Description

"Micro segment" (SRv6 uSID or uSID for short) is an extension of SRv6 architecture, specifically designed to represent SRv6 SIDs in an extremely compact way. It addresses the overhead of using full 128-bit IPv6 SIDs for routing. Instead of using a 128-bit address for single SID, multiple uSIDs are packed into a single 128-bit address. Each 128-bit address comprises a block value representing the domain followed by multiple uSIDs, each of the same bit length. If there are bits left they are filled with trailing zeros. This allows for a complete SRv6 path to be represented by a 128-bit IPv6 address. Like a regular SID, each uSID is associated with a specific behavior on the SRv6 capable node. SRv6 uN refers to the End behavior with uSIDs.

Support for SRv6 uN has been added in 4.34.2F on Arista's DCS-7060X6 family of switches.

Feature History

Support for SRv6 uN has been added in 4.34.2F on Arista's DCS-7060X6 family of switches.

Release	Update
4.34.2F	Initial introduction
4.34.2F	Support for uN functionality in DCS-7060X6 platform with static routes, where static routes are programmed on each node to the uNs of the neighboring nodes.
4.34.2F	Support for uSID format F3216.
4.34.2F	Support for SRv6 Ping which helps with reachability checks on target uNs via some specific path
4.35.0F	Support for SRv6 Traceroute which helps with knowing the intermediate routers to reach target uN via some specific path
4.35.1F	Support for uN functionality with F3216 format, without SRH and without decapsulation in DCS-7280R3,DCS-7500R3 and DCS-7800R3 platforms

Terminology

- uSID Block Prefix: This is an IPv6 prefix from which all the uSIDs are allocated. Also referred to as the "uSID Domain" in this document.
- uSID Block Length: The prefix length (in bits) of the uSID Block prefix. This is usually 32-bits.

