COSC 417: Topics in Networking

TOPIC 6: IS-IS ROUTING

TOPIC 7: ROUTING POLICIES & LOOKING GLASS SERVERS

SCHEDULE

1. *IS-IS Routing Protocol*
2. *BGP Looking Glass Servers*
3. *Routing Policy*

IS-IS IGP ROUTING

AN ALTERNATIVE LINK-STATE PROTOCOL

- Last week we talked about the IGP protocol known as *OSPF (Open Shortest Path First)*
- This is a link-state protocol, based on Dijkstra's algorithm
- Now, we'll talk about the *IS-IS* protocol, an alternative link-state protocol

IS-IS ROUTING

- *IS-IS* stands for *Intermediate System to Intermediate System*
- As an IGP protocol that uses flooding and topology mapping, it's very similar to OSPF, the differences primarily being in the smaller details
- Originally developed in the late 1970s, standardized in 1987 as ISO 10589

THE MAJOR DIFFERENCE: AREAS

- IS-IS uses a very different area and router classification system than OSPF does
- The major classification of areas are:
  - Level 1 – Other areas
  - Level 2 – The backbone
- Routers are classified in the same level schema:
  - Level 1 routers
  - Level 2 routers
  - Level 1-2 routers

LEVEL 1 & 2 ROUTERS

- A *level 1 router* has neighbours only within the same area
  - A level 1 router has a *Link State Data Base* (LSDB) with routing information for the area it resides in
- A *level 2 router* has neighbours in other areas, creating the backbone area of the network which allows inter-area transit
  - A level 2 router has an LSDB that contains routing information for other level 2 routers

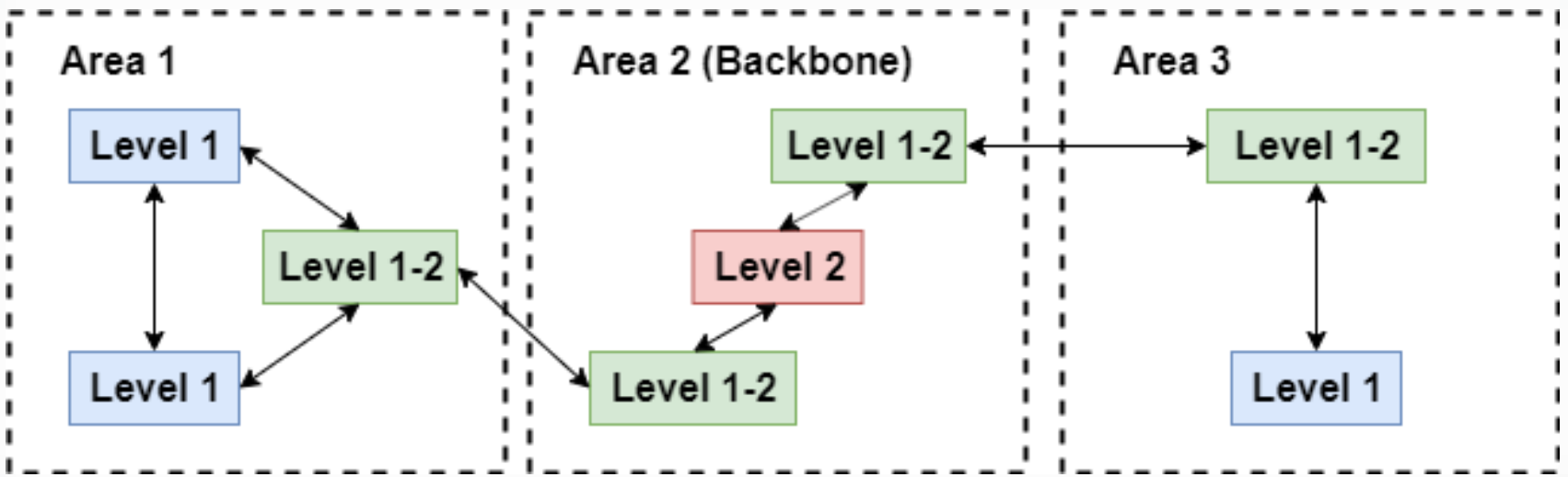
LEVEL 1-2 ROUTERS

- The final type of router is known as a *Level 1-2* router
- These routers act as both Level 1 and Level 2 routers – they will share local area routes with other level 1 routers, while sharing inter-area level 2 routes with other level 2 routers
  - They maintain separate LSDBs for each – a level 1 and a level 2

THE BACKBONE AREA

- Unlike in OSPF, the backbone area of the IS-IS protocol provides for flexibility
- You can have multiple backbone areas, and they don't necessarily have to be contiguous
- Backbone areas may contain either Level 2 or Level 1-2 routers, or both
- Non-backbone areas have host connections (endpoints) and level 1 routers

