OSPF Protocol

bintec Dm714-I

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Chapter 1 Introduction

1.1 The OSPF Protocol

This chapter describes how to use the Open Shortest Path First (OSPF) protocol, which is an interior gateway protocol (IGP). The bintec router supports three different IGPs to build the IP routing table, including the I-BGP protocol, the Open Shortest Path First (OSPF) protocol, and the RIP protocol.

OSPF is based on link-state technology or the shortest-path first (SPF) algorithm. RIP is based on the Bellman-Ford or distance-vector algorithm. The information is divided into the following sections:

- The OSPF Routing Protocol.
- Configuring the OSPF Protocol.
- OSPF Configuration Commands.
- OSPF Monitoring Commands.

Routers that use a common routing protocol form an autonomous system (AS). This common routing protocol is called an interior gateway protocol (IGP). IGPs dynamically detect network reachability and routing information within an AS and use this information to build the IP routing table. IGPs can also import external routing information into the AS.

bintec routers can run the I-BGP, OSPF and RIP protocols simultaneously.

Protocols are assigned a preference value or administrative distance, with a lower value indicating a favored route. The table below contains the default administrative distance values for each route:

Type of Route	Administrative Distance
Directly Attached	0
OSPF (intra-area e inter-area)	10
Static	60
RIP	100
OSPF (external)	150
BGP	170

1.2 The OSPF Routing Protocol

bintec routers support a complete implementation of the OSPF routing protocol, as specified in RFC 1247 (Version 2). This version is incompatible with bridging routers that run OSPF version 1. Routers running both versions do not exchange OSPF information.

OSPF is a dynamic link state routing protocol that detects and learns the best routes to reachable destinations. OSPF can quickly perceive changes in the topology of an AS and, after a short convergence period, calculate new routes. The OSPF protocol does not encapsulate IP packets, but forwards them based on the destination address.

OSPF is designed to provide services not available with RIP. OSPF features include the following:

- *Least cost routing*. Configures path costs based on any combination of network parameters. For example, bandwidth, delay, and cost.
- *No limitations to the routing metric*. While RIP restricts the routing metric to 16 hops, there is no such restriction with OSPF.
- *Multipath routing*. Uses multiple equal cost paths that connect the same points. You can then use these paths to balance loads and make a more efficient use of network bandwidth.
- *Area routing*. Decreases the resources (memory and network bandwidth) consumed by the protocol and provides an additional level of routing protection.
- *Variable length subnet masks*. Breaks an IP address into subnets of different sizes, thus preserving IP address space.

- *Routing authentication*. Provides additional routing security.

OSPF supports the following physical network types:

- *Point-to-Point*. Networks that use a communication line to join a single pair of routers. Default network type for interfaces such as PPP, HDLC and TNIP.
- *Broadcast*. Networks that support more than two attached routers and are capable of addressing a single physical message to all attached routers. Default network type for Ethernet and Token-Ring interfaces.
- *Non-Broadcast*. Networks that support more than two attached routers but have no broadcast capabilities (despite being able to emulate them through configuration). Default network type for X.25 interfaces.
- *Point-to-Mpoint broadcast*. Partially meshed networks with more than two routers, generally with a star topology setup. The network also supports or emulates broadcast traffic so you don't need to configure the neighbors.
- *Point-to-Mpoint non-broadcast*. Partially meshed networks with more than two routers. The traffic flow must pass through a central point. In addition, since the network does not support or emulate broadcast traffic, all neighbors must be configured. Default network type for Frame-Relay interfaces.

1.3 Configuring OSPF

Follow the steps below to get the OSPF protocol up and running. The coming sections describe each step in detail and include examples.

(1) Enable the OSPF protocol.

(2) Define OSPF areas attached to the router. If no OSPF areas are defined, a single backbone area is assumed.

(3) Define the router's OSPF network interfaces. The cost of sending a packet from each interface must be configured, along with a collection of the OSPF operating parameters.

(4) If the router connects to any non-broadcast networks, configure the non-broadcast network parameters. These consist of a list of the other OSPF routers that are connected to the non-broadcast network.

(5) If you want the router to import routes learned from other routing protocols (RIP or statically configured routes), enable **AS boundary** routing. In addition, define whether routes are imported as Type 2 or Type 1 external routes. Routes imported from other dynamic routing protocols are specified through specific commands that enable or disable these imports per protocol or through the **redistribute** command.

(6) If you want to boot a neighboring router over a connected point-to-point interface, the neighbor's IP address must be configured. This is done by defining non-broadcast parameters for the point-to-point interface.

1.3.1 Enabling the OSPF Protocol

Each router running the OSPF protocol has a database containing a map of the routing domain. This database is identical in all participating routers. From this database, the IP routing table is built by setting up a shortest-path tree in which the router serves as root. The routing domain refers to the AS that runs the OSPF protocol.

To enable the OSPF protocol, enter **enable ospf**:

Syntax:

```
OSPF config>enable ospf
```

Example:

```
OSPF config>enable ospf
OSPF config>
```

1.3.2 Defining Backbone and Attached OSPF Areas

Defines the OSPF areas directly attached to the router. If no areas are defined, the router software assumes all networks directly attached to the router belong to the backbone area (area ID 0.0.0.0).

OSPF splits the AS into regions known as *areas*. OSPF areas are a collection of contiguous networks. An area's topology is hidden from other areas. Hiding information significantly reduces routing traffic and protects routing (carried out within an area) from outside influences.

A router has a separate database that contains the topology for each area it is attached to. Two routers belonging to the same area have identical topologies for said area.

OSPF areas are defined as address ranges. A single route is advertised outside of the area for each address range. For example, an OSPF area made up of all subnets belonging to class B network 128.185.0.0 would be defined as a single address range (i.e., address 128.185.0.0 with mask 255.255.0.0). Outside this area, the entire subnetted network would be advertised as a single route to network 128.185.0.0.

Every OSPF routing domain must have a backbone. Said backbone is a special OSPF area with an area ID equal to 0.0.0.0. Although the OSPF backbone must be contiguous, it is possible to define areas where the backbone is not physically contiguous (configuring a virtual link to maintain the backbone's connectivity). You can configure virtual links between any two backbone routers that have an interface to a common non-backbone area.
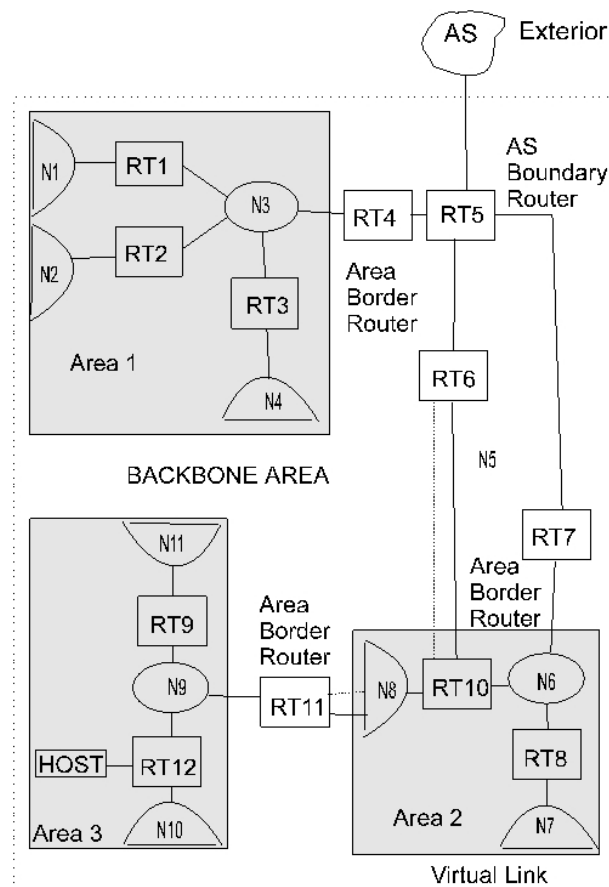
Fig. 1: **Backbone and Attached OSPF Areas**

The backbone is responsible for distributing inter-area routing information. A backbone area consists of any of the following:

- Routers belonging to Area 0.0.0.0 (Backbone routers).
- Networks belonging to Area 0.0.0.0 (Backbone networks, defined by such backbone routers).
- Hosts connected to said backbone networks.
- Configured virtual links.

To set the parameters for an OSPF area, run the **area** command and respond to the following prompts:

Syntax:

```
OSPF config>area
  <a.b.c.d>     Area number
    default         creates an area with defaults
      <cr>
    authentication    enables authentication
      message-digest    Enable MD5 authentication on the area
      <cr>
    range            range
      <a.b.c.d>    IP Address
        <a.b.c.d>    IP Address Mask
          advertisement    specifies a range to enable/disable advertisement
            <cr>
          no              Negates a command or sets its defaults
            advertisement    specifies a range to enable/disable advertisement
              <cr>
```

```
   stub-area        stub area
     default            creates a stub area with defaults
        <cr>
     stub-cost          default stub cost
        <1..65535>   Stub default cost
           <cr>
     import-summaries    import summaries
        <cr>
     no
        stub-cost          default stub cost
           <cr>
        import-summaries    import summaries
           <cr>
   no                Negates a command or sets its defaults
     authentication    disables authentication
        <cr>
     range             range
        <a.b.c.d>    IP Address
           <a.b.c.d>    IP Address Mask
              <cr>
     stub-area         stub area
        <cr>
```

Example:

```
OSPF config>area  0.0.0.1 default
OSPF config>
```

Area number: the OSPF area address. An OSPF area is a contiguous group of networks defined by a list of address ranges, each indicated by a combination of the IP address and an address mask. A network belongs to an area if its address is on the list.

Once the area number has been entered, a series of distinct options appears:

- *default*: creates an area with the default values: type 0 authentication, no area stub.
- *authentication* (type of authentication) security schema to be used in the area. Possible authentication types are: type 2, indicates a password to generate an encrypted signature; type 1, indicates a simple password; or 0, which indicates authentication exchange is unnecessary.
- *no*: negates a previously configured option or provides default values for the various parameters.
- *range*: adds a range of addresses to the OSPF area. In ospf inter-area routes, a single route is advertised for each range of addresses.
- *stub-area (Stub area designation)*: configures the OSPF area as a stub area. In this case:

The area does not receive any AS external link advertisements, reducing the size of the area's OSPF database and decreasing memory usage for external routers in the stub area.

You cannot create a virtual link through a stub area.

You cannot configure a router within the stub area as an AS boundary router.

> **Note**
>
> You cannot configure the backbone as a stub area. External routing in stub areas is based on a default route. Each area border router attached to a stub area generates a default route for this purpose. Default route cost is configurable through the **area** command.

1.3.3 Setting OSPF Interfaces

Run **interface** to engage a particular router interface in OSPF and to configure OSPF interface-specific parameters.

Within the OSPF router category, two particular types stand out: area border routers and AS boundary routers.