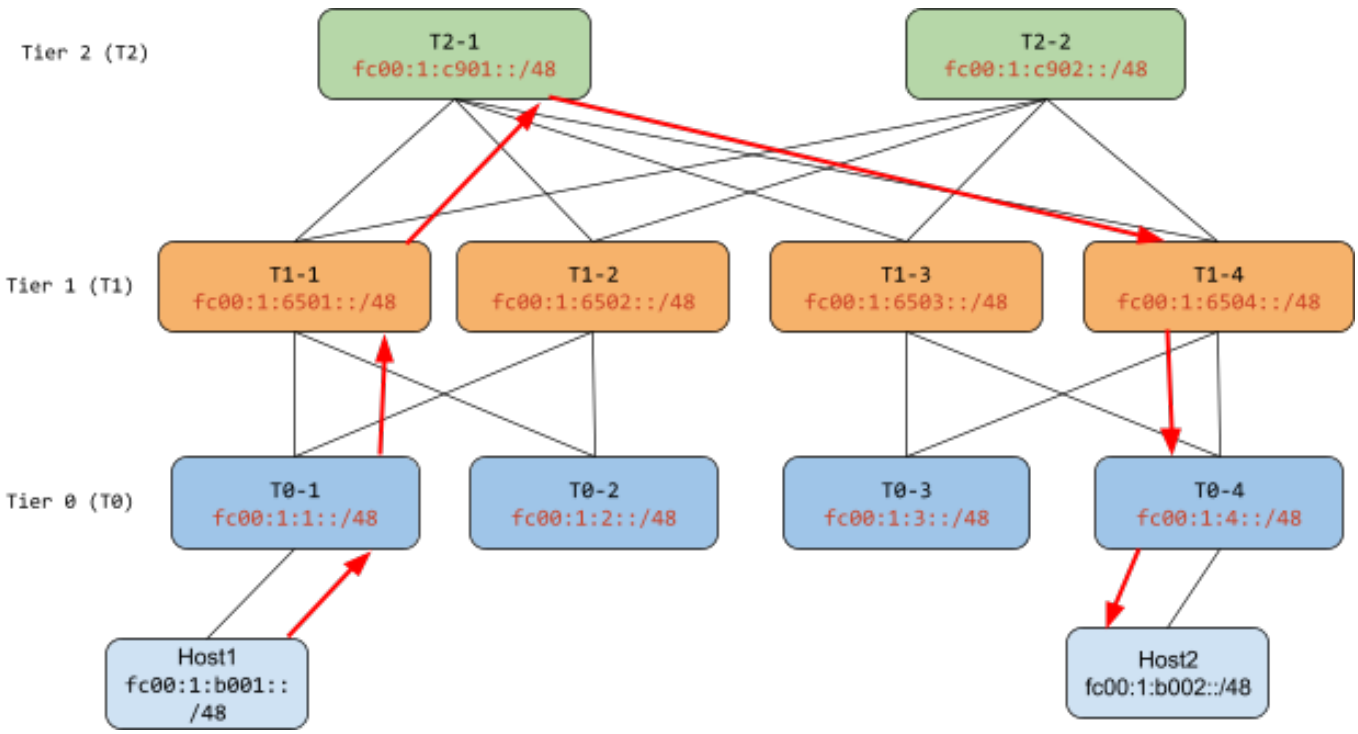
- uSID Length: This is the size of the uSID value, in bits. It is usually 16-bits.
- uSID: A 16-bit value, in case of 16-bit uSID length. It can vary based on uSID length.
- uSID Format: A concise representation of the uSID block length and uSID length in the form of FXXYY, where XX is the uSID block length and YY is the uSID length. For example, F3216 will mean uSID block length of 32 and uSID length of 16.
- uSID Container: A 128-bit IPv6 SRv6 SID with the structure: <uSID Block Prefix><uSID1><uSID2>..<uSIDn>. In case of F3216, the uSID container would contain the 32-bit block prefix followed by a maximum of 6 uSIDs (16-bit length).
- SRH: Segment Routing Header is an IPv6 routing extension header that can be used for SRv6
- System SFIB Table: Every locally configured uN will have a corresponding entry in the System SFIB table. The platform will do a LPM lookup in this table to determine whether the IPv6 DA matches a locally instantiated uN and if so, perform SRv6 processing on the packet.

Platform Compatibility

- DCS-7060X6 family of switches
- DCS-7280R3, DCS-7500R3 and DCS-7800R3 family of switches from 4.35.1F onwards

SRv6 Operation

This section briefly explains SRv6 operation using a 3-tier network as shown below. The IPv6 prefix in each box represents the uN of that node. In this example, the reachability to the uN is achieved using static routes. So, each node will have static routes to the uNs of the neighboring nodes.



As mentioned above, at each node we will have static routes to the uNs of each of the neighboring nodes.

For example, on T0-1, the static route for T1-1's uN would be as follows:

```
ipv6 route fc00:1:6501::/48 2001:db8:10::1101
```

Where the nexthop address corresponds to the interface address on T1-1, for the link between T0-1 and T1-1.

In case the nexthop happens to be an IPv6 link-local address, the static can be configured as follows:

```
ipv6 route fc00:1:6501::/48 Ethernet 1/1 fe80::9e69:edff:fe62:4153
```

Similarly T1-1 will have static routes to the uNs of T1-2 And all the nodes in the network would have such static routes which provide reachability to the neighboring node's uNs.

SRv6 Forwarding

Host1 requires prior knowledge of the uNs of all nodes along the path (T0-1 -> T1-1 -> T2-1 -> T1-4 -> T0-4 -> Host2) to send traffic to Host2. The method by which Host1 acquires this information is beyond the scope of this document.

Host1 needs to know the uNs of all the nodes in the path. With that information, Host1 can compute the IPv6 address which represents the desired path. In this example, the computed address would be fc00:1:1:6501:c901:6504:4:b002, where the initial fc00:1::/32 is the uSID block and rest are 16-bit uSID values of each node in the path. Notice that, with uSIDs, we are able to represent a path consisting of 6 nodes in a single 128-bit IPv6 address.

