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Deploying OSPF for ISPs

ISP/IXP Workshops

Agenda

- OSPF Design in SP Networks
- Adding Networks in OSPF
- OSPF in IOS

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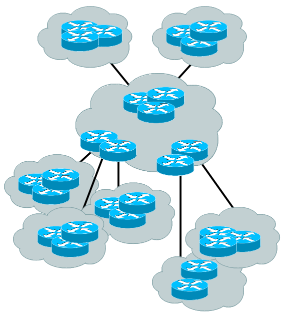
OSPF Design

As applicable to Service Provider Networks

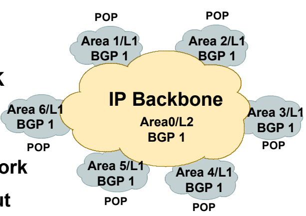
Service Providers

- SP networks are divided into PoPs
- Transit routing information is carried via BGP
- IGP is used to carry next hop only
- Optimal path to the next hop is critical



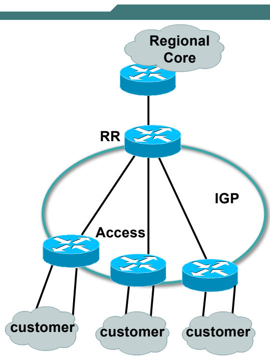
SP Architecture

- Major routing information is ~155K prefixes via BGP
- Largest known IGP routing table is ~6–7K
- Total of 162K
- 6K/162K ~ 4% of IGP routes in an ISP network
- A very small factor but has a huge impact on network convergence!



SP Architecture

- You can reduce the IGP size from 6K to approx the number of routers in your network
- This will bring really fast convergence
- Optimise where you must and summarise where you can
- Stops unnecessary flapping



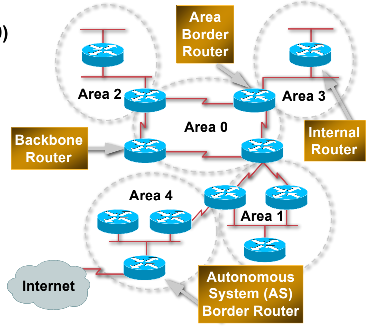
OSPF Areas and Rules

Backbone area (0) must be present

All other areas must have connection to backbone

Backbone must be contiguous

Do NOT partition area (0)



OSPF Design: Addressing

- OSPF Design and Addressing go together
  - Objective is to keep the Link State Database *lean*
  - Create an address hierarchy to match the topology
  - Use separate Address Blocks for network infrastructure, customer interfaces, customers, etc.

OSPF Design: Areas

- Examine physical topology
  - Is it meshed or hub-and-spoke?
- Use areas and summarisation
  - This reduces overhead and LSA counts
  - (but watch next-hop for iBGP when summarising)
- Don’t bother with the various stub areas
  - No benefits for ISPs, causes problems for iBGP
- Push the creation of a backbone
  - Reduces mesh and promotes hierarchy

OSPF Design: Areas

- One SPF per area, flooding done per area
  - Watch out for overloading ABRs
- Avoid externals in OSPF
  - External LSAs flood through entire network
- Different types of areas do different flooding
  - Normal areas
  - Stub areas
  - Totally stubby (stub no-summary)
  - Not so stubby areas (NSSA)

OSPF Design: Summary

- Think Redundancy
  - Dual Links out of each area – using metrics (cost) for traffic engineering
- Too much redundancy…
  - Dual links to backbone in stub areas must be the same cost – other wise sub-optimal routing will result
  - Too Much Redundancy in the backbone area without good summarization will effect convergence in the area 0

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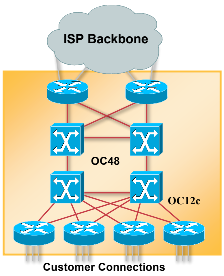
OSPF for Service Providers

Adding Networks

OSPF: Adding Networks

- BCP – Individual OSPF Network statement for each infrastructure link
  - Have separate IP address blocks for ***infrastructure*** and ***customer links***
  - Use *IP Unnumbered* Interfaces or iBGP next-hop-self for customer /30 point-to-point links
  - OSPF should only carry infrastructure routes in an ISP's network



OSPF: Adding Networks Method One

- redistribute connected subnets
  - Works for all connected interfaces on the router but sends networks as external type-2s – which are not summarized

```
router ospf 100
 redistribute connected subnets
```

- Do NOT do this!
  - Because:
  - Type-2 LSAs flood through entire network
  - These LSAs are not all useful for determining paths through backbone; simply take up space

