Initial Configurations for OSPF over Frame Relay Subinterfaces

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Contents

Introduction

This document provides sample configurations for Open Shortest Path First (OSPF) over Frame Relay subinterfaces.

Prerequisites

Requirements

Before you attempt this configuration, make sure that you meet these requirements:

- A basic understanding of Frame Relay and OSPF configuration

Refer to Configuring OSPF and Configuring and Troubleshooting Frame Relay for more information.

Components Used

The information in this document is based on these software and hardware versions:

- Cisco 2503 routers
- Cisco IOS® software version 12.3(3) on both routers

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to Cisco Technical Tips Conventions.

Background Information

In order to configure and troubleshoot OSPF over a network, you must have a good understanding of the underlying network topology. The neighbor discovery mechanism, election of Designated Router (DR) and Backup Designated Router (BDR), and update flooding depend on it. The underlying Layer 2 topology can be one of these:

- Broadcast multi−access (for example, Ethernet) A Broadcast network is one which allows broadcast or multicast packets to be sent over the network and hence every device able to communicate directly with every other device in the segment. A multi−access network is a network that connects more than two devices. Refer to Initial Configurations for OSPF Over Broadcast Media for more information.
- Point−to−Point (such as serial links with Point−to−Point and High−Level Data Link Control (PPP/HDLC)) point−to−point networks also allow broadcast or multicast packets to be sent over the network, and these networks connect only two devices on the segment. Refer to Initial Configurations for OSPF over a Point−to−Point Link for more information.
- Non−Broadcast multi−access (NBMA), such as Frame Relay These networks do not support broadcasts or multicasts, but can connect more than devices and are multi−access in nature. Refer to Initial Configurations for OSPF over Non−Broadcast Links for more information.
- Point−to−Multipoint This is a collection of point−to−point links between various devices on a segment. These networks also allow broadcast or multicast packets to be sent over the network. These networks can represent the multi−access segment as multiple point−to−point links that connect all the devices on the segment.

When OSPF is run on a network, two important events happen before routing information is exchanged:

- Neighbors are discovered using multicast hello packets.
- DR and BDR are elected for every multi−access network to optimize the adjacency building process. All the routers in that segment should be able to communicate directly with the DR and BDR for proper adjacency (in the case of a point−to−point network, DR and BDR are not necessary since there are only two routers in the segment, and hence the election does not take place).

For a successful neighbor discovery on a segment, the network must allow broadcasts or multicast packets to be sent.

In the broadcast multi−access Layer 2 topology, broadcasts are supported; therefore, a router that runs OSPF can discover OSPF neighbors automatically and elect any router as DR and BDR since any device can talk to all other routers in that broadcast segment.

In a point−to−point topology, neighbors are discovered automatically since neighbors are directly connected to each other through a point−to−point link, and broadcast or multicast packets are forwarded over the network; however, the DR and BDR election does not take place as explained earlier.

In an NBMA network topology, which is inherently nonbroadcast, neighbors are not discovered automatically. OSPF tries to elect a DR and a BDR due to the multi−access nature of the network, but the election fails since neighbors are not discovered. Neighbors must be configured manually to overcome these problems. Also, additional configuration is necessary in a hub and spoke topology to make sure that the hub routers, which have connectivity with every other spoke router, are elected as the DR and BDR. Alternatively, you can change the configuration on the NBMA interface to make OSPF believe that it is another network type that does not have these problems.

The correct configuration is necessary for the proper operation of OSPF.

Frame Relay subinterfaces can run in two modes:

- Point–to–Point When a Frame Relay point–to–point subinterface is configured, the subinterface emulates a point–to–point network and OSPF treats it as a point–to–point network type.
- Multipoint When a Frame Relay multipoint subinterface is configured, OSPF treats this subinterface as an NBMA network type.

