VRF-Lite Facility

Teldat Dm775-I

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Chapter 1 Introduction

1.1 Introduction

Virtual Private Networks (VPNs) provide a means for users to share bandwidth over an Internet Service Provider (ISP) backbone network. A VPN can be defined as a collection of sites that share the same routing table. A client site connects to a service provider through one or more interfaces. The service provider associates each interface with a VPN routing table. A VPN routing table is known as a VRF (VPN routing/forwarding) table.

1.2 VRF-Lite Feature

With the VRF-Lite feature, our routers can support multiple routing tables (i.e., multiple VRFs) when acting as client devices. Hence VRF-Lite is also known as multi-VRF CE (multi-VRF Customer Edge Device). VRF-Lite allows a service operator to support two or more VPNs with overlapping addressing spaces using a single physical interface.

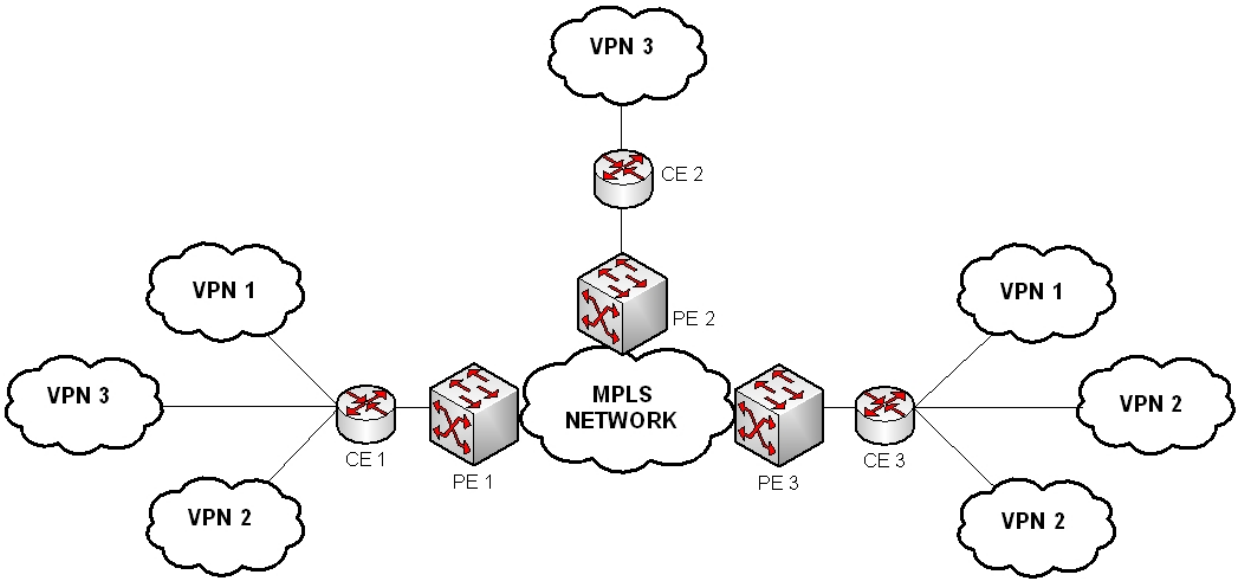
VRF-Lite uses input interfaces to distinguish between different VPNs. Each interface is associated with a VRF through configuration. The interfaces can be either physical (Ethernet ports) or logical (VLANs), but an interface cannot belong to more than one VRF at a time. VRF-associated interfaces must be layer 3 interfaces.

The VRF-Lite network architecture includes the following devices:

- Customer edge (CE) devices provide customer access to the service provider network to communicate with the remote client site CEs. The CE advertises the local routes to the PE router and learns the remote VPN routes sent by the PE.
- The service provider network's provider edge (PE) routers exchange routing information with CE devices by using static routing such as RIP or BGP. Each PE maintains a VRF for each of the directly connected VPNs. Various interfaces on a PE router can be associated with a single VRF if all of the client sites participate in the same VPN. After learning local routes from the directly connected CEs, a PE router exchanges said routes with other PE routers by using internal BGP (IBPG).
- Provider routers (or core routers) are routers in the service provider network that are not connected to CE devices.

With VRF-Lite, several clients can share one CE, and only one physical link is used between the CE and the PE. The shared CE maintains a separate VRF for each client. VRF-Lite thereby extends the PE functionality to the CEs, by allowing them to maintain separate VRFs on the client site.

