Teldat Router

OSPF Protocol

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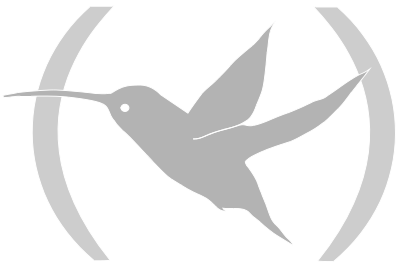
INDEX

Chapter 1
Introduction



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 **Teldat Router** supports three different IGPs for building the IP routing table, I-BGP Protocol, Open Shortest Path First (OSPF) Protocol, and RIP Protocol.

OSPF is based on link-state technology or the shortest-path first (SPF) algorithm. RIP is based on the Bellman-Ford or the distance-vector algorithm. The information is organized within 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.

The **Teldat Router** can simultaneously run I-BGP, OSPF and RIP.

Preference between protocols is marked by the administrative distance. The shorter the administrative distance the greater the preference. Below you can see a table containing the default values for the administrative distance depending on the type of route:

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

2. The OSPF Routing Protocol

The **Teldat Router** supports a complete implementation of the OSPF routing protocol, as specified in RFC 1247 (Version 2). This version is incompatible with bridging routers running OSPF version 1. OSPF information will not be exchanged between routers running version 1 and version 2.

OSPF is a link state dynamic 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 destination address only.

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

- *Least Cost Routing*. Allows you to configure 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, OSPF has no restriction.
- *Multipath Routing*. Allows you to use multiple paths of equal cost that connect the same points. You can then use these paths for load balancing resulting in 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*. Allow you to break an IP address into variable size subnets, conserving IP address space.
- *Routing Authentication*. Provides additional security to the routing.

OSPF supports the following physical network types:

- *Point-to-Point*. Networks that use a communication line to join a single pair of routers. This is the type of default network 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. This is the type of default network for Ethernet and Token-Ring interfaces.
- *Non-Broadcast*. Networks that support more than two attached routers but have no broadcast capabilities, although through configuration, they are capable of emulating them. This is the type of default network for X.25 interfaces.
- "*Point-to-Mpoint broadcast*". Networks with more than two routers and partially meshed, generally with star topology. Additionally, the network supports or emulates broadcast traffic so you don't need to configure the neighbors.
- "*Point-to-Mpoint non-broadcast*". Networks with more than two routers and partially meshed. The traffic flow must pass through a central point. Additionally, the network does not support or emulate broadcast traffic; consequently it's essential to configure the neighbors. This is the type of default network for Frame-Relay interfaces.

3. Configuring OSPF

The following steps outline the tasks required to get the OSPF protocol up and running. The sections that follow explain each step in detail, including 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 out each interface must be set, along with a collection of the OSPF operating parameters.
4. If the router interfaces to non-broadcast networks, you must also set the non-broadcast network parameters. This consists 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), you have to enable AS boundary routing. In addition, you must define whether routes are imported as Type 2 or Type 1 externals. 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 an attached 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.

3.1. Enabling the OSPF Protocol

Each router running the OSPF protocol has a database describing a map of the routing domain. This database is identical in all participating routers. From this database the IP routing table is built through the construction of a shortest-path tree, with the router itself as root. The routing domain refers to an AS running the OSPF protocol.

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

Syntax:

```
OSPF config>enable ospf
```

Example:

