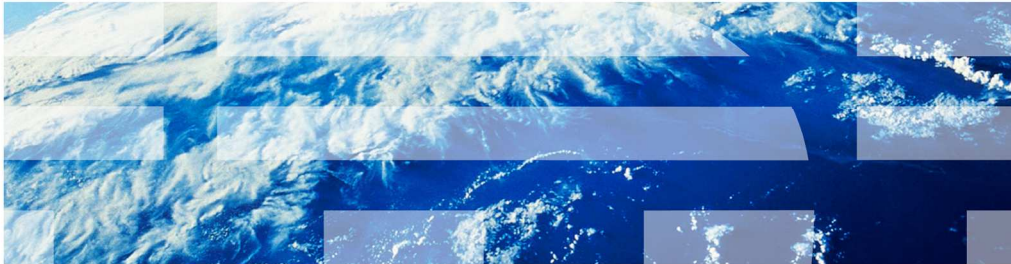# z/OS V2R1 Communications Server

IPv6 support for policy-based routing - Part 1

This presentation covers the IPv6 support that is added to z/OS® Communications Server V2R1 for the policy-based routing function. It provides background information, a description of the problem and the solution. A separate presentation provides information about the function externals and tips for common problems.

Background: Standard IP routing

- The TCP/IP stack maintains and uses a single route table for routing outbound traffic
- Routes to all reachable destinations appear in the table
    - Static routes and dynamic routes
- Routes can use any stack interface and any next hop router
- Routes to be used for traffic are selected using only the destination IP address of the traffic
    - ALL traffic to a destination MUST use the same routes

Before policy-based routing was added to Communications Server, all traffic was routed using standard IP routing. With standard IP routing, the TCP/IP stack maintains a single table of routes and it uses that single table when routing all outbound traffic. All destinations that are known to be reachable, either because they have been statically configured or because they have been learned from dynamic routing protocols, are represented in the table. The routes can use any of the interfaces available on the stack and any next hop router that is available out those interfaces.

When routes are selected for sending traffic, the selection is done based on only the destination IP address of the traffic. This means that all traffic to that destination must use the same routes and, therefore, the same interfaces and next hop routers.

Background: Policy-based route tables

- Multiple policy-based route tables are supported in addition to the previous single table
- Each policy-based route table is similar to the main route table
    - Can contain static routes, dynamic routes, or both
    - Replaceable and non-replaceable static routes supported
    - Can contain multiple equal-cost routes to the same destination

With policy-based routing, the stack maintains and uses multiple route tables. These include the table that existed previously, now referred to as the main route table, plus multiple policy-based route tables.

Like the main route table, policy-based route tables can contain both static and dynamic routes and the static routes can be configured as either replaceable or non-replaceable by dynamic routes. Also, like the main route table, policy-based route tables can contain multiple routes to the same destination, when those routes have the same cost value.
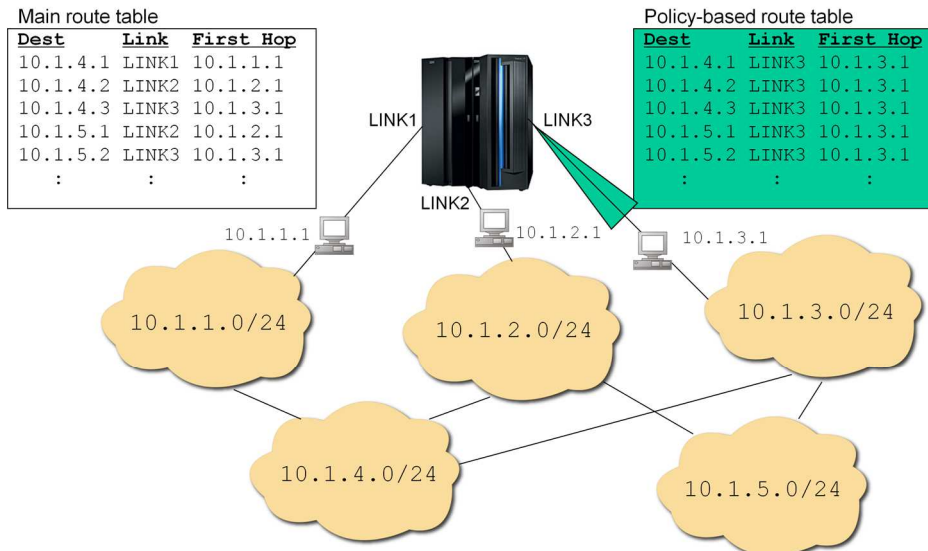
Background: Policy-based route tables continued