Cisco IOS software uses the **ip ospf network** command to allow the flexibility run OSPF on an interface in different modes:

ip ospf network {broadcast | non–broadcast | {point–to–multipoint [non–broadcast] | point–to–point}}

The Configure section of this document contains sample configurations for OSPF over Frame Relay point–to–point subinterfaces, OSPF over Frame Relay multipoint subinterfaces with broadcast, non–broadcast, and point–to–multipoint networks.
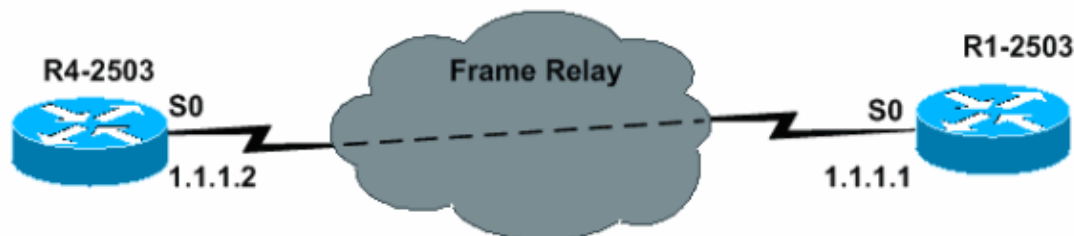
Configure

In this section, you are presented with the information to configure the features described in this document.

Note: Use the Command Lookup Tool (registered customers only) to find more information on the commands used in this document.

Network Diagram

This document uses the network setup shown here:

Configurations

This document uses the configurations shown in this section.

Point–to–Point Configuration

R4–2503

```
interface Loopback0
     ip address 3.3.3.3 255.255.255.255
     !
     interface Serial0
      no ip address
      encapsulation frame-relay
```

!--- To enable Frame Relay encapsulation

!--- on the interface.

```
     no keepalive
     !
```

```
    interface Serial0.1 point-to-point
```

!--- The subinterface is configured to

!--- function as a point-to-point link

!--- with this command.

```
     ip address 1.1.1.2 255.255.255.0
     frame-relay interface-dlci 16
```

!--- To assign a data-link connection identifier

!--- (DLCI) to a specified Frame Relay subinterface.

!--- Without this command, all the DLCIs are assigned

!--- to the physical interface.

```
     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
      !
```

R1–2503

```
interface Loopback0
      ip address 2.2.2.2 255.255.255.255
      !
     interface Serial0
      no ip address
      encapsulation frame-relay
```

!--- To enable Frame Relay encapsulation on

!--- the interface.

```
      no keepalive
      clockrate 2000000
      !
     interface Serial0.1 point-to-point
```

!--- The subinterface is configured to function

!--- as a point-to-point link with this command.

```
      ip address 1.1.1.1 255.255.255.0
      frame-relay interface-dlci 16
```

!--- To assign a data-link connection identifier

!--- (DLCI) to a specified Frame Relay subinterface.

!--- Without this command, all the DLCIs are

```
!--- assigned to the physical interface.

     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
     !
```

Verification Tips for Point–to–Point Configuration

The commands outlined here are useful for verification:

- **show ip ospf neighbor** This command is used to display OSPF–neighbor information.
- **show ip ospf interface** This command is used to display OSPF–related interface information.

The outputs of these commands are shown here:

```
R4-2503# show ip ospf neighbor

    Neighbor ID  Pri   State      Dead Time   Address   Interface
    2.2.2.2        1   FULL/  -   00:00:33    1.1.1.1   Serial0.1
```