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

3.2. Defining Backbone and Attached OSPF Areas

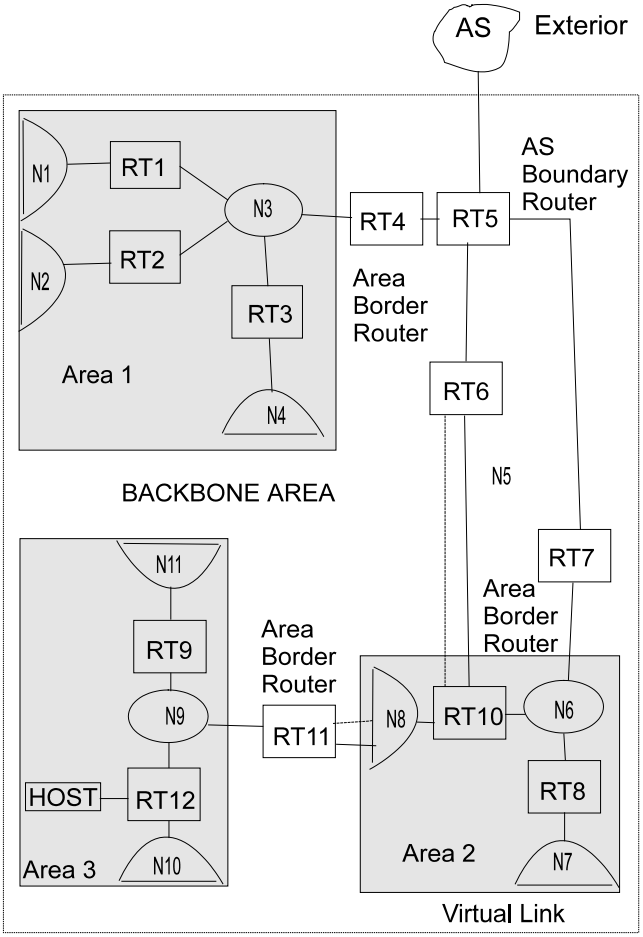
Define the OSPF areas that are directly attached to the router. If no areas are defined, the router software assumes that all the router's directly attached networks belong to the backbone area (area ID 0.0.0.0).

OSPF allows you to split the AS into regions called areas. OSPF areas are a collection of contiguous networks. The topology of any one area is hidden from that of the other areas. Hiding information significantly reduces routing traffic and protects routing within an area from outside influence.

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

OSPF areas are defined as address ranges. External to the area, a single route is advertised for each address range. For example, if an OSPF area consisted of all subnets of the class B network 128.185.0.0, it would consist of a single address range. The address range would be specified as an address of 128.185.0.0 together with a mask of 255.255.0.0. Outside the 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. The backbone is a special OSPF area having an area ID equal to 0.0.0.0. The OSPF backbone must be contiguous; however, it is possible to define areas where the backbone is not physically contiguous. When this situation exists, you must configure a virtual link to maintain the backbone's connectivity. You can configure 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.



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

- Networks belonging to Area 0.0.0.0
- Routers attached to those networks
- Routers belonging to multiple areas
- Configured virtual links

To set the parameters for an OSPF area, use 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 is the OSPF area address. An OSPF area is a contiguous group of networks that is 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 in the list.
Once the area number has been introduced, there are a series of distinct options:

- *default*: creates an area with the default values: authentication type 0, no area stub.
- *authentication* (type of authentication) security schema to be used in the area. The types of possible authentication are: type 2, which indicates a password to generate a encripted signature; type 1, which indicates a simple password; or 0, which indicates that no authentication is necessary exchange.
- *no*: permits you to negate a previously configured option or give default values to 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 configure virtual links through a stub area.

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

NOTE: You cannot configure the backbone as a stub area. External routing in stub areas is based on a default route. Each border area router connecting to a stub area originates a default route for this purpose. The cost of this default route is also configurable through the AREA command.

3.3. Setting OSPF Interfaces

The **INTERFACE** command is used to make a determined interface in an OSPF process router participate and to configure specific parameters for the protocol interface.

There are two special kinds of OSPF routers, area border routers and AS boundary routers.

- Area Border Routers. A router attached to multiple areas, which runs multiple copies of the basic algorithm, one copy for each attached area and an additional copy for the backbone. Area border routers condense the topology information of attached areas for distribution to the backbone. The backbone then distributes this information to other areas.
- AS Boundary Routers. A router that exchanges information with routers that belong to other ASs. These routers import this information to the OSPF routing domain in AS external link advertisements.

3.4. OSPF Routing Summary

When a router is initialized, it uses the Hello Protocol to send hello packets to its neighbors, and 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 the 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 that 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 with itself designated as the root. Then the shortest path tree generates the routing table.

a) Designated Router

Every multi-access network has a designated router that performs two main functions for the routing protocol, it originates network link advertisements and it becomes adjacent to all other routers on the network.

