OSPF虚链路：传输功能

目录

简介

本文目的将展示开放最短路径优先(OSPF)行为，当V位(连接位)时是存在非骨干区域。只有当路由器是一个或更多完全相邻的虚链路，终端V位在类型1 LSA发信号。当V位设置时这可能更改路径在区域内和区域间路由之间的计算首选。

先决条件

参考在图1的网络图，您使用本文：

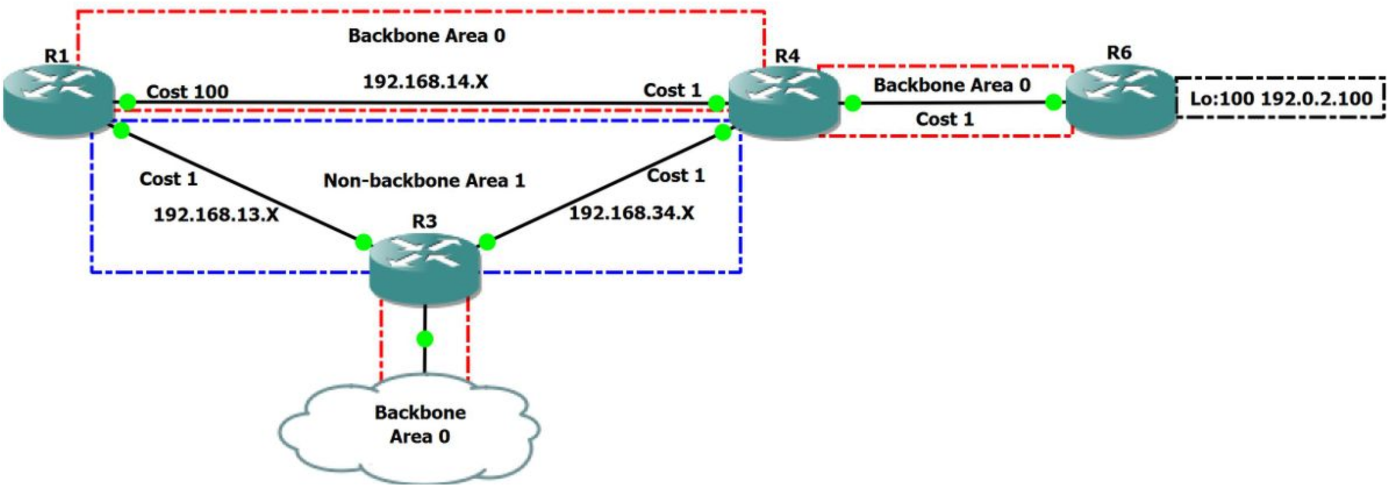

图 1

在以上的网络图中，我们有骨干区域0，并且非骨干区域1. R1是连接area 0的区域边界路由器(ABR)，并且区域1， R4和R3有在此网络的相似的作用。在此结构部分中，因为R3和R4没有通过area 0，连接0间断。

背景信息

必须连接OSPF自治系统的所有区域到骨干区域(area 0)。有时您有在您的骨干区域之间的地方一非骨干区域，这可能造成自治系统的一些区域变得不可得到并且导致您的网络间断。 当有一连续骨干区域时是不可能的，您可以使用虚链路通过非骨干区域连接您的骨干网。您配置虚链路的区域是公认的中转区域。

