Oracle® Communications
Diameter Signaling Router ENUM User Guide

Release 8.5

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Oracle Communications Diameter Signaling Router ENUM User Guide, Release 8.5

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Contents

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2. Select **3** for Hardware, Networking and Solaris Operating System Support.

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1
Introduction

This document provides a brief description of the ENUM Support feature of the Oracle Communications Diameter Signaling Router. It contains the feature description, configurations, measurements, and troubleshooting details associated with the ENUM Support feature.

Locate Product Release Software on the Oracle Software Delivery Cloud Site

Oracle Communications software is available for electronic download at the Oracle Software Delivery Cloud site, https://edelivery.oracle.com. Only authorized customers with a valid password may download software from the site.

For directions on downloading the software and other information about using this site, click **FAQ** in the top right corner.

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Feature Description

This chapter describes the ENUM Support feature.

Overview

The ENUM Support feature enhances the capability to access the Unified Data Repository (UDR) database using the ENUM protocol. The ENUM application in DSR supports the ENUM interface on UDP with the bind9 software.

After receiving ENUM message from bind9 through the UDP interface, the ENUM application queries UDR with ComAgent Connection for the DN received in the message. After getting response from UDR, ENUM application generates the response and send it to bind9 through UDP interface. Bind9 forwards the response to the sender of the message.

ENUM Architecture with DSR

The following figure shows the overall system architecture for the ENUM feature with DSR:

Figure 2-1   ENUM Architecture with DSR
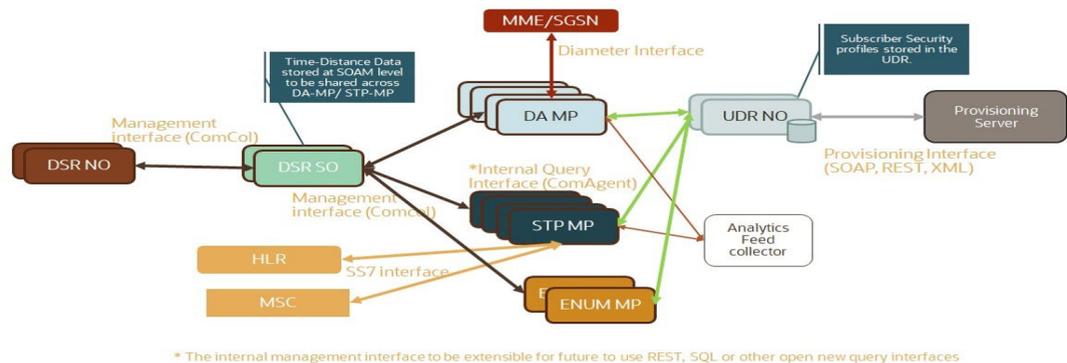
E.164 Number Mapping (ENUM)

E.164 Number Mapping (ENUM) is a Telephone Number Mapping standard defined for mapping of traditional PSTN numbers in E.164 format to IP-based format such as URI. ENUM uses a special DNS record type to translate a telephone number into a URI that can be used in an IP network. ENUM allows Internet-based services, such as E-mail, VoIP, and Voice Mail to be located based on the telephone number. ENUM accomplishes this by placing the telephone numbers into the global Domain Name System (**DNS**).

The following figure shows an example of the ENUM Tier resolution from a DNS perspective. The ENUM data format begins with a phone number, then reverses the digits, places a "."

between each number, and adds an .e164.arpa root domain that is common across both ENUM and this feature.

Figure 2-2   ENUM Tier Record Resolution
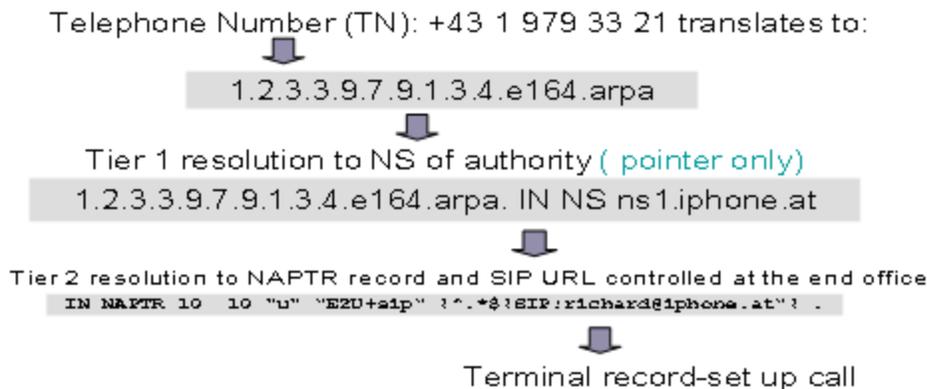
ENUM implementation is based on a tiered architecture. At Tier 0 is the **RIPE NCC** which maintains the e164.arpa zone. Entries in the RIPE NCC DNS server correspond to country codes or portions of country codes and point to the Tier 1 Registry that is the authoritative DNS server for that country code or portion of country code. The Tier 1 Registry maintains records that indicate the authoritative DNS server for individual E.164 numbers in the country code or portion thereof. The Tier 2 Provider for an E.164 number maintains the actual **NAPTR** records that contain information for specific communication services.