- Area Border Router. Router attached to multiple areas, which runs multiple copies of the basic algorithm, one copy per attached area (and an additional copy for the backbone if configured). Area border routers summarize the topology information of their attached areas and distribute said information into the backbone area. The backbone then forwards this to other areas.
- AS Boundary Router. Router that exchanges information with routers from other ASs. These routers import information to the OSPF network in AS external link advertisements.

1.3.4 OSPF Routing Summary

When a router is initialized, it uses the Hello Protocol to send hello packets to its neighbors. They, in turn, send their packets to the router. On broadcast and point-to-point networks, the router dynamically detects its neighboring routers by sending its Hello packets to the multicast address ALLSPFRouters; on non-broadcast networks, you must configure information to help the router discover its neighbors. On all multi-access networks (broadcast and non-broadcast), the Hello Protocol also elects a designated router for the network.

The router then attempts to form adjacencies with its neighbors to synchronize their topological databases. Adjacencies control the distribution (sending and receiving) of the routing protocol packets as well as the distribution of the topological database updates. On a multi-access network, the designated router determines which router becomes adjacent.

A router periodically advertises its status or link state to its adjacencies. Link state advertisements flood throughout an area ensuring all routers have exactly the same topological database. This database is a collection of the link state advertisements received from each router belonging to an area. From the information in this database, each router can calculate a shortest-path tree designating itself as the root. The shortest-path tree then generates the routing table.

1.3.4.1 Designated Router

Every multi-access network has a designated router that performs two main functions: it generates network link advertisements and it becomes adjacent to all other routers on the network.

When a designated router generates network link advertisements, it lists all the routers (including itself) currently connected to the network. The link ID for this advertisement is the IP interface address of the designated router. By using the subnet/network mask, the designated router obtains the IP network number.

The designated router becomes adjacent to all other routers and is tasked with synchronizing the link state databases on the broadcast network.

The Hello Protocol uses the Rtr Pri field of the Hello packet to determine router priority and select the designated router.

When a router's interface first becomes functional, it checks whether the network has a designated router. If it does, it accepts that designated router regardless of the router's priority. If it doesn't, the router declares itself the designated router. If two routers declare themselves to be the designated router simultaneously, the router with the highest router priority (Rtr Pri) becomes the designated router. If the routers have the same router priority, the one with the higher router ID is selected.

Once the designated router is chosen, it becomes the endpoint for many adjacencies. On a broadcast network, it optimizes the flooding procedure by allowing the designated route to multicast its Link State Update packets to the address ALLSPFRouters rather than sending separate packets over each adjacency.

To set the OSPF parameters for the router's network interfaces, run the **interface** command.

Enter the IP address for each router interface. The following parameters must be configured with the **same value** on all routers connected to a common network segment:

- Hello interval.
- Dead router interval.
- Authentication key (if type 1 authentication (simple password) is used).

The **area** option configures the OSPF area the interface attaches to. In the following example, let's assume the interface address mask is 255.255.255.0 (meaning the interface connects to subnet 128.185.138.0 of network 128.185.0.0). All other OSPF routers connected to subnet 128.185.138.0 must also have their *hello interval* set to 20, their *dead router interval* set to 50, and their interface *authentication key* set to xyz_q.

Example:

```
OSPF config>interface 172.24.78.115 ?
  area                    area to attach this interface
  authentication-key      authentication key
  dead-interval           dead interval
  default                 creates an interface
  hello-interval          hello interval
  message-digest-key      message digest MD5 key for this interface
  network-type            network type
  no                      Negates a command or sets its defaults
  router-priority         router priority
  retransmission-interval retransmission interval
```

```
  tos0-cost                tos 0 cost
  transmission-delay          transmission delay
OSPF config>interface 172.24.78.115 he
OSPF config>interface 172.24.78.115 hello-interval 20
OSPF config>interface 172.24.78.115 ded
OSPF config>interface 172.24.78.115 dea
OSPF config>interface 172.24.78.115 dead-interval 50
OSPF config>interface 172.24.78.115 a
OSPF config>interface 172.24.78.115 au
OSPF config>interface 172.24.78.115 authentication-key ?
  <word>    Authentication Key
OSPF config>interface 172.24.78.115 authentication-key xyz_q ?
  <cr>
OSPF config>interface 172.24.78.115 authentication-key xyz_q
OSPF config>
```

1.3.5 Setting Non-Broadcast Network Parameters

If the router is connected to a non-broadcast, multi-access network (such as an X.25 PDN), configure the parameters below to help the router discover its OSPF neighbors. This configuration is only necessary if the router can be selected as the designated router for the non-broadcast network.

First, configure the OSPF poll interval with the following command:

Example:

```
OSPF config>non-broadcast ?
  <a.b.c.d>    Interface IP address
OSPF config>non-broadcast 172.24.78.115 ?
  <1s..18h12m15s>    Poll Interval
OSPF config>non-broadcast 172.24.78.115 30s ?
  <cr>
OSPF config>non-broadcast 172.24.78.115 30s
OSPF config>
```

Subsequently, configure the IP addresses for all other OSPF routers connected to the non-broadcast network. For each router configured, specify its eligibility to become the designated router.

Example:

```
OSPF config>neighbor ?
  <a.b.c.d>      Interface IP address
  <interface>    Interface ID
OSPF config>neighbor 172.24.78.115 ?
  <a.b.c.d>    IP Address of Neighbor
OSPF config>neighbor 172.24.78.115 172.24.78.116 ?
  yes    That router can become Designated Router on this net
  no     That router can not become Designated Router on this net
OSPF config>neighbor 172.24.78.115 172.24.78.116 no ?
  <cr>
OSPF config>neighbor 172.24.78.115 172.24.78.116 no
OSPF config>
```

1.3.6 Enabling AS Boundary Routing

To import routes learned from other protocols (BGP, RIP and statically configured information) into the OSPF domain, enable **AS boundary routing**. This is mandatory even if the only route you want to import is the default route (destination 0.0.0.0).

When enabling AS boundary routing, you are asked what external routes you want to import. You can choose to import (or not) routes belonging to several categories by running the **import** subcommand (from the **AS-boundary-routing** command) or the **redistribute** command. The categories are as follows:

- RIP routes.
- BGP Routes.
- Static routes.
- Direct routes.
- Default route.

For example, you can choose to import direct routes (away from the OSPF interface configuration), but not BGP, RIP nor static routes. The cost of all routes imported is equal to their routing table cost. They are all imported as either type 1 or type 2 external routes, depending on the routing protocol comparison.

In addition to the above-mentioned external categories, you can also configure whether or not to import subnet routes into the OSPF domain. This configuration item defaults to OFF (subnets not imported).

The metric type used when importing routes determines how the imported cost is viewed by the OSPF domain. When comparing two type 2 metrics, only the external cost is considered when picking the best route. When comparing two type 1 metrics, the external and internal costs of the route are combined before making the comparison.

Use this command to also enable default route generation with a specified type, cost and next hop.

AS-boundary-routing syntax is as follows:

Example:

```
OSPF config> as-boundary-routing
  default                enable as boundary routing with defaults
    <cr>
  import                 selects which routes to import
    bgp-routes             import static routes
      <cr>
    cost-of-imported-routes    cost of imported routes
      <0..4294967295>    Import routes cost
        <cr>
    default-routes         import default routes
      <cr>
    direct-routes          import direct routes
      <cr>
    rip-routes             import rip routes
      <cr>
    static-routes          import static routes
      <cr>
    subnet-routes          import subnet routes
      <cr>
    aggregation-type       choses aggregation type
      none               do not aggregate
        <cr>
      aggregation-routes    use aggregation routes
        <cr>
      subnetted-networks    aggregate subnetted networks
        <cr>
      all                aggregate all
        <cr>
    originate-default-route    originates default route
      always             always originate a default route
        <cr>
      type               type of originated default route
        <1..2>    Originate as type 1 or 2
          <cr>
      cost               cost of originated default route
        <0..4294967295>    Default route cost
          <cr>
      forwarding-address    forwarding ip address for the default route
        <a.b.c.d>    Default forwarding address
          <cr>
  no
    import                 selects which routes to import
      bgp-routes             import bgp routes
        <cr>
      cost-of-imported-routes    cost of imported routes
        <cr>
      default-routes         import default routes
        <cr>
      direct-routes          import direct routes
        <cr>
      rip-routes             import rip routes
        <cr>
```

```
    static-routes              import static routes
      <cr>
    subnet-routes              import subnet routes
      <cr>
  aggregation-type          choses aggregation type
    <cr>
  originate-default-route   originates default route
    always                   always originate a default route
     <cr>
    type                     type of originated default route
      <cr>
    cost                     cost of originated default route
      <cr>
    forwarding-address     forwarding ip address for the default route
      <cr>
```

Further details on the various configuration options are given in the chapter on configuration.

1.3.7 Other Configuration Tasks

1.3.7.1 Setting OSPF Router IDS

Every router in an OSPF routing domain must be assigned a 32-bit router-ID. The current OSPF implementation sets the OSPF router-ID to be the address of the first OSPF interface appearing in the router's configuration.

The OSPF router-ID can also be explicitly set by the **router-id** command from the IP menu. The router-ID must still be one of the router's IP interface addresses.

1.3.7.2 Setting Virtual Links

To maintain backbone connectivity, all your backbone routers must be interconnected either by permanent or virtual links. Virtual links may be configured between any two area border routers sharing a common non-backbone and non-stub area. Virtual links are considered to be separate router interfaces connecting to the backbone area. Many interface parameters need specifying when configuring a virtual link.

The example below illustrates the configuration of a virtual link. Virtual links must be configured in each of the link's two endpoints. Note: OSPF router IDs are entered in the same way as IP addresses.

Example:

```
OSPF config>area 0.0.0.0 default
OSPF config>virtual-link 172.24.78.116 0.0.0.1 ?
  authentication-key        authentication key
  default                   creates a virtual link
  dead-interval             dead interval
  hello-interval            hello interval
  no                        Negates a command or sets its defaults
  retransmission-interval   retransmission interval
  transmission-delay        transmission delay
OSPF config>virtual-link 172.24.78.116 0.0.0.1 default
OSPF config>
```

> **Note**
>
> Prior to defining a virtual-link for a router, ensure that said router belongs to the backbone area (0.0.0.0).

Further details on the various configuration options are given in the chapter on configuration.

1.3.7.3 Configuring for Routing Protocol Comparisons

When using an additional routing protocol, or changing your routing protocol to OSPF, set the Routing Protocol Comparison. OSPF routing in an AS occurs on the following three levels: intra-area, Inter-area, and exterior.

Intra-area routing occurs when a packet's source and destination address reside in the same area (N1 and N2 in Area 1 for example). Information relating to other areas does not affect this type of routing.

Inter-area routing occurs when the packet's source and destination addresses reside in different areas of an AS (N1

of Area 1 and N7 of Area 2 for example). OSPF does inter-area routing by dividing the path into three contiguous parts: an intra-area path from source to an area border router; a backbone path between the source and destination areas; and another intra-area path to the destination. This three-level routing can be represented by a star topology where the backbone is the central point all other areas connect to.