场景 1

网络图：

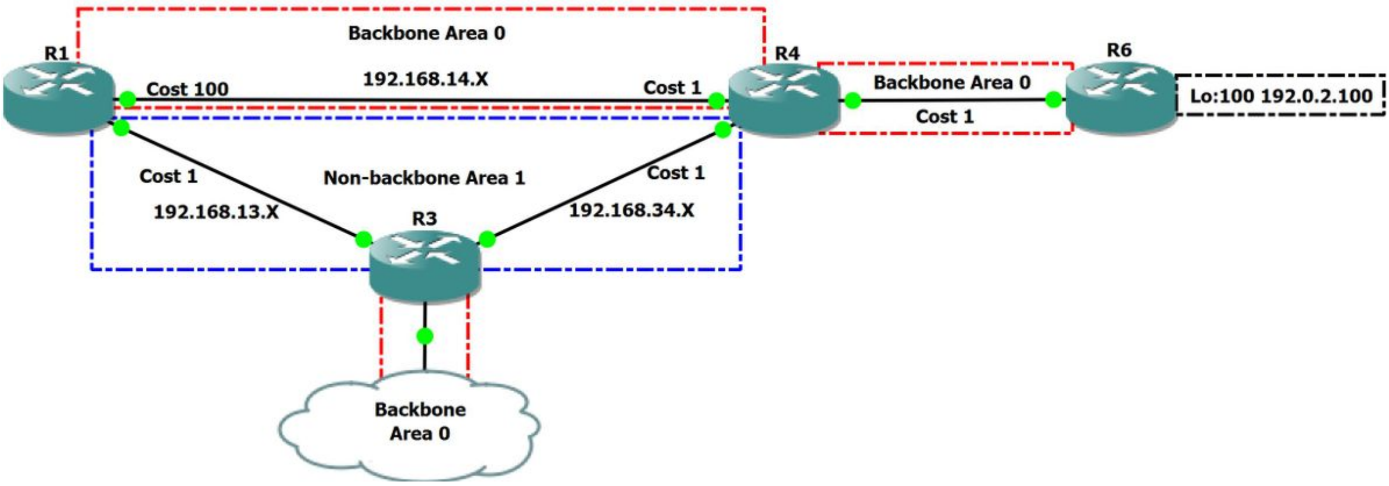

图 2

在此方案中，我们在预计路径计算去在上述网络拓扑里。我们调查什么路径被选，当路由从往R6有IP地址的192.0.2.100/32的环回100时的R1

lets查看一下在R1的OSPF数据库对进一步undestand拓扑：

```
R1#show ip ospf database

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         22          0x8000000C 0x00CD7A 2
4.4.4.4         4.4.4.4         289         0x8000000F 0x00434E 4
6.6.6.6         6.6.6.6         374         0x80000009 0x00630A 3

                Summary Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.13.0    1.1.1.1         18          0x80000001 0x00348D
192.168.13.0    4.4.4.4         207         0x80000001 0x00E3D0
192.168.34.0    1.1.1.1         8           0x80000001 0x005655
192.168.34.0    4.4.4.4         683         0x80000001 0x00F1AE

                Router Link States (Area 1)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         17          0x80000009 0x00EC2B 2
3.3.3.3         3.3.3.3         18          0x8000000E 0x005A64 4
4.4.4.4         4.4.4.4         544         0x80000005 0x0007CF 2

                Summary Net Link States (Area 1)
```

```
Link ID         ADV Router      Age         Seq#       Checksum
155.1.37.0      3.3.3.3         1558        0x80000004 0x00A7C3
192.0.2.100     1.1.1.1         23          0x80000001 0x009F0C   <- R6 Loopback
192.0.2.100     4.4.4.4         370         0x80000001 0x0059AA   <- R6 Loopback
192.168.14.0    1.1.1.1         23          0x80000001 0x000B52
192.168.14.0    4.4.4.4         331         0x80000001 0x00CEE5
192.168.34.0    1.1.1.1         3608        0x80000002 0x00406C
192.168.46.0    1.1.1.1         23          0x80000001 0x00B388
192.168.46.0    4.4.4.4         484         0x80000001 0x006D27
```