ENUM Process

This feature supports up to 16 ENUM application per MP. Each MP operates independently.

The ENUM MP works as a standalone application. There is no HA role for ENUM MP.

By default, ENUM process remains off. You can enable the application from vSTP Graphical User Interface (GUI). For more information, see GUI Configurations for ENUM Support.

vENUM shall not implement any load balancing mechanism between multiple ENUM MP. The BIND9 server manages load balancing of the queries between the various ENUM servers.

ENUM Connection States

The ENUM MP server connection is based on UDP socket with Bind9 and it has three states as shown in the following table:

Table 2-1   ENUM Connection States

State	Description
OPEN	ENUM connection is set OPEN=YES by OAM. The ENUM server UDP socket is created and listening for incoming ENUM packets
CLOSING	ENUM connection is set OPEN=NO by OAM. Transit state to process outstanding messages before moving to Closed state. All incoming ENUM requests are rejected in this state.
CLOSED	ENUM server UDP socket is closed.

The ENUM card is not allowed to be in the In-Service (IS-NR) state unless an ENUM server connection is provisioned on the ENUM card. Initially after provisioning a new ENUM server connection, the connection is set to the CLOSED state with OPEN=NO. When OPEN is changed to YES, the ENUM application creates a new UDP socket listening for incoming ENUM Request messages and the connection is changed to the OPEN state. In the OPEN state, the ENUM card is ready to receive and process incoming ENUM traffic. When the ENUM connection is set to OPEN=NO, the connection state transitions to the CLOSING state. In the CLOSING state, new incoming ENUM Request messages are rejected; only outstanding ENUM Response messages are processed and sent back to the client before transitioning to CLOSED state. In the CLOSED state, all incoming ENUM packets are discarded.

> **Note:**
>
> The queries may be lost on UDP sockets if ENUM MP is not able to read all the queries and the UDP socket buffers overflow.

UDR Connection with ENUM

ENUM makes a connection with UDR through ComAgent. The ENUM MP registers the Routed Service with ComAgent to configure the connection with UDR.

Congestion Manager

The ENUM application supports congestion detection and alarming for each ENUM connection. Two congestion thresholds can be configured and are derived using the ENUM card TPS as shown in the following table:

Table 2-2   ENUM Congestion Thresholds

Congestion Threshold	Value (% of Card TPS)	Notes
Congestion Level 1	0 – 100 (Default = 40)	Raise a Minor alarm when the TPS for outgoing messages exceeds Congestion Threshold Level 1.
Congestion Level 2	0 – 100 (Default = 80)	Raise a Major alarm when the TPS for outgoing messages exceeds Congestion Threshold Level 2.

An alarm is also raised if TPS for incoming messages exceeds 4000 on ENUM MP.

Flow Control

An ENUM card can process up to 4000 messages per second (4000 TPS). Above the 4000 TPS limit, the ENUM card:

• may discard the messages

• notify the client with an ENUM Error Response message if the ENUMOPTS option CNGNTFY = TRUE

• notify the client with an ENUM Error Response Code configured in the ENUMOPTS option CNGRCODE

    The allowed values for the ENUMOPTS option CNGRCODE are 5 (ENUM_QRY_REFUSED), and 11 to 15. The default value of CNGRCODE is 5. ENUM Error Response messages due to congestion are paced at a rate of one error message per 100 discarded ENUM messages at the application level.

• peg the measurements for Total Discarded ENUM Messages and Messages Discarded due to Congestion at the application level

    Any incoming message discarded due to the UDP socket receive buffer overflow are silently discarded by the network stack. For those messages, discard measurement are not pegged at the application level. This may cause the Error Response message count to not match exactly the rate of one error message per 100 incoming messages causing congestion.

