OSPF

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OSPF

REFERENCE

1 Open Shortest Path First (OSPF)

In this chapter we will describe the Setup Tool menus and settings you will see while using Setup Tool to configure the Open Shortest Path First (OSPF) protocol on your router.

After that, we have included an overview of the OSPF protocol as well as an example OSPF installation using different BinTec routers.

1.1 Setup Tool Menus

After entering `setup` from the shell prompt, Setup Tool's Main Menu is displayed as below. Depending on your hardware setup and software configuration your router's menu may differ slightly.

```
BinTec router Setup Tool                        BinTec Communications AG
                                                                MyRouter


Licences                  System

Slot1:                    CM-BNC/TP, Ethernet
Slot2:                    CM-2XBRI, ISDN S0, Unit 0
                          CM-2XBRI, ISDN S0, Unit 1

Slot3:                    CM-1BRI, ISDN S0

WAN Partner
IP      IPX     PPP     X.25    VPN

Configuration Management
Monitoring and Debugging
Exit


Press <Ctrl-n>, <Ctrl-p> to scroll through menu items, <Return> to
enter
```

1.1.1 OSPF

The starting point for all OSPF settings:

➤ Go to ***IP*** ➧ ***OSPF.***

OSPF on the router can be configured from Setup Tool using the three menus available here:

```
BinTec router Setup Tool                          BinTec Communications AG
[IP] [OSPF]: OSPF Configuration                                   MyRouter



                                Static Settings
                                Interfaces
                                Areas

                                Exit


Press <Ctrl-n>, <Ctrl-p> to scroll through menu items, <Return> to
enter
```

Field	Meaning
Static Settings	Contains global OSPF parameters. This is where OSPF is enabled on the router.
Interfaces	Lists all OSPF capable router interfaces and is used for configuring interface-specific settings.
Areas	Lists all known OSPF areas and is used for adding/configuring area-specific settings.

Table A-1: ***OSPF CONFIGURATION***

1.1.2 Static Settings

To obtain the global settings for the OSPF protocol:

➤ Go to ***STATIC SETTINGS.***

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][STATIC]: OSPF Static Settings                        MyRouter


    OSPF                                                        disabled
    Generate Default Route for the AS                           no


                        SAVE                        CANCEL

Use <Space> to select
```

Field	Meaning
OSPF	Is used to enable or disable OSPF. A valid license is also required before OSPF can be used on the router.
Generate Default Route for the AS	When set to *yes* the router advertises a default route over all active OSPF interfaces (see the **Admin Status** field in the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu).

Table A-2: ***OSPF STATIC SETTINGS***

Special consideration should be given to deciding which router is to provide a default route. This router should have the appropriate routes so that it can properly handle traffic for the AS.

1.1.3 Interfaces

To obtain a list of the router interfaces OSPF can be configured for:

➤ Go to ***INTERFACES.***

By default, all IP compatible interfaces (present at the time OSPF was enabled) are added to this list and are placed in the passive state.

To configure an interface:

➤ Scroll to the appropriate entry and press **Enter**.

The fields shown in the resulting ***EDIT*** menu shown below can be configured separately for each interface.

Interface Configuration via Setup Tool

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][INTERFACE][EDIT]: Configure Interface en1          MyRouter


Admin Status                        passive (propagate routes)
Area ID                             0.0.0.0

Metric Determination                auto (ifSpeed)
Metric (direct routes)              10

Authentication Type                 none
Authentication Key

Export indirect static routes       no


                  SAVE                            CANCEL

Use <Space> to select
```

Once an interface is placed in the active state (and saved to memory), OSPF connections may be established over the interface resulting in appropriate costs for dial-up interfaces.

For dialup interfaces the Base Metric Value changes dynamically as ISDN channels are added/removed while the link is up. For leased line interfaces the base metric is equivalent to the result of the same function less 20 (i.e., 1542 for one leased B-Channel, 781 for two B-channels).

Field	Meaning
Admin Status	The status of an OSPF interface defines whether routes and/or OSPF protocol packets are propagated over the interface. If OSPF has not been enabled yet, only the **Admin Status** field is displayed (in which case changes are irrelevant). OSPF routers propagate a Router Link (RL), one per Area, which identifies the router's interfaces in that Area. Both active and passive interfaces are identified in the RL. Status may be active, passive, or off with the following results: ■ *Active*: OSPF is running over this interface ■ *Passive*: OSPF is not running over this interface OSPF protocol packets are neither sent nor received over the interface, however this interface may be included in other Router Links. ■ *Off*: OSPF is not running over this interface this interface is not included in Router Links.
Area ID	Identifies the Area this interface is assigned to.
Metric Determination	Determines how the metric for this interface is calculated. This is the cost of the link that is propagated via link state advertisements see table A-4, page 12.

Field	Meaning
Metric	Identifies the base metric value, or cost of this interface. For *auto* determination values (see table A-4, page 12) the actual metric used is adjusted starting a base metric value which is a simple function of the bandwidth of the physical medium (except leased line interfaces) use the function $\text{Base Metric Value} = \frac{1000,000,000}{\text{bandwidth in bps}}$ This results in 10 for ethernet, 6 for token ring, and 1562 for dialup ISDN interfaces (1 B-Channel). For fixed determination values (see previous field) the base metric value can be configured here.
Authentication Type	The type of authentication to use when sending (or verifying incoming) OSPF packets via this OSPF interface. This determines how the key in the **Authentication Key** field is used. By default this is set to *none*. With *simple*, Key is transmitted as a text string in each packet. With *md5*, Key is used to create (verify) an encrypted digest which is sent with each packet.
Authentication Key	A text string to use in connection with the Authentication Type set above.

Field	Meaning
Import indirect static routes	If set to *no* (default) only direct routes for this interface are propagated over active OSPF interfaces (see the **Admin Status** field). When set to *yes*, indirect static routes are also propagated over active interfaces and are contained in external advertisements.

Table A-3: ***CONFIGURE INTERFACE EN1***

Although practical for sites using WAN interfaces without transfer networks, caution should be given to avoiding routing loops when importing indirect static routes.