Note: In this output, the OSPF neighbor state is shown as "FULL / –", but the DR and BDR state is not indicated. This is because there is no DR and BDR election on a point–to–point link.

```
R4-2503# show ip ospf interface s0
    %OSPF: OSPF not enabled on Serial0

R4-2503# show ip ospf interface s0.1
    Serial0.1 is up, line protocol is up
      Internet Address 1.1.1.2/24, Area 0
      Process ID 1, Router ID 3.3.3.3, Network Type POINT_TO_POINT, Cost: 64
      Transmit Delay is 1 sec, State POINT_TO_POINT,
      Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
        oob-resync timeout 40
        Hello due in 00:00:09
          Index 1/1, flood queue length 0
      Next 0x0(0)/0x0(0)
      Last flood scan length is 1, maximum is 1
      Last flood scan time is 0 msec, maximum is 0 msec
      Neighbor Count is 1, Adjacent neighbor count is 1
        Adjacent with neighbor 2.2.2.2
      Suppress hello for 0 neighbor(s)

R1-2503# show ip ospf neighbor

    Neighbor ID  Pri   State      Dead Time   Address   Interface
    3.3.3.3        1   FULL/  -   00:00:37    1.1.1.2   Serial0.1

R1-2503# show ip ospf interface s0
    %OSPF: OSPF not enabled on Serial0

R1-2503# show ip ospf interface s0.1
    Serial0.1 is up, line protocol is up
      Internet Address 1.1.1.1/24, Area 0
      Process ID 1, Router ID 2.2.2.2, Network Type POINT_TO_POINT, Cost: 64
      Transmit Delay is 1 sec, State POINT_TO_POINT,
      Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
        oob-resync timeout 40
        Hello due in 00:00:03
          Index 1/1, flood queue length 0
      Next 0x0(0)/0x0(0)
      Last flood scan length is 1, maximum is 1
      Last flood scan time is 0 msec, maximum is 0 msec
```

```
        Neighbor Count is 1, Adjacent neighbor count is 1
           Adjacent with neighbor 3.3.3.3
        Suppress hello for 0 neighbor(s)
```

Multipoint Configuration with Broadcast Network

In this configuration, the network type is changed to broadcast with the **ip ospf network broadcast** command. Now, the NBMA network is viewed as a broadcast multi−access network where DR and BDR election takes place. The **frame relay map** commands are also set to forward broadcast addresses.

R4−2503

```
interface Loopback0
     ip address 3.3.3.3 255.255.255.255
     !
     interface Serial0
      no ip address
      encapsulation frame-relay
      no keepalive
     !
     interface Serial0.2 multipoint

!--- The subinterface is treated as a multipoint link.

     ip address 1.1.1.2 255.255.255.0
     ip ospf network broadcast

!--- This command is used to define the network


!--- type as broadcast. The network type is defined


!--- on non-broadcast networks so as to not configur


!--- the neighbors explicitly.

     frame-relay map ip 1.1.1.1 16 broadcast

!--- To define the mapping between a destination


!--- protocol address and the data-link connection


!--- identifier (DLCI) used to connect to the


!--- destination address. The broadcast keyword


!--- is used to forward broadcasts and multicasts


!--- to this address.

     !
     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
     !
```

```
                        R1−2503

interface Loopback0
    ip address 2.2.2.2 255.255.255.255
    !
    !
    interface Serial0
     no ip address
     encapsulation frame-relay
     no keepalive
     clockrate 2000000
    !
    interface Serial0.2 multipoint

!--- The subinterface is treated as a multipoint link.


    ip address 1.1.1.1 255.255.255.0
    ip ospf network broadcast

!--- This command is used to define the network


!--- type as broadcast. The network type is defined


!--- on non-broadcast networks so as not configure


!--- the neighbors explicitly.

     frame-relay map ip 1.1.1.2 16 broadcast

!--- To define the mapping between a


!--- destination protocol address and the data-link


!--- connection identifier (DLCI) used to connect


!--- to the destination address.  The broadcast


!--- keyword is used to forward broadcasts and multicasts


!--- to this address.

    !
    router ospf 1
     network 1.1.1.0 0.0.0.255 area 0
    !
```

Note: If a subinterface is configured as point−to−point, the same subinterface cannot be reassigned as a multipoint subinterface unless the router is reloaded. In this case, a different subinterface is used for the multipoint configuration.

