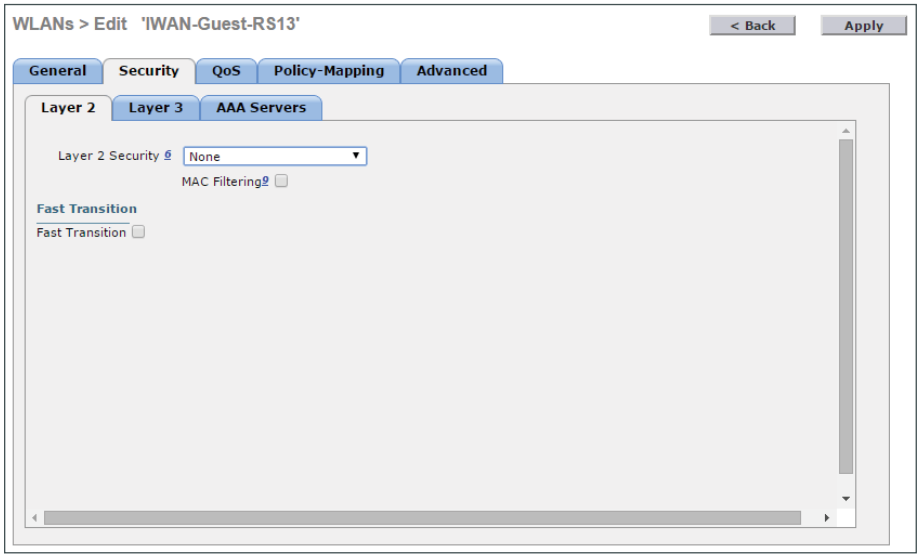
Step 2: In the **Interface/Interface Group(G)** list, choose the controller's management interface. (Example: **management**)

Step 3: Accept the default values for the remaining fields.



Step 4: Click the **Security** tab.

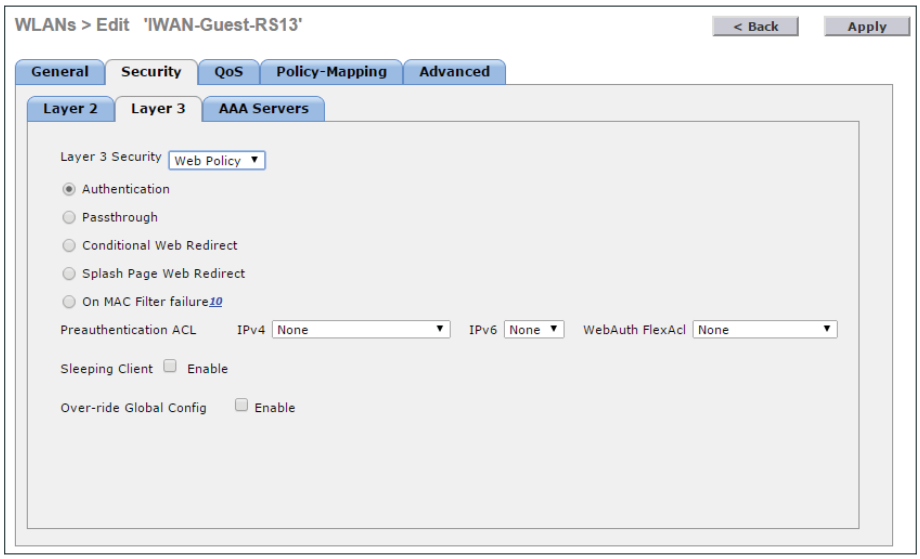
Step 5: In the Layer 2 tab, in the **Layer 2 Security** list, choose **None**.



Step 6: On the Layer 3 tab, in the **Layer 3 Security** list, choose **Web Policy**. A message appears about DNS traffic and a Pre-Auth ACL.

Step 7: Click **OK**.

Step 8: Choose **Authentication**.

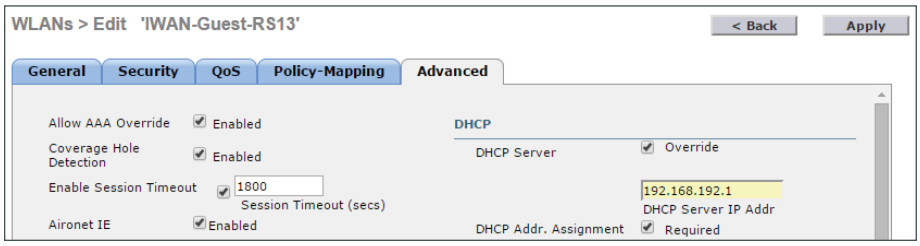


Step 9: Click the **Advanced** tab.

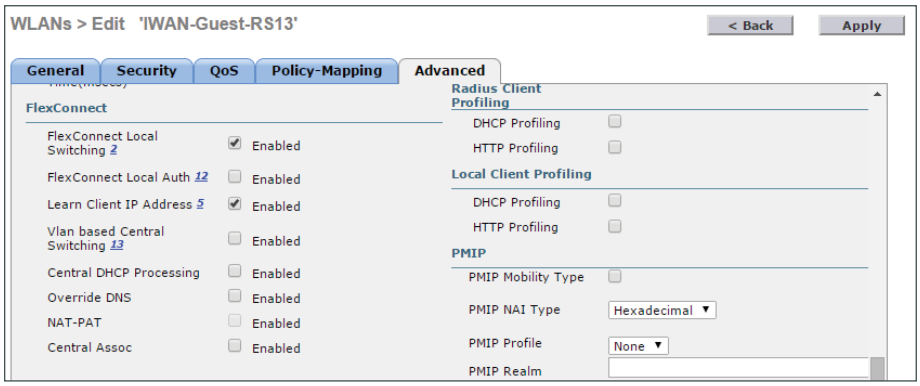
Step 10: Next to **Allow AAA Override**, choose **Enabled**.

Step 11: Next to DHCP server, choose **Override**, and then enter the IP address of the DHCP server (Example: **192.168.192.1**).

Step 12: Next to DHCP Addr. Assignment, select **Required**.



Step 13: Scroll down and in the FlexConnect section, next to FlexConnect Local Switching, select **Enabled**.



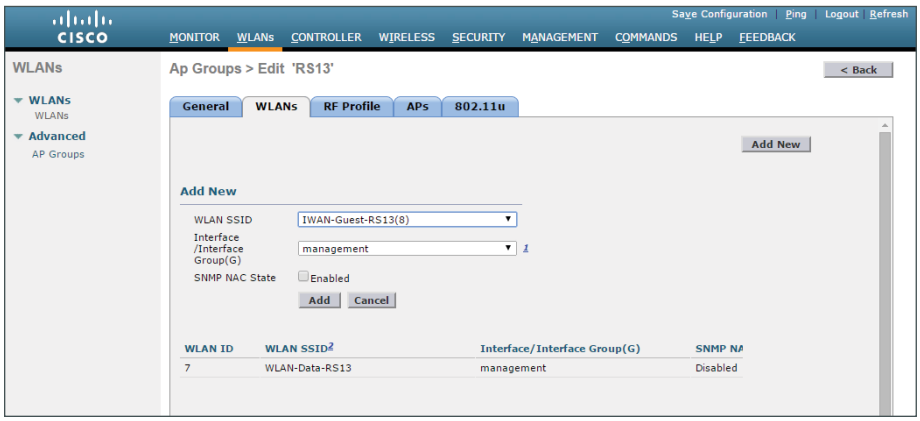
Step 14: Click **Apply**. A message appears about mDNS snooping.

Step 15: Click **OK**.

Step 16: If you are using AP groups in your deployment, you need to add the new SSID to the appropriate AP group. Navigate to **WLANs >Advanced >AP Groups** and select the AP group you wish to add the SSID (Example: **RS13**).

Step 17: Select the **WLANs** tab, and then click **Add New**.

Step 18: Select the SSID created in the Procedure 2, "Create SSID for guest users," and then click **Add**.

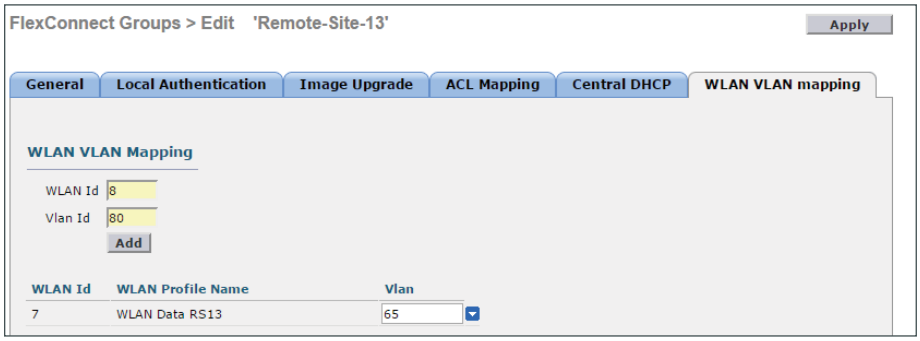


Procedure 4 Add SSID to FlexConnect group

Because this is a FlexConnect deployment, you now add the SSID to the FlexConnect group.

Step 1: Navigate to **Wireless >FlexConnect Groups** and click the FlexConnect group where you will add the SSID (Example: **Remote-Site-13**).

Step 2: On the WLAN VLAN mapping tab, enter the WLAN ID (Example: 8) and the VLAN ID (Example: 80) of the SSID created in Procedure 2.



Step 3: Click **Add**.

Step 4: Click **Apply**.

Procedure 5 Create guest users

You create users that are stored in the internal database on the WLC that will be used for guest access.

Step 1: Navigate to **Security >AAA >Local Net Users**, and then click **New**.

Step 2: In the **User Name** box, enter a username for the guest user (Example: **iwan-guest**).

Step 3: Enter a password and confirm it.

Step 4: Select **Guest User**.

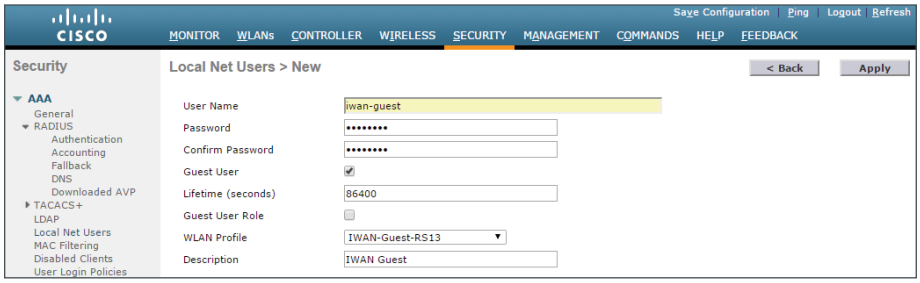
Step 5: In the **Lifetime** box, enter a number (in seconds) for how long the guest user will be active.

Step 6: In the **WLAN Profile** list, choose the profile created in Procedure 2. Click **OK** to acknowledge the dialog about web-policy.

Tech Tip

If you will be using the same guest user account for multiple SSIDs, you can choose **Any WLAN** instead of specifying a profile.

Step 7: Add a description if desired, and then click **Apply**.



Step 8: Repeat this procedure for each guest user you wish to create.

Step 9: Click **Save Configuration**.

Procedure 6 Configure the guest anchor controller

This deployment uses a guest anchor controller where all guest traffic is tunneled from the FlexConnect controller to an anchor controller in the DMZ. This isolates the guest traffic from the rest of your wireless traffic when using a shared FlexConnect controller for both guest and employee wireless connectivity. You need to configure the SSID on that controller as well. The configuration of the SSID and guest login portal need to match on both controllers.

Step 1: Open a web browser and access the guest anchor WLC. (Example: https://192.168.151.16)

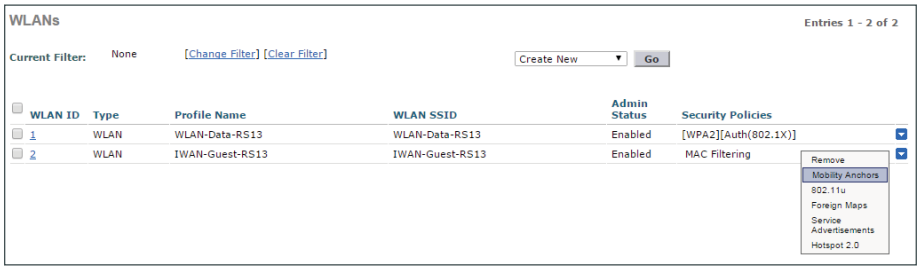
Step 2: Log in using credentials that have administrative privileges.

Step 3: Repeat Procedure 1, “Configure guest login page,” starting with Step 3.

Step 4: Repeat Procedure 2, “Create SSID for guest users,” and Procedure 3, “Configure SSID for guest users.”

Step 5: Navigate to **WLANs**.

Step 6: Hover over the blue arrow next to your guest WLAN, and then click **Mobility Anchors**.



Step 7: In the **Switch IP Address (Anchor)** list, choose **(local)**.

Step 8: Click **Mobility Anchor Create**, and then click **OK**.

Step 9: Click **Save Configuration**.

PROCESS

Configuring Central Web Authentication on WLC running AireOS with FlexConnect

1. Configure WLC to use RADIUS
2. Create ACL for web redirection
3. Create SSID for guest users
4. Configure SSID for guest users
5. Add SSID to the FlexConnect group
6. Configure the guest anchor controller

The WLC in the main campus manages the remote site access point, and the guest portal is configured on an ISE server in a DMZ.

Procedure 1 Configure WLC to use RADIUS

Step 1: Open a web browser and access the centralized WLC (Example: https://10.4.59.68).

Step 2: Log in using credentials that have administrative privileges.

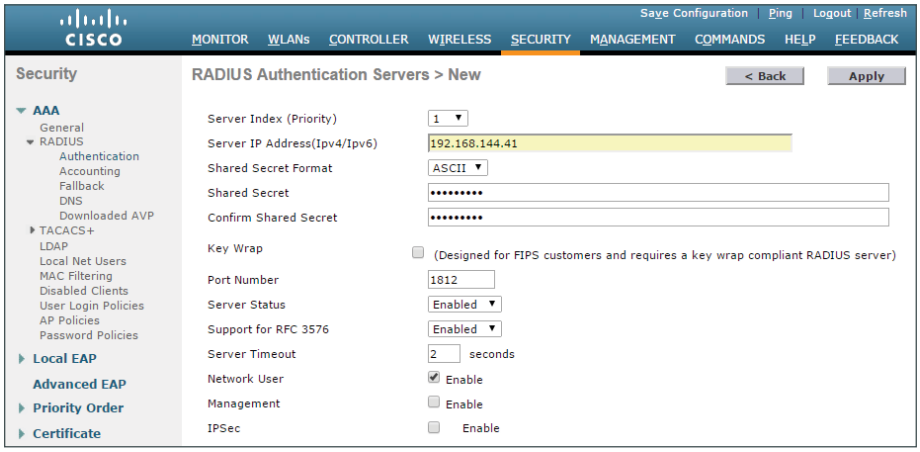
Step 3: Navigate to **Security >RADIUS >Authentication**, and then click **New**.

Step 4: In the **Server IP Address** box, enter the IP address of the ISE server in the DMZ (Example: **192.168.144.41**).

Step 5: Enter and confirm the RADIUS shared secret.

Step 6: In the **Support for RFC 3576** list, choose **Enabled**.

Step 7: Clear **Management**, and then click **Apply**.

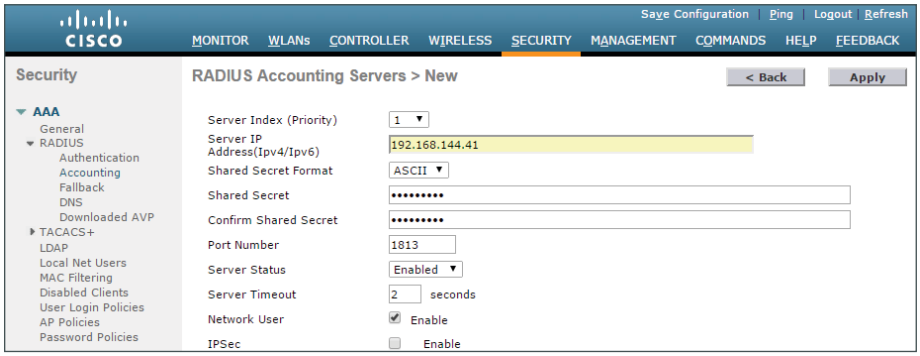


Step 8: Navigate to **Security >RADIUS >Accounting**, and then click **New**.

Step 9: In the **Server IP Address** box, enter the IP address of the ISE server in the DMZ (Example: **192.168.144.41**).

Step 10: Enter and confirm the RADIUS shared secret.

Step 11: Click **Apply**.



Procedure 2 Create ACL for web redirection

The WLC will redirect web traffic to the ISE guest portal for authentication. In order for this to take place, you configure an ACL that denies all traffic except for DNS queries and traffic to the ISE server. In a FlexConnect deployment, you also configure a FlexConnect ACL that is identical to the regular ACL.

Step 1: Navigate to **Security >Access Control Lists**, and then click **New**.

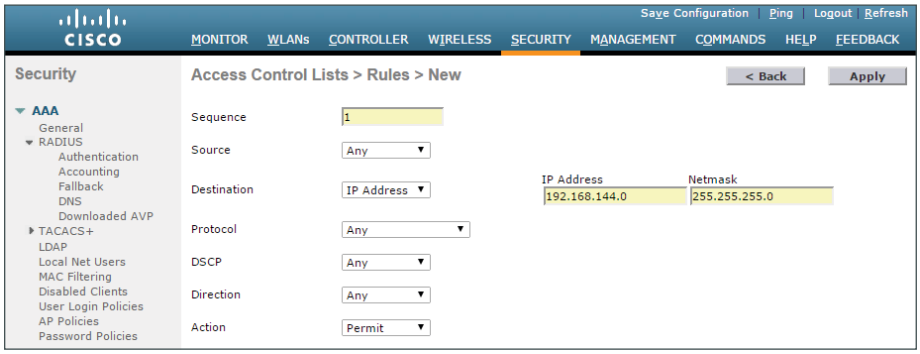
Step 2: In the **Access Control List Name** box, enter the name (Example: **CWA-Redirect**).

Step 3: Select **IPv4** as the ACL type, and then click **Apply**.

Step 4: Click the name of the newly created access control list (Example: **CWA-Redirect**), and then click **Add New Rule**.

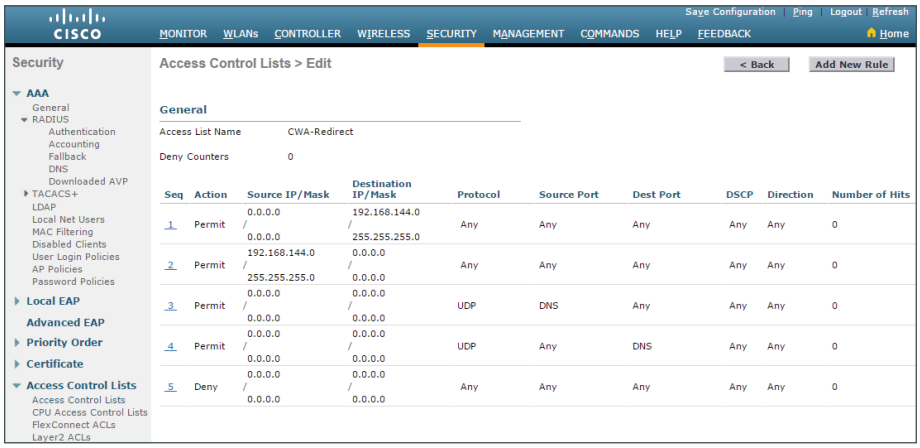
Step 5: In the window, enter the following configuration details, and then click **Apply**.

- Sequence–1
- Source–**Any**
- Destination–IP Address–**192.168.144.0/255.255.255.0**
- Protocol–**Any**
- Action–**Permit**



Step 6: Repeat Step 4 through Step 5, using the configuration details in the following table.

Sequence	Source	Destination	Protocol	Source Port	Destination Port	Action
1	192.168.144.0/ 255.255.255.0	Any	Any	Any	Any	Permit
2	Any	192.168.144.0/ 255.255.255.0	Any	Any	Any	Permit
3	Any	Any	UDP	DNS	Any	Permit
4	Any	Any	UDP	Any	DNS	Permit
5	Any	Any	Any	Any	Any	Deny



Step 7: Navigate to **Security >Access Control Lists >FlexConnect ACLs**, and then click **New**.

Step 8: In the **Access Control List Name** box, enter the name (Example: **CWA-Redirect**), and then click **Apply**.

Step 9: Repeat Step 4 through Step 6 and create an identical FlexConnect ACL as the ACL created after completing Step 6.

Procedure 3 Create SSID for guest users

Step 1: Navigate to WLANs and in the list, choose **Create New,** and then click **Go**.

Step 2: In the **Type** list, choose **WLAN**.

Step 3: Give the profile a name (Example: **IWAN-Guest-RS13**).

Step 4: In the SSID box, enter the SSID you wish to advertise for wireless guest users. (Example: **IWAN-Guest-RS13**).

Step 5: In the **ID** list, choose an ID for this WLAN.

Step 6: Click **Apply**.

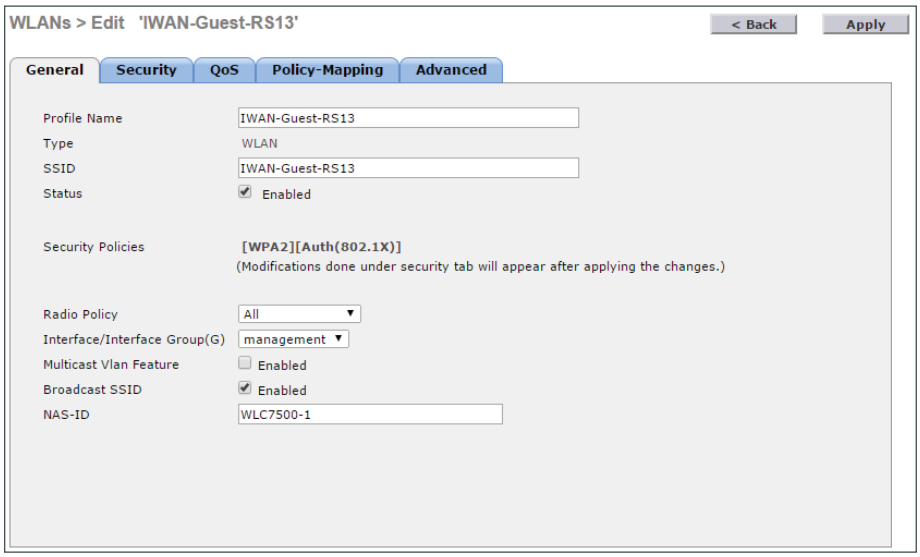
Procedure 4 Configure SSID for guest users

After you create the SSID, you configure the options for the SSID.

Step 1: On the General tab, under **Status**, select **Enabled**.

Step 2: In the **Interface/Interface Group(G)** list, choose the controller's management interface (Example: **management**).

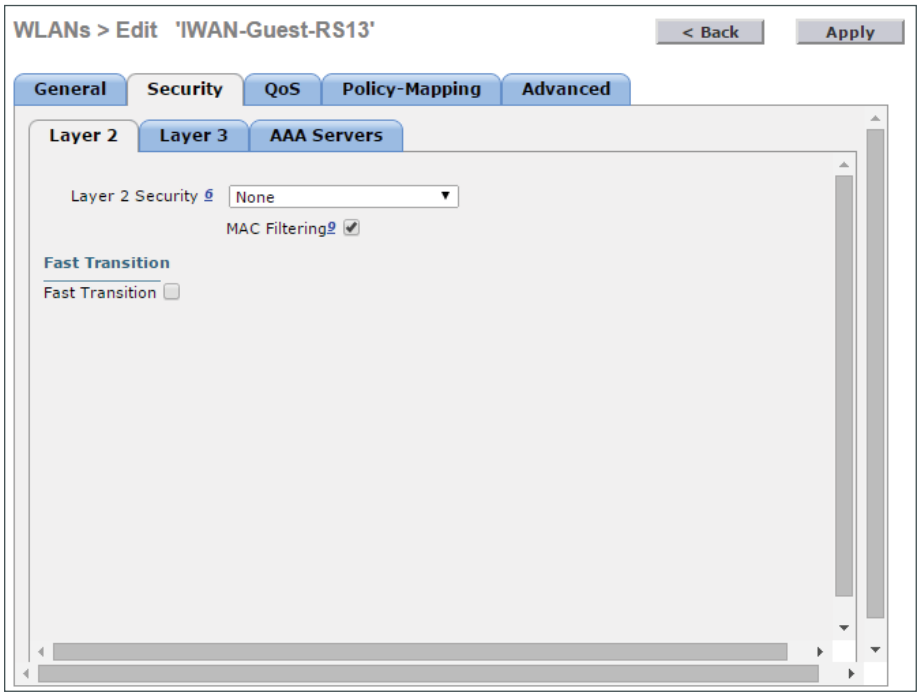
Step 3: Accept the default values for the remaining fields.



Step 4: Click the **Security** tab.

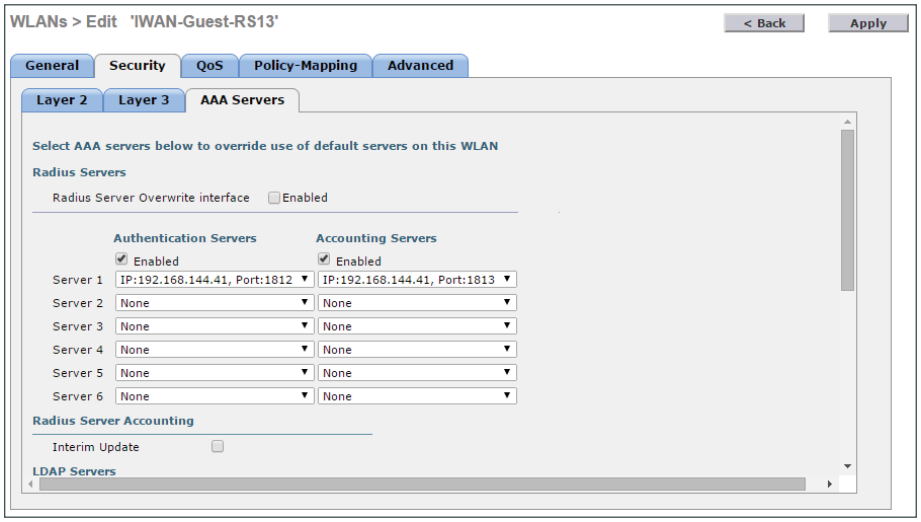
Step 5: On the Layer 2 tab, in the **Layer 2 Security** list, choose **None**.

Step 6: Select **MAC Filtering**.

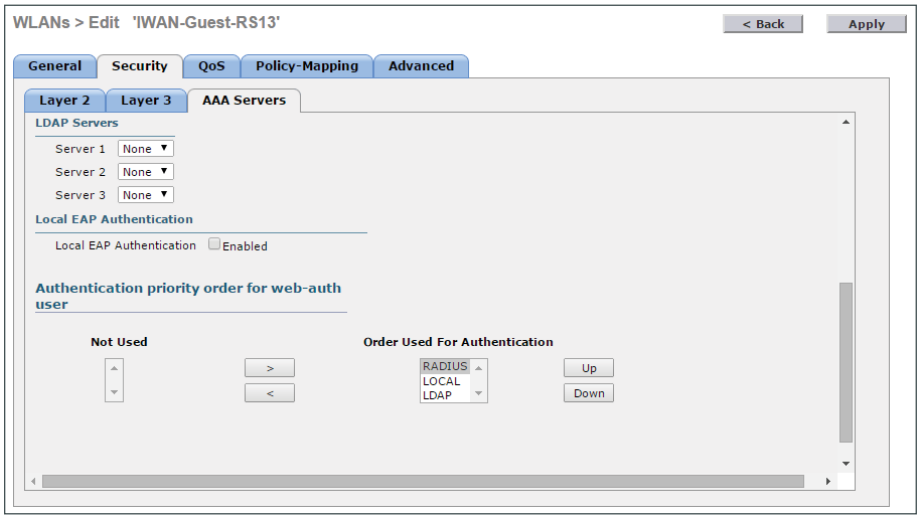


Step 7: On the Layer 3 tab, in the **Layer 3 Security** list, choose **None**.

