Oracle® Communications
EAGLE ENUM User's Guide

Release 47.0

F41403-01

September 2022

ORACLE®

Contents

3   Commands

4   Feature Configuration

5   Measurements

6   Maintenance

My Oracle Support (MOS)

My Oracle Support (MOS) is your initial point of contact for any of the following requirements:

- **Product Support**:
  The generic product related information and resolution of product related queries.

- **Critical Situations**
  A critical situation is defined as a problem with the installed equipment that severely affects service, traffic, or maintenance capabilities, and requires immediate corrective action. Critical situations affect service and/or system operation resulting in one or several of these situations:

  - A total system failure that results in loss of all transaction processing capability

  - Significant reduction in system capacity or traffic handling capability

  - Loss of the system's ability to perform automatic system reconfiguration

  - Inability to restart a processor or the system

  - Corruption of system databases that requires service affecting corrective actions

  - Loss of access for maintenance or recovery operations

  - Loss of the system ability to provide any required critical or major trouble notification

  Any other problem severely affecting service, capacity/traffic, billing, and maintenance capabilities may be defined as critical by prior discussion and agreement with Oracle.

- **Training Need**
  Oracle University offers training for service providers and enterprises.

My Oracle Support (https://support.oracle.com) is your initial point of contact for all product support and training needs. A representative at Customer Access Support can assist you with My Oracle Support registration.

Call the Customer Access Support main number at 1-800-223-1711 (toll-free in the US), or call the Oracle Support hotline for your local country from the list at http://www.oracle.com/us/support/contact/index.html. When calling, make the selections in the sequence shown below on the Support telephone menu:

- For Technical issues such as creating a new Service Request (SR), select **1**.

- For Non-technical issues such as registration or assistance with My Oracle Support, select **2**.

- For Hardware, Networking and Solaris Operating System Support, select **3**.

You are connected to a live agent who can assist you with My Oracle Support registration and opening a support ticket.

My Oracle Support is available 24 hours a day, 7 days a week, 365 days a year.

Acronyms

The following table provides information about the acronyms and the terminology used in the document:

Table   Acronyms

Acronym	Description
ACL	Access Control List
CC	Country Code
DNS	Domain Name System
MNP	Mobile Number Portability
RN	Routing Number
RR	Resource Record
UAM	Unsolicited Alarm Message
UIM	Unsolicited Information Message

What's New in This Guide

This section introduces the documentation updates for Release 47.0 in Oracle Communications EAGLE ENUM User's Guide.

Release 47.0 -F41403-01, September 2022

- Added Response Formats for Number Portability and Response Formats for NAPTR sub-sections in ENUM Response Format section to ensure that TIF enhancements are consistent with ENUM.

- Updated ENUM Configuration section to show Port 53 support for ENUM query.

1
Introduction

This chapter provides a brief description of the ENUM Mobile Number Portability and Tier One Address Resolution (**ENUM**) feature of the Oracle Communications EAGLE. The chapter also includes the scope, audience, and organization of the manual; how to find related publications; and how to contact Oracle for assistance.

Overview

This manual provides feature descriptions, along with commands, maintenance, measurements, and configuration details associated with the ENUM Mobile Number Portability and Tier One Address Resolution (**ENUM**) feature of the Oracle Communications EAGLE. The ENUM feature adds an E.164 Number Mapping (ENUM) interface to allow ENUM Number Portability Query messages to be received by an EAGLE ENUM card, processed by the database (RxDB, ENUM), and then a Tier 1 ENUM Response message pointing to a carrier Tier 2 server returned to the requestor. The ENUM64 GPLs support the ENUM protocol over UDP; this GPL runs on the E5-SM8G-B or SLIC card.

Scope and Audience

This manual is intended for anyone responsible for installing, maintaining, and using the Oracle Communications **EAGLE** ENUM Mobile Number Portability and Tier One Address Resolution feature. Users of this manual must have a working knowledge of telecommunications and network installations.

References

For more information, refer to the following documents:

1. *Commands User's Guide*
2. *Measurements Reference*
3. *Database Administration - System Management User's Guide*
4. *Unsolicited Alarm and Information Messages Reference*
5. *EPAP Alarms and Maintenance Guide*

2

Feature Description

This chapter describes the ENUM Mobile Number Portability and Tier One Address Resolution feature.

Introduction

The ENUM Mobile Number Portability and Tier One Address Resolution (**ENUM**) feature of the Oracle Communications EAGLE enhances the ability of EAGLE to access the Number Portability database (RxDB) using ENUM protocol. Using the ENUM interface supported on UDP, EAGLE is able to process a destination number lookup in an IP-based addressing scheme in the Number Portability database and provide a routing solution to the originating carrier.

ENUM Architecture

Figure 2-1 shows the overall system architecture for the ENUM feature on the EAGLE.

- The ENUM application runs on the E5-SM8G-B or SLIC card loaded with the ENUM64 GPL.
- The ENUM application communicates with OAMHC on EAGLE using the IMT bus.
- The ENUM card connects to the EPAP using Ethernet Port A.
- The ENUM card connects to the ENUM clients (switches or CSCF) using Ethernet Port B.

Figure 2-1   ENUM Architecture on EAGLE
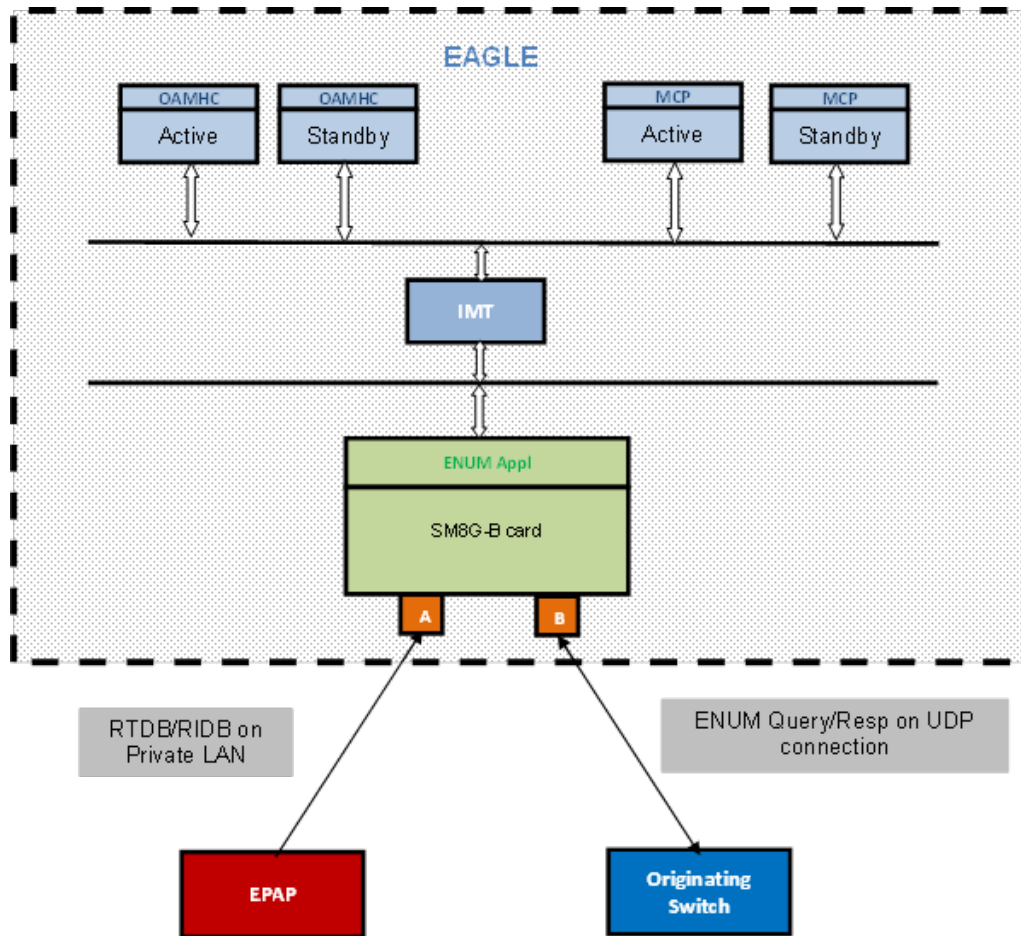
E.164 Number Mapping (ENUM)

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**).

An ENUM Tier resolution from a DNS perspective example is shown in Figure 2-2. 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
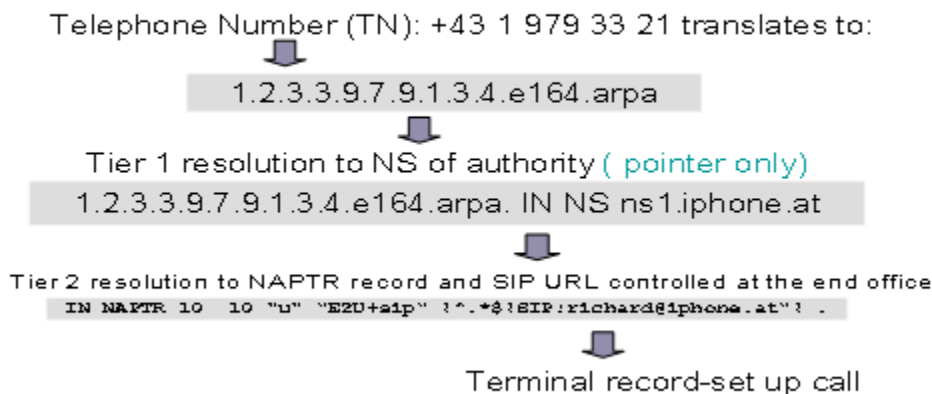
ENUM implementation is based on a tiered architecture. At Tier 0 is the **RIPE NCC** which maintains the e164.arpa zone. Entries in the RIPE NCC DNS server correspond to country codes or portions of country codes and point to the Tier 1 Registry that is the authoritative DNS server for that country code 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.

Redundancy/Failover

Redundancy is divided into the Signaling Network redundancy and the Private Network redundancy on E5-SM8G-B or SLIC cards. Figure 2-3 shows the network redundancy for E5-SM8G-B cards on EAGLE.

Figure 2-3   Network Redundancy with E5-SM8G-B Cards
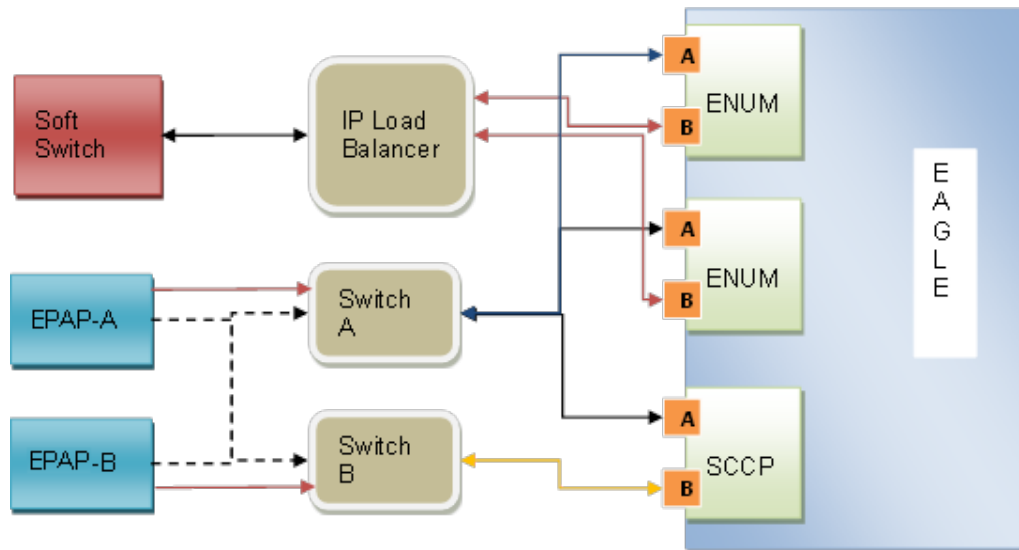
E5-SM8G-B Signaling Network

EAGLE supports up to 16 ENUM cards. Each ENUM card has its own IP address and operates independently. EAGLE does not provide load balancing between multiple ENUM cards. Users can implement load balancing on the client side or use a third-party load balancer between the client and the ENUM server on EAGLE which tracks connection status of each ENUM card. The ENUM client or load balancer must implement a failover mechanism in the event of connection failure and ENUM application card failure.

An ENUM card discards incoming messages from the ENUM client and pegs measurements for discarded ENUM queries in these two scenarios:

- Inbound connection congestion on the ENUM card - Socket queue or Application Receive queue becoming full
- Connection failure - ENUM messages on Receive and Transmit queues discarded

E5-SM8G-B Private Network

An ENUM card connects to the EPAP on a private network using Ethernet Port A. The RxDB data is downloaded to the ENUM card in same manner as Service Module cards are loaded.

However EPAP connectivity to an ENUM card and a Service Module card are different in the event of failure of Switch A. If Switch A (between EPAP A and EAGLE) or Port A on the EAGLE Service Module card fails, the Service Module card starts data download using Switch B or Port B. For the ENUM card, the connecting cable must be moved manually to the other switch, and then the ENUM card re-provisioned with the address of the other EPAP.

SLIC Network Redundancy

Four (4) network interfaces are supported for ENUM: Two (2) interfaces for EPAP communication and two (2) interfaces for signaling. One SLIC card with the ENUM application can connect to two (2) EPAPs and two (2) signaling networks at the same

time. Interface A/D will be used for EPAP connectivity, while interface B/C used for the signaling network.