Determination	Meaning
auto	The metric = the value of the base metric which is based on the bandwidth (*ifSpeed*) of the interface.
fixed	The metric defined (configurable) in the following field is always used (no adjustment).
auto + adjust (Only valid for Dial-up interfaces)	When the dial-up interface is in the up state, the `metric = <base metric value> – 10`. Otherwise `metric = <base metric value>`.
fixed + adjust	When the dial-up interface is in the up state the `metric = <base metric value> – 10`. Otherwise `metric = <base metric value>`.

Table A-4: *Metric Determination*

1.1.4 Areas

To obtain a list of the OSPF Areas known to the router:

➤ Go to ***Areas.***
Before a router interface can be assigned to an Area, the **Area ID** must first be added here.

The exception is the backbone area which is automatically generated at boot time if no other area is configured and which all interface assignments default to if not explicitly assigned.

➤ To edit area-specific settings select the **Area ID** and press **Enter**.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][AREA][ADD]: Area Configuration                        MyRouter


    Area ID                                     0.0.0.0
    Import external routes                      no


        Area Ranges>

                        SAVE                CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

Field	Meaning
Area ID	Identifies the OSPF Area this entry corresponds to. The backbone area is *0.0.0.0*.
Import external routes	Specifies whether external routes should be imported for this area. When set to *no*, this Area is defined as an OSPF Stub Area.
Area Ranges	This submenu specifies IP Address ranges for route condensation among areas.

Table A-5: ***Area Configuration***

1.1.5 Monitoring and Debugging

This menu consists of several submenus which allow you to monitor the router's operational status (and debug problems) in different ways:

➤ Go to ***MONITORING AND DEBUGGING.***

```
BinTec router Setup Tool                          BinTec Communications AG
[MONITOR]: Monitoring and Debugging                                MyRouter


                    ISDN Monitor
                    X.25 Monitor
                    Interfaces
                    Messages
                    TCP/IP
                    OSPF

                    EXIT
```

Field	Meaning
ISDN Monitor	lets you track incoming and outgoing ISDN calls
X.25 Monitor	lets you track incoming and outgoing X.25 calls
Interfaces	lets you monitor traffic by interface
Messages	displays system messages generated by the router´s system logging and accounting mechanisms.
TCP/IP	menu lets you monitor IP traffic by protocol
OSPF	menu lets you monitor OSPF related information

Table A-6: ***MONITORING AND DEBUGGING***

➤ Go to ***OSPF.***

The OSPF monitor is divided horizontally in three sections and displays information relating to OSPF Interfaces, Neighbors, and Areas.

```
BinTec router Setup Tool                          BinTec Communications AG
[MONITOR][OSPF]: OSPF Monitor                                      MyRouter

Interface       DR              BDR          Admin Status     State
en1             192.168.30.1    192.168.30.0 active           BDR
brickxs         0.0.0.0         0.0.0.0      active           PTP

Neighbor        Router ID       Interface    Retx Queue       State

192.168.30.1    10.0.1.1        en1          0                full
12.0.0.2        11.0.0.2        brickxs      0                full

Area     Type         Link State ID   Router ID    Sequence    Age
0.0.0.0  Summary Net  10.0.0.0        10.0.1.1     0x800000003 1641=
0.0.0.0  Network Link 192.168.30.1    10.0.1.1     0x800000001 361 I
11.0.0.0 Router Link   11.0.0.2       11.0.0.2     0x800000009 1   I
11.0.0.0 Summary Net   0.0.0.0        192.168.40.3 0x800000001 2   V
EXIT


Press <Ctrl-n>, <Ctrl-p> to scroll
```

Interfaces Section

The Interfaces section lists all enabled OSPF interfaces (interfaces that have NOT been turned “off” in the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu)

Field	Meaning
Interface	The router interface the entry corresponds to.
Designed Router (DR)	The Designated Router’s IP address on this interface (a DR is not shown for Point-To-Point interfaces).
Backup Designed Router (BDR)	The Backup Designated Router’s IP address on this interface (a BDR is not shown for Point-To-Point interface).
Admin Status	Only active and passive interfaces are shown here (see the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu in "Interface Configuration via Setup Tool", page 9).
State	The OSPF status (**ospfIfState**) of the interface shown here may be ■ *down*: OSPF is not running on this interface. ■ *wait*: The initial phase of OSPF where DR and BDR are determined. ■ *PTP*: The interface is a Point-To-Point interface. No DR or BDR is shown. ■ *DR*: The router is the Designated Router for this interface. ■ *BDR*: The router is the Backup Designated Router for this interface. ■ *DRouter*: Another router is the DR/BDR for this interface.

Table A-7: ***OSPF MONITOR***

Neighbor Section

The Neighbor section lists the OSPF neighbor routers that have been identified via the HELLO protocol.

Field	Meaning
Neighbor	The neighbor router's address on this interface.
Router ID	The neighbor router's system wide Router ID.
Interface	The router interface this router was identified over.
Retx Queue	The size of the retransmission queue for this neighbor. This is the number of advertisements that need to be sent to (and acknowledged from) this neighbor.
State	The state of OSPF with this neighbor router may be ■ *init*: The initial phase. A HELLO packet was received from this neighbor. ■ *twoWay*: Bidirectional communication with the neighbor. Transmitted HELLO packets have been accepted by the neighbor router (parameters are correct). ■ *EXstart*: The exchange of Database Description Packets between the router and neighbor has begun. ■ *exchange*: Actively exchanging Database Description Packets with the neighbor router. ■ *loading*: The router and the neighbor router are now exchanging Link State Advertisements. ■ *full*: The router and neighbor routers' Link State Database are now synchronized.

Table A-8: ***NEIGHBOR SECTION***

LSDB Section The Link State Database section lists the headers for all Link State Advertisements (LSA).

Field	Meaning
Area	The Area database to which this LSA belongs
Type	The type of LSA. Five types of LSAs exist: Router Link, Network Link, Summary Link, Summary ASBR, and AS External
Link State ID	The LSA's Link State ID. The Link State ID's meaning depends on the Type of advertisement
Router ID	Identifies the router that generated this LSA
Sequence	This advertisement's sequence number. Sequence numbers allow routers to determine if their database is current or if needs to request an update.
Age	The age (in seconds) of this LSA

Table A-9: ***LSDB SECTION***

1.2 Overview of the OSPF Protocol

OSPF (Open Shortest Path First), is an interior routing protocol that is often used by larger network installations as an alternative to RIP (Routing Information Protocol). It was originally designed to address some of the limitations of RIP (when used in larger networks). Here are some of the problems (with RIP) that OSPF addresses:

- Faster Network Convergence
  Changes in routing information are propagated immediately when changes occur and not periodically as with RIP.