About BIND9

ENUM uses BIND9 domain name server for interacting with the Domain Name System (DNS).

BIND is a suite of software for interacting with DNS. It acts as an authoritative name server for DNS zones and as well as a recursive resolver in the network.

BIND9 facilitates the following functions:

Access Control

Access Control Lists (ACLs) are the address match lists that give users control over who can access the name server. The ACLs can be configured using the DSR MMI or Graphical User Interface (GUI). You can select any of ther following option for an address:

• Allowed

• Blocked

The Blocked ACLs take precedence over allowed ones. For example, if there are two subnets configured with some common IPs as follows:

```
acl allowed{
172.16.0.0/22;
};
acl blocked{
```

```
172.16.1.0/24;
};
```

In the above example, the subnet 172.16.0.0/22 is allowed, which means that all the IPs in the range 172.16.0.1 - 172.16.3.254 are allowed. And the subnet 172.16.1.0/24 is blocked, which means the IPs in the range 172.16.1.1 - 172.16.1.254 are blocked. As blocked takes precedence, all IPs in the range 172.16.1.1 - 172.16.1.254 are considered as blocked.

Forwarding queries from validated IPs to ENUM application

The configured `e164.arp` zone allows BIND9 to forward all these queries to vENUM servers.

Load balancing the queries between multiple ENUM MPs

BIND9 load balances the queries between the various vENUM servers. It uses response times from previous queries to select the server that is likely to respond the most quickly. Dynamic adjustment of the recorded response times ensures that all forwarders are queried, even those with slower response times.

Caching

BIND9 caches the responses. The advantages of caching responses are:

- Improvement in application performance
- Reduction in the load on the backend
- Reduction of database cost
- Elimination of database hotspots

ENUM Application

The ENUM application task on each ENUM provides the following functions:

- Receive ENUM Query messages
- Verify client IP addresses
- Validate incoming ENUM Queries
- Perform lookups in UDR
- Create and send ENUM Response messages

ENUM Query Screening

The ENUM application allows ENUM Query messages to be received from only trusted ENUM clients. The ENUMACL table is used to provision the IP addresses of trusted ENUM clients. A Query message is discarded if the Query message is received from a client other than a trusted ENUM client stored in the ENUMACL table. The ENUMACL table has a maximum capacity of 100 IPADDR entries.

Table 2-3   ENUMACL Table

Field Name	Constraints	Comments
IPADDR	• Four numbers in the range 0-255 separated by dots • Mandatory	The ENUM client IP address is allowed to query the ENUM server.

Wild Cards (*) in IP Addresses

An ACL IPADDR entry of *.*.*.* is invalid. ACL entries which overlap with other entries with wild cards are not allowed. DSR allows the use of wild cards to support IP address ranges covered by an ACL entry as follows:

• xxx.xxx.xxx.*

• xxx.xxx.*.*

• xxx.*.*.*

Table 2-4   ENUMACL Table Example Entries

IPADDR
10.250.80.41
10.250.60.*
10.252.*.*

ENUM Query Validation

The ENUM application validates the incoming ENUM Query message to verify whether the the message conforms to the Query format. At a minimum, ENUM supports validations for the error conditions shown in the following table to be handled during the validation of ENUM query:

Table 2-5   ENUM Query Validation Errors

Error Condition	Response
QR (Query/Response flag) Field in ENUM Query Header = 1	ENUM Error Response with RCODE=1 (Format Error)
OPCODE other than 0 (Not a standard DNS query)	ENUM Error Response with RCODE=4 (Not Implemented)
TC (Truncation Flag) in ENUM Query Header = 1	ENUM Error Response with RCODE=4 (Not Implemented)
TC (Truncation Flag) in ENUM query header = 0 and query packet size > 512 bytes	ENUM Error Response with RCODE=4 (Not Implemented)
Z (Reserved Field) in ENUM Query Header = 1	ENUM Error Response with RCODE=4 (Not Implemented)
RCODE(Response Code) in ENUM Query Header = 1	ENUM Error Response with RCODE=1 (Format Error)
QDCOUNT (Question Count) in ENUM Query Header > 1	ENUM Error Response with RCODE=4 (Not Implemented)