Host1 will then send a packet out towards T0-1 with that computed address as the IPv6 Destination address.

The following would be the sequence of steps that would be performed on T0-1 when processing the packet.

1. The IPv6 DA of the packet would be fc00:1:1:6501:c901:6504:4:b002
2. The "active SID" would be fc00:1:1::/48
3. T0-1 recognizes that the active SID is its own uN.
4. Consequently, as per uN processing, T0-1 will shift out (shift left) its uSID value and move the rest of the bits in the DA to the left by 16-bits. The trailing 16-bits will be filled with 0s.
5. After the "shift" operation, the resulting DA would be fc00:1:6501:c901:6504:4:b002::

6. T0-1 will then do an LPM lookup of the resulting DA in the IPv6 FIB.
7. Since we have configured a static route for fc00:1:6501::/48, which is the neighboring node's uN (T1-1), the lookup will match that route and the packet will be sent to T1-1.
8. T1-1 will recognize that the "active SID" (fc00:1:6501::/48) is its own uN and do the same shift-and-lookup operation as above and send the packet to T2-1.
9. As can be seen from the above steps, the IPv6 DA keeps changing as the packet traverses the SRv6 path.
10. When it reaches T0-4, the IPv6 DA would be fc00:1:4:b002::.
11. T0-4 will recognize that the active SID is its own uN, perform the shift operation with the resulting IPv6 DA being fc00:1:b002::/48. And then perform an LPM lookup for the same.
12. Since it would have a static route for fc00:1:b002::/48 towards Host2, the packet will be sent to Host2.
13. Host2 will recognize the active SID as its own uN. It will also see that there are no more uSIDs in the uSID container and so it will consume the packet.

Configuration

Configuring a locator

Configuring an SRv6 uN involves configuring a "locator". A Locator is a routable IPv6 prefix that identifies a specific SRv6-capable node in the network. It comprises a uSID domain and an uSID value.

To configure a locator we need to configure the micro-segment domain referenced by the locator first.

Steps to configure a micro-segment domain are as below.

Enter srv6 mode.

```
switch#router srv6
```

Enter default vrf configuration submode.

```
switch(config-router-srv6)#vrf default
```

Enter the "micro-segment domain" configuration submode and add a domain with a unique name.

```
switch(config-router-srv6-vrf-default)#micro-segment domain <DOMAIN_NAME>
```

Configure the uSID block prefix for the micro-segment domain.

```
switch(config-router-srv6-vrf-default-domain)#block <block>
```

Steps to configure a locator are as below.

Enter srv6 mode.

```
switch#router srv6
```

Enter default vrf configuration sub-mode.

```
switch(config-router-srv6)#vrf default
```

Configure locator with unique name.

```
switch(config-router-srv6-vrf-default)#locator <LOCATOR_NAME>
```

Add the locator micro-segment domain and usid value.

```
switch(config-router-srv6-vrf-default-locator)#prefix micro-
segment domain <DOMAIN_NAME> end usid <usid_value>
```

The <usid_value> can be configured in either decimal or hexadecimal format. An example configuration for a locator fc00:42:C901::/48 where the uSID domain block is fc00:42::/32 and 16-bit uSID value is 51457 (0xC901) is as below.

```
router srv6
   vrf default
      micro-segment domain DOM1
         block fc00:42::/32
      locator Locator1
         prefix micro-segment domain DOM1 end usid 51457
```

Global ID Block (GIB) range can be configured per micro-segment domain as per below

configuration.

Enter srv6 mode.

```
switch#router srv6
```

Enter default vrf configuration submode.

```
switch(config-router-srv6)#vrf default
```

Enter “micro-segment domain” configuration submode and configure a domain with a unique name.

```
switch(config-router-srv6-vrf-default)#micro-segment domain <DOMAIN_NAME>
```

Configure the GIB range.

```
switch(config-router-srv6-vrf-default-domain)#gib range <GIB_START> -<GIB_END>
```

All locators using this micro-segment domain should have uSID value within the range configured for them to be active.
If the GIB range is not configured, the default range is 1 - 57343(0xDFFF).