- Reduced Network Load
  After a brief initialization phase, routing information does not need to be refreshed as in RIP where the entire routing table is broadcast every 30 seconds.
- Routing Authentication
  Routers advertising OSPF routes can be authenticated.
- Routing Traffic Control
  OSPF areas can be closed to limit the amount of traffic resulting from routing advertisements.
- Link-Costs
  When calculating a route's cost OSPF can account for the different transport mediums such as LAN or WAN links.
- No hop-count limitations
  In RIP, routes spanning more than 15 hops are unreachable.
  Although the OSPF protocol is more complex than RIP the basic concept is the same; the best interface must be calculated for forwarding packets to a particular station.

1.2.1 Shortest Path Routing

With RIP, routes are measured and selected according to the number of hops it takes for a packet to reach its destination. In the diagram below, each node

represents an IP router. According to RIP, the best route for a packet travelling from A to C will always be ABC.

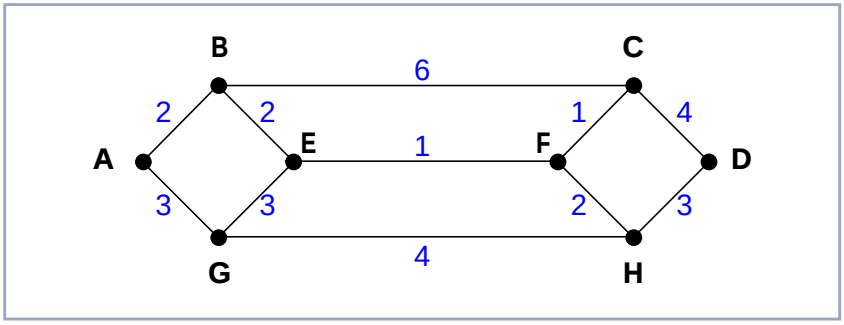

Figure A-1: Shortest Path Routing

In OSPF each link has a cost associated with it (typically some fixed number divided by the bandwidth of the link). Routes are calculated and selected according to the least cost of the overall path a packet will travel. Thus in shortest-path routing the best path is also the fastest path (theoretically), regardless of the number of stations a packet travels through.

Assuming the relative costs of the links in the diagram above (shown in blue), according to OSPF the best route for a packet travelling from A to C is ABEFC (cost = 6). This route requires 4 hops as opposed to the 2 hop route (ABC) selected.

1.2.2 OSPF Routers and Link State Advertisement

OSPF is based on a concept of Areas. An Autonomous System (AS) consists of one or more Areas defined by network management. An Area may contain one or more IP networks.

If an AS does contain more than one area, one must be designated as the backbone, area: 0.0.0.0. All Area Border Routers (see section A, chapter 1.2.4, page 22) in an AS must have a physical connection to the backbone.

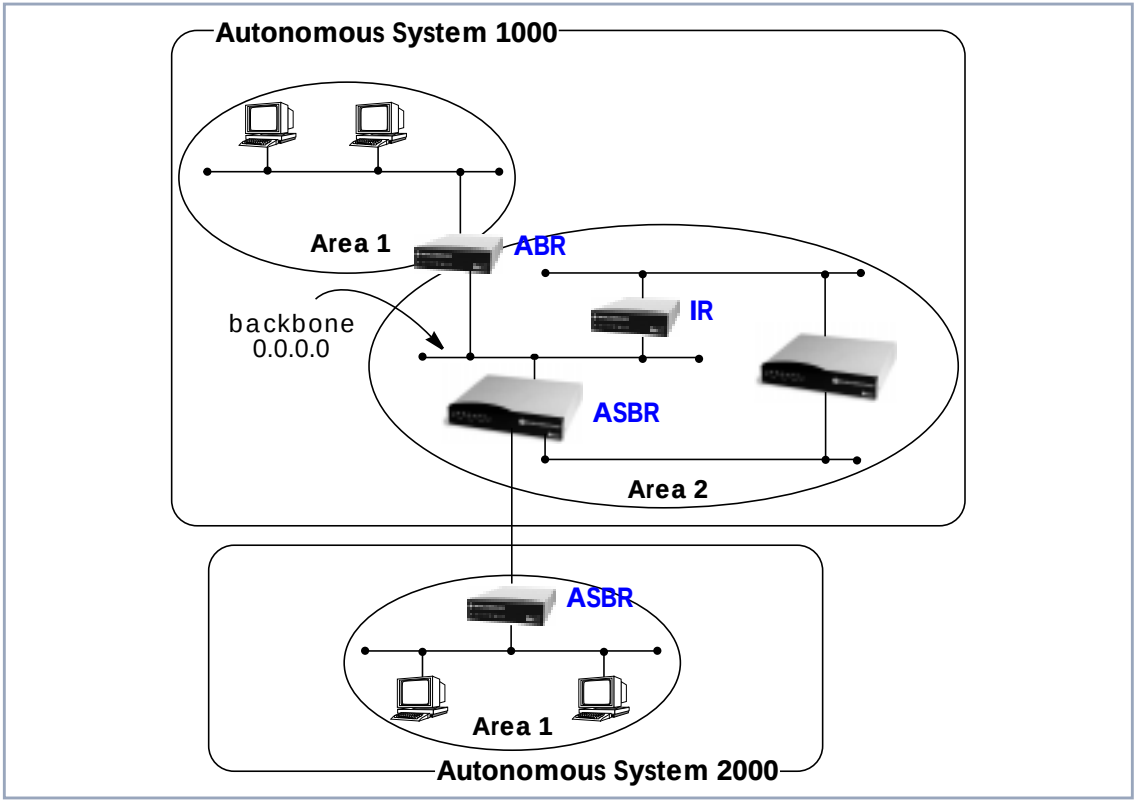

Figure A-2: OSPF Routers and Link State Advertisement

Any of the routers shown above could additionally be the Designated Router or Backup Designated Router for its respective network.

1.2.3 OSPF Virtual Links

Note that in OSPF the backbone, Area 0.0.0.0, is the center for all areas in the Autonomous System. However, sometimes it is not possible to physically connect all areas to the backbone. By configuring a “Virtual Link” between two area border routers a remote area can still be assigned to the backbone.