AN EXAMPLE OF IS-IS AREAS



- Area 2 is acting as the backbone area, allowing areas 1 and 2 to communicate with each other

COMMUNICATION METHOD

- Interestingly, IS-IS can run on a different layer of the network than OSPF
- While OSPF runs at the network layer (IP protocol), IS-IS can use one layer below, on the data-link level, or via IP protocol
- Minor benefits: potentially more secure, lower overhead because no IP packet headers

MESSAGING IN IS-IS

- With it's tiered routing system, most of the messaging is between routers is discriminated into these two tiers
- Namely, level 2 routers will ignore messages from level 1 routers, and vice versa. Level 1-2 routers will generally send and receive both

THE HELLO MESSAGE

- As with OSPF, a “Hello” message is sent via multicast (multiple recipient flooding) to discover neighbours
- Area ID data is exchanged as well, which is used by level 1 routers to discard messages from external areas

EXCHANGING ROUTING DATA

- When a network change is detected, routers send out updated information by flooding *Link State PDUs*
- These function similarly to Link-State packets or Link-State advertisements in OSPF
- Broadcast to all routers to allow updating of their LSDBs if necessary

POPULARITY IN USAGE

- IS-IS is commonly used as an IGP routing protocol for backbone-tier autonomous systems. Why?
  - It's old, and stable – something that appeals to large enterprises
  - Has good scalability and convergence speed – can handle many very large areas within an AS
  - Can potentially work without IP protocol via layer 2 connectivity
  - More flexibility in handling areas

BETTER THAN OSPF?

- In general, OSPF and IS-IS are similar enough in performance it's hard to consider one better than the other
- IS-IS scales better and received more frequent updates and attention, but OSPF is still commonly used on smaller (non-backbone) enterprise networks

BGP LOOKING GLASS SERVERS

DISCOVERING ROUTING INFORMATION

- As we've seen in the labs, we can obtain some routing information via traceroutes
- A rather "brute force" method – takes a long time, and doesn't produce a fantastic map – requires a lot of data
  - We'll see this shortcoming in our lab this week

A BETTER WAY: LOOKING GLASS SERVERS

- An alternative to this is to use *looking glass servers*
- Looking glass servers allow us to fetch routing data directly from a router within an ASN
- Many major service providers offer a looking glass service that allows us a better look at the routing behind the scenes

THE HURRICANE ELECTRIC LOOKING GLASS

- Hurricane Electric offers a looking glass service here:

https://lg.he.net

- With this, we can find routing summaries, as well as detailed routing entries for a number of Hurricane Electric's routers

SPECIFIC ROUTE INFORMATION

Status	Network	Next Hop	Metric	LocPrf	Weight	Path	Origin	ROA
BI	207.216.0.0/16	154.11.15.9	160	100	0	852	IGP	?

- Selecting the “Datahive Calgary” router, the “BGP Route” command, and using my own IP address as a target, we can fetch specific route information from that router to our IP
- In this case, you can see that the path includes ASN 852 – Telus Communications

GENERAL ROUTE SUMMARIES

- Conversely, by selecting the “BGP Summary”, we can see a general summary of all the neighbouring ASNs (peers) of a given router

core1.yyc1.he.net> show ip bgp summary

Local AS Number	6939
Number of Neighbors Configured	53, 45 up
Number of Routes Installed	3221211 (318899889 bytes)
Number of Routes Advertised	23232074 (1811063 entries) (86931024 bytes)
Number of Attribute Entries	628793 (56591370 bytes)

Neighbor Address	ASN	State	Time	Rt:Accepted	Rt:Filtered	Rt:Sent	Rt:ToSend
64.62.244.150	32121	ESTAB	277d 5h17m	2	0	802991	0
64.71.176.98	53403	CONN	115d11h17m	0	0	0	802993
65.19.155.98	25635	ESTAB	83d 7h36m	1	0	802993	0
65.19.155.99	25635	ESTAB	617d 6h13m	1	0	802992	0
65.19.157.210	33501	ESTAB	118d17h24m	5	0	802989	0
72.52.101.150	18638	ESTAB	257d 6h46m	11	3	802982	0
72.52.106.98	55195	ESTAB	615d18h57m	1	0	1	0

WHAT IS THE PURPOSE OF A LOOKING GLASS SERVER?