Figure 2-4   SLIC Network Redundancy Model
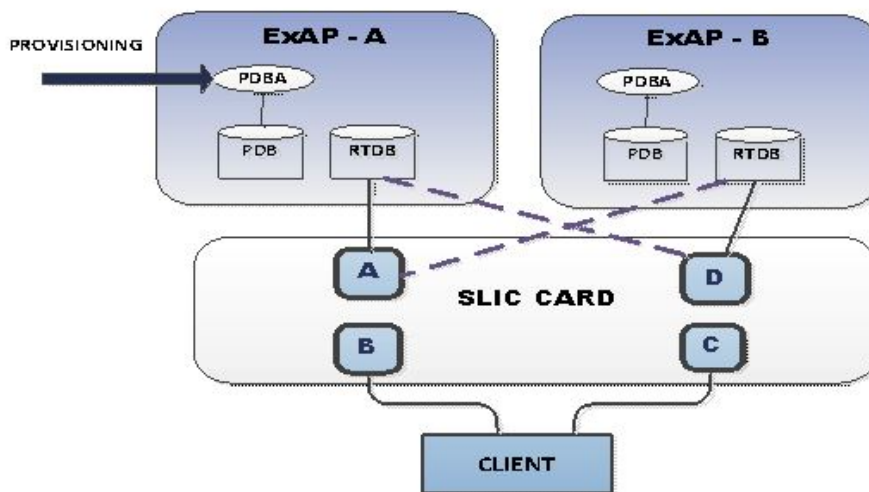
SLIC Signaling Network Redundancy

To achieve signaling network redundancy with the ENUM application, operators need to configure parallel UDP connections on both interfaces. One UDP connection per interface will be possible with a SLIC card running the ENUM application. If one interface/switch goes down, the operator needs to switch the traffic to another port/switch.

Figure 2-5   SLIC Card Signaling Network Redundancy
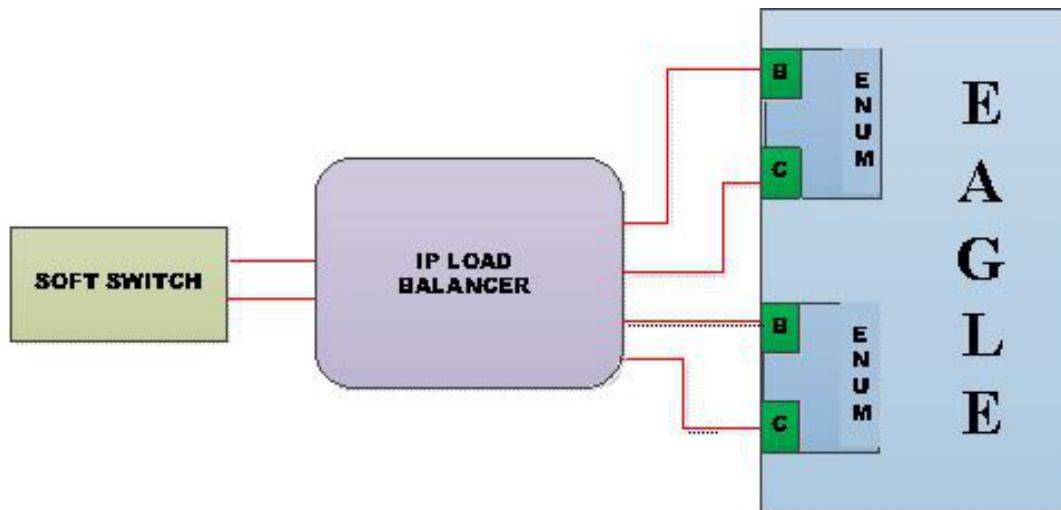
SLIC Private Network Redundancy

A SLIC card running the ENUM application will connect to EPAP using ports A and D to support redundancy. The RTDB data will be downloaded in the same manner as on E5-SM8G-B cards.

The difference between the EPAP connectivity on a SLIC card and E5-SM8G-B card is that, upon the failure of one switch or port, the SLIC card starts data download via another switch or port in the same manner as data downloads for the SCCP application.

> **Note:**
>
> Failure of a port on a single SLIC card (out of many) will not cause the card to download via another port until all the cables are disconnected from the active EPAP.

Figure 2-6   SLIC Card Private Network Redundancy
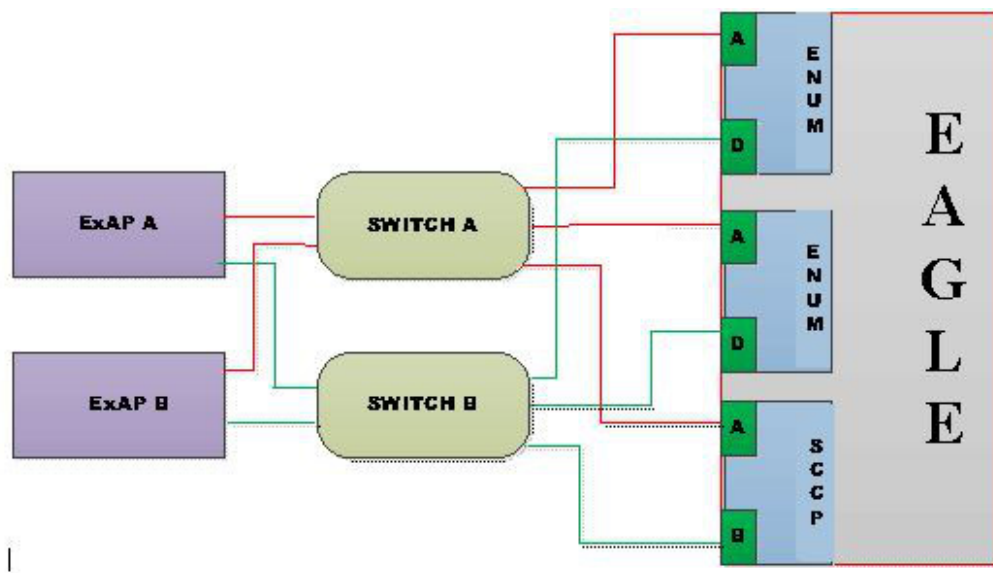
ENUM Connection States

The ENUM server connection is based on UDP socket and it has three states as shown in Table 2-1.

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

Table 2-1   (Cont.) ENUM Connection States

State	Description
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.

Congestion Manager

The UDP protocol used between the ENUM client and server does not support congestion handling. 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 Table 2-2.

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 card TPS exceeds Congestion Threshold Level 1.
Congestion Level 2	0 – 100 (Default = 80)	Raise a Major alarm when the card TPS exceeds Congestion Threshold Level 2.

The congestion caused by TPS flow control is handled aaccording to Flow Control.

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.

ENUM DNS Interface

ENUM is a telephone number mapping system designed to locate applicable communication servers on the Internet for servicing a given telephone number using DNS queries. ENUM uses a telephone number translated into URI format that is used in a DNS lookup to to retrieve a DNS record that can be used in Internet communication.

The Domain Name System (**DNS**) is the method by which Internet addresses in mnemonic form are converted into the equivalent numeric IP address. For example, sunc.scit.wlv.ac.uk. is converted to 134.220.4.1. To the user and application process this translation is a service provided either by the local host or from a remote host using the Internet. The **DNS server** (or *resolver*) may communicate with other Internet DNS servers if the DNS server cannot translate the address itself. The message formats used for exchange of queries and responses between hosts and DNS servers are defined by IETF standards (RFC 1035). Queries and responses can be transferred either by TCP or UDP; the EAGLE ENUM application supports only UDP. Both queries and responses have the same general format, containing up to five individual sections carrying information.

DNS Message Format

All communications inside of the domain protocol are carried in a single format called a message. The top level format of message is divided into five sections. Some sections are empty in certain cases. The five sections are shown below.

```
+---------------+
|     Header    |
+---------------+
|    Question   | Question for the DNS Server
+---------------+
|     Answer    | Resource Records answering the question
+---------------+
|   Authority   | Resource Records pointing toward an authority
+---------------+
|   Additional  | Resource Records holding additional information
+---------------+
```

The Header section is always present. The Header section includes fields that specify which of the remaining sections are present, and also specify whether the message is a query or a response, a standard query, or other opcode.

The names of the sections after the Header section are derived from their use in standard queries. The Question section contains fields that describe a question to a DNS Server. These fields are a Query Type (QTYPE), a Query Class (QCLASS), and a Query Domain Name (QNAME). The last three sections are the same format: a list of concatenated **Resource Record**s (RRs) which may be empty. The Answer section contains RRs that answer the question. The Authority section contains RRs that point toward an authoritative DNS Server; the additional records section contains RRs which relate to the query, but are not strictly answers for the question.

Header Section Format

The Header section contains the following fields:

```
                                    1  1  1  1  1  1
    0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                       ID                      |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |QR|   Opcode   |AA|TC|RD|RA|    Z    |  RCODE  |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                    QDCOUNT                    |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                    ANCOUNT                    |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                    NSCOUNT                    |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                    ARCOUNT                    |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```
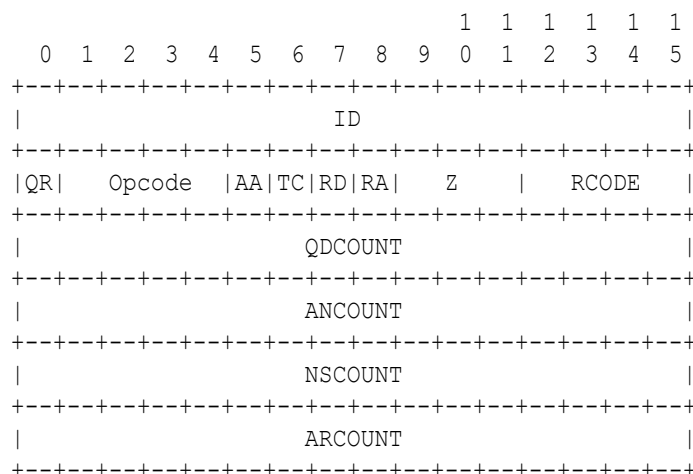
The Header section fields are described in Table 2-3. The total size of the Header section format is 12 octets.

Table 2-3   DNS Header Section Format

Field	Type	Description
ID	Ushort	This 16-bit identifier is assigned by the program that generates any kind of query. This identifier is copied to the corresponding reply and can be used by the requester to match replies to outstanding queries.
QR	Bitfield	This 1-bit field specifies whether this message is a query (0), or a response (1).
OPCODE	Bitfield	This 4-bit field specifies the kind of query in this message. This value is set by the originator of a query and copied into the response. The values are: 0 - a standard query (QUERY) 1 - an inverse query (IQUERY) 2 - a server status request (STATUS) Values 3 -15 are reserved for future use.
AA	Bitfield	The Authoritative Answer bit is valid in responses, and specifies that the responding DNS server is an authority for the domain name in question section.

Table 2-3   (Cont.) DNS Header Section Format

Field	Type	Description
TC	Bitfield	The Truncation bit specifies that this message was truncated due to a message length greater than the length permitted on the transmission channel.
RD	Bitfield	The Recursion Desired bit may be set in a query and is copied into the response. If the RD bit is set, the DNS server is directed to pursue the query recursively. Recursive query support is optional.
RA	Bitfield	The Recursion Available bit is set or cleared in a response, and denotes whether recursive query support is available in the DNS server.
Z	Bitfield	These bits are reserved for future use. These bits nust be zero in all queries and responses.
RCODE	Bitfield	The 4-bit Response Code field is set as part of responses. The values are:

		0 - No error condition
		    1 - Format error: The DNS server was unable to interpret the query.
		    2 - Server failure: The DNS server was unable to process this query due to a problem with the DNS server.
		    3 - Name Error: This code is only for responses from an authoritative DNS server. This code signifies that the domain name referenced in the query does not exist.
		    4 - Not Implemented: The DNS server does not support the requested kind of query.
		    5 - Refused: The DNS server refuses to perform the specified operation for policy reasons. For example, a DNS server may not wish to provide the information to the particular requester, or a DNS server may not wish to perform a particular operation (example: zone transfer) for particular data.

		Values 6-15 are reserved for future use.
QDCOUNT	Ushort	This field is an unsigned 16-bit integer specifying the number of entries in the Question section.
ANCOUNT	Ushort	This field is an unsigned 16-bit integer specifying the number of resource records in the Answer section.
NSCOUNT	Ushort	This field is an unsigned 16-bit integer specifying the number of DNS server resource records in the Authority Records (Name Server) section.
ARCOUNT	Ushort	This field is an unsigned 16-bit integer specifying the number of resource records in the Additional Records section.

Question Section Format

The Question section is used to carry the question in most queries. The question includes the parameters that define what is being asked. The Question section contains QDCOUNT (usually one) entries, each with the following format:

```
                              1  1  1  1  1  1
      0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
```

```
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                                               |
|                    QNAME                      |
|                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    QTYPE                       |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    QCLASS                      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```
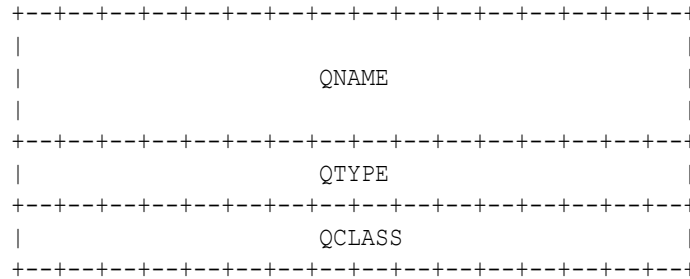
The Question section fields are described in Table 2-4.

Table 2-4   DNS Question Section Format

Field	Type	Description
QNAME	Char[]	This field is a domain name represented as a sequence of labels, where each label consists of a length octet followed by that number of octets. The domain name terminates with the zero length octet for the null label of the root. Note that this field may be an odd number of octets; no padding is used.
QTYPE	Ushort	This field is a 2-octet code which specifies the type of the query. The values for this field include all codes valid for a TYPE field, together with more general codes which can match more than one type of RR.
QCLASS	Ushort	This field is a 2-octet code that specifies the class of the query. For example, the QCLASS field is IN for the Internet.