As shown in the diagram below, a virtual link is established between two Area Border Routers that share a common area; called the “transit area”. Both routers must be physically connected to the backbone.

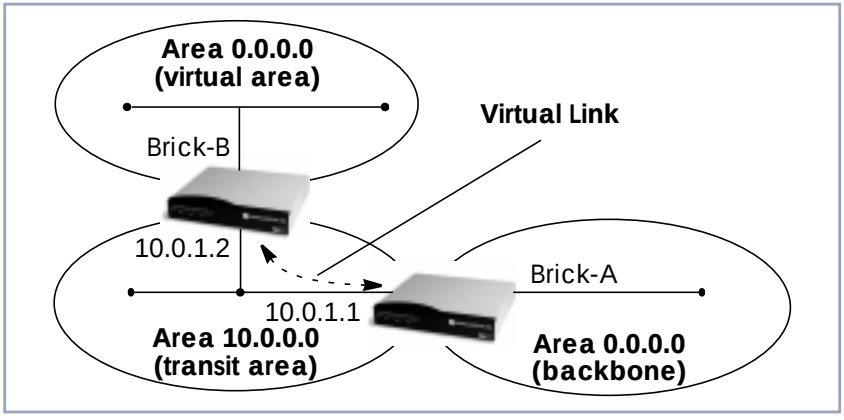

Figure A-3: OSPF Virtual Links

1.2.4 Router Types

The location of a router’s interface with respect to an area determines the type of router it is and the types of Link State Advertisements it exchanges with other routers in that area.

- Internal Routers (IR)
  A router whose interfaces are within the same area. All Internal Routers compute the shortest path tree to all destinations within its area.

- Area Border Router (ABR)
  A router with interfaces in different areas but within the same autonomous system. Topological information is gathered (and stored) for each attached area allowing the ABR to compute the shortest path tree for each area separately.
- Autonomous System Border Router (ASBR)
  A router that acts as a gateway between OSPF and external routes (i.e., routes provided by other routing protocols, static indirect routes, etc.). These routers propagate routes to external networks.
- Designated Router (DR)
  On broadcast networks (token ring and ethernet) where more than two routers are present only the DR needs to synchronize its link state database with other routers.
- Backup Designated Router (BDR)
  A backup router assumes the responsibilities performed by the DR if that system goes down.

1.2.5 Link State Advertisement Types

OSPF routers exchange routing information via Link State Advertisements (LSAs) that contain information about the networks that can be reached over the router's interfaces.

Link State Advertisements are broken down into five different types shown in the table below. The example network shown on the previous page is redisplayed below and shows where the different types of LSAs would be found in an OSPF network.

LSA Type	Purpose
Router Links	Generated by: All OSPF Routers. Purpose: Contains information regarding the state of a router's interfaces within a particular area. Router Links are only flooded within a single area.
Network Links	Generated by: The Designated Router (or Backup Designated Router). Purpose: Identifies all OSPF routers present on the network segment and their state. These links are only flooded within a single area.
Summary Links	Generated by: Area Border Routers. Purpose: Identifies the presence of networks within an AS but outside the (local) area. Provides Inter-Area routes allowing routers to learn of networks in other Areas but within the AS.
ASBR Summary Links	Generated by: An Area Border Router. Purpose: A special type of summary link that provides routes to Autonomous System Border Routers allowing other routers in the AS to find their way out of the system.
External Links	Generated by: An Autonomous System Border Router. Purpose: Contains information about other Autonomous Systems and allows routers to learn about routes to networks there. External links are flooded into all areas except stub areas.

Table A-10: Link State Advertisement Types

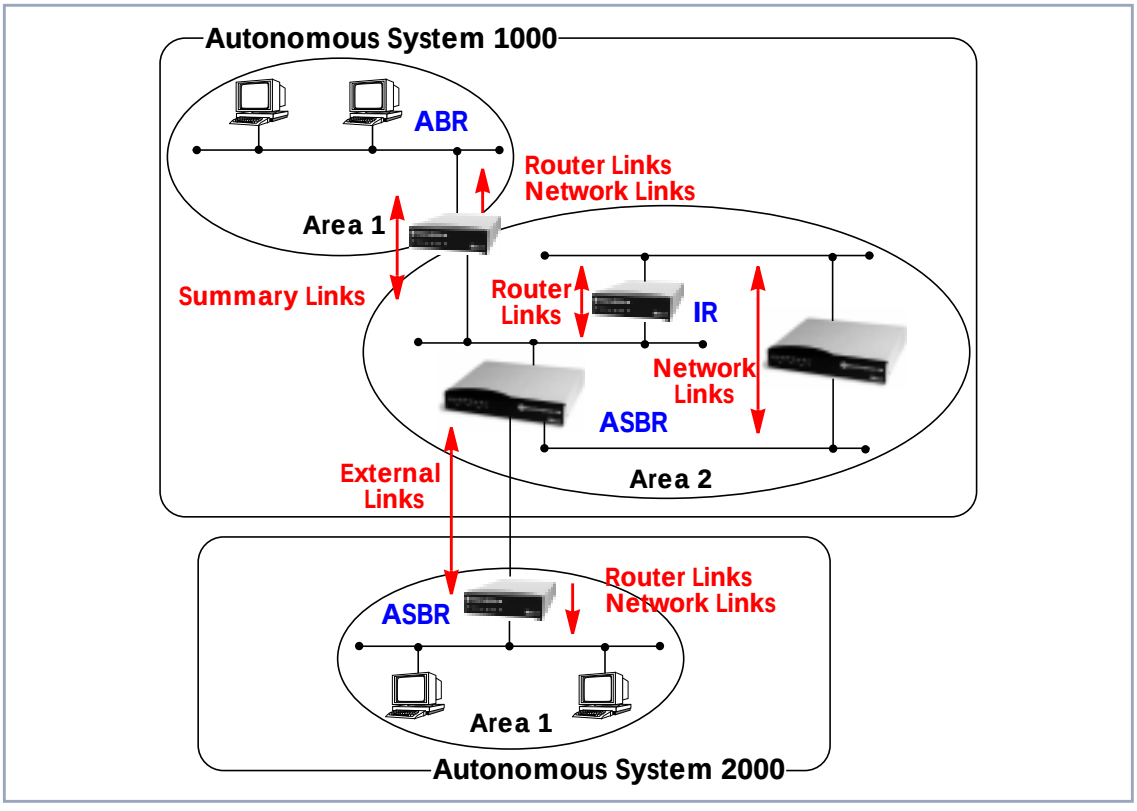

Figure A-4: Different LSA Types in OSPF Network

1.2.6 Router Identification

All OSPF routers in an Autonomous System must have a unique Router ID that identifies the router with respect to the AS. Generally an OSPF router's Router ID is taken to be the highest IP address for its first LAN interface.