从我们能看到的上述输出R1通过R4学习R6 Lo100:192.0.2.100作为第三类型汇总LSA， R1也产生自己第三类型汇总LSA，因为通过区域内骨干网认识R6 Lo100:192.0.2.100。在下面的输出中我们能看到R6有直接地连接的192.0.2.100。

```
R1#show ip ospf da router 6.6.6.6

 OSPF Router with ID (1.1.1.1) (Process ID 1)

           Router Link States (Area 0)

 LS age: 614
 Options: (No TOS-capability, DC)
 LS Type: Router Links
 Link State ID: 6.6.6.6
 Advertising Router: 6.6.6.6
 LS Seq Number: 8000000D
 Checksum: 0x5B0E
 Length: 60
 Number of Links: 3

 Link connected to: a Stub Network
 (Link ID) Network/subnet number: 192.0.2.100      <-- Loopback 100 directly connected
 (Link Data) Network Mask: 255.255.255.255
 Number of MTID metrics: 0
 TOS 0 Metrics: 1

 Link connected to: another Router (point-to-point)
 (Link ID) Neighboring Router ID: 4.4.4.4
 (Link Data) Router Interface address: 192.168.46.6
 Number of MTID metrics: 0
 TOS 0 Metrics: 1

 Link connected to: a Stub Network
 (Link ID) Network/subnet number: 192.168.46.0
 (Link Data) Network Mask: 255.255.255.0
 Number of MTID metrics: 0
 TOS 0 Metrics: 1
```

从RFC 2328部分16.2提取

```
16.2.  Calculating the inter-area routes


        (5) Next, look up the routing table entry for the destination N.
            (If N is an AS boundary router, look up the "router" routing
            table entry associated with Area A).  If no entry exists for
            N or if the entry's path type is "type 1 external" or "type
```

```
        2 external", then install the inter-area path to N, with
        associated area Area A, cost IAC, next hop equal to the list
        of next hops to router BR, and Advertising router equal to
        BR.

    (6) Else, if the paths present in the table are intra-area
        paths, do nothing with the LSA (intra-area paths are always
        preferred).

    (7) Else, the paths present in the routing table are also
        inter-area paths.  Install the new path through BR if it is
        cheaper, overriding the paths in the routing table.
        Otherwise, if the new path is the same cost, add it to the
        list of paths that appear in the routing table entry.
```

在上述输出中我们能看到陈述域间路由在区域间路由更喜欢。因此在我们的方案R1应该喜欢去通过区域内骨干网每RFC 2328。

让检查此行为是否在我们的拓扑方面被观察：

```
R1#show ip ospf rib 192.0.2.100

   OSPF Router with ID (1.1.1.1) (Process ID 1)

 Base Topology (MTID 0)

OSPF local RIB
Codes: * - Best, > - Installed in global RIB
LSA: type/LSID/originator

*> 192.0.2.100/32, Intra, cost 102, area 0
 SPF Instance 9, age 02:19:34
 Flags: RIB, HiPrio
 via 192.168.14.4, GigabitEthernet3 label 1048578
 Flags: RIB
 LSA: 1/6.6.6.6/6.6.6.6

R1#show ip route 192.0.2.100
Routing entry for 192.0.2.100/32
 Known via "ospf 1", distance 110, metric 102, type intra area
 Last update from 192.168.14.4 on GigabitEthernet3, 02:26:29 ago
 Routing Descriptor Blocks:
 * 192.168.14.4, from 6.6.6.6, 02:26:29 ago, via GigabitEthernet3
 Route metric is 102, traffic share count is 1
```

正如你从以上输出看到我们喜欢去在往R6 loopback100的骨干区域0。在我们的林克状态数据库我们也知道一个域间路径通过R3然后R4。通过R4了解以一开销2的汇总LSA能如下被看到：

```
R1#show ip ospf database summary 192.0.2.100

            OSPF Router with ID (1.1.1.1) (Process ID 1)

                Summary Net Link States (Area 1)

  LS age: 523
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 192.0.2.100 (summary Network Number)
  Advertising Router: 1.1.1.1
  LS Seq Number: 80000005
  Checksum: 0x9710
```

```
Length: 28
Network Mask: /32
      MTID: 0          Metric: 102

LS age: 973
Options: (No TOS-capability, DC, Upward)
LS Type: Summary Links(Network)
Link State ID: 192.0.2.100 (summary Network Number)
Advertising Router: 4.4.4.4                          <- This is Type-3 LSA injected by ABR R4
LS Seq Number: 80000005
Checksum: 0x51AE
Length: 28
Network Mask: /32
      MTID: 0          Metric: 2
```