Verification Tips for Multipoint Configuration with Broadcast Network

```
R4−2503# show ip ospf neighbor
    Neighbor ID    Pri   State         Dead Time   Address    Interface
    2.2.2.2          1   FULL/BDR      00:00:32    1.1.1.1    Serial 0.2
```

```
R4-2503# show ip ospf interface s0
      %OSPF: OSPF not enabled on Serial0

R4-2503# show ip ospf interface s0.2
      Serial0.2 is up, line protocol is up
        Internet Address 1.1.1.2/24, Area 0
        Process ID 1, Router ID 3.3.3.3, Network Type BROADCAST, Cost: 64
        Transmit Delay is 1 sec, State DR, Priority 1
        Designated Router (ID) 3.3.3.3, Interface address 1.1.1.2
        Backup Designated router (ID) 2.2.2.2, Interface address 1.1.1.1
        Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
          oob-resync timeout 40
          Hello due in 00:00:05
      Index 1/1, flood queue length 0
      Next 0x0(0)/0x0(0)
      Last flood scan length is 1, maximum is 1
      Last flood scan time is 0 msec, maximum is 0 msec
        Neighbor Count is 1, Adjacent neighbor count is 1
          Adjacent with neighbor 2.2.2.2  (Backup Designated Router)
        Suppress hello for 0 neighbor(s)
R1-2503# show ip ospf neighbor


      Neighbor ID   Pri   State      Dead Time   Address    Interface
      3.3.3.3         1   FULL/DR    00:00:35    1.1.1.2    Serial0.2

R1-2503# show ip ospf interface s0
      %OSPF: OSPF not enabled on Serial0

R1-2503# show ip ospf interface s0.2
      Serial0.2 is up, line protocol is up
        Internet Address 1.1.1.1/24, Area 0
        Process ID 1, Router ID 2.2.2.2, Network Type BROADCAST, Cost: 64
        Transmit Delay is 1 sec, State BDR, Priority 1
        Designated Router (ID) 3.3.3.3, Interface address 1.1.1.2
        Backup Designated router (ID) 2.2.2.2, Interface address 1.1.1.1
        Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
          oob-resync timeout 40
          Hello due in 00:00:01
       Index 1/1, flood queue length 0
       Next 0x0(0)/0x0(0)
       Last flood scan length is 1, maximum is 1
       Last flood scan time is 0 msec, maximum is 0 msec
       Neighbor Count is 1, Adjacent neighbor count is 1
         Adjacent with neighbor 3.3.3.3  (Designated Router)
       Suppress hello for 0 neighbor(s)
```

Multipoint Configuration with Non–Broadcast Network

In this configuration, the network is non–broadcast, which does not allow neighbors to be discovered automatically. The **neighbor** command is used to manually configure OSPF neighbors. However, this command is necessary only with Cisco IOS software versions earlier than 10.0. As an alternate solution, issue the **ip ospf network** command to change the default network type (see the Multipoint Configuration with Broadcast Network configuration example). Refer to the "Avoiding DRs and neighbor Command on NBMA" section of OSPF Design Guide for more information. DR and BDR are elected due to the multi–access nature.

R4–2503

```
interface Loopback0
     ip address 3.3.3.3 255.255.255.255
     !
    interface Serial0
     no ip address
     encapsulation frame-relay
     no keepalive
```

```
     !
     interface Serial0.2 multipoint
      ip address 1.1.1.2 255.255.255.0
      frame-relay map ip 1.1.1.1 16 broadcast
      ip ospf priority 2

!--- This command assigns a higher priority for this router on this interface,
      !--- so that it gets elected as the DR. In case of a Hub and Spoke topology,
      !--- the hub should be elected as the DR as it has connectivity to all the spokes.

     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
     !
```

R1–2503

```
interface Loopback0
     ip address 2.2.2.2 255.255.255.255
     !
     interface Serial0
      no ip address
      encapsulation frame-relay
      no keepalive
      clockrate 2000000
     !
     interface Serial0.2 multipoint
      ip address 1.1.1.1 255.255.255.0
      frame-relay map ip 1.1.1.2 16 broadcast
     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
      neighbor 1.1.1.2


!--- Used to manually configure neighbors.
```