Resource Record Format

The Answer section, Authority section, and Additional section share the same format which is a variable number of Resource Records. The number of Resource Records is specified in the corresponding field in the header - ANCOUNT, NSCOUNT, ARCOUNT. A Resource Record (RR) has the following format:

```
                              1  1  1  1  1  1
  0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                                               |
|                                               |
|                    NAME                       |
|                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    TYPE                        |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    CLASS                       |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    TTL                         |
|                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                  RDLENGTH                      |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--|
|                    RDATA                       |
```

```
|                                                         |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```
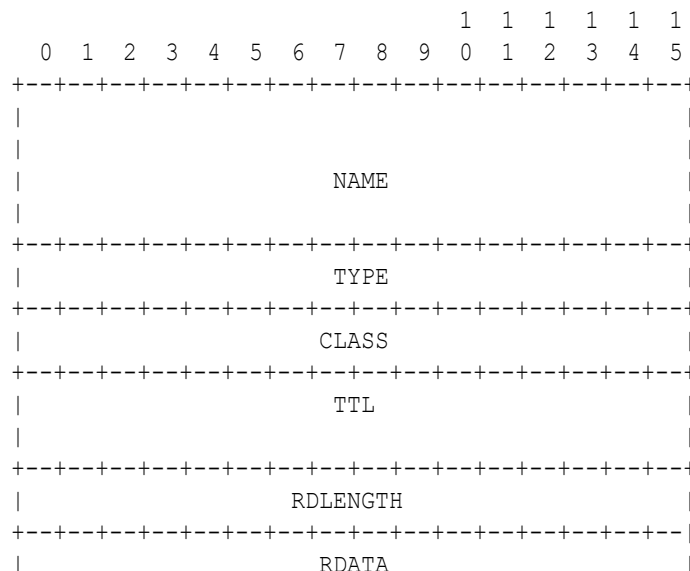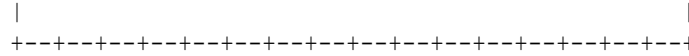
The Resource Record fields are described in Table 2-5.

Table 2-5   DNS Resource Record Format

Field	Type	Description
NAME	Char[]	This field is a domain name to which this resource record pertains.
TYPE	Ushort	This 2-octet field contains one of the Resource Record type codes. This field specifies the meaning of the data in the RDATA field.
CLASS	Ushort	This 2-octet field specifies the class of the data in the RDATA field.
TTL	Ulong	This field is a 32-bit unsigned integer that specifies the time interval in seconds that the Resource Record may be cached before it should be discarded. Zero values are interpreted to mean that the Resource Record can be used only for the transaction in progress, and should not be cached.
RDLENGTH	Ushort	This field is a 16-bit unsigned integer that specifies the length in octets of the RDATA field.
RDATA	Uchar[]	This variable length string of octets describes the resource. The format of this information varies according to the TYPE and CLASS of the Resource Record. For example, if the TYPE = A and CLASS = IN, the RDATA field is a 4-octet ARPA Internet address.

NAPTR Resource Record Format

The DNS type code for NAPTR is 35. The packet format for the NAPTR Resource Record (RR) is:

```
                                      1  1  1  1  1  1
    0  1  2  3  4  5  6  7  8  9  0  1  2  3  4  5
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                        ORDER                        |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                     PREFERENCE                      |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                        FLAGS                        |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                       SERVICES                      |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                        REGEXP                       |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
  |                     REPLACEMENT                     |
  |                                                     |
  +--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```
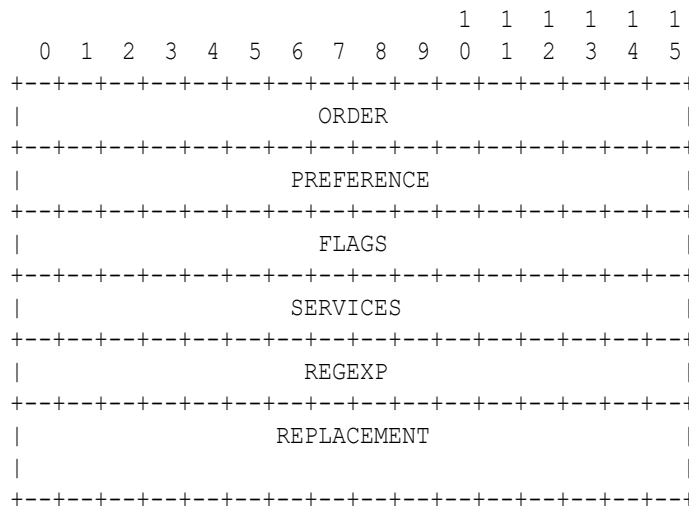
The NAPTR RR packet format fields are described in Table 2-6.

Table 2-6   NAPTR Resource Record Format

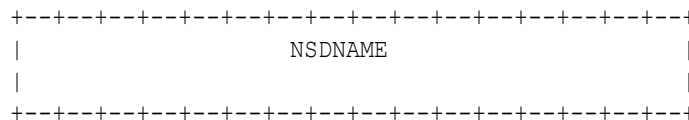| Field	Type	Description
ORDER	Ushort	This field is a 16-bit unsigned integer specifying the order in which the NAPTR records **must** be processed to accurately represent the ordered list of Rules. The ordering is from lowest to highest. If two records have the same order value, then they are considered to be the same rule and should be selected based on the combination of the Preference values and Services offered.
PREFERENCE	Ushort	This field is a 16-bit unsigned integer that specifies the order in which NAPTR records with equal ORDER values should be processed. Low numbers are processed before high numbers.
		Although the field is identified as "Preference" in deference to DNS terminology, this field is equivalent to the Priority value in the DDDS Algorithm. This field is similar to the Preference field in an MX record, and is used to allow domain administrators to direct clients towards more capable hosts or lighter weight protocols. A client may look at records with higher preference values if the client has a valid reason (example: not capably supporting a particular protocol or service).
		The important difference between ORDER and PREFERENCE fields is that when a match is found the client must not consider records with a different ORDER but the client may process records with the same ORDER but different PREFERENCEs. The only exception to this is noted in the second important note in the DDDS algorithm specification concerning allowing clients to use more complex Service determination between steps 3 and 4 in the algorithm. PREFERENCE is used to communicate a higher quality of service to rrules that are considered the same from an authority standpoint but not from a simple load-balancing perspective.
		Note that DNS contains several load-balancing mechanisms. If load balancing among otherwise equal services is needed, then methods such as SRV records or multiple A records should be utilized to accomplish load balancing.
FLAGS	Char[]	This field is a character string containing flags to control aspects of the rewriting and interpretation of the fields in the record. Allowable values are single alphanumeric characters (A-Z, 0-9). Alphabetic characters can be upper case or lower case with no significance. The field can be empty. The application must specify how it is using this database to define the flags in this field, and must define which flags are terminal and which are not.
SERVICES	Char[]	This field is a character string that specifies the service parameters applicable to this delegation path. The application must specify the values found in this field.
REGEXP	Char[]	This field is a character string containing a substitution expression that is applied to the original string held by the client in order to construct the next domain name to lookup.
		As stated in the DDDS algorithm which provides the syntax of this field, the regular expressions must not be used in a cumulative fashion; they can be applied only to the original string held by the client and never to the domain name produced by a previous NAPTR rewrite.

Table 2-6   (Cont.) NAPTR Resource Record Format

Field	Type	Description
REPLACEMENT	Char[]	This field is a domain name which is the next domain name to query, depending on the potential values found in the FLAGS field. The REPLACEMENT field is used when the regular expression is a simple replacement operation. Any value in this field must be a fully-qualified domain name. Name compression cannot be used for this field.
		The REPLACEMENT field and the REGEXP field together make up the Substitution Expression in the DDDS Algorithm. This field exists for reasons of historical optimization, specifically for DNS compression. The fields are mutually exclusive. If a record is returned that has values for both fields, then it is considered to be in error and either should be ignored or an error returned.

NS Resource Record Format

NSDNAME is a domain name which specifies a host which should be authoritative for the specified class and domain.

```
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                   NSDNAME                     |
|                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```

CNAME Resource Record Format

CNAME is a domain name which specifies the canonical or primary name for the owner. The owner name is an alias.