1.2.7 Initialization

OSPF networks are said to be much "quieter" in comparison to RIP based networks. This is because in OSPF once the initialization phase is complete routing

information is only exchanged when link state changes occur. This is much different than with RIP where every 30 seconds a router's complete routing table is broadcast and verified over the network.

The initialization phase of OSPF is completed once the Link State Database for the area has stabilized and generally occurs once:

- The OSPF Neighbors have been identified.
- The Designated and Backup Designated Routers have been established.

1.2.8 Neighbor Identification

When first coming into service an OSPF router attempts to identify its neighbor OSPF routers using the HELLO protocol. Two routers are neighbors if they:

- Share a common network.
- Are using the same Area Number for that segment.
- Are using the same Authentication for the segment.
- Are using the same parameters (HELLO interval, etc.).

Neighbor routers then decide whether to synchronize their Link State Database (LSDB) with one another. All routers on the segment synchronize their LSDBs with the Designated Router (DR) and the Backup Designated Router (BDR).

1.2.9 Designated / Backup Designated Router Election

When Neighbor routers are identified (via the HELLO protocol) the DR and BDR are also identified. This is sometimes called DR and BDR election and is achieved via IP multicast packets which a router broadcasts via each network segment. For each segment the router with the highest OSPF priority generally

becomes the DR. In case of a tie, the router with the higher Router ID becomes the DR.

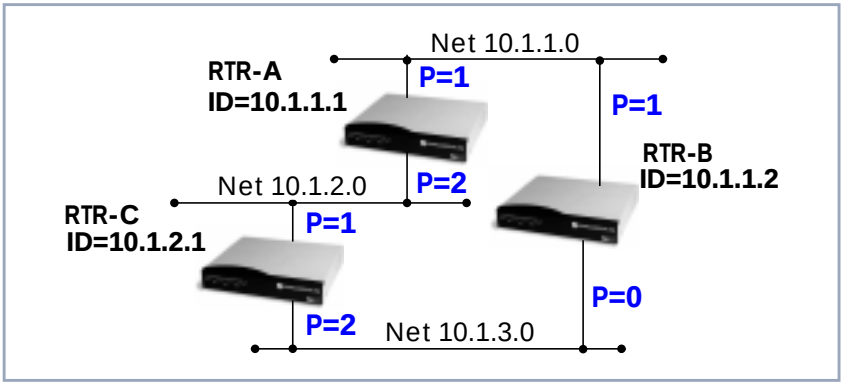

Figure A-5: Designated/Backup Designated Router Election

The DR and BDRs for the three networks shown above would be elected as follows:

Network	DR	BDR
10.1.1.0	RTR-B	RTR-A
10.1.2.0	RTR-A	RTR-C
10.1.3.0	RTR-C	RTR-B

1.2.10 Building up the LSD and the SPT

Link State Database (LSD)

Link State Advertisements contain information about a router´s interfaces (i.e., link's IP address, mask, network type, networks reachable over the link, etc.).

All routers within an area receive all link state information for all routers in the area. Once synchronized each router has an identical image of the link state database that describes the topological structure of the area.

Shortest Path Tree (SPT)

This database allows each router to separately calculate a shortest path tree (SPT), using itself as the root, to any destination in the area. The SPT is used to determine the best interface to route a packet. As in RIP the lowest cost route

is used however the cost to a destination is calculated differently. In OSPF the cost (or metric) of a link is a function of the bandwidth provided by the link. The higher the bandwidth, the lower the cost.

1.2.11 Authentication

OSPF allows packets containing OSPF routing information to be individually authenticated. Two authentication methods are available which must be configured separately for each network segment.

- Simple (password) authentication
  A simple text string is sent with each packet. This method is less secure since packet contents can be “sniffed” off the wire using a link analyzer.
- MD5 (cryptographic) authentication
  When MD5 (Message Digest) is used, each packet is appended with a 16 byte encrypted digest. The digest is a function of an authentication key and the contents of the packet. This method is more secure since the key is not sent with the packet.

With MD5 authentication, only the digest is encrypted and not the actual contents of the OSPF packet.

1.2.12 OSPF over Demand Circuits

Although OSPF generates less network traffic than RIP, the occasional exchange of routing information (HELLO packets, Link State Database updates or changes, etc.) can lead to increased costs for dial-up interfaces.

To help minimize these costs, OSPF on the BinTec router has been implemented to include special extensions for Demand Circuits as defined in RFC 1793, OSPF over Demand Circuits. These extensions allow for efficient use of dial-up

interfaces with OSPF and avoiding excessive ISDN costs. In particular, this means:

- The exchange of HELLO packets between neighbors is suppressed once the BinTec router has synchronized its LSDB with that neighbor (a dial-up connection is initially opened to synchronize the database.)

Link State advertisements are only flooded to neighbor routers when an actual change needs to be propagated.
Each LSA is marked with a special DoNotAge flag (identifiable by the DC-bit of the LSA or OSPF packet)

If a router without RFC 1793 support is removed from the domain in which this feature has been used it is recommended that all OSPF routers be briefly deactivated and re-activated to ensure that all LSAs generated by the removed router are actually flushed.

1.3 Example OSPF Installation

A typical network installation showing how OSPF could be put to use is shown in the diagram below. Highlights for this setup are shown below. Following the diagram is a Configuration Overview and following that a detailed listing of the configuration steps is provided for each router.