When a designated router originates network link advertisements, it lists all the routers, including itself, currently attached 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 elects the designated router after determining the routers priority from the Rtr Pri field of the Hello packet.

When a router's interface first becomes functional, it checks to see if the network currently has designated router. If it does, it accepts that designated router regardless of that router's priority, otherwise, it declares itself the designated router at the same time another router does, the router with highest router priority (Rtr Pri) becomes the designated router. In the case that both Rtr Pris are equal, the one with the higher router ID is elected.

Once the designated router is elected, it becomes the endpoint for many adjacencies. On a broadcast network this 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, use the **INTERFACE** command.

You need to introduce the IP address for each router interface. For the parameters listed below you must enter the **same value** for all routers attached to a common network segment.

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

The 'area' option configures the OSPF area which the interface attaches to. In the following example, suppose that the interface address mask is 255.255.255.0, indicating that the interface attaches to a subnet (128.185.138.0) of network 128.185.0.0. All other OSPF routers attached to subnet 128.185.138.0 must also have their *hello interval* set to 20, *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>
```

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, you have to configure the parameters below to help the router discover its OSPF neighbors. This configuration is only necessary if the router will be eligible to become designated router of 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>
```

Then configure the IP addresses of all other OSPF routers that will be attached to the non-broadcast network. For each router configured, you must also 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>
```

3.6. Enabling AS Boundary Routing

To import routes learned from other protocols (RIP and statically configured information) into the OSPF domain, enable AS boundary routing. You must do this 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 which external routes you want to import. You can choose to import, or not to import, routes belonging to several categories by using the subcommand IMPORT from the AS-BOUNDARY-ROUTING command, or through 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, but not RIP or static routes. All routes are imported with cost 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.

Independently of the above 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 in 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 in picking the best

route. When comparing two type 1 metrics, the external and internal costs of the route are combined before making the comparison.

Through this command you can also enable the generation of a default route with a specified type, cost and next hop.

The syntax of the **AS-BOUNDARY-ROUTING** command 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 distinct configuration options are given in the chapter dedicated to the configuration.

3.7. Other Configuration Tasks

a) 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.

b) Setting Virtual Links

To maintain backbone connectivity you must have all of your backbone routers interconnected either by permanent or virtual links. Virtual links may be configured between any two area border routers that share a common non-backbone and non-stub area. Virtual links are considered to be separate router interfaces connecting to the backbone area. Therefore, you are asked to also specify many of the interface parameters 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 that OSPF router IDs are entered in the same form as IP addresses.

Example:

```
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>
```

Further details on the distinct configuration options are given in the chapter dedicated to the configuration.

c) Configuring for Routing Protocol Comparisons

If you use a routing protocol in addition to OSPF, or when you change your routing protocol to OSPF, you must 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. For example, N1 and N2 in Area 1of. Information that is about 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, for example, N1 of Area 1 and N7 of Area 2. OSPF does inter-area routing by dividing the path into three contiguous pieces: an intra-area path from source to an area border router; a backbone

path between the source and destination areas; and then another intra-area path to the destination. You can visualize this high-level of routing as a star topology with the backbone as hub and each of the areas as a spoke.

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 in 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 external type 2 routes, assumes that the external cost is greater than the cost of any internal OSPF (link-state) path.

OSPF has a 4-level routing hierarchy as shown below. 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 will be imported as type 2 externals. All OSPF external type 1 routes override received RIP routes, regardless of metric.

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

The syntax of the **COMPARISON** command 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>
```

d) Configuring for OSPF routes filtering

Route filtering in the OSPF entry permits you to define a route-map to select routes that you do not want to install in the device's active routes table. Filtering is executed at the point 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 Manual 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:

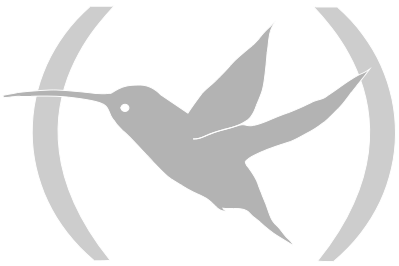
distribute-list route-map <route-map> **in**