```
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|                    CNAME                      |
|                                               |
+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
```
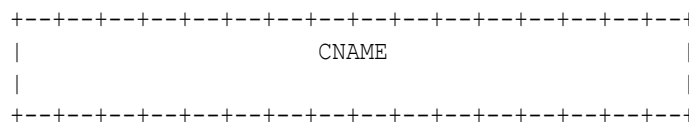
ENUM Query Format

The ENUM application (Tier 1 NAPTR) expects a DNS Query with the formats for the Header and Question sections, as shown respectively in Table 2-7 and Table 2-8:

Table 2-7   ENUM Query Section Format - Header Section

Data Field	Description	Possible Values
ID	This 16-bit identifier is used to correlate queries and responses.	any valid 16-bit number
QR	The Query/Response field must be 0.	0 = Query

Table 2-7   (Cont.) ENUM Query Section Format - Header Section

Data Field	Description	Possible Values
OPCODE	The OPCODE field specifies the type of query and must be 0.	0 = Standard Query
AA	The Authoritative Answer bit is ignored by the ENUM application.	0 or 1
TC	The Truncation bit must be 0.	0
RD	The Recursion Desired bit may be 0 or 1.	0 or 1
RA	The Recursion Available bit may be 0 or 1.	0 or 1
Z	Reserved; must be 0	0
RCODE	The Response Code field must be 0 in a query.	0
QDCOUNT	The Question section count must be 1.	1
ANCOUNT	The Answer section count must be 0.	0
NSCOUNT	The Authority Records (Name Server) section count is ignored.	0
ARCOUNT	The Additional Records section count is ignored.	0

Table 2-8   ENUM Query Section Format - Question Section

Data Field	Description	Possible Values
QNAME	This field is the Telephone Number to be queried in an e164.arpa format.	any valid e164.arpa format Telephone Number
QTYPE	This field is the type of Question.	• NAPTR (35) • NS (2) • CNAME (5)
QCLASS	This field is the class of Question.	1 (Internet)

ENUM Response Format

The ENUM application (Tier 1 NAPTR) responds with a DNS Response with the following formats for the Header, Question, Answer, and Authority sections, if no errors occurred and the carrier associated with the telephone number was found:

Table 2-9   ENUM Response Format - Header Section

Data Field	Description	Possible Values
ID	This identifier is used to correlate queries andresponses.	The ID from the Query is placed in the ID field of the Response.
QR	The Query/Response field must be 1.	1 = Response
OPCODE	The OPCODE field specifies the type of Query and must be 0.	0 = Standard Query
AA	The Authoritative Answer bit must be 1.	1

Table 2-9 (Cont.) ENUM Response Format - Header Section

Data Field	Description	Possible Values
TC	The Truncation bit must be 0.	0
RD	The Recursion Desired bit depends on the Query RD value. The RD from the Query is placed in the RD field of the Response.	0 or 1
RA	The Recursion Available bit must be 0. Recursion is not supported.	0
Z	Reserved; must be 0	0
RCODE	The Response Code depends on the error. (Table 2-13)	0, 1, 2, 3, 4, 5, 11 - 15
QDCOUNT	The Question section count must be 1.	1
ANCOUNT	The Answer section count can be up to 2.	0, 1, or 2
NSCOUNT	The Authority Records (Name Server) section count can be 0 or 1.	0 or 1
ARCOUNT	The Additional Records section count is ignored.	0

The Question section in the ENUM Response message reflects the Question section of the received Query.

Table 2-10 ENUM Response Format - Question Section

Data Field	Description	Possible Values
QNAME	This field is the Telephone Number in an e164.arpa format.	valid e164.arpa format Telephone Number of Query
QTYPE	This field is the type of Question.	• NAPTR (35) • NS (2) • CNAME (5)
QCLASS	This field is the class of Question.	1 (Internet)

The DNS Response from the ENUM application may include multiple Answer Response Records with the following format.

Table 2-11 ENUM Response Format - Answer Section

Data Field	Description	Possible Values
NAME	This field is the Telephone Number in an e164.arpa format.	valid e164.arpa format Telephone Number of Query
TYPE	This field contains the Resource Record type code.	• NAPTR (35) • NS (2) • CNAME (5)
CLASS	The CLASS must be 1 for Internet.	1
TTL	The Time to Live for a Resource Record to be cached in seconds is 0.	0
RDLENGTH	This field is the length in octets of the RDATA field.	variable

Table 2-11   (Cont.) ENUM Response Format - Answer Section

Data Field	Description	Possible Values
RDATA	The Resource Data field is a variable length string of octets that describes the resource.	variable
ORDER	This field specifies the order in which NAPTR records are processed. The lowest number is the highest order.	variable; 16-bit unsigned number (0 - 63535)
PREFERENCE	This field specifies the order in which NAPTR records with identical ORDER values are processed. The lowest number is the highest order.	variable; 16-bit unsigned number (9 - 63535)
FLAGS	This field controls the rewriting and interpretation of the record.	U - Terminal Rule
SERVICES	This field specifies the protocol associated with a service.	E2U+pstn:tel E2U+pstn:sip E2U+SIP
REGEXP	This field specifies the substitution expression applied to the original string.	!^.*$!sip:\1;npdi;rn=\1%40gw.example.com;user=phone!. !^.*$!sip:+1442079460148@example.com!

The Authority Section contains the name of the host on which the ENUM server (Tier 1 NAPTR) is running as authoritative for the requested query.

Table 2-12   ENUM Response Format - Authority Section

Data Field	Description	Possible Values
NAME	This field is the domain name to which this Resource Record pertains.	1.e164.arpa
TYPE	The Resource Record TYPE must be 2.	2 = authoritative DNS server
CLASS	The CLASS of this Query must be 1 for Internet.	1
TTL	The Time to Live for a Resource Record to be cached in seconds is 0.	0
RDLENGTH	Rhis field in the length of the RDATA field	variable
RDATA	This field is the resource data.	variable
hostname	This is the hostname of the Tier 1 NAPTR ENUM Server	variable

The ENUM application uses the following response codes when responding to erroneous queries. RCODES values 6 - 10 are reserved for future use.

Table 2-13   ENUM Error Response Codes (RCODEs)

RCODE	Name	Error
0	No Error	Query processed successfully
1	Format Error	QR field other than 0 (a response)
1	Format Error	Could not parse Query
2	Server Failure	Database inaccessible
3	NXDomain	QNAME-domain does not match what is provisioned
4	Not Implemented	Opcode value other than 0 (not a standard DNS Query)
4	Not Implemented	TC value other than 0 (Truncated Queries are not required to be supported.)
4	Not Implemented	Z value other than 0 (Z is reserved for future use.)
4	Not Implemented	QDCOUNT value other than 1
4	Not Implemented	QTYPE value other than NAPTR (35), CNAME(5), or NS (2)
4	Not Implemented	QCLASS value other than 1
5, 11 - 15	Query Refused	Query refused due to inbound congestion

The ENUM application responds to badly-formed queries with an error response with the following format:

Table 2-14   ENUM Error Response - Header Section

Data Field	Description	Possible Values
ID	This identifier is used to correlate queries andresponses.	The ID from the Query is placed in the ID field of the Response.
QR	The Query/Response field must be 1.	1 = Response
OPCODE	The OPCODE field specifies the type of Query and must be 0.	0 = Standard Query
AA	The Authoritative Answer bit must be 1.	1
TC	The Truncation bit must be 0.	0
RD	The Recursion Desired bit depends on the Query RD value. The RD from the Query is placed in the RD field of the Response.	0 or 1 This bit is ignored regardless of its value.
RA	The Recursion Available bit must be 0. Recursion is not supported.	0
Z	Reserved; must be 0	0
RCODE	The Response Code depends on the error. (Table 2-13)	0, 1, 2, 3, 4, 5, 11 - 15
QDCOUNT	The Question section count must be 1.	1
ANCOUNT	The Answer section count must be 0.	0

Table 2-14   (Cont.) ENUM Error Response - Header Section

Data Field	Description	Possible Values
NSCOUNT	The Authority Records (Name Server) section count can be 0 or 1.	0 or 1
ARCOUNT	The Additional Records section count is ignored.	0

Response Formats for Number Portability

The ENUM Number Portability functionality supports the following response format specifications for generating the ENUM responses:

- For the Native or ported in subscribers:

  – The PSTNTEL URI does not include the SP value.
    Example: E2U+pstn:tel.!^.*$!tel:< +Called Party DN >;npdi!

  – The SIP URI does not include the SP value.
    Example: E2U+pstn:sip.!^.*$!sip: <+Called Party DN >;npdi;user=phone!

- For the ported out or ported between subscribers, the PSTNTEL URI does not include the **rn-context** parameter with the Country Code (CC) prefixed by the + sign.
  Note: The DEFCC value in STPOPTS table is used as CountryCode.

  Example: E2U+pstn:tel%!^.*$!tel: <+Called Party DN >;npdi;rn=<rn>;rn-context=+<CC>!

For more information, see the EXCLUDESP and RNCONTEXT parameters in Table 2-28.

- The "tel" URI and SIP URI responses include the LSBLSET parameter stored for a DN in the EPAP application.

Example

PSTNTEL URI response: E2U+pstn:tel.!^.*$!tel:< +Called Party DN >;npdi;lsblset=20!

SIP URI response: E2U+pstn:sip.!^.*$!sip: <+Called Party DN >;npdi;user=phone;lsblset=none!

Response Formats for NAPTR

The NAPTR functionality inserts a prefix after the RN tags in the regular expressions for the ported and non-ported DN queries responses. The response format is applicable in the following scenarios:

1. When INCPREFIX option in ENUMOPTS is set to YES

2. When NAPTR service configured in ENUM PROFILE is PSTNSIP

The following cases are applicable when DEFCC parameter from STPOPTS table, RN/SP from EPAP lookup and Prefix in ENUM Profile are configured:

- **When the country code in DN and the configured DEFCC match**

  1. Append the beginning digits of DN, equivalent to the length of the DEFCC, to regex string.

  2. Add the RN or SP, obtained from EPAP lookup, to the regex string.

  3. Add the remaining digits of DN to the regex string.

4. Use the Routing Number (RN) tag, followed by DEFCC.

5. Insert the Prefix configured in the ENUM profile.

EXAMPLE

Incoming DN = 20000001, DEFCC = 200, RN=6001, prefix = a5544

Regex: "!^.*$!sip:
+200600100001;npdi;rn=+200a5544@oracletests.com;user=phone!"

- **When the country code in DN and the configured DEFCC do not match**

  1. Add DEFCC to the regex string.

  2. Add the RN or SP, obtained from EPAP lookup, to the regex string.

  3. Add all the DN digits, including the country code, to the regex string.

  4. Use the Routing Number (RN) tag, followed by DEFCC.

  5. Insert the Prefix configured in the ENUM profile.

  EXAMPLE

  Incoming DN = 20000001, DEFCC = 59, RN=6001, prefix = a5544

  Regex: : "!^.*$!sip:
  +59600120000001;npdi;rn=+59a5544@oracletests.com;user=phone!"

- **When DEFCC is not configured but prefix is configured**

  1. Add the RN or SP, obtained from EPAP lookup, to the regex string

  2. Add all the DN digits.

  3. Append the Prefix configured in ENUM profile after the RN tag in regex response.

  EXAMPLE

  Incoming DN = 20000001, DEFCC = none, RN=6001, prefix = a5544

  Regex: "!^.*$!sip:+600120000001;npdi;rn=+a5544@oracletests.com;user=phone!"

- **When RN or SP are not found for the DN after EPAP lookup**

  1. Add DEFCC to the regex string.

  2. Add all the DN digits.

  3. In case the country code of DN matches with DEFCC, do not add DEFCC to the string. Only add the DN digits.

  4. Append the Prefix configured in ENUM profile after the RN tag in regex response.

  EXAMPLE

  Incoming DN = 20000001, DEFCC = 91, RN = None, prefix = a5544

  Regex: "!^.*$!sip:+9120000001;npdi;rn=+91a5544@oracletests.com;user=phone!"

- **When Prefix is not configured in the ENUM Profile**

  1. Form the regex string using DEFCC, RN and DN as described in above cases.

  2. Only append DEFCC after the RN tag in regex string.

  3. Leave the value after RN tag blank if DEFCC is not configured.

  EXAMPLE

Incoming DN = 20000001, DEFCC = 91, RN = 6001, prefix = None

Regex: "!^.*$!sip:+91600120000001;npdi;rn=+91@oracletests.com;user=phone!"

ENUM Application

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

- Receive ENUM Query messages