- Policy-based route tables configured to limit the routes to specific interfaces, and optionally to specific first hop routers
    - Static routes configured to use only those interfaces and routers
    - Dynamic routes added only if they use those interfaces and routers

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Unlike the main route table, policy-based route tables can be configured to limit the routes that are added to only those that use specific interfaces. In addition, the tables can be configured to limit the routes that are added to only specific first hop routers that are available using the specified interfaces. This is accomplished by defining only static routes that use those interfaces and next hop routers and by allowing dynamic routes to be added only if they use those interfaces and next hop routers.

A maximum of 255 policy-based route tables can be defined.

Background: Route table example

Main route table

Dest	Link	First Hop
10.1.4.1	LINK1	10.1.1.1
10.1.4.2	LINK2	10.1.2.1
10.1.4.3	LINK3	10.1.3.1
10.1.5.1	LINK2	10.1.2.1
10.1.5.2	LINK3	10.1.3.1
:	:	:

Policy-based route table

Dest	Link	First Hop
10.1.4.1	LINK3	10.1.3.1
10.1.4.2	LINK3	10.1.3.1
10.1.4.3	LINK3	10.1.3.1
10.1.5.1	LINK3	10.1.3.1
10.1.5.2	LINK3	10.1.3.1
:	:	:

LINK1   LINK3

LINK2

10.1.1.1   10.1.2.1   10.1.3.1

10.1.1.0/24   10.1.2.0/24   10.1.3.0/24

10.1.4.0/24   10.1.5.0/24

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This route table example shows a node connected to a set of IP subnets. The partial main route table shown contains routes to destinations throughout the network and those routes use all of the three available network links. These might be routes that were added to the main route table by OMPROUTE.

If there is a need for a certain type of IP traffic to be sent out LINK3, a policy-based route table such as the one shown can be created. You might want all traffic sent by a specific job name or to a specific port to be sent out LINK3. In this example, the policy-based route table contains routes to all of the same destinations as are in the main route table. However, all of the routes in the policy-based route table use LINK3.

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Background: Policy-based route selection

A route can be selected based on one of more of these criteria
- Source IP address
- Destination IP address
- Source port
- Destination port
- Protocol (TCP or UDP)
- Job/application name
- NetAccess security zone
- Multi-level security (MLS) label

Outbound traffic that matches specified criteria can be targeted to specific route tables (specific interfaces and first hop routers)

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Policy-based routing allows a route to be selected for outbound traffic based on much more than just the destination IP address of the traffic. The additional route selectors are the source IP address, the source and destination port, the protocol, the job name, the security zone, and the security label. The selectors can be used to cause traffic that meets more specific criteria to be targeted to specific route tables and, therefore, to specific network interfaces and first hop routers.

Background: Using policy-based routing

- Policy rules are defined to control which route tables are used to route traffic that matches certain criteria
- Traffic that matches no defined policy uses the main route table
- Up to eight policy-based route tables can be specified to be used for the traffic
- The main route table can be specified as a backup route table for the traffic
- Each route table is searched until a route is found that can used to reach the destination of the traffic
  – Table search order is controlled by the policy

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Once route tables are defined, targeted to specific interfaces and next hop routers, and different types of traffic are defined, you can define policy rules by using a subset of the route selectors. Policy rules can be defined to control which route tables are to be used to route each type of traffic.

Most often there is one policy-based route table defined to be used for a type of traffic, but there can be as many as eight. Each of the policy-based route tables to be used is searched, in the order defined, for a route to the destination. If any active route to the destination is found in a route table, the search is stopped and that route is used for the traffic. This route might be a host route, a subnet, network, or supernet route, or a default route. If no active route to the destination is found in a route table, the search continues with the next route table. If all policy-based route tables are searched without success, the main route table is also searched if the policy indicates that the main route table can be used as a backup.

Any traffic that does not match one of the types of traffic defined by the policy is routed using only the main route table.

Background: Traffic supported

- Policy-based routing is supported for locally originated TCP and UDP traffic
- Only the main route table can be used for:
    - Forwarded traffic
    - Traffic using IP protocols other than TCP and UDP
        - For example, ICMP and RAW

Policy-based routing is not supported for all types of IP traffic. The support is limited to locally originated TCP and UDP traffic, including Enterprise Extender traffic. All forwarded traffic and all traffic using protocols other than TCP and UDP is not processed by policy-based routing and continues to be routed using only the main route table.