Exterior routes are paths to networks that lie outside the AS. These routes originate either from dynamic routing protocols, or from static routes entered by the network administrator. The exterior routing information provided by other dynamic routing protocols does not interfere with the internal routing information provided by the OSPF protocol.

AS boundary routers may import exterior routes into the OSPF routing domain. OSPF represents these routes as AS external link advertisements.

OSPF imports external routes at two separate levels. The first level, called type 1 routes, is used when the external metric is comparable to the OSPF metric (e.g., they might both use delay in milliseconds). The second level, called type 2 external routes, assumes the external cost is greater than the cost of any internal OSPF (link-state) path.

OSPF has, as shown below, a 4-level routing hierarchy. The **comparison** command tells the router where the RIP/BGP/static routes fit in the OSPF hierarchy. The two lower levels consist of the OSPF internal routes. OSPF intra-area and inter-area routes take precedence over information obtained from any other sources, all of which are located on a single level.

To put the RIP/BGP/static routes on the same level as OSPF external type 1 routes, set the comparison to 1. To put the RIP/BGP/static routes on the same level as OSPF external type 2 routes, set the comparison to 2. The default setting is 2.

For example, suppose the comparison is set to 2. In this case, when RIP routes are imported into the OSPF domain, they are imported as type 2 external routes. All OSPF type 1 external routes override the RIP routes received, regardless of metric.

> ☞ **Note**
>
> The comparison values for all your OSPF routers must match. If the comparison values set for the routers are inconsistent, your router will not function properly.

The **comparison** command syntax is as follows:

Syntax:

```
OSPF config>comparison ?
  <1..2>    Compare to type 1 or 2 externals
OSPF config>comparison 2 ?
  <cr>
OSPF config>comparison 2
OSPF config>
```

1.3.7.4 Configuring for OSPF routes filtering

Route filtering in the OSPF entry defines a route-map to select routes you do not want to install in the device's active routing table. Filtering is executed when the OSPF is going to install the route in the routing table and does not affect the protocol Link State broadcasting.

The match conditions checked to select the route, are as follows (please see *bintec Dm764-I Route Mapping*):

match ip address

match ip prefix-list

match ip next-hop

match ip route-source

match interface

match metric

match route-type

match tag

The command to use to configure filtering in OSPF is as follows:

distribute-list route-map <route-map> **in**

Below you can see a configuration example for filtering OSPF external routes; the exit interface is eth0/1.

Example:

```
   network ethernet0/0
; -- Ethernet Interface User Configuration --
     ip address 192.168.10.1 255.255.255.0
;
   exit
;
   network ethernet0/1
; -- Ethernet Interface User Configuration --
     ip address 192.168.20.1 255.255.255.0
;
   exit
;
   feature route-map
; -- Route maps user configuration --
     route-map "FILTER"
        entry 1 default
        entry 1 deny
        entry 1 match interface ethernet0/1
        entry 1 match route-type external
;
     exit
;
   exit
;
   protocol ospf
; -- Open SPF-Based Routing Protocol configuration console --
     enable ospf
;
     interface 192.168.20.1 default
;
     interface 192.168.10.1 default
;
     distribute-list route-map FILTER in
   exit
;
```

Chapter 2 Configuration

2.1 Configuration Commands

This chapter describes the OSPF configuration commands. To access to the OSPF Configuration environment, enter the following:

```
*process 4
Config>protocol ospf

-- Open SPF-Based Routing Protocol configuration console --
OSPF config>
```

The OSPF protocol supports an instance per VRF configured in the device. To configure this protocol in a VRF other than the main VRF, execute the following command from the OSPF configuration root menu:

```
OSPF config>vrf VRF-1


OSPF vrf config>
```

Command	Function
?(HELP)	Displays available commands and their options.
AREA	Configures the parameters for an OSPF area.
AS-BOUNDARY-ROUTING	Configures the AS boundary routing capacity.
COMPARISON	Tells the router where to insert the static/RIP routes in the OSPF hierarchy.
DISABLE	Disables the OSPF protocol.
DISTANCE	Configures the OSPF administrative distance.
DISTRIBUTE-LIST	Configures OSPF route filtering.
ENABLE	Enables the OSPF protocol.
HOST	Defines the special device addresses considered as HOST type OSPF routes (advertised as internal in each of the router areas).
INTERFACE	Configures the OSPF parameters for the router interfaces.
LIST	Displays the OSPF configuration.
NEIGHBOR	Aggregates and configures neighbors to non-broadcast networks.
NO	Deletes parts of the executed configuration.
NON-BROADCAST	Configures the parameters for non-broadcast networks.
REDISTRIBUTE	Configures the redistribution (importation) of routes coming from other protocols towards OSPF.
VIRTUAL-LINK	Configures virtual links between any two area border routers.
VRF	Enters the OSPF configuration menu associated with a VRF that is not the main one. This only appears in the OSPF root menu.
EXIT	Exits the OSPF configuration process.

2.1.1 ? (HELP)

Use the **? (HELP)** command to list the commands that are available at the current prompt level. You can also enter ? after a command to list its options.

Syntax:

```
OSPF config>?
```

Example:

```
OSPF config>?
  area                 Set the parameters for an OSPF area
  as-boundary-routing  Configure AS boundary routing
  comparison           Set where external routes fit in the OSPF hierarchy
  disable              Disable the entire OSPF protocol
  distance             Define an administrative distance
  distribute list      Networks filter configuration
  enable               Enable the entire OSPF protocol
  host                 Define host addresses to be exported
  interface            Set the OSPF params for the router's network ifs
  list                 Display OSPF configuration information
  neighbor             Add neighbors to non-broadcast networks
  no                   Negates a command or sets its defaults
  non-broadcast        Configure non-broadcast network description
  redistribute         Redistribute information from another routing protocol
  virtual-link         Configure virtual links between 2 area border routers
  exit
```

2.1.2 AREA

Creates and sets the parameters for an OSPF area. If no areas are defined, the router software assumes that all the router's directly connected networks belong to the backbone area (area ID 0.0.0.0).

Syntax:

```
OSPF config>area
  <a.b.c.d>    Area number
    default          creates an area with defaults
      <cr>
    authentication   enables authentication
      message-digest   Enable MD5 authentication on the area
      <cr>
    range            range
      <a.b.c.d>    IP Address
        <a.b.c.d>    IP Address Mask
          advertisement    specifies a range to enable/disable advertisement
            <cr>
          no               Negates a command or sets its defaults
            advertisement    specifies a range to enable/disable advertisement
              <cr>
    stub-area        stub area
      default          creates a stub area with defaults
        <cr>
      stub-cost        default stub cost
        <1..65535>    Stub default cost
          <cr>
      import-summaries   import summaries
        <cr>
      no
        stub-cost          default stub cost
          <cr>
        import-summaries    import summaries
          <cr>
    no             Negates a command or sets its defaults
      authentication    disables authentication
        <cr>
      range             range
```

```
      <a.b.c.d>    IP Address
        <a.b.c.d>    IP Address Mask
          <cr>
    stub-area        stub area
       <cr>
```

Area-number	OSPF area address. An OSPF area is an adjacent group of networks defined by a list of address ranges, each indicated by an IP address/mask combination. A network belongs to an area if its address is on the list.
Options:	
default	Creates an area with the default options. I.e., type 0 authentication and no stub.
authentication	Configures the security schema used in the area. The **authentication** option enables authentication, i.e., it configures Type 1 authentication, which indicates a simple password. The **no authentication** option, Type 0, indicates that no authentication exchange is necessary to send packets. The **message-digest** suboption configures Type 2. This requires an additional encrypted signature based on a password configured through the **message-digest-key** subcommand found in the interface command.
range	Adds ranges to OSPF areas. A single route for each address range is advertised outside the area (inter-area routes). For instance, an OSPF area made up of all subnets in class B 128.185.0.0 network are defined as if they consist of a single address range. The address range is specified as a 128.185.0.0 address with mask 255.255.0.0. Outside of the area, the entire subnets network (subnetted) is advertised as a single route to network 128.185.0.0.
no	Deletes configurations created with other options.
- no authentication	Disables authentication (configures authentication Type 0).
- no range	Deletes a range previously added to the area.
- no stub-area	Deletes the characteristic to be stub in the indicated area.
stub-area	Configures the area as stub. In this case:

stub-area (continued):

- The area does not receive any AS external link advertisements, reducing the size of your database and decreasing memory usage for routers in the stub area.
- You cannot configure virtual links through a stub area.
- You cannot configure a router within the stub area as an AS boundary router.

To deconfigure a stub area, use the **no stub-area** option.

- stub-area default	Creates a stub area with the default parameters. These are:

- cost 0.
- network summaries are imported.

- stub-area stub-cost	External routing in stub areas is based on a default route. Each area border router attached to a stub area generates a default route. This option configures the cost of this default route.
- stub-area import-summaries	Imports network summaries.
- stub-area no	Configures the previous parameters with the default values (**stub-cost** and **import-summaries**).

Example:

```
OSPF config>area 1.2.3.4 ?
 default          creates an area with defaults
 authentication    enables authentication
 no              Negates a command or sets its defaults
 range            range
 stub-area        stub area
```

```
OSPF config>area 1.2.3.4 default
OSPF config>area
OSPF config>area 1.2.3.4 ran
OSPF config>area 1.2.3.4 range ?
  <a.b.c.d>    IP Address
OSPF config>area 1.2.3.4 range 172.24.0.0 ?
  <a.b.c.d>    IP Address Mask
OSPF config>area 1.2.3.4 range 172.24.0.0 255.255.0.0 ?
  advertisement    specifies a range to enable/disable advertisement
  no               Negates a command or sets its defaults
OSPF config>area 1.2.3.4 range 172.24.0.0 255.255.0.0 ad
OSPF config>area 1.2.3.4 range 172.24.0.0 255.255.0.0 advertisement ?
  <cr>
OSPF config>area 1.2.3.4 range 172.24.0.0 255.255.0.0 advertisement
OSPF config>ar
OSPF config>area 1.2.3.4 au
OSPF config>area 1.2.3.4 authentication ?
  <cr>
OSPF config>area 1.2.3.4 authentication
OSPF config>
```

2.1.3 AS BOUNDARY ROUTING

Command history:

Release	Modification
11.00.06	The **subnet-routes** option under **import** is obsolete.
11.01.02	The **subnet-routes** option under **import** is obsolete.

Enables the AS boundary routing capability, which imports routes learned from other protocols (BGP, RIP, and statically configured information) into the OSPF protocol. This also configures automatic generation of a default route.

You can also configure the type of aggregation and additional cost.