- Verify client IP addresses
- Validate incoming ENUM Queries
- Perform lookups in Number Portability database (RxDB) and ENUM database
- 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 and the ENUMACLDISC measurement is pegged 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 2-15   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. EAGLE 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 2-16   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 specified in ENUM Query Format. At a minimum,

EAGLE supports validations for the error conditions shown in Table 2-17 to be handled during the validation of ENUM query.

Table 2-17   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)
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:

- Pre-defined values for some of the fields in the Response message
- Configurable data in the ENUMPROF table
- Dynamic data resulting from the RxDB lookup, such as Entity ID (RN)

Refer to ENUM Profile Table (ENUMPROF) for details on configurable fields in the ENUMPROF table to be used in building an ENUM response for **NAPTR**, **CNAME** and **NS** Queries.

Pre-defined Fields for NAPTR Response

Table 2-18 describes the pre-defined NAPTR Resource Record (RR) fields.

Table 2-18   Pre-defined Fields for NAPTR Response

Data Field	Description	Pre-Defined Values
TYPE	Resource Record Type	NAPTR – 35
CLASS	Class of Query (1 for Internet)	1
TTL	Time to Live in seconds for an RR to be cached	0

Table 2-18   (Cont.) Pre-defined Fields for NAPTR Response

Data Field	Description	Pre-Defined Values
ORDER	Order in which NAPTR records are processed 16-bit unsigned value (Range = 0 to 63535). Lowest number = Highest order	10
PREFERENCE	Order in which equal order NAPTR records are processed	100 - If PREF field in the ENUMPROF table = FALSE 10 – if PREF field in the ENUMPROF table = TRUE
FLAGS	Controls rewriting and interpretation of the record U = Terminal Rule	U
SERVICE TYPE	Supported ENUM services are: • E2U+pstn:tel • E2U+pstn:sip • E2U+SIP	Values defined for SERVICE TYPE in ENUMPROF tables are: • PSTNTEL • PSTNSIP • SIP The default value is PSTNTEL.

NAPTR Resource Record Regular Expression

NAPTR Resource Record (RR) Regular expression is used to build a URI to be sent to the ENUM client in the NAPTR response. The format used for preparing regular expression in NAPTR is:

"!^.*$!<URI>!"

The PSTNSIP URI uses percent encoding for the "@" symbol (%40). Table 2-19 describes the format for Regular expression forming URIs for all services.

Table 2-19   ENUM NAPTR RR Regular Expression Format

Service	Ported	Non-Ported
PSTNSIP (INCPREFIX set to NO)	sip:<+Called Party DN>;npdi;RN=<RN from the NPDB lookup>%40<domain name defined in ENUMPROF Table>	sip:<+Called Party DN>;npdi%40<domain name defined in ENUMPROF Table>
PSTNSIP (INCPREFIX set to YES)	sip:+<DEFCC><RN from the NPDB lookup><Called Party DN>;npdi;RN=<+DEFCC><PREFIX configured in ENUM profile>@<domain name defined in ENUMPROF Table>	sip:+<DEFCC><RN from the NPDB lookup><Called Party DN>;npdi;RN=<+DEFCC><PREFIX configured in ENUM profile>@<domain name defined in ENUMPROF Table>
PSTNTEL	Tel:<+Called Party DN>;npdi;RN=<RN from the NPDB lookup>	Tel:<+Called Party DN>;npdi
SIP	sip:<+Called Party DN>@<domain name defined in ENUMPROF Table>	sip:<+Called Party DN>@<domain name defined in ENUMPROF Table>

Pre-defined Fields for NS Response

Table 2-20 describes the NS Resource Record (RR) fields which are pre-defined.

Table 2-20   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

Table 2-21 describes the CNAME Resource Record (RR) which are pre-defined.

Table 2-21   ENUM CNAME Response Pre-defined Fields

Data Field	Description	Pre-Defined Values
TYPE	Resource Record Type	5
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 two database lookups:

- Number Portability RxDB lookup to find the matching Entity ID for a DN included in the incoming Query

- ENUM Database lookup to generate an ENUM response using the Entity Id as the key

The ENUM Database is composed of three tables on the EAGLE which store the data needed for generating ENUM Response based on the incoming DN in the ENUM Query.

- ENUM Profile Selection table (ENUMPRID)

- ENUM DN Block table (ENUMDNBK)

- ENUM Profile table (ENUMPROF)

The ENUMACL table which stores the IP Addresses of trusted ENUM clients is described in ENUM Query Screening.

Another table used with the ENUM Mobile Number Portability and Tier One Address Resolution (ENUM) feature is the ENUM Options (ENUMOPTS) table which contains the system-wide configuration information required for the operation of the ENUM application. The ENUMOPTS table is part of the EGLEOPTS table.

ENUM Profile Selection Table (ENUMPRID)

The ENUM Profile Selection table (ENUMPRID) provides the mapping between Entity ID and ENUM Profile Selection ID, which is used as the lookup key in the ENUM Profile table (ENUMPROF). The primary advantage of the ENUMPRID table is the flexibility provided to dynamically change the ENUM Response Resource Record format (NAPTR, NS, or CNAME) for a specific Entity ID without making provisioning changes in the Number Portability RxDB using LSMS.

The ENUMPRID table allows a single Entity ID to be mapped to a maximum of four ENUM Profile IDs. Of the maximum of four ENUM Profile IDs, a maximum of two are for NAPTR records, one is for an NS record, and one is for a CNAME record from the ENUM Profile table (ENUMPROF). At least one Profile name must be assigned to an Entity ID entry in the ENUMPRID table. The maximum number of entries allowed in the ENUMPRID table is 2048.

Table 2-22   ENUMPRID Table Parameters

Name	Constraints	Comment
ENTITYID	• digit string • 1-15 digits • mandatory	This field is an individual Entity ID found from the DN or DN Block lookup in the Number Portability RxDB.
PRN1	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	First Profile Name; PRN1 must be of NS type.
PRN2	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Second Profile Name; PRN2 must be of CNAME type.
PRN3	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Third Profile Name; PRN3 must be of NAPTR type.
PRN4	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Fourth Profile Name; PRN4 must be of NAPTR type.

Table 2-23   ENUMPRID Table Example Entries

ENTITYID	PROFILE
1234	PROF1, PROF2
3244	PROF2

ENUM DN Block Profile Table (ENUMDNBK)

The ENUM DN Block Profile table (ENUMDNBK) provides the mapping between DN Blocks and the ENUM Profile Selection ID, which is used as the lookup key in the ENUM Profile table (ENUMPROF). The primary advantage of the ENUMDNBK table is that it provides an ENUM Profile Selection for DNs which are missing from the Individual DN table and the DN Block table in the Number Portability RxDB. Another advantage of the ENUMDNBK table is the flexibility provided to dynamically change the ENUM Response Resource Record format (NAPTR, NS, or CNAME) for a specific DN Block without making provisioning changes in the Number Portability RxDB using LSMS.

The ENUMDNBK table allows a single DN Block to be mapped to a maximum of four ENUM Profile IDs. Of the maximum of four ENUM Profile IDs, a maximum of two are for NAPTR records, one is for an NS record, and one is for a CNAME record from the ENUM Profile table (ENUMPROF). At least one Profile name must be assigned to a DN Block entry in the ENUMDNBK table. The maximum number of entries allowed in the ENUMDNBK table is 4096.

Table 2-24   ENUMDNBK Table Parameters

Name	Constraints	Comment
SDN	• digit string • 5-15 hex digits • mandatory	This field is the Starting DN in a DN Block range.
EDN	• digit string • 5-15 hex digits • mandatory	This field is the Last DN in a DN Block range. The number of EDN digits must be identical to the number of SDN digits. The EDN parameter value must be greater than the SDN parameter value.
PRN1	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	First Profile Name; PRN1 must be of NS type.
PRN2	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Second Profile Name; PRN2 must be of CNAME type.
PRN3	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Third Profile Name; PRN3 must be of NAPTR type.
PRN4	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • optional	Fourth Profile Name; PRN4 must be of NAPTR type.

Table 2-25   ENUMDNBK Table Example Entries

SDN	EDN	PROFILE
9194841000	9194841999	PROF1, PROF2
7733548000	7733548999	PROF1

ENUM Profile Table (ENUMPROF)

The ENUM Profile table (ENUMPROF) contains the data needed to generate an ENUM Response for three supported Resource Record formats: NAPTR, NS and CNAME. The Profile ID selected from the Profile Selection table (ENUMPRID) lookup is used as the key to find the matching entry for the ENUM Response. The maximum allowed ENUM Profile Name (PRN) entries in the ENUMPROF table is 2048.

Table 2-26   ENUMPROF Table Parameters

	Constraints	Comment
PRN	• character string • 10 characters • 1 alphabetic character followed by 9 alphanumeric characters • mandatory	Profile Name The Profile Name provides the key for Profile lookup in the ENUMPROF Table.
RTYPE	• character string • valid Response Type value: NAPTR [default], NS, CNAME • optional	Response Type The Response Type determines the type of Response (NAPTR, NS, or CNAME) to send to the ENUM client.
PREF	• Boolean • valid value: YES, NO [default] • optional	Preferred Response Because the ENUM application allows only two NAPTR Resource Records in a single ENUM Response, the Preferred Response (PREF) parameter determines the values for the Order and Preference fields to be encoded for each NAPTR Resource Record. The value of this field does not apply if only one NAPTR Resource Record is in a single ENUM Response. The PREF parameter is valid for only the NAPTR Response Type.
SPARM	• character string • valid values: PSTNTEL [default], PSTNSIP, SIP • optional	Service Parameter (Service Type) The ENUM application supports only three ENUM Services: E2U+pstn:tel, E2U+pstn:sip, E2U+SIP. The SPARM parameter is valid for only the NAPTR Response Type.

Table 2-26   (Cont.) ENUMPROF Table Parameters

	Constraints	Comment
RRDOMAIN	• character string • valid values: 0-9 A-Z - . • Default value is no character (*blank*) • 64 characters maximum • optional, except with RTYPE=NAPTR and SPARM=PSTNSIP/SIP when this parameter is mandatory	Domain Name in Regular Expression The Domain Name in Regular Expression is the domain name used in SIP URI for both ported and non-ported numbers. The RRDOMAIN parameter is valid for only the NAPTR Response Type.
RPDOMAIN	• character string • valid values: 0-9 A-Z - . • Default value is no character (*blank*) • 64 characters maximum • optional, except with RTYPE=NS and RTYPE=CNAME when this parameter is mandatory	Replacement Domain Name This field is used for: • Replacement domain name in NAPTR record • Domain name of the DNS server in the NS record • Canonical Name of domain server in the CNAME records
PREFIX	• Hexadecimal digits valid • Values: 0 - fffff • 5 digits maximum • optional	Prefix digits for NAPTR Regular expression The prefix digits are inserted as RN in regular expression in response to NAPTR queries. This case applies when INCPREFIX option in ENUMOPTS is set to YES and the NAPTR service configured in ENUM PROFILE is PSTNSIP.

Table 2-27   ENUMPROF Table Example Entries

PRN	RTYPE	PREF	SPARM	RRDOMAIN	RPDOMAIN	PREFIX
Default	NS	NO			Gw.ns1example.com	
PROF1	NAPTR	NO	PSTNTEL			
PROF2	NAPTR	YES	PSTNSIP	Gw3.nptrexample.com		6002
PROF3	CNAME	NO			Gw4.cnexample.com	
PROF4	NS	NO			Gw4.nsexample.com	
PROF5	NAPTR	YES	SIP	Gw3.nptrexample.com		

Default Profile

Upon start-up, the ENUM application initializes the first entry in the ENUM Profile table (ENUMPROF) as a default profile with these values:

• Profile Name (PRN) = default

- Response Type (RTYPE) = NAPTR

- Service Parameter (SPARM) = PSTNTEL

These provisioning rules apply to the ENUM default profile:

- Default profile cannot be deleted.

- Response Type (RTYPE) can be changed only for the default profile and no other profiles.