Step 8: On the AAA Servers tab, for Server 1, select the Authentication and Accounting server defined in Procedure 1, "Configure WLC to use RADIUS".



Step 9: Scroll down and in the **Order Used for Authentication** list, choose **RADIUS,** and then click **Up** to move it to the top of the list.

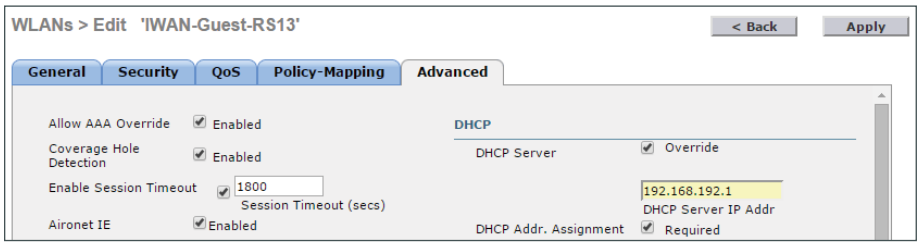


Step 10: Click the **Advanced** tab.

Step 11: Next to Allow AAA Override, select **Enabled**.

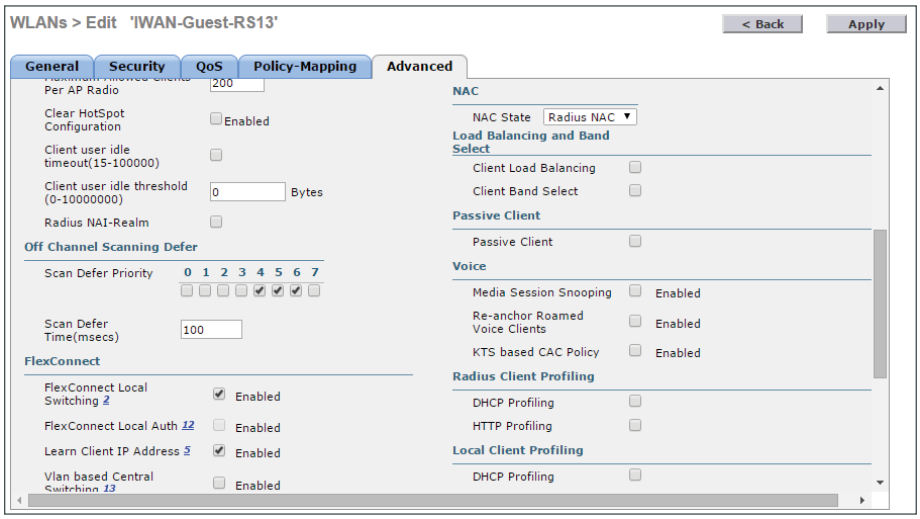
Step 12: Next to DHCP server, select **Override**, and then enter the IP address of the DHCP server (Example: **192.168.192.1**).

Step 13: Next to DHCP Addr. Assignment, select **Required**.



Step 14: In the NAC section, in the **NAC State** list, choose **Radius NAC**.

Step 15: Scroll down and in the FlexConnect section, next to FlexConnect Local Switching, select **Enabled**.



Tech Tip

Although it is not required for this deployment, enabling HTTP Profiling in the Radius Client Profiling section will give you greater visibility into the types of clients accessing the network and allow you to develop policies based on that information.

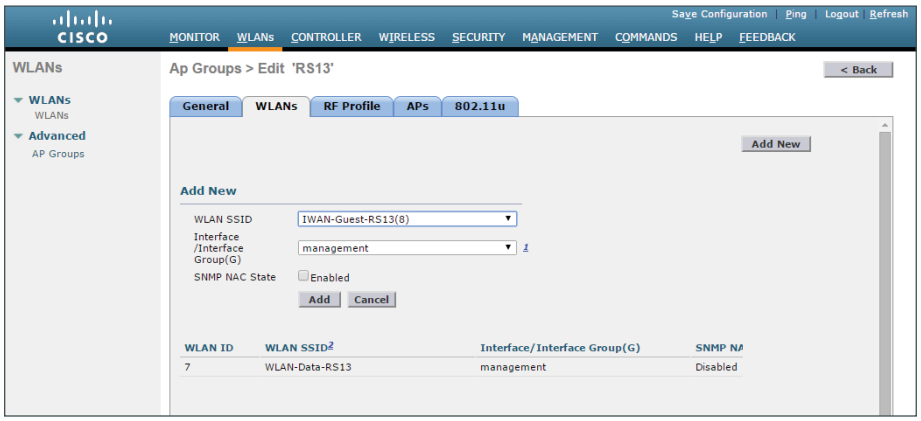
Step 16: Click **Apply**. A message appears about mDNS snooping.

Step 17: Click **OK**.

Step 18: If you are using AP groups in your deployment, you need to add the new SSID to the appropriate AP group. Navigate to **WLANs >Advanced >AP Groups** and select the AP group you wish to add the SSID (Example: **RS13**).

Step 19: Select the **WLANs** tab, and then click **Add New**.

Step 20: Select the SSID create in Procedure 3, "Create SSID for guest users," and then click **Add**.

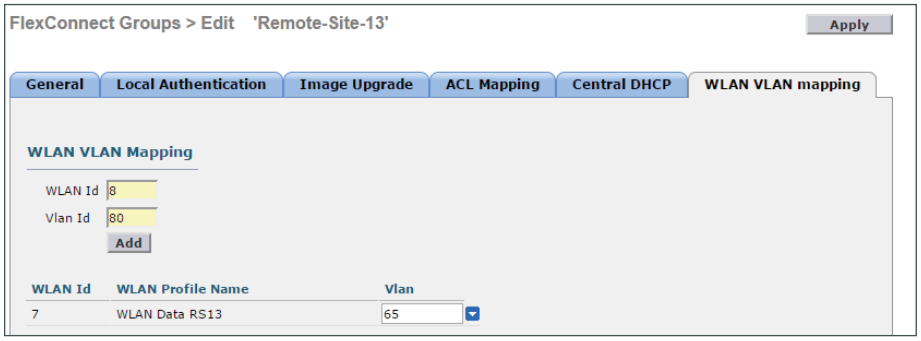


Procedure 5 Add SSID to the FlexConnect group

Because this is a FlexConnect deployment, you must add the SSID to the FlexConnect group.

Step 1: Navigate to **Wireless >FlexConnect Groups** and click the FlexConnect group where you will add the SSID (Example: **Remote-Site-13**).

Step 2: On the **WLAN VLAN mapping** tab, enter the WLAN ID (Example: **8**) and the VLAN ID (Example: **80**) of the SSID created in Procedure 3. Click **Add**.



Step 3: Click **Apply**.

Step 4: Click **Save Configuration**.

Procedure 6 Configure the guest anchor controller

This deployment is using a guest anchor controller, so you need to configure the SSID on that controller as well. The configuration of the SSID needs to match on both controllers.

Step 1: Open a web browser and access the guest anchor WLC (Example: https://192.168.151.16).

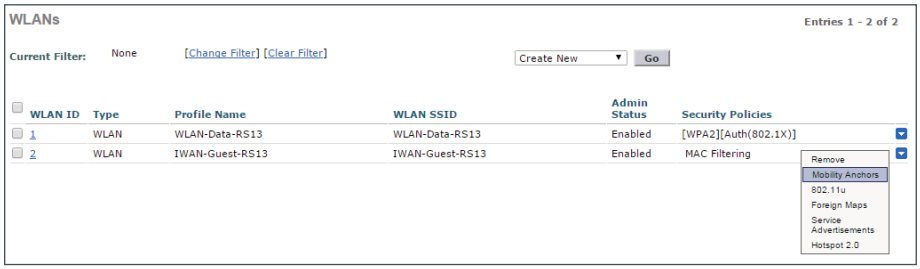
Step 2: Log in using credentials that have administrative privileges.

Step 3: Repeat Procedure 1, “Configure WLC to use RADIUS,” starting with Step 3.

Step 4: Repeat Procedure 2, “Create ACL for web redirection,” Procedure 3, “Create SSID for guest users”, and Procedure 4, “Configure SSID for guest users”.

Step 5: Navigate to **WLANs**.

Step 6: Hover over the blue arrow next to your guest WLAN, and then click **Mobility Anchors**.



Step 7: In the **Switch IP Address (Anchor)** list, choose **(local)**.

Step 8: Click **Mobility Anchor Create**, and then click **OK**.

Step 9: Click **Save Configuration**.

Guest Wireless Using Local Controller with AireOS

This section describes the steps required to deploy guest wireless in an environment where the wireless LAN controller is deployed at the remote site running AireOS.

PROCESS

Configuring Local Web Authentication on Remote WLC Running AireOS

1. Configure guest login page
2. Create guest interface
3. Create SSID for guest users
4. Configure SSID for guest users
5. Create guest users

The WLC manages the remote site access point located at the remote site, and the guest portal is configured on this local controller.

Procedure 1 Configure guest login page

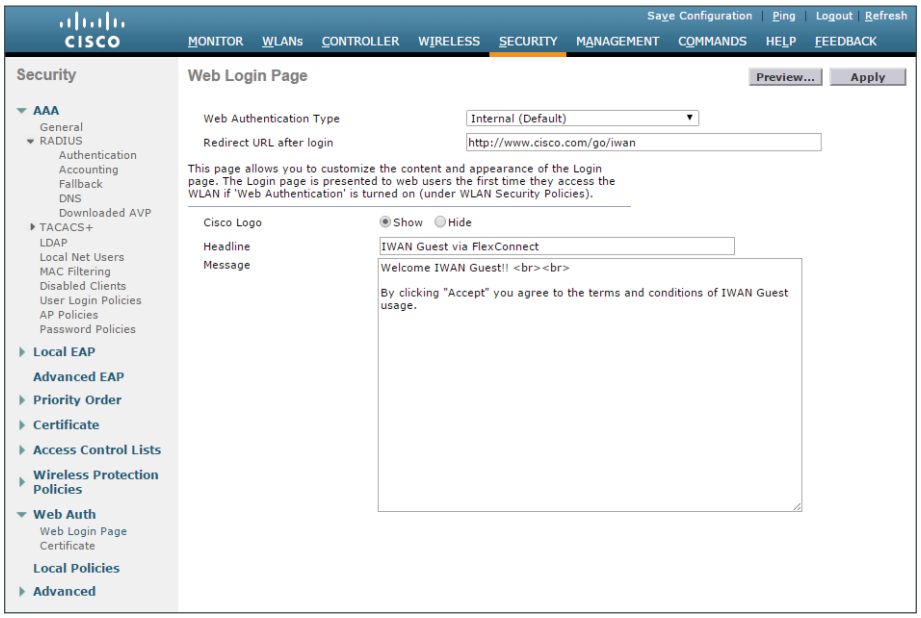
Step 1: Open a web browser and access the local WLC (Example: https://10.7.199.16).

Step 2: Log in using credentials that have administrative privileges.

Step 3: Navigate to **Security >Web Auth >Web Login Page**.

Step 4: In the Web Authentication Type list, choose **Internal (default)**.

Step 5: Fill out the remaining fields with values that adhere to your organization's policies and needs.



Procedure 2 Create guest interface

In the "Configuring Guest VLAN at Remote Site" section, you created a guest VLAN on the switch. You now configure an interface on the WLC for this guest VLAN.

Step 1: Navigate to **Controller >Interfaces**, and then click **New**.

Step 2: In the **Interface Name** box, enter a name for the interface (Example: **guest**).

Step 3: In the **VLAN ID** box, enter the VLAN number that was configured on the switch (Example: **80**).

Step 4: Click **Apply**.

Step 5: In the Physical Information section, enter **1** for the **Port Number**.

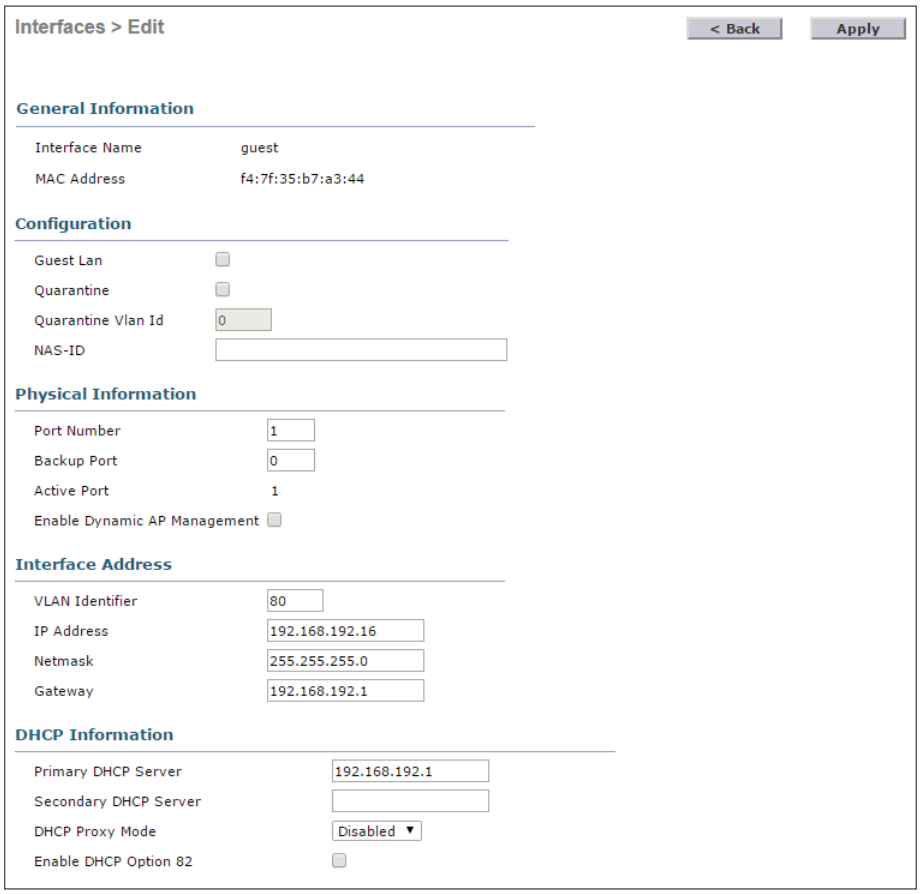
Step 6: In the Interface Address section, enter the following configuration details

- VLAN Identifier–**80**
- IP Address–**192.168.192.16**
- Netmask–**255.255.255.0**
- Gateway–**192.168.192.1**

Step 7: In the DHCP Information section, in the **Primary DHCP Server** box, enter the DHCP server (Example: **192.168.192.1**).

Step 8: In the **DHCP Proxy Mode** list, **Disabled**.

Step 9: Click **Apply**.



Procedure 3 Create SSID for guest users

Step 1: Navigate to **WLANs** and in the list, choose **Create New**, and then click **Go**.

Step 2: In the **Type** list, choose **WLAN**.

Step 3: Give the profile a name (Example: **IWAN-Guest-RS41**).

Step 4: In the **SSID** box, enter the SSID you wish to advertise for wireless guest users. (Example: **IWAN-Guest-RS41**).

Step 5: In the **ID** list, choose an ID for this WLAN.

Step 6: Click **Apply**.

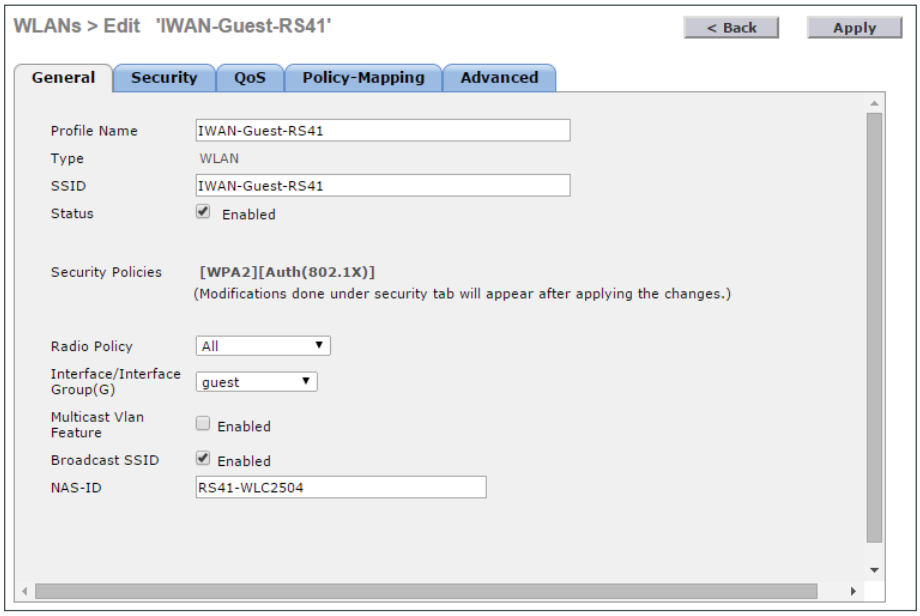
Procedure 4 Configure SSID for guest users

After you create the SSID, you configure the options for the SSID.

Step 1: On the General tab, next to **Status,** select **Enabled**.

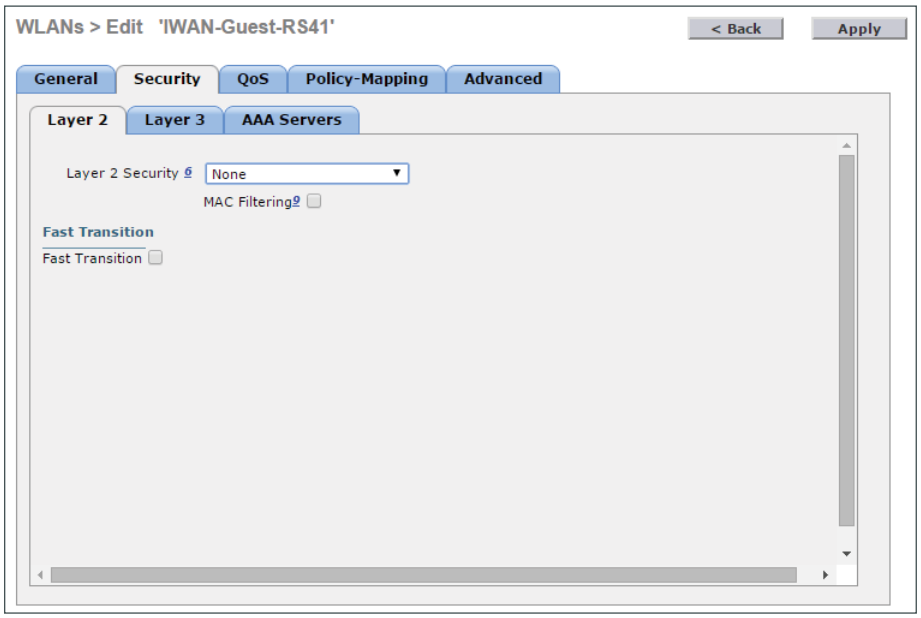
Step 2: In the **Interface/Interface Group(G)** list, choose the guest interface created in Procedure 2 (Example: **guest**).

Step 3: Accept the default values for the remaining fields.



Step 4: Click the **Security** tab.

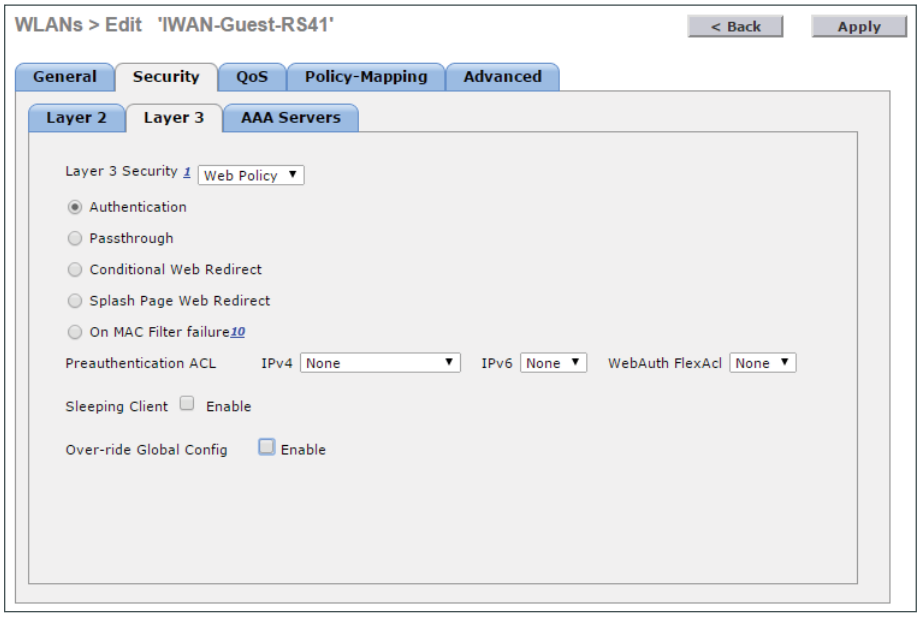
Step 5: In the Layer 2 tab, in the **Layer 2 Security** list, choose **None**.



Step 6: In the Layer 3 tab, in the **Layer 3 Security** list, choose **Web Policy**. A message appears about DNS traffic and a Pre-Auth ACL.

Step 7: Click **OK**.

Step 8: Choose **Authentication**.



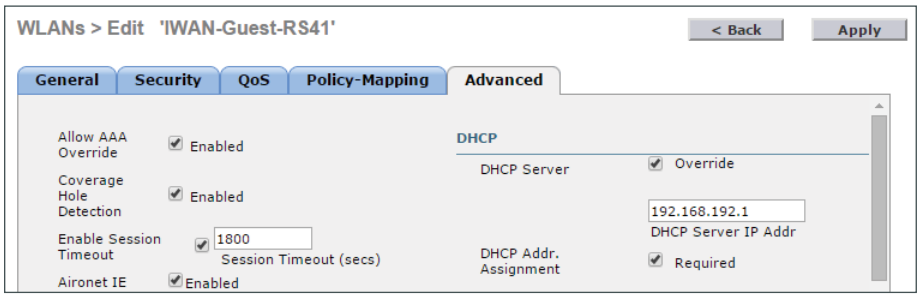
Step 9: Click the **Advanced** tab.

Step 10: Next to Allow AAA Override, select **Enabled**.

Step 11: Next to DHCP server, select **Override.**

Step 12: Enter the IP address of the DHCP server (Example: **192.168.192.1**).

Step 13: Next to DHCP Addr. Assignment, select **Required**, and then click **Apply**.



Procedure 5 Create guest users

You create users that are stored in the internal database (on the WLC that will be used for guest access).

Step 1: Navigate to **Security >AAA >Local Net Users**, and then click **New**.

Step 2: In the **User Name** box, enter a username for the guest user (Example: **iwan-guest**).

Step 3: Enter a password and confirm it.

Step 4: Select **Guest User**.

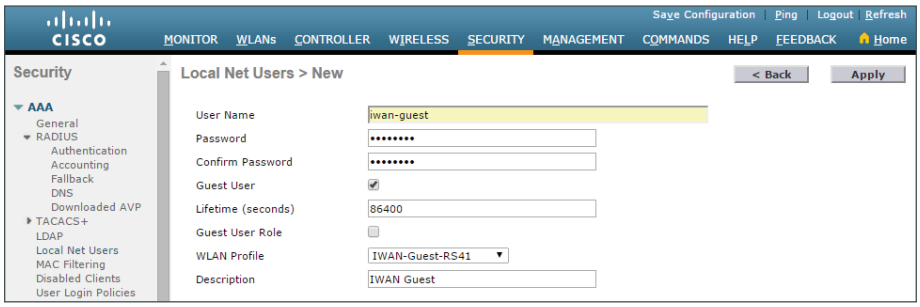
Step 5: In the **Lifetime** box, enter a number (in seconds) for how long the guest user will be active.

Step 6: In the **WLAN Profile** list, choose the profile created in Procedure 3. Click **OK** to acknowledge the dialog about web-policy.

Tech Tip

If you will be using the same guest user account for multiple SSIDs, you can choose **Any WLAN** instead of specifying a profile.

Step 7: Add a description if desired and then click **Apply**.



Step 8: Repeat this procedure for each guest user you wish to create.

Step 9: Click **Save Configuration**.

PROCESS

Configuring Central Web Authentication on Local WLC Running AireOS

1. Configure WLC to use RADIUS
2. Create ACL for web redirection
3. Create SSID for guest users
4. Configure SSID for guest users

The WLC manages the remote site access point located at the remote site, and the guest portal is configured on an ISE server in a DMZ.

Procedure 1 Configure WLC to use RADIUS

Step 1: Open a web browser and access the remote site WLC (Example: https://10.7.199.16).

Step 2: Log in using credentials that have administrative privileges.

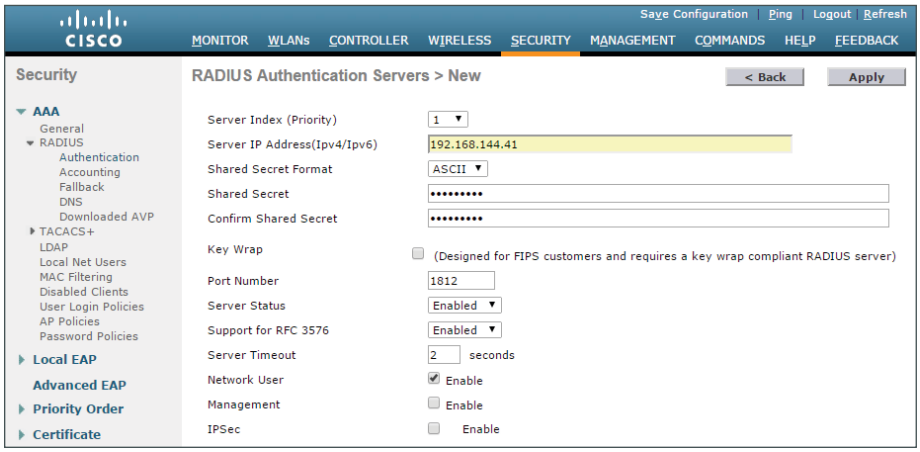
Step 3: Navigate to **Security >RADIUS >Authentication**, and then click **New**.

Step 4: In the **Server IP Address box**, enter the IP address of the ISE server in the DMZ (Example: **192.168.144.41**).

Step 5: Enter and confirm the RADIUS shared secret.

Step 6: In the **Support for RFC 3576** list, choose **Enabled**.

Step 7: Clear **Management**, and then click **Apply**.

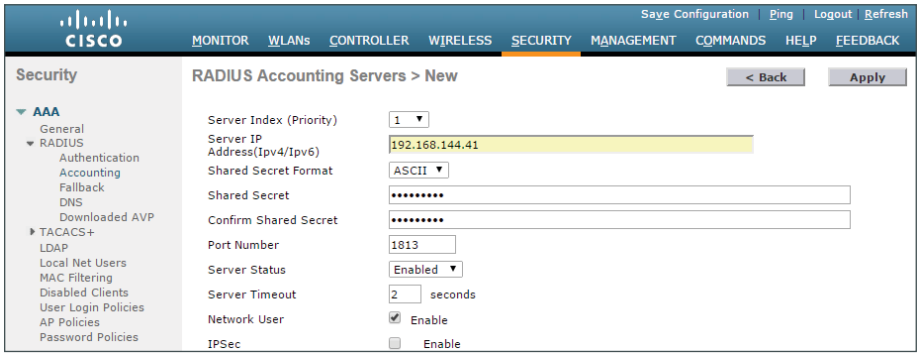


Step 8: Navigate to **Security >RADIUS >Accounting**, and then click **New**.