请考虑到此开销2反射ABR有往目的地前缀的开销。第三类型LSA从area 0被充斥到非骨干区域和反过来也是一样地，它描述往链路的ABR的可接通性在其他区域。它包括费用从enjected第三类型LSA的ABR方面，但是从接收第三类型LSA的路由器的隐藏全双工开销。

从以上输出我们当前知道我们有我们可能采取到达R6从R1的环回的两个路径：

1. 区域内有一开销102
2. 域间有通过第三类型已知的一开销2 LSA + R1请开销往也是2.的R4。这给我们一个总成本4

在此方案中我们已经注意到我们选较高区域内路径，因为在区域内在域间更喜欢的RFC 2328定义。

在继续进行方案2这是示例前OSPF如何解释第三类型LSA ：

•ABR R4能到达区域内的链路A以开销X
•R1能到达ABR R4以开销Y
•暗示R1能通过SPT到达链路A以开销X + Y

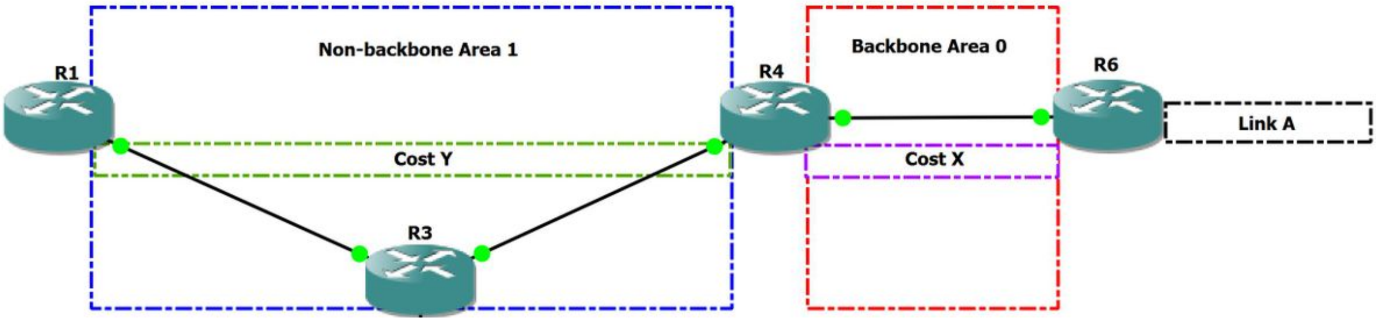

图 3

这就是为什么，因为在区域之间的信息隐藏，区域间路由通常与距离矢量协议比较。
由于域间OSPF是距离矢量，是易受攻击对路由环路。它通过要求一无环回路域间拓扑避免环路，在方面从一个区域的流量能通过area 0只到达另一个区域。

