

OSPF 如何将外部路由传播到多个区域

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简介

本文档说明 Open Shortest Path First (OSPF) 如何将外部路由传播到多个网络区域。

先决条件

要求

本文档没有任何特定的要求。

使用的组件

本文档不限于特定的软件和硬件版本。

规则

有关文档规则的详细信息，请参阅 [Cisco 技术提示规则](#)。

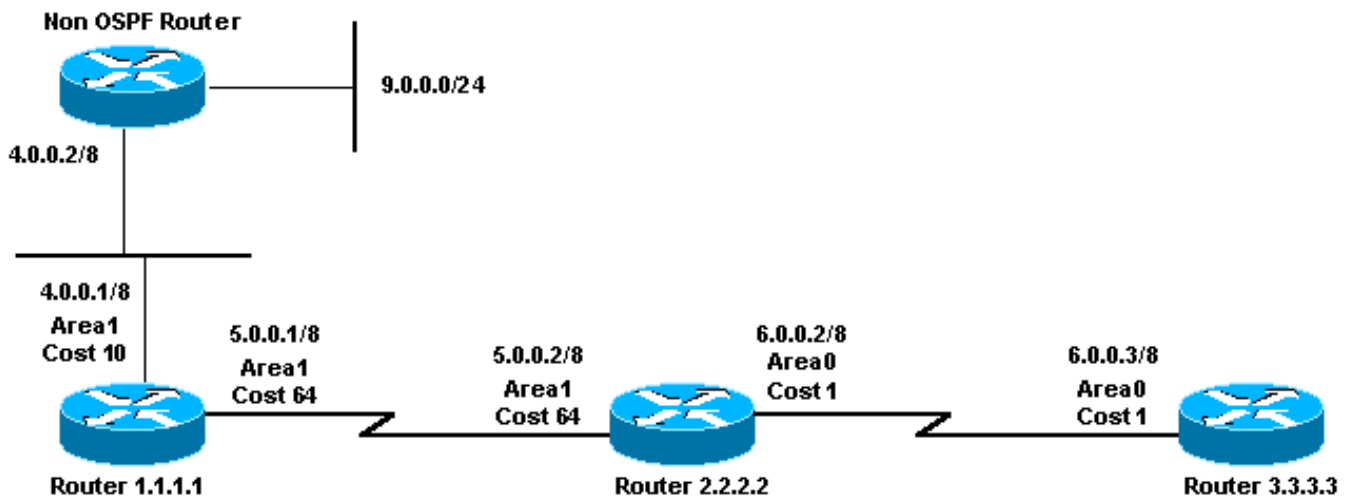
配置

本部分提供有关如何配置本文档所述功能的信息。

注：要查找有关本文档中使用的命令的其他信息，请使用命令 [查找工具](#) (仅注册客户)。

网络图

本文档使用此图所示的网络设置。



配置

本文档使用此处所示的配置。

- [路由器 1.1.1.1](#)
- [路由器 2.2.2.2](#)
- [路由器 3.3.3.3](#)

路由器 1.1.1.1

Current configuration:

```
hostname r1.1.1.1

interface Loopback0
 ip address 1.1.1.1 255.0.0.0

interface Serial2/1/0
 ip address 5.0.0.1 255.0.0.0

interface Ethernet2/0/0
 ip address 4.0.0.1 255.0.0.0

router ospf 4
 redistribute static metric 5 metric-type 1
 network 5.0.0.0 0.255.255.255 area 1
 network 4.0.0.0 0.255.255.255 area 1

ip route 9.0.0.0 255.0.0.0 4.0.0.2

end
```

路由器 2.2.2.2

Current configuration:

```
hostname r2.2.2.2
```

```
interface Loopback0
 ip address 2.2.2.2 255.0.0.0

interface Serial0/1/0
 ip address 5.0.0.2 255.0.0.0

interface ATM1/0.20
 ip address 6.0.0.2 255.0.0.0

router ospf 2
 network 5.0.0.0 0.255.255.255 area 1
 network 6.0.0.0 0.255.255.255 area 0

end
```

路由器 3.3.3.3

```
Current configuration:

hostname r3.3.3.3

interface Loopback0
 ip address 3.3.3.3 255.0.0.0

interface ATM2/0.20 point-to-point
 ip address 6.0.0.3 255.0.0.0

router ospf 2
 network 6.0.0.0 0.255.255.255 area 0

end
```