- A looking glass server is primarily an administration tool – it makes it easier to check routing and connectivity information from many routers on the fly
- By making these services public, service providers help administrators of client services with diagnosis (for example, you can verify that your service provider has a route available to your organization/enterprise)

SOME DOWNSIDES

- As most ISPs implement their looking glasses in slightly different ways, it's hard to interact with them programmatically
- Additionally, many of the services specifically forbid automation/scraping of the data due to the load on the service
- Unfortunately, not a great option if we wanted to programmatically do a lot of exploration – at least, not without breaking the TOS

ROUTING POLICY

POLICY-BASED ROUTING

- *Routing Policy* is the reasoning and criteria used to discriminate among incoming (and outgoing) routes, and preference certain routes over others
- It is in defining routing policy that an administrator can determine how traffic is routed through their autonomous system

A HIERARCHICAL CHOICE

- Choosing a route can depend on the following criteria, in order:
  - Local preference
  - Shortest AS-Path
  - Lowest Multi-Exit Discriminator, or *metric*
  - iBGP is preferred over eBGP routes
  - Lowest IGP cost (or, lowest IGP # of hops)

LOCAL PREFERENCE

- The local preference for a given route is entirely determined internally
- Local preference is used for iBGP routes, and is a locally assigned metric
  - In short, the local preference value is only valid, and only used, within the autonomous system → not shared with other systems
- Could be manually set to encourage/discourage traffic along certain routes or AS's (for example, discouraging use of a paid link)

SHORTEST AS-PATH

- After local preference, routes with the shortest AS-Path variable will be preferred
- The route with the shortest AS Path for a give destination IP will traverse the fewest number of autonomous systems, therefore it should be faster (in theory)
- This can also be fiddled with on the outgoing end to discourage certain traffic

SHORTEST AS-PATH MEDDLING

LocPrf	Weight	Path
140	0	271x4

- Here is an example. UBC runs an autonomous network routed through BC NET, which is ASN 271.
- ASN 271 will append itself multiple times to the AS Path, seen here four times (x4), in an attempt to artificially make the AS Path longer
- This has the effect of discouraging other autonomous systems from routing traffic through BC NET, as it will have a longer AS Path

LOWEST MULTI-EXIT DISCRIMINATOR

- The *multi-exit discriminator*, more commonly referred to as *metric*, is an additional attribute that can be sent with BGP to "suggest" a better route
- Kind of like local preference, but for outgoing routes → tell other routers which route they should prefer if they have two options
- Lower metric values are preferred to higher metric values
- Another means, besides adding multiple copies to the AS path, of letting others know whether you want them to use a route or not

LOWEST IGP COST

- IBGP routes are preferred to EBGP routes, and specifically, lowest IGP cost is preferred if all else is equal
- The IGP cost is the total cost of the internal routing of the traffic *within* the autonomous system, for example from gateway-to-gateway in a transit system

HOT POTATO ROUTING

- Lowest-IGP-Cost routing is also known as *hot potato routing*
- Why? Because the general idea is: get the packet out of the autonomous system as fast as possible
- Obviously, it makes sense that a network wants to minimize how much time traffic spends on the local network – minimize load, don't tie up routers with traffic that could be routed more efficiently

A MINOR PROBLEM WITH HOT-POTATO ROUTING

- A problem with using hot-potato routing is while it guarantees the lowest cost within your ASN, it doesn't guarantee lowest cost across the whole route
- Could potentially be a faster exit from the AS, but a longer/slower journey overall once the entire route is factored in
- Part of the reason lowest-IGP cost is one of the last of the attributes used to determine the best route

ROUTE FILTERING

- Routes may be filtered when they are received, or when re-advertised
- The inbound and outbound filtering rules will be determined by administrator policy
- Inbound filters control outbound traffic, and outbound filters will limit inbound traffic; this seems reversed, but it’s not

WHAT ROUTE FILTERING CAN DO

- An AS may arbitrarily:
  - Choose to not advertise certain routes
  - Reject routes that have been advertised to it
  - Modify attributes of outbound routes (i.e. AS-Path lengthening)
- In general, this gives the administrator complete control over what routes inbound and outbound traffic travels on, without having to actually manually place entries in the routing table

REASONS BEHIND ROUTING POLICY

- Routing policy can be guided by many things:
  - Monetary cost – prefer peers over paid transit networks
  - Security – limit connections to other autonomous systems?
  - Avoiding transit across non-transit networks – discourage unnecessary traffic
  - Increase performance – prefer faster routes to slower routes via a manual metric or preference
  - Retain redundant connections without using them unless necessary

ROUTE POLICY SUMMARY

- Primarily, remember the order of the hierarchy in how the best route is chosen – this is important
- Administrators have a combination of manually applied metrics or preferences, as well as filtering, to impose policy upon their routing system
- Additional tie-breaker options for determining best route: AS-path length, hot-potato routing, iBGP vs eBGP

FRIDAY, JAN 31 QUIZ

- Topics will be posted up this evening
- Primarily:
  - Autonomous systems
  - BGP Routing
  - IGP Routing – RIP, OSPF, distance-vector versus link-state
- Does *not* cover the material from today's lecture
- Quiz will be held in-class, and will take ~40 minutes

SCHEDULE

1. *IS-IS Routing Protocol*
2. *BGP Looking Glass Servers*
3. *Routing Policy*

SO LONG, FOLKS!