场景 2

网络图：

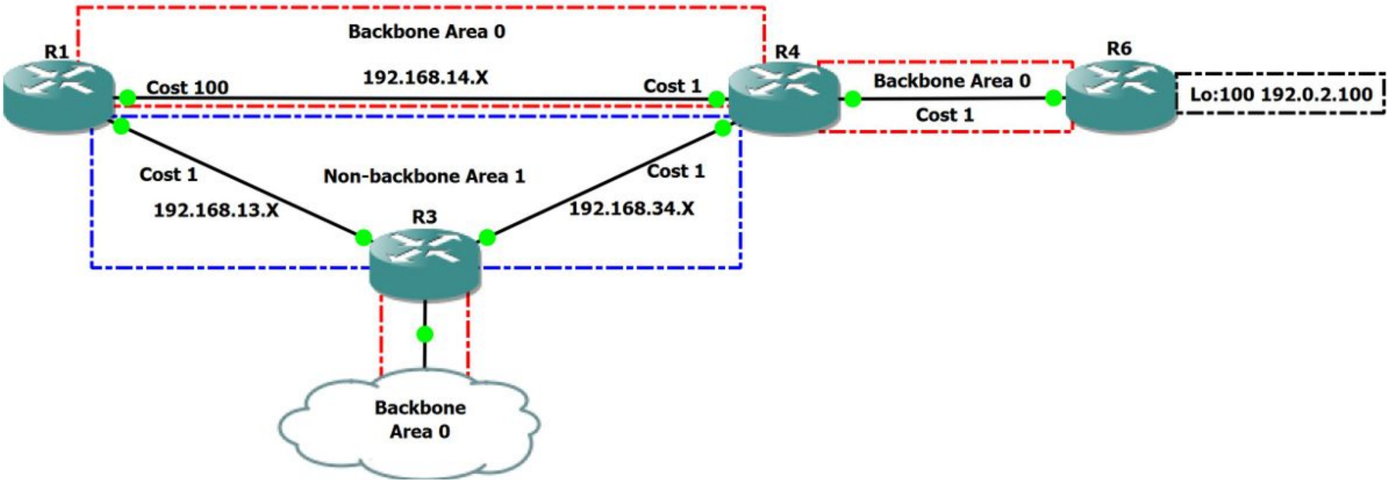

图 4

在此方案中我们设置R3和R4的V位，因此我们可能检查路径首选，当此位是存在类型1 LSA非骨干区域1.时。

从RFC 2328部分6提取

```
6. The Area Data Structure
```

TransitCapability

This parameter indicates whether the area can carry data traffic that neither originates nor terminates in the area itself. This parameter is calculated when the area's shortest-path tree is built (see Section 16.1, where TransitCapability is set to TRUE if and only if there are one or more fully adjacent virtual links using the area as Transit area), and is used as an input to a subsequent step of the routing table build process (see Section 16.3). When an area's TransitCapability is set to TRUE, the area is said to be a "transit area".

从RFC 2328部分16.1提取

```
16.1 Calculating the shortest-path tree for an area
```

(2) Call the vertex just added to the tree vertex V. Examine the LSA associated with vertex V. This is a lookup in the Area A's link state database based on the Vertex ID. **If this is a router-LSA, and bit V of the router-LSA (see Section A.4.2) is set, set Area A's TransitCapability to TRUE.** In any case, each link described by the LSA gives the cost to an adjacent vertex. For each described link, (say it joins vertex V to vertex W):

从在RFC的上述语句我们能看到，当V位在路由器LSA时设置，我们认识位设置是有能力的传输的该区域或换句话说当运行Dijkstra算法TransitCapability真实对该区域。

一旦我们知道区域可能为capability transit考虑，如果有V位集，我们必须检查此功能是否配置：默认情况下OSPF区域传输功能功能启用。

```
R1#show run all | sec ospf
router ospf 1
capability opaque
capability lls
capability transit
```

要设置V位在区域1我们将创建从R3的一虚拟链路往R4。当虚链路启动时，我们应该看到在类型1 LSA设置的V位。

```
R3(config)#router ospf 1
R3(config-router)#area 1 virtual-link 4.4.4.4

R3#show ip ospf interface brief
Interface     PID   Area             IP Address/Mask    Cost  State Nbrs F/C
VL0           1     0                192.168.34.3/24    1     P2P   1/1    <-- Here we have
Virtual-link present and 1 neighborship over VLO
Gi3           1     0                192.168.80.3/24    1     DR    0/0
Gi2           1     1                192.168.13.3/24    1     P2P   1/1
Gi1           1     1                192.168.34.3/24    1     P2P   1/1
R3#
```