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



1. Configuration Commands

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

```
*process 4
Config>protocol ospf

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

The OSPF protocol supports and instance for each VRF configured in the device. To configure this protocol in a different VRF from the main one, execute the following command from the OSPF configuration root menu:

```
OSPF config>vrf VRF-1


OSPF vrf config>
```

Command	Function
? (HELP)	Displays available commands or options.
AREA	Configures the parameters for an OSPF area.
AS-BOUNDARY-ROUTING	Configures the AS boundary routing capacity.
COMPARISON	Notifies 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 the OSPF route filtering.
ENABLE	Enables the OSPF protocol.
HOST	Defines what special device addresses are considered as HOST type OSPF routes and consequently advertised as internal in each of the router areas.
INTERFACE	Configures the OSPF parameters for the router interfaces.
LIST	Displays OSPF configuration.
NEIGHBOR	Aggregates and configures neighbors to non-broadcast networks.
NO	Permits you to delete parts of the executed configuration.
NON-BROADCAST	Configures the parameters for non-broadcast networks.
REDISTRIBUTE	Configures the redistribution (importation) for routes coming from other protocols towards OSPF.
VIRTUAL-LINK	Configures the virtual links between any pair of area boundary routers.
VRF	Enters the OSPF configuration menu associated to a different VRF from the main one. This only appears in the OSPF root menu.
EXIT	Exits the OSPF configuration process.

1.1. ? (HELP)

Use the **?** (HELP) command to list the commands that are available from 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         Netwoks 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
```

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 attached 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 that is defined by a list of address ranges, each indicated by a combination of the IP address mask. A network belongs to an area if its address is in the list.

Options:

default — Creates an area with the default options. I.e. authentication type 0 and no stub.

authentication — Configures the security scheme to be used in the area. The authentication option enables authentication, i.e. configures authentication Type 1. This indicates a simple password. The no authentication option, Type 0, indicates that no authentication is necessary to pass packets. The message-digest suboption configures Type 2. This indicates adding a encripted 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 announced externally to the area (inter-area routes). E.g. if an OSPF area is going to be made up of all the subnets of class B 128.185.0.0 network, this will be defined as if it consisted of a single address range. The address range will be specified as a 128.185.0.0 address together with mask 255.255.0.0. Outside of the area, the entire subnets network (subnetted) will be announced as a single route to network 128.185.0.0.

no — Permits you to delete configurations created with other options.

no authentication — Disables authentication (configures authentication Type 0).

no range — Permits you to delete 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:

- 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 routers.

To eliminate the characteristic to be 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 border area router attaching to a stub area originates a default route for this purpose. The cost of this default route is configurable with this option.
stub-area import-summaries	imports network summaries.
stub-area no	Permits you to configure 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>
```

1.3. AS BOUNDARY ROUTING

Enables the AS boundary routing capability that allows you to import routes learned from other protocols (BGP, RIP, and statically configured information) into the OSPF protocol. This also permits you to configure the automatic generation of a default route.

This also permits you to 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 importing routes within the OSPF. You can configure that default routes, direct routes, RIP routes, static routes and subnet routes are imported. The additional cost parameter ensures that all the imported routes have their costs increased by however many units indicated by this parameter. The default value is zero. The no import option permits you to configure the default value for the additional cost as well as eliminating the routes importation as you wish.

aggregation-type Configures the type of aggregation.

The meaning of the types of aggregation is as follows:

none No aggregation is carried out of any type. Neither the aggregation routes nor the subnet aggregation routes are imported here.

subnetted-networks When in the route table a subnet route is learnt or configured, a “Sbnt” type route or a subnet aggregation route automatically appears with a

destination of “subnet network” and the next hop as “none”. On activating this type of aggregation, the subnet aggregation routes are imported only when the route being aggregated is one within the set of routes to import. This is the default option.

aggregation-routes The aggregation routes are not truly routes but marks that appear in the active routes table which indicate that there exists a series of routes which are being aggregated. On activating this type of aggregation, only the aggregation routes and the routes which do not belong to any aggregation are imported. This means that the aggregated routes are not imported. Also on activating this type of aggregation, the subnet aggregation routes are imported only when the route being aggregated is one within the set of routes to import.

all Aggregation of subnets and routes.

originate-default-route Configures the imported default route parameters: if you import a default routes (option *always*), default route cost (option *cost*), type of default route (option *type*) and the forwarding IP address used in the imported default route (option *forwarding-address*).

originate-default-route enables the automatic generation of the default route

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

always always originates the default route

cost cost of the originated default route

type type of originated default route

forwarding-address next hop for the originated default route

no Permits you to configure the default values for the distinct parameters.

Example:

Enable the AS boundary routing capacity so that routes learned by RIP are imported as well as direct, static and subnets routing information. Additionally configure aggregation of subnets and additional cost of imported routes equal to 1.