Step 9: In the **Server IP Address** box, enter the IP address of the ISE server in the DMZ (Example: **192.168.144.41**).

Step 10: Enter and confirm the RADIUS shared secret.

Step 11: Click **Apply**.



Procedure 2 Create ACL for web redirection

The WLC will redirect web traffic to the ISE guest portal for authentication. In order for this to take place, you configure an ACL that denies all traffic except for DNS queries and traffic to the ISE server.

Step 1: Navigate to **Security >Access Control Lists**, and then click **New**.

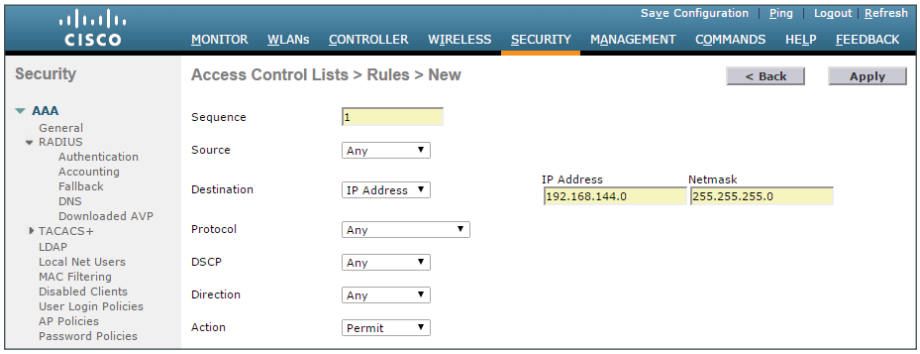
Step 2: In the **Access Control List Name** box, enter the name (Example: **CWA-Redirect**).

Step 3: Select **IPv4** as the ACL type, and then click **Apply**.

Step 4: Click the name of the newly created access control list (Example: **CWA-Redirect**) and then click **Add New Rule**.

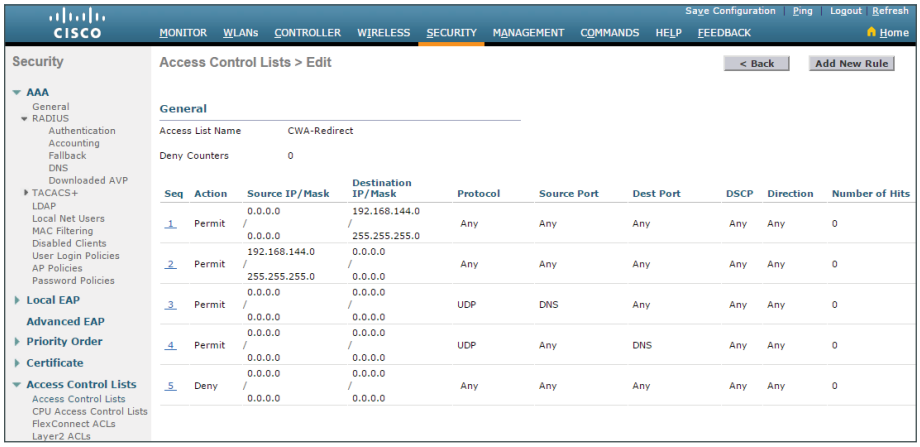
Step 5: In the window, enter the following configuration details, and then click **Apply**.

- Sequence–**1**
- Source–**Any**
- Destination–IP Address–**192.168.144.0/255.255.255.0**
- Protocol–**Any**
- Action–**Permit**



Step 6: Repeat Step 4 through Step 5, using the configuration details in the following table.

Sequence	Source	Destination	Protocol	Source Port	Destination Port	Action
1	192.168.144.0/ 255.255.255.0	Any	Any	Any	Any	Permit
2	Any	192.168.144.0/ 255.255.255.0	Any	Any	Any	Permit
3	Any	Any	UDP	DNS	Any	Permit
4	Any	Any	UDP	Any	DNS	Permit
5	Any	Any	Any	Any	Any	Deny



Procedure 3 Create SSID for guest users

Step 1: Navigate to **WLANs**, and in the list, choose **Create New**.

Step 2: Click **Go**.

Step 3: In the **Type** list, choose **WLAN**.

Step 4: Give the profile a name (Example: **IWAN-Guest-RS41**).

Step 5: In the SSID box, enter the SSID you wish to advertise for wireless guest users. (Example: **IWAN-Guest-RS41**).

Step 6: In the **ID** list, choose an ID for this WLAN.

Step 7: Click **Apply**.

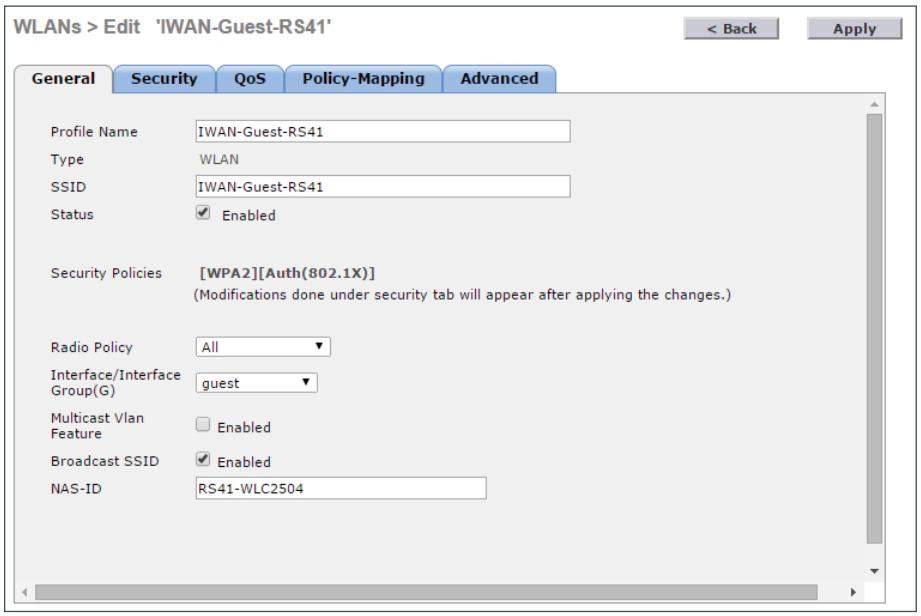
Procedure 4 Configure SSID for guest users

After you create the SSID, you configure the options for the SSID.

Step 1: On the General tab, **next to Status**, select **Enabled**.

Step 2: In the **Interface/Interface Group(G)** list, choose the guest interface created in Procedure 3 (Example: **guest**).

Step 3: Accept the default values for the remaining fields.



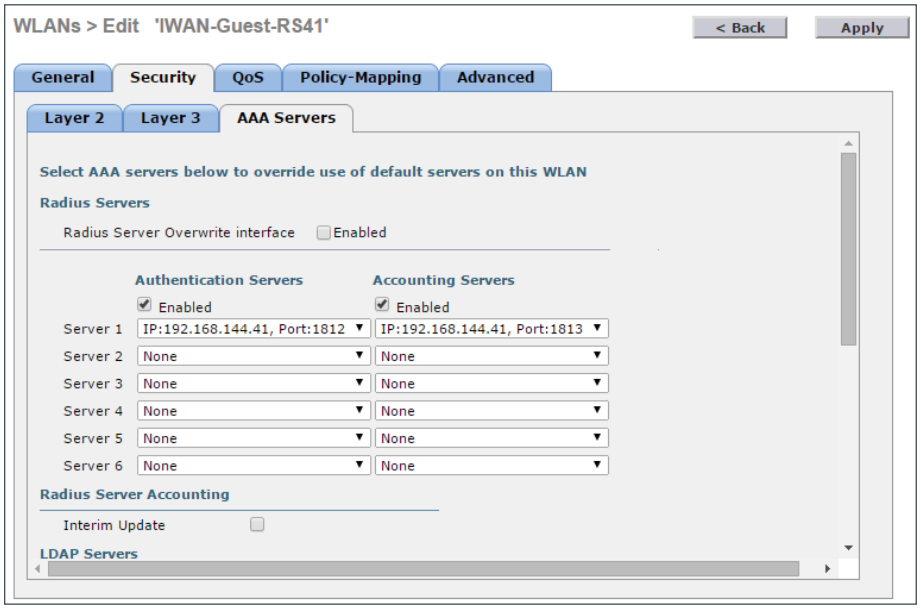
Step 4: Click the **Security** tab.

Step 5: On the Layer 2 tab, in the **Layer 2 Security** list, choose **None**.

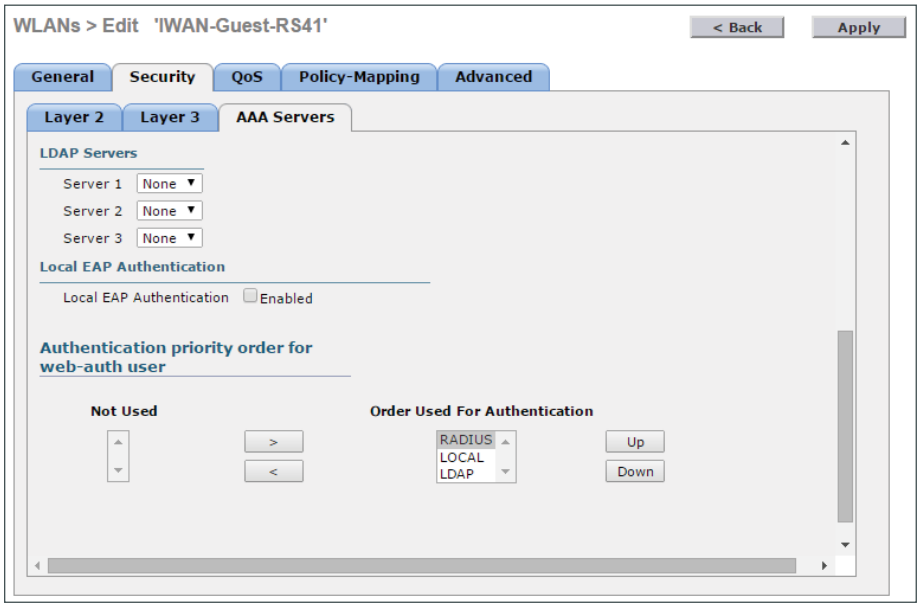
Step 6: Select **MAC Filtering**.

Step 7: On the Layer 3 tab, in the **Layer 3 Security** list, choose **None**.

Step 8: On the AAA Servers tab, for Server 1, select the Authentication and Accounting server defined in Procedure 1, "Configure WLC to use RADIUS."



Step 9: Scroll down and in the **Order Used for Authentication** list, choose **RADIUS**, and then click **Up** to move it to the top of the list.



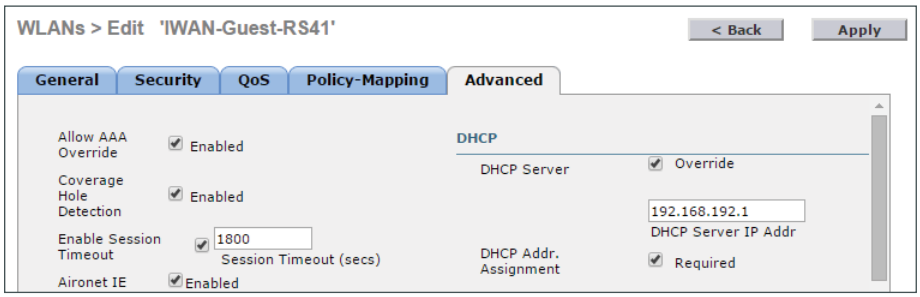
Step 10: Click the **Advanced** tab.

Step 11: Next to Allow AAA Override, select **Enabled**.

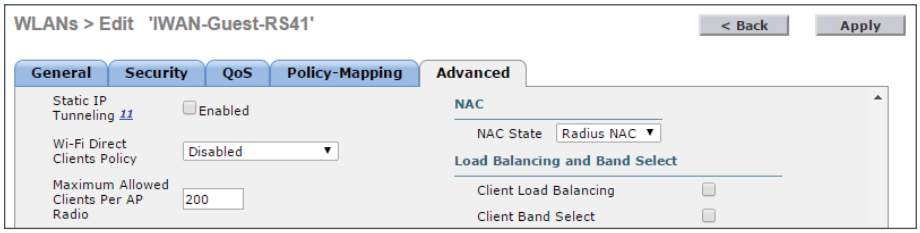
Step 12: Next to DHCP server, select **Override**,

Step 13: Enter the IP address of the DHCP server (Example: **192.168.192.1**).

Step 14: Next to DHCP Addr. Assignment, select **Required**.



Step 15: In the NAC section, in the **NAC State** list, choose **Radius NAC**.



Tech Tip

Although it is not required for this deployment, enabling HTTP Profiling in the Radius Client Profiling section will give you greater visibility into the types of clients accessing the network and allow you to develop policies based on that information.

Step 16: Click **Save Configuration**.

Guest Wireless Using Unified Access Switches

This section details the steps required to deploy guest wireless in an environment where the wireless LAN controller function of a Unified Access switch is deployed at the remote site.

PROCESS

Configuring Local Web Authentication on a Unified Access Switch

1. Configure guest interface
2. Configure AAA and guest users
3. Configure the guest portal
4. Configure a pre-authentication access list
5. Configure HTTP server
6. Configure SSID for guests

Cisco Unified Access is the convergence of the wired and wireless networks into one physical infrastructure. The Cisco Catalyst 3850 and 3650 switches both combine wired ports along with wireless tunnel termination and WLC functionality. The remote-site switch is used as the WLC, and the guest portal is configured on the switch, as well.

Procedure 1 Configure guest interface

You configure the guest VLAN in the "Configuring Guest VLAN at Remote Site" section. In this procedure, you configure the Layer 3 interface for that VLAN.

Step 1: Access the console of the remote site switch and configure the guest interface.

```
interface Vlan80
 ip address 192.168.192.5 255.255.255.0
```

Procedure 2 Configure AAA and guest users

Authentication, authorization and accounting (AAA) is required for guest access. The guest user database will be on the switch, and in this example, the guest account has a lifetime of five days.

Step 1: Configure AAA.

```
aaa new-model
aaa authentication login Local-Auth local
```

Step 2: Configure guest user.

```
user-name iwan-guest
 privilege 0
 password 0 [password]
 type network-user description IWAN guest-user lifetime year 0 month 0 day 5
```

Procedure 3 Configure the guest portal

The switch uses parameter maps to specify the options for the guest portal. In the parameter map, you configure the login banner for the portal as well as any web redirection that takes place for successful login or failed login. There is also a global parameter map that provides a virtual IP address for the switch that is used as the login portal address.

Step 1: Configure the global parameter map.

```
parameter-map type webauth global
 type webauth
 virtual-ip ipv4 192.0.2.1
```

Step 2: Configure the parameter map for local web authentication.

```
parameter-map type webauth LWA
 type webauth
 redirect on-success http://www.cisco.com/go/iwan
 banner text ^C Welcome to IWAN RS23!! ^C
```

Tech Tip

CONTROL-C (^C) is used as the default delimiter for the banner text, but you can use any character.

Procedure 4 Configure a pre-authentication access list

You use the pre-authentication ACL to limit the traffic on an interface prior to successful authentication. Typically, this limits the port to having access to only the infrastructure necessary for authentication to take place. In this example, DHCP and DNS traffic are allowed and everything else is denied. Although a pre-authentication ACL isn't required, it is a best practice.

Step 1: Configure pre-authentication ACL.

```
ip access-list extended PreAuth
 permit udp any any eq domain
 permit tcp any any eq domain
 permit udp any eq bootps any
 permit udp any any eq bootpc
 permit udp any eq bootpc any
```

Procedure 5 Configure HTTP server

The switch acts as an HTTP server in order to provide the guest portal. You need to enable the HTTP service and support AAA authentication.

Step 1: Configure the HTTP server.

```
ip http server
ip http authentication aaa
```

Procedure 6 Configure SSID for guests

The SSID for guest access is mapped to the guest VLAN. The SSID uses the parameter map and AAA options configured above.

Step 1: Configure the guest SSID.

```
wlan IWAN-Guest-RS23 4 IWAN-Guest-RS23
 no shutdown
```

Step 2: Configure AAA support.

```
 aaa-override
```

Step 3: Configure VLAN mapping and ACL.

```
 client vlan IWAN-Guest
 ip access-group web PreAuth
```

Step 4: Configure Layer 2 options.

```
 no security wpa
 no security wpa akm dot1x
 no security wpa wpa2
 no security wpa wpa2 ciphers aes
```

Step 5: Configure Layer 3 options.

```
 security web-auth
 security web-auth authentication-list Local-Auth
 security web-auth parameter-map LWA
 ip dhcp required
 ip dhcp server 192.168.192.1
```

Tech Tip

For increased visibility into the types of clients that access the guest network and the applications that are being run, you can add the following commands to the SSID configuration.

```
device-classification
ip flow monitor wireless-avc-basic input
ip flow monitor wireless-avc-basic output
profiling local http
```

PROCESS

Configuring Central Web Authentication on Unified Access Switch

1. Configure guest interface
2. Configure AAA and guest users
3. Configure the guest portal
4. Configure a pre-authentication access list
5. Configure HTTP server
6. Configure SSID for guests

Cisco Unified Access is the convergence of the wired and wireless networks into one physical infrastructure. The Cisco Catalyst 3850 and 3650 switches both combine wired ports along with wireless tunnel termination and WLC functionality. The remote-site switch is used as the WLC, and the guest portal is configured on an ISE server installed in a DMZ at the central site.

Procedure 1 Configure guest interface

You configure the guest VLAN in the "Configuring Guest VLAN at Remote Site" section. In this procedure, you configure the Layer 3 interface for that VLAN.

Step 1: Access the console of the remote site switch and configure the guest interface.

```
interface Vlan80
 ip address 192.168.192.5 255.255.255.0
```

Procedure 2 Configure AAA and guest users

AAA is required for guest access. You add the ISE server as an AAA server and then configure the policies for authentication, authorization, and accounting. For guest users, you also configure RADIUS Change of Authorization.

Step 1: Add a RADIUS server.

```
radius server ISE-IWAN
 address ipv4 192.168.144.41 auth-port 1812 acct-port 1813
 key [shared secret]
```

Step 2: Configure AAA policies.

```
aaa new-model
aaa group server radius ISE-DMZ
 server name ISE-IWAN
 mac-delimiter colon
aaa authentication login CWA-DMZ group ISE-DMZ
aaa authorization network CWA-DMZ-AuthZ group ISE-DMZ
aaa accounting identity CWA-DMZ start-stop group ISE-DMZ
```

Step 3: Configure RADIUS Change of Authorization.

```
aaa server radius dynamic-author
 client 192.168.144.41 server-key [shared secret]
 auth-type any
```

Procedure 3 Configure the guest portal

The switch uses parameter maps to specify the options for the guest portal. In the parameter map, for you configure the URL for the guest portal on the ISE server, as well as any web redirection that takes place for successful login or failed login. There is also a global parameter map that provides a virtual IP address for the switch that is used for redirection.

Step 1: Configure the global parameter map.

```
parameter-map type webauth global
 type webauth
 virtual-ip ipv4 192.0.2.1
```

Step 2: Configure the parameter map for central web authentication.

```
parameter-map type webauth CWA-DMZ
 type webauth
 redirect for-login https://192.168.144.41:8443/guestportal/Login.action
 redirect on-success http://www.cisco.com/go/iwan
 redirect portal ipv4 192.168.144.41
```

Procedure 4 Configure a pre-authentication access list

You use the pre-authentication ACL to limit the traffic on an interface prior to successful authentication. Typically, this limits the port to having access to only the infrastructure necessary for authentication to take place. In this example, DHCP and DNS traffic are allowed as well as traffic to the ISE server for authentication. Everything else is denied.

Step 1: Configure pre-authentication ACL.

```
ip access-list extended PreAuth
 permit ip any 192.168.144.0 0.0.0.255
 permit udp any any eq domain
 permit tcp any any eq domain
 permit udp any eq bootps any
 permit udp any any eq bootpc
 permit udp any eq bootpc any
```

Procedure 5 Configure HTTP server

The switch acts as an HTTP server in order to provide the guest portal. You need to enable the HTTP service and support AAA authentication.

Step 1: Configure the HTTP server.

```
ip http server
ip http authentication aaa
```

Procedure 6 Configure SSID for guests

The SSID for guest access is mapped to the guest VLAN. The SSID uses the parameter map and AAA options configured above.

Step 1: Configure the guest SSID.

```
wlan IWAN-Guest-RS43 7 IWAN-Guest-RS43
 no shutdown
```

Step 2: Configure AAA support.

```
 aaa-override
 accounting-list CWA-DMZ
```

Step 3: Configure VLAN mapping and ACL.

```
 client vlan IWAN-Guest
 ip access-group web PreAuth
```

Step 4: Configure Layer 2 options.

```
 no security wpa
 no security wpa akm dot1x
 no security wpa wpa2
 no security wpa wpa2 ciphers aes
 mac-filtering CWA-DMZ-AuthZ
```

Step 5: Configure Layer 3 options.

```
 security dot1x authentication-list CWA-DMZ
 nac
 ip dhcp required
 ip dhcp server 192.168.192.1
```

Tech Tip

For increased visibility into the types of clients that access the guest network and the applications that are being run, you can add the following commands to the SSID configuration.

```
device-classification
ip flow monitor wireless-avc-basic input
ip flow monitor wireless-avc-basic output
profiling local http
profiling radius http
```

Configuring Identity Services Engine

This section details the configuration of the Cisco ISE to support CWA for wireless guest access.

PROCESS

Implementing ISE for CWA

1. Install ISE
2. Join ISE to Active Directory
3. Add network devices
4. Add device groups and locations
5. Add devices to groups
6. Add devices to a location
7. Configure default device
8. Configure guest locations and SSIDs
9. Configure the sponsor portal
10. Configure the guest type
11. Configure sponsor groups
12. Add sponsor group to guest type
13. Configure guest portal
14. Configure authentication policy
15. Configure authorization policy
16. Create guest user

In this design, you deploy ISE in standalone mode in a DMZ at the central site. You can run it as an appliance or as a VMware virtual machine.

Procedure 1 Install ISE

Step 1: Use the Cisco Identify Services Engine Hardware Installation Guide, Release 1.3 to install the ISE server in standalone mode. Use the table below for configuration information.

Table 6 - ISE installation details

Parameter	CVD Value
Hostname	ise-iwan
IP address	192.168.144.41
Netmask	255.255.255.0
Domain	cisco.local
Default Router	192.168.144.1
DNS Server	10.4.48.10
NTP Server	10.4.48.17

Procedure 2 Join ISE to Active Directory

This design uses ISE to authenticate guest users and also to allow sponsors to create guest users. The sponsors are defined in the Active Directory domain, and ISE is a member of the domain, as well. ISE then uses Active Directory as the back-end authentication service for the sponsors.

Step 1: Open a web browser and access the ISE server (Example: https://192.168.144.41)

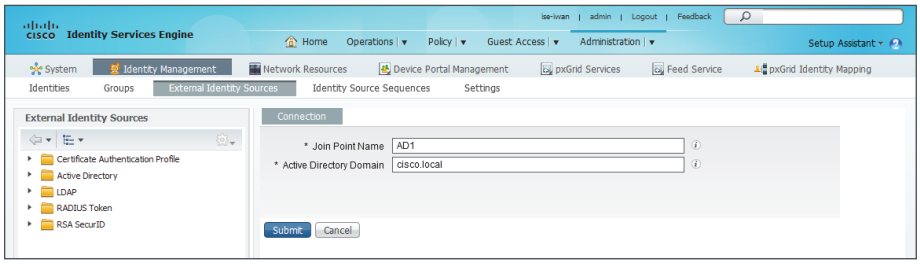
Step 2: Log in using credentials that have administrative privileges.

Step 3: Navigate to **Administration >Identity Management >External Identity Sources >Active Directory**, and then click **Add**.

Step 4: In the **Join Point Name** box, enter a name for the Active Directory server that will be used in ISE policies (Example: **AD1**).

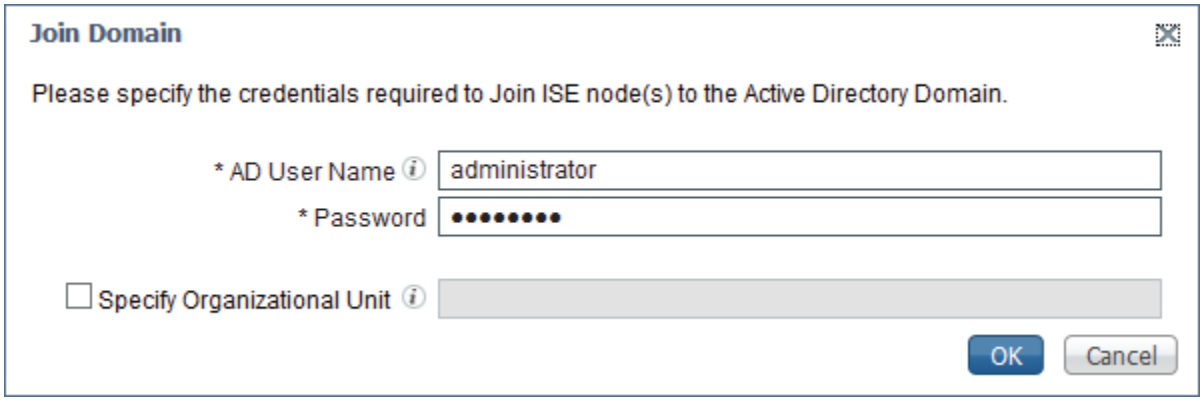
Step 5: In the **Active Directory Domain** box, enter the name of the domain for the deployment (Example: **cisco.local**).

Step 6: Click **Submit**.



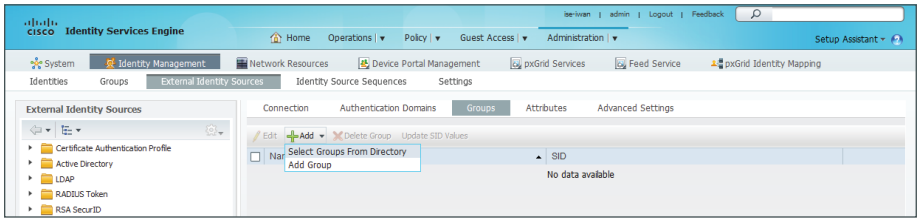
Step 7: In the message that asks if you want to join the domain, click **Yes**.

Step 8: In the Join Domain window, log in to the domain using credentials that have administrator privileges, and then click **OK**. A window appears confirming a successful join.



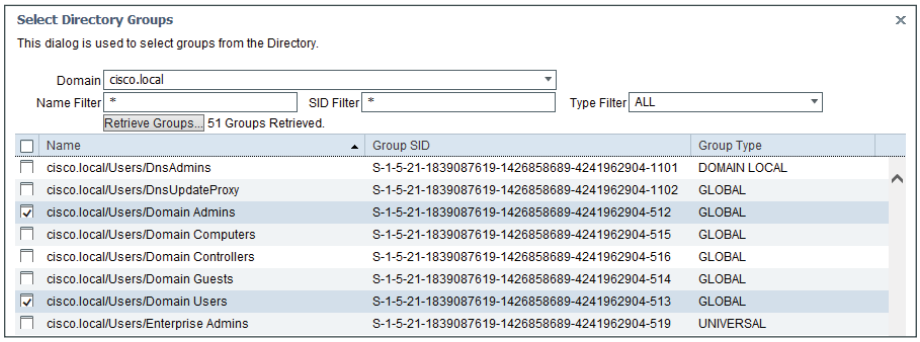
Step 9: Click **OK**.