现在让检查R3区域的1.类型1 LSA。

```
R3#show ip ospf 1 1 database router 3.3.3.3 OSPF Router with ID (3.3.3.3) (Process ID 1) Router Link States (Area 1)
LS age: 189 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: 80000018 Checksum: 0x525E Length: 72 Area Border Router Virtual Link Endpoint <- V-bit
set
  Number of Links: 4

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 1.1.1.1
     (Link Data) Router Interface address: 192.168.13.3
      Number of MTID metrics: 0
       TOS 0 Metrics: 1

    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.13.0
     (Link Data) Network Mask: 255.255.255.0
      Number of MTID metrics: 0
       TOS 0 Metrics: 1

    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 4.4.4.4
     (Link Data) Router Interface address: 192.168.34.3
      Number of MTID metrics: 0
       TOS 0 Metrics: 1

    Link connected to: a Stub Network
     (Link ID) Network/subnet number: 192.168.34.0
     (Link Data) Network Mask: 255.255.255.0
      Number of MTID metrics: 0
       TOS 0 Metrics: 1
```

我们在上述输出中能看到， R3当前有在其区域的1类型1 LSA设置的V位并且有启用的capability transit在路由进程级别。

我们能也看到R1有为区域启用的cababilty传输1在下面的输出中：

```
R1#show ip ospf
 Routing Process "ospf 1" with ID 1.1.1.1
 Start time: 00:02:48.412, Time elapsed: 01:27:00.690
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Supports NSSA (compatible with RFC 3101)
 Supports Database Exchange Summary List Optimization (RFC 5243)
 Event-log enabled, Maximum number of events: 1000, Mode: cyclic
 It is an area border router
 Router is not originating router-LSAs with maximum metric
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 EXCHANGE/LOADING adjacency limit: initial 300, process maximum 300
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 2. 2 normal 0 stub 0 nssa
 Number of areas transit capable is 1
 External flood list length 0
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
 Reference bandwidth unit is 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 1
        Area has no authentication
        SPF algorithm last executed 00:00:33.554 ago
        SPF algorithm executed 11 times
        Area ranges are
        Number of LSA 10. Checksum Sum 0x05EB7B
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 3
        Flood list length 0
    Area 1
        Number of interfaces in this area is 1
        This area has transit capability            <-- This area is transit capabile
        Area has no authentication
        SPF algorithm last executed 00:00:04.259 ago
        SPF algorithm executed 8 times
        Area ranges are
        Number of LSA 10. Checksum Sum 0x0517AA
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

因为区域1当前通过所有标准变为中转区域我们应该现在遵守在我们的第一个方案/首选以前然后看到的一个不同的路径计算。

它是陈述的RFC 2328，如果应该跟转换区域不同地examinded的区域考虑作为中转区域

从RFC 2328部分16.1提取

```
16.3. Examining transit areas' summary-LSAs
```

This step is only performed by area border routers attached to one or more non-backbone areas that are capable of carrying transit traffic (i.e., "transit areas", or those areas whose TransitCapability parameter has been set to TRUE in Step 2 of the Dijkstra algorithm (see Section 16.1).

The purpose of the calculation below is to examine the transit areas to see whether they provide any better (shorter) paths than the paths previously calculated in Sections 16.1 and 16.2. Any paths found that are better than or equal to previously discovered paths are installed in the routing table.

根据RFC，如果区域是传输有能力，它是受在RFC 2328的描述的路径计算支配第16.3部分

Note:在本例中虚链路启用通过区域将转发的过渡数据数据量1，但是实际路径过渡数据数据量采取不需要跟随虚链路。换句话说，虚链路允许通过区域将转发的中转流量，但是不指明流量将采取的准确的路径。

假设capability transit在R1禁用。请用traceroute检查往目的地R6 loopback:100 192.0.2.100的路径。