Disable SRv6 config

SRv6 functionality can be disabled using below steps.

Enter srv6 mode.

```
switch#router srv6
```

Enter default vrf configuration submode.

```
switch(config-router-srv6)#vrf default
```

Configure disabled under vrf default.

```
switch(config-router-srv6-vrf-default)#disabled
```

TCAM Profile

On the DCS-7280R3, DCS-7500R3 and DCS-7800R3 family of switches, a TCAM profile must be defined in CLI which includes the *srv6 usid f3216* feature and this profile must be specified as the active system profile. An example TCAM profile is as follows srv6-usid-f3216

Show Commands

show srv6 locator

Each Arista device can be configured with multiple locators. “show srv6 locator “ will show the locator status of all configured locators.

```
switch# show srv6 locator
SRv6 configuration for VRF default
Administrative status: enabled
Operational status: enabled
Encapsulation source address: 2001:db8:100::1
Number of configured locators: 2

Locator LOC1
State: active
Type: micro-SID
Micro-SID domain: DOM1
uSID: 1 (0x1)
Prefix: fc00:42:1::/48
Block length: 32
Function length: 16

Locator LOC2
State: active
Type: micro-SID
Micro-SID domain: DOM1
uSID: 2 (0x2)
Prefix: fc00:42:2::/48
Block length: 32
Function length: 16
```

To get the locator status of a specific locator, the command can be used with the locator name as a filter, as shown below.

Example:

```
switch#show srv6 locator LOC2
SRv6 configuration for VRF default
Administrative status: enabled
Operational status: enabled
Encapsulation source address: 2001:db8:100::1
Number of configured locators: 2

Locator LOC2
State: active
Type: micro-SID
Micro-SID domain: DOM1
uSID: 1 (0x1)
Prefix: fc00:42:1::/48
Block length: 32
Function length: 16
```

show srv6 route

Configuring a locator will result in an entry being added to the System SFIB table. The “show srv6 route” command can be used to list the entries in the System SFIB.

```
switch #show srv6 route
VRF default
Source Codes: S - Static
End Behaviors: End - Endpoint

S  fc00:42:1::/48, End with NEXT-CSID, locator LOC1
    via IPv6 lookup, VRF default
S  fc00:42:2::/48, End with NEXT-CSID, locator LOC2
    via IPv6 lookup, VRF default
```

To get routes added by a specific locator, “show srv6 route” can be used with a locator name as filter.

```
switch#show srv6 route locator <LOCATOR_NAME>
VRF default
Source Codes: S - Static
```

```
End Behaviors: End - Endpoint

S  fc00:42:1::/48, End with NEXT-CSID, locator <LOCATOR_NAME>
    via IPv6 lookup, VRF default
```

show srv6 capabilities

The SRv6 capabilities of Arista devices can be found using the “show srv6 capabilities” command.

```
Switch #show srv6 capabilities
Supported end behaviors
End: supported
End.X: unsupported
End.DX4: unsupported
End.DX6: unsupported
End.DT4: supported
End.DT6: supported

Supported end behavior flavors
PSP: supported
USP: unsupported
USD: supported
Next-CSID: supported

Supported headend behaviors
H.Encaps: supported
H.Encaps.Red: unsupported
H.Insert: unsupported
H.Insert.Red: unsupported

Other Capabilities
uSID Formats: F3216
```

SRv6 Ping

To help in troubleshooting and debugging SRv6 networks, it will be useful to perform reachability checks on target uNs (node sid) via some specific paths. This can be done using the SRv6 ping utility, which is accessed via the “ping srv6” command. With this command, one can ping a target uN via a specific path, which is essentially a list of uNs of each of the nodes in the path.

```
switch #ping srv6 sid <TARGETSID> via segment-list <SID1> <SID2> <SID3> .... [PING-
OPTIONS]
where
PING-OPTIONS:
  dont-frag        Disable fragmentation
  interval         Specify time to wait between sending each packet
  repeat           Specify repeat count
  size             Specify datagram size
  source           Specify source address or choose an address from specified interfa
ce
  timeout          Specify time to wait for a response
```