验证

本部分所提供的信息可用于确认您的配置是否正常工作。

[命令输出解释程序工具 \(仅限注册用户 \) 支持某些 show 命令](#)，使用此工具可以查看对 show 命令输出的分析。

- [show ip ospf database](#) -显示Link State Advertisement (LSA)列表并且键入他们到连结状态数据库。此列表仅显示 LSA 报头中的信息。
- [show ip ospf database \[router\] \[link-state-id\]](#) -显示在数据库中的一台路由器所有的LSA列表。LSA是由每个路由器生产的。这些基本LSA列出所有路由器链路或者接口，以及链路的状态和流出开销。他们应只在产生的区内被泛洪。
- [show ip ospf database summary <link state id>](#) -显示区域边界路由器(ABR)汇总链路。
- [show ip ospf database external](#) - 仅显示有关外部 LSA 的信息。
- [show ip ospf database asbr-summary](#) - 仅显示有关自治系统边界路由器汇总 LSA 的信息。

检查 OSPF 数据库

下面的输出使用 `show ip ospf database` 命令来显示 OSPF 数据库在此网络环境中的外观。

```
r2.2.2.2#show ip ospf database
```

OSPF Router with ID (2.2.2.2) (Process ID 2)

Router Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
2.2.2.2	2.2.2.2	93	0x80000020	0xCD0B	2
3.3.3.3	3.3.3.3	1225	0x8000000D	0x9057	2

Summary Net Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
4.0.0.0	2.2.2.2	73	0x80000001	0xFFE6
5.0.0.0	2.2.2.2	1651	0x80000006	0x8466

Summary ASB Link States (Area 0)

Link ID	ADV Router	Age	Seq#	Checksum
1.1.1.1	2.2.2.2	74	0x80000001	0x935C

Router Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum	Link count
1.1.1.1	1.1.1.1	89	0x80000011	0xFF59	3
2.2.2.2	2.2.2.2	88	0x80000033	0x2130	2

Summary Net Link States (Area 1)

Link ID	ADV Router	Age	Seq#	Checksum
6.0.0.0	2.2.2.2	94	0x8000001F	0xCC43

Type-5 AS External Link States

Link ID	ADV Router	Age	Seq#	Checksum	Tag
9.0.0.0	1.1.1.1	135	0x80000001	0x3AE8	0

为了将外部路由通告给 OSPF，自治系统边界路由器 (ASBR) 将创建 (类型 5) 外部 LSA。

```
r2.2.2.2#show ip ospf database external 9.0.0.0
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Type-5 AS External Link States
```

```
Routing Bit Set on this LSA
```

```
LS age: 286
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: AS External Link
```

```
Link State ID: 9.0.0.0 (External Network Number )
```

```
!--- 9.0.0.0/8 is advertised by the !--- ASBR (Router 1.1.1.1). Advertising Router: 1.1.1.1 LS  
Seq Number: 80000001 Checksum: 0x3AE8 Length: 36 Network Mask: /8 Metric Type: 1 (Comparable  
directly to link state metric) TOS: 0 Metric: 5 Forward Address: 0.0.0.0 !--- Forwarding address  
is not specified since there !--- are no OSPF neighbors on Router 1.1.1.1's Ethernet. !--- When  
the forward address is 0.0.0.0, this means that !--- the traffic for this network is to be sent  
to the !--- advertising router (1.1.1.1). External Route Tag: 0
```

为了将 ASBR 的可访问性通告给其他区域，ABR 将创建 (类型 4) ASBR 汇总 LSA。

```
r2.2.2.2#show ip ospf database asbr-summary 1.1.1.1
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Summary ASB Link States (Area 0)
```

```
LS age: 266
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Summary Links(AS Boundary Router)
Link State ID: 1.1.1.1 (AS Boundary Router address)
!--- ABR (Router 2.2.2.2) is advertising that it knows how !--- to reach the ASBR (Router
1.1.1.1). Advertising Router: 2.2.2.2 LS Seq Number: 80000001 Checksum: 0x935C Length: 28
Network Mask: /0 TOS: 0 Metric: 64 !--- The ABR's cost to reach the ASBR.
```

ABR (路由器 2.2.2.2) 已安装从 ASBR (路由器 1.1.1.1) 获知的外部路由器并将外部 LSA 从区域 1 泛洪到区域 0。(外部 LSA 照旧泛洪到所有区域。) 但是 , ASBR 不在区域 0 中。区域 0 中的路由器不知道如何访问 ASBR。这就是 ABR 创建 ASBR 汇总 LSA 并将路由器 1.1.1.1 的可访问性通告给区域 0 的原因。