```
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>
```

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 gained from any other source, all of which are located on a single level.

Example:

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

1.5. DISABLE

Use the **DISABLE** command to disable the OSPF protocol.

Syntax:

```
OSPF config>disable ospf
```

Example:

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

1.6. DISTANCE

Use the **DISTANCE** command to modify the administrative distance for the OSPF external routes. By default the administrative distance for the said routes is 150.

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

Syntax:

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

Example:

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

1.7. DISTRIBUTE-LIST

Use the **DISTRIBUTE-LIST** command to filter the routes that OSPF installed in the active routes table. To disable route filtering, place the word **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.

By default, route filtering is disabled.

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

1.8. ENABLE

Use the **ENABLE** command to enable the entire OSPF protocol.

Syntax:

```
OSPF config>enable ospf
```

Example:

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

1.9. HOST

Defines which special device addresses are considered as HOST type OSPF routes and consequently must be advertised as internal 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 protocol commands are special IP addresses associated to an internal loopback interface in the device and cannot be used as an argument for the OSPF protocol **INTERFACE** command. By default, the router considers networks defined through these commands as host type networks which are associated to any defined OSPF area, and therefore sent as intra-area networks. To modify this behavior, the **HOST** and the negation for this, **NO HOST** commands appear.

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 said 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>
```

1.10. INTERFACE

Permits you to enable OSPF in router network interfaces. Additionally, this permits you to configure 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:

Configuring an interface with IP address 192.7.1.253 with the default values.

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

For each router interface you need to introduce its IP address, or in cases where this is an unnumbered interface, the interface name... For the parameters listed below you must enter the **same value** for all routers attached to a common network.

- Hello interval
- Dead router interval
- Authentication key (if an authentication of 1 is used)

The *area* option permits you to configure the OSPF area which the interface attaches to.

Options:

default	Enables OSPF in an interface or IP address with the default values and associates it to the backbone area (area 0.0.0.0).
area	Area identifier to which the interface is associated.
authentication-key	Authentication key for type 1 simple authentication.
dead-interval	Configures the time which a device must wait before considering an OSPF neighbor to be down when the former does not received the hello packets. If you configure the minimal suboption, you are enabling the FastHello feature. This consists of a down interval of 1 second and a number of hello packets per second equal to the value of the configured hello-multiplier.
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 determined interface. The possible values are: point-2-point, point-2-mpoint, broadcast, and non-broadcast.
router-priority	Configures the router priority that is taken into account in the selection algorithm from the network's "designated-router".
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 to the configuration of an interface in OSPF is the type of network. The following types of networks exist for OSPF:

- "*Point-to-Point*". Networks that use a communications line to join a single pair of routers. This is the default network types for interfaces such as PPP, HFLC, and TNIP.
- "*Broadcast"*. Networks that support more than two attached routers and are capable of addressing a single physical message to all attached routers. This is the type of default network for Ethernet and Token-Ring interfaces.
- *"Non-Broadcast" (NBMA)*. Networks that support more than two attached routers but have no broadcasting capabilities, although through configuration, they are capable of emulating them. This is the type of default network for X.25 interfaces.
- "*Point-to-Mpoint broadcast*". Networks with more than two routers and partially meshed, generally with star topology. Additionally, the network supports or emulates broadcast traffic so you don't need to configure the neighbors.
- "*Point-to-Mpoint non-broadcast*". Networks with more than two routers and partially meshed. The traffic flow must pass through a central point. Additionally, the network does not support or emulate broadcast traffic; consequently it's essential to configure the neighbors. This is the type of default network for Frame-Relay interfaces.