Table 2-5   (Cont.) ENUM Query Validation Errors

Error Condition	Response
ENUM Query Question Section QNAME field root other than e164.arpa	ENUM Error Response with RCODE=3 (Non-Existent Domain Error)
ENUM Query Question Section QTYPE field other than NAPTR (35), NS (2) or CNAME (5)	ENUM Error Response with RCODE=4 (Not Implemented)
ENUM Query Question Section QCLASS field other than 1 (Internet)	ENUM Error Response with RCODE=4 (Not Implemented)

ENUM Response

The ENUM application generates ENUM Response messages using:

- Bind9 as external database
- Configurable data in table ENUMOPTION MO
- Dynamic data resulting from the UDR Lookup

Pre-defined Fields for NAPTR Response

The following table describes the pre-defined NAPTR Resource Record (RR) fields.

Table 2-6   Pre-defined Fields for NAPTR Response

Data Field	Description	Pre-Defined Values
TYPE	Resource Record Type	2
CLASS	Class of Query (1 for Internet)	1
TTL	Time to Live in seconds for an RR to be cached	0

Pre-defined Fields for NS Response

The following table describes the NS Resource Record (RR) fields which are pre-defined.

Table 2-7   ENUM NS Response Pre-defined Fields

Data Field	Description	Pre-Defined Values
TYPE	Resource Record Type	2
CLASS	Class of Query (1 for Internet)	1
TTL	Time to Live in seconds for an RR to be cached	0

Pre-defined Fields for CNAME Response

The following table describes the CNAME Resource Record (RR) which are pre-defined.

Table 2-8   ENUM CNAME Response Pre-defined Fields

Data Field	Description	Pre-Defined Values
TYPE	Resource Record Type	5

Table 2-8   (Cont.) ENUM CNAME Response Pre-defined Fields

Data Field	Description	Pre-Defined Values
CLASS	Class of Query (1 for Internet)	1
TTL	Time to Live in seconds for an RR to be cached	0

ENUM Database

To generate a Response for an ENUM Query, the ENUM application performs the UDR lookup to find the matching Entity Id for a DN in the incoming query. The following data is provisioned on UDR:

1. ENUM, DNS, and MNP records for handling the ENUM processing

2. ENUM and MNP Records for subscribers

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Feature Configurations

This section provides procedures to perform the ENUM Support feature configurations.

The ENUM setup can be configured using ONE PUSH with the ENUM heat template.

Once the setup is complete, ENUM application can be configured using the ENUM managed objects and ENUM GUI. The MMI API contains details about the URI, an example, and the parameters available for each managed object.

Configurations

New Setup Configuration

Install and configure the ENUM application as mentioned in the following steps:

1. Configure the vSTP setup with ONE PUSH using the ENUM heat template. To refer the heat template, download *ENUM Heat Template.zip* file from OHC.

2. Create Server group with Function id `STPENUM` and add `EnumMPs` (according to Requirement) under this Server Group for ENUM feature.

3. Configure the ENUM application using MMI API or ENUM GUI.

Upgrading Existing setup

To upgrade an existing SS7 setup (without ENUM MPs), perform the following steps:

1. Create new Enum MP(s) instance.

2. Create Server group with Function id `STPENUM` at C level.

3. Add the newly created MPs under the Server Group created in above step.

MMI Managed Objects for ENUM Support

MMI information associated with ENUM can be configured from a DSR NOAM or SOAM from **Main Menu**, and then **MMI API Guide**.

Once the *MMI API Guide* gets opened, use the application navigation to locate specific ENUM managed object information.

The following table lists the managed objects and operations supported for ENUM:

Managed Object Name	Supported Actions
Enum ACLs	POST, DELETE
Enum Options	PUT

Enum ACLs

The `Enum ACLs` MO supports the following parameters:

Table 3-1   Enum ACLs Parameters

Parameter Name	Description
ipAddress	IPv4 or IPv6 addresses which are to be allowed or blocked for ENUM feature. Valid entries are valid IPv6 and IPv4 addresses.
prefix	Specifies number of bits in netmask. Allowed values are: • 1-31 for IPv4 • 32,40,48,56,64 or 96 for IPv6
filter	Specifies whether the configured IP is to be allowed or blocked. Blocked filter takes precedence over Allowed, if an IP falls in both ranges.