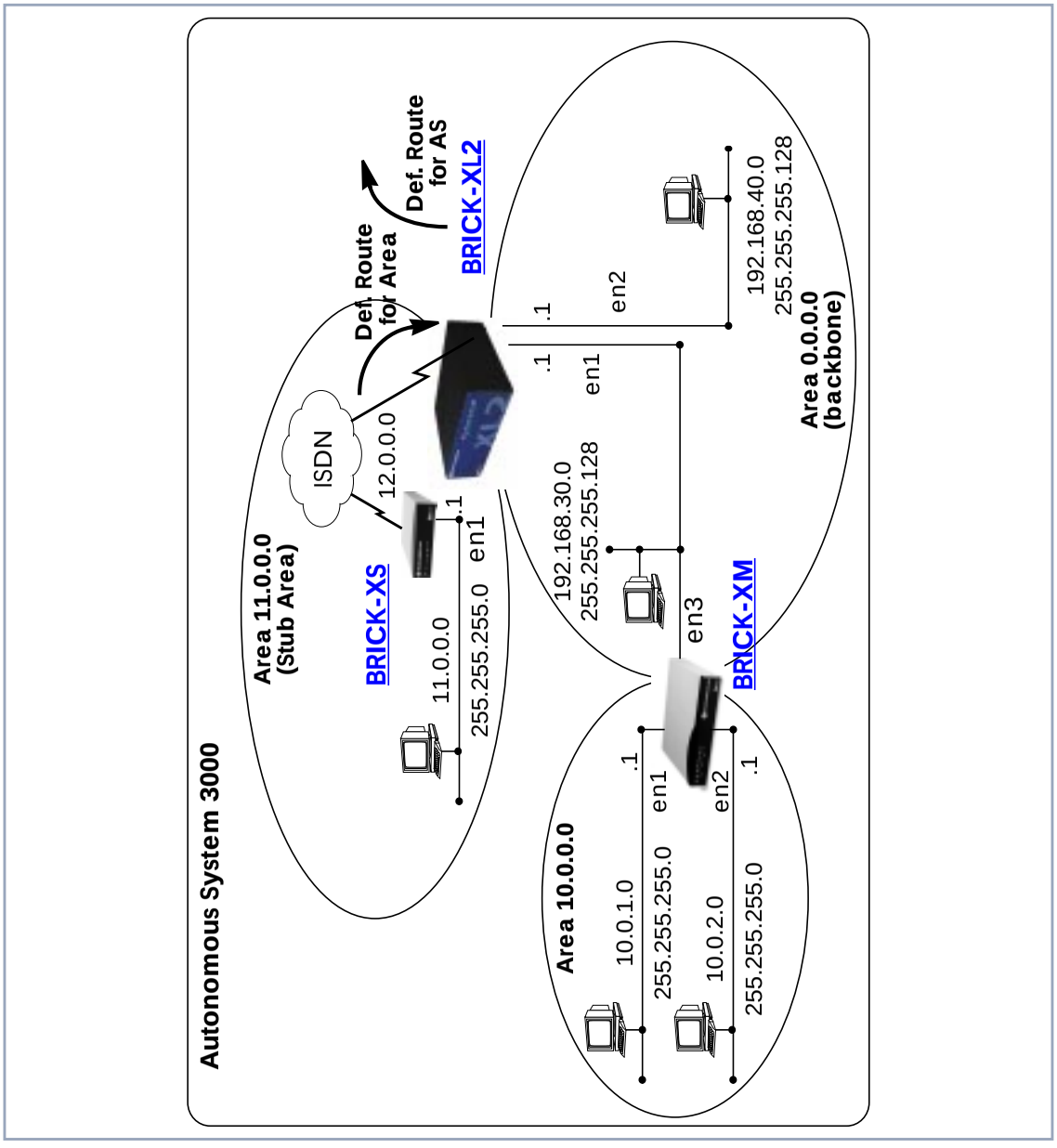

Figure A-6: OSPF Installation

Area 11.0.0.0 (stub area)

- Since the remote LAN in Area 11.0.0.0 is linked to the backbone via an ISDN dialup link this area is configured as a stub area. This means that external routing information advertisements will not flow into this area. The default route for this area is provided by the router BRICK-XL2.
- Because OSPF on the BinTec router includes support for Demand Circuits (RFC 1793) the dialup link is only opened when changes in routing information must be propagated.

Area 0.0.0.0 (backbone)

Area 0.0.0.0 is the backbone of the Autonomous System. The router at BRICK-XL2 will provide the default route for the entire AS and a default route for Area 11.0.0.0.

Area 10.0.0.0

Area 10.0.0.0 is connected to the backbone via the border router BRICK-XM. Since this is the only link between networks in this area and any external networks (such as the Internet) BRICK-XM will provide Summary Links to routers in other areas. This means that routing information about networks in Area 10.0.0.0 will be combined (or aggregated) into a single advertisement. This lessens the amount of traffic on the backbone and keeps the size of the link state database for area 0.0.0.0 small.

1.3.1 Configuration Overview

Prerequisite for all BinTec routers:

- A valid OSPF license must be installed. This can be added to the **biboAdmLicenseTable** or from Setup Tool's ***LICENCES*** menu.
- OSPF must be enabled by setting **ospfAdminStat** to enabled, or from Setup Tool's ***IP*** ➧ ***OSPF*** ➧ ***STATIC SETTINGS*** menu.

BRICK-XL2 Overview

- ➤ Create the dial-up partner interface to BRICK-XS.
- ➤ Have BRICK-XL2 advertise the default route for the AS.

- Create the Area entry for Area *11.0.0.0.*
- Assign the new dialup partner interface to Area *11.0.0.0* and set the interface to *active.*

BRICK-XM Overview

- Create the Area entry for Area *10.0.0.0.*
- Assign ethernet interfaces en1 and en2 to Area *10.0.0.0* and set both interfaces to *active.*
- Verify ethernet interface en3 is assigned to Area *11.0.0.0* and set the interface to *active.*
- Create the OSPF aggregate for the LANs attached to en1 and en2 to reduce the routing traffic sent over en3.