OSPF: Adding Networks Method Two

- Specific network statements
  - Every active interface with a configured IP address needs an OSPF network statement
  - Interface that will have no OSPF neighbours needs *passive-interface* to disable OSPF Hello's
    - That is: all interfaces connecting to devices outside the ISP backbone (i.e. customers, peers, *etc*)

```
router ospf 100
 network 192.168.1.1 0.0.0.3 area 51
 network 192.168.1.5 0.0.0.3 area 51
 passive interface Serial 1/0
```


OSPF: Adding Networks Method Three

- Network statements – wildcard mask
  - Every active interface with configured IP address covered by wildcard mask used in OSPF network statement
  - Interfaces covered by wildcard mask but having no OSPF neighbours need *passive-interface* (or use *passive-interface default* and then activate the interfaces which will have OSPF neighbours)

```
router ospf 100
 network 192.168.1.0 0.0.0.255 area 51
 passive-interface default
 no passive interface POS 4/0
```


OSPF: Adding Networks Recommendations

- Don't ever use Method 1
- Method 2 doesn't scale too well when router has a large number of interfaces but only a few with OSPF neighbours
  - → solution is to use Method 3 with "no passive" on interfaces with OSPF neighbours
- Method 2 is fine for core/infrastructure routers
- Method 3 is preferred for aggregation routers
  - Or use iBGP next-hop-self
  - Or even ip unnumbered on external point-to-point links

OSPF: Adding Networks Example One

- Aggregation router with large number of leased line customers and just two links to the core network:

```
interface loopback 0
 ip address 192.168.255.1 255.255.255.255
interface POS 0/0
 ip address 192.168.10.1 255.255.255.252
interface POS 1/0
 ip address 192.168.10.5 255.255.255.252
interface serial 2/0:0 ...
 ip unnumbered loopback 0
! Customers connect here ^^^^^^^
router ospf 100
 network 192.168.255.1 0.0.0.0 area 51
 network 192.168.10.0 0.0.0.3 area 51
 network 192.168.10.4 0.0.0.3 area 51
 passive-interface default
 no passive interface POS 0/0
 no passive interface POS 1/0
```


OSPF: Adding Networks Example Two

- Core router with only links to other core routers (as core routers do!):

```
interface loopback 0
 ip address 192.168.255.1 255.255.255.255
interface POS 0/0
 ip address 192.168.10.129 255.255.255.252
interface POS 1/0
 ip address 192.168.10.133 255.255.255.252
interface POS 2/0
 ip address 192.168.10.137 255.255.255.252
interface POS 2/1
 ip address 192.168.10.141 255.255.255.252
router ospf 100
 network 192.168.255.1 0.0.0.0 area 0
 network 192.168.10.128 0.0.0.3 area 0
 network 192.168.10.132 0.0.0.3 area 0
 network 192.168.10.136 0.0.0.3 area 0
 network 192.168.10.140 0.0.0.3 area 0
 passive interface loopback 0
```


OSPF: Adding Networks Summary

- **Key Theme when selecting a technique: Keep the Link State Database Lean**
  - Increases Stability
  - Reduces the amount of information in the Link State Advertisements (LSAs)
  - Speeds Convergence Time

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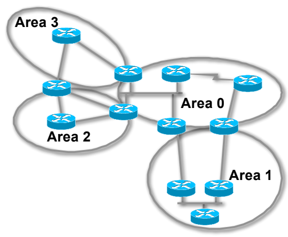
OSPF in IOS

Useful features for ISPs

Areas

- Areas defined with 32 bit number
  - Defined in IP address format
  - Can also be defined using single decimal value (i.e., Area 0.0.0.0, or Area 0)
- 0.0.0.0 reserved for the backbone area



Logging Adjacency Changes

- The router will generate a log message whenever an OSPF neighbour changes state
- Syntax:

```
[no] [ospf] log-adjacency-changes
```

(OSPF keyword is optional, depending on IOS version)

- Example of a typical log message:

```
%OSPF-5-ADJCHG: Process 1, Nbr 223.127.255.223
on Ethernet0 from LOADING to FULL, Loading Done
```


Number of State Changes

- The number of state transitions is available via SNMP (ospfNbrEvents) and the CLI:

```
show ip ospf neighbor [type number]
[neighbor-id] [detail]
```

Detail—(Optional) Displays all neighbours given in detail (list all neighbours). When specified, neighbour state transition counters are displayed per interface or neighbour ID

State Changes (Continued)

- To reset OSPF-related statistics, use the clear ip ospf counters EXEC command. At this point neighbor is the only available option; it will reset neighbour state transition counters per interface or neighbour id

```
clear ip ospf counters [neighbor [<type number>] [neighbor-id]]
```