The following figure shows a configuration where CEs 1 and 3 act as multiple virtual CEs:



In the scenario shown in the above figure, the packet forwarding process is as follows:

- When the CE 1 receives a packet from one of the locally connected VPNs, it looks up the routing table based on the input interface. When a route is found, the CE forwards the packet to the PE.
- In the physical link connecting each CE with its PE, as many virtual interfaces are defined (VLANs in the case of Ethernet ports) as directly connected VPNs the CE has configured. E.g., in cases regarding the link between CE1 and PE1, there are three virtual links defined so, when PE1 receives a packet from CE1, it looks up the VRF routing table associated with the corresponding virtual interface. When the route is found, the PE adds a corresponding MPLS label to the packet and sends it to the MPLS network.

- When a remote PE receives the packet from the MPLS network, it strips the label and uses the VRF associated with the label to look up the next route.
- When a remote CE receives a packet, it uses the virtual input interface information to find out the VRF associated with the packet, so that it can forward the packet within the corresponding VPN.

1.3 Configuring the VRF-Lite feature

To configure the VRF-Lite feature in a CE, you need to create one or more VRF tables and specify the associated layer 3 interfaces. Then you configure the routing protocols for the VPNs directly connected to the CE and the routing protocol between the CE and the PE.

1.3.1 Considerations prior to Configuration

Before configuring VRF-Lite, the following points should be taken into account:

- Independent of the VRF-Lite configuration, the device has a global routing table where (by default) all the interfaces participate. This can be considered as one more VRF and is known as the main VRF. The rest of the VRFs are secondaries.
- A router with VRF-Lite configured is a router shared by multiple clients (multiple VPNs). Each client has their own routing table.
- VRF-Lite allows the physical line between the PE and CE to be shared. To do this, the virtual interfaces (normally VLANs) are defined, one per client. The VLANs are multiplexed over the physical line: truck ports.
- The VRF-Lite feature does not support all features associated with the MPLS-VRF: label exchange, LDP adjacency, labeled packets.
- For the PE, there is no difference between connecting to a multi-VRF CE or connecting to multiple mono-VRF CEs.
- BGP, RIP and static routing are the possible routing protocols between CEs and PEs.

1.3.2 Default Configuration

- VRF-Lite is disabled by default; therefore there is no active secondary VRF.
- The interfaces are associated with the main VRF.
- The static, RIP and BGP routing protocols participate from the main VRF.
- All the device's functions that use IP, use the main VRF.

1.3.3 Steps to follow when configuring

To configure VRF-Lite, carry out the following steps:

(1) Configure the names of the secondary VRFs.

(2) Associate each interface or subinterface with the corresponding VRF.

(3) Configure the IP protocol parameters associated with each VRF.

(4) Configure the routing protocol for each VRF. Currently the following routing protocols are supported:

Static Routing.

RIP.

BGP.

(5) Configure TNIP to pass VRFs.

1.3.3.1 Configuring the names for the secondary VRFs

Before you can assign a secondary VRF to a particular interface, you need to create it. To do this, access the VRF feature menu and create each VRF assigning a name to it.

Syntax:

```
VRF config>vrf <vrf-name>
```

Example:

```
Config>feature vrf

-- VRF user configuration --
VRF config>vrf vrf-1
```

```
VRF config>vrf vrf-2
VRF config>vrf vrf-2
```

1.3.3.2 Associating each interface or subinterface with the corresponding VRF

Once the VRFs have been defined, associate each interface with the corresponding secondary VRF. By default, those interfaces not assigned to a secondary VRF, remain associated with the main VRF.

To associate an interface with a secondary VRF, enter the following command in the corresponding interface/ subinterface menu.

Syntax:

```
<interface_name> config>vrf forwarding <vrf-name>
```

Example:

```
Config>network ethernet0/0.1

-- Config of the Ethernet Subinterface --
ethernet0/0.1 config>vrf forwarding vrf-1
ethernet0/0.1 config>
```

Command history:

Release	Modification
11.01.09	The **ip vrf forwarding** command is obsolete as of version 11.01.09. The **vrf forwarding** command should be used instead. For further information, refer to Teldat manual *Dm772-I Common Configuration for Interfaces*.

1.3.3.3 Configuring the IP protocol parameters associated with each VRF

Within the IP protocol menu, explained in Teldat manual *Dm702-I TCP IP*, the VRF submenu has been created. This contains a collection of commands in the menu that correspond to a collection of parameters used today to configure a secondary VRF. To access the submenu, specify the name of the VRF where you wish to configure the IP parameters. The IP commands in the IP protocol root menu affect the main VRF and the commands in the VRF submenu for the IP protocol affect the specified secondary VRF.