Sample output.

```
switch#ping srv6 sid fc00:42:3:: via segment-list fc00:42:4:: fc00:42:7:: fc00:42:6::
Pinging fc00:42:4:7:6:3:: [fc00:42:4:7:6:3::] with 64 bytes
64 bytes from fc00:42:3:: icmp_seq=1  ttl=61 time=6.475ms
64 bytes from fc00:42:3:: icmp_seq=2  ttl=61 time=6.153ms
64 bytes from fc00:42:3:: icmp_seq=3  ttl=61 time=6.429ms
64 bytes from fc00:42:3:: icmp_seq=4  ttl=61 time=6.190ms
64 bytes from fc00:42:3:: icmp_seq=5  ttl=61 time=5.827ms

--- fc00:42:4:7:6:3:: ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4009.661ms
rtt min/avg/max/mdev = 5.827/6.215/6.475/0.259ms
```

For the “ping srv6” command to work, the uN prefix must be configured on an interface on the target node. With such a configuration, the Linux Kernel will respond back to the ICMPv6 requests. Based on the above sample output, fc00:42:3::/48 must be configured on a loopback interface, for example, on the target node.

The “ping srv6” command will pick the source address for the ICMPv6 request packet based on:

1. The “source” command line option
2. The “local address” configured under “router srv6”, “vrf default” mode
3. The IPv6 address configured on an interface.

The destination address is derived by concatenating the common address block of the segment

list and target, with the sequential uSIDs from the segment list and the final target uSID. In this case, the target address fc00:42:4:7:6:3:: is derived by concatenating the block (fc00:42) with uSIDs (4, 7, 6) from the segment list, followed by the uSID from the target (3).

It must be ensured that there is reachability to the source address in the network so that the originating node can receive back the ICMPv6 replies.

The locator and loopback interface configuration for a sample node is as given below:

```
router srv6
   vrf default
      local address 2001:db8:100::1
      !
      micro-segment domain DOM1
         block fc00:42::/32
      !
      locator LOC1
         prefix micro-segment domain DOM1 end usid 3


interface Loopback0
   ipv6 address fc00:42:3::/48
```

SRv6 Traceroute

The SRv6 Traceroute command is useful for identifying the path taken by SRv6 traffic. With this command, one can determine the intermediate hops to a target uN along a specific path, which is essentially a list of uSIDs for each node in that path. This command is also useful for understanding how the destination address within the SRv6 header changes as packets traverse the SRv6 network.

Command

```
switch#traceroute srv6 sid <TARGETSID> via segment-
list <SID1> <SID2> <SID3> .... [TRACEROUTE-OPTIONS]
where
TRACEROUTE-OPTIONS:
  source Specify source address or choose an address from specified interface
```

Similar to SRv6 Ping, the uN prefix should be configured as a /48 (representing the combined block and function lengths) on a loopback interface.

The source address in the traceroute probe packets is determined using a mechanism similar to that of SRv6 Ping.

Sample output

```
switch#traceroute srv6 sid fc00:42:3:: via segment-
list fc00:42:2:: traceroute to fc00:42:2:3::, 30 hops max, 64 byte packets
1 2001:db8:200:12::2 2.085ms 1.272ms 1.090ms
  DA: fc00:42:2:3::
2 2001:db8:200:23::3 2.014ms 1.407ms 1.405ms
  DA: fc00:42:2:3::
3 fc00:42:3:: 2.154ms 1.845ms 1.790ms
  DA: fc00:42:3::
```

The output provides information about the hop number, the source address of the ICMPv6 responses, and the destination address of the probe packets as received at an intermediate router.