Syntax:

```
OSPF config> as-boundary-routing
  default                 enable as boundary routing with defaults
    <cr>
  import                  selects which routes to import
    bgp-routes              import static routes
      <cr>
    cost-of-imported-routes    cost of imported routes
      <0..4294967295>    Import routes cost
        <cr>
    default-routes          import default routes
      <cr>
    direct-routes           import direct routes
      <cr>
    rip-routes              import rip routes
      <cr>
    static-routes           import static routes
      <cr>
    subnet-routes           import subnet routes
      <cr>
    aggregation-type        choses aggregation type
      none                do not aggregate
        <cr>
      aggregation-routes    use aggregation routes
        <cr>
      subnetted-networks    aggregate subnetted networks
        <cr>
      all                 aggregate all
        <cr>
    originate-default-route    originates default route
      always              always originate a default route
        <cr>
```

```
    type                 type of originated default route
      <1..2>    Originate as type 1 or 2
         <cr>
    cost                 cost of originated default route
      <0..4294967295>   Default route cost
         <cr>
    forwarding-address   forwarding ip address for the default route
      <a.b.c.d>   Default forwarding address
         <cr>
 no
   import                 selects which routes to import
     bgp-routes            import bgp routes
       <cr>
     cost-of-imported-routes   cost of imported routes
       <cr>
     default-routes        import default routes
       <cr>
     direct-routes         import direct routes
       <cr>
     rip-routes            import rip routes
       <cr>
     static-routes         import static routes
       <cr>
     subnet-routes         import subnet routes
       <cr>
   aggregation-type       choses aggregation type
     <cr>
   originate-default-route   originates default route
     always               always originate a default route
       <cr>
     type                 type of originated default route
       <cr>
     cost                 cost of originated default route
       <cr>
     forwarding-address   forwarding ip address for the default route
       <cr>
```

Options:

default	Enables the AS boundary routing capability with the default values.
import	Configures the importing of routes into OSPF. You can configure default routes, direct routes (away from the OSPF interface configuration), RIP routes, static routes and subnet routes to be independently imported. The **additional cost** parameter ensures that all imported routes have their costs increased by as many units as indicated by the parameter. Default is zero. No import configures the default value for the additional cost, as well as preventing routes being imported at will.
aggregation-type	Configures the type of aggregation.

The meaning of the types of aggregation is as follows:

none	No aggregation of any type is carried out. Neither the aggregation routes nor the subnet aggregation routes are imported here.
subnetted-networks	When a subnet route is learned or configured in the routing table, a *Sbnt* route or a subnet aggregation route automatically appears with the subnet network destination and next hop as none. When this type of aggregation is enabled, the subnet aggregation routes are imported only when the route being aggregated is one within the set of routes to import. This is default.
aggregation-routes	Aggregation routes are not real routes, but marks on the active routing table indicating a number of routes are being aggregated. When this type of aggregation is enabled, only aggregation routes and routes that do not belong to any aggregation are imported. This means that aggregated routes are not imported. When this type of aggregation is enabled, subnet aggregation router are only imported when the route (being aggregated) is in the set of routes to import.

all	Aggregation of subnets and routes.
originate-default-route	Configures the imported default route parameters: default route (*always* option), default route cost (*cost* option), type of default route (*type* option) and the forwarding IP address used in the imported default route (*forwarding-address* option).
originate-default-route	Enables the automatic generation of the default route.

The meaning of the *originate-default route* options are:

always	Always generates the default route.
cost	Cost of the generated default route.
type	Type of generated default route.
forwarding-address	Next hop for the generated default route.
no	Configures the default values for the different parameters.

Example:

The AS boundary routing capability is enabled so routes learned by RIP are imported (together with direct, static and subnet routing information). Subnet aggregation and additional cost of imported routes equal to 1 are also configured.

```
OSPF config>as-boundary-routing default
OSPF config>as-boundary-routing import cost-of-imported-routes 1
OSPF config>as-boundary-routing import default-routes
OSPF config>as-boundary-routing import direct-routes
OSPF config>as-boundary-routing import rip-routes
OSPF config>as-boundary-routing import static-routes
OSPF config>as-boundary-routing import subnet-routes
OSPF config>as-boundary-routing aggregation-type subnetted-networks
OSPF config>
```

2.1.4 COMPARISON

Tells the router where the RIP/static routes fit in the OSPF hierarchy. The two lower levels consist of the OSPF internal routes. OSPF internal routes take precedence over information obtained from any other source and are located on one level.

Example:

```
OSPF config>comparison ?
  <1..2>    Compare to type 1 or 2 externals
OSPF config>comparison 2
OSPF config>
```

2.1.5 DISABLE

Enter **disable** to disable the OSPF protocol.

Syntax:

```
OSPF config>disable ospf
```

Example:

```
OSPF config>disable ospf
OSPF config>
```

2.1.6 DISTANCE

Enter **distance** to modify the administrative distance for the OSPF external routes. By default, the administrative distance for said routes is 150.

Type of Route	Administrative Distance

Directly Attached	0
OSPF (intra-area and inter-area)	10
Static	60
RIP	100
OSPF (external)	150
BGP	170

If a value for **distance** is configured and the **administrative-distance** command is not configured in the IP menu, specific distance comparison between OSPF and the remaining protocols is still activated. (Please see *bintec Dm702-I TCP IP* for more information about the **administrative-distance** command)

If no specific **distance** in OSPF and no **administrative-distance** in the IP menu are configured, distance comparison is not performed for OSPF routes.

Syntax:

```
OSPF config>distance ospf external
  <1..255>    Distance for external routes
    <cr>
```

Example:

```
OSPF config>distance ospf external 90
OSPF config>
```

> ⚠️ **Warning**
>
> We do not recommend operating this command in RUNNING-CONFIG mode because the distance of routes previously learned will not be updated with new values.

2.1.7 DISTRIBUTE-LIST

Enter **distribute-list** to filter the routes that OSPF installs in the active routing table. To disable route filtering, enter **NO** before the command.

Syntax:

```
OSPF config> distribute-list route-map <word> in
```

The meaning of the options is as follows:

route-map	Route map examined in order to filter the installation of routes in the active routing table.

Default is route filtering disabled.

For further information, please see section *3.7 Other Configuration Tasks d) Configuring for OSPF routes filtering* in Chapter 1 of this manual.

2.1.8 ENABLE

Enter **enable** to enable the entire OSPF protocol.

Syntax:

```
OSPF config>enable ospf
```

Example:

```
OSPF config>enable ospf
OSPF config>
```

2.1.9 HOST

Defines which of the device's special addresses are considered HOST type OSPF routes and should therefore be advertised as internal routes in each of the router areas.

Syntax:

```
OSPF config>host
  internal-ip-address      Configured internal ip address
    <cr>
  management-ip-address    Configured management ip address
    <cr>
```

IP addresses configured through the **internal-ip-address** and **management-ip-address ip** commands are special IP addresses associated with an internal loopback interface in the device and cannot be used as an argument for the OSPF **interface** command. By default, the router considers networks defined through these commands as host type networks, which are associated with any defined OSPF area and, therefore, sent as intra-area networks. Use the **host** and **no host** commands to modify this behavior.

In the following example, the sending of the internal ip address and the management address as intra-areas within any area defined in the router has been disabled.

Example:

```
OSPF config>no host internal-ip-address
OSPF config>no host management-ip-address
OSPF config>
```

In the next example, the handling of these networks as intra-area host type networks has been re-enabled.

Example:

```
OSPF config>host internal-ip-address
OSPF config>host management-ip-address
OSPF config>
```

2.1.10 INTERFACE

Enables OSPF in router network interfaces. It also configures various OSPF protocol parameters per interface.

Syntax:

```
OSPF config>interface <a.b.c.d>|<interface>
    area                    area to attach this interface
      <a.b.c.d>    Attaches to area
        <cr>
    authentication-key        authentication key
      <word>    Authentication Key
        <cr>
    dead-interval            dead interval
      <0s..18h12m15s>    Dead Interval (Time value)
        <cr>
    default                  creates an interface
      <cr>
    hello-interval           hello interval
      <1s..4m15s>    Hello Interval (Time value)
        <cr>
    message-digest-key        message digest MD5 key for this interface
      <1..255>                 Key ID identifier
        md5                     MD5 key
          <1..16 chars>           Text
    network-type              network type
      broadcast         Configures an interface as broadcast
        <cr>
      point-2-point     Configures an interface as point-2-point
        <cr>
      point-2-mpoint    Configures an interface as point-2-mpoint
        broadcast        Configures an interface as point-2-mpoint for broadcast
                         media
```

```
            <cr>
       non-broadcast     Configures an interface as point-2-mpoint for a
                         nonbroadcast media
          <cr>
     non-broadcast      Configures an interface as nonbroadcast
          <cr>
   router-priority          router priority
      <0..255>    Router Priority
          <cr>
   retransmission-interval    retransmission interval
      <1s..18h12m15s>    Dead Router Interval (Time value)
          <cr>
   tos0-cost                tos 0 cost
      <1..65535>     Type Of Service 0 cost
          <cr>
   transmission-delay        transmission delay
      <1s..18h12m15s>    Transmission Delay (Time value)
          <cr>
   no                       Negates a command or sets its defaults
      area                     area to attach this interface
          <cr>
      authentication-key        authentication key
          <cr>
      dead-interval            dead interval
          <cr>
      hello-interval           hello interval
          <cr>
      message-digest-key       message digest MD5 key for this interface
          <cr>
      network-type
          <cr>
      router-priority          router priority
          <cr>
      retransmission-interval    retransmission interval
          <cr>
      tos0-cost                tos 0 cost
          <cr>
      transmission-delay        transmission delay
          <cr>
```

Example:

Resetting the interface with IP address 192.7.1.253 to its default values.

```
OSPF Config>interface 192.7.1.253 default
OSPF config>
```

Enter the IP address or name for each interface on the router. If the interface is unnumbered, enter the interface name. If the interface is numbered, enter either the IP address or the interface name. If the name of an interface is entered, the main IP address of the interface is engaged in OSPF. Secondary interface IP addresses must be configured by explicitly entering the IP address.

All routers on the same network must be configured with the *same value* for each of the following parameters.

- Hello interval.
- Dead router interval.
- Authentication key (if type 1 authentication is used).

The **area** option configures the OSPF area the interface will connect to.

Options:

default	Enables OSPF default settings on an interface or IP address and associates it with the backbone area (area 0.0.0.0).
area	Area identifier associated with the interface.
authentication-key	Authentication key for type 1 simple authentication.

dead-interval	Configures how long a device must wait after not receiving any hello packets from an OSPF neighbor before considering said neighbor down. If the minimal suboption is configured, the FastHello feature is enabled. This consists of a 1 second dead interval and a set number of hello packets per second, equal to the configured hello-multiplier value.
hello-interval	Configures the time interval between hello packets.
message-digest-key	Configures the key identifier and its value for type 2 authentication (enabled through the **area** command **authentication message-digest** subcommand).
network-type	Configures the type of OSPF network for a given interface. Possible values are: point-2-point, point-2-mpoint, broadcast and non-broadcast.
router-priority	Sets the router priority, which determines the designated-router for the network.
retransmission-interval	Specifies the time between link-state-advertisement (LSA) retransmissions.
transmission-delay	Configures the time required to send a link-state-update packet.
tos0-cost	Specifies the cost of sending a packet over this interface.