Example- Insert

Create a file with following content to set values of the parameters. File name could be anything, for example option name can be used as filename:

```
{
"filter": "BLOCKED",
"ipAddress": "10.75.219.180",
"prefix": "24"
}
```

Execute the following command on Active SOAM to insert the data:

```
/venum/enumacls/ -v POST -r <filename>.json
```

Execute the following command to display the content:

```
venum/enumacls
{
"filter": "BLOCKED",
"ipAddress": "10.75.219.180",
"prefix": "24"
}
```

Enum Options

The Enum Options MO supports the following parameters:

Table 3-2   Enum Options Parameters

Parameter Name	Description
congestionNotification	Congestion Notification Flag for response, valid values are Yes, No

Table 3-2   (Cont.) Enum Options Parameters

Parameter Name	Description
congestionResCode	RCODE values in ENUM error response message to be sent due to congestion on ENUM application. Range [5,15] Default: 5
maxDnDigits	Max number of DN digits from an incoming ENUM query. Range [8,15] Default: 15
defaultProfileType	It identifies the profile used to generate the ENUM response for each resource record type.
defaultNaptrSrvc	Service parameter. This parameter specifies the supported ENUM services. This parameter is only valid for NAPTR response type.
defaultNSDomain	This parameter specifies the domain name of the name server in the NS record. This parameter is only valid for the NS response type.
defaultNaptrFlag	A containing flags to control aspects of the rewriting and interpretation of the fields in the record. This parameter is only valid for NAPTR response type.
defaultNaptrRegex	NAPTR Regex Response. This parameter is only valid for NAPTR response type.

Example- Update

Create a file with following content to set values of the parameters. File name could be anything, for example option name can be used as filename:

```
{
        "addRnContext": "No",
        "congestionNotification": "No",
        "congestionResCode": 5,
        "defaultNSDomain": "abc2.com",
        "defaultNaptrFlag": "U",
        "defaultNaptrRegex": "!^.*$!sip:info@example.com!",
        "defaultNaptrSrvc": "SIP",
        "defaultProfileType": "NAPTR",
    "maxDnDigits": 15
    }
```

Execute the following command on Active SOAM to insert the data:

```
/venum/enumoptions -v PUT -r <filename>.json
```

Execute the following command to display the content:

```
venum/enumoptions{
        "addRnContext": "No",
        "congestionNotification": "No",
        "congestionResCode": 5,
        "defaultNSDomain": "abc2.com",
        "defaultNaptrFlag": "U",
        "defaultNaptrRegex": "!^.*$!sip:info@example.com!",
        "defaultNaptrSrvc": "SIP",
        "defaultProfileType": "NAPTR",
      "maxDnDigits": 15
    }
```

GUI Configurations for ENUM Support

The ENUM Support feature can be configured from Active System OAM (SOAM). Select **VENUM** , and then **Configuration** page.

Enum ACLs

Enum ACLs allow user to allow or block IPs from accessing the ENUM feature.

Select the **VENUM**, and then **Configuration**, and then **Enum ACLs** page. The page displays the elements on the **Enum ACLs** View, Insert, and Edit pages.

Table 3-3   Enum ACLs Elements

Element	Description	Data Input Notes
IP Address	IPv4 or IPv6 addresses which are to be allowed or blocked for ENUM feature. This is a mandatory field.	Valid IPv6 and IPv4 addresses
Prefix	Specifies number of bits in netmask.	Allowed values are • 1-31 for IPv4 • 32,40,48,56,64 or 96 for IPv6
Filter	Specifies whether the configured IP is to be allowed or blocked. Blocked filter takes precedence over Allowed, if an IP falls in both ranges. This is a mandatory field.	

You can perform add, edit, or delete tasks on **VENUMConfigurationEnum ACLs** page.

Adding Enum ACL

Perform the following steps to configure a new Enum ACL:

1. Click **Insert**.

2. Enter the applicable values.

3. Click **OK**, **Apply**, or **Cancel**

Editing Enum ACL

Use this procedure to change the field values for a selected Enum ACL. (The **Enum ACL Name** field cannot be changed.):

1. Select the **Enum ACL** row to be edited.

2. Click **Edit**

3. Enter the updated values.

4. Click **OK**, **Apply**, or **Cancel**

Deleting Enum ACL

Use the following procedure to delete a Enum ACL.

> **Note:**
>
> A Enum ACL will only be deleted if all delete validation checks pass.

1. Select the **Enum ACL** to be deleted.

2. Click **Delete**.

3. Click **OK** or **Cancel**.

Enum Options

The Enum Options are those configuration values that govern the overall Enum Application. There is a single instance of this resource, which contains each of the individual options that can be retrieved and set. Because there is no collection of instances, there is no collection GET action. No new Enum Options resource can be created, so there is no POST action, and the single instance cannot be removed, so there is no DELETE action. The single instance GET is used to retrieve the options, and PUT is used to update one or more values within the set of options. A name for this single, non-deletable instance is neither required nor expected.