Step 10: On the Groups tab, click **Add**, and then select **Select Groups From Directory**.



Step 11: Click **Retrieve Groups** in order to get a list of groups from Active Directory.

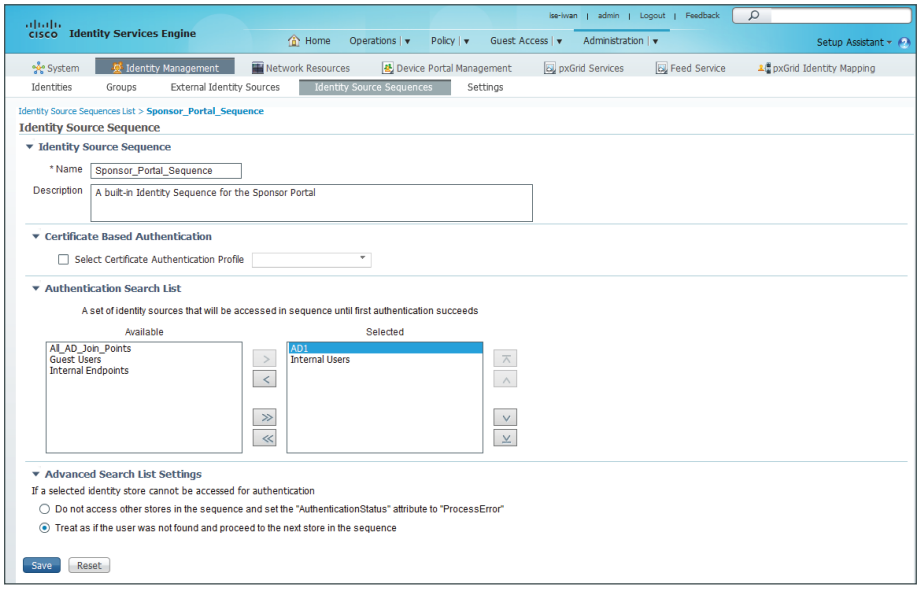
Step 12: Select the groups that you will use for sponsors on ISE (Example: Domain Users), and then click **OK**.



Step 13: Click **Save**.

Step 14: Navigate to **Administration >Identity Management >Identity Source Sequences**, and then click **Sponsor_Portal_Sequence.**

Step 15: In the Authentication Search List section, under Available, select the Active Directory server (Example: AD1) and move it under Selected.



Step 16: Click **Save**.

Procedure 3 Add network devices

Add each network device used to provide guest access services to ISE as a RADIUS network access device. The devices are identified in the logs, making it easier to troubleshoot issues and identify users.

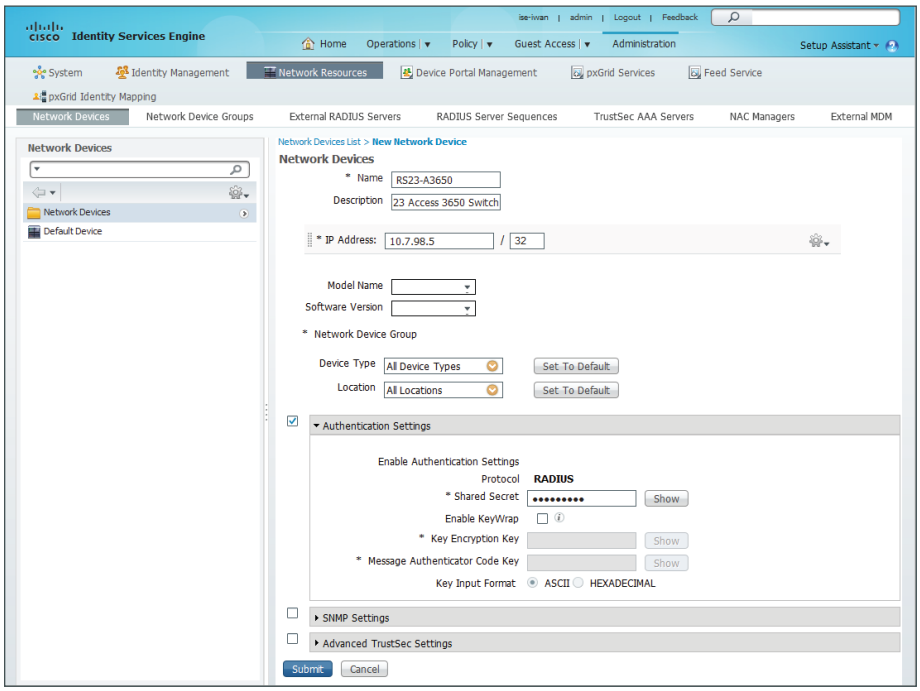
Step 1: Navigate to **Administration >Network Resources >Network Devices**, and then click **Add**.

Step 2: Enter a name and a description for the device.

Step 3: In the **IP address** box, enter the IP address of the device (Example: **10.7.98.5**).

Step 4: Select the box next to **Authentication Settings**.

Step 5: In the **Shared Secret** box, enter the RADIUS shared secret, and then click **Submit**.



Step 6: Repeat Step 1 through Step 5 for each device you wish to add.

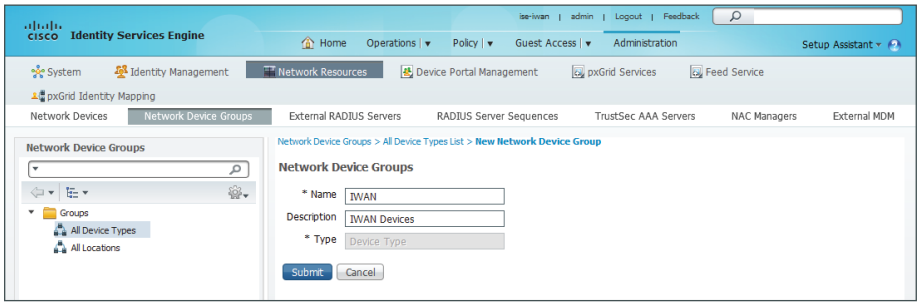
Procedure 4 Add device groups and locations

Step 1: Navigate to **Administration >Network Resources >Network Device Groups**.

Step 2: In the Network Device Groups column, expand **Groups**¸ and then click **All Device Types**.

Step 3: Click **Add**.

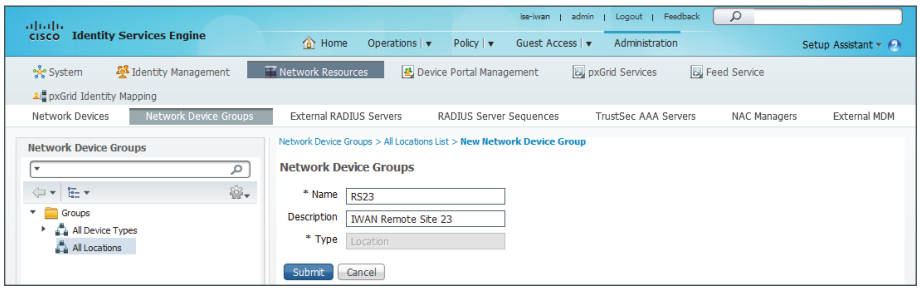
Step 4: Enter a name (Example: IWAN) and description for the group, and then click **Submit**.



Step 5: Repeat Step 1 through Step 4 for each group you wish to add.

Step 6: In the Network Device Groups column, click All **Locations**, and then click **Add**.

Step 7: Enter a name (Example: RS23) and description for the location, and then click **Submit**.



Step 8: Repeat Step 6 and Step 7 for each location you wish to add.

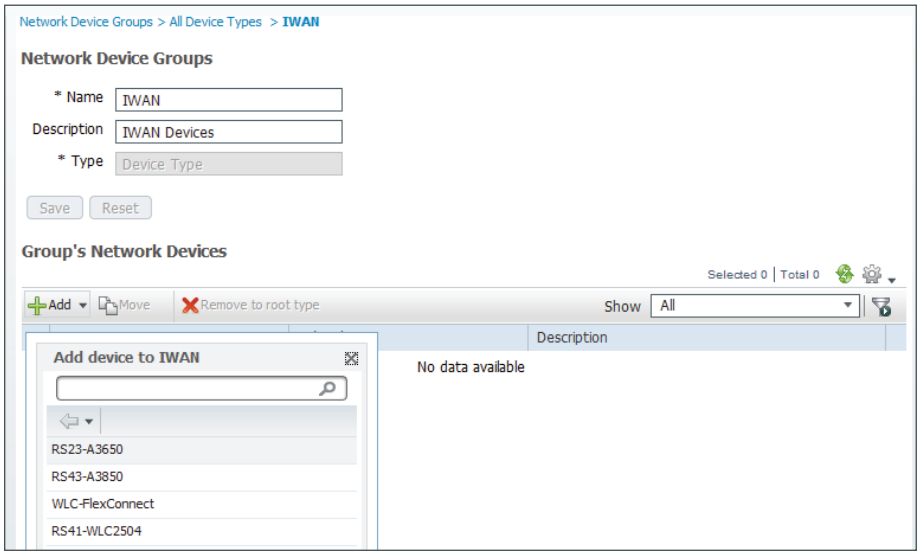
Procedure 5 Add devices to groups

Step 1: Navigate to **Administration >Network Resources >Network Device Groups**.

Step 2: In the Network Device Groups column, expand **Groups**.

Step 3: Click **All Device Types**, and then click **IWAN**.

Step 4: Click **Add**, and then select the device you wish to add.



Step 5: Repeat Step 1through Step 4 for each device you wish to add to a group.

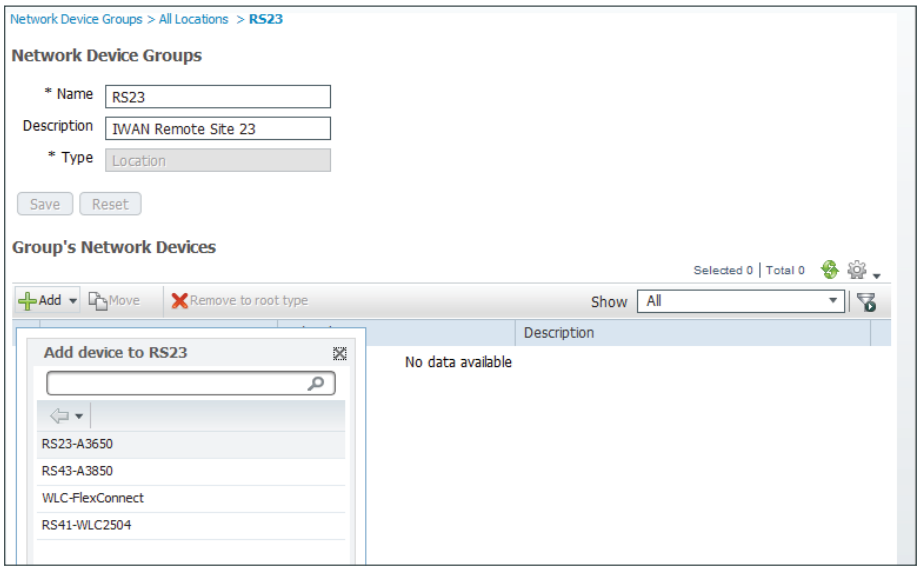
Procedure 6 Add devices to a location

Step 1: Navigate to **Administration >Network Resources >Network Device Groups**.

Step 2: In the Network Device Groups column, expand **Groups**.

Step 3: Click **All Locations**, and then click **RS23**.

Step 4: Click **Add**, and then select the device you wish to add.



Step 5: Repeat Step 1 through Step 4 for each device who wish to add to a location.

Procedure 7 Configure default device

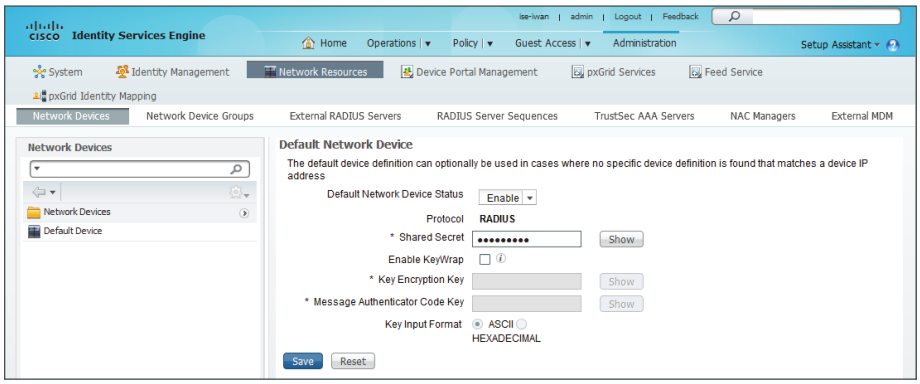
When a network access device communicates with the server and that device is not defined on the server, the RADIUS default device is used.

Step 1: Navigate to **Administration >Network Resources >Network Devices**.

Step 2: Click **Default Network Device**.

Step 3: In the **Default Network Device Status** list, choose **Enable**.

Step 4: In the **Shared Secret** box, enter the RADIUS shared secret, and then click **Save**.



Procedure 8 Configure guest locations and SSIDs

For guest access policies, you configure locations and SSIDs that are used when the sponsor creates a guest account.

Step 1: Navigate to **Guest Access >Settings**.

Step 2: Expand **Guest Locations and SSIDs**.

Step 3: In the **Location Name** box, enter a name for the location (Example: **RS13**), and then select a time zone.

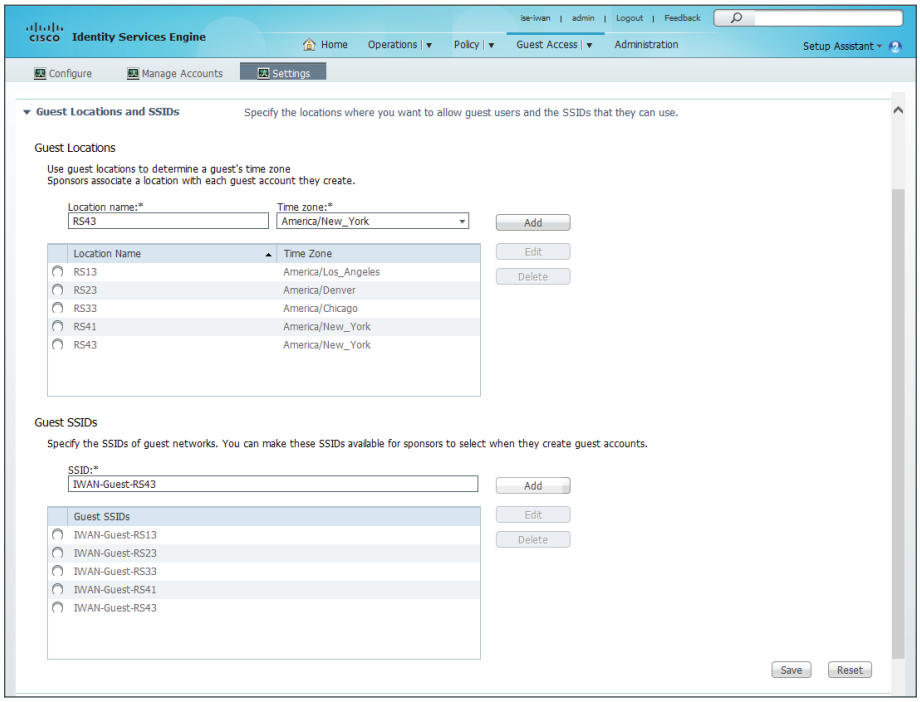
Step 4: Click **Add**.

Step 5: Repeat Step 3 through Step 4 for each location you wish to add.

Step 6: In the SSID box, enter an SSID (Example: **IWAN-Guest-RS13**), and then click **Add**.

Step 7: Repeat Step 6 for each SSID you wish to add.

Step 8: Click **Save**.



Procedure 9 Configure the sponsor portal

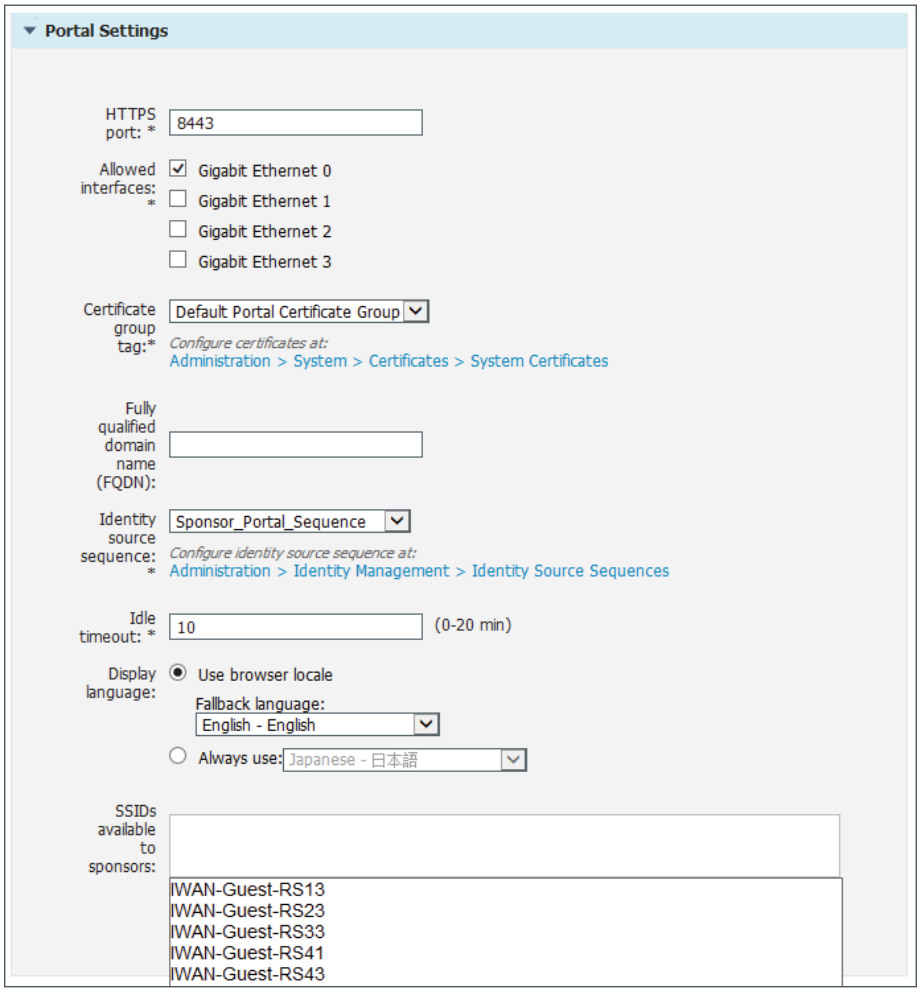
You configure a portal that sponsors use to create guest accounts.

Step 1: Navigate to **Guest Access >Configure**.

Step 2: In the left column, click **Sponsor Portals**, and then click **Create**.

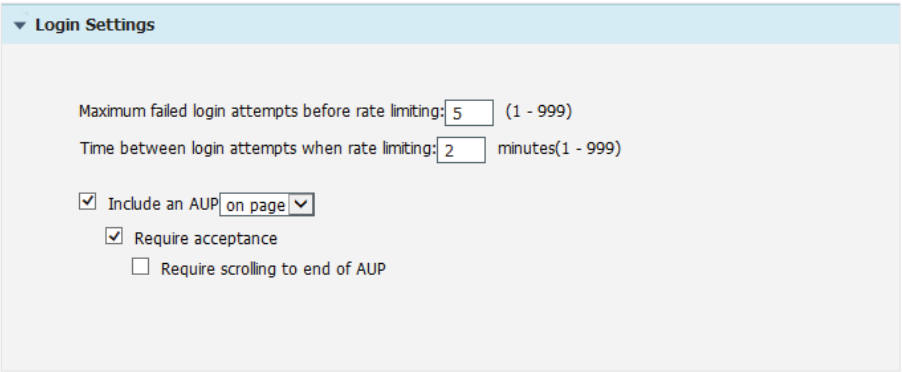
Step 3: Enter a name (Example: **IWAN-Sponsor-Portal**) and description for the portal.

Step 4: In the Portal Settings section, click the **SSIDs available to sponsors** box and then, in the list that appears, choose the SSIDs you wish to allow sponsors to configure with this portal.



Step 5: In the Login Settings section, select **Include an AUP**, and then select **on page** from the list. This enables an acceptable use policy.

Step 6: Select **Require Acceptance** and accept the default values for the remaining settings.



Step 7: If you want to customize the sponsor portal to meet the needs of your organization, at the top of the page, click **Portal Page Customization**.

You can customize the user experience for the sponsor portal by changing text, updating the acceptable use policy, changing the colors and graphics, and so on. In this design, the only customization is to the title page and banner text.

Reader Tip

For detailed customization instructions, see the Customize End-User Web Portals section of the Cisco Identity Services Engine Administrator Guide, Release 1.3.

Step 8: After you've completed any customizations, click **Save**.

Tech Tip

At the top of the page, there is a link for the **Portal test URL**. This allows you to preview what the portal will look like and is also the URL that you provide to sponsors that will be creating guest accounts. You should save the URL for future reference.

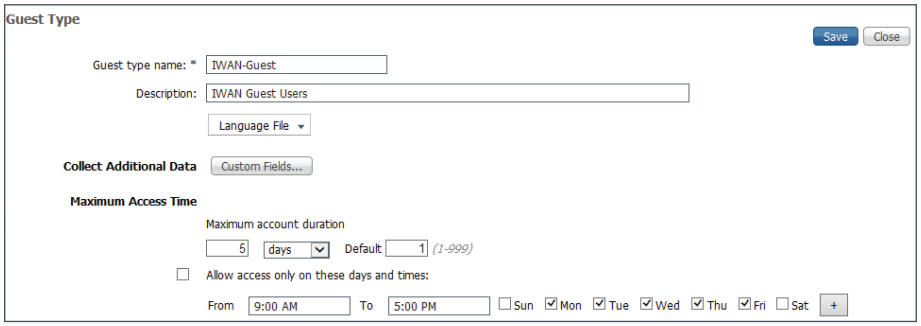
Procedure 10 Configure the guest type

Step 1: Navigate to **Guest Access >Configure**.

Step 2: In the left column, click **Guest Types**, and then click **Create**.

Step 3: Enter a name (Example: **IWAN-Guest**) and description for the guest type.

Step 4: In the Maximum Access Time section, for **Maximum account duration**, enter the length of time the account will be valid (Example: 5 days).



Step 5: Configure the remaining options according to the policies of your organization.

Step 6: Click **Save**.

Procedure 11 Configure sponsor groups

You use sponsor groups to define the permissions and settings for users who can create guest accounts.

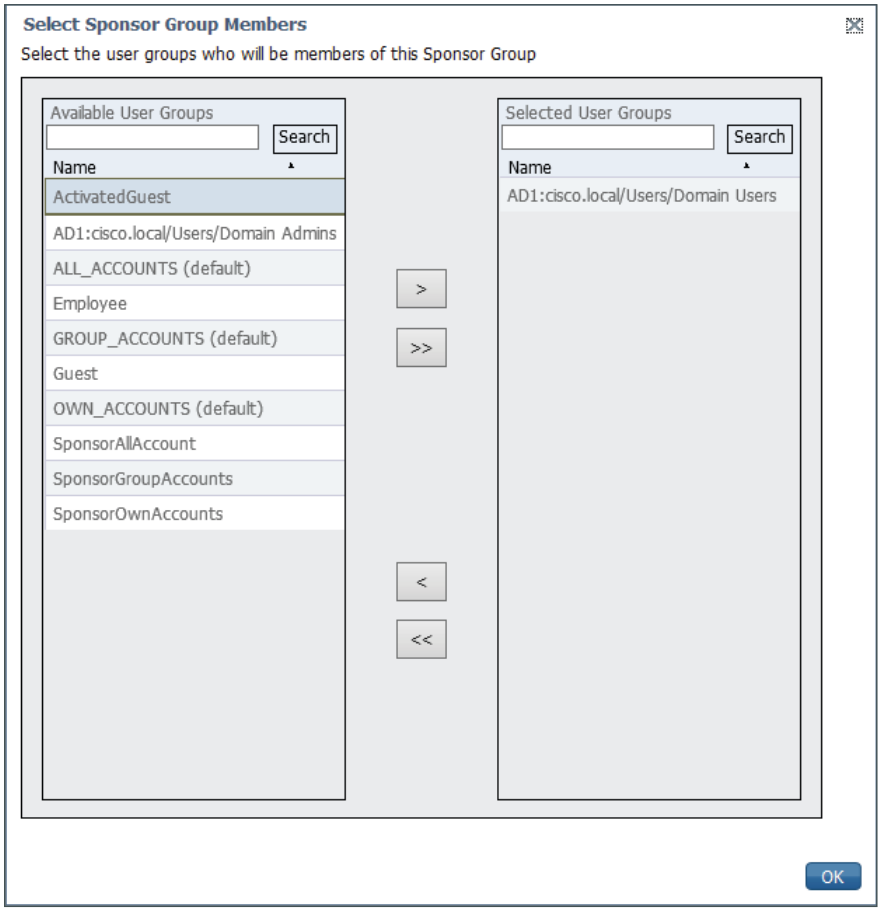
Step 1: Navigate to **Guest Access >Configure**.

Step 2: In the left column, click **Sponsor Groups**, and then click **Create**.

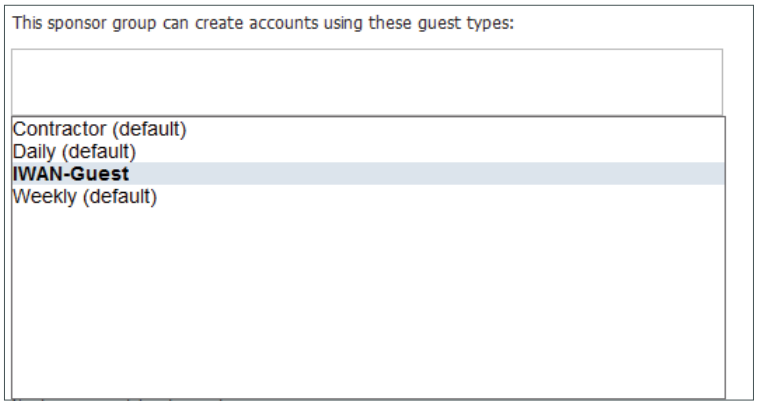
Step 3: Enter a name (Example: **IWAN-Sponsors**) and description for the sponsor group.

Step 4: Click **Members**.

Step 5: Move the Active Directory group **Domain Users** from the Available User Groups column to the Selected User Groups column, and then click **OK**.



Step 6: Click the **This sponsor group can create accounts using these guest types** box and, in the list that appears, choose the guest type created in Procedure 10.



Step 7: In the **Select the locations that guest will be visiting** box, choose the locations that you created in Procedure 8.

Step 8: Click **Save**.

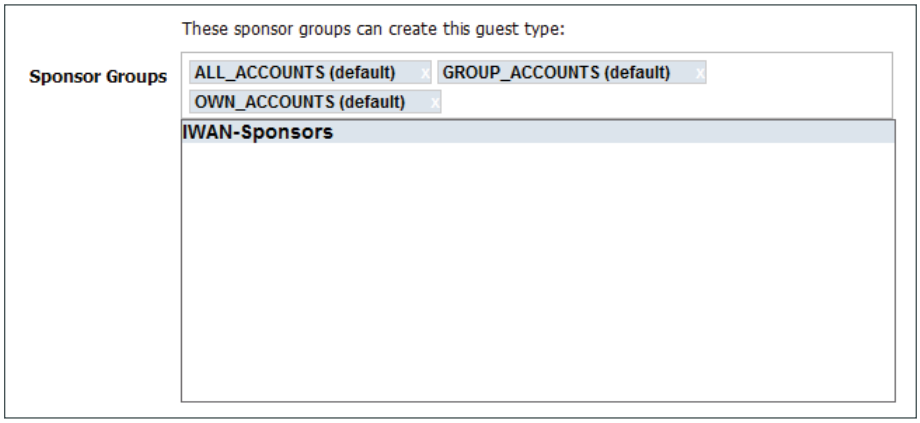
Procedure 12 Add sponsor group to guest type

You need to apply the new sponsor group to the guest type created in Procedure 10.

Step 1: Navigate to **Guest Access >Configure**.

Step 2: In the left column, click **Guest Types**, and then click **IWAN-Guest**.

Step 3: Click the **Sponsor Groups** box and, in the list that appears, choose the sponsor group created in Procedure 11 (Example: **IWAN-Sponsors**).



Step 4: Click **Save**.

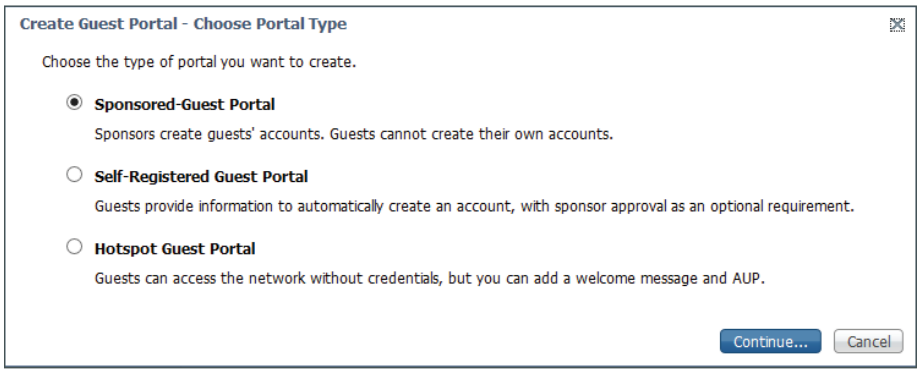
Procedure 13 Configure guest portal

You configure a portal that guests will use to login to the network.

Step 1: Navigate to **Guest Access >Configure**.

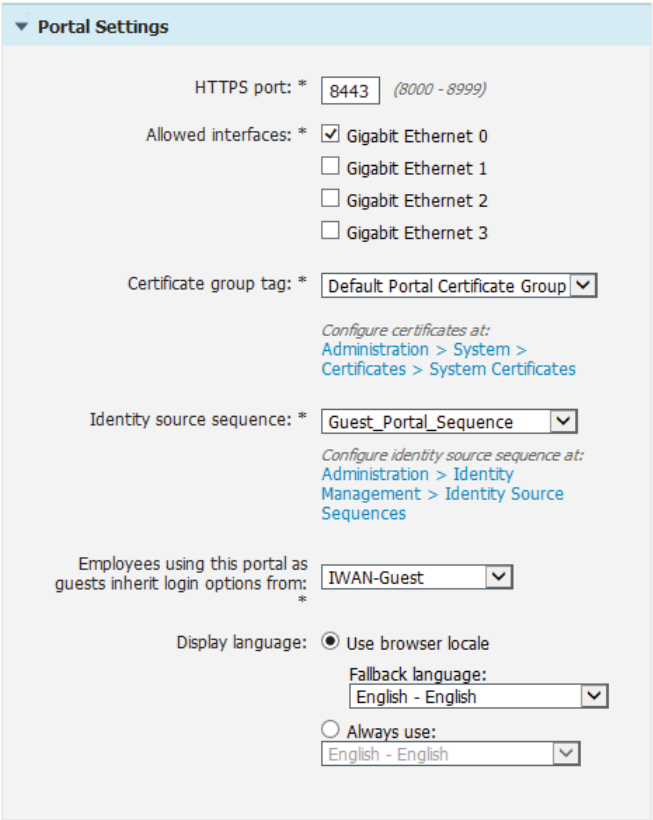
Step 2: In the left column, click **Guest Portals**, and then click **Create**.

Step 3: Select **Sponsored-Guest Portal**, and then click **Continue**.



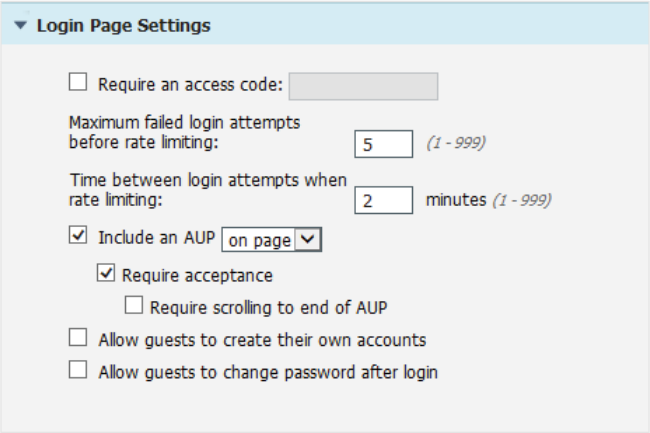
Step 4: Give the portal a name (Example: **IWAN-Guest-Portal**) and description.

Step 5: In the Portal Setting section, in the **Employees using this portal as guests inherit login options from** list, choose **IWAN-Guest**.



Step 6: In the Login Page Settings section, select **Include an AUP** and choose **on page** from the list.

Step 7: Select **Require Acceptance**.



Step 8: Configure the remaining settings according to the policies for your organization.

Step 9: If you want to customize the guest portal to meet the needs of your organization, at the top of the page, click **Portal Page Customization**.

You can customize the user experience for the guest portal by changing text, updating the acceptable use policy, changing the colors and graphics, and so on. In this deployment, the only customization is to the title page and banner text.

> **Reader Tip**
>
> For detailed customization information, see the Customize End-User Web Portals section of the Cisco Identity Services Engine Administrator Guide, Release 1.3.

Step 10: After you've completed any customizations, click **Save**.

> **Tech Tip**
>
> At the top of the page, there is a link for the **Portal test URL**. This allows you to preview what the portal will look like and is also the URL that you provide to sponsors that will be creating guest accounts. You should save the URL for future reference.

Procedure 14 Configure authentication policy

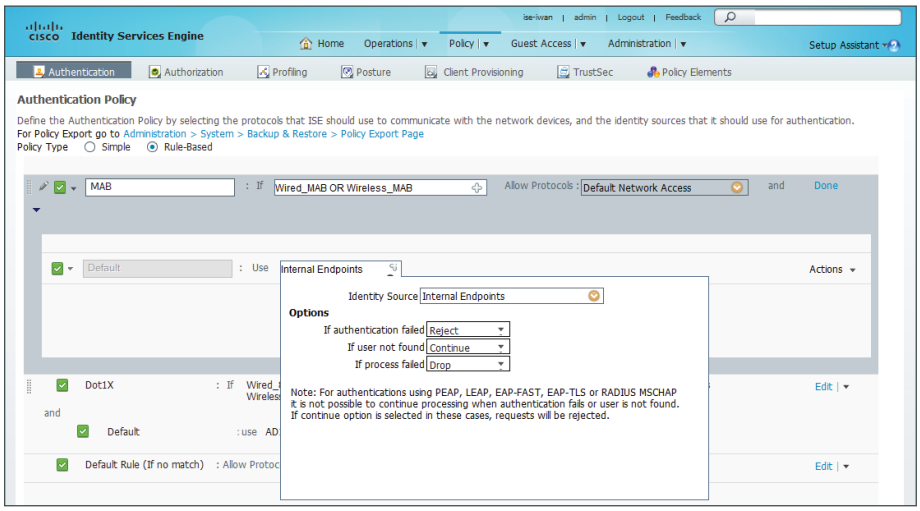
Configure an authentication policy for guest users.

Step 1: Navigate to **Policy >Authentication**.

Step 2: Next to the MAB rule, click **Edit**.

Step 3: Next to Internet Endpoints, click the **+** symbol, and then choose the following options:

- If authentication failed: **Reject**
- If user not found: **Continue**
- If process failed: **Drop**



Step 4: Click **Save**.

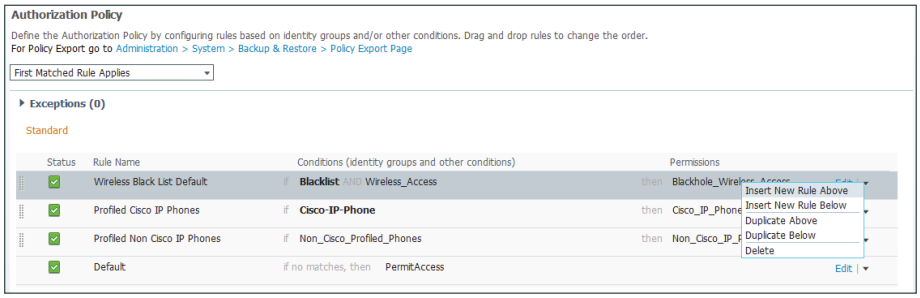
Procedure 15 Configure authorization policy

Configure two authorization policies for guest users:

- The first policy governs clients who are associated to the wireless network. The policy goes through MAC filtering. The MAC address will be unknown and client will get passed a redirect URL. The redirect access list on the wireless LAN controller will be activated.
- The second policy gives full access to the guest upon successful authentication.

Step 1: Navigate to **Policy >Authorization**.

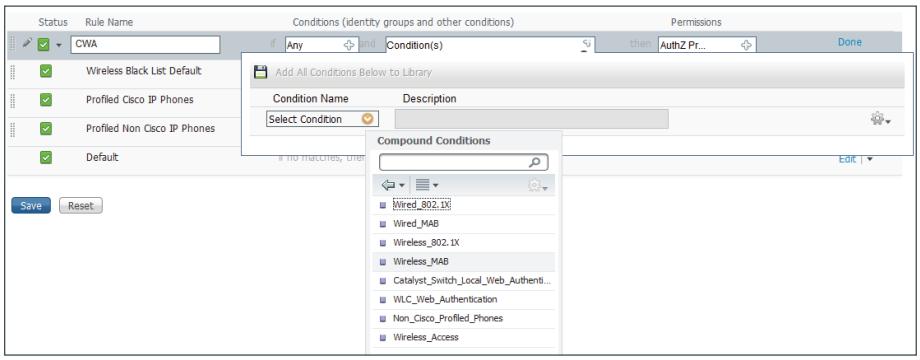
Step 2: Next to the top rule, Wireless Black List Default, click the arrow, and then choose **Add New Rule Above**.



Step 3: Enter a **CWA** as the rule name.

Step 4: Next to Condition(s), click the **+** symbol, and then click **Select Existing Condition from Library**.

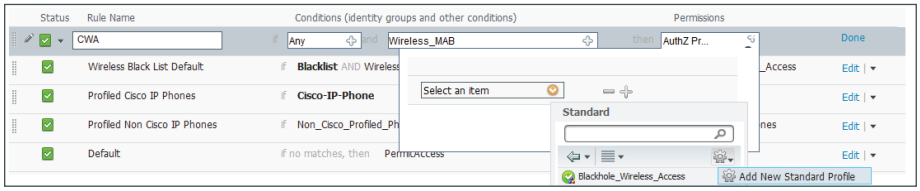
Step 5: In the **Select Condition** list, choose **Compound Conditions**, and then select **Wireless_MAB**.



Step 6: In the Permissions column, next to AuthZ Profile, click the **+** symbol.

Step 7: In the **Select an item** list, choose **Standard**.

Step 8: Click the gear icon, and then select **Add New Standard Profile**.



Step 9: In the **Name** box, enter **CWA**.

Step 10: In the **Access Type** list, choose ACCESS_ACCEPT.

Step 11: In the Common Tasks section, select **Web Redirection (CWA, MDM, NSP, CPP)**.

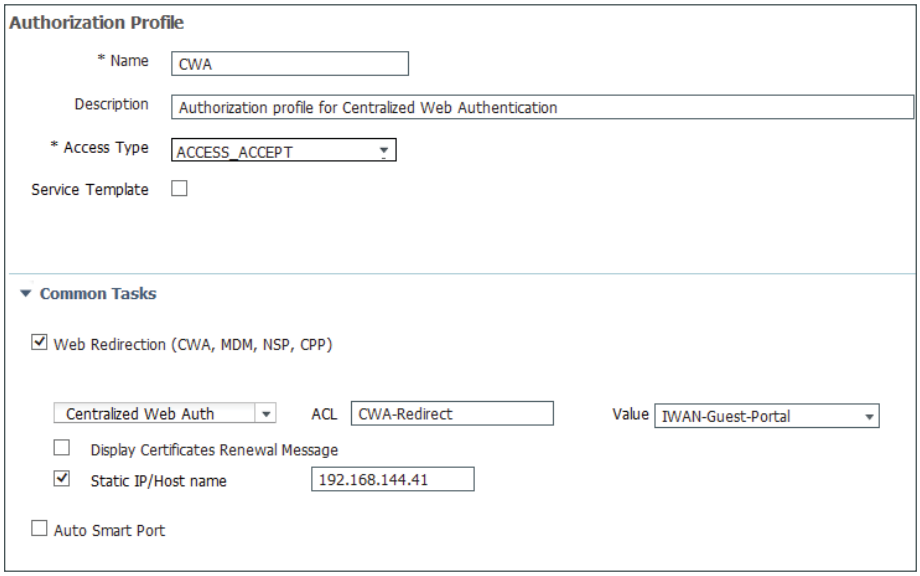
Step 12: From the list, choose **Centralized Web Auth**.

Step 13: For the ACL, enter **CWA-Redirect**.

Step 14: In the **Value** list, choose **IWAN-Guest-Portal**.

Step 15: Clear **Display Certificates Renewal Message**.

Step 16: Select **Static IP/Host name**, and then enter the IP address of the ISE server (Example: **192.168.144.41**).



Step 17: Click **Save,** and then click **OK**.

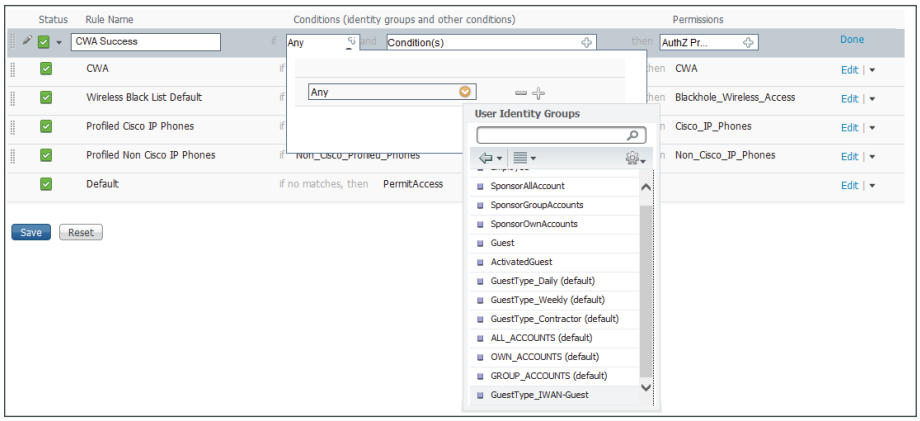
Step 18: Click **Done**.

Step 19: Next to the **CWA** rule, click the arrow, and then choose **Add New Rule Above**.

Step 20: Enter a **CWA Success** as the rule name.

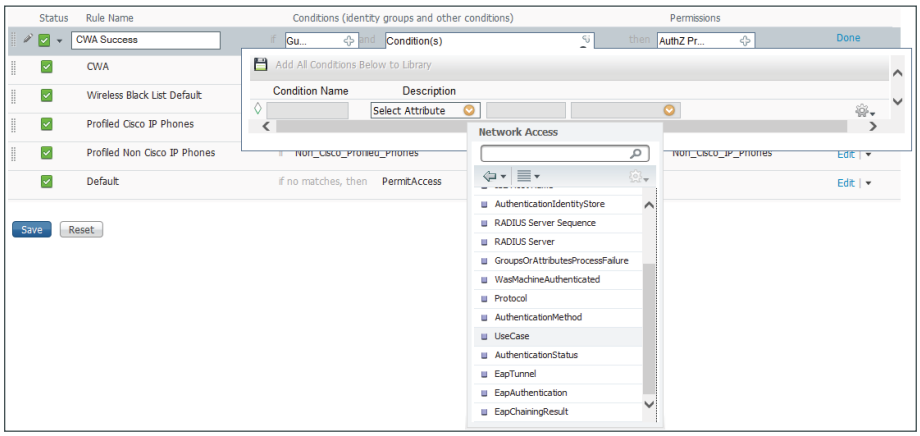
Step 21: Next to Any, click the **+** symbol, and then in the **Any** list, choose **User Identity Groups**.

Step 22: Select **GuestType_IWAN-Guest**.



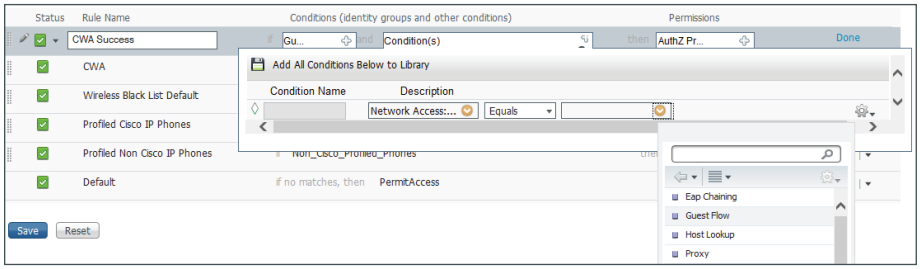
Step 23: Next to Condition(s), click the **+** symbol, and then click **Create New Condition (Advance Option)**.

Step 24: From the **Select Attribute** list, choose **Network Access**, and then choose **UseCase**.



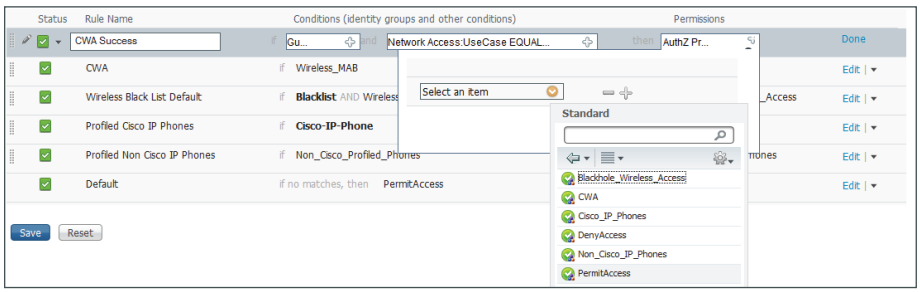
Step 25: In the second list, ensure that Equals is selected.

Step 26: In the third list, choose **Guest Flow**.

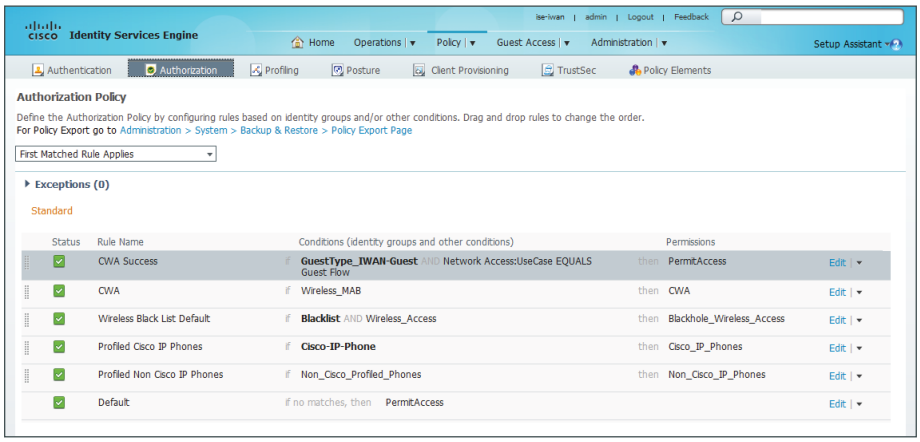


Step 27: In the Permissions column, next to AuthZ Profile, click the **+** symbol.

Step 28: In the **Select an item** list, choose **Standard**, and then choose **Permit Access**.



Step 29: Click **Done**, and then click **Save**.



Procedure 16 Create guest user

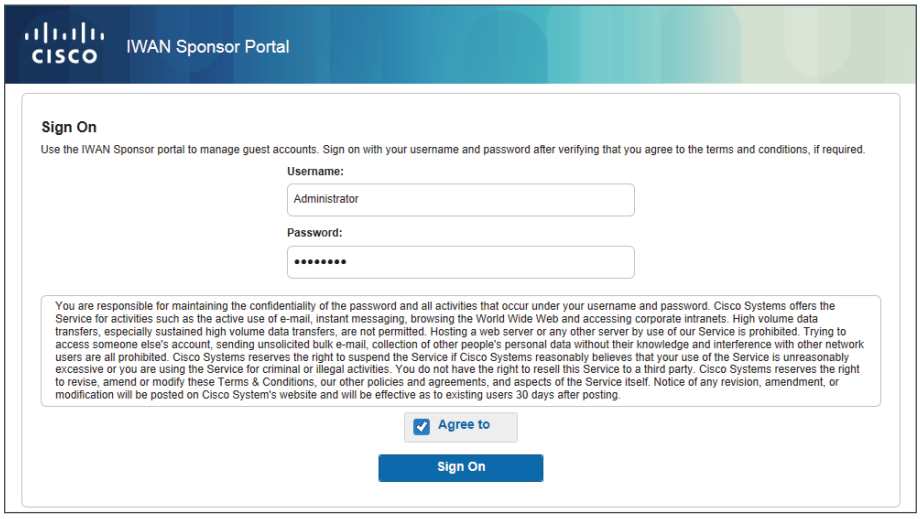
Add a guest user account by using the sponsor portal you just created.

Step 1: In a web browser, connect to the sponsor portal.

Tech Tip

You can obtain the URL from the ISE console in **Guest Access >Configure >Sponsor Portals.** Click the portal name, and then click **Portal test URL**. Save this URL to give to sponsors.

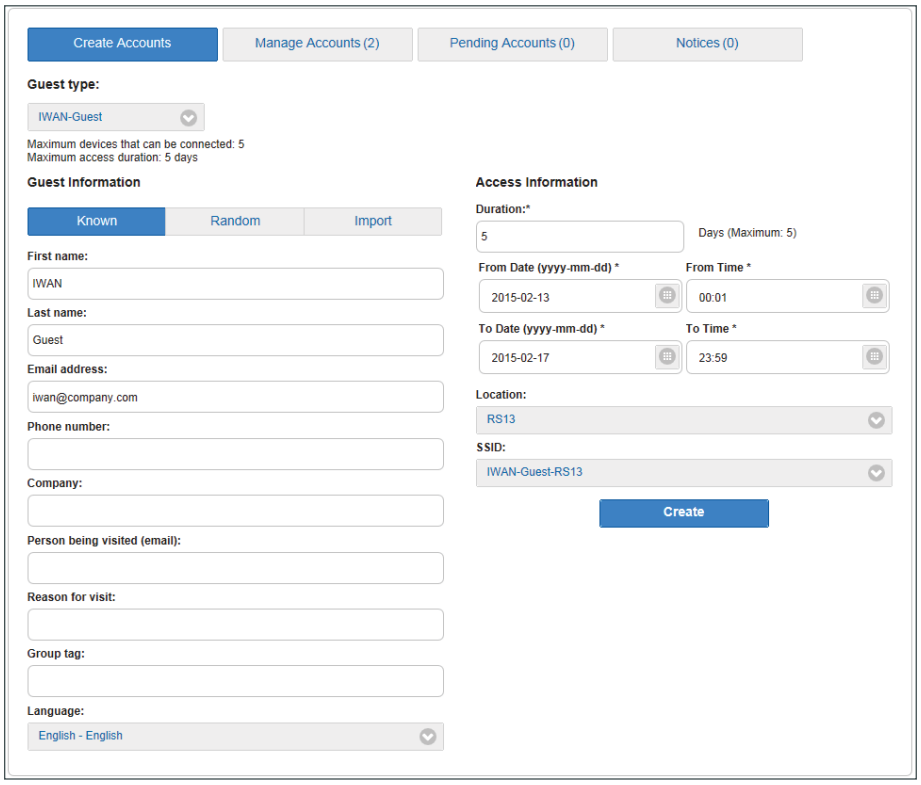
Step 2: Login to the portal by providing sponsor credentials, select **Agree To**, and then click **Sign On**.



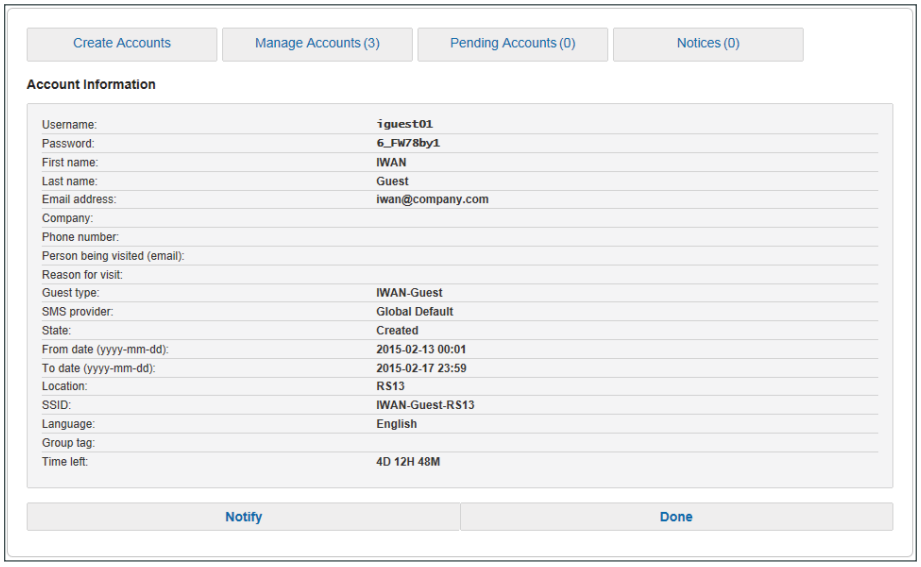
Step 3: In Create Accounts, select **IWAN-Guest** as the Guest type.

Step 4: Click **Known**, and then complete the form with values applicable for your deployment. This design uses the following values:

- First name: **IWAN**
- Last name: **Guest**
- Email address: **iwan@company.com**
- Duration: **5** days
- Location: **RS-13**
- SSID: **IWAN-Guest-RS13**



Step 5: Click **Create**. The account is created, and the account information is displayed and ready to be distributed to the guest.



PROCESS

Logging In As a Guest User

1. Access the LWA guest portal on WLC running AireOS
2. Access the LWA guest portal on WLC running IOS XE
3. Access the CWA guest portal

Now that guest portals have been configured and guest credentials created and issued, you can login as a guest user on the network. There were two guest access methods configured–LWA and CWA–and this section details each guest user login experience. For LWA, there are two different controllers in use. One is running AireOS, and the other is running IOS XE. Their login portals are different.

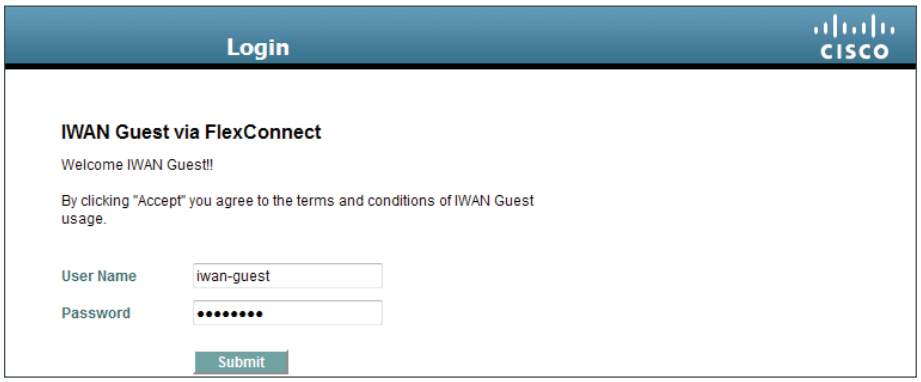
Procedure 1 Access the LWA guest portal on WLC running AireOS

The LWA portal is resident on the local WLC or on the centralized WLC in a FlexConnect deployment. The guest client connects to the guest SSID, opens a web browser, and gets redirected to the guest portal. After successful authentication, the user is redirected to a URL defined in the portal configuration (Example: http://www.cisco.com/go/iwan).

Step 1: From a guest client, associate to the guest SSID (Example: **IWAN-Guest-RS13**).

Step 2: Open up a web browser. If the browser is configured to automatically open up a home page, you will be redirected to the sponsor portal. Otherwise, enter a URL and click **Enter**. You will be redirected.

Step 3: Enter the guest credentials provided by the sponsor, and then click **OK**.



Reader Tip

Although this screen shot is for a controller in a FlexConnect deployment, the procedure is the same for a local controller at the remote site, and the portal looks similar.

The client is redirected briefly to a page that states that authentication was successful. The client is then redirected to the URL defined in the portal configuration.

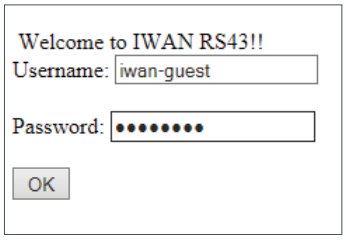
Procedure 2 Access the LWA guest portal on WLC running IOS XE

The LWA portal is resident on the local wireless LAN controller functionality in the access switch at the remote site. The guest client connects to the guest SSID, opens a web browser, and is redirected to the guest portal. After successful authentication, the user is redirected to a URL defined in the portal configuration (Example: http://www.cisco.com/go/iwan).

Step 1: From a guest client, associate to the guest SSID (Example: **IWAN-Guest-RS43**).

Step 2: Open up a web browser. If the browser is configured to automatically open up a home page, you will be redirected to the sponsor portal. Otherwise, enter a URL and click **Enter**. You will be redirected.

Step 3: Enter the guest credentials provided by the sponsor, and then click **OK**.



The client is redirected briefly to a page that states that authentication was successful. The client is then redirected to the URL defined in the portal configuration.

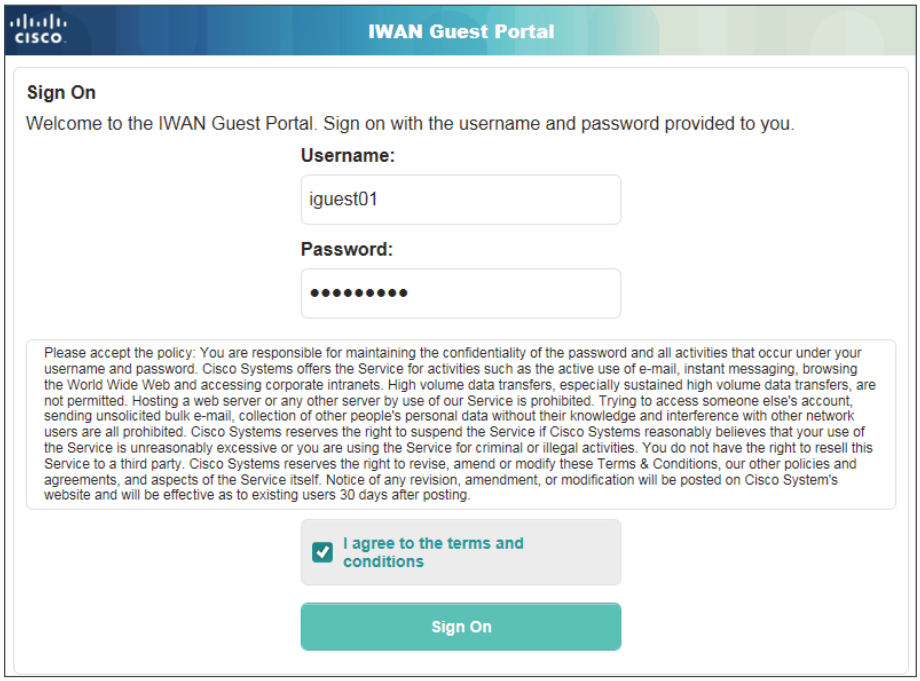
Procedure 3 Access the CWA guest portal

The CWA portal is configured on an ISE server that is located at the central site. The guest client connects to the guest SSID, opens a web browser and gets redirected to the guest portal. After successful authentication, the user is redirected to a URL defined in the portal configuration (Example: http://www.cisco.com/go/iwan).

Step 1: From a guest client, associate to the guest SSID (Example: **IWAN-Guest-RS43**).

Step 2: Open up a web browser. If the browser is configured to automatically open up a home page, you will be redirected to the sponsor portal. Otherwise, enter a URL and click **Enter**. You will be redirected.

Step 3: Enter the guest credentials provided by the sponsor, agree to the acceptable use policy, and then click **Sign On**.



The client will be redirected briefly to a page stating that authentication was successful. The client is then redirected to the URL defined in the portal configuration.

Appendix A: Product List

WAN Aggregation

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
WAN-aggregation Router	Aggregation Services 1002X Router	ASR1002X-5G-VPNK9	IOS-XE 15.5(1)S	Advanced Enterprise
	Cisco ISR 4451-X Security Bundle w/ SEC license PAK	ISR4451-X-SEC/K9	IOS-XE 15.5(1)S	securityk9

WAN Remote Site

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Modular WAN Remote-site Router	Cisco ISR 4451 w/ 4GE,3NIM,2SM,8G FLASH, 4G DRAM, IP Base, SEC, AX license with: DATA, AVC, ISR-WAAS with 2500 connection RTU	ISR4451-X-AX/K9	IOS-XE 15.5(1)S	securityk9, appxk9

Internet Edge

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Firewall	Cisco ASA 5545-X IPS Edition - security appliance	ASA5545-IPS-K9	ASA 9.1(5), IPS 7.1(8p2) E4	–
	Cisco ASA 5525-X IPS Edition - security appliance	ASA5525-IPS-K9	ASA 9.1(5), IPS 7.1(8p2) E4	–
	Cisco ASA 5515-X IPS Edition - security appliance	ASA5515-IPS-K9	ASA 9.1(5), IPS 7.1(8p2) E4	–
	Cisco ASA 5512-X IPS Edition - security appliance	ASA5512-IPS-K9	ASA 9.1(5), IPS 7.1(8p2) E4	–
	Cisco ASA 5512-X Security Plus license	ASA5512-SEC-PL	–	–
	Firewall Management	ASDM	7.1(6)	–

Internet Edge LAN

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
DMZ Switch	Cisco Catalyst 2960-X Series 24 10/100/1000 PoE and 2 SFP+ Uplink	WS-C2960X-24PS	15.0(2)EX5	LAN Base
	Cisco Catalyst 2960-X FlexStack-Plus Hot-Swappable Stacking Module	C2960X-STACK	–	–

LAN Access Layer

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Modular Access Layer Switch	Cisco Catalyst 4500E Series 4507R+E 7-slot Chassis with 48Gbps per slot	WS-C4507R+E	3.3.1XO(15.1.1XO1)	IP Base
	Cisco Catalyst 4500E Supervisor Engine 8-E, Unified Access, 928Gbps	WS-X45-SUP8-E	3.3.1XO(15.1.1XO1)	IP Base
	Cisco Catalyst 4500E 12-port 10GbE SFP+ Fiber Module	WS-X4712-SFP+E	–	–
	Cisco Catalyst 4500E 48-Port 802.3at PoE+ 10/100/1000 (RJ-45)	WS-X4748-RJ45V+E	–	–
	Cisco Catalyst 4500E Series 4507R+E 7-slot Chassis with 48Gbps per slot	WS-C4507R+E	3.5.3E(15.2.1E3)	IP Base
	Cisco Catalyst 4500E Supervisor Engine 7L-E, 520Gbps	WS-X45-SUP7L-E	3.5.3E(15.2.1E3)	IP Base
	Cisco Catalyst 4500E 48 Ethernet 10/100/1000 (RJ45) PoE+,UPoE ports	WS-X4748-UPOE+E	–	–
	Cisco Catalyst 4500E 48 Ethernet 10/100/1000 (RJ45) PoE+ ports	WS-X4648-RJ45V+E	–	–

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Stackable Access Layer	Cisco Catalyst 3850 Series Stackable 48 Ethernet 10/100/1000 PoE+ ports	WS-C3850-48F	3.6.0E(15.2.2E)	IP Base
	Cisco Catalyst 3850 Series Stackable 24 Ethernet 10/100/1000 PoE+ Ports	WS-C3850-24P	3.6.0E(15.2.2E)	IP Base
	Cisco Catalyst 3850 Series 2 x 10GE Network Module	C3850-NM-2-10G	–	–
	Cisco Catalyst 3850 Series 4 x 1GE Network Module	C3850-NM-4-1G	–	–
	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 2x10GE or 4x1GE Uplink	WS-C3650-24PD	3.6.0E(15.2.2E)	IP Base
	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 4x1GE Uplink	WS-C3650-24PS	3.6.0E(15.2.2E)	IP Base
	Cisco Catalyst 3650 Series Stack Module	C3650-STACK	–	–
	Cisco Catalyst 3750-X Series Stackable 48 Ethernet 10/100/1000 PoE+ ports	WS-C3750X-48PF-S	15.2(1)E3	IP Base
	Cisco Catalyst 3750-X Series Stackable 24 Ethernet 10/100/1000 PoE+ ports	WS-C3750X-24P-S	15.2(1)E3	IP Base
	Cisco Catalyst 3750-X Series Two 10GbE SFP+ and Two GbE SFP ports network module	C3KX-NM-10G	–	–
	Cisco Catalyst 3750-X Series Four GbE SFP ports network module	C3KX-NM-1G	–	–
	Cisco Catalyst 2960-X Series 24 10/100/1000 Ethernet and 2 SFP+ Uplink	WS-C2960X-24PD	15.0(2)EX5	LAN Base
Standalone Access Layer Switch	Cisco Catalyst 3650 Series 24 Ethernet 10/100/1000 PoE+ and 4x1GE Uplink	WS-C3650-24PS	3.6.0E(15.2.2E)	IP Base

LAN Distribution Layer

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Modular Distribution Layer Virtual Switch Pair	Cisco Catalyst 6500 VSS Supervisor 2T with 2 ports 10GbE and PFC4	VS-S2T-10G	15.1(2)SY3	IP Services
	Cisco Catalyst 6800 Series 6807-XL 7-Slot Modular Chassis	C6807-XL	15.1(2)SY3	IP Services
	Cisco Catalyst 6500 4-port 40GbE/16-port 10GbE Fiber Module w/DFC4	WS-X6904-40G-2T	–	–
	Cisco Catalyst 6500 4-port 10GbE SFP+ adapter for WX-X6904-40G module	CVR-CFP-4SFP10G	–	–
	Cisco Catalyst 6500 CEF720 48 port 10/100/1000mb Ethernet	WS-X6748-GE-TX	–	–
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-A	–	–
	Cisco Catalyst 6500 Series 6506-E 6-Slot Chassis	WS-C6506-E	15.1(2)SY3	IP services
	Cisco Catalyst 6500 VSS Supervisor 2T with 2 ports 10GbE and PFC4	VS-S2T-10G	15.1(2)SY3	IP services
	Cisco Catalyst 6500 4-port 40GbE/16-port 10GbE Fiber Module w/DFC4	WS-X6904-40G-2T	–	–
	Cisco Catalyst 6500 4-port 10GbE SFP+ adapter for WX-X6904-40G module	CVR-CFP-4SFP10G	–	–
	Cisco Catalyst 6500 48-port GigE Mod (SFP)	WS-X6748-SFP	–	–
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-A	–	–
	Cisco Catalyst 6500 24-port GigE Mod (SFP)	WS-X6724-SFP	–	–
	Cisco Catalyst 6500 Distributed Forwarding Card 4	WS-F6K-DFC4-A	–	–
Extensible Fixed Distribution Layer Virtual Switch Pair	Cisco Catalyst 6800 Series 6880-X Extensible Fixed Aggregation Switch (Standard Tables)	C6880-X-LE	15.1(2)SY3	IP Services
	Cisco Catalyst 6800 Series 6880-X Multi Rate Port Card (Standard Tables)	C6880-X-LE-16P10G	–	–
Modular Distribution Layer Virtual Switch Pair	Cisco Catalyst 4500E Series 4507R+E 7-slot Chassis with 48Gbps per slot	WS-C4507R+E	3.5.3E(15.2.1E3)	Enterprise Services
	Cisco Catalyst 4500E Supervisor Engine 7-E, 848Gbps	WS-X45-SUP7-E	3.5.3E(15.2.1E3)	Enterprise Services
	Cisco Catalyst 4500E 12-port 10GbE SFP+ Fiber Module	WS-X4712-SFP+E	–	–
	Cisco Catalyst 4500E 48-Port 802.3at PoE+ 10/100/1000 (RJ-45)	WS-X4748-RJ45V+E	–	–
Fixed Distribution Layer Virtual Switch Pair	Cisco Catalyst 4500-X Series 32 Port 10GbE IP Base Front-to-Back Cooling	WS-C4500X-32SFP+	3.5.3E(15.2.1E3)	Enterprise Services

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Stackable Distribution Layer Switch	Cisco Catalyst 3850 Series Stackable Switch with 12 SFP Ethernet	WS-C3850-12S	3.6.0E(15.2.2E)	IP Services
	Cisco Catalyst 3850 Series 4 x 1GE Network Module	C3850-NM-4-1G	–	–
	Cisco Catalyst 3850 Series 2 x 10GE Network Module	C3850-NM-2-10G	–	–
	Cisco Catalyst 3750-X Series Stackable 12 GbE SFP ports	WS-C3750X-12S-E	15.2(1)E3	IP Services
	Cisco Catalyst 3750-X Series Two 10GbE SFP+ and Two GbE SFP ports network module	C3KX-NM-10G	–	–
	Cisco Catalyst 3750-X Series Four GbE SFP ports network module	C3KX-NM-1G	–	–

Wireless LAN Controllers

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Remote Site Controller	Cisco 7500 Series Wireless Controller for up to 6000 Cisco access points	AIR-CT7510-6K-K9	8.0.100.0	–
	Cisco 7500 Series Wireless Controller for up to 3000 Cisco access points	AIR-CT7510-3K-K9	8.0.100.0	–
	Cisco 7500 Series Wireless Controller for up to 2000 Cisco access points	AIR-CT7510-2K-K9	8.0.100.0	–
	Cisco 7500 Series Wireless Controller for up to 1000 Cisco access points	AIR-CT7510-1K-K9	8.0.100.0	–
	Cisco 7500 Series Wireless Controller for up to 500 Cisco access points	AIR-CT7510-500-K9	8.0.100.0	–
	Cisco 7500 Series Wireless Controller for up to 300 Cisco access points	AIR-CT7510-300-K9	8.0.100.0	–
	Cisco 7500 Series High Availability Wireless Controller	AIR-CT7510-HA-K9	8.0.100.0	–

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
On Site Controller	Cisco 5760 Series Wireless Controller for up to 1000 Cisco access points	AIR-CT5760-1K-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Series Wireless Controller for up to 500 Cisco access points	AIR-CT5760-500-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Series Wireless Controller for up to 250 Cisco access points	AIR-CT5760-250-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Series Wireless Controller for up to 100 Cisco access points	AIR-CT5760-100-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Series Wireless Controller for up to 50 Cisco access points	AIR-CT5760-50-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Series Wireless Controller for up to 25 Cisco access points	AIR-CT5760-25-K9	3.6.0E(15.2.2E)	–
	Cisco 5760 Wireless Controller for High Availability	AIR-CT5760-HA-K9	3.6.0E(15.2.2E)	–
On Site, Remote Site, or Guest Controller	Cisco 5500 Series Wireless Controller for up to 500 Cisco access points	AIR-CT5508-500-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for up to 250 Cisco access points	AIR-CT5508-250-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for up to 100 Cisco access points	AIR-CT5508-100-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for up to 50 Cisco access points	AIR-CT5508-50-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for up to 25 Cisco access points	AIR-CT5508-25-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for up to 12 Cisco access points	AIR-CT5508-12-K9	8.0.100.0	–
	Cisco 5500 Series Wireless Controller for High Availability	AIR-CT5508-HA-K9	8.0.100.0	–
On Site Controller, Guest Controller	Cisco 2500 Series Wireless Controller for up to 50 Cisco access points	AIR-CT2504-50-K9	8.0.100.0	–
	Cisco 2500 Series Wireless Controller for up to 25 Cisco access points	AIR-CT2504-25-K9	8.0.100.0	–
	Cisco 2500 Series Wireless Controller for up to 15 Cisco access points	AIR-CT2504-15-K9	8.0.100.0	–
	Cisco 2500 Series Wireless Controller for up to 5 Cisco access points	AIR-CT2504-5-K9	8.0.100.0	–

Wireless LAN Access Points

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Wireless Access Points	Cisco 3700 Series Access Point 802.11ac and CleanAir with Internal Antennas	AIR-CAP3702I-x-K9	8.0.100.0	–
	Cisco 3700 Series Access Point 802.11ac and CleanAir with External Antenna	AIR-CAP3702E-x-K9	8.0.100.0	–
	Cisco 3600 Series Access Point Dual Band 802.11a/g/n and CleanAir with Internal Antennas	AIR-CAP3602I-x-K9	8.0.100.0	–
	Cisco 3600 Series Access Point Dual Band 802.11a/g/n and CleanAir with External Antennas	AIR-CAP3602E-x-K9	8.0.100.0	–
	Cisco 2600 Series Access Point Dual Band 802.11a/g/n and CleanAir with Internal Antennas	AIR-CAP2602I-x-K9	8.0.100.0	–
	Cisco 2600 Series Access Point Dual Band 802.11a/g/n and CleanAir with External Antennas	AIR-CAP2602E-x-K9	8.0.100.0	–
	Cisco 1600 Series Access Point Dual-band controller-based 802.11a/g/n with Internal Antennas	AIR-CAP1602I-x-K9	8.0.100.0	–
	Cisco 1600 Series Access Point Dual-band controller-based 802.11a/g/n with External Antennas	AIR-CAP1602E-x-K9	8.0.100.0	–

Wireless LAN

Place In Network	Product Desc.	Part Number	SW Version	Feature Set
Wireless LAN	Cisco 802.11ac Wave 1 Module for 3600 Series Access Point	AIR-RM3000AC-x-K9=	8.0.100.0	–
	Cisco 802.11ac Wave 1 Module for 3600 Series Access Point 10 Pack	AIR-RM3000ACxK910=	8.0.100.0	–
Cisco ISE Server	Cisco Identity Services Engine Virtual Appliance	ISE-VM-K9=	1.3.0.876	–
	Cisco ISE Wireless 5-year License for 500 Endpoints	LS-ISE-AD5Y-W-500=	–	–
	Cisco ISE Wireless 5-year License for 250 Endpoints	LS-ISE-AD5Y-W-250=	–	–
	Cisco ISE Wireless 5-year License for 100 Endpoints	LS-ISE-AD5Y-W-100=	–	–

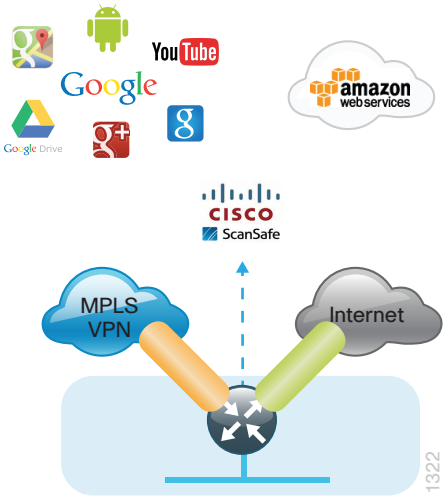
Appendix B: Router Configurations

Included here for reference are the validated router configurations for each of the remote sites and working solutions presented in this guide.

Single Router Hybrid with DIA and Guest Access

This shows the configuration for the single-router hybrid design with internal employee DIA and guest access with DIA.

Figure 95 - Single-Router Hybrid Configurations



RS31-4451X

```
version 15.5
no service pad
service tcp-keepalives-in
service tcp-keepalives-out
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
service password-encryption
no platform punt-keepalive disable-kernel-core
!
hostname RS31-4451X
!
boot-start-marker
boot-end-marker
!
!
```

```
vrf definition IWAN-GUEST
 !
 address-family ipv4
 exit-address-family
!
vrf definition IWAN-TRANSPORT-1
 !
 address-family ipv4
 exit-address-family
!
vrf definition IWAN-TRANSPORT-2
 !
 address-family ipv4
 exit-address-family
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
!
enable secret 5 $1$WBJm$kaSX7tfn3eQOsV3Zl4gVI.
!
aaa new-model
!
!
aaa group server tacacs+ TACACS-SERVERS
 server name TACACS-SERVER-1
!
aaa authentication login default group TACACS-SERVERS local
aaa authorization console
aaa authorization exec default group TACACS-SERVERS local
!
!
aaa session-id common
clock timezone PST -8 0
clock summer-time PDT recurring
!
ip domain name cisco.local
ip name-server 10.4.48.10
ip multicast-routing distributed
ip dhcp excluded-address vrf IWAN-GUEST 192.168.192.1 192.168.192.19
!
ip dhcp pool IWAN-GUEST
 vrf IWAN-GUEST
```

```
 network 192.168.192.0 255.255.255.0
 default-router 192.168.192.1
 dns-server 8.8.8.8
!
!
parameter-map type inspect global
 log dropped-packets
multilink bundle-name authenticated
!
flow record Record-FNF-IWAN
 description Flexible NetFlow for IWAN Monitoring
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 collect routing source as
 collect routing destination as
 collect routing next-hop address ipv4
 collect ipv4 dscp
 collect ipv4 id
 collect ipv4 source prefix
 collect ipv4 source mask
 collect ipv4 destination mask
 collect transport tcp flags
 collect interface output
 collect flow sampler
 collect counter bytes
 collect counter packets
 collect timestamp sys-uptime first
 collect timestamp sys-uptime last
 collect application name
!
!
flow exporter Export-FNF-LiveAction
 description FNFv9 with LiveAction
 destination 10.4.48.178
 source Loopback0
 transport udp 2055
 option application-attributes
 option interface-table
 option application-table
!
!
```

```
flow monitor Monitor-FNF-IWAN
 description IWAN Traffic Analysis
 exporter Export-FNF-LiveAction
 cache timeout inactive 10
 cache timeout active 60
 record Record-FNF-IWAN
!
!
domain iwan
 vrf default
  border
   source-interface Loopback0
   master local
   password 7 0205554808095E731F
   collector 10.4.48.178 port 2055
  master branch
   source-interface Loopback0
   password 7 08221D5D0A16544541
   hub 10.6.32.251
   collector 10.4.48.178 port 2055
!
key chain WAN-KEY
 key 1
   key-string 7 110A4816141D5A5E57
!
!
crypto pki trustpoint TP-self-signed-1487794786
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-1487794786
 revocation-check none
 rsakeypair TP-self-signed-1487794786
!
!
license udi pid ISR4451-X/K9 sn FOC182638DX
license accept end user agreement
license boot level appxk9
license boot level uck9 disable
license boot level securityk9
spanning-tree extend system-id
!
username admin secret 5 $1$Fanf$EZ2MBUBPJB9VhcH0Iweuk1
!
redundancy
 mode none
!
!
!
```

```
crypto ikev2 keyring DMVPN-KEYRING-1
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key c1sco123
 !
!
crypto ikev2 keyring DMVPN-KEYRING-2
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key c1sco123
 !
!
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-1
 match fvrf IWAN-TRANSPORT-1
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local DMVPN-KEYRING-1
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-2
 match fvrf IWAN-TRANSPORT-2
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local DMVPN-KEYRING-2
!
crypto ikev2 dpd 40 5 on-demand
!
!
!
track 80 interface Tunnel10 line-protocol
 delay up 20
!
ip tftp source-interface GigabitEthernet0
ip ssh source-interface Loopback0
ip ssh version 2
ip scp server enable
!
class-map type inspect match-any GUEST-RTR-ICMP
 match access-group name GUEST-ICMP-IN
class-map type inspect match-any RTR-GUEST-ICMP
 match access-group name GUEST-ICMP-OUT
class-map type inspect match-any GUEST-RTR-DHCP
 match access-group name GUEST-DHCP-IN
class-map type inspect match-any RTR-GUEST-DHCP
 match access-group name GUEST-DHCP-OUT
```

```
!
class-map match-any STREAMING-VIDEO
 match dscp af31  af32  cs5
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol tcp
 match protocol udp
 match protocol icmp
class-map match-any INTERACTIVE-VIDEO
 match dscp cs4  af41  af42
class-map type inspect match-any GUEST-TO-INSIDE-CLASS
 match protocol tcp
 match protocol udp
 match protocol icmp
 match access-group name GUEST-IN
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
class-map match-any CRITICAL-DATA
 match dscp af11  af21
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
class-map match-any NET-CTRL-MGMT
 match dscp cs2  cs6
 match access-group name ISAKMP
class-map match-any VOICE
 match dscp ef
class-map match-any SCAVENGER
 match dscp cs1
class-map match-any CALL-SIGNALING
 match dscp cs3
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
class-map type inspect match-any GUEST-TO-OUTSIDE-CLASS
 match protocol dns
 match protocol http
 match protocol https
 match protocol ftp
 match access-group name GUEST-OUT
!
policy-map type inspect GUEST-TO-OUTSIDE-POLICY
 class type inspect GUEST-TO-OUTSIDE-CLASS
  inspect
```

```
 class class-default
  drop
!
policy-map type inspect GUEST-SELF-POLICY-OUT
 class type inspect RTR-GUEST-DHCP
  pass
 class type inspect RTR-GUEST-ICMP
  inspect
 class class-default
  drop
policy-map type inspect GUEST-SELF-POLICY-IN
 class type inspect GUEST-RTR-DHCP
  pass
 class type inspect GUEST-RTR-ICMP
  inspect
 class class-default
  drop
!
policy-map WAN
 class INTERACTIVE-VIDEO
  bandwidth remaining percent 30
  random-detect dscp-based
  set dscp af41
 class STREAMING-VIDEO
  bandwidth remaining percent 10
  random-detect dscp-based
  set dscp af41
 class NET-CTRL-MGMT
  bandwidth remaining percent 5
  set dscp cs6
 class CALL-SIGNALING
  bandwidth remaining percent 4
  set dscp af41
 class CRITICAL-DATA
  bandwidth remaining percent 25
  random-detect dscp-based
  set dscp af21
 class SCAVENGER
  bandwidth remaining percent 1
  set dscp af11
 class VOICE
  priority level 1
  police cir percent 10
  set dscp ef
 class class-default
  bandwidth remaining percent 25
  random-detect
```

```
  set dscp default
policy-map WAN-INTERFACE-G0/0/1
 class class-default
  shape average 100000000
   service-policy WAN
policy-map WAN-INTERFACE-G0/0/0
 class class-default
  shape average 200000000
   service-policy WAN
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
policy-map type inspect GUEST-TO-INSIDE-POLICY
 class type inspect GUEST-TO-INSIDE-CLASS
  inspect
 class class-default
  drop
!
!
zone security default
zone security OUTSIDE
zone security GUEST
zone-pair security FROM-ROUTER source self destination OUTSIDE
 service-policy type inspect ACL-OUT-POLICY
zone-pair security GUEST-IN source GUEST destination default
 service-policy type inspect GUEST-TO-INSIDE-POLICY
zone-pair security GUEST-OUT source GUEST destination OUTSIDE
 service-policy type inspect GUEST-TO-OUTSIDE-POLICY
zone-pair security GUEST-RTR-IN source GUEST destination self
 service-policy type inspect GUEST-SELF-POLICY-IN
zone-pair security RTR-GUEST-OUT source self destination GUEST
```

```
 service-policy type inspect GUEST-SELF-POLICY-OUT
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
!
!
crypto ipsec security-association replay window-size 512
!
crypto ipsec transform-set AES256/SHA/TRANSPORT esp-aes 256 esp-sha-hmac
 mode transport
!
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-1
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-1
!
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-2
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-2
!
!
interface Loopback0
 ip address 10.255.241.31 255.255.255.255
 ip pim sparse-mode
!
interface Loopback192
 description GUEST-NET LOOPBACK
 vrf forwarding IWAN-GUEST
 ip address 192.168.255.13 255.255.255.255
!
interface Tunnel10
 bandwidth 200000
 ip address 10.6.34.31 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip nat outside
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-200MBPS
 ip nhrp network-id 101
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.34.1 nbma 192.168.6.1 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
```

```
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/0
 tunnel mode gre multipoint
 tunnel key 101
 tunnel vrf IWAN-TRANSPORT-1
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-1
!
interface Tunnel11
 bandwidth 100000
 ip address 10.6.36.31 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-100MBPS
 ip nhrp network-id 102
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.36.1 nbma 172.16.140.1 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/1
 tunnel mode gre multipoint
 tunnel key 102
 tunnel vrf IWAN-TRANSPORT-2
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-2
!
interface GigabitEthernet0/0/0
 bandwidth 200000
 vrf forwarding IWAN-TRANSPORT-1
 ip address 192.168.6.21 255.255.255.252
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 negotiation auto
 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/0
!
interface GigabitEthernet0/0/1
 description Internet Connection
```

```
 bandwidth 100000
 vrf forwarding IWAN-TRANSPORT-2
 ip address dhcp
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 ip nat outside
 zone-member security OUTSIDE
 ip policy route-map INET-INTERNAL
 negotiation auto
 no cdp enable
 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/1
!
interface GigabitEthernet0/0/2
 description RS31-A3650 Gig1/0/48
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/2.64
 description Data
 encapsulation dot1Q 64
 ip address 10.7.130.1 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim sparse-mode
 no cdp enable
!
interface GigabitEthernet0/0/2.65
 description Wireless Data
 encapsulation dot1Q 65
 ip address 10.7.132.1 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim sparse-mode
 no cdp enable
!
interface GigabitEthernet0/0/2.69
 description Voice
 encapsulation dot1Q 69
 ip address 10.7.131.1 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim sparse-mode
 no cdp enable
```

```
!
interface GigabitEthernet0/0/2.70
 description Wireless Voice
 encapsulation dot1Q 70
 ip address 10.7.133.1 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim sparse-mode
 no cdp enable
!
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 encapsulation dot1Q 80
 vrf forwarding IWAN-GUEST
 ip address 192.168.192.1 255.255.255.0
 ip nat inside
 zone-member security GUEST
!
!
!
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  !
  af-interface default
   passive-interface
  exit-af-interface
  !
  af-interface Tunnel10
   summary-address 10.7.128.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   hello-interval 20
   hold-time 60
   no passive-interface
  exit-af-interface
  !
  af-interface Tunnel11
   summary-address 10.7.128.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   hello-interval 20
   hold-time 60
   no passive-interface
  exit-af-interface
  !
  topology base
```

```
   distribute-list route-map BLOCK-DEFAULT in Tunnel11
  exit-af-topology
  network 10.6.34.0 0.0.1.255
  network 10.6.36.0 0.0.1.255
  network 10.7.0.0 0.0.255.255
  network 10.255.0.0 0.0.255.255
  eigrp router-id 10.255.241.31
  eigrp stub connected summary redistributed
 exit-address-family
!
!
!
ip nat inside source route-map NAT interface GigabitEthernet0/0/1 overload
ip nat inside source route-map GUEST-NAT-AUTH interface Tunnel10 vrf IWAN-GUEST overload
ip nat inside source route-map GUEST-NAT-INET interface GigabitEthernet0/0/1 vrf IWAN-
GUEST overload
ip forward-protocol nd
no ip http server
ip http authentication aaa
ip http secure-server
ip http secure-trustpoint TP-self-signed-1487794786
ip http client secure-trustpoint TP-self-signed-1487794786
ip pim autorp listener
ip pim register-source Loopback0
ip route 10.0.0.0 255.0.0.0 Null0 254
ip route 192.168.192.0 255.255.255.0 GigabitEthernet0/0/2.80
ip route 192.168.255.13 255.255.255.255 Loopback192
ip route vrf IWAN-TRANSPORT-1 0.0.0.0 0.0.0.0 192.168.6.22
ip route vrf IWAN-GUEST 192.168.144.0 255.255.255.0 Tunnel10 10.6.34.1 global
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10
ip route vrf IWAN-GUEST 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10
ip tacacs source-interface Loopback0
!
!
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
!
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
ip access-list extended ACL-RTR-OUT
```

```
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit udp any any eq domain
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc
ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
ip access-list extended ESP-IN
 permit esp any any
ip access-list extended ESP-OUT
 permit esp any any
ip access-list extended GRE-IN
 permit gre any any
ip access-list extended GUEST-AUTH
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
ip access-list extended GUEST-DHCP-IN
 permit udp any eq bootpc any eq bootps
ip access-list extended GUEST-DHCP-OUT
 permit udp any eq bootps any eq bootpc
ip access-list extended GUEST-ICMP-IN
 permit icmp any any echo
 permit icmp any any echo-reply
ip access-list extended GUEST-ICMP-OUT
 permit icmp any any echo
 permit icmp any any echo-reply
ip access-list extended GUEST-IN
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
ip access-list extended GUEST-INET
 deny   ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
 permit ip 192.168.192.0 0.0.0.255 any
ip access-list extended GUEST-OUT
 permit ip 192.168.192.0 0.0.0.255 any
ip access-list extended ISAKMP
 permit udp any eq isakmp any eq isakmp
ip access-list extended NAT-LOCAL
 permit ip 10.7.128.0 0.0.7.255 any
!
no service-routing capabilities-manager
!
route-map GUEST-NAT-AUTH permit 10
 match ip address GUEST-AUTH
 match interface Tunnel10
!
route-map GUEST-NAT-INET permit 10
 match ip address GUEST-INET
 match interface GigabitEthernet0/0/1
```

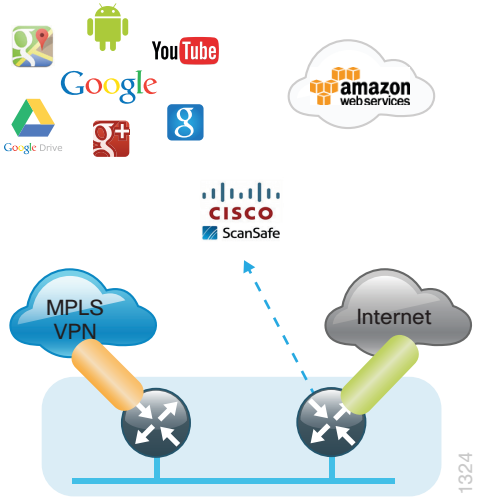
```
!
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
 match ip address ALL-EXCEPT-DEFAULT
!
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
!
route-map NAT permit 10
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/1
!
route-tag notation dotted-decimal
snmp-server community cisco RO
snmp-server community cisco123 RW
snmp-server trap-source Loopback0
snmp ifmib ifindex persist
!
tacacs server TACACS-SERVER-1
 address ipv4 10.4.48.15
 key 7 0235015819031B0A4957
!
!
!
control-plane
!
!
line con 0
 logging synchronous
 transport preferred none
 stopbits 1
line aux 0
 stopbits 1
line vty 0
 exec-timeout 0 0
 no activation-character
 transport preferred none
 transport input ssh
 stopbits 1
line vty 1 4
 exec-timeout 0 0
 transport preferred none
 transport input ssh
line vty 5 15
 transport preferred none
```

```
 transport input ssh
!
ntp source Loopback0
ntp server 10.4.48.17
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 DISABLED"
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/1 ENABLED"
!
End
```

Dual Router hybrid with DIA

This shows the configuration for the secondary router in the dual-router hybrid design.

Figure 96 - Dual-router hybrid configurations



RS32-4451X-2 Secondary Router

```
version 15.5
no service pad
service tcp-keepalives-in
service tcp-keepalives-out
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
service password-encryption
no platform punt-keepalive disable-kernel-core
!
hostname RS32-4451X-2
!
boot-start-marker
boot-end-marker
!
aqm-register-fnf
!
vrf definition IWAN-TRANSPORT-2
 !
 address-family ipv4
 exit-address-family
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
```

```
 address-family ipv6
 exit-address-family
!
enable secret 5 $1$S7wW$LwAu9mADPzeXE.yQjFmIc1
!
aaa new-model
!
!
aaa group server tacacs+ TACACS-SERVERS
 server name TACACS-SERVER-1
!
aaa authentication login default group TACACS-SERVERS local
aaa authorization console
aaa authorization exec default group TACACS-SERVERS local
!
!
aaa session-id common
clock timezone PST -8 0
clock summer-time PDT recurring
!
!
!
ip domain name cisco.local
ip multicast-routing distributed
!
!
!
!
subscriber templating
!
multilink bundle-name authenticated
!
flow record Record-FNF-IWAN
 description Flexible NetFlow for IWAN Monitoring
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 collect routing source as
 collect routing destination as
 collect routing next-hop address ipv4
 collect ipv4 dscp
 collect ipv4 id
```

```
 collect ipv4 source prefix
 collect ipv4 source mask
 collect ipv4 destination mask
 collect transport tcp flags
 collect interface output
 collect flow sampler
 collect counter bytes
 collect counter packets
 collect timestamp sys-uptime first
 collect timestamp sys-uptime last
 collect application name
!
!
flow exporter Export-FNF-LiveAction
 description FNFv9 with LiveAction
 destination 10.4.48.178
 source Loopback0
 transport udp 2055
 option application-attributes
 option interface-table
 option application-table
!
!
flow monitor Monitor-FNF-IWAN
 description IWAN Traffic Analysis
 exporter Export-FNF-LiveAction
 cache timeout inactive 10
 cache timeout active 60
 record Record-FNF-IWAN
!
!
domain iwan
 vrf default
  border
   source-interface Loopback0
   master 10.255.241.32
   password 7 08221D5D0A16544541
   collector 10.4.48.178 port 2055
!
!
key chain WAN-KEY
 key 1
   key-string 7 110A4816141D5A5E57
!
!
crypto pki trustpoint TP-self-signed-98238700
 enrollment selfsigned
```

```
 subject-name cn=IOS-Self-Signed-Certificate-98238700
 revocation-check none
 rsakeypair TP-self-signed-98238700
!
!
!
license udi pid ISR4451-X/K9 sn FOC175097J7
license accept end user agreement
license boot level appxk9
license boot level uck9
license boot level securityk9
spanning-tree extend system-id
!
username admin secret 5 $1$SnKm$ibEw/1V702JMAMj/C/qzs.
!
redundancy
 mode none
!
!
!
crypto ikev2 keyring DMVPN-KEYRING-2
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key c1sco123
 !
!
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-2
 match fvrf IWAN-TRANSPORT-2
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local DMVPN-KEYRING-2
!
crypto ikev2 dpd 40 5 on-demand
!
!
!
track 80 interface Tunnel11 line-protocol
 delay up 20
!
ip ftp source-interface Loopback0
ip tftp source-interface GigabitEthernet0
ip ssh source-interface Loopback0
ip ssh version 2
ip scp server enable
!
```

```
class-map type appnav match-any MAPI
 match protocol mapi
class-map match-any STREAMING-VIDEO
 match dscp af31  af32  cs5
class-map match-any INTERACTIVE-VIDEO
 match dscp cs4  af41  af42
class-map match-any CRITICAL-DATA
 match dscp af11  af21
class-map match-any NET-CTRL-MGMT
 match dscp cs2  cs6
 match access-group name ISAKMP
class-map match-any VOICE
 match dscp ef
class-map match-any SCAVENGER
 match dscp cs1
class-map match-any CALL-SIGNALING
 match dscp cs3
!
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol icmp
 match protocol udp
 match protocol tcp
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
!
policy-map WAN
 class INTERACTIVE-VIDEO
  bandwidth remaining percent 30
  random-detect dscp-based
  set dscp af41
 class STREAMING-VIDEO
  bandwidth remaining percent 10
  random-detect dscp-based
  set dscp af41
 class NET-CTRL-MGMT
  bandwidth remaining percent 5
  set dscp cs6
```

```
 class CALL-SIGNALING
  bandwidth remaining percent 4
  set dscp af41
 class CRITICAL-DATA
  bandwidth remaining percent 25
  random-detect dscp-based
  set dscp af21
 class SCAVENGER
  bandwidth remaining percent 1
  set dscp af11
 class VOICE
  priority level 1
  police cir percent 10
  set dscp ef
 class class-default
  bandwidth remaining percent 25
  random-detect
  set dscp default
policy-map WAN-INTERFACE-G0/0/0
 class class-default
  shape average 300000000
   service-policy WAN
!
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
!
!
zone security default
zone security OUTSIDE
zone-pair security FROM-ROUTER source self destination OUTSIDE
```

```
 service-policy type inspect ACL-OUT-POLICY
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
!
crypto ipsec security-association replay window-size 512
!
crypto ipsec transform-set AES256/SHA/TRANSPORT esp-aes 256 esp-sha-hmac
 mode transport
!
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-2
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-2
!
interface Loopback0
 ip address 10.255.242.32 255.255.255.255
 ip pim sparse-mode
!
interface Port-channel2
 description Link to RS32-A3850
 no ip address
 no negotiation auto
!
interface Port-channel2.64
 description Data
 encapsulation dot1Q 64
 ip address 10.7.146.3 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim dr-priority 105
 ip pim sparse-mode
 standby 1 ip 10.7.146.1
 standby 1 priority 105
 standby 1 preempt
 standby 1 authentication md5 key-string 7 06055E324F41584B56
!
!
interface Port-channel2.99
 description Transit Net
 encapsulation dot1Q 99
 ip address 10.7.144.10 255.255.255.252
 ip nat inside
 ip pim sparse-mode
!
interface Tunnel11
 bandwidth 300000
```

```
 ip address 10.6.36.32 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-300MBPS
 ip nhrp network-id 102
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.36.1 nbma 172.16.140.1 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/0
 tunnel mode gre multipoint
 tunnel key 102
 tunnel vrf IWAN-TRANSPORT-2
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-2
!
interface GigabitEthernet0/0/0
 bandwidth 300000
 vrf forwarding IWAN-TRANSPORT-2
 ip address dhcp
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 ip nat outside
 zone-member security OUTSIDE
 ip policy route-map INET-INTERNAL
 negotiation auto
 no cdp enable
 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/0
!
interface GigabitEthernet0/0/1
 no ip address
 negotiation auto
!
interface GigabitEthernet0/0/2
 description RS32-A3850 (gig 2/0/24)
 no ip address
 negotiation auto
```

```
 channel-group 2
!
interface GigabitEthernet0/0/3
 description RS32-A3850 (gig 1/0/24)
 no ip address
 negotiation auto
 channel-group 2
!
!
!
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  !
  af-interface default
   passive-interface
  exit-af-interface
  !
  af-interface Port-channel2.99
   authentication mode md5
   authentication key-chain WAN-KEY
   no passive-interface
  exit-af-interface
  !
  af-interface Tunnel11
   summary-address 10.7.144.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   no passive-interface
  exit-af-interface
  !
  topology base
   distribute-list route-map BLOCK-DEFAULT in Tunnel11
   distribute-list route-map ROUTE-LIST out Tunnel11
   redistribute static route-map STATIC-IN
  exit-af-topology
  network 10.6.36.0 0.0.1.255
  network 10.7.0.0 0.0.255.255
  network 10.255.0.0 0.0.255.255
  eigrp router-id 10.255.242.32
  eigrp stub connected summary redistributed leak-map STUB-LEAK-ALL
 exit-address-family
!
!
!
ip nat inside source route-map NAT interface GigabitEthernet0/0/0 overload
ip forward-protocol nd
```

```
no ip http server
ip http authentication aaa
ip http secure-server
ip http secure-trustpoint TP-self-signed-98238700
ip http client secure-trustpoint TP-self-signed-98238700
ip pim autorp listener
ip pim register-source Loopback0
ip route 10.0.0.0 255.0.0.0 Null0 254
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
!
!
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
ip access-list standard STATIC-ROUTE-LIST
 permit 10.7.146.9
!
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc
ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
ip access-list extended ESP-IN
 permit esp any any
ip access-list extended ESP-OUT
 permit esp any any
ip access-list extended GRE-IN
 permit gre any any
!
ip access-list extended ISAKMP
 permit udp any eq isakmp any eq isakmp
ip access-list extended NAT-LOCAL
 permit ip 10.7.144.0 0.0.7.255 any
!
```

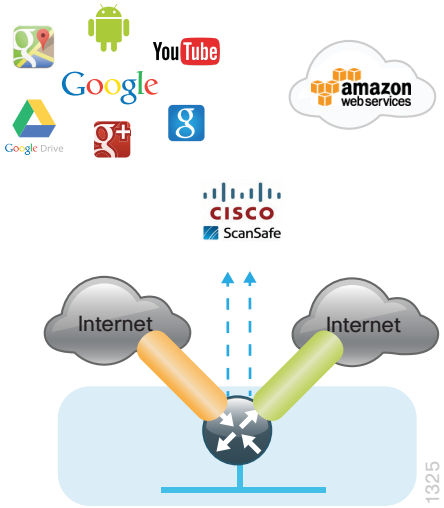
```
no service-routing capabilities-manager
!
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
 match ip address ALL-EXCEPT-DEFAULT
!
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
!
route-map STATIC-IN permit 30
 match ip address STATIC-ROUTE-LIST
!
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
!
route-map STUB-LEAK-ALL permit 100
 description Leak all routes to neighbors
!
route-map NAT permit 10
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/0
!
route-map ROUTE-LIST deny 10
 description Block readvertisement of learned WAN routes
 match tag 10.6.34.0 10.6.36.0
!
route-map ROUTE-LIST deny 20
 description Block advertisement of Local Internet Default route out to WAN
 match ip address DEFAULT-ONLY
!
route-map ROUTE-LIST permit 100
 description Advertise all other routes
!
route-tag notation dotted-decimal
snmp-server community cisco123 RW
snmp-server community cisco RO
snmp-server trap-source Loopback0
snmp ifmib ifindex persist
!
tacacs server TACACS-SERVER-1
 address ipv4 10.4.48.15
 key 7 15210E0F162F3F0F2D2A
!
!
```

```
line con 0
 transport preferred none
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 transport preferred none
 transport input ssh
line vty 5 15
 transport preferred none
 transport input ssh
!
ntp source Loopback0
ntp server 10.4.48.17
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
!
end
```

Single-Router Dual-Internet with Guest Access

This configuration shows internal employee DIA and guest access DIA. This also shows all three options for ISP black-hole routing detection.

Figure 97 - Single-router dual-Internet configurations



RS33-4451X

```
version 15.5
no service pad
service tcp-keepalives-in
service tcp-keepalives-out
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
service password-encryption
no platform punt-keepalive disable-kernel-core
!
hostname RS33-4451X
!
boot-start-marker
boot-end-marker
!
!
vrf definition IWAN-GUEST
 !
 address-family ipv4
 exit-address-family
!
vrf definition IWAN-TRANSPORT-3
 !
 address-family ipv4
 exit-address-family
```

```
!
vrf definition IWAN-TRANSPORT-4
 !
 address-family ipv4
 exit-address-family
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
!
enable secret 5 $1$DX0n$4Uc9nQzr3IlgstXP5LPtZ0
!
aaa new-model
!
aaa group server tacacs+ TACACS-SERVERS
 server name TACACS-SERVER-1
!
aaa authentication login default group TACACS-SERVERS local
aaa authorization console
aaa authorization exec default group TACACS-SERVERS local
!
!
aaa session-id common
clock timezone PST -8 0
clock summer-time PDT recurring
!
!
ip domain name cisco.local
!
ip multicast-routing distributed
ip dhcp excluded-address vrf IWAN-GUEST 192.168.192.1 192.168.192.19
!
ip dhcp pool IWAN-GUEST
 vrf IWAN-GUEST
 network 192.168.192.0 255.255.255.0
 default-router 192.168.192.1
 dns-server 8.8.8.8
!
!
parameter-map type inspect global
 log dropped-packets
multilink bundle-name authenticated
!
```

```
flow record Record-FNF-IWAN
 description Flexible NetFlow for IWAN Monitoring
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 collect routing source as
 collect routing destination as
 collect routing next-hop address ipv4
 collect ipv4 dscp
 collect ipv4 id
 collect ipv4 source prefix
 collect ipv4 source mask
 collect ipv4 destination mask
 collect transport tcp flags
 collect interface output
 collect flow sampler
 collect counter bytes
 collect counter packets
 collect timestamp sys-uptime first
 collect timestamp sys-uptime last
 collect application name
!
!
flow exporter Export-FNF-LiveAction
 description FNFv9 with LiveAction
 destination 10.4.48.178
 source Loopback0
 transport udp 2055
 option interface-table
 option application-table
 option application-attributes
!
!
flow monitor Monitor-FNF-IWAN
 description IWAN Traffic Analysis
 exporter Export-FNF-LiveAction
 cache timeout inactive 10
 cache timeout active 60
 record Record-FNF-IWAN
!
!
domain iwan2
```

```
 vrf default
  border
   source-interface Loopback0
   master local
   password 7 130646010803557878
   collector 10.4.48.178 port 2055
  master branch
   source-interface Loopback0
   password 7 141443180F0B7B7977
   hub 10.6.32.252
   collector 10.4.48.178 port 2055
!
!
key chain WAN-KEY
 key 1
   key-string 7 110A4816141D5A5E57
!
!
crypto pki trustpoint TP-self-signed-3027894822
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-3027894822
 revocation-check none
 rsakeypair TP-self-signed-3027894822
!
crypto pki trustpoint IWAN-CA
 enrollment url http://172.16.140.110:80
 serial-number none
 fqdn RS33-4451X.cisco.local
 ip-address 10.255.243.33
 fingerprint 75BEF6259A9876CF6F341FE586D4A5D8
 vrf IWAN-TRANSPORT-4
 revocation-check none
 rsakeypair IWAN-CA-KEYS 2048 2048
!
!
license udi pid ISR4451-X/K9 sn FOC182638DU
license accept end user agreement
license boot level securityk9
spanning-tree extend system-id
!
username admin secret 5 $1$xNG3$A2SQaof3YNJ/DiBhTFjjC.
!
crypto ikev2 keyring DMVPN-KEYRING-3
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key c1sco123
 !
```

```
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-3
 match fvrf IWAN-TRANSPORT-3
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local DMVPN-KEYRING-3
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-4
 match fvrf IWAN-TRANSPORT-4
 match identity remote address 0.0.0.0
 authentication remote rsa-sig
 authentication local rsa-sig
 pki trustpoint IWAN-CA
!
crypto ikev2 dpd 40 5 on-demand
!
track 60 ip sla 110 reachability
!
track 61 ip sla 111 reachability
!
track 70 ip sla 115 reachability
!
track 71 ip sla 116 reachability
!
track 72 ip sla 117 reachability
!
track 73 ip sla 118 reachability
!
track 74 ip sla 119 reachability
!
track 80 interface Tunnel20 line-protocol
 delay up 20
!
track 100 list boolean or
 object 60
 object 61
 object 70
 object 71
 object 72
 object 73
 object 74
 object 80
!
ip ftp username cisco
ip ftp password 7 045802150C2E
ip tftp source-interface GigabitEthernet0
```

```
ip ssh source-interface Loopback0
ip ssh version 2
ip scp server enable
!
!
class-map type inspect match-any GUEST-RTR-ICMP
 match access-group name GUEST-ICMP-IN
class-map type inspect match-any RTR-GUEST-ICMP
 match access-group name GUEST-ICMP-OUT
class-map type inspect match-any GUEST-RTR-DHCP
 match access-group name GUEST-DHCP-IN
class-map type inspect match-any RTR-GUEST-DHCP
 match access-group name GUEST-DHCP-OUT
!
class-map match-any STREAMING-VIDEO
 match dscp af31  af32  cs5
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol icmp
 match protocol udp
 match protocol tcp
class-map match-any INTERACTIVE-VIDEO
 match dscp cs4  af41  af42
class-map type inspect match-any GUEST-TO-INSIDE-CLASS
 match protocol tcp
 match protocol udp
 match protocol icmp
 match access-group name GUEST-IN
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
class-map match-any CRITICAL-DATA
 match dscp af11  af21
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
class-map match-any NET-CTRL-MGMT
 match dscp cs2  cs6
 match access-group name ISAKMP
class-map match-any VOICE
 match dscp ef
class-map match-any SCAVENGER
 match dscp cs1
class-map match-any JABBER-VIDEO
 match access-group 101
class-map match-any JABBER-VOICE
 match access-group 100
```

```
class-map match-any CALL-SIGNALING
 match dscp cs3
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
class-map type inspect match-any GUEST-TO-OUTSIDE-CLASS
 match protocol dns
 match protocol http
 match protocol https
 match protocol ftp
 match access-group name GUEST-OUT
!
policy-map type inspect GUEST-TO-OUTSIDE-POLICY
 class type inspect GUEST-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect GUEST-SELF-POLICY-IN
 class type inspect GUEST-RTR-DHCP
  pass
 class type inspect GUEST-RTR-ICMP
  inspect
 class class-default
  drop
!
policy-map type inspect GUEST-SELF-POLICY-OUT
 class type inspect RTR-GUEST-DHCP
  pass
 class type inspect RTR-GUEST-ICMP
  inspect
 class class-default
  drop
policy-map type inspect GUEST-SELF-POLICY-IN
 class type inspect GUEST-RTR-DHCP
  pass
 class type inspect GUEST-RTR-ICMP
  inspect
 class class-default
  drop
!
policy-map WAN
 class INTERACTIVE-VIDEO
  bandwidth remaining percent 30
  random-detect dscp-based
  set dscp af41
```

```
 class STREAMING-VIDEO
  bandwidth remaining percent 10
  random-detect dscp-based
  set dscp af41
 class NET-CTRL-MGMT
  bandwidth remaining percent 5
  set dscp cs6
 class CALL-SIGNALING
  bandwidth remaining percent 4
  set dscp af41
 class CRITICAL-DATA
  bandwidth remaining percent 25
  random-detect dscp-based
  set dscp af21
 class SCAVENGER
  bandwidth remaining percent 1
  set dscp af11
 class VOICE
  priority level 1
  police cir percent 10
  set dscp ef
 class class-default
  bandwidth remaining percent 25
  random-detect
  set dscp default
policy-map WAN-INTERFACE-G0/0/1
 class class-default
  shape average 100000000
   service-policy WAN
policy-map WAN-INTERFACE-G0/0/0
 class class-default
  shape average 200000000
   service-policy WAN
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
```

```
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
policy-map type inspect GUEST-TO-INSIDE-POLICY
 class type inspect GUEST-TO-INSIDE-CLASS
  inspect
 class class-default
  drop
!
zone security OUTSIDE-A
zone security OUTSIDE-B
zone security GUEST
zone security default
!
zone-pair security FROM-ROUTER-A source self destination OUTSIDE-A
 service-policy type inspect ACL-OUT-POLICY
zone-pair security FROM-ROUTER-B source self destination OUTSIDE-B
 service-policy type inspect ACL-OUT-POLICY
zone-pair security GUEST-IN source GUEST destination default
 service-policy type inspect GUEST-TO-INSIDE-POLICY
zone-pair security GUEST-OUT-A source GUEST destination OUTSIDE-A
 service-policy type inspect GUEST-TO-OUTSIDE-POLICY
zone-pair security GUEST-OUT-B source GUEST destination OUTSIDE-B
zone-pair security IN_OUT-A source default destination OUTSIDE-A
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
zone-pair security IN_OUT-B source default destination OUTSIDE-B
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
zone-pair security TO-ROUTER-A source OUTSIDE-A destination self
 service-policy type inspect ACL-IN-POLICY
zone-pair security TO-ROUTER-B source OUTSIDE-B destination self
 service-policy type inspect ACL-IN-POLICY
zone-pair security GUEST-RTR-IN source GUEST destination self
 service-policy type inspect GUEST-SELF-POLICY-IN
zone-pair security RTR-GUEST-OUT source self destination GUEST
 service-policy type inspect GUEST-SELF-POLICY-OUT
!
crypto ipsec security-association replay window-size 512
!
crypto ipsec transform-set AES256/SHA/TRANSPORT esp-aes 256 esp-sha-hmac
 mode transport
!
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-3
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-3
!
```

```
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-4
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-4
!
!
interface Loopback0
 ip address 10.255.243.33 255.255.255.255
 ip pim sparse-mode
!
interface Loopback192
 description GUEST-NET LOOPBACK
 vrf forwarding IWAN-GUEST
 ip address 192.168.255.13 255.255.255.255
!
interface Tunnel20
 bandwidth 200000
 ip address 10.6.38.33 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip nat outside
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-200MBPS
 ip nhrp network-id 201
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.38.1 nbma 172.16.140.11 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/0
 tunnel mode gre multipoint
 tunnel key 201
 tunnel vrf IWAN-TRANSPORT-3
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-3
!
interface Tunnel21
 bandwidth 100000
 ip address 10.6.40.33 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
```

```
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-100MBPS
 ip nhrp network-id 202
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.40.1 nbma 172.17.140.11 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/1
 tunnel mode gre multipoint
 tunnel key 202
 tunnel vrf IWAN-TRANSPORT-4
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-4
!
!
interface GigabitEthernet0/0/0
 bandwidth 200000
 vrf forwarding IWAN-TRANSPORT-3
 ip address dhcp
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 ip nat outside
 zone-member security OUTSIDE-A
 ip policy route-map INET-INTERNAL
 media-type rj45
 negotiation auto
 no cdp enable

 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/0
!
interface GigabitEthernet0/0/1
 bandwidth 100000
 vrf forwarding IWAN-TRANSPORT-4
 ip address dhcp
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 ip nat outside
 zone-member security OUTSIDE-B
 ip policy route-map INET-INTERNAL
 media-type rj45
```

```
 negotiation auto
 no cdp enable
 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/1
!
interface GigabitEthernet0/0/2
 description RS33-A2960X Gig1/0/48
 no ip address
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/0/2.64
 encapsulation dot1Q 64
 ip address 10.7.162.1 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim sparse-mode
 no cdp enable
!
!
interface GigabitEthernet0/0/2.80
 description GUEST-NET
 encapsulation dot1Q 80
 vrf forwarding IWAN-GUEST
 ip address 192.168.192.1 255.255.255.0
 ip nat inside
 zone-member security GUEST
!
!
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  !
  af-interface default
   passive-interface
  exit-af-interface
  !
  af-interface Tunnel20
   summary-address 10.7.160.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   hello-interval 20
   hold-time 60
   no passive-interface
  exit-af-interface
```

```
  !
  af-interface Tunnel21
   summary-address 10.7.160.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   hello-interval 20
   hold-time 60
   no passive-interface
  exit-af-interface
  !
  topology base
   distribute-list route-map BLOCK-DEFAULT in Tunnel20
   distribute-list route-map BLOCK-DEFAULT in Tunnel21
  exit-af-topology
  network 10.6.38.0 0.0.1.255
  network 10.6.40.0 0.0.1.255
  network 10.7.0.0 0.0.255.255
  network 10.255.0.0 0.0.255.255
  eigrp router-id 10.255.243.33
  eigrp stub connected summary redistributed
 exit-address-family
!
!
ip nat inside source route-map ISP-A interface GigabitEthernet0/0/0 overload
ip nat inside source route-map ISP-B interface GigabitEthernet0/0/1 overload
ip nat inside source route-map GUEST-NAT-AUTH interface Tunnel20 vrf IWAN-GUEST overload
ip nat inside source route-map GUEST-NAT-INET interface GigabitEthernet0/0/0 vrf IWAN-
GUEST overload
ip forward-protocol nd
no ip http server
ip http authentication aaa
ip http secure-server
ip http secure-trustpoint TP-self-signed-3027894822
ip http client secure-trustpoint TP-self-signed-3027894822
ip pim autorp listener
ip pim register-source Loopback0
ip route 10.0.0.0 255.0.0.0 Null0 254
ip route 192.168.192.0 255.255.255.0 GigabitEthernet0/0/2.80
ip route 192.168.255.13 255.255.255.255 Loopback192
ip route vrf IWAN-GUEST 10.4.48.0 255.255.255.0 Tunnel20 10.6.38.1 global
ip route vrf IWAN-GUEST 192.168.144.0 255.255.255.0 Tunnel20 10.6.38.1 global
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/1 dhcp 15
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
ip route vrf IWAN-GUEST 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
ip tacacs source-interface Loopback0
!
!
```

```
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
!
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
!
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
 permit tcp any any eq 8080
 permit udp any any eq domain
!
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc
!
ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
!
ip access-list extended ESP-IN
 permit esp any any
!
ip access-list extended ESP-OUT
 permit esp any any
!
ip access-list extended GRE-IN
 permit gre any any
!
ip access-list extended GUEST-AUTH
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
 permit ip 192.168.192.0 0.0.0.255 10.4.48.0 0.0.0.255
!
ip access-list extended GUEST-DHCP-IN
 permit udp any eq bootpc any eq bootps
!
ip access-list extended GUEST-DHCP-OUT
 permit udp any eq bootps any eq bootpc
!
ip access-list extended GUEST-ICMP-IN
 permit icmp any any echo
```

```
 permit icmp any any echo-reply
!
ip access-list extended GUEST-ICMP-OUT
 permit icmp any any echo
 permit icmp any any echo-reply
!
ip access-list extended GUEST-IN
 permit ip 192.168.192.0 0.0.0.255 10.4.48.0 0.0.0.255
 permit ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
!
ip access-list extended GUEST-INET
 deny   ip 192.168.192.0 0.0.0.255 192.168.144.0 0.0.0.255
 deny   ip 192.168.192.0 0.0.0.255 10.4.48.0 0.0.0.255
 permit ip 192.168.192.0 0.0.0.255 any
!
ip access-list extended GUEST-OUT
 permit ip 192.168.192.0 0.0.0.255 any
!
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
!
ip access-list extended ISAKMP
 permit udp any eq isakmp any eq isakmp
!
ip access-list extended NAT
 permit ip 10.7.160.0 0.0.7.255 any
!
ip sla 110
 icmp-echo 172.18.1.253 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 110 life forever start-time now
ip sla 111
 icmp-echo 172.18.1.254 source-interface GigabitEthernet0/0/0
 vrf IWAN-TRANSPORT-3
 threshold 1000
 frequency 15
ip sla schedule 111 life forever start-time now
dns d.root-servers.net name-server 199.7.91.13
 vrf IWAN-TRANSPORT-3
 tag EAST-ROOT-DNS-PROBE-1
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 118 life forever start-time now
ip sla 119
```

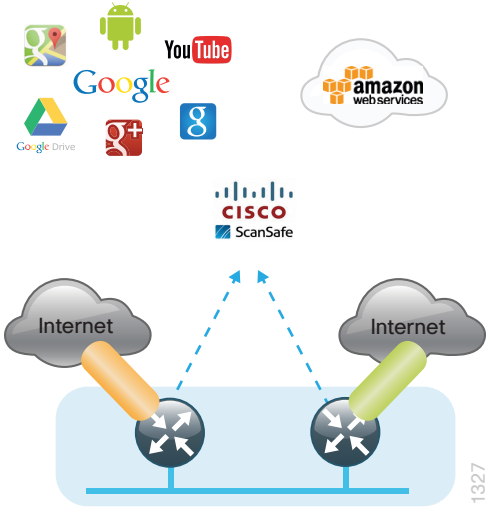
```
 dns b.root-servers.net name-server 192.228.79.201
 vrf IWAN-TRANSPORT-3
 tag WEST-ROOT-DNS-PROBE-2
 threshold 1000
 timeout 3000
 frequency 15
ip sla schedule 119 life forever start-time now
no service-routing capabilities-manager
!
route-map GUEST-NAT-AUTH permit 10
 match ip address GUEST-AUTH
 match interface Tunnel20
!
route-map GUEST-NAT-INET permit 10
 match ip address GUEST-INET
 match interface GigabitEthernet0/0/0
!
route-map ISP-B permit 10
 match ip address NAT
 match interface GigabitEthernet0/0/1
!
route-map ISP-A permit 10
 match ip address NAT
 match interface GigabitEthernet0/0/0
!
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
 match ip address ALL-EXCEPT-DEFAULT
!
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
!
route-tag notation dotted-decimal
snmp-server community cisco RO
snmp-server community cisco123 RW
snmp-server trap-source Loopback0
snmp ifmib ifindex persist
!
tacacs server TACACS-SERVER-1
 address ipv4 10.4.48.15
 key 7 0235015819031B0A4957
!
!
line con 0
 logging synchronous
```

```
 transport preferred none
 stopbits 1
line aux 0
 stopbits 1
line vty 0
 exec-timeout 0 0
 no activation-character
 transport preferred none
 transport input ssh
 stopbits 1
line vty 1 4
 exec-timeout 0 0
 transport preferred none
 transport input ssh
line vty 5 15
 exec-timeout 0 0
 transport preferred none
 transport input ssh
!
ntp source Loopback0
ntp server 10.4.48.17
!
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - IPSLA
 event track 100 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - IPSLA
 event track 100 state up
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
!
end
```

Dual-Router Dual-Internet

This shows the configuration for both routers in the dual-router dual-Internet remote site with DIA.

Figure 98 - Dual-router dual-Internet configurations



RS34-4451X-1 Primary Router

```
version 15.5
no service pad
service tcp-keepalives-in
service tcp-keepalives-out
service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
no platform punt-keepalive disable-kernel-core
!
hostname RS34-4451X-1
!
boot-start-marker
boot-end-marker
!
!
vrf definition IWAN-TRANSPORT-3
 !
 address-family ipv4
 exit-address-family
!
vrf definition Mgmt-intf
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
```

```
 exit-address-family
!
enable secret 5 $1$S7wW$LwAu9mADPzeXE.yQjFmIc1
!
aaa new-model
!
!
aaa group server tacacs+ TACACS-SERVERS
 server name TACACS-SERVER-1
!
aaa authentication login default group TACACS-SERVERS local
aaa authorization console
aaa authorization exec default group TACACS-SERVERS local
!
aaa session-id common
clock timezone PST -8 0
clock summer-time PDT recurring
!
!
!
ip domain name cisco.local
ip multicast-routing distributed
!
!
parameter-map type inspect global
 log dropped-packets
multilink bundle-name authenticated
!
flow record Record-FNF-IWAN
 description Flexible NetFlow for IWAN Monitoring
 match ipv4 tos
 match ipv4 protocol
 match ipv4 source address
 match ipv4 destination address
 match transport source-port
 match transport destination-port
 match interface input
 match flow direction
 collect routing source as
 collect routing destination as
 collect routing next-hop address ipv4
 collect ipv4 dscp
 collect ipv4 id
 collect ipv4 source prefix
 collect ipv4 source mask
 collect ipv4 destination mask
 collect transport tcp flags
```

```
 collect interface output
 collect flow sampler
 collect counter bytes
 collect counter packets
 collect timestamp sys-uptime first
 collect timestamp sys-uptime last
 collect application name
!
!
flow exporter Export-FNF-LiveAction
 description FNFv9 with LiveAction
 destination 10.4.48.178
 source Loopback0
 transport udp 2055
 option interface-table
 option application-table
 option application-attributes
!
!
flow monitor Monitor-FNF-IWAN
 description IWAN Traffic Analysis
 exporter Export-FNF-LiveAction
 cache timeout inactive 10
 cache timeout active 60
 record Record-FNF-IWAN
!
!
domain iwan2
 vrf default
  border
   source-interface Loopback0
   master local
   password c1sco123
   collector 10.4.48.178 port 2055
  master branch
   source-interface Loopback0
   password c1sco123
   hub 10.6.32.252
   collector 10.4.48.178 port 2055
!
!
key chain WAN-KEY
 key 1
   key-string 7 110A4816141D5A5E57
!
!
crypto pki trustpoint TP-self-signed-3321404653
```

```
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-3321404653
 revocation-check none
 rsakeypair TP-self-signed-3321404653
!
no watchdog
!
license udi pid ISR4451-X/K9 sn FOC1832ACNH
spanning-tree extend system-id
!
username admin secret 5 $1$yCu6$q6emTtaou/8c6tnJVFqul0
!
redundancy
 mode none
!
!
!
crypto ikev2 keyring DMVPN-KEYRING-3
 peer ANY
  address 0.0.0.0 0.0.0.0
  pre-shared-key c1sco123
 !
!
!
crypto ikev2 profile FVRF-IKEv2-IWAN-TRANSPORT-3
 match fvrf IWAN-TRANSPORT-3
 match identity remote address 0.0.0.0
 authentication remote pre-share
 authentication local pre-share
 keyring local DMVPN-KEYRING-3
!
crypto ikev2 dpd 40 5 on-demand
!
!
!
track 50 interface Tunnel20 line-protocol
 delay up 20
!
track 80 interface Tunnel20 line-protocol
 delay up 20
!
ip ftp source-interface Loopback0
ip tftp source-interface GigabitEthernet0
ip ssh source-interface Loopback0
ip ssh version 2
ip scp server enable
!
```

```
class-map match-any STREAMING-VIDEO
 match dscp af31  af32  cs5
class-map type inspect match-any INSIDE-TO-OUTSIDE-CLASS
 match protocol ftp
 match protocol icmp
 match protocol udp
 match protocol tcp
class-map match-any INTERACTIVE-VIDEO
 match dscp cs4  af41  af42
class-map type inspect match-any INSPECT-ACL-OUT-CLASS
 match access-group name ACL-RTR-OUT
class-map match-any CRITICAL-DATA
 match dscp af11  af21
class-map type inspect match-any PASS-ACL-IN-CLASS
 match access-group name ESP-IN
 match access-group name DHCP-IN
 match access-group name GRE-IN
class-map match-any NET-CTRL-MGMT
 match dscp cs2  cs6
 match access-group name ISAKMP
class-map match-any VOICE
 match dscp ef
class-map match-any SCAVENGER
 match dscp cs1
class-map match-any JABBER-VIDEO
 match access-group 101
class-map match-any JABBER-VOICE
 match access-group 100
class-map match-any CALL-SIGNALING
 match dscp cs3
class-map type inspect match-any PASS-ACL-OUT-CLASS
 match access-group name ESP-OUT
 match access-group name DHCP-OUT
class-map type inspect match-any INSPECT-ACL-IN-CLASS
 match access-group name ACL-RTR-IN
!
policy-map WAN
 class INTERACTIVE-VIDEO
  bandwidth remaining percent 30
  random-detect dscp-based
  set dscp af41
 class STREAMING-VIDEO
  bandwidth remaining percent 10
  random-detect dscp-based
  set dscp af41
 class NET-CTRL-MGMT
  bandwidth remaining percent 5
```

```
  set dscp cs6
 class CALL-SIGNALING
  bandwidth remaining percent 4
  set dscp af41
 class CRITICAL-DATA
  bandwidth remaining percent 25
  random-detect dscp-based
  set dscp af21
 class SCAVENGER
  bandwidth remaining percent 1
  set dscp af11
 class VOICE
  priority level 1
  police cir percent 10
  set dscp ef
 class class-default
  bandwidth remaining percent 25
  random-detect
  set dscp default
policy-map WAN-INTERFACE-G0/0/0
 class class-default
  shape average 300000000
   service-policy WAN
policy-map type inspect INSIDE-TO-OUTSIDE-POLICY
 class type inspect INSIDE-TO-OUTSIDE-CLASS
  inspect
 class class-default
  drop
policy-map type inspect ACL-IN-POLICY
 class type inspect INSPECT-ACL-IN-CLASS
  inspect
 class type inspect PASS-ACL-IN-CLASS
  pass
 class class-default
  drop
policy-map type inspect ACL-OUT-POLICY
 class type inspect INSPECT-ACL-OUT-CLASS
  inspect
 class type inspect PASS-ACL-OUT-CLASS
  pass
 class class-default
  drop
!
!
zone security default
zone security OUTSIDE
zone-pair security FROM-ROUTER source self destination OUTSIDE
```

```
 service-policy type inspect ACL-OUT-POLICY
zone-pair security IN_OUT source default destination OUTSIDE
 service-policy type inspect INSIDE-TO-OUTSIDE-POLICY
zone-pair security TO-ROUTER source OUTSIDE destination self
 service-policy type inspect ACL-IN-POLICY
!
crypto ipsec security-association replay window-size 512
!
crypto ipsec transform-set AES256/SHA/TRANSPORT esp-aes 256 esp-sha-hmac
 mode transport
!
crypto ipsec profile DMVPN-PROFILE-TRANSPORT-3
 set transform-set AES256/SHA/TRANSPORT
 set ikev2-profile FVRF-IKEv2-IWAN-TRANSPORT-3
!
interface Loopback0
 ip address 10.255.243.34 255.255.255.255
 ip pim sparse-mode
!
interface Port-channel1
 no ip address
 no negotiation auto
!
interface Port-channel1.64
 description Data
 encapsulation dot1Q 64
 ip address 10.7.178.2 255.255.255.0
 ip helper-address 10.4.48.10
 ip nat inside
 ip pim dr-priority 110
 ip pim sparse-mode
 standby 1 ip 10.7.178.1
 standby 1 priority 110
 standby 1 preempt
 standby 1 authentication md5 key-string c1sco123
 standby 1 track 50 decrement 10
 service-policy input Ingress-LAN-Mark
!
!
interface Port-channel1.99
 description Transit Net
 encapsulation dot1Q 99
 ip address 10.7.176.9 255.255.255.252
 ip nat inside
 ip pim sparse-mode
!
interface Tunnel20
```

```
 bandwidth 300000
 ip address 10.6.38.34 255.255.254.0
 no ip redirects
 ip mtu 1400
 ip flow monitor Monitor-FNF-IWAN input
 ip flow monitor Monitor-FNF-IWAN output
 ip pim dr-priority 0
 ip pim sparse-mode
 ip nhrp authentication cisco123
 ip nhrp group RS-GROUP-300MBPS
 ip nhrp network-id 201
 ip nhrp holdtime 600
 ip nhrp nhs 10.6.38.1 nbma 172.16.140.11 multicast
 ip nhrp registration no-unique
 ip nhrp shortcut
 ip tcp adjust-mss 1360
 if-state nhrp
 tunnel source GigabitEthernet0/0/0
 tunnel mode gre multipoint
 tunnel key 201
 tunnel vrf IWAN-TRANSPORT-3
 tunnel protection ipsec profile DMVPN-PROFILE-TRANSPORT-3
!
!
interface GigabitEthernet0/0/0
 bandwidth 300000
 vrf forwarding IWAN-TRANSPORT-3
 ip address dhcp
 no ip redirects
 no ip unreachables
 no ip proxy-arp
 ip nat outside
 zone-member security OUTSIDE
 media-type rj45
 negotiation auto
 no cdp enable
 no mop enabled
 no lldp transmit
 no lldp receive
 service-policy output WAN-INTERFACE-G0/0/0
!
interface GigabitEthernet0/0/1
 no ip address
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/0/2
```

```
 description RS34-A3650 (gig2/1/3)
 no ip address
 media-type rj45
 negotiation auto
 channel-group 1
!
interface GigabitEthernet0/0/3
 description RS34-A3650 (gig1/1/3)
 no ip address
 media-type rj45
 negotiation auto
 channel-group 1
!
!
router eigrp IWAN-EIGRP
 !
 address-family ipv4 unicast autonomous-system 400
  !
  af-interface default
   passive-interface
  exit-af-interface
  !
  af-interface Port-channel1.99
   authentication mode md5
   authentication key-chain WAN-KEY
   no passive-interface
  exit-af-interface
  !
  af-interface Tunnel20
   summary-address 10.7.176.0 255.255.248.0
   authentication mode md5
   authentication key-chain WAN-KEY
   hello-interval 20
   hold-time 60
   no passive-interface
  exit-af-interface
  !
  topology base
   distribute-list route-map BLOCK-DEFAULT in Tunnel20
   distribute-list route-map ROUTE-LIST out Tunnel20
   redistribute static route-map STATIC-IN
  exit-af-topology
  network 10.6.38.0 0.0.1.255
  network 10.7.0.0 0.0.255.255
  network 10.255.0.0 0.0.255.255
  eigrp router-id 10.255.243.14
  eigrp stub connected summary redistributed leak-map STUB-LEAK-ALL
```

```
 exit-address-family
!
!
!
ip nat inside source route-map NAT interface GigabitEthernet0/0/0 overload
ip forward-protocol nd
no ip http server
ip http authentication aaa
ip http secure-server
ip http secure-trustpoint TP-self-signed-3321404653
ip http client secure-trustpoint TP-self-signed-3321404653
ip pim autorp listener
ip pim register-source Loopback0
ip route 10.0.0.0 255.0.0.0 Null0 254
ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10
ip tacacs source-interface Loopback0
!
!
ip access-list standard ALL-EXCEPT-DEFAULT
 deny   0.0.0.0
 permit any
ip access-list standard DEFAULT-ONLY
 permit 0.0.0.0
ip access-list standard STATIC-ROUTE-LIST
 permit 10.7.178.8
!
ip access-list extended ACL-RTR-IN
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any echo
 permit icmp any any echo-reply
 permit icmp any any ttl-exceeded
 permit icmp any any port-unreachable
 permit udp any any gt 1023 ttl eq 1
ip access-list extended ACL-RTR-OUT
 permit udp any any eq non500-isakmp
 permit udp any any eq isakmp
 permit icmp any any
ip access-list extended DHCP-IN
 permit udp any eq bootps any eq bootpc
ip access-list extended DHCP-OUT
 permit udp any eq bootpc any eq bootps
ip access-list extended ESP-IN
 permit esp any any
ip access-list extended ESP-OUT
 permit esp any any
ip access-list extended GRE-IN
```

```
 permit gre any any
ip access-list extended INTERNAL-NETS
 permit ip any 10.0.0.0 0.255.255.255
ip access-list extended ISAKMP
 permit udp any eq isakmp any eq isakmp
ip access-list extended NAT-LOCAL
 permit ip 10.7.176.0 0.0.7.255 any
!
no service-routing capabilities-manager
!
route-map BLOCK-DEFAULT permit 10
 description block only the default route inbound from the WAN
 match ip address ALL-EXCEPT-DEFAULT
!
route-map STATIC-IN permit 10
 description Redistribute local default route
 match ip address DEFAULT-ONLY
!
route-map STATIC-IN permit 30
 match ip address STATIC-ROUTE-LIST
!
route-map INET-INTERNAL permit 10
 description Return routing for Local Internet Access
 match ip address INTERNAL-NETS
 set global
!
route-map STUB-LEAK-ALL permit 100
 description Leak all routes to neighbors
!
route-map NAT permit 10
 match ip address NAT-LOCAL
 match interface GigabitEthernet0/0/0
!
route-map ROUTE-LIST deny 10
 description Block readvertisement of learned WAN routes
 match tag 10.6.38.0 10.6.40.0
!
route-map ROUTE-LIST deny 20
 description Block advertisement of Local Internet Default route out to WAN
 match ip address DEFAULT-ONLY
!
route-map ROUTE-LIST permit 100
 description Advertise all other routes
!
route-tag notation dotted-decimal
snmp-server community cisco RO
snmp-server community cisco123 RW
```

```
snmp-server trap-source Loopback0
snmp ifmib ifindex persist
!
tacacs server TACACS-SERVER-1
 address ipv4 10.4.48.15
 key 7 15210E0F162F3F0F2D2A
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable
!
mgcp profile default
!
!
line con 0
 transport preferred none
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 exec-timeout 0 0
 transport preferred none
 transport input ssh
line vty 5 15
 transport preferred none
 transport input ssh
!
ntp source Loopback0
ntp server 10.4.48.17
event manager applet DISABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state down
 action 1  cli command "enable"
 action 2  cli command "configure terminal"
 action 3  cli command "no ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 DISABLED"
event manager applet ENABLE-IWAN-DIA-DEFAULT
 description ISP Black hole Detection - Tunnel state
 event track 80 state up
 action 1  cli command "enable"
```

```
 action 2  cli command "configure terminal"
 action 3  cli command "ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 dhcp 10"
 action 4  cli command "end"
 action 99 syslog msg "IWAN DIA DEFAULT IP ROUTE via GIG0/0/0 ENABLED"
!
end
```

Appendix C: Glossary

AAA authentication, authorization and accounting

ACL access control list

AD administrative distance

ARP address resolution protocol

ASR Cisco Aggregation Services Router

AS autonomous system

ATM asynchronous transfer mode

AUP acceptable use policies

BGP border gateway protocol

C3PL Cisco Common Classification Policy Language

CAPWAP control and provisioning of wireless access points

CDP Cisco Discovery Protocol

Cisco ASR Cisco Aggregation Services Router

Cisco ISR Cisco Integrated Services Router

Cisco IWAN Cisco Intelligent WAN

Cisco SRE Cisco Services Ready Engine

CLI command-line interface

CWA centralized web authentication

DHCP dynamic host configuration protocol

DIA direct Internet access

DMVPN dynamic multipoint virtual private network

DMVPNv3 dynamic multipoint virtual private network version 3

DNS domain name system

DoS denial of service attack

EEM Cisco IOS Embedded Event Manager

EIGRP enhanced interior gateway routing protocol

EoMPLS Ethernet over MPLS

FVRF front door routing and forwarding

ICMP Internet control message protocol

IP Internet protocol

IPSLA Internet protocol service-level agreement

ISE Cisco Identity Services Engine

ISP Internet service provider

ISR Cisco Integrated Services Router

IWAN Cisco Intelligent WAN

LAN local-area network

LLDP link layer discovery protocol

LWA local web identification

mGRE multipoint generic routing encapsulation

MOP maintenance operation protocol

MPLS multiprotocol label switching

MQC modular QoS CLI

NAT network address translation

NMS network management systems

PAD Packet Assembler/Disassembler service

PAT port address translation

PfR performance routing

PfRv3 performance routing version 3

PKI public key infrastructure

Proxy ARP proxy address resolution protocol

SRE Cisco Services Ready Engine

TFTP trivial file transfer protocol

VPLS Virtual Private LAN Service

VRF virtual routing and forwarding

WAN WAN

WLAN wireless LAN

WLC wireless LAN controller

ZBFW zone-based firewall

Feedback

Please use the feedback form to send comments and suggestions about this guide.

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B-0000220i-2 08/16