- Response Type (RTYPE) = CNAME is invalid for the default profile.

- Changing Response Type (RTYPE) = NS to Response Type (RTYPE) = NAPTR requires that the SPARM parameter must remain set to the default value of PSTNTEL.

- Changing Response Type (RTYPE) = NAPTR to Response Type (RTYPE) = NS requires that the Replacement Domain (RPDOMAIN) be provisioned, and the RRDOMAIN, PREF, PREFIX, and SPARM parameters must be set to blank values.

ENUM Options Table (ENUMOPTS)

The ENUM Options table (ENUMOPTS) contains the system-wide configuration information required for the operation of the ENUM application. The ENUMOPTS table is part of the EGLEOPTS table.

Table 2-28   ENUMOPTS Table Parameters

Name	Constraints	Comment
MAXDNDIGS	• integer • range: 5 - 15 • default value: 15	Maximum Number of Digits from an Incoming ENUM Query If the incoming ENUM Query has a DN with the number of digits exceeding MAXDNDIGS, then only the first MAXDNDIGS digits will be used for lookup in the RxDB DN and DN Block tables.
CONGLVL1	• integer • range: 1 - 99 • default value: 40	ENUM Card Congestion Threshold Level 1
CONGLVL2	• integer • range: 2 - 100 • default value: 80	ENUM Card Congestion Threshold Level 2
CNGNTFY	• Boolean • range: YES, NO • default value: NO	Congestion Notification Flag
CNGRCODE	• integer • range: 5, 11 - 15 • default value: NO	RCODE Values in ENUM Error Response The RCODEs are sent due to congestion on the ENUM card. • 5 = ENUM_QRY_REFUSED • 11 - 15 = USER CONFIGURABLE

Table 2-28   (Cont.) ENUMOPTS Table Parameters

Name	Constraints	Comment
EXCLUDESP	• Boolean • range: YES, NO • default value: NO	If EXCLUDESP is set to NO and the RxDB look up for a DN in individual DN table or DN Block table results in SP entity Id, that SP entity Id will be used as the key to do lookup in the ENUM profile selection Table. If EXCLUDESP is set to YES and the RxDB look up for a DN in the individual DN table or DN Block table results in an SP entity Id, that SP entity Id will be ignored and treated as no entity Id found for the DN.
RNCONTEXT	• Boolean • range: YES, NO • default value: NO	If RNCONTEXT is set to NO and the rn parameter is to be included in the NAPTR response with "tel" URI, the rn value will be preceded by "+" sign, as in: rn=+<msrn digits>. If RNCONTEXT is set to YES, the parameter RNCONTEXT with a value of <+CountryCode will be included in the ENUM Tel response. The DEFCC value in STPOPTS will be used as CountryCode.
INCPREFIX	• Boolean • range: YES, NO • default value: NO	If INCPREFIX option is set to YES, then the regular expression used in ENUM response for NAPTR PSTNSIP service is: • The DEFCC and RN from the NPDB lookup are inserted before the called party DN, as"sip: +<DEFCC><RN from the NPDB lookup><Called Party DN>" • TheDEFCC and PREFIX parameter configured inENUM PROFILE are inserted after RNtag as"rn=+<DEFCC><PREFIX>"

ENUM Query Processing for MNP

Figure 2-7 and Figure 2-8 show the overall flow of ENUM messages within the ENUM application for Mobile Number Portability (MNP). The flow of ENUM messages within the ENUM application for MNP is described below.

1. The ENUM Query is received on the ENUM card over the UDP port.

2. If the incoming Query is received from a client IP address that is not in the Access Control List (ENUMACL table), the ENUM Query is rejected.

3. The ENUM Query is validated. If the ENUM Query is invalid, then an Error Response is sent to the originator of ENUM Query.

4. The ENUM Query domain is verified. If the ENUM Query domain is other than E.164 ARPA, then an Error Response is sent to the originator.

5. The ENUM Query is decoded. Number conditioning is performed on the digits string in the Query to extract the E.164 DN.

6. **Incoming DN Digits as Lookup Key:** Determine the number of digits from the incoming DN to be used as a lookup key for both the RxDB and ENUM databases:

   • If the number of digits from the incoming DN is greater than or equal to the MAXDNDIGS option in the ENUMOPTS table, then use the first MAXDNDIGS digits for the lookup key.

   • If the number of digits from the incoming DN is less than the MAXDNDIGS option in the ENUMOPTS table, then use all of the incoming digits in DN as the lookup key.

7. An RxDB lookup with the lookup key determined in item 6 is performed in the Individual DN table of the RxDB.

8. If the Incoming DN is found in Individual DN table of the RxDB with an associated Entity ID (RN/SP), use that Entity ID to retrieve the associated Profile ID from the ENUM Profile Selection table (ENUMPRID). If a Profile ID is found, use that to generate the ENUM Response. Otherwise, form the ENUM Response as shown below in Default Profile Response.

9. If the Incoming DN is found in the Individual DN table of the RxDB without an associated Entity ID (RN/SP), then a lookup is performed in the ENUM DN Block Profile table (ENUMDNBK) with the incoming DN digits determined in item 6 as the lookup key. If the Profile ID is found, then use that to generate the ENUM Response. Otherwise, form the ENUM Response as shown below in Default Profile Response.

10. If the incoming DN digits determined in item 6 are not found in the Individual DN table of the RxDB, then an RxDB DN Block table lookup is performed

11. If the incoming DN digits determined in item 6 are found in the RxDB DN Block table with an associated Entity ID (RN/SP), use that Entity ID to retrieve the associated Profile ID from the ENUM Profile Selection table (ENUMPRID). If a Profile ID is found, use that to generate the ENUM Response. Otherwise, form the ENUM Response as shown below in Default Profile Response.

12. If the incoming DN digits determined in item 6 are not found in the RxDB DN Block table, then a lookup is performed in the ENUM DN Block Profile table (ENUMDNBK) with the incoming DN digits determined in item 6 as the lookup key. If a Profile ID is found, use that to generate the ENUM Response. Otherwise, form the ENUM Response as shown below in Default Profile Response.

Default Profile Response

If the Default Profile is RTYPE = NS, then send an ENUM Response message with RCODE = 0 and NS in the Authority Section.

If the Default Profile is RTYPE = NAPTR and QTYPE = NAPTR, then send an ENUM NAPTR Response message with RCODE =0.

Otherwise, send an ENUM Error Response message with RCODE=3 (Non-Existent Domain).

See Figure 2-9.

Figure 2-7   ENUM Message Flow for MNP
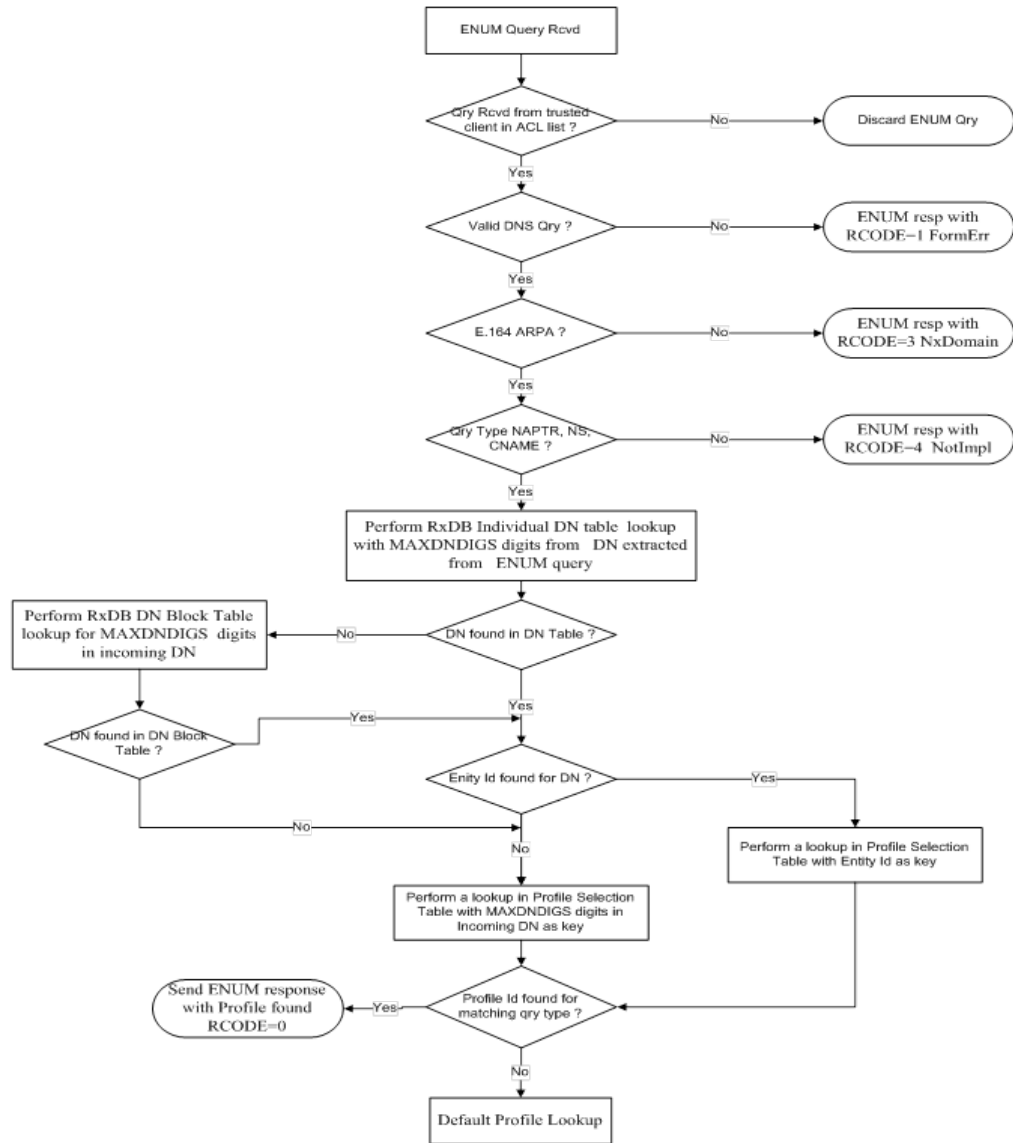
Figure 2-8   ENUM Message Flow within EAGLE
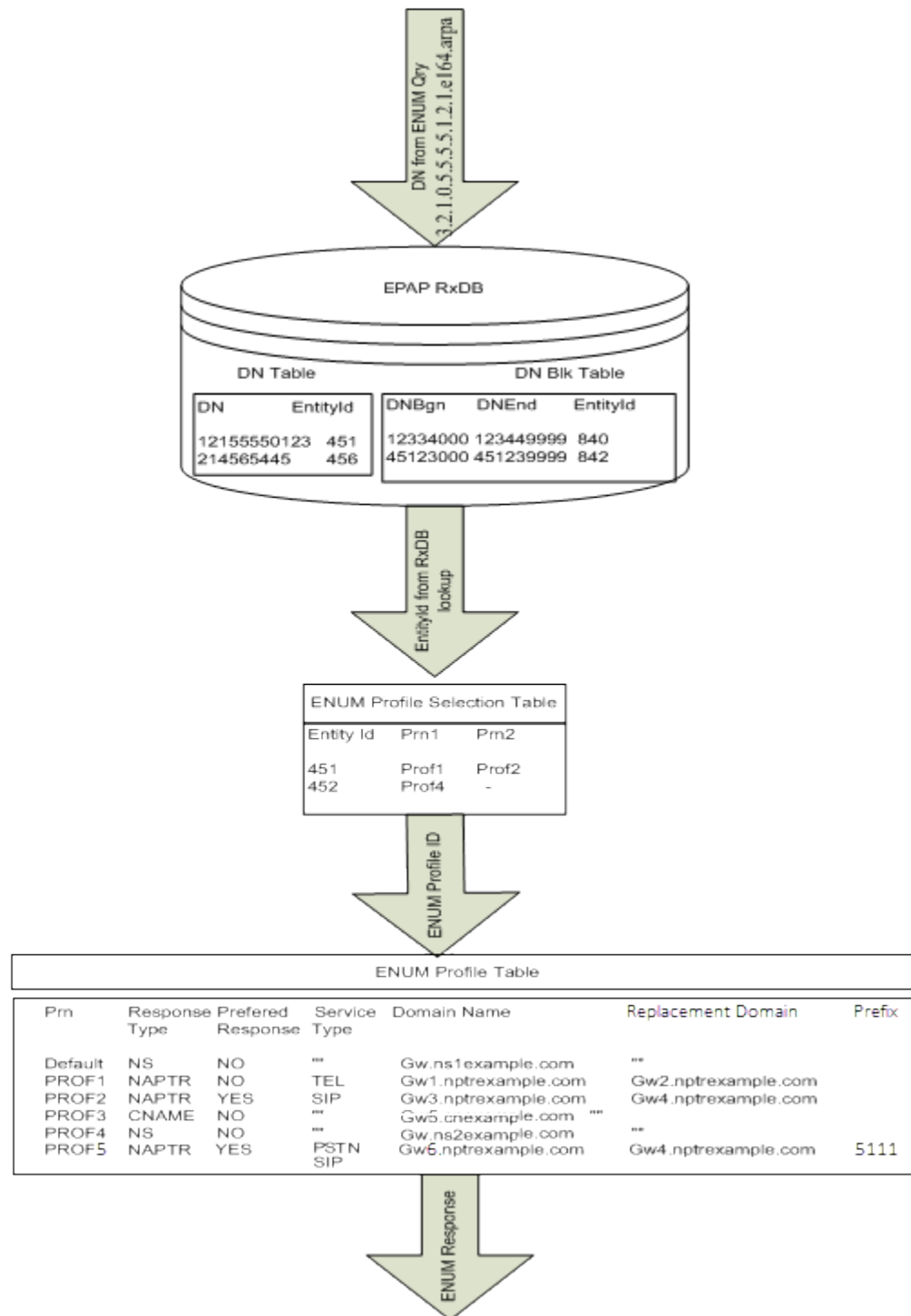
Figure 2-9   ENUM Default Profile Response
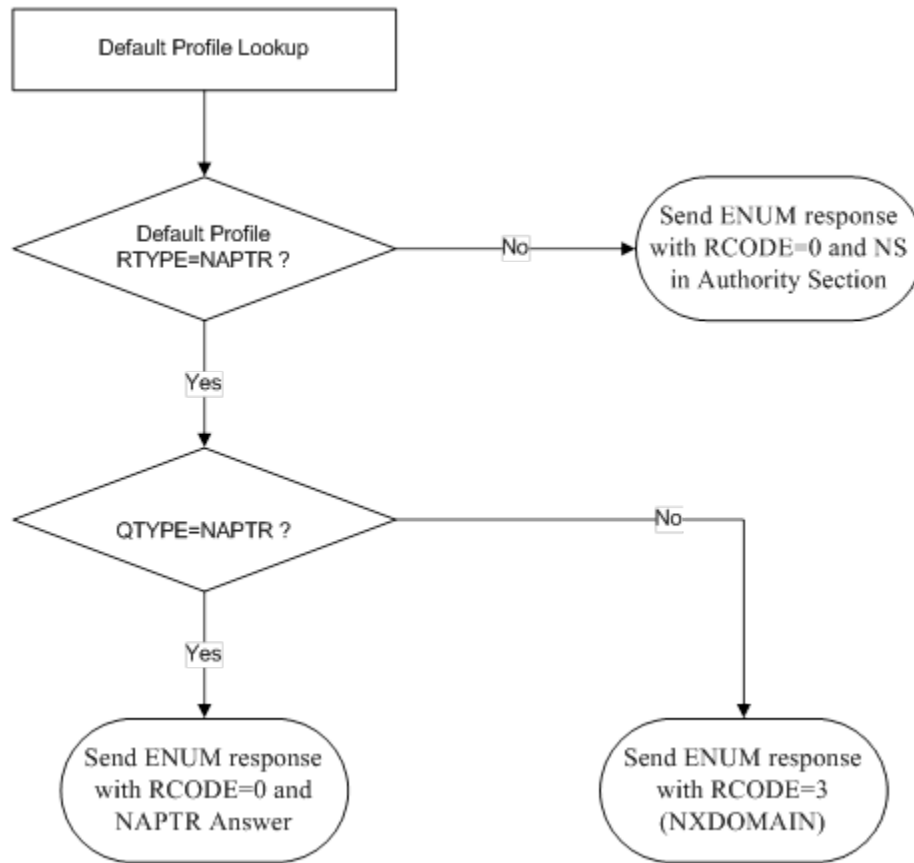
MNP RxDB Lookup

For EAGLE with MNP support, the ENUM Response generated for a specific ENUM Query is determined by the result of RxDB lookup and ENUM database lookup. Figure 2-10 shows the various MNP RxDB database lookup scenarios during the processing of the ENUM Query.

Figure 2-10   MNP RxDB Database Lookup
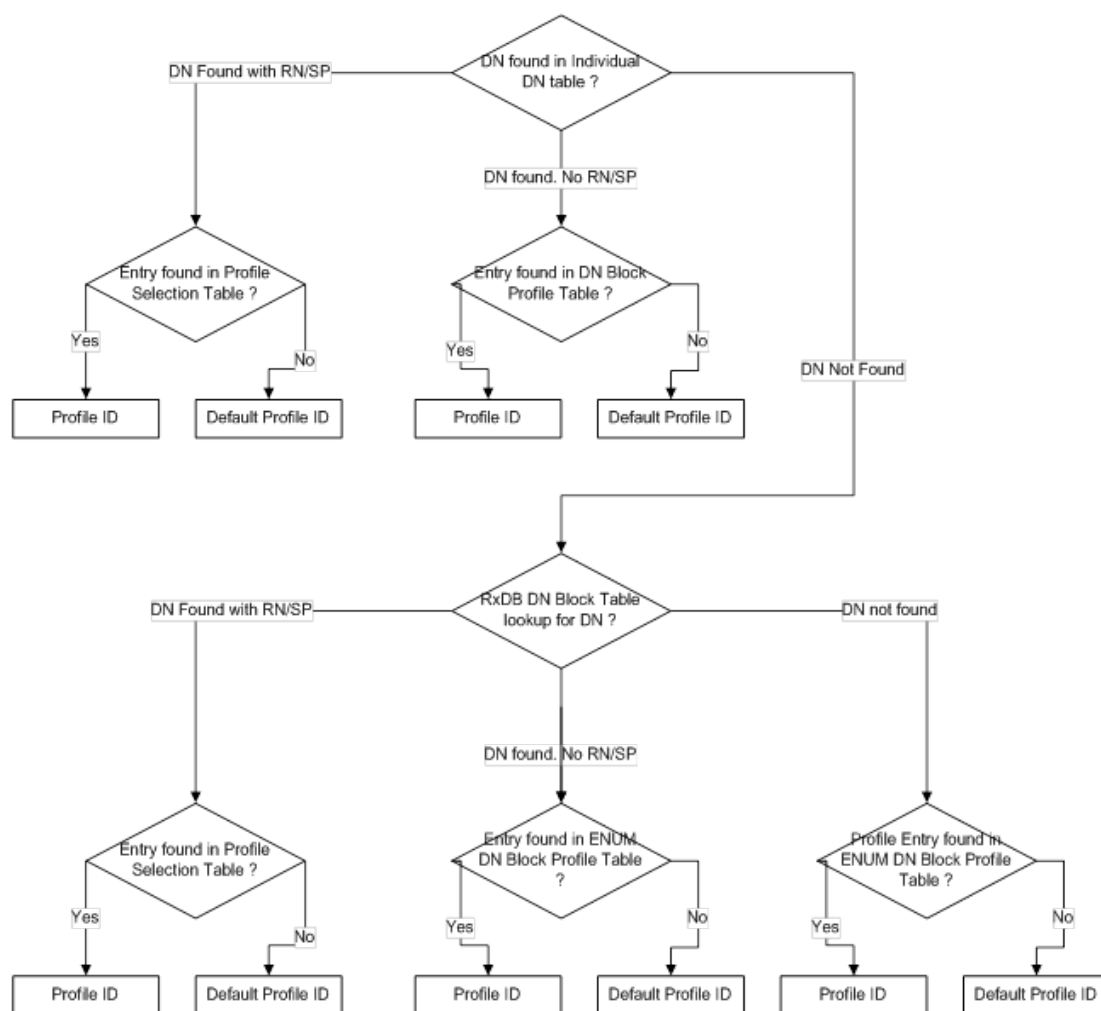
ENUM Feature Limitations

- If the E5-SM8G-B card loses its EPAP connection, the cable from the ENUM card must be moved manually to the other switch and the ENUM card re-provisioned with the IP address of the other switch.

- If the EPAP database connection is lost, the ENUM card continues to process traffic with the copy of the database it had before the connection was lost, even if the database is stale.

- If the Signaling Network interface on an E5-SM8G-B card stops functioning, the ENUM traffic corresponding to that Signaling Network interface is discarded.

- If the ENUM application stops functioning on an ENUM card, all open ENUM transactions handled by that card are lost.

- Load-balancing of ENUM on the EAGLE is not supported.

- STC Monitoring and Fast Copy are not supported for ENUM Traffic.

- The EPAP Data Split feature must be turned on at the EAGLE with 240M EPAP database (120M DNs + 120 M IMSIs) to download the EPAP database on the ENUM card and bring the ENUM card to an in-service state (IS-NR).

- If PREFIX parameter is configured in an ENUM PROFILE entry, but INCPREFIX option is set to NO in ENUMOPTS, then the PREFIX configured will not be used in the URI of the regular expression of ENUMNAPTR response.

ENUM Measurement Limitations

The measurement registers of ENUM-based reports store a maximum count of 4,294,967,295, due to the size of the register. An additional measurement peg above this limit rolls over the register count to 0.

This limitation constrains the number of ENUM cards in the system running at the maximum of 4000 TPS per ENUM card or the maximum TPS value of the maximum number of allowed ENUM cards (16) in the system.

- A maximum of 12 ENUM card can process at the maximum of 4000 TPS per card in the system without exceeding the count capacity.

- The maximum number of allowed ENUM cards (16) in the system can run at a maximum of 3100 TPS per card in the system without exceeding the count capacity.

- The maximum number of allowed ENUM cards (16) running at the maximum of 4000 TPS per card in the system can run for 18 hours before the count capacity is exceeded.

This measurement register limitation does not affect the processing of traffic. If the limits described above are not respected, then the value of the measurement register will roll over after reaching its maximum value and the peg count will be incorrect.

Hardware Requirements

The ENUM Mobile Number Portability and Tier One Address Resolution (ENUM) feature is supported on the E5-SM8G-B or SLIC card. A maximum of 16 E5-SM8G-B or SLIC cards per EAGLE can be configured as ENUM cards.

EPAP: An EPAP system can support up to 32 Service Module cards (E5-SM8G-B or SLIC cards). Sixteen of the E5-SM8G-B or SLIC cards can be configured as ENUM cards running the ENUM64 GPL. EPAP-related features that perform an RxDB lookup require Service Module cards (E5-SM8G-B or SLIC cards) running the SCCPHC application.

A Third Party Load Balancer product is required to achieve load-sharing and fault tolerance for the ENUM application.

ENUM Card

The ENUM card is an E5-SM8G-B or SLIC card running the ENUM64 GPL.

On the E5-SM8G-B card, Ethernet Interface **A** is used for EPAP connectivity and Ethernet Interface **B** is used for the Signaling Network. Table 2-29 and Table 2-30 describe LED operations for the Ethernet Interfaces on E5-SM8G-B cards.

Table 2-29   E5-SM8G-B Faceplate IP Interface/Logical Link Status LED Operation for Port A

IP Interface Status	EPAP Connection		
	EPAP Connection Status	PORT A LED	ACT A LED
IP port not configured Card inhibited	N/A	Off	Off
Cable removed and/or not synched	N/A	Red	Red
Sync and/or act-ip-lnk	IP connection down	Green (100 Mbps) / Amber (1 Gbps)	Red
	IP connection up	Green (100 Mbps) / Amber (1 Gbps)	Green
dact-ip-lnk	N/A	Green	Red

Table 2-30   E5-SM8G-B Faceplate IP Interface/Logical Link Status LED Operation for Port B

IP Interface Status	Signaling Connection		
	Link/Connection Status	PORT B LED	ACT B LED
IP port not configured Card inhibited	N/A	Off	Off
Cable removed and/or not synched	N/A	Red	Red
Sync	Not configured	Green	Red
Sync and/or act-ip-lnk	Configured but ENUM UDP connection CLOSED (open=no)	Green	Red
	ENUM UDP Connection is ACTIVE (open=yes)	Green	Green
dact-ip-lnk	N/A	Green	Red

On the SLIC card, the Ethernet Interfaces **1** and **4** (mapped to ports **A** and **D**, respectively, are used for EPAP connectivity and Ethernet Interfaces **2** and **3** (mapped to ports **B** and **C**, respectively) are used for the Signaling Network. As shown in Figure 2-11, backplane DB26 ports A and B are labeled on the backplane for each slot of the shelf (that is, **Port *<slot number>* A** and **Port *<slot number>* B**). Backplane adaptors (part number 830-1102-03) are attached to backplane ports A and B. The adaptor connected to backplane port A supports the port A Ethernet interface through adaptor port P3, and the adaptor connected to backplane port B supports the port B Ethernet interface through adaptor port P3.