Select the **VENUM**, and then **Configuration**, and then **Enum Options** page. The page displays the elements on the **Enum Options** View, Insert, and Edit pages.

Table 3-4   Enum Options Elements

Element	Description	Data Input Notes
Congestion Notification	Congestion Notification Flag for response	valid values are Yes, No
Congestion Result Code	RCODE values in ENUM error response message to be sent due to congestion on ENUM application.	Range [5,15] Default: 5
Max DN Digits	Max number of DN digits from an incoming ENUM query.	Range [8,15] Default: 15
Default Profile Type	It identifies the profile used to generate the ENUM response for each resource record type.	

Table 3-4   (Cont.) Enum Options Elements

Element	Description	Data Input Notes
Default NS Domain	This parameter specifies the domain name of the name server in the NS record. This parameter is only valid for the NS response type.	
Default Naptr Service	Service parameter. This parameter specifies the supported ENUM services. This parameter is only valid for NAPTR response type.	
Default Naptr Flag	A character-string containing flags to control aspects of the rewriting and interpretation of the fields in the record. This parameter is only valid for NAPTR response type.	
Default Naptr Regex	NAPTR Regex Response. This parameter is only valid for NAPTR response type.	

You can perform add, edit, or delete tasks on **VENUMConfigurationEnum Options** page.

Adding Enum Option

Perform the following steps to configure a new Enum Option:

1. Click **Insert**.
2. Enter the applicable values.
3. Click **OK**, **Apply**, or **Cancel**

Editing Enum Option

Use this procedure to change the field values for a selected Enum Option. (The **Enum Option Name** field cannot be changed.):

1. Select the **Enum Option** row to be edited.
2. Click **Edit**
3. Enter the updated values.
4. Click **OK**, **Apply**, or **Cancel**

Deleting Enum Option

Use the following procedure to delete a Enum Option.

> ✏ **Note:**
>
> A Enum Option will only be deleted if all delete validation checks pass.

1. Select the **Enum Option** to be deleted.
2. Click **Delete**.
3. Click **OK** or **Cancel**.

Alarms and Measurements

Alarms and Events

The following table lists the alarms or events specific to the ENUM Support functionality for vSTP:

Alarm/Event ID	Alarm/Event Name
70462	ENUM Threshold - Level 2 exceeded
70464	ENUM card capacity exceeded
70467	UDR Enum DB unavailable
70474	ENUM Event Queue Utilization
70475	ENUM Udp Event Queue Utilization
70461	ENUM Threshold - Level1 exceeded
70468	enumMsgDecodeFailed
70469	enumRcvdInvalidMsg
70470	enumMpTpsExceeded
70472	enumDefaultProfQryTypeMismatch

For more details related to measurements, refer to *Diameter Signaling Router Alarms and KPIs Reference*.

Measurements

The following table lists the measurements specific to the ENUM Support functionality for vSTP:

Measurement ID	Measurement Name
22256	EnumQueryRx
22257	NaptrQueryRx
22258	NsQueryRx
22259	CnameQueryRx
22260	EnumQueryReject
22261	EnumQueryCongestionDiscard
22262	SuccessfulEnumTx
22263	EnumTxRC1
22264	EnumTxRC2
22265	EnumTxRC3
22266	EnumTxRC4
22267	EnumTxRC5
22268	EnumTxDefltProfile
22277	EnumUdrLookupFailure
22278	VstpEnumEventQueuePeak
22279	VstpEnumEventQueueAvg

Measurement ID	Measurement Name
22280	VstpEnumUdpEventQueuePeak
22281	VstpEnumUdpEventQueueAvg
22282	VstpEnumStackQueueFull
22283	VstpENUMUDPStackQueueFull
22284	VstpEnumMpCpuPeak
70468	enumMsgDecodeFailed
70469	enumRcvdInvalidMsg
70470	enumMpTpsExceeded
70472	enumDefaultProfQryTypeMismatch

For more details related to measurements, refer to *Diameter Signaling Router Measurement Reference*.

4
Troubleshooting

In case of the error scenarios, the ENUM measurements are pegged. For information related to ENUM measurements, see *Measurement Reference* guide.