Through the "network type" parameter, you can modify the type of OSPF network associated to an interface. Using this functionality, you can configure a broadcast network, such as NBMA, and vice versa. On configuring an NBMA network as Broadcast, you assume the network supports or emulates broadcast traffic and 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".

1.11. LIST

This command 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>
```

a) LIST ALL

List 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 meaning of each of the global configuration fields is:

OSPF protocol	Displays 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	Displays whether the router will import external routes into the OSPF domain.
Import external routes	Displays which routes will be imported.
Aggregate subnets	Displays the type of aggregation configured.
External routes cost	Displays the configured additional cost.
Orig default route	Displays whether the router will import a default route into the OSPF domain. When the value is "YES", a non-zero network number is displayed in parentheses. This indicates that the default route will originate if and only if a route to that network is available.
Default route cost	Cost and type that will be used in the imported default route.
Default forward addr	Forwarding address that will be used in the imported default route.
Multicast forwarding	Displays if the multicast routing is enabled or not.

Information for the rest of the fields that appear can be seen in the various sections that describe the individual list of the rest of the elements making up the OSPF configuration.

b) 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 the encripted 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.

c) LIST INTERFACES

For each interface its IP address is printed, together with 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 which the interface is connected 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	This is the 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	This is the Priority of the interface router which is sued when you select the Designated Router DR.
Hello	This is the number of seconds between the "Hello" packets sent by the interface.
Dead	This is the number of seconds which should pass after the "Hello" packets to consider that the router is down and not operative.

d) LIST NEIGHBORS

Lists all the information related to 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 of the fields is as follows:

Neighbor Addr	Neighbor IP address.
Interface Address	Interface IP address.
DR eligible	If the designated router is eligible.

e) LIST NON-BROADCAST

List all information related to interfaces connected to non-broadcast networks. For each non-broadcast interface, as long as the router is eligible to become designated router on the attached 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>
```

f) LIST VIRTUAL-LINKS

List all virtual links that have been configured with this router as endpoint. "Virtual endpoint" indicated the OSPF router ID of the other endpoint. "Transit area" indicates the non-backbone area through which the virtual link is configured. Virtual links are considered treated by the OSPF protocol similarly to point-to-point networks. The other parameters listed in the command ("Rtrns", "TrnsDly", "Hello", and "Dead") are maintained for all interfaces. See the OSPF **LIST INTERFACES** command for more 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>
```

1.12. NEIGHBOR

Adds neighbors to networks which do not either support or emulate broadcast: "non-broadcast" and "point-2-point". You have to use this command to help the router discover its OSPF neighbors. This configuration is only necessary if the router is eligible to become designated router for the non-broadcast network. You need to configure the IP addresses for all other OSPF routers that have been attached to the non-broadcast network.

For each router configured, you must also specify its eligibility to become 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>
```

1.13. NO

Permits you to delete OSPF information from the router's configuration memory or configure 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
```

a) NO AREA

Deletes OSPF areas from the current OSPF configuration.

Syntax:

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

b) 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
```

c) NO DISTANCE

Reestablishes the default value for the OSPF external routes administrative distance.

Syntax:

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

d) NO DISTRIBUTE LIST

Deletes the configuration of OSPF routing filtering through route-map.

Syntax:

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

e) 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>
```

f) NO INTERFACE

Deletes the configuration of an interface.

Syntax:

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

g) 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>
```

h) 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>
```

i) NO REDISTRIBUTE

Deletes a redistribute 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>
```

j) 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>
```

1.14. NON-BROADCAST

Helps the router discover its OSPF neighbors. This configuration is only necessary if the router will be eligible to become designated router of the non-broadcast network. After using this command you must then configure the IP addresses of all other OSPF routers that will be attached to the non-broadcast network. See the **NEIGHBOR** command for more information.

Syntax:

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

1.15. REDISTRIBUTE

Use the **REDISTRIBUTE** command to redistribute routes from one routing domain in another routing domain. To disable redistribution, use the particle **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 for 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 in order to filter the importation of routes from the source protocol to the current protocol. If none is specified, all the routes will be redistributed.

By default, redistribution is disabled.

The following example provokes redistribution of RIP routes in OSPF.

Example:

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

The next example provokes redistribution of BGP routes in OSPF after they have been filtered by the BGP2OSPF route map. Please note how the OSPF cost for routes to 5 and type to 2, after being imported, has been specified.

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
;
```