注意 : 此下一组输出仅提供有关此示例设置中 OSPF 数据库的更多详细信息。如果您熟悉此信息 , 请跳到[计算最短路径部分](#)。

```
r2.2.2.2#show ip ospf database router 1.1.1.1
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Router Link States (Area 1)
```

```
Routing Bit Set on this LSA
```

```
LS age: 109
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Router Links
```

```
Link State ID: 1.1.1.1
```

```
!--- For router links, Link State Id is always the !--- same as the Advertising Router.
```

```
Advertising Router: 1.1.1.1 !--- This is the router ID of the router that created !--- this LSA.
```

```
LS Seq Number: 80000011 Checksum: 0xFF59 Length: 60 AS Boundary Router !--- Bit E in the router
```

```
LSA indicates that this !--- router originates external LSAs. Number of Links: 3 !--- There are
```

```
three links in area 1. Link connected to: a Stub Network !--- This line represents the Ethernet
```

```
segment !--- 4.0.0.0/8. (Link ID) Network/subnet number: 4.0.0.0 (Link Data) Network Mask:
```

```
255.0.0.0 Number of TOS metrics: 0 TOS 0 Metrics: 10 !--- OSPF cost of the Ethernet segment.
```

```
Link connected to: another Router (point-to-point) !--- This line shows that Router 1.1.1.1 is a
```

```
!--- neighbor with Router 2.2.2.2. (Link ID) Neighboring Router ID: 2.2.2.2 (Link Data) Router
```

```
Interface address: 5.0.0.1 !--- The interface address that connects to !--- Router 2.2.2.2 is
```

```
5.0.0.1. Number of TOS metrics: 0 TOS 0 Metrics: 64 !--- OSPF cost of the link connecting the
```

```
two routers. Link connected to: a Stub Network !--- This line represents the serial link
```

```
5.0.0.0/8. (Link ID) Network/subnet number: 5.0.0.0 (Link Data) Network Mask: 255.0.0.0 Number
```

```
of TOS metrics: 0 TOS 0 Metrics: 64 !--- OSPF cost of the serial link. r2.2.2.2#show ip ospf
```

```
database router 2.2.2.2
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Router Link States (Area 0)
```

```
LS age: 135
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Router Links
```

```
Link State ID: 2.2.2.2
```

```
Advertising Router: 2.2.2.2
```

```
LS Seq Number: 80000020
```

```
Checksum: 0xCD0B
```

```
Length: 48
```

```
Area Border Router
```

```
Number of Links: 2
```

```
Link connected to: another Router (point-to-point)
```

```
(Link ID) Neighboring Router ID: 3.3.3.3
```

```
(Link Data) Router Interface address: 6.0.0.2
```

```
Number of TOS metrics: 0
```

TOS 0 Metrics: 1

Link connected to: a Stub Network
(Link ID) Network/subnet number: 6.0.0.0
(Link Data) Network Mask: 255.0.0.0
Number of TOS metrics: 0
TOS 0 Metrics: 1

Router Link States (Area 1)

LS age: 130
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 2.2.2.2
Advertising Router: 2.2.2.2
LS Seq Number: 80000033
Checksum: 0x2130
Length: 48
Area Border Router
Number of Links: 2

Link connected to: another Router (point-to-point)
(Link ID) Neighboring Router ID: 1.1.1.1
(Link Data) Router Interface address: 5.0.0.2
Number of TOS metrics: 0
TOS 0 Metrics: 64

Link connected to: a Stub Network
(Link ID) Network/subnet number: 5.0.0.0
(Link Data) Network Mask: 255.0.0.0
Number of TOS metrics: 0
TOS 0 Metrics: 64

r2.2.2.2#**show ip ospf database router 3.3.3.3**

OSPF Router with ID (2.2.2.2) (Process ID 2)

Router Link States (Area 0)

LS age: 1280
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 3.3.3.3
Advertising Router: 3.3.3.3
LS Seq Number: 8000000D
Checksum: 0x9057
Length: 48
Number of Links: 2

Link connected to: another Router (point-to-point)
(Link ID) Neighboring Router ID: 2.2.2.2
(Link Data) Router Interface address: 6.0.0.3
Number of TOS metrics: 0
TOS 0 Metrics: 1

Link connected to: a Stub Network
(Link ID) Network/subnet number: 6.0.0.0
(Link Data) Network Mask: 255.0.0.0
Number of TOS metrics: 0
TOS 0 Metrics: 1

为了将路由从一个区域通告给另一个区域，ABR 将创建 (类型 3) 汇总 LSA。

```
r2.2.2.2#show ip ospf database summary 4.0.0.0
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Summary Net Link States (Area 0)
```

```
LS age: 184
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Summary Links(Network)
```

```
Link State ID: 4.0.0.0 (summary Network Number)
```

```
!--- 4.0.0.0/8 is advertised into area 0 by !--- the ABR (Router 2.2.2.2). Advertising Router:  
2.2.2.2 LS Seq Number: 80000001 Checksum: 0xFFE6 Length: 28 Network Mask: /8 TOS: 0 Metric: 74
```

```
r2.2.2.2#show ip ospf database summary 5.0.0.0
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Summary Net Link States (Area 0)
```

```
LS age: 1768
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Summary Links(Network)
```

```
Link State ID: 5.0.0.0 (summary Network Number)
```

```
!--- 5.0.0.0/8 is advertised into area 0 by !--- the ABR (Router 2.2.2.2). Advertising Router:  
2.2.2.2 LS Seq Number: 80000006 Checksum: 0x8466 Length: 28 Network Mask: /8 TOS: 0 Metric: 64
```

```
r2.2.2.2#show ip ospf database summary 6.0.0.0
```

```
OSPF Router with ID (2.2.2.2) (Process ID 2)
```

```
Summary Net Link States (Area 1)
```

```
LS age: 216
```

```
Options: (No TOS-capability, DC)
```

```
LS Type: Summary Links(Network)
```

```
Link State ID: 6.0.0.0
```

```
!--- 6.0.0.0/8 is advertised into area 1 by the ABR(2.2.2.2). Advertising Router: 2.2.2.2 LS  
Seq Number: 8000001F Checksum: 0xCC43 Length: 28 Network Mask: /8 TOS: 0 Metric: 1
```