Configuring the type of OSPF network

One of the parameters associated with the OSPF interface configuration is the type of network. OSPF has the following types of networks:

- *Point-to-Point*. Networks that use a communication line to connect a single pair of routers. Default network for interfaces such as PPP, HFLC, and TNIP.
- *Broadcast*. Networks that support more than two connected routers and are capable of addressing a single physical message to all connected routers. Default network for Ethernet and Token-Ring interfaces.
- *Non-Broadcast (NBMA)*. Networks that support more than two connected routers but have no broadcasting capabilities (despite being able to emulate them through configuration). Default network for X.25 interfaces.
- *Point-to-Mpoint broadcast*. Partially meshed networks with more than two routers, generally with a star topology setup. Said network also supports or emulates broadcast traffic so you don't need to configure the neighbors.
- *Point-to-Mpoint non-broadcast*. Partially meshed networks with more than two routers. The traffic flow must pass through a central point. As the network does not support or emulate broadcast traffic, all neighbors must be configured. Default network for Frame-Relay interfaces.

The **network type** parameter modifies the type of OSPF network associated with an interface. Use this feature to configure a broadcast network, such as NBMA, and vice versa. When configuring an NBMA network as Broadcast, assume that the network supports or emulates broadcast traffic and it is completely meshed. In the majority of cases however, the NBMA networks are partially meshed, so for these cases, the only solution is to configure them as Point-to-Multipoint.

2.1.11 LIST

Displays the OSPF configuration information.

Syntax:

```
OSPF config>list
  all            Display complete OSPF configuration
    <cr>
  areas          Display areas configuration
    <cr>
  interfaces     Display interfaces configuration
    <cr>
  neighbors      Display neighbors configuration
    <cr>
  non-broadcast  Display non-broadcast configuration
    <cr>
  virtual-links  Display virtual links configuration
```

```
    <cr>
```

2.1.11.1 LIST ALL

Lists all OSPF-related configuration information.

Example:

```
OSPF config>list all
                    --Global configuration--
            OSPF Protocol:         Enabled
            External comparison:   Type 2
            AS boundary capability: Enabled
            Import external routes: RIP STA DIR SUB
            Aggregate subnets
            External routes cost:  1
            Orig. default route:   No (0,0.0.0.0)
            Default route cost:    (1, Type 2)
            Default forward. addr.: 0.0.0.0
            Multicast forwarding:  Disabled

                  --Area configuration--
Area ID          AuType          Stub? Default-cost Import-summaries?
0.0.0.0          0=None          No        N/A           N/A
0.0.0.1          1=Simple-pass   No        N/A           N/A

                    --Interface configuration--
IP address        Area            Cost  Rtrns  TrnsDly  Pri  Hello  Dead
192.3.1.2         0.0.0.1            1      5        1    1     10    40
192.7.1.253       0.0.0.0            1      5        1    1     10    40

                    --NBMA configuration--
            Interface Addr      Poll Interval
            192.168.253.1       120

                    --Neighbor configuration--
            Neighbor Addr      Interface Address   DR eligible?
            192.3.1.1          192.3.1.2           yes
OSPF config>
```

The following table details each global configuration field:

OSPF protocol	Shows whether OSPF is enabled or disabled.
External comparison	External route type used by OSPF when importing external information into the OSPF domain and when comparing OSPF external routes to RIP routes.
AS boundary capability	Shows whether the router imports external routes into the OSPF domain.
Import external routes	Shows which routes are imported.
Aggregate subnets	Shows the type of aggregation configured.
External routes cost	Shows the configured additional cost.
Orig default route	Shows whether the router imports a default route into the OSPF domain. When the value is YES, a non-zero network number is displayed in parentheses. This indicates that said default route is generated if (and only if) a route to that network is available.
Default route cost	Cost and type used in the imported default route.
Default forward addr	Forwarding address used in the imported default route.
Multicast forwarding	Shows whether multicast routing is enabled or not.

Information on the other fields is given in the sections describing the various elements making up the OSPF configuration.

2.1.11.2 LIST AREAS

Lists all information concerning configured OSPF areas.

Example:

```
OSPF Config>list areas
Area ID         AuType         Stub? Default-cost Import-summaries?
0.0.0.0         0=None         No        N/A          N/A
0.0.0.1         1=Simple-pass  No        N/A          N/A
11.0.0.0        2=MD5          No        N/A          N/A


                  --Area ranges--
Area ID         Address        Mask            Advertise?
0.0.0.0         1.1.1.0        255.255.255.0   No
OSPF Config>
```

The meaning of each of the fields is as follows:

Area ID	Attached area ID (area summary information).
AuType	Method used for area authentication. Simple-pass means a simple password scheme is being used for the area's authentication. MD5 indicates type 2 through an encrypted signature.
Stub area	Displays whether or not the area being summarized is a stub area. Stub areas do not carry external routes, resulting in a smaller routing database. However, stub areas cannot contain AS boundary routers, nor can they support configured virtual links.

2.1.11.3 LIST INTERFACES

Prints each interface's IP address and configuration parameters.

Example:

```
OSPF Config>list interfaces
             --Interface configuration--
IP address      Area        Cost Rtrns  TrnsDly Pri  Hello  Dead
192.3.1.2       0.0.0.1     1    5      1       1    10     40
12.0.0.1        11.0.0.0    1    5      1       1    0.33   1
192.7.1.253     0.0.0.0
OSPF Config>
```

The meaning of each of the fields is as follows:

Area	The OSPF area the interface is attached to.
Cost	The TOS 0 (or metric) associated with the interface.
Rtrns	Retransmission interval, i.e., the number of seconds between non-acknowledged routing information retransmissions.
TrnsDly	Transmission delay, which is an estimation of the number of seconds it takes to transmit the routing information through the interface (this should be a value greater than zero).
Pri	Interface router priority, which is used to select the Designated Router DR.
Hello	Time, in seconds, between each Hello packet sent by the interface.
Dead	Number of seconds that must lapse after sending Hello packets before considering the router down and not operational.

2.1.11.4 LIST NEIGHBORS

Lists all information concerning the neighbors.

Example:

```
OSPF Config>list neighbors
        --Neighbor configuration--
Neighbor Addr     Interface Address    DR eligible?
192.3.1.1          192.3.1.2            yes
OSPF Config>
```

The meaning of each field is as follows:

Neighbor Addr	Neighbor IP address.
Interface Address	Interface IP address.
DR eligible	If it qualifies as a designated router.

2.1.11.5 LIST NON-BROADCAST

Lists all the information concerning interfaces connected to non-broadcast networks. For each non-broadcast inter-
face, as long as the router is eligible to become the designated router on the connected network, the polling interval
is displayed together with a list of the router's neighbors on the non-broadcast network.

Example:

```
OSPF Config>list non-broadcast
        --NBMA configuration--
Interface Addr     Poll Interval
192.168.253.1      120
OSPF Config>
```

2.1.11.6 LIST VIRTUAL-LINKS

Lists all the virtual links that have been configured with this router as endpoint. *Virtual endpoint* indicates the OSPF
router ID of the other endpoint. *Transit area* indicates the non-backbone area the virtual link is configured through.
Generally speaking, virtual links are considered and treated similarly to point-to-point networks by the OSPF pro-
tocol. The other parameters listed in the command (Rtrns, TrnsDly, Hello, and Dead) are maintained for all inter-
faces. Please see the **ospf list interfaces** command for further information.

Example:

```
OSPF Config>list virtual-links
            --Virtual link configuration--
Virtual endpoint    Transit area     Rtrns  TrnsDly Hello  Dead
192.7.1.153          0.0.0.1          10     5       30     180
OSPF Config>
```

2.1.12 NEIGHBOR

Adds neighbors to networks that do not support or emulate non-broadcast and point-2-point. This command helps
the router discover its OSPF neighbors. Only configure this if the router is capable of becoming the designated router
for the non-broadcast network. You need to configure IP addresses for all other OSPF routers connected to the non-
broadcast network.

For each router configured, specify whether said router is eligible to become the designated router.

Syntax:

```
OSPF config>neighbor ?
  <a.b.c.d>      Interface IP address
    <a.b.c.d>    IP Address of Neighbor
      yes    That router can become Designated Router on this net
        <cr>
      no     That router can not become Designated Router on this net
        <cr>
  <interface>    Interface ID
    <a.b.c.d>    IP Address of Neighbor
      yes    That router can become Designated Router on this net
        <cr>
      no     That router can not become Designated Router on this net
```

```
      <cr>
```

2.1.13 NO

Deletes OSPF information from the router's configuration memory or configures the default values.

Syntax:

```
OSPF config>no
  area                 Set the parameters for an OSPF area
  as-boundary-routing  Configure AS boundary routing
  distance             Define an administrative distance
  host                 Define host addresses to be exported
  interface            Set the OSPF params for the router's network ifs
  neighbor             Add neighbors to non-broadcast networks
  non-broadcast        Configure non-broadcast network description
  redistribute         Redistribute information from another routing protocol
  virtual-link         Configure virtual links between 2 area border routers
```

2.1.13.1 NO AREA

Deletes OSPF areas from the current OSPF configuration.

Syntax:

```
OSPF config>no area
  <a.b.c.d>    Area number
    <cr>
```

2.1.13.2 NO AS-BOUNDARY-ROUTING

Disables the AS boundary routing capability. When disabled, the router will NOT import external information into the OSPF domain.

Syntax:

```
OSPF config>no as-boundary-routing
```

2.1.13.3 NO DISTANCE

Resets the administrative distance default values for external OSPF routes.

Syntax:

```
OSPF config>no distance ospf external
```

2.1.13.4 NO DISTRIBUTE LIST

Deletes OSPF route map filtering configuration.

Syntax:

```
OSPF config>no distribute-list
```

2.1.13.5 NO HOST

Disables the ability to send special IP addresses (internal ip address and the management address) as intra-areas within any area defined in the router.

Syntax:

```
OSPF config>no host
  internal-ip-address      Configured internal ip address
    <cr>
  management-ip-address    Configured management ip address
    <cr>
```

2.1.13.6 NO INTERFACE

Deletes an interface configuration.

Syntax:

```
OSPF config>no interface
 <a.b.c.d>        Interface IP address
    <cr>
 <interface>    Interface ID
    <cr>
```

2.1.13.7 NO NEIGHBOR

Deletes neighbors on non-broadcast networks from the current OSPF configuration.

Syntax:

```
OSPF config>no neighbor
 <a.b.c.d>        Interface IP address
   <a.b.c.d>     IP Address of Neighbor
      <cr>
 <interface>    Interface ID
   <a.b.c.d>     IP Address of Neighbor
      <cr>
```

2.1.13.8 NO NON-BROADCAST

Deletes non-broadcast network information from the current OSPF configuration.

Syntax:

```
OSPF config>no non-broadcast
 <a.b.c.d>     Interface IP address
    <cr>
```

2.1.13.9 NO REDISTRIBUTE

Deletes a redistribution clause.