1.16. VIRTUAL-LINK

Configures virtual links between any two area border routers. To maintain backbone connectivity you must have all of your backbone routers interconnected either by permanent or virtual links. Virtual links are considered to be separate router interfaces connecting to the backbone area. Therefore, you are asked to also specify many of the interface parameters 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 identifier of router 192.7.1.253 through area 0.0.0.1. Configure the retransmission interval as 15 seconds, transmission delay as 5 seconds and xyz_q authentication.

```
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>
```

1.17. VRF

The VRF command permits you to access a new instance in the OSPF configuration menu associated to the indicated VRF. The new menu you access has 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>?
```

1.18. EXIT

Use the **EXIT** command to return to the previous prompt level.

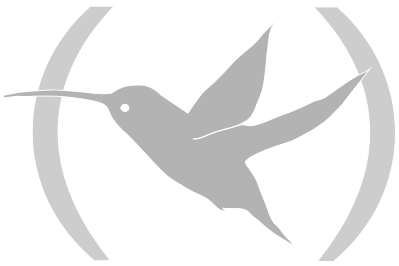
Syntax:

```
OSPF config>exit
```

Example:

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

Chapter 3
Monitoring



1. Monitoring Commands

This section describes the OSPF monitoring commands. To access to the OSPF Configuration environment you must enter the following:

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

The OSPF protocol supports and instance for each VRF configured in the device. To monitor this protocol in a different VRF from 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-EXTERNAL-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.

1.1. ? (HELP)

Use the **?** (HELP) command to list the commands that are available from 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+
```

1.2. ADVERTISEMENT-EXPANSION

Use the **ADVERTISEMENT-EXPANSION** command to print the contents of a link state advertisement contained in the OSPF database. For a summary of the router's advertisements use the **DATABASE** command.

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. Providing an area-id on the command line tells the software which database you want to search.

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

- Router links - Contain descriptions of a single router's interface.
- Network links - Contain the list of routers attached 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 links 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 shown below.

This command has also 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. In those cases where there is no reverse link (which means that 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 were displayed in the detailed OSPF **NEIGHBOR** command.

New group-membership-LSAs can also be displayed. The "LS destination" of each group-membership-LSA is a group address. A router originates a group-membership-LSA for each group with members on one or more of the router's attached 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 you 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 piece of the routing domain described by the advertisement. These capabilities are denoted by E (processes type 5 externals; when this is not set to the area to which the advertisement belongs has been configured as a stub), T (can route based on TOS).
LS type	Classifies the advertisement and dictates its contents: 1 (router links 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 advertisement type. For router links and ASBR summaries, it is the OSPF router ID. For network links, it is the IP address of the network's designated router. For summary links and AS external links, it is 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	A checksum of advertisement contents, used to detect data corruption.

LS length	The size of the advertisement in bytes.
Router type	Level of functionality of the router. ASBR means that 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, it is the IP address of the network designated router. For interfaces to stub networks, it is the network's network/subnet number.
Link Data	4 bytes of extra information concerning the link, it is either the IP address of the interface (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	The number of non-zero TOS values for which metrics are provided for this interface.
TOS 0 metric	The cost of the interface. In parenthesis the reverse cost of the link is given (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 (the router currently does not router based on TOS, and looks at the TOS 0 cost only).

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 scheme is being used for the area's authentication. The router has three interfaces attaching to the area, and has found 4 transit networks, 7 routers and no area border routers when doing the 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 functional.
#nets	Transit networks found while doing the SPF tree calculation for this area.

#rtrs Routers found when doing the SPF tree calculation for this area.

#brdrs Area border routers found when doing the SPF tree calculation for this area.

1.4. AS-EXTERNAL-ADVERTISEMENTS

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

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: its link state type (called Type), its link state ID (called the LS destination) and the advertising router (called the 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. Its 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.