计算最短路径

本部分将从路由器 3.3.3.3 的角度来计算最短路径。

路由器 3.3.3.3 会在其自己的 LSA 中进行查找，并发现路由器 2.2.2.2 是邻居。然后，它会查看路由器 2.2.2.2 的 LSA 以验证路由器 2.2.2.2 是否将路由器 3.3.3.3 视为邻居。如果两个路由器互相看见作为邻居，则他们被认为可及的。

每个路由器还会检查自己的本地邻居表（可使用 `show ip ospf neighbor` 命令查看），以验证自身接口与邻居的接口是否位于公用 IP 子网上。

注意：未在未编号的接口上执行此检查。

如果这些接口位于一个公用子网上，则路由器将安装各自邻居的路由器 LSA 中列出的所有末节网络路由。在本示例中，60.0.0.0/8 是区域 0 中路由器 2.2.2.2 的 LSA 中列出的唯一末节网络，路由器 3.3.3.3 已直接与其相连。

检查完区域 0 中的所有可访问路由器的 LSA 之后，路由器 3.3.3.3 会查看数据库中的汇总 LSA。它查找 4.0.0.0/8 和 5.0.0.0/8 的汇总 LSA。如果路由器 3.3.3.3 知道如何到达创建汇总 LSA 的通告路由器，它会将该路由添加到其路由表中。在本示例中，通告路由器是路由器 2.2.2.2，路由器 3.3.3.3 知道如何访问它。该通告路由器会在其路由表中安装 4.0.0.0/8 和 5.0.0.0/8 的路由。这些路由器的度

量是访问通告路由器的度量与汇总 LSA 的度量之和。汇总 LSA 的度量是从访问生成了汇总 LSA 的区域内部路由或区域间路由的成本计算得出的。

在计算所有内部 OSPF 路由 (区域内部或区域间) 后，路由器 3.3.3.3 会检查外部 LSA。它首先检查 ASBR 1.1.1.1 创建的外部 LSA 9.0.0.0/8，然后计算如何访问 ASBR。路由器 3.3.3.3 检查路由器 1.1.1.1 的 ASBR 汇总 LSA，而该 LSA 是由 ABR (路由器 2.2.2.2) 创建的。执行此操作后，路由器 3.3.3.3 就知道可通过 ABR 来访问 ASBR。因此，路由器 3.3.3.3 将在其路由表中安装 9.0.0.0/8 的路由。在本示例中，该路由是 E1 路由，因此，其度量是访问 ABR 的路由器 3.3.3.3 的度量、访问 ASBR 的 ABR 的度量与外部 LSA 的度量之和。

下面的输出显示了上述每个路由器的路由表中的 OSPF 路由。

```
r3.3.3.3#  
show ip route ospf  
O IA 4.0.0.0/8 [110/75] via 6.0.0.2, 00:07:59, ATM2/0.20  
O IA 5.0.0.0/8 [110/65] via 6.0.0.2, 00:07:59, ATM2/0.20  
O E1 9.0.0.0/8 [110/70] via 6.0.0.2, 00:07:59, ATM2/0.20  
  
r2.2.2.2#show ip route ospf  
O 4.0.0.0/8 [110/74] via 5.0.0.1, 00:06:55, Serial0/1/0  
O E1 9.0.0.0/8 [110/69] via 5.0.0.1, 00:06:55, Serial0/1/0  
  
r1.1.1.1#show ip route 9.0.0.0  
Routing entry for 9.0.0.0/8  
  Known via "static", distance 1, metric 0  
  Redistributing via ospf 4  
  Advertised by ospf 4 metric 5 metric-type 1  
  Routing Descriptor Blocks:  
  * 4.0.0.2  
    Route metric is 0, traffic share count is 1
```

[故障排除](#)

目前没有针对此配置的故障排除信息。

[相关信息](#)

- [OSPF 数据库说明指南](#)
- [OSPF 支持页](#)
- [IP 路由 支持页](#)
- [技术支持 - Cisco Systems](#)