Verification Tips for Multipoint Configuration with Non–Broadcast Network

```
R4-2503# show ip ospf neighbor

     Neighbor ID   Pri   State      Dead Time   Address   Interface
     2.2.2.2         1   FULL/BDR   00:01:56    1.1.1.1   Serial0.2

R4-2503# show ip ospf interface s0
     %OSPF: OSPF not enabled on Serial0

R4-2503# show ip ospf interface s0.2
     Serial0.2 is up, line protocol is up
       Internet Address 1.1.1.2/24, Area 0
       Process ID 1, Router ID 3.3.3.3, Network Type NON_BROADCAST, Cost: 64
       Transmit Delay is 1 sec, State DR,Priority 2
       Designated Router (ID) 3.3.3.3, Interface address 1.1.1.2
       Backup Designated router (ID) 2.2.2.2, Interface address 1.1.1.1
       Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
         oob-resync timeout 40
         Hello due in 00:00:25
       Index 1/1, flood queue length 0
        Next 0x0(0)/0x0(0)
        Last flood scan length is 1, maximum is 1
        Last flood scan time is 0 msec, maximum is 0 msec
       Neighbor Count is 1, Adjacent neighbor count is 1
         Adjacent with neighbor 2.2.2.2  (Backup Designated Router)
```

```
                Suppress hello for 0 neighbor(s)
   R1-2503# show ip ospf neighbor

         Neighbor ID  Pri  State       Dead Time  Address    Interface
         3.3.3.3        2  FULL/DR     00:01:52   1.1.1.2    Serial0.2


   R1-2503# show ip ospf interface s0
         %OSPF: OSPF not enabled on Serial0


   R1-2503# show ip ospf interface s0.2
         Serial0.2 is up, line protocol is up
           Internet Address 1.1.1.1/24, Area 0
           Process ID 1, Router ID 2.2.2.2, Network Type NON_BROADCAST, Cost: 64
           Transmit Delay is 1 sec, State BDR, Priority 1
           Designated Router (ID) 3.3.3.3, Interface address 1.1.1.2
           Backup Designated router (ID) 2.2.2.2, Interface address 1.1.1.1
           Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
             oob-resync timeout 40
             Hello due in 00:00:01
           Index 1/1, flood queue length 0     Next 0x0(0)/0x0(0)
           Last flood scan length is 1, maximum is 1
           Last flood scan time is 0 msec, maximum is 0 msec
           Neighbor Count is 1, Adjacent neighbor count is 1
             Adjacent with neighbor 3.3.3.3  (Designated Router)
           Suppress hello for 0 neighbor(s)
```

Multipoint Configuration with Point−to−Multipoint Network

In this configuration, the network type is changed with the **ip ospf network point−to−multipoint** command to function as a collection of point−to−point links. Neighbors are discovered automatically and DR and BDR election does not take place.

R4−2503

```
interface Loopback0
     ip address 3.3.3.3 255.255.255.255
     !
     interface Serial0
      no ip address
      encapsulation frame-relay
      no keepalive
     !
     interface Serial0.2 multipoint
      ip address 1.1.1.2 255.255.255.0
      ip ospf network point-to-multipoint

!--- To configure an interface as
!--- point-to-multipoint for non-broadcast media.



     frame-relay map ip 1.1.1.1 16 broadcast
     !
     !
     router ospf 1
      network 1.1.1.0 0.0.0.255 area 0
     !
```

R1−2503

```
interface Loopback0
     ip address 2.2.2.2 255.255.255.255
     !
     interface Serial0
      no ip address
```

```
     encapsulation frame-relay
     no keepalive
     clockrate 2000000
    !
    interface Serial0.2 multipoint
     ip address 1.1.1.1 255.255.255.0
     ip ospf network point-to-multipoint
```

!--- To configure an interface as

!--- point-to-multipoint for non-broadcast media.

```
    frame-relay map ip 1.1.1.2 16 broadcast
    !
    router ospf 1
     network 1.1.1.0 0.0.0.255 area 0
    !
```