To access a secondary VRF IP submenu, execute the following command from the IP protocol menu:

Syntax:

```
IP config>vrf <vrf-name>
```

Example:

```
Config>protocol ip

-- Internet protocol user configuration --
IP config>vrf vrf-1
```

The following list contains the IP commands that can be configured for a secondary VRF:

```
IP vrf config>?
  access-group             Specifies per-interface access control system
  address                  Assigns an ip address to one network interfaces
  aggregation-route        Configures ip aggregation information
  broadcast-address        Sets the ip broadcast format for an interface
  classless                Enables ip classless routing strategy
  directed-broadcast       Enables directed broadcast
  filter                   Designates an ip network/subnet to be filtered
  icmp-redirects           Enables sending icmp redirects
  icmp-unreachables        Enables sending icmp unreachables
  id-route
  internal-ip-address      Sets the internal ip address
  list                     Lists ip configuration elements
  local                    Local (not forwarded) traffic settings
  management-ip-address    Sets the management ip address
  multipath                Enables multipath routing
  no                       Negates a command or sets its defaults
  policy                   Enable policy routing on an interface
```

```
  route                     Configures a static network/subnet ip route
  router-id                 Sets the router id
  tvrp                      Enters in the TVRP configuration menus
  vrrp                      Enters in the VRRP configuration menus
  exit
IP vrf config>
```

For further information on the above commands, please see Teldat manual *Dm702-I TCP IP*.

1.3.3.4 Configuring the routing protocol for each VRF

1.3.3.4.1 Configuring static routing in a secondary VRF

The static routing is configured from the IP protocol VRF submenu, explained in the above paragraph.

1.3.3.4.2 Configuring the RIP protocol parameters associated with each VRF

Within the RIP protocol menu (see Teldat manual *Dm718-I RIP Protocol* for further information), the VRF submenu has been created. This contains a collection of commands that correspond to the collection of parameters used today to configure a secondary VRF. To access the submenu, specify the name of the VRF where you wish to configure the RIP parameters. The RIP commands in the RIP protocol root menu affect the main VRF and the commands in the VRF submenu for the RIP protocol affect the specified secondary VRF.

To access a secondary VRF RIP submenu, execute the following command from the RIP protocol menu:

Syntax:

```
RIP config>vrf <vrf-name>
```

Example:

```
Config>protocol rip

-- RIP protocol user configuration --
RIP config>vrf vrf-1
```

The following list contains the RIP commands that can be configured for a secondary VRF:

```
RIP vrf config>?
  aggregation-type                        RIP aggregation parameters
  allow-disconnected-subnetted-networks   Routes to subnets are always sent
  authentication                          Authentication is sent and checked
  clear                                   Clears current configuration
  compatibility                           Configure the compatibility selectors
  cost-additional                         Associates a cost to an interface
  disable                                 Disables the RIP protocol
  distribute-list                         Establish input/output filters
  enable                                  Enables the RIP protocol
  fast-updates                            Enable fast updates
  limit-rip                               Deactivates the RIP protocol in FR
  list                                    Display RIP configuration
  no
  offset-list                             Establish input/output offset lists
  originate-rip-default                   Originate a default ip route
  receiving                               RIP reception parameters
  redistribute                            Redistribute information from
                                          another routing protocol
  sending                                 RIP sending parameters
  timers                                  Timers which control the algorithm
  exit
RIP vrf config>
```

For further information on the above commands, please see Teldatmanual *Dm718-I RIP Protocol*.

1.3.3.4.3 Configuring the BGP protocol parameters associated with each VRF

Within the BGP protocol menu (see Teldat manual *Dm763-I BGP Protocol* for further information), the VRF submenu has been created. This contains a collection of commands that correspond to the collection of parameters used today to configure a secondary VRF. To access the submenu, specify the name of the VRF where you wish to configure the BGP parameters. The BGP commands in the BGP protocol root menu affect the main VRF and the commands in the VRF submenu for the BGP protocol affect the specified secondary VRF.