Syntax:

```
OSPF config>no redistribute
 bgp         Border Gateway Protocol (BGP)
   route-map    Route map reference
     <word>    Route map name
        <cr>
   <cr>
 connected    Connected
   route-map    Route map reference
     <word>    Route map name
        <cr>
   <cr>
 rip         Routing Information Protocol (RIP)
   route-map    Route map reference
     <word>    Route map name
        <cr>
   <cr>
 static      Static routes
   route-map    Route map reference
     <word>    Route map name
        <cr>    <cr>
 <cr>
```

2.1.13.10 NO VIRTUAL-LINK

Deletes a virtual link. Virtual links can be configured between any two backbone routers that have an interface to a common non-backbone area. Virtual links are used to maintain backbone connectivity and must be configured at both endpoints.

Syntax:

```
OSPF config>no virtual-link
 <a.b.c.d>     Virtual endpoint (Router ID)
```

```
    <a.b.c.d>    Link's transit area
       <cr>
```

2.1.14 NON-BROADCAST

Helps the router discover its OSPF neighbors. This configuration is only necessary if the router qualifies to become the designated router for the non-broadcast network. Subsequently, configure the IP addresses for all other OSPF routers connected to the non-broadcast network. Please see the **neighbor** command for further information.

Syntax:

```
OSPF config>non-broadcast ?
  <a.b.c.d>    Interface IP address
    <1s..18h12m15s>    Poll Interval
       <cr>
```

2.1.15 REDISTRIBUTE

Enter **redistribute** to redistribute routes from one routing domain to another routing domain. To disable redistribution, enter **NO** before the command.

Syntax:

```
RIP config> redistribute <protocol>
    route-map    Route map reference
      <word>    Route map name
        <cr>
    <cr>
```

The meaning of the options is as follows:

protocol	Source protocol of the routes going to be redistributed. This can be any of the following: bgp, connected, ospf, static.
route-map	(Optional) Route map, which is queried to filter the importation of routes from the source protocol to the current protocol. If none is specified, all routes are redistributed.

Default is redistribution disabled.

The following example causes RIP routes to be redistributed into OSPF.

Example:

```
RIP config> redistribute rip
RIP config>
```

The next example causes BGP routes to be redistributed into OSPF after they have been filtered by the BGP2OSPF route map. Note how you specify the OSPF cost of the routes to 5 and the type to 2 after they have been imported.

Example:

```
feature access-lists
; -- Access Lists user configuration --
   access-list 1
;
     entry 1 default
     entry 1 permit
     entry 1 source address 10.0.0.0 255.0.0.0
;
   exit
;
exit
;
feature route-map
; -- Route maps user configuration --    route-map BGP2OSPF
;
     entry 1 default
     entry 1 permit
     entry 1 match ip address 1
```

```
        entry 1 set metric 5
        entry 1 set metric-type type-2
;
    exit
;
exit
;
protocol ospf
    redistribute bgp route-map BGP2OSPF
exit
;
```

2.1.16 VIRTUAL-LINK

Configures virtual links between any two area border routers. To maintain backbone connectivity, all your backbone routers must be interconnected by permanent or virtual links. Virtual links are considered to be separate router interfaces connecting to the backbone area. A number of interface parameters require specifying when configuring a virtual link.

Syntax:

```
OSPF config>virtual-link
  <a.b.c.d>    Virtual endpoint (Router ID)
    <a.b.c.d>    Link's transit area
      authentication-key        authentication key
        <word>    Authentication Key
          <cr>
      default                   creates a virtual link
        <cr>
      dead-interval             dead interval
        <0s..18h12m15s>   Dead Router Interval (Time value)
          <cr>
      hello-interval            hello interval
        <1s..4m15s>    Hello Interval (Time value)
          <cr>
      retransmission-interval    retransmission interval
        <1s..18h12m15s>    Retransmission Interval (Time value)
          <cr>
      transmission-delay        transmission delay
        <1s..18h12m15s>    Transmission Delay (Time value)
          <cr>
      no                        Negates a command or sets its defaults
        authentication-key        authentication key
          <cr>
        dead-interval             dead interval
          <cr>
        hello-interval            hello interval
          <cr>
        retransmission-interval    retransmission interval
          <cr>
        transmission-delay        transmission delay
          <cr>
```

Example:

Creating a virtual link with router identifier 192.7.1.253 through area 0.0.0.1. This is configured with a 15 second retransmission interval, a 5 second transmission delay and xyz_q authentication.

```
OSPF config>area 0.0.0.0 default
OSPF config>virtual-link 192.7.1.253 0.0.0.1 default
OSPF config>virtual-link 192.7.1.253 0.0.0.1 retransmission-interval 15
OSPF config>virtual-link 192.7.1.253 0.0.0.1 transmission-delay 5
OSPF config>virtual-link 192.7.1.253 0.0.0.1 authentication-key xyz_q
OSPF config>
```

> ☞ **Note**
>
> Prior to defining a virtual-link for a router, ensure that said router belongs to the backbone area (0.0.0.0).

2.1.17 VRF

The **VRF** command accesses a new instance in the OSPF configuration menu (associated with the specified VRF). This new menu contains the same commands as the root menu except for the VRF command.

Syntax:

```
OSPF config>vrf <word>
```

Example:

```
OSPF config>vrf VRF-1

OSPF vrf config>?
```

2.1.18 EXIT

Returns to the previous prompt level.

Syntax:

```
OSPF config>exit
```

Example:

```
OSPF config>exit
Config>
```

Chapter 3 Monitoring

3.1 Monitoring Commands

This section describes the OSPF monitoring commands. To access the OSPF monitoring environment, enter the following:

```
*p 3
Console Operator
+protocol ospf
-- Open SPF-Based Routing protocol monitor --
OSPF+
```

The OSPF protocol supports an instance for each VRF configured on the device. To monitor this protocol in a VRF other than the main one, execute the following command from the OSPF monitoring root menu.

```
OSPF+vrf VRF-1


OSPF vrf+
```

Command	Function
? (HELP)	Displays available commands or options.
ADVERTISEMENT-EXPANSION	Displays a link state advertisement belonging to the OSPF database.
AREA	Displays OSPF area statistics and parameters.
AS-EXTERN-AL-ADVERTISEMENT	Lists the AS external advertisements belonging to the OSPF link state database.
DATABASE	Displays the advertisements belonging to an OSPF area's link state database.
INTERFACE	Displays OSPF interface statistics and parameters.
NEIGHBOR	Displays OSPF neighbor statistics and parameters.
ROUTERS	Displays the reachable OSPF area border routers and AS boundary routers.
SIZE	Displays the number of LSAs currently in the link state database, categorized by type.
STATISTICS	Displays OSPF statistics detailing memory and network usage.
EXIT	Exits the OSPF monitor process.

3.1.1 ? (HELP)

Use the **?(HELP)** command to list the commands available at the current prompt level. You can also enter ? after a command to list its options.

Syntax:

```
OSPF+?
```

Example:

```
OSPF+?
  advertisement-expansion      Display a link state advertisement from
                               database
  area                         OSPF area statistics and parameters
  as-external-advertisements   List the AS external advertisements from OSPF
                               routing domain
  database                     Display the advertisements belonging to an OSPF
```

```
                                  area's link state database
  Interface                       OSPF interface statistics and parameters
  neighbor                        OSPF neighbor statistics and parameters
  routers                         Reachable OSPF area-border routers and
                                  AS-boundary routers
  size                            Number of LSAs in the link state database
  statistics                      OSPF statistics
  vrf                             OSPF monitoring in a VRF instance
  exit
OSPF+
```

3.1.2 ADVERTISEMENT-EXPANSION

Use the **advertisement-expansion** command to print the contents of a link state advertisement in the OSPF database. For a summary of the router's advertisements, run **database**.

A link state advertisement is defined by its link state type, link state ID and its advertising router. There is a separate link state database for each OSPF area. Tell the software which database you want to search by providing an **area-id** on the command line.

> **Note**
>
> Link State IDs, advertising routers (specified by their router IDs), and area IDs take the same format as IP addresses. For example, the backbone area can be entered as 0.0.0.0.

The following are different kinds of advertisements, which depend on the value given for link-state-type:

- Router links - Contain descriptions of a single router's interface.
- Network links - Contain the list of routers connected to a particular interface.
- Summary nets - Contain descriptions of a single inter-area route.
- Summary AS boundary routers - Contain descriptions of the route to an AS boundary router in another area.
- AS external nets - Contain descriptions of a single route.
- Group Links – Contains linking descriptions for OSPF Multicast groups.

The example below shows an expansion of a router link advertisement. The router's ID is 128.185.184.11. It is an AS boundary router and has three interfaces to the backbone area (all of cost 1). Detailed field descriptions are provided with the example.

This command has been enhanced in two ways. First of all, when displaying router-LSAs and network-LSAs, the reverse cost of each router-to-router link and router-to-transit-network link is displayed, as well as the previously displayed forward cost. This is done because routing of multicast datagrams, whose source lies in different areas/ASs, is based on reverse cost instead of forward cost. When there is no reverse link (which means the link will never be used by the Dijkstra), the reverse cost is shown as 1-way.

In addition, the LSA's OSPF options are displayed in the same manner as they are displayed in the detailed **ospf neighbor** command.

New group-membership-LSAs can also be displayed. The LS destination for each group-membership-LSA is a group address. A router generates a group-membership-LSA for each group with members on one or more of the router's connected networks.

Syntax:

```
OSPF+advertisement-expansion <tipo_ls> <ID_destino> [<ID_origen>] [<ID_area>]
```

Depending on the **<type_1s>** value (a number between 1 and 6), you need the **<ID_source>** parameter or the **<ID_area>** value or both. In the following example where **<type_1s>** is 1, the options required for the command are **<ID_destination>** and **<ID_area>**. For further information on the corresponding parameters, we recommend using the help (**?**) command.

Example:

```
OSPF+advertisement-expansion 1 192.7.1.253 0.0.0.0


      LS age:     1693
      LS options:  E
      LS type:     1
      LS destination (ID): 192.7.1.253
```

```
        LS originator:   192.7.1.253
        LS sequence no:  0x80000002
        LS checksum:     0xCF63
        LS length:       36
        Router type:  ABR,ASBR
        # router ifcs:   1
                Link ID:          192.7.1.254
                Link Data:        192.7.1.253
                Interface type:   2
                        No. of metrics: 0
                        TOS 0 metric:   1 (0)

OSPF+
```

The meaning of each field is as follows:

LS age	Age of the advertisement in seconds.
LS options	Optional OSPF capabilities supported by the routing domain object corresponding to the advertisement. These capabilities include: E (processes type 5 external advertisements; when this option is not set, the area the advertisement belongs to, is configured as a stub), T (supports TOS routing).
LS type	Classifies the advertisement and dictates its contents: 1 (router link advertisement), 2 (network link advertisement), 3 (summary link advertisement), 4 (summary ASBR advertisement), 5 (AS external link) and 6 (group-membership advertisement).
LS destination	Identifies what is being described by the advertisement. Depends on the type of advertisement. For router links and ASBR summaries, this is the OSPF router ID. For network links, IP address for the network's designated router. For summary links and AS external links, a network/subnet number.
LS originator	OSPF router ID of the originating router.
LS sequence no	Used to distinguish separate instances of the same advertisement. Should be looked at as a signed 32-bit integer. Starts at 0x80000001, and increments by one each time the advertisement is updated.
LS checksum	Checksum of advertisement contents, used to detect data corruption.
LS length	Size of the advertisement in bytes.
Router type	Level of router functionality. ASBR means the router is an AS boundary router, ABR that the router is an area border router, and W that the router is a wildcard multicast receiver.
# router ifcs	Router interface described in the advertisement.
Link ID	Indicates what the interface connects to. Depends on the interface type. For interfaces to routers (i.e., point-to-point links), the Link ID is the neighbor's router ID. For interfaces to transit networks, the IP address for the network designated router. For interfaces to stub networks, this is the network's network/subnet number.
Link Data	4 bytes of extra information concerning the link. This is either the interface IP address (for interfaces to point-to-point networks and transit networks) or the subnet mask (for interfaces to stub networks).
Interface type	One of the following: 1 (point-to-point connection to another router), 2 (connection to transit network), 3 (connection to stub network) or 4 (virtual link).
No. of metrics	Number of non-zero TOS values for which metrics are provided for this interface.
TOS 0 metric	Cost of the interface. The reverse cost of a link is displayed in aprenthesis (derived from another advertisement). If there is no reverse link, 1-way is displayed.