BRICK-XS Overview

- Create the dial-up partner interface to BRICK-XL2.
- Create the Area entry for Area *11.0.0.0.*
- Assign the ethernet interface (en1) to Area *11.0.0.0* and set the interface to *active.*
- Assign the new dial-up interface to Area *0.0.0.0* and set the interface to *active.*

1.3.2 Configuration Steps for BRICK-XL2

- Enable OSPF and create the partner interface to BRICK-XS. Note that our example uses a transfer network (network 12.0.0.0).
- Since BRICK-XL2 should advertise the default route for the AS go to ***IP*** ➧ ***OSPF*** ➧ ***STATIC SETTINGS*** and set the **Generate Default Route for the AS** field to *yes.*

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][STATIC]: OSPF Static Settings                         MyRouter


OSPF                                                             enabled
Generate Default Route for the AS                                yes

                      SAVE                  CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

- In the ***IP*** ➧ ***OSPF*** ➧ ***AREAS*** menu create an entry for Area *11.0.0.0*. Define this area as a Stub Area and have BRICK-XL2 generate the default route for this area.

```
BinTec routerSetup Tool                         BinTec Communications AG
[IP][OSPF][AREA][ADD]: Area Configuration                        MyRouter


Area ID                                          11.0.0.0

Import external routes                           no
Import summary routes                            no
Create area default route (only ABR)             yes

Area Ranges>

                          SAVE                   CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

- In the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu locate the dialup interface entry created before and press **Enter** to edit the settings.
- Set the **Admin Status** to *active* and assign it to Area *11.0.0.0* (or the area created before) and select **SAVE.**

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][INTERFACE]: Configure Interface BRICK                MyRouter


Admin Status                        active (propagate routes + run OSPF)
Area ID                             11.0.0.0

Metric Determination                auto (ifSpeed)
Metric (direct routes)              1562

Authentication Type                 none
Authentication Key

Import indirect static routes       no

                      SAVE                  CANCEL

Use (Space) to select
```

By default, dial-up interfaces are set to *passive* in the **Admin Status** field.

- In ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu verify the ethernet interfaces en1 and en2 are assigned to the backbone, (Area *0.0.0.0* which is the default area).
- Set the **Admin Status** to active and assign it to Area *11.0.0.0* (or the value from the step before) and select **SAVE.**

1.3.3 Configuration Steps for BRICK-XM

- Enable OSPF in ***IP*** ➧ ***OSPF*** ➧ ***STATIC SETTINGS.***
- Then create an area entry for Area 10.0.0.0 in the ***IP*** ➧ ***OSPF*** ➧ ***AREAS*** menu.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][AREA][ADD]: Area Configuration                        MyRouter


Area ID                                  10.0.0.0
Import external routes                   yes


Area Ranges>

                SAVE                     CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

- In the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu assign ethernet interfaces en1 and en2 to Area *10.0.0.0* (or the value from the previous step) and set the **Admin Status** for each interface to active.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][AREA][ADD]: Area Configuration                        MyRouter


Admin Status                  active (propagate routes + run OSPF)
Area ID                       10.0.0.0

Metric Determination          auto (ifSpeed)
Metric (direct routes)        10

Authentication Type           none
Authentication Key

Import indirect routes        no

                SAVE                        CANCEL

Use (Space) to select
```

- Ethernet interface en3 should already be assigned to the backbone, Area *0.0.0.0* which is the default.
- In the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu verify this setting and change the **Admin Status** to *active.*
- Return to the ***IP*** ➧ ***OSPF*** ➧ ***AREAS*** menu and scroll to the **Area ID** entry for the backbone and press **Enter**.
- Move to the ***AREA RANGES*** submenu to add an OSPF aggregate for the LANs attached to en1 and en2. The Address and Mask entries shown below will match any routes with a destinations starting with 10, or 10.*.*.*.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][AREA][RANGE][ADD]: Configure Address range for AreaMyRouter


Address                                 10.0.0.0
Mask                                    255.0.0.0

Advertise Matching                      yes

                SAVE                    CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

This entry means that BRICK-XM will consolidate multiple routes (routes for destinations in Area *10.0.0.0*) into a single link state advertisement.

This will effectively reduce the amount of traffic sent over the backbone as will help keep the size of the link state database and routing tables for routers in other areas to a minimum.

1.3.4 Configuration Steps for BRICK-XS

- Enable OSPF and create the dial-up partner interface to BRICK-XL2. In our example a transfer network (12.0.0.0) is used.
- In the ***IP*** ➧ ***OSPF*** ➧ ***AREAS*** menu create Area *11.0.0.0.* and define it as a Stub Area.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][AREA][ADD]: Area Configuration                       MyRouter


Area ID                                 11.0.0.0

Import external routes                  no
Import summary routes                   no
Create area default route (only ABR)    no

Area Ranges>

                    SAVE                CANCEL

Enter IP address (a.b.c.d or resolvable hostname)
```

➤ In the ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu assign the ethernet interface (en1) to Area *11.0.0.0* and make sure the **Admin Status** is set to *active*.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][INTERFACES] Configure Interface en1                  MyRouter


Admin Status                  active (propagate routes + run OSPF)
Area ID                       11.0.0.0

Metric Determination          auto (ifSpeed)
Metric (direct routes)        10

Authentication Type           none
Authentication Key

Import indirect routes        no

                 SAVE                        CANCEL

Use (Space) to select
```

➤ In ***IP*** ➧ ***OSPF*** ➧ ***INTERFACES*** menu locate the dialup interface (created in step 1) and assign the interface to Area *11.0.0.0* (or the value used in the step before).

➤ Set the **Admin Status** for the dialup interface to active and select **SAVE**.

```
BinTec router Setup Tool                        BinTec Communications AG
[IP][OSPF][INTERFACES] Configure Interface dialup               MyRouter


Admin Status                  active (propagate routes + run OSPF)
Area ID                       11.0.0.0

Metric Determination          auto(ifSpeed)
Metric (direct routes)        1562

Authentication Type           none
Authentication Key


                     SAVE                        CANCEL

Use (Space) to select
```

1.3.5 Configuring OSPF Virtual Links

A virtual interface must be defined on each of the ABRs by creating an entry in the **ospfVirtIfTable**. This is done by setting the **ospfVirtIfNeighbor** and **ospfVirtIfAreaID** objects.

- **ospfVirtIfNeighbor** should be set to the Router ID of the Area Border Router at the other end of the virtual link.
- **ospfVirtIfAreaID** should be set to the **Area ID** of the transit area.

The virtual link in the diagram here would be configured on BRICK-A as follows:

```
BRICK-A:system> ospfVirtIfTable
inx   AreaID(rw*)          Neighbor(rw*)     TransitDelay(rw)
      Retrasitinterval(rw) Hellointerval(rw) RtrDeadInterval(rw)
      State(ro)            Events(ro)        AuthKey(rw)
      Status(-rw)          AuthType(rw)