```
R1#traceroute 192.0.2.100
Tracing the route to 192.0.2.100
VRF info: (vrf in name/id, vrf out name/id)
1 192.168.14.4 2 msec 2 msec 2 msec   <--R4
2 192.168.46.6 3 msec 3 msec *        <--R6
```

一旦我们打开此功能在区域设置的V位1我们观察以下日志：

```
R1#debug ip ospf spf intra
OSPF SPF intra debugging is on
R1#debug ip ospf spf inter OSPF SPF inter debugging is on R1#conf Enter configuration commands,
one per line. End with CNTL/Z. R1(config)#router ospf 1 R1(config-router)#capability transit
R1(config-router)#
*Aug 14 15:28:07.934: OSPF-1 INTER: Running spf for summaries in transit area 1
*Aug 14 15:28:07.934: OSPF-1 INTER: Summary transit processing lsid 192.0.2.100 adv_rtr 4.4.4.4
type 3 seq 0x8000000B
*Aug 14 15:28:07.934: OSPF-1 INTER: Summary metric 2
*Aug 14 15:28:07.934: OSPF-1 INTER: found best path to adv_rtr:
i,ABR [2] via 192.168.13.3, GigabitEthernet1, Area 1 orp_txit_adv_rtr 0.0.0.0 pathflag 0x0
*Aug 14 15:28:07.934: OSPF-1 INTER: Add transit path via area 1
*Aug 14 15:28:07.934: OSPF-1 SPF : Exist path: next-hop 192.168.13.3, interface GigabitEthernet1
*Aug 14 15:28:07.934: OSPF-1 INTRA: Route update succeeded for 192.0.2.100/255.255.255.255,
metric 4, Next Hop: GigabitEthernet1/192.168.13.3 area 0
```

现在如何让检查R1往R6 loopback100的路由

```
R1#show ip ospf rib 192.0.2.100
```

```
            OSPF Router with ID (1.1.1.1) (Process ID 1)


                Base Topology (MTID 0)

OSPF local RIB
Codes: * - Best, > - Installed in global RIB
LSA: type/LSID/originator

*>  192.0.2.100/32, Intra, cost 4, area 0
     SPF Instance 14, age 00:12:28
     Flags: RIB, HiPrio, Transit
      via 192.168.13.3, GigabitEthernet1 label 1048578
       Flags: RIB
       LSA: 1/6.6.6.6/6.6.6.6

R1#show ip route 192.0.2.100
Routing entry for 192.0.2.100/32
Known via "ospf 1", distance 110, metric 4, type intra area
Last update from 192.168.13.3 on GigabitEthernet1, 00:01:26 ago
Routing Descriptor Blocks:
 * 192.168.13.3, from 6.6.6.6, 00:01:26 ago, via GigabitEthernet1
Route metric is 4, traffic share count is 1
```

为什么看到区域内而不是域间？在RFC 2328第16.3部分被提及，当执行路径calulcation，如果我们有是在中转区域的一个路由时(第三类型)的更低成本我们应该更新前缀的下一跳。这的确是我们在上述输出中看到的行为。被提及的下一跳正确，但是类型是令人误解的。

从RFC 2328部分16.3提取

```
16.3. Examining transit areas' summary-LSAs

(4) Look up the routing table entry for the advertising router
BR associated with the Area A. If it is unreachable, examine
the next LSA. Otherwise, the cost to destination N is the
sum of the cost in BR's Area A routing table entry and the
cost advertised in the LSA. Call this cost IAC.