The *LS age*, *LS options*, *LS type*, *LS destination*, *LS originator*, *LS sequence no*, *LS checksum* and *LS length* fields are common to all advertisements. The *Router type* and *# router ifcs* are seen only in router links advertisements. Each link in the router advertisement is described by the *Link ID*, *Link Data*, and *Interface type* fields.

Each link can also be assigned a separate cost for each IP Type of Service (TOS); this is described by the *No. of metrics* and *TOS 0 metric* fields (currently, the router does not route based on TOS, and only looks at the TOS 0 cost).

3.1.3 AREA

Use the **area** command to display the statistics and parameters for all OSPF areas attached to the router.

In the example below, the router attaches to a single area (the backbone area). A simple password schema is being used for the area's authentication. The router has three interfaces attached to the area and has found 4 transit networks, 7 routers and no area border routers when carrying out an SPF tree calculation for the backbone.

Syntax:

```
OSPF+area
```

Example:

```
OSPF+area
Area ID          Authentication  #ifcs  #nets  #rtrs  #brdrs
0.0.0.0             None            1      1      2      1
0.0.0.1             None            1      0      1      1
OSPF+
```

#ifcs	Router interfaces attached to the particular area. These interfaces are not necessarily operational.
#nets	Transit networks found while carrying out an SPF tree calculation for this area.
#rtrs	Routers found when carrying out an SPF tree calculation for this area.
#brdrs	Area border routers found when carrying out an SPF tree calculation for this area.

3.1.4 AS-EXTERNAL-ADVERTISEMENTS

Use the **as-external-advertisements** command to list the AS external advertisements belonging to the OSPF routing domain. One line is printed for each advertisement. Each advertisement is defined by the following three parameters: link state type (always 5 for AS external advertisements), link state ID (LS destination), and the advertising router (LS originator).

Syntax:

```
OSPF>as-external-advertisements
```

Example:

```
OSPF>as-external-advertisements
Type  Ls destination   LS originator   Seqno       Age  Xsum
  5   0.0.0.0          128.185.123.22  0x80000084  430  0x41C7
  5   128.185.131.0    128.185.123.22  0x80000080  450  0x71DC
  5   128.185.132.0    128.185.123.22  0x80000080  450  0x66E6
  5   128.185.144.0    128.185.123.22  0x80000002  329  0xF2CA
  5   128.185.178.0    128.185.123.22  0x80000081  450  0x72AA
  5   128.185.178.0    128.185.129.40  0x80000080  382  0xDD28
  5   129.9.0.0        128.185.123.22  0x80000082  451  0x4F30
  5   129.9.0.0        128.185.126.24  0x80000080  676  0x324A
  5   134.216.0.0      128.185.123.22  0x80000082  451  0x505A
  5   134.216.0.0      128.185.126.24  0x80000080  676  0x3374
  5   192.9.3          128.185.123.22  0x80000082  451  0xF745
  5   192.9.3          128.185.126.24  0x80000080  677  0xDA5F
  5   192.9.12         128.185.123.22  0x80000082  452  0x949F
  5   192.9.12         128.185.128.41  0x80000080  679  0x31B2
  5   192.26.100.0     128.185.123.22  0x80000081  452  0xFDCD
  5   192.26.100.0     128.185.126.24  0x80000080  21   0xDEE8
etc.
```

```
           # advertisements:  133
           Checksum total:    0x43CC41
OSPF+
```

Type	Always 5 for AS external advertisements.
LS destination	IP network/subnet number. These network numbers belong to other Autonomous Systems.
LS originator	Advertising router.
Seqno, Age, Xsum	Several instances of an advertisement can be present in the OSPF routing domain at any one time. However, only the most recent instance is kept in the OSPF link state database (and printed by this command). The LS sequence number (*Seqno*), LS age (*Age*) and LS checksum fields (*Xsum*) are compared to see which instance is most recent. The LS *age* field is expressed in seconds. Its maximum value is 3600.

At the end of the display, the total number of AS external advertisements is printed, along with a checksum total over all of their contents. The checksum total is simply the 32-bit sum (carries discarded) of the individual advertisement's LS checksum fields. This information can be used to quickly determine whether two OSPF routers have synchronized databases.

3.1.5 DATABASE

Use the **database** command to display a description of the contents of a particular OSPF area's link state database. AS external advertisements are omitted from the display. A single line is printed for each advertisement. Each advertisement is defined by the following three parameters: link state type (Type), link state ID (LS destination) and the advertising router (LS originator).

Syntax:

```
OSPF+database summary <ID_area>
```

Example:

```
OSPF+database 0.0.0.0
Type   LS destination    LS originator   Seqno        Age   Xsum
  1*   10.1.2.7          10.1.2.7        0x80000025   390   0xB13C
  1*   10.1.26.9         10.1.26.9       0x80000016   393   0x987D
  1*   10.1.26.41        10.1.26.41      0x80000018   122   0x533D
  1*   10.1.40.40        10.1.40.40      0x80000015   192   0x317C
  1*   10.1.50.16        10.1.50.16      0x80000031   394   0x7A74
  2*   10.1.25.40        10.1.40.40      0x80000006   193   0xCB35
  2*   10.1.26.16        10.1.50.16      0x80000007   401   0x9669
  3*   10.2.50.9         10.1.26.9       0x80000010   397   0xA430
  3*   10.5.0.0          10.1.26.41      0x8000000F   133   0x4E9E
  3*   10.5.50.41        10.1.26.9       0x80000006   394   0x5D5D
  3*   128.185.214.0     10.1.40.40      0x8000000E   740   0x3CA2
  6    224.185.0.0       10.1.50.16      0x8000000F   469   0x9B7A
  6    225.0.1.36        10.1.2.7        0x80000006   405   0x5CC8
  6    225.0.1.36        10.1.26.9       0x8000000F   404   0x8265
  6    225.0.1.36        10.1.26.41      0x8000000F   133   0x3A4
  6    225.0.1.36        10.1.40.40      0x8000000E   755   0x1D71
  6    225.0.1.100       10.1.50.16      0x80000006   476   0x5E14
           # advertisements:  17
           Checksum total:    0x73121
OSPF+
```

Type	Separate LS types are numerically displayed: type 1 (router links advertisements), type 2 (network links advertisements), type 3 (network summaries), type 4 (AS boundary router summaries), and type 6 (group-membership-LSAs).
LS destination	Indicates what is being described by the advertisement.
LS originator	Advertising router.
Seqno, Age, Xsum	It is possible for several instances of an advertisement to be present in the OSPF

routing domain at any one time. However, only the most recent instance is kept in the OSPF link state database (and printed by this command). The *LS sequence number* (*Seqno*), *LS age* (*Age*) and *LS checksum* fields (*Xsum*) are compared to see which instance is most recent. The *LS age* field is expressed in seconds. Maximum value is 3,600.

At the end of the display, the total number of advertisements in the area database is printed, along with a checksum total over all of their contents. The checksum total is simply the 32-bit sum (carries discarded) of the individual advertisement's *LS checksum* fields. This information can be used to quickly determine whether two OSPF routers have synchronized databases.

3.1.6 INTERFACE

Use the **interface** command to display the statistics and parameters related to OSPF interfaces. If no arguments are given, a single line is printed summarizing the main characteristics of each interface. If you specify an interface, detailed statistics for that interface are displayed. The unnumbered interfaces are specified by name, numbered ones by their IP address, and virtual links (VLink interfaces) through the **virtual-link** option followed by the virtual interface index (0 for VL/0, 1 for VL/1, etc.).

Syntax:

```
OSPF+interface [<Interface-Name> |
               <Interface-IP-Address> |
               virtual-link <VL-Index>]
```

Example 1:

```
OSPF+interface

Ifc Address     Phys               assoc. Area     Type       State   #nbrs   #adjs
192.7.1.253     ethernet0/0        0.0.0.0         Brdcst      32      1       1
192.3.1.2       fr1                0.0.0.1         P-2-MP       8      1       0
- Unnumbered -  VL/0               0.0.0.0         VLink        8      1       1
OSPF+
```

Ifc Address	Interface IP address.
assoc. Area	Attached area ID.
Type	Can be either *Brdcst* (broadcast, e.g., an Ethernet interface), *P-P* (a point-to-point network, e.g., a synchronous serial line), *Multi* (non-broadcast multi-access, e.g., an X.25 connection) or *VLink* (an OSPF virtual link).
State	Can be one of the following: 1 (down), 2 (looped back), 4 (waiting), 8 (point-to-point), 16 (DR other), 32 (backup DR) or 64 (designated router).
#nbrs	Number of neighbors. This is the number of routers whose hellos have been received, plus those that have been configured.
#adjs	Number of adjacencies. This is the number of neighbors the router has synchronized with (or is in the process of synchronization).

Example 2:

```
OSPF+interface 192.7.1.253
            Interface address:      192.7.1.253
            Attached area:          0.0.0.0
            Physical interface:     ethernet0/0
            Interface mask:         255.255.255.0
            Interface type:         Brdcst
            State:                  32
            Designated Router:      192.7.1.254
            Backup DR:              192.7.1.253

 DR Priority:      1  Hello interval:   10  Rxmt interval:     5
 Dead interval:   40  TX delay:          1  Poll interval:     0
 Max pkt size:  1500  TOS 0 cost:        1

 # Neighbors:      1  # Adjacencies:     1  # Full adjs.:      1
```

```
  # Mcast floods:    5  # Mcast acks:      4

OSPF+
```

Interface address	Interface IP address.
Attached Area	Attached area ID.
Physical interface	Displays physical interface type and number.
Interface Mask	Interface subnet mask.
Interface type	Can be either *Brdcst* (broadcast, e.g., an Ethernet interface), *P-P* (a point-to-point network, e.g., a synchronous serial line), *Multi* (non-broadcast multi-access, e.g., an X.25 connection) or *VLink* (an OSPF virtual link).
State	Can be one of the following: 1 (Down), 2 (Attempt), 4 (Init), 8 (2-Way), 16 (ExStart), 32 (Exchange), 64 (Loading) or 128 (Full).
Designated Router	IP address of the designated router.
Backup DR	IP address of the backup designated router.
DR Priority	Priority assigned to designated router.
Hello interval	Current hello interval value.
Rxmt interval	Current retransmission interval value.
Dead interval	Current dead interval value.
TX delay	Current transmission delay value.
Poll interval	Current poll interval value.
Max pkt size	Maximum size for an OSPF packet sent out by this interface.
TOS 0 cost	Interface's TOS 0 cost.
# Neighbors	Routers whose hellos have been received, plus those configured.
# Adjacencies	Neighbors in *Exchange* state (32) or greater.
# Full adjs.	Full adjacencies is the number or neighbors whose state is Full – 128 - (i.e., that to which the router has synchronized databases with).
# Mcast floods	Link state updates flooded out the interface (not counting retransmissions).
# Mcast acks	Link state acknowledgments flooded out the interface (not counting retransmissions).