BRICK-A:ospdVirtIfTable> AreaID=10.0.0.0 Neighbor=10.0.1.2
```

This creates a new OSPF virtual interface (on BRICK-A) that links two parts of the backbone via the transit area *10.0.0.0*. The respective interface would be created on BRICK-B using almost the same command (**ospfVirtIfAreaID**=*10.0.0.0* **ospfVirtIfNeighbor**=*10.0.1.1*).

Remember that the area being used as the transit area must already be defined in the **ospfAreaTable**.

1.4 Controlling Link State Database Overflow

Sites with large (or complicated) network installations that are running OSPF may notice the Link State Database (LSDB) becoming large. Most often this is the case where external routes are being imported as external advertisements.

One way to minimize the size of the LSDB (on the BinTec router) is to use the **ospfExtLsdbLimit** variable. This object defines the maximum number of external LSAs to store in the database (the local copy).

Once the limit is reached the BinTec router goes into Overflow State. In Overflow State two things happen:

- The BinTec router begins to flush all external advertisements generated locally.
- The BinTec router ignores all new external advertisements.

The maximum size of the LSDB must be the same for all OSPF routers in the domain for this feature to perform efficiently.

By default the BinTec router remains in overflow state but can optionally be configured to leave overflow state (and continue to process new external LSAs) automatically after a time period. The **ospfExtOverflowInterval** variable defines the number of seconds to wait before leaving overflow state automatically. The default is *0* seconds (i.e., stay in overflow state). After waiting **ospfExtOverflowInterval** seconds the number of external LSAs in the LSDB is compared to the **ospfExtLsdbLimit**. If there is room in the database for new LSAs, the BinTec router leaves overflow state; otherwise another time interval is waited.

The diagram shown below attempts to illustrate the behavior of database overflow control using the **ospfExtLsdbLimit** and **ospfExtOverflowInterval** variables.

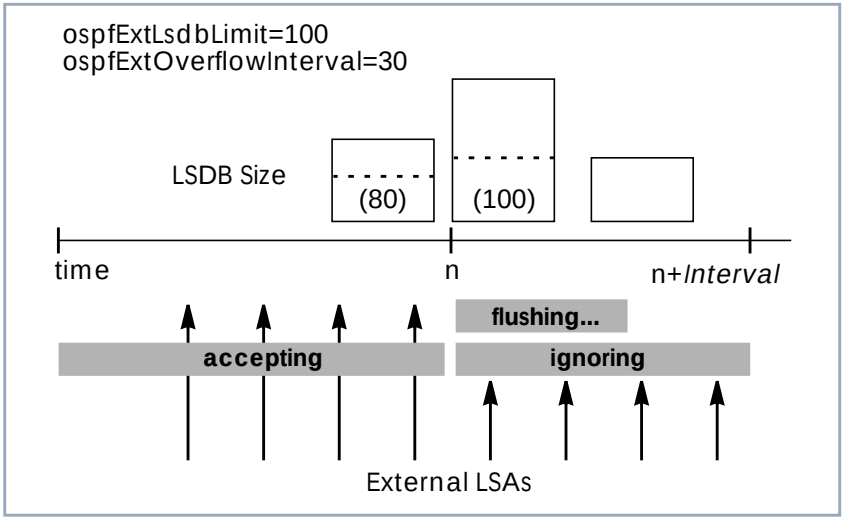

Figure A-7: Database Overflow Control

1.5 Enabling Demand Circuit Support

Demand Circuit support for dial-up partner interfaces is enabled by default when an existing interface is enabled for OSPF (**AdminStatus** is set to *active*). Support can be manually controlled by setting the interface's **IfDemand** object (**ospfIfTable**) to *true* or *false*. When set to *false*, the state of this interface is always up.

Setting this variable to *true* for one side of the connection is sufficient (that is, as long as OSPF has been enabled on both sides, i.e., **ipExtIfOspf**=*active*) if both sides support RFC 1793.

Until a neighbor router has been identified HELLO packets are periodically transmitted (default, **ospfIfPollInterval** = *120* seconds) over the interface. This results in the link being opened. Once the LSDB has been synchronized, the HELLO protocol is then suppressed.

1.6 Import / Export of Routing Information

When different routing protocols are used within the same domain it is sometimes useful to be able to exchange (import or export) routing information between these protocols.

Using the **ipImportTable** routing information generated by one protocol (**ipImportSrcProto**) can be imported or exported to another protocol (**ipImportDstProto**).

Currently the following SrcProto ↔DstProto combinations are possible:

		ipImportDstProto	
		rip	ospf
ipImportSrcProto	default route		✓(1) (see table 2-11)
	direct		
	static		✓(2) (see table 2-11)
	rip		
	ospf	✓(3) (see table 2-11)	

For further control, the fields of the **ipImportTable** allow how (and what) routing information is imported.

Variable	Meaning
ipImportSrcProto (1)	default_route **ipImportDstProto**=ospf This entry forces an external Link State Advertisement to be generated that defines a default route for the Autonomous System.
ipImportSrcProto (2)	static **ipImportDstProto**=ospf With this entry statically configured indirect routes will be propagated via OSPF as external LSAs.
ipImportSrcProto (3)	ospf **ipImportDstProto**=rip With this entry, all routes learned via OSPF are imported to RIP. If an OSPF route changes, the import to RIP will trigger an immediate broadcast of the entire routing table.
ipImportMetric1	The metric in the context of the destination protocol the imported routes should get. If set to *-1* these routes get a protocol-specific default metric.
ipImportType	This object might define protocol specific properties of the imported routes in the context of the destination protocol.
ipImportAddr	Specifies (together with **ipImportMask**) the range of IP addresses for which the table entry should be valid. The entry is valid if the destination IP address of the route lies in the range specified by both objects. If both objects are set to *0.0.0.0*, the table entry will be valid for destination.

Variable	Meaning
ipImportMask	Together with **ipImportAddr** specifies the range of IP addresses for which the table entry should be valid. For example, if Addr=*X.X.0.0* and Mask=*255.255.0.0* then addresses *X.X.0.0* through *X.X.255.255* are valid.
ipImportEffect	Defines the effect of this entry. If set to *import* importation from **SrcProto** to **DstProto** takes place. If set to *doNotImport* importation is prevented.
ipImportIfIndex	Specifies the interface index of the interface for which the entry should be valid. If set to *0* the entry is valid for all interfaces.

Table A-11: **ipImportTable**