Router ID

- If the loopback interface exists and has an IP address, that is used as the router ID in routing protocols – stability!
- If the loopback interface does not exist, or has no IP address, the router ID is the highest IP address configured – danger!
- OSPF sub command to manually set the Router ID:

```
router-id <ip address>
```


Cost & Reference Bandwidth

- Bandwidth used in Metric calculation

  Cost = 10^8/bandwidth

  Not useful for interface bandwidths > 100 Mbps
- Syntax:

```
ospf auto-cost reference-bandwidth <reference-bw>
```

- Default reference bandwidth still 100 Mbps for backward compatibility
- Most ISPs simply choose to develop their own cost strategy and apply to each interface type

Cost: Example Strategy

10GE/OC192	10Gbps	cost = 1
OC48	2.5Gbps	cost = 5
GigEthernet	1Gbps	cost = 10
OC12	622Mbps	cost = 20
OC3	155Mbps	cost = 50
FastEthernet	100Mbps	cost = 100
Ethernet	10Mbps	cost = 500
E1	2Mbps	cost = 1000

Clear/Restart

- OSPF `clear` commands

  If no process ID is given, all OSPF processes on the router are assumed
- `clear ip ospf [pid] redistribution`

  This command clears redistribution based on OSPF routing process ID
- `clear ip ospf [pid] counters`

  This command clears counters based on OSPF routing process ID
- `clear ip ospf [pid] process`

  This command will restart the specified OSPF process. It attempts to keep the old router-id, except in cases, where a new router-id was configured, or an old user configured router-id was removed. Since this command can potentially cause a network churn, a user confirmation is required before performing any action.

Use OSPF Authentication

- Use authentication; too many people overlook this basic feature
- When using authentication, use the MD5 feature

  area <area-id> authentication message-digest (whole area)

  ip ospf message-digest-key 1 md5 <key>
- Authentication can be selectively disabled per interface with:

  ip ospf authentication null

Tuning OSPF (1)

- Hello/Dead Timers

  ip ospf hello-interval 3 (default 10)

  ip ospf dead-interval 15 (default is 4x hello)

  This allows for faster network awareness of a failure, and can result in faster reconvergence, but requires more router CPU and generates more overhead

- LSA Pacing

  timers lsa-group-pacing 300 (default 240)

  This is a great feature; allows grouping and pacing of LSA updates at configured interval; reduces overall network and router impact

Tuning OSPF (2)

- DR/BDR Selection

  ip ospf priority 100 (default 1)

  This feature should be in use in your OSPF network; forcibly set your DR and BDR per segment so that they are known; choose your most powerful, or most idle routers; try to keep the DR/BDR limited to one segment each

- OSPF Internal Timers

  timers spf 2 8 (default is 5 and 10)

  Allows you to adjust SPF characteristics; first number sets wait time from topology change to SPF run; second is hold-down between SPF runs; BE CAREFUL WITH THIS COMMAND; if you're not sure when to use it, it means you don't need it; default is 95% effective

Tuning OSPF (3)

- LSA filtering/interface blocking

  Per interface:

  ip ospf database-filter all out (no options)

  Per neighbor:

  neighbor 1.1.1.1 database-filter all out (no options)

  OSPFs router will flood an LSA out all interfaces except the receiving one; LSA filtering can be useful in cases where such flooding unnecessary (i.e., NBMA networks), where the DR/BDR can handle flooding chores

  area <area-id> filter-list <acl>

  Filters out specific Type 3 LSAs at ABRs

- Improper use can result in routing loops and black-holes that can be very difficult to troubleshoot

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OSPF Command Summary

Redistributing Routes into OSPF

```
ROUTER OSPF <pid#x>
REDISTRIBUTE {protocol} <as#y>
        <metric>
        <metric-type (1 or 2)
        <tag>
        <subnets>
```

Router Sub-commands

- NETWORK <n.n.n.n> <mask> AREA <area-id>
- AREA <area-id> STUB {no-summary}
- AREA <area-id> AUTHENTICATION
- AREA <area-id> DEFAULT_COST <cost>
- AREA <area-id> VIRTUAL-LINK <router-id>...
- AREA <area-id> RANGE <address mask>

Interface Subcommands

- IP OSPF COST <cost>
- IP OSPF PRIORITY <8-bit-number>
- IP OSPF HELLO-INTERVAL <number-of-seconds>
- IP OSPF DEAD-INTERVAL <number-of-seconds>
- IP OSPF AUTHENTICATION-KEY <8-bytes-of-password>