3.1.7 NEIGHBOR

Use the **neighbor** command to display statistics and parameters related to OSPF neighbors. If no arguments are given, a single line is printed summarizing each neighbor. If a neighbor's IP address is given, detailed statistics for that neighbor is displayed.

Syntax:

```
OSPF>neighbor [<neighbor-ip-address>]
```

Example 1:

```
OSPF+neighbor
Neighbor addr     Neighbor ID      State  LSrxl DBsum LSreq  Ifc
192.7.1.254       192.7.1.254       128    0     0     0      Eth/0
```

```
192.3.1.1        0.0.0.0          1     0     0     0       FR/0
OSPF+
```

Neighbor addr	Displays neighbor address.
Neighbor ID	Displays the neighbor's OSPF router ID.
Neighbor State	Can be one of the following: 1 (Down), 2 (Attempt), 4 (Init), 8 (2-Way), 16 (ExStart), 32 (Exchange), 64 (Loading) or 128 (Full).
LSrxl	Size of the current link state retransmission list for said neighbor.
DBsum	Size of the database summary list waiting to be sent to a neighbor.
LSreq	Number of more recent advertisements being requested from a neighbor.
Ifc	Interface shared by the router and a neighbor.

Example 2:

```
OSPF+neighbor 128.185.184.34
  Neighbor IP address:    192.7.1.254
  OSPF Router ID:         192.7.1.254
  Neighbor State:         128
  Physical interface:     Eth/0
  DR choice:              192.7.1.254
  Backup choice:          192.7.1.253
  DR Priority:            1
  Nbr options:            E

  DB summ qlen:      0  LS rxmt qlen:      0  LS req qlen:       0
  Last hello:        2

  # LS rxmits:       0  # Direct acks:     0  # Dup LS rcvd:     0
  # Old LS rcvd:     0  # Dup acks rcv:    1  # Nbr losses:      0
  # Adj. resets:     0
OSPF+
```

The meaning of each field is:

Neighbor IP address	Neighbor IP address.
OSPF router ID	Neighbor's OSPF router ID.
Neighbor State	Can be one of the following: 1 (Down), 2 (Attempt), 4 (Init), 8 (2-Way), 16 (ExStart), 32 (Exchange), 64 (Loading) or 128 (Full).
Physical interface	Displays physical interface type and number of the router and neighbor's common network.
DR choice	Indicates the value seen in the last hello received from a neighbor.
Backup choice	Indicates the value seen in the last hello received from a neighbor.
DR Priority	Indicates the value seen in the last hello received from a neighbor.
Nbr options	Indicates the optional OSPF capabilities supported by a neighbor. Said capabilities include: E (processes type 5 external advertisements; when this is not set, the area the common network belongs to, is configured as sub), T (supports TOS routing). This field is only valid for those neighbors in an *Exchange* state (32) or greater.
DB summ qlen	Indicates the number of advertisements waiting to be summarized in Database Description packets. This should be zero, unless a neighbor is in an *Exchange* state (32).
LS rxmt qlen	Indicates the number of advertisements flooded to the neighbor, but not yet ac-

knowledged.

LS req qlen	Indicates the number of advertisements being requested from a neighbor in a *Loading* state (64).
Last hello	Indicates the number of seconds since a hello has been received from a neighbor.
# LS rxmits	Indicates the number of retransmissions that have occurred during flooding.
# Direct acks	Indicates responses to duplicate link state advertisements.
# Dup LS rcvd	Indicates the number of duplicate retransmissions that have occurred during flooding.
# Old LS rcvd	Indicates the number of old advertisements received during flooding.
# Dup acks rcvd	Indicates the number of duplicate acknowledgments received.
# Nbr losses	Indicates the number of times a neighbor has transitioned to *Down* (1) state.
# Adj. Resets	Counts entries to state ExStart (16).

The meaning of the majority of the fields displayed in the previous example can be found in section 10, OSPF RFC 1131 specification.

3.1.8 ROUTERS

Use the **routers** command to display routes that have been calculated by OSPF and are now present in the routing table.

> **Note**
>
> The **routers** command does not show all known (discovered) routers. The only routers listed are the border routers (used for calculating inter-area routes) and boundary routers (used for calculating external routes).

Syntax:

```
OSPF>routers
```

Example:

```
OSPF>routers
DType  RType  Destination      Area     Cost  Next hop(s)
ASBR   SPF    128.185.142.9    0.0.0.0  1     128.185.142.9
Fadd   SPF    128.185.142.98   0.0.0.0  1     0.0.0.0
Fadd   SPF    128.185.142.7    0.0.0.0  1     0.0.0.0
Fadd   SPF    128.185.142.48   0.0.0.0  1     0.0.0.0
Fadd   SPF    128.185.142.111  0.0.0.0  1     0.0.0.0
Fadd   SPF    128.185.142.38   0.0.0.0  1     0.0.0.0
Fadd   SPF    128.185.142.11   0.0.0.0  1     0.0.0.0
BR     SPF    128.185.142.9    0.0.0.0  1     128.185.142.9
BR     SPF    128.185.142.9    0.0.0.0  2     128.185.184.114
Fadd   SPF    128.185.142.48   0.0.0.0  1     0.0.0.0
OSPF+
```

DType	Indicates destination type. *Net* indicates the destination is a network, *ASBR* that the destination is an AS boundary router, *ABR* that the destination is an area border router and *Fadd* a forwarding address (for external routes).
RType	Indicates route type and how the route was derived. *SPF* indicates the route is an intra-area route (comes from the Dijkstra calculation); *SPIA* indicates it is an inter-area route (comes from considering summary link advertisements).
Destination	Destination router's OSPF ID. For Type D entries, one of the router's IP addresses is displayed (which corresponds to a router in another AS).

Area	Area it belongs to.
Cost	Displays the route cost.
Next hop(s)	Address of the next router on the path toward the destination host. A number in parentheses at the end of the column indicates the number of equal-cost routes to the destination.

3.1.9 SIZE

Use **size** to display the number of LSAs currently in the link state database, categorized by type.

Syntax:

```
OSPF+size
```

Example:

```
OSPF+size
# Router-LSAs:            7
# Network-LSAs:            6
# Summary LSAs:           14
# Summary Router-LSAs:    2
# AS External-LSAs:       44
# Group-membership-LSAs:  21
OSPF+
```

3.1.10 STATISTICS

Use **statistics** to display statistics generated by the OSPF routing protocol. These statistics indicate how well the implementation is performing, including its memory and network utilization. Many of the fields displayed are a confirmation of the OSPF configuration.

Syntax:

```
OSPF+statistics
```

Example:

```
OSPF+statistics

           S/W version:          2.1
           OSPF Router ID:       192.7.1.253
           External comparison:  Type 2
           AS boundary capability: yes
           Import external routes: RIP STA SUB
           Do not aggregate
           External routes cost:  5
           Orig. default route:   No (0,0.0.0.0)
           Default route cost:    (1, Type 2)
           Default forward. addr: 0.0.0.0

 Attached areas:                2
 OSPF packets rcvd:           484  OSPF packets rcvd w/ errs:      0
 Transit nodes allocated:      20  Transit nodes freed:           16
 LS adv. allocated:            26  LS adv. freed:                 20
 Queue headers alloc:          32  Queue headers avail:           32

 # Dijkstra runs:               4  Incremental summ. updates:      0
 Incremental VL updates:        0  Buffer alloc failures:          0
 Multicast pkts sent:         481  Unicast pkts sent:              5
 LS adv. aged out:              0  LS adv. flushed:                0
 Incremental ext. updates:      9
OSPF+
```

The meaning of each field is:

S/W version	Displays the OSPF software revision level.

OSPF Router ID	Displays the router's OSPF ID.
External comparison	Displays the external route type used by the router when importing external routes.
AS boundary capability	Displays whether external routes are imported.
Import external routes	Displays what external routes are imported.
Aggregation Type	Aggregation type.
External routes cost	Additional cost for the imported routes.
Orig default route	Displays whether the router advertises an OSPF default route (or not). If the value is Yes and a non-zero number is displayed in parentheses, then a default route is advertised when a route to the network exists.
Default route cost	Displays the cost and type of the default route (if advertised).
Default forward addr	Displays the forwarding address specified in the default route (if advertised).
Attached areas	Indicates the number of areas the router has active interfaces to.
OSPF packets rcvd	OSPF packets received.
OSPF packets rcvd w/ errs	OSPF packets received with errors.
Transit nodes	Allocated to store router links and network link advertisements.
LS adv.	Allocated to store summary link and AS external link advertisements.
Queue headers	Lists link state advertisements used in the flooding and database exchange processes. If the number of allocated queue headers is not equal to the number freed, database synchronization with a neighbor is in progress.
# Dijkstra runs	Indicates how many times the OSPF routing table has been calculated from scratch.
Incremental summ. updates	Indicates that new summary link advertisements have caused the routing table to be partially rebuilt.
Incremental VL updates	Indicates that new summary link advertisements have caused the routing table to be partially rebuilt.
Buffer alloc failures	Indicates buffer allocation failures.The OSPF system will recover from temporary lack of packet buffers.
Multicast pkts sent	Covers OSPF hello packets and packets sent during flooding.
Unicast pkts sent	Covers OSPF packet retransmissions and the Database Exchange Procedure.
LS adv. aged out	Counts the number of advertisements that have hit 60 minutes. Link state advertisements are aged out after 60 minutes. They are usually refreshed before this time.
LS adv. flushed	Indicates number of advertisements removed (and not replaced) from the link state database.
Incremental ext. updates	Displays the number of changes to external destinations incrementally installed in the routing table.

3.1.11 VRF

The **VRF** command accesses a new instance in the OSPF monitoring menu associated with the specified VRF. This new menu contains the same commands as the root menu, except for the VRF command.

Syntax:

```
OSPF+vrf <word>
```

Example:

```
OSPF+vrf VRF-1


OSPF vrf+
```

3.1.12 EXIT

Returns to the previous prompt level.

Syntax:

```
OSPF+exit
```

Example:

```
OSPF+exit
+
```