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 for each interface where the main characteristics are summarized. If you specify an interface, the statistics for the said interface are displayed in detail.

The unnumbered interfaces are specified through their names, the numbered ones through their IP addresses and the 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) and 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 with whom the router has synchronized 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) and 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 this interface.
TOS 0 cost	Interface's TOS 0 cost.
# Neighbors	Routers whose hellos have been received, plus those that have been configured.
# Adjacencies	Neighbors in state Exchange (32) or greater.
# Full adjs.	Full adjacencies is the number or neighbors whose state is Full – 128 - (and therefore, with which the router has synchronized databases).
# Mcast floods	Link state updates flooded out the interface (not counting retransmissions).
# Mcast acks	Link state acknowledgments flooded out the interface (not counting retransmissions).

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 will be 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 the 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 this neighbor.
DBsum	Size of the database summary list waiting to be sent to the neighbor.
LSreq	Number of more recent advertisements that are being requested from the neighbor.
Ifc	Interface shared by the router and the 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	Indicate the value seen in the last hello received from the neighbor.
Backup choice	Indicate the value seen in the last hello received from the neighbor.
DR Priority	Indicate the value seen in the last hello received from the neighbor.
Nbr options	Indicates the optional OSPF capabilities supported by the neighbor. These capabilities are denoted by E (processes type 5 externals; when this is not set the area to which the common network belongs has been configured as a stub), T (can route based on TOS). This field is valid only for those neighbors in state Exchange (32) or greater.
DB summ qlen	Indicates the number of advertisements waiting to be summarized in Database Description packets. It should be zero except when the neighbor is in state Exchange (32).
LS rxmt qlen	Indicates the number of advertisements that have been flooded to the neighbor, but not yet acknowledged.
LS req qlen	Indicates the number of advertisements that are being requested from the neighbor in state Loading (64).
Last hello	Indicates the number of seconds since a hello has been received from the 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 the 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.

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 by the command 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 that the destination is a network, "ASBR" indicates that the destination is an AS boundary router, and "ABR" indicates that the destination is an area border router, and "Fadd" indicates a forwarding address (for external routes).

RType Indicates route type and how the route was derived. "SPF" indicates that the route is an intra-area route (comes from the Dijkstra calculation); "SPIA" indicates that 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 which 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.

1.9. SIZE

Use the **SIZE** command 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+
```

1.10. STATISTICS

Use the **STATISTICS** command to display statistics generated by the OSPF routing protocol. The statistics indicate how well the implementation is performing, including its memory and network utilization. Many of the fields displayed are 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 will be imported.
Import external routes	Displays which external routes will be imported.
Aggregation Type	Aggregation type.
External routes cost	Additional cost for the imported routes.
Orig default route	Displays whether the router will advertise an OSPF default route. If the value is "Yes" and a non-zero number is displayed in parentheses then a default route will be advertised only 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 that 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 links advertisements.
LS adv.	Allocated to store summary link and AS external link advertisements.
Queue headers	Form lists of link state advertisements used in the flooding and database exchange processes. If the number of queue headers allocated is not equal to the number freed, database synchronization with some neighbor is in progress.
# Dijkstra runs	Indicates how many times the OSPF routing table has been calculated from scratch.
Incremental summ. updates	Indicates that the new summary link advertisements have caused the routing table to be partially rebuilt.
Incremental VL updates	Indicates that the 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 the flooding procedure.
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. Usually they will be refreshed before this time.
LS adv. flushed	Indicates number of advertisements removed (and not replaced) from the link state database.
Incremental ext. updates.	Displays number of changes to external destinations that are incrementally installed in the routing table.

1.11. VRF

The VRF command permits you to access a new instance in the OSPF monitoring menu associated to the indicated VRF. The new menu you access has the same commands as the root menu except for the VRF command.

Syntax:

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

Example:

```
OSPF+vrf VRF-1


OSPF vrf+
```

1.12. EXIT

Use the **EXIT** command to return to the previous prompt level.

Syntax:

```
OSPF+exit
```

Example:

```
OSPF+exit
+
```