Background: Configuration

- Policy-based routing is configured in a policy agent flat file
  - Consists of routing rules, routing actions, and route tables
- Use of IBM Configuration Assistant for z/OS Communications Server is recommended to generate the flat file
  - Simplifies configuration
  - Provides flexible configuration
  - Checks for configuration problems

Policy-based routing is configured in a policy agent flat file. The items configured for policy-based routing consist of routing rules, routing actions, and route tables.

You can manually create the policy agent flat file or you can use the IBM Configuration Assistant for z/OS Communications Server to generate the file. The benefits of using the Configuration Assistant include simplified and flexible configuration and automatic checking for some configuration problems.

Background: A routing example

- The problem
  - The performance of outbound FTP traffic (large file transfers) to a specific destination needs to be optimized
  - Networks that supports a large MTU size should be used
    - If no large MTU network available, other networks can be used
- The solution
  - Using policy-based routing, all FTP traffic to the destination address can be routed over networks with a large MTU
    - Other traffic continues to be routed over all networks
    - If a large MTU network is not active, all networks can also be used for the FTP traffic

As an example of a situation where policy-based routing might be useful, consider a scenario where you need to optimize the performance of outbound FTP traffic to a particular destination. The FTP traffic involves large file transfers. Your stack has access to networks with a variety of MTU sizes, but networks with a large MTU size will provide the best performance for the traffic.

Using policy-based routing you can improve the performance of this FTP traffic by making all of that traffic go out over the networks with a large MTU, whenever possible. All other traffic will continue to be routed over all networks.

Background: a routing example continued

- The setup
  - Define a policy-based route table that contains only routes that use high MTU networks
  - Define routing rules and actions to specify that FTP traffic to the destination must use the policy-based route table. The main route table is the backup
    - Identify traffic using protocol, job name, and destination IP address
- When a route is needed for the traffic:
  - A route is selected from the policy-based route table, if available (ensuring use of a high MTU network)
  - Otherwise, a route from the main route table is used (allowing use of any network)

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Using policy-based routing you can create a policy-based route table that contains only routes that use networks with a large MTU. You can then define policy such that all of the FTP traffic to the particular destination uses that route table. All of that FTP traffic is now routed using large MTU networks. All other traffic, which does not match the policy rule, continues to be routed using the main route table.

You can also indicate that the main route table is to be used as a backup to the policy-based route table. This allows the FTP traffic to continue to be routed, even if the link to the large MTU network becomes unavailable.

Problem statement

- Policy-based routing, as implemented in V1R9 Communications Server, supports only IPv4 traffic

- IPv6 traffic uses only the main route table

- Outbound IPv6 traffic cannot be targeted to specific interfaces and next hop routers

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The policy-based routing function that was implemented in V1R9 is limited to only supporting IPv4 traffic. After the addition of that support, all IPv6 traffic continues to be routed using only the main route table and cannot be targeted to specific interfaces and next hop routers.

Solution

- V2R1 Communications Server adds policy-based routing support for IPv6 traffic
- Support is for same types of traffic as are supported for IPv4
    - Locally originated TCP and UDP traffic
- A policy-based route table can now contain
    - Only IPv4 routes
    - Only IPv6 routes
    - Both IPv4 and IPv6 routes

Beginning in Communications Server V2R1, policy-based routing supports both IPv4 and IPv6 traffic. The same types of traffic are supported for IPv6 as are supported for IPv4. This includes all locally originated TCP and UDP traffic, including Enterprise Extender traffic.

With the addition of support for IPv6, each policy-based route table can now be defined such that it will contain only IPv4 routes, only IPv6 routes, or a combination of IPv4 and IPv6 routes.

Solution

- Routing policy rules can now specify IPv6 source and destination IP addresses
  - A rule that does not specify IP addresses now applies to both IPv4 and IPv6 traffic that matches the rule

Routing policy rules, which define the different types of traffic, can now be defined for IPv6 traffic by specifying an IPv6 address for the source or destination address value. Any rule that does not specify IP addresses for the traffic, for example a rule that defines all traffic sent to a particular port, now applies to both IPv4 and IPv6 traffic that matches the rule.

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