Verification Tips for Multipoint Configuration with Point–to–Multipoint Network

```
    R4-2503# show ip ospf neighbor

        Neighbor ID   Pri  State       Dead Time   Address    Interface
        2.2.2.2         1  FULL/  -   00:01:58    1.1.1.1    Serial0.2

    R4-2503# show ip ospf interface s0
       %OSPF: OSPF not enabled on Serial0

    R4-2503# show ip ospf interface s0.2
        Serial2.1 is up, line protocol is up
          Internet Address 1.1.1.2/24, Area 0
          Process ID 1, Router ID 3.3.3.3, Network Type POINT_TO_MULTIPOINT, Cost: 64
          Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT,
          Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
            oob-resync timeout 40
            Hello due in 00:00:07
         Index 1/1, flood queue length 0
         Next 0x0(0)/0x0(0)
         Last flood scan length is 1, maximum is 2
         Last flood scan time is 0 msec, maximum is 0 msec
          Neighbor Count is 1, Adjacent neighbor count is 1
            Adjacent with neighbor 2.2.2.2
          Suppress hello for 0 neighbor(s)

    R1-2503# show ip ospf neighbor

        Neighbor ID   Pri  State       Dead Time   Address    Interface
        3.3.3.3         1  FULL/  -   00:01:49    1.1.1.2    Serial0.2

    R1-2503# show ip ospf interface s0
        %OSPF: OSPF not enabled on Serial0

    R1-2503# show ip ospf interface s0.2
        Serial0.2 is up, line protocol is up
          Internet Address 1.1.1.1/24, Area 0
          Process ID 1, Router ID 2.2.2.2, Network Type POINT_TO_MULTIPOINT, Cost: 64
          Transmit Delay is 1 sec, State POINT_TO_MULTIPOINT,
          Timer intervals configured, Hello 30, Dead 120, Wait 120, Retransmit 5
            oob-resync timeout 40
            Hello due in 00:00:00
         Index 1/1, flood queue length 0
         Next 0x0(0)/0x0(0)
          Last flood scan length is 1, maximum is 2
          Last flood scan time is 0 msec, maximum is 0 msec
```

```
    Neighbor Count is 1, Adjacent neighbor count is 1
      Adjacent with neighbor 3.3.3.3
    Suppress hello for 0 neighbor(s)
```

Verify

In order to verify your configurations, use the subsections provided in the Configure section of this document.

Troubleshoot

This section provides information you can use to troubleshoot your configuration.

Before you troubleshoot any OSPF neighbor−related issues on an NBMA network, it is important to remember that an NBMA network can be configured in these modes of operation with the **ip ospf network** command:

- Point−to−Point
- Point−to−Multipoint
- Broadcast
- NBMA

The Hello and Dead Intervals of each mode are described in this table:

Network Type	Hello Interval (secs)	Dead Interval (secs)
Point−to−Point	10	40
Point−to−Multipoint	30	120
Broadcast	10	40
Non−Broadcast	30	120

When OSPF is configured on a physical interface (for example, interface S0) of a non broadcast multi−access technology such as Frame Relay, the default network type of NON_BROADCAST is assigned. When OSPF is configured on point−to−point subinterfaces, the default interface type of POINT_TO_POINT is assigned. When OSPF is configured on multipoint subinterfaces, the default interface type of NON_BROADCAST is assigned.

When the NBMA network is made up of a combination of physical and logical interfaces (subinterfaces) on different routers, different OSPF network types come into play. Hello mismatches are likely to occur in such cases; as a result, OSPF adjacencies are not formed.

Refer to Problems with Running OSPF in NBMA Mode over Frame Relay and Troubleshooting OSPF for more information on how to troubleshoot OSPF.

Related Information

- **Troubleshooting OSPF**
- **OSPF Design Guide**
- **OSPF Neighbor Problems Explained**
- **Why Doesn't OSPF Form Adjacency on a PRI, BRI, or Dialer Interface?**
- **Common Routing Problem with OSPF Forwarding Address**
- **OSPF Commands**

- **OSPF Technology Support Page**
- **IP Routing Technology Support Page**
- **Technical Support – Cisco Systems**

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