Figure 2-11   SLIC ENUM Card - Ethernet Interface Connections and Status LEDs
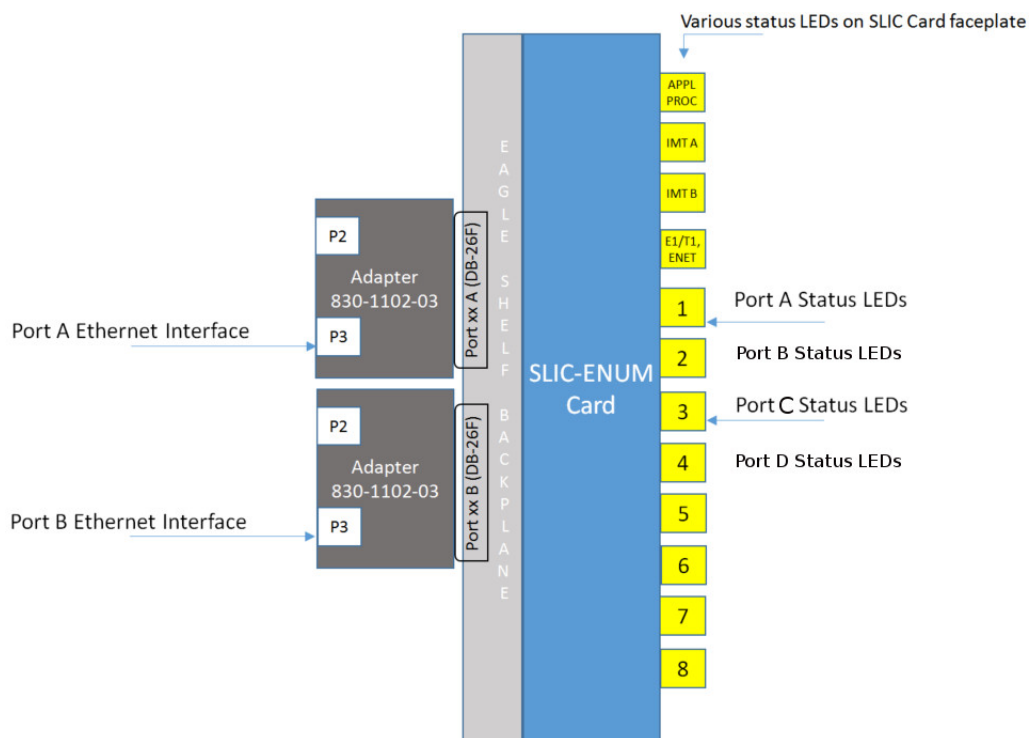
Figure 2-11 also shows the status LEDs 1 and 3 that are on the SLIC faceplate, and their associations with the A and B Ethernet interface ports. The status LEDs on the SLIC faceplate are pictured in Figure 2-12.

Figure 2-12   SLIC Faceplate Status LEDs
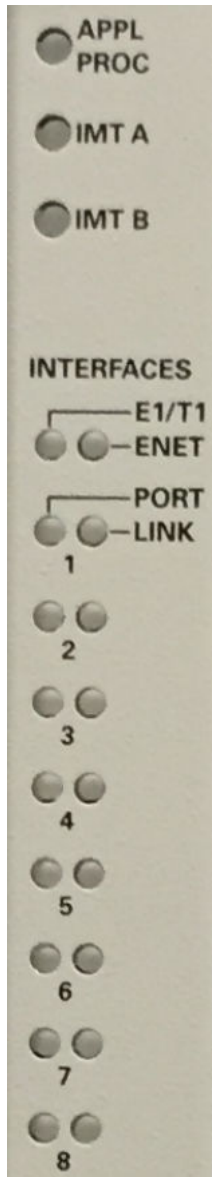
and describe LED operations for the Ethernet Interfaces on SLIC cards.

Table 2-31   SLIC Front Faceplate IP Interface/Logical Link Status LED Operation for Ports A and D (represented by LED 1 and 4)

IP Interface Status	EPAP Connection Status on IP Port A	EPAP Connection	
		PORT LED	**LINK LED**
IP port not configured Card inhibited	N/A	Off	Off
Cable removed and/or not synched	N/A	Red	Red

Table 2-31   (Cont.) SLIC Front Faceplate IP Interface/Logical Link Status LED Operation for Ports A and D (represented by LED 1 and 4)

IP Interface Status	EPAP Connection Status on IP Port A	EPAP Connection	
		PORT LED	**LINK LED**
Sync and/or act-ip-lnk	IP connection down	Green (100 Mbps) / Amber (1 Gbps)	Red
	IP connection up	Green (100 Mbps) / Amber (1 Gbps)	Green
dact-ip-lnk	N/A	Green	Red

Table 2-32   SLIC Front Faceplate IP Interface/Logical Link Status LED Operation for Ports B and C (represented by LED 2 and 3)

IP Interface Status	Signaling Link/ Connection Status on IP Port B	Signaling Connection	
		PORT LED	**LINK LED**
IP port not configured Card inhibited	N/A	Off	Off
Cable removed and/or not synched	N/A	Red	Red
Sync	Not configured	Green	Red
Sync and/or act-ip-lnk	Configured but ENUM UDP connection CLOSED (open=no)	Green	Red
	ENUM UDP Connection is ACTIVE (open=yes)	Green	Green
dact-ip-lnk	N/A	Green	Red

3

Commands

This chapter contains brief descriptions of the EAGLE commands used for the configuration and control of the ENUM Mobile Number Portability and Tier One Address Resolution feature.

Introduction

This chapter contains the EAGLE commands used to support the ENUM Mobile Number Portability and Tier One Address Resolution (ENUM) feature. Refer to *Commands User's Guide* for complete command descriptions including parameter names, valid parameter values, examples, and dependencies.

EAGLE Commands Added to Support ENUM

The new commands to support configuration of the ENUM Mobile Number Portability and Tier One Address Resolution (ENUM) feature are described below. Refer to ENUM Database for descriptions of the ENUM-related tables.

ENUM Profile ID Tables Commands

These commands are used to add, modify, delete, and display entries in the ENUM Profile Selection table (ENUMPRID) and the ENUM DN Block Profile table (ENUMDNBK).

`ent-enum-profsel`
This command adds a new entry in the ENUM Profile Selection table (ENUMPRID) mapping Entity ID to Profile ID or the ENUM DN Block Profile table (ENUMDNBK) mapping DN Blocks to Profile ID.
Command Examples:

- `ent-enum-profsel:entityid=1234:prn1=prof1:prn2=prof2`

- `ent-enum-profsel:sdn=9194841000:edn=914841999:prn1=prof1:prn2=prof2`

`chg-enum-profsel`
This command modifies an existing entry in ENUM Profile Selection table (ENUMPRID) mapping Entity ID to Profile ID or ENUM DN Block Profile table (ENUMDNBK) mapping DN Blocks to Profile ID.
Command Examples:

- `chg-enum-profsel:entityid=1234:prn2=prof4`

- `chg-enum-profsel:sdn=9194841000:prn1=prof5`

- `chg-enum-profsel:edn=9194841999:prn2=prof6`

`dlt-enum-profsel`
This command deletes an entry in ENUM Profile Selection table (ENUMPRID) for a specific Entity ID or an entry from ENUM DN Block Profile table (ENUMDNBK) for a specific DN Block.

Command Examples:

- `dlt-enum-profsel:entityid=1234`

- `dlt-enum-profsel:sdn=9194841000`

- `dlt-enum-profsel:edn=9194841999`

rtrv-enum-profsel
This command displays an entry for a specific Entity ID in table ENUMPRID, an entry for a specific DN Block in table ENUMDNBK, or all entries in table ENUMPRID and ENUMDNBK
Command Examples:

- `rtrv-enum-profsel:entiyid=1234`

- `rtrv-enum-profsel:sdn=9194841000`

- `rtrv-enum-profsel:edn=9194841999`

- `rtrv-enum-profsel`

ENUM Profile Table Commands

These commands are used to add, modify, delete, and display entries in the ENUM Profile table (ENUMPROF) which contains data to generate the ENUM Response for the supported Resource Record formats: NAPTR, NS, CNAME.

ent-enum-prof
This command adds a new entry in the ENUM Profile table (ENUMPROF) containing the ENUM Response Resource Records (RRs) in the supported formats.
Command Examples:

- `ent-enum-prof:prn=prof1:rtype=naptr:sparm=pstntel`

- `ent-enum-
prof:prn=prof2:rtype=ns:rpdomain=gw100.nc.oracle.com`

- `ent-
enumprof:prn=prof3:rtype=naptr:sparm=pstnsip:rrdomain=def.or
acle.com:prefix=60011`

chg-enum-prof
This command changes an existing entry in the ENUM Profile table (ENUMPROF) containing the ENUM Response Resource Records (RRs) in the supported formats.
Command Examples:

- `chg-enum-prof:prn=prof1:rrdomain=gw4.example.com`

- `chg-enum-prof:prn=pr3:rpdomain=def.oracle.com`

- `chg-enum-prof:prn=prof3:prefix=6002`

dlt-enum-prof
This command deletes an entry in the ENUM Profile table (ENUMPROF).
Command Examples:

- `dlt-enum-prof:prn=prof1`

- `dlt-enum-prof:prn=pr3`

rtrv-enum-prof
This command displays an entry for a specific Profile ID or all entries in the ENUM Profile table (ENUMPROF).
Command Examples:

- `rtrv-enum-prof:prn=prof1`

- `rtrv-enum-prof:rtype=naptr`

- `rtrv-enum-prof`

- `rtrv-enum-prof:prefix=6001`

ENUM Access Control List Table Commands

These commands are used to add, delete, and display entries in the ENUM Access Control List table (ENUMACL) which contains IP addresses of trusted ENUM clients.

ent-enum-acl
This command adds a new entry of the IP address of a trusted ENUM client to the ENUM Access Control List table (ENUMACL).
Command Examples:

- `ent-enum-acl:ipaddr=10.250.8.120`

- `ent-enum-acl:ipaddr=10.240.*.*`

dlt-enum-acl
This command deletes an entry from the ENUM Access Control List table (ENUMACL).
Command Examples:

- `dlt-enum-acl:ipaddr=10.250.8.120`

- `dlt-enum-acl:ipaddr=10.248.6.66`

rtrv-enum-acl
This command displays a specific entry or all entries in the ENUM Access Control List table (ENUMACL).
Command Examples:

- `rtrv-enum-acl`

- `rtrv-enum-acl:ipaddr=10.248.13.9`

ENUM Options Table Commands

These commands are used to change and display ENUM-specific data in the ENUM Options table (ENUMOPTS).

chg-enumopts
This command changes the ENUM-specific data in the ENUM Options table (ENUMOPTS).
Command Examples:

- `chg-enumopts:conglvl1=50:congrlvl2=85:cngntfy=yes:cngrcode= 11`

- `chg-enumopts:maxdndigs=12`

- `chg-enumopts:conglvl1=50`

- `chg-enumopts:conglvl2=10`

- `chg-enumopts:cngntfy=yes`

- `chg-enumopts:cngrcode=6`

- `chg-enumopts:incprefix=yes`

rtrv-enumopts
This command displays the ENUM-specific data in the ENUM Options table
(ENUMOPTS). This command has no parameters.
Command Example: `rtrv-enumopts`

ENUM Feature Verification Command

The `rept-stat-enum` command displays the overall status of the ENUM service on
the EAGLE. If the `rept-stat-enum` command is entered without any parameters,
the displayed status includes the per-ENUM-card status and TPS, the total ENUM
system statistics, and the ENUM-related alarms. The `rept-stat-enum` command is
used with the `rept-stat-db` command, which reports database status, to display the
various statuses which verify that the ENUM service is operating correctly.

Command Examples:

- `rept-stat-enum`

- `rept-stat-enum:peakreset=yes:loc=1101`

- `rept-stat-enum:loc=1101`

- `rept-stat-enum:mode=perf`

EAGLE Commands Modified to Support ENUM

These commands are modified as described below to support the ENUM Mobile
Number Portability and Tier One Address Resolution (ENUM) feature.

Table 3-1   EAGLE Commands Modified to Support ENUM

Modifications	Affected Commands
Generate measurements reports and FTPed ENUM measurements data	`rept-ftp-meas`

Verify Warm Restart capability for ENUM cards	`alw-card`
	`init-card`
	`init-network`
	`init-sys`

Support ENUM tables	`chg-upgrade-config`
	`copy-tbl`
	`copy-fta`
	`disp-disk-stats`
	`disp-tbl`
	`set-tbl`

Support ENUM as a file type	`act-ftp-trans`

Table 3-1   (Cont.) EAGLE Commands Modified to Support ENUM

Modifications	Affected Commands

Support ENUM64 GPL	`act-gpl`
	`chg-gpl`
	`copy-gpl`
	`inh-card`
	`rept-stat-gpl`
	`rmv-card`
	`rst-card`
	`rtrv-gpl`

Support `appl=enum64` for ENUM cards	`alw-card`
	`ent-card`
	`rept-stat-card`

Support for auditing of ENUM64 GPL and ENUM tables	`aud-data`
Support display of alarms	`rept-stat-alm` `rept-stat-trbl`

Support ENUM cards	`rept-stat-mps`
	`rept-stat-rtdb`
	`rtrv-stp`

Support status display of databases on ENUM cards	`rept-stat-db`
Allow enable/disable of the automatic generation and FTP transfer of ENUM measurement reports	`chg-mtc-measopts`
Support status display of ENUM scheduled maintenance measurements reports	`rtrv-mtc-measopts`

Support configuration/deletion of ENUM transport on ENUM cards	`chg-ip-conn`
	`dlt-ip-conn`
	`ent-ip-conn`

Support configuration/display of IP for ENUM cards	`chg-ip-lnk` `rtrv-ip-lnk`

EAGLE Pass-Through Commands

The ENUM application supports the following pass-through commands:

- **arp** - display and modify the Internet to Ethernet address translation tables used by the address resolution protocol
- **connmgr** - connection manager event logging services used to display different connection details of the card
- **cpum** - display cpu utilization
- **ee** - Eagle Eyes support on ENUM cards for capturing ENUM packet wireshark traces
- **msucount** - display number of queries and responses for an ENUM connection
- **netstat** - display network statistics from the tcp/ip stack

- **nslookup** - return the ip address for a given hostname or return a hostname for a given ip address
- **ping** - test for the presence of hosts on the network
- **sysstat** - display sys buffer, cpuconfig, database-related information
- **traceroute** - determine the path taken by a UDP message to a specified remote host

For additional details about the pass-through commands, refer to *Commands User's Guide*.

4
Feature Configuration

This chapter provides the procedure for configuring the EAGLE ENUM Mobile Number Portability and Tier One Address Resolution feature.

Introduction

This chapter contains example commands for configuring the ENUM Mobile Number Portability and Tier One Address Resolution (**ENUM**) feature of the Oracle Communications EAGLE.

Refer to *Commands User's Guide* for complete command descriptions including parameter names, valid parameter values, examples, and dependencies.

ENUM Configuration

EAGLE supports the value of 53 for LPORT along with the range from 1024 to 65535 for ENUM queries. This section describes the commands for configuring the ENUM feature.

1. Enter the serial number.

   ```
   ent-serial-num:serial=nt00001659
   ```

   ```
   ent-serial-num:serial=nt00001659:lock=yes
   ```

2. Provision an ENUM card.

   ```
   ent-card:loc=1105:type=dsm:appl=enum64:data=epap
   ```

3. Configure Ports A, B, C and D of an ENUM card.

   ```
   chg-ip-
   lnk:port=a:submask=255.255.255.0:mcast=yes:ipaddr=192.168.120.11:
   loc=1101:duplex=full:speed=100
   ```

   ```
   chg-ip-
   lnk:port=b:submask=255.255.255.0:mcast=yes:ipaddr=10.248.13.11:lo
   c=1101:duplex=full:speed=100
   ```

4. Set up the ENUM connections.

   ```
   ent-ip-host:host=tekelec.com:ipaddr=192.168.120.133:type=local
   ```

   ```
   ent-ip-host:host=abc.com:ipaddr=250.001.001.001:type=remote
   ```

   ```
   chg-ip-card:loc=1105:domain=tekelec.com:defrouter=10.248.13.9
   ```

   ```
   ent-ip-conn:lport=1025:lhost=tekelec.com:prot=udp:cname=c1
   ```

   ```
   chg-ip-conn:open=yes:cname=c1
   ```

   ```
   ent-ip-conn:lport=53:lhost=tekelec.com:prot=udp:cname=c2
   ```

   ```
   chg-ip-conn:open=yes:cname=c2
   ```

   ```
   alw-card:loc=1105
   ```

5. Enter profile entries in the ENUM Profile table (ENUMPROF).