In the above sample output, when attempting to reach target SID fc00:42:3:: via SID fc00:42:2::, the destination address (CSID-container) of the probe packets is fc00:42:2:3::.The first hop replied with an ICMPv6 response, containing 2001:db8:200:12::2 as the source address in the IPv6 header.The destination address in the received probe packets at the first hop is fc00:42:2:3::.Similarly the second hop replies. Notice that the destination address in the probe packets is altered when they reach the second hop. This is due to the change in the destination address of probes at the first hop.

Syslog Messages

No Syslogs have been added as part of this feature.

Troubleshooting

1. For SRv6 functionality to work, IPv6 routing must be enabled in the default VRF.
2. On every node, ensure that there's IPv6 reachability to the neighboring node's uN.
    1. The "ping srv6" command can be used to verify the SID reachability via the desired path.

3. On every node, ensure that the System SFIB has an entry corresponding to the node's uN prefix (locator)
    1. This is verified using the "show srv6 route" command.

4. Ensure that the locator's status is active
    1. The "show srv6 locator" output will indicate the state. It must be "active"
    2. If the state is "inactive", then the reason is also shown in brackets. It must be resolved by making the necessary configuration changes.
    3. The System SFIB entry corresponding to the locator is programmed only when the locator's state is "active".

5. A locator could be inactive for different reasons. The reasons and steps for resolution are listed below.
    1. SRv6 not operational in VRF
        1. Ensure that "ipv6 unicast-routing" is enabled in the default VRF
        2. Ensure that "disabled" is not configured under "router srv6", "vrf default" mode
    2. micro segment domain has not been fully configured
        1. The micro-segment domain being referred to by the locator must be configured along with its block prefix
    3. End uSID value is not within GIB range
        1. The end uSID value specified in the locator configuration must be within the micro-segment domain's GIB range.
        2. The default GIB range is 1 - 57343 (0x1 - 0xDFFF)
    4. Conflicting locator prefix End uSID value
        1. Two or more locators have been configured with the same end uSID value.
        2. Every locator on the node should have a unique value.
        3. If there are multiple locators with the same end uSID value, the locator with the lexicographically higher name would be active and the rest would be in inactive state.
    5. uSID format not supported
        1. The micro-segment domain block prefix configured must comply with the uSID format supported by the platform.
        2. If the micro-segment domain block prefix is not in compliance with the uSID format supported by the platform, all locators referring to this domain will be inactive with this reason.
    6. Conflicting locator prefix
        1. Locator prefixes must be distinct and unique.
        2. This reason can occur when there are multiple locators referring to different domains with overlapping block prefixes.
        3. The micro-segment domain block prefixes must be unique. We cannot have micro-segment domains whose block prefixes are the same or overlapping.

Caveats / Limitations

Srv6 Agent, SandTunnel and StrataL3Unicast Agent Restarts are Hitful
In case of the SRv6 agent restart or SandTunnel agent restart or StrataL3Unicast agent restart, we can expect SRv6 functionality to be impacted for a brief period of time.

SRv6 Ping Limitation to Neighbour Nodes For the SRv6 ping command to function, a Segment List is mandatory, therefore this command cannot be used to directly ping neighboring nodes, because a Segment List would be absent in such a scenario. In these cases, the standard ping command should be used instead to verify reachability of neighbor nodes.

Limitations on DCS-7280R3, DCS-7500R3, DCS-7800R3

Starting from 4.35.1F, on DCS-7280R3, DCS-7500R3 and DCS-7800R3 platforms, SRv6 uN is supported only with F3216 format i.e, 32-bit uSID block length and 16-bit uSID length. It is supported without SRH i.e, a maximum of 6 micro segments can be packed into the destination IPv6 address in the packet. SRv6 with decapsulation of the outer IPv6 header is not supported.

Limitations on Domain Block Prefixes For this feature to work correctly, it must be ensured that the block prefixes of different domains do not overlap or conflict. If they do, *all* the affected domains will be marked inactive and consequently the associated locators will be marked inactive and removed from the System SFIB.