To access a secondary VRF BGP submenu, execute the following command from the BGP protocol menu:

Syntax:

```
BGP config>vrf <vrf-name>
```

Example:

```
Config>protocol bgp

-- Border Gateway Protocol user configuration -
BGP config>vrf vrf-1
```

The following list contains the BGP commands that can be configured for a secondary VRF:

```
BGP vrf config>?
  aggregate         Define route aggregation policy
  as                Autonomous system number of this router
  as-path           Define an as path
  as-path-set       Define an as path set
  default-metric    Metric for BGP routes advertising
  disable           Disable BGP protocol
  enable            Enable BGP protocol
  export            Define route exportation policy
  generate          Define route generation policy
  group             Define a group of peers
  import            Define route importation policy
  martians          Define martian addresses
  multipath         Enable BGP multipath
  no                Negates a command or sets its defaults
  preference        Preference for routes learned from BGP
  exit
BGP vrf config>
```

For further information on the above commands, please see Teldat manual *Dm763-I BGP Protocol*.

1.3.3.5 Configuring TNIP to pass VRFs

When a “TNIP” tunnel interface is associated with a VRF, by default the IP tunnel destination address remains associated with that VRF. Therefore, the route used to reach this destination is searched for in the associated VRF routing table.

Through configuration, you can change this behavior so that the VRF associated with the interface and the tunnel destination are different. To do this, execute **vrf-encap** for the IP tunnel interfaces.

Syntax:

```
tnip1 config>vrf-encap <vrf-name>
```

The following is an example where a different VRF is configured for the IP tunnel interface and for the tunnel destination. With this configuration, the traffic belonging to vrf-1 is transmitted encapsulated or, is run through the vrf-2.

Example:

```
tnip1 config>ip vrf forwarding vrf-1
tnip1 config>vrf-encap vrf-2
tnip1 config>
```

For further information, please see Teldat manual *Dm719-I IP Tunnel*.

Chapter 2 Configuration

2.1 Configuration Commands

This section summarizes and explains all the router's configuration commands available in the VRF feature configuration menu.

There are features whose configuration parameters can be associated with a specific VRF, i.e., they are multi-VRF, for example: IP, RIP, BGP, etc. The specific configuration commands for these functions are accessible in the configuration menus of each function, and are explained in the manuals corresponding to each individual case.

Enter the IP configuration commands when you see the VRF config> prompt. To access this prompt, enter the following:

```
*p 4
config>feature vrf

-- VRF user configuration --
VRF config>
```

Command	Function
? (HELP)	Lists the commands or their options.
NO	Deletes a previously added configuration parameter or reestablishes the default value.
VRF	Configures the name for a VRF.
EXIT	Exits the VRF configuration.

2.1.1 ? (HELP)

This command lists the valid commands at the level where the router is programmed. You can also use it after a specific command to list the available options.

Syntax:

```
VRF config>?
```

Example:

```
VRF config>?
  no      Negates a command or sets its defaults
  vrf     configure a vrf
  exit    Exit to parent menu
VRF config>
```

2.1.2 NO

Negates a command or restores the default configuration for a particular parameter.

Syntax:

```
VRF config>no ?
  vrf    remove a vrf
```

In the sections on each command that can be preceded by "NO", you will find an explanation on how this affects the commands and an example is given in the appropriate sections.

2.1.3 VRF

Creates a secondary VRF and assigns a name to it.

Syntax:

```
VRF config>vrf
  <1..32 chars>    Table name
```

Example:

```
Config>feature vrf

-- VRF user configuration --
VRF config>vrf vrf-1
VRF config>vrf vrf-2
VRF config>vrf vrf-2
```

VRF preceded by **no** deletes the VRF.

Example:

```
VRF config>no vrf vrf-1
VRF config>
```

2.1.3.1 Associating a context with the secondary VRF

In addition to configuring the name of the secondary VRF, we can optionally associate an SNMP context with each VRF. The context is unique to each VRF.

Syntax:

```
VRF config>vrf <vrf-name> context <context-name>
```

Example:

```
Config>feature vrf

-- VRF user configuration --
VRF config>vrf vrf-1 ?
  context    Configure a SNMP context
  no         Negate a command or set its defaults
  <cr>
VRF config>vrf vrf1 context ?
  <1..32 chars>    Context name
VRF config>vrf vrf1 context cntxt
```

This association allows SNMP managers to access the information relevant to the secondary VRFs.

2.1.4 EXIT

Run **exit** to return to the previous prompt level.

Syntax:

```
VRF config>exit
```

Example:

```
VRF config>exit
Config>
```

Chapter 3 Monitoring

3.1 Monitoring Commands

There are no monitoring commands for the VRF feature.

There are functionalities that can be associated with a specific VRF, i.e., they are multi-VRF, for example: IP, RIP, BGP, etc. The specific monitoring commands for these are accessible from the monitoring menus of each feature and are explained in the manuals corresponding to each individual case.