(5) If this cost is less than the cost occurring in N's routing
            table entry, overwrite N's list of next hops with those used
            for BR, and set N's routing table cost to IAC. Else, if IAC
            is the same as N's current cost, add BR's list of next hops
            to N's list of next hops. In any case, the area associated
            with N's routing table entry must remain the backbone area,
            and the path type (either intra-area or inter-area) must
            also remain the same.
```

R1更喜欢在类型1区域内路由的域间第三类型，虽然陈述如区域内在输出中。我们清楚看见下一跳没有assosiated对area 0

```
R1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
4.4.4.4           0   FULL/  -        00:00:39    192.168.14.4    GigabitEthernet3
3.3.3.3           0   FULL/  -        00:00:32    192.168.13.3    GigabitEthernet1


R1#show ip ospf neighbor detail

 Neighbor 4.4.4.4, interface address 192.168.14.4
    In the area 0 via interface GigabitEthernet3
```

```
    Neighbor priority is 0, State is FULL, 6 state changes
    DR is 0.0.0.0 BDR is 0.0.0.0
    Options is 0x12 in Hello (E-bit, L-bit)
    Options is 0x52 in DBD (E-bit, L-bit, O-bit)
    LLS Options is 0x1 (LR)
    Dead timer due in 00:00:36
    Neighbor is up for 00:30:20
    Index 1/1/1, retransmission queue length 0, number of retransmission 3
    First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 2
    Last retransmission scan time is 135 msec, maximum is 135 msec

Neighbor 3.3.3.3, interface address 192.168.13.3
    In the area 1 via interface GigabitEthernet1
    Neighbor priority is 0, State is FULL, 6 state changes
    DR is 0.0.0.0 BDR is 0.0.0.0
    Options is 0x12 in Hello (E-bit, L-bit)
    Options is 0x52 in DBD (E-bit, L-bit, O-bit)
    LLS Options is 0x1 (LR)
    Dead timer due in 00:00:39
    Neighbor is up for 00:30:20
    Index 1/1/2, retransmission queue length 0, number of retransmission 3
    First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
    Last retransmission scan length is 4, maximum is 4
    Last retransmission scan time is 126 msec, maximum is 126 msec
```

也我们往R6 loopback100的目的地的traceroute ：

```
R1#traceroute 192.0.2.100
Tracing the route to 192.0.2.100
VRF info: (vrf in name/id, vrf out name/id)
1 192.168.13.3 2 msec 4 msec 3 msec          <-- R3
2 192.168.34.4 5 msec 3 msec 3 msec          <-- R4
3 192.168.46.6 5 msec 6 msec *               <-- R6
R1#
```

因此在上述输出中我们看到非骨干区域1在骨干区域0更喜欢到达R6环回100。

有ECMP (多重通道的等价)也是可能的使用区域内和区域间路由，如果在他们之间的开销是相等的。这能在我们的拓扑方面完成由减小往R4的R1s链路从100到2。

当这执行时我们有以下输出在RIB和OSPF RIB ：

```
R1#show ip ospf rib 192.0.2.100 OSPF Router with ID (1.1.1.1) (Process ID 1) Base Topology (MTID 0) OSPF local RIB
Codes: * - Best, > - Installed in global RIB LSA: type/LSID/originator *> 192.0.2.100/32, Intra, cost 4, area 0 SPF
Instance 14, age 00:13:08 Flags: RIB, HiPrio, Transit, OldTrans via 192.168.13.3, GigabitEthernet1 label 1048578
Flags: RIB LSA: 1/6.6.6.6/6.6.6.6 via 192.168.14.4, GigabitEthernet3 label 1048578 Flags: RIB LSA: 1/6.6.6.6/6.6.6.6
```

```
R1#show ip route 192.0.2.100
Routing entry for 192.0.2.100/32
Known via "ospf 1", distance 110, metric 4, type intra area
Last update from 192.168.14.4 on GigabitEthernet3, 00:12:44 ago
Routing Descriptor Blocks:
192.168.14.4, from 6.6.6.6, 00:12:44 ago, via GigabitEthernet3
Route metric is 4, traffic share count is 1
* 192.168.13.3, from 6.6.6.6, 00:12:44 ago, via GigabitEthernet1
Route metric is 4, traffic share count is 1
```