```
ent-enum-
prof:prn=prof1:rtype=naptr:sparm=pstnsip:rrdomain=gw1.exampl
e.com
```

```
ent-enum-prof:prn=prof2:rtype=ns:rpdomain=gw2.example.com
```

6. Enter an Entity ID entry in the ENUM Profile Selection table (ENUMPRID).

```
ent-enum-profsel:entityid=1234:prn1=prof2,prn3=prof1
```

7. Enter a DN Block entry in the ENUM DN Block Profile table (ENUMDNBK).

```
ent-enum-
profsel:sdn=9194841000:edn=914841999:prn1=prof2,prn3=prof1
```

8. Enter the IP address of a trusted ENUM client in the ENUM ACL table(ENUMACL).

```
ent-enum-acl:ipaddr=10.250.8.120
```

9. Allow the card to come into service.

```
alw-card:loc=1105
```

Example 4-1   Additional Configuration Commands

The ENUM Options commands (`chg-enumopts`, `rtrv-enumopts`) are used to change and display ENUM-specific data in the ENUM Options table (ENUMOPTS).

The `rept-stat-enum` command is used to display the overall status of the ENUM feature on the EAGLE.

5
Measurements

This chapter describes the measurements information available from the EAGLE ENUM Mobile Number Portability and Tier One Address Resolution feature.

ENUM Measurements

Refer to *Measurements Reference* for information about measurement systems and reporting.

Refer to *Commands User's Guide* for descriptions of commands used to generate, schedule, and transfer measurements reports.

Refer to *Database Administration - System Management User's Guide* for provisioning information and procedures for these measurement systems:

- OAM-based Measurements - measurements are available using the File Transfer Area (**FTA**) feature and not directly by EAGLE terminals.
- Measurements Platform
- E5-OAM Integrated Measurements

System Level Measurements

The ENUM application supports the measurements pegs described in Table 5-1 on a per system basis.

Table 5-1   ENUM System Level Measurements Pegs

Register	Description
ENUMACLDISC	total number of ENUM queries discarded due to ACL validation failure
ENUMCNAMERX	total number of CNAME queries received
ENUMCNGDISC	total number of ENUM queries discarded due to congestion
ENUMNAPTRRX	total number of NAPTR queries received
ENUMNSRX	total number of NS queries received
ENUMQRYRJTD	total number of ENUM queries rejected by ENUM server
ENUMQRYRX	total number of ENUM queries received
ENUMTXDEFPR	total number of ENUM responses sent with default ENUM profile
ENUMTXRC0	total number of successful ENUM response sent (RCODE = 0)
ENUMTXRC1	total number of ENUM error response sent due to ENUM Query format error (Format Error RCODE = 1)
ENUMTXRC2	total number of ENUM error response sent due to ENUM Server failure (Server Failure Error RCODE = 2)
ENUMTXRC3	total number of ENUM error response sent due to non-existent domain error (Non-existent Domain Error RCODE = 3)
ENUMTXRC4	total number of ENUM error response sent due to not implemented error (Not Implemented Error RCODE = 4)

Table 5-1   (Cont.) ENUM System Level Measurements Pegs

Register	Description
ENUMTXRC5	total number of ENUM error response sent due to refusal by ENUM server (Refused Error RCODE = 5)

Card Level Measurements

The ENUM application supports the measurements pegs described in Table 5-2 on a per card basis.

Table 5-2   ENUM Card Level Measurements Pegs

Register	Description
ENUMCACLDSC	total number of ENUM queries discarded due to ACL validation failure
ENUMCCNAMRX	total number of CNAME queries received
ENUMCCNGDSC	total number of ENUM queries discarded due to congestion
ENUMCNAPTRX	total number of NAPTR queries received
ENUMCNSRX	total number of NS queries received
ENUMCQRRJTD	total number of ENUM queries rejected by ENUM server
ENUMCQRYRX	total number of ENUM queries received
ENUMCTXDEFP	total number of ENUM responses sent with default ENUM profile
ENUMCTXRC0	total number of successful ENUM response sent (RCODE = 0)
ENUMCTXRC1	total number of ENUM error response sent due to ENUM Query format error (Format Error RCODE = 1)
ENUMCTXRC2	total number of ENUM error response sent due to ENUM Server failure (Server Failure Error RCODE = 2)
ENUMCTXRC3	total number of ENUM error response sent due to non-existent domain error (Non-existent Domain Error RCODE = 3)
ENUMCTXRC4	total number of ENUM error response sent due to not implemented error (Not Implemented Error RCODE = 4)
ENUMCTXRC5	total number of ENUM error response sent due to refusal by ENUM server (Refused Error RCODE = 5)

Entity Level Measurements

The ENUM application supports the following measurements peg described in Table 5-3 on the basis of per Entity ID in the Entity ID table or per DN in the DN Block Profile table:

Table 5-3   ENUM Entity Level Measurements Pegs

Register	Description
ENUMENTMSGS	total number of ENUM queries received or ENUM responses sent per entity

ACL Level Measurements

The ENUM application supports the measurements pegs described in Table 5-4 on a per Access Control List (ACL) basis.

Table 5-4   ENUM ACL Level Measurements Pegs

Register	Description
ENUMACLQRCV	total number of ENUM queries received
ENUMACLQRJD	total number of ENUM queries rejected by ENUM server due to congestion and invalid ENUM messages causing error message to be sent to client
ENUMACLRC0	total number of successful ENUM response sent (RCODE = 0)
ENUMACLRC1	total number of ENUM error response sent due to ENUM Query format error (Format Error RCODE = 1)
ENUMACLRC2	total number of ENUM error response sent due to ENUM Server failure (Server Failure Error RCODE = 2)
ENUMACLRC3	total number of ENUM error response sent due to non-existent domain error (Non-existent Domain Error RCODE = 3)
ENUMACLRC4	total number of ENUM error response sent due to not implemented error (Not Implemented Error RCODE = 4)
ENUMACLRC5	total number of ENUM error response sent due to refusal by ENUM server (Refused Error RCODE = 5)

6
Maintenance

This chapter describes the maintenance information available from the EAGLE ENUM Mobile Number Portability and Tier One Address Resolution feature. The information includes status, alarms (UAMs), and information messages (UIMs).

Alarms

Refer to *Unsolicited Alarm and Information Messages Reference* for descriptions and corrective procedures for alarms related to EAGLE features and functions.

For descriptions of and corrective procedures for MPS-related alarms, refer to *Alarms and Maintenance Guide* for EAGLE Application Processor.

This section lists new Unsolicited Alarm Messages (UAMs) used to support the EAGLE ENUM Mobile Number Portability and Tier One Address Resolution feature.

Table 6-1   Unsolicited Alarm Messages

UAM	Text	Description	Severity	Output Group
084	IP Connection Unavailable	IP Connection Unavailable	Major	LINK
085	IP Connection Available	IP Connection Available	Normal	LINK
120	ENUM SYSTEM is not available	The system has no ENUM card which is Active/IS-NR.	Critical	SYSTEM
121	ENUM SYSTEM is available	The number of active ENUM cards (IS-NR state) are equal to or more than half the configured ENUM cards.	Normal	SYSTEM
122	ENUM SYSTEM normal, card(s) abnormal	The number of active ENUM cards (IS-NR state) are less than half the configured ENUM cards.	Major	SYSTEM
123	ENUM SYSTEM is removed	All ENUM cards are deleted from the system.	Normal	SYSTEM
124	ENUM Threshold -Level 1 exceeded	CONGLVL1 of ENUM card capacity has been exceeded.	Minor	CARD
125	ENUM Threshold -Level 2 exceeded	CONGLVL2 of ENUM card capacity has been exceeded.	Major	CARD
126	ENUM Threshold Condition cleared	Congestion was cleared on ENUM card.	Normal	CARD
127	ENUM card capacity exceeded	ENUM Card capacity has been exceeded.	Critical	CARD
129	ENUM Card TPS normal	ENUM card capacity is normal	Normal	CARD
132	Loading failed: table not found	Table not found during loading	Major	CARD

Table 6-1   (Cont.) Unsolicited Alarm Messages

UAM	Text	Description	Severity	Output Group
133	Loading failed: data read Error	Unable to read data from Table	Major	CARD
134	Loading failed: bad checksum returned	Bad Checksum is returned for the table	Major	CARD
135	Loading failed: GPL load timeout	GPL Loading Timer is expired	Major	CARD
136	Loading failed: data load timeout	Data Loading Timer is expired	Major	CARD
137	Loading failed: invalid GPL	Invalid GPL is encountered while loading	Major	CARD
138	Loading failed: GPL format error	Error in GPL Format	Major	CARD
142	System release alarm cleared	Alarm is cleared for System Release	Normal	SYSM
143	System release GPL(s) not approved	GPL is not approved	Minor	SYSM
144	System release version unknown	Release version is unknown	Minor	SYSM
231	ELAP Operating in Simplex Mode Cleared	ELAP Operating in Simplex Mode Cleared	Normal	MPS
250	MPS available	MPS is available now	Normal	MPS
261	MPS unavailable	MPS is down	Critical	MPS
302	Cooling Fan Failure	Cooling Fan faced Failure	Minor	SYSM
303	Cooling Fans Normal	Cooling Fans is Normal	Normal	SYSM
370	Critical Platform Failure(s)	Critical Platform Failure(s)	Critical	MPS
371	Critical Application Failure(s)	Critical Application Failure(s)	Critical	MPS
372	Major Platform Failure(s)	Major Platform Failure(s)	Major	MPS
373	Major Application Failure(s)	Major Application Failure(s)	Major	MPS
374	Minor Platform Failure(s)	Minor Platform Failure(s)	Minor	MPS
375	Minor Application Failure(s)	Minor Application Failure(s)	Minor	MPS
400	Alarm cleared by deleting card	Alarm cleared by deleting card	Normal	CARD
409	Clock configuration corrected	Clock configuration corrected	Normal	CLCK
422	Insufficient extended memory	Insufficient extended memory	Major	CARD
423	Card reload attempted	Card reload attempted	Normal	CARD
441	Incorrect MBD – CPU	Incorrect MBD – CPU	Major	CARD
442	RTDB database capacity is 90% full	RTDB is 90% full	Critical	CARD

Table 6-1   (Cont.) Unsolicited Alarm Messages

UAM	Text	Description	Severity	Output Group
443	RTDB database is corrupted	RTDB database is corrupted	Major	CARD
444	RTDB database is inconsistent	RTDB database is inconsistent	Minor	CARD
445	RTDB database has been corrected	RTDB database has been corrected	Normal	CARD
446	RTDB database capacity is 80% full	RTDB database capacity is 80% full	Major	CARD
447	RTDB database capacity alarm cleared	RTDB database capacity alarm cleared	Normal	CARD
448	RTDB database is incoherent	RTDB database is incoherent	Minor	CARD
449	RTDB resynchronization in progress	RTDB resynchronization in progress	Major	CARD
451	RTDB reload is required	RTDB reload is required	Major	CARD
47	Card type not valid for application	Card/Application type mismatch	Major	CARD
537	Ethernet error threshold exceeded	Ethernet error threshold exceeded	Major	LINK
538	Ethernet error threshold cleared	Ethernet error threshold cleared	Normal	LINK
539	Ethernet Interface Down	Ethernet Interface Down	Major	LINK
540	Ethernet Interface Up	Ethernet Interface Up	Normal	LINK
570	Incompatible flash image for sys rel	Incompatible flash image for sys release	Major	CARD
629	ENUM Card TPS normal	ENUM card capacity is normal.	Normal	CARD

UIMs

This section lists new Unsolicited Information Messages (UIMs) used to support the EAGLE ENUM Mobile Number Portability and Tier One Address Resolution feature. Refer to *Unsolicited Alarm and Information Messages Reference* for complete descriptions of all UIM text and formats.

Table 6-2   Unsolicited Information Messages

UIM	Text	Description	Output Group
1120	TRBL Queue is full: elements overwritten	TRBL queue is full	SYSM
1187	Table Checksum Mismatch	There is a mismatch in Table Checksum	SYSM
1188	DB Subset Checksum Mismatch	There is a mismatch in DB Subset Checksum	SYSM

Table 6-2   (Cont.) Unsolicited Information Messages

UIM	Text	Description	Output Group
1194	IP connection Refused, RHOST mismatch	IP connection is Refused as the RHOST is mismatched	SYSM
1238	Full database reload initiated	Full database reload is initiated	CARD
1321	EAGLE RTDB Birth date Mismatch	RTDB Birth date is mismatched	SYSM
1322	EAGLE RTDB Levels Invalid	RTDB Levels are Invalid	SYSM
1323	EAGLE/Elap TN Quantity Mismