Dynamic On-Demand Tunnels

Table 1: Feature History

Feature Name	Release Information	Description
Dynamic On-Demand Tunnels	Cisco SD-WAN Release 20.3.1 Cisco vManage Release 20.3.1	This feature enables you to configure an Inactive state for tunnels between edge devices, reducing performance demands on devices and reducing network traffic.

Cisco SD-WAN supports dynamic on-demand tunnels between any two Cisco SD-WAN spoke devices. These tunnels are triggered to be set up only when there is traffic between the two devices. After the flow of traffic between the devices stops, a user-configurable inactivity timer starts, and after the configured time, the tunnel between the devices is removed. The on-demand link between the two devices is then considered to be inactive. In this inactive state, it does not use network bandwidth and does not affect device performance.

Backup Route and Reactivating the Tunnel

To enable two spoke device peers to use on-demand tunnels, they must have an alternate route, a backup route, through a hub. Using the backup route, either spoke device can resume traffic flow between the two spokes, which reactivates the tunnel to handle the traffic directly from peer to peer.

Advantages

On-demand tunnels offer the following advantages:

- Improved performance, especially for less-powerful platforms operating in a full-mesh network.
- Improved latency in hub-and-spoke deployments when on-demand tunnels are used between spokes.
- Reduced bandwidth use in the network because tunnels in Inactive state do not require Bidirectional Forwarding Detection (BFD) probes, so there is less BFD traffic produced in the network.
- Direct tunnels between spokes, while also optimizing CPU and memory usage.

- On-Demand Tunnel Mechanism in Detail, on page 2
- Notes and Limitations, on page 3
- Configure On-Demand Tunnels, on page 4

On-Demand Tunnel Mechanism in Detail

When you configure a site to use dynamic tunnels, the on-demand functionality is enabled. In this mode of operation, Cisco SD-WAN edge routers do not bring up direct tunnels to other sites that are also enabled with on-demand functionality.

Cisco SD-WAN selects one or more edge routers (typically centrally located routers) to act as backup forwarding node(s), providing a secondary path for traffic between two nodes. The backup node(s) are not enabled for on-demand. All on-demand sites form static tunnels with the backup node(s). The backup node(s) provide a static backup route for traffic between two nodes that have on-demand enabled.

The first packet of traffic between two nodes is routed though the static backup path, and triggers the on-demand tunnel to become active between the sites. The backup path continues to forward traffic until the direct path becomes active.

All on-demand sites learn the TLOCs and prefixes of all other on-demand remote sites. The prefixes also have a backup path set up through Cisco vSmart Controller control policy. So in the control plane, the on-demand tunnel network has the same state as a full-mesh tunnel network, including a backup path. The control plane downloads to the data plane, routes, with the backup path and remote TLOCs that represent a potential direct path between any two sites, but it does not set up a direct path tunnel to remote TLOCs.

Traffic from either end of the on-demand tunnel triggers setting up the tunnel. This enables on-demand tunnels to accommodate network address translation (NAT) traversal.

The on-demand tunnel feature introduces two states for the on-demand branch site:

- **Inactive**: The on-demand tunnel is not set up with the remote site. There is no active traffic to or from the remote site. Remote site TLOCs are inactive - no bidirectional forwarding detection (BFD) is set up, the prefix is installed with the inactive paths, and the backup path is set as the path to forward any traffic. The inactive path detects flows and triggers a direct site-to-site tunnel to be set up.
- **Active**: The on-demand direct site-to-site tunnel is set up to the remote site. There is active traffic to or from the remote site. This state is identical to the case of a typical tunnel, where the remote TLOCs have BFD set up, and the prefix is installed with the direct path tunnel. In this state, tunnel activity is tracked. If there is no traffic for the “idle time” duration (default 10 minutes), the direct site-to-site tunnel is removed and the state changes to Inactive.

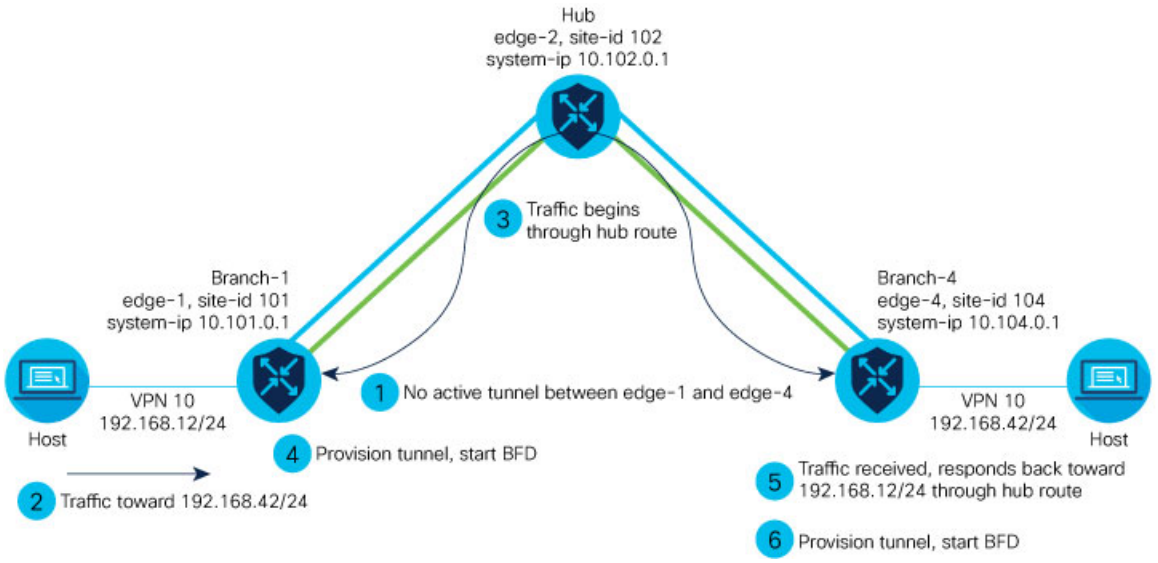
Steps in Illustrations

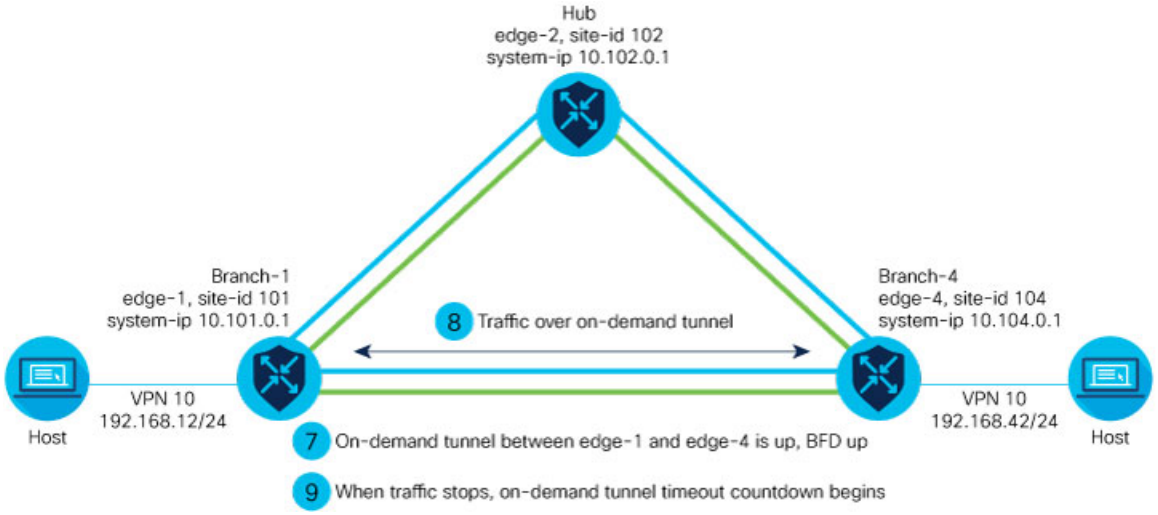
The figures below show the following steps that occur between two edge routers with an on-demand tunnel configured.

1. There is no active tunnel between the two edge routers. edge-1 and edge-4 are in Inactive state.
2. The host behind edge-1 initiates traffic toward the host behind edge-4.
3. edge-1 forwards the traffic through the backup path using the hub or backup node to edge-4.
4. edge-1 provisions the on-demand tunnel and begins bidirectional forwarding detection (BFD). edge-4 is now in Active state on edge-1.
5. When edge-4 receives the return traffic for the host behind edge-1, it forwards the traffic through the backup path using the hub or backup node to edge-1.
6. edge-4 provisions the on-demand tunnel and begins BFD. edge-1 is now in Active state on edge-4.

7. At this point, the on-demand tunnel between edge-1 and edge-4 is up, and BFD is up.
8. Traffic between the two edge devices takes the direct route through the on-demand tunnel.
9. Both edge-1 and edge-4 track the traffic activity on the on-demand tunnel in both directions.

   If there is no traffic for the idle timeout duration, the on-demand tunnel is deleted, and the edge-1 and edge-4 devices go back to the Inactive state.





Notes and Limitations

- On-demand tunnel Performance Routing (PfR) statistics collection starts fresh every time an on-demand tunnel is setup. PFR statistics are not cached for deleted on-demand tunnels after idle timeout.
- Out of order (OOO) packets may occur when traffic moves from the backup path to the direct on-demand tunnel. Packets are forwarded by the Cisco SD-WAN router as they are received.

- Unidirectional flows do not trigger on-demand tunnel setup. They continue to use the backup path.
- Multicast traffic does not trigger on-demand tunnel setup. It continues to use the backup path.
- Do not configure a data policy that applies a **set tloc-list** action to an on-demand site TLOC. If configured, traffic will be dropped.
- On-demand tunnels are not supported when the Pair Wise Key (PWK) IPSEc feature is enabled.
- All TLOCs in the system will be reset (disabled and enabled) when **on-demand enable** or **no on-demand enable** is executed.
- When an edge device provisions on-demand tunnels, it provisions to all the TLOCs on the remote site.
- For a multi-home site to be in on-demand mode, you must configure on-demand enable on all of the systems at the site.
- All edge devices using on-demand tunnels are kept active if there is a service or user traffic on any on-demand tunnel in either direction.
- On-demand tunnels can be enabled between two sites only if both sites are enabled with on-demand mode.
- The first packet to any host behind a remote site triggers on-demand tunnel setup to that remote site. Return traffic from that host triggers tunnel setup in the opposite direction.
- All prefixes from on-demand remote sites must also have a backup path configured. If not, sites will not be able set up on-demand tunnels. The backup path is a static tunnel and must be always UP.
- The setup or removal of on-demand tunnels does not affect overlay route (OMP) updates by Cisco vSmart Controller, or service/LAN-side route updates (examples: OSPF or BGP).
- If either the local site or the remote site is not in on-demand mode, static tunnels are set up between the sites.

Configure On-Demand Tunnels

Prerequisites for On-Demand Tunnels

There are several prerequisites for using on-demand tunnels:

- Prerequisites: Cisco vSmart Controller Centralized Control Policy, on page 4
- Prerequisites: OMP Settings, on page 6
- Prerequisites: Hub Device, on page 6
- Prerequisites: Spoke Devices, on page 7

Prerequisites: Cisco vSmart Controller Centralized Control Policy

1. The Cisco vSmart Controller centralized control policy must include the **tloc-action backup** action.

Explanation: This ensures that the backup path through the hub for communication between all of the spoke devices.

2. The Cisco vSmart Controller centralized control policy must accept all spoke prefix routes.
3. The Cisco vSmart Controller centralized control policy must accept TLOCs of all spokes.

   For information about configuring a Cisco vSmart Controller **centralized control policy**, see the Policies configuration guides on the Cisco SD-WAN Configuration Guides page.

CLI Example, Centralized Control Policy Addressing Prerequisites

```
viptela-policy:policy
 control-policy Dynamic-Tunnel-Control-Policy
    sequence 100
     match route
      site-list Branches
     !
     action accept
      set
       tloc-action backup
       tloc-list Hub-TLOCs
      !
     !
     sequence 200
      match tloc
     !
     action accept
    !
  default-action accept
 !
 lists
  site-list Branches
   site-id 200
   site-id 300
  !
  tloc-list Hub-TLOCs
   tloc 10.0.0.1 color mpls encap ipsec
   tloc 10.0.0.1 color public-internet encap ipsec
!
!
apply-policy
 site-list Branches
  control-policy Dynamic-Tunnel-Control-Policy out
 !
!
```

Cisco vManage Procedure

1. From the Cisco vManage menu, choose **Configuration** > **Policies**.
2. Select **Centralized Policy**.
3. Click **Add Topology** and select **Custom Control (Route & TLOC)**.
4. From **Match Conditions**, in **Site** , select one or more site lists, and click **Accept**.
5. From **Actions**, in **TLOC Action**, select the **Backup** action.
6. From **TLOC List**, select an existing TLOC list or create a new one.

Prerequisites: OMP Settings

1. The Cisco vSmart Controller send-path-limit must be more than the default 4.

   Explanation: When on-demand tunnels are enabled, spokes use backup paths through the hub, so a higher path limit is necessary. The direct paths as well as the backup paths need to be advertised. To accommodate this, increase the Cisco vSmart Controller send-path-limit to advertise all available paths. We recommend to use the maximum possible value.

Note If there are too many Hub TLOCs configured in the On-Demand Tunnel control policy, the recommended value for **send-path-limit** is not enough always. In such cases, the On-Demand Tunnel feature will not work at all.

Starting from Cisco vManage Release 20.8.1 and Cisco IOS XE Release 17.8.1a, the maximum **send-path-limit** is 32. In Cisco vManage Release 20.7.x and earlier releases, the maximum **send-path-limit** is 16.

For information about configuring the vSmart **send-path-limit**, see the Routing Configuration guides on the Cisco SD-WAN Configuration Guides page.

CLI Example

```
omp
 no shutdown
 send-path-limit 16
 graceful-restart
```

Cisco vManage Procedure

1. From the Cisco vManage menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Click **Add Template**.
4. Select a device and click **Cisco OMP**.
5. In **Basic Configuration**, set the **Number of Paths Advertised per Prefix** to 16 (recommended).

Prerequisites: Hub Device

1. On the hub device, the Traffic Engineering service (service TE) must be enabled.

   Explanation: This ensures that the Cisco SD-WAN Overlay Management Protocol (OMP) on the spoke devices accepts the backup path through the hub, which is being added as an intermediate path between the two spoke devices. Without this, the backup path through the hub would be considered invalid and unresolved by the spoke devices.

CLI Example (Cisco vEdge Devices)

```
vpn 0
 service TE
 exit
```

CLI Example (Cisco IOS XE SD-WAN Devices)

```
sdwan
 service TE vrf global
exit
```

Cisco vManage Procedure

1. In Cisco vManage, open **Configuration** > **Templates**.
2. Click **Feature Templates**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Click **Add Template**.
4. Select a platform.
5. From **VPN**, select **VPN**.
6. Ensure that in **Basic Configuration**, the **VPN** field is set to 0.
7. From **Service**, click **New Service** and select **TE**.
8. Click **Add**, and then click **Update**. The TE service appears in the table of services.
9. Apply the VPN-0 template to the hub.

Prerequisites: Spoke Devices

1. On spoke devices, the ecmp-limit must be more than the default 4. Recommended: 16

   Explanation: When on-demand tunnels are enabled, spoke devices create both direct and backup paths. To accommodate the need for more paths, increase the ecmp-limit.

CLI Example

```
omp
 no shutdown
 ecmp-limit       16
```

Note You can view the current ecmp-limit using the **show running-config omp** command.

Cisco vManage Procedure

1. From the Cisco vManage menu, choose **Configuration** > **Templates**.

2. Click **Feature Templates**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Click **Add Template**.
4. Select a device and click **Cisco OMP**.
5. In **Basic Configuration**, set the **ECMP Limit** field to 16 (recommended).

Configure On-Demand Tunnels Using Cisco vManage

Note
- See the Prerequisites for On-Demand Tunnels.
- Do not enable on-demand on the hub device.

On the spoke devices, enable on-demand at the system level on all VPN-0 transport interfaces. In the case of multi-homed sites, enable on-demand on all systems in the site.

1. From the Cisco vManage menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Feature Templates** is titled **Feature**.

3. Click **Add Template**.
4. Select a device.
5. From **Basic Information**, select **Cisco System**.
6. Click **Advanced**.
7. Enable **On-demand Tunnel**.
8. (optional) Configure the **On-demand Tunnel Idle Timeout** time. The default idle timeout value is 10 minutes. Range: 1 to 65535 minutes
9. Attach the System feature template to the device template for the spoke device.

Configure On-Demand Tunnels Using the CLI

Note

- See Prerequisites for On-Demand Tunnels, on page 4.
- Do not enable on-demand on the hub device

1. On the spoke devices, enable on-demand tunnels at the system level. In the case of multi-homed sites, enable on-demand on all systems in the site.

   The default idle timeout value is 10 minutes. Range: 1 to 65535 minutes

Example

```
system
     on-demand enable
     on-demand idle-timeout 10
```

View Current Status of On-Demand Tunnels in Cisco vManage

1. From the Cisco vManage menu, choose **Monitor** > **Devices**.

   Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.
2. Select a device.
3. Select **Real Time**.
4. For **Device Options**, select one of the following:
   - **On Demand Local**: Displays the status of on-demand tunnels on the specified device.
   - **On Demand Remote**: Displays the status of on-demand tunnels on the specified device, and on all connected devices.

The output is equivalent to executing the **show** [**sdwan**] **system on-demand** [**remote-system**] [**system-ip** *ip-address*] CLI command. It displays the status of on-demand tunnels.

View Chart of On-Demand Tunnel Status Over Time in Cisco vManage

1. From the Cisco vManage menu, choose **Monitor** > **Devices**.

   Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.
2. Select a device.
3. From **WAN**, choose **Tunnel**.
4. From the **Chart Options** drop-down list, select **On-Demand Tunnel Status**. The chart shows the status of tunnels as ACTIVE or INACTIVE. INACTIVE indicates that an on-demand tunnel is in Inactive mode.

For more information, see the Monitor and Maintain guide on the Cisco SD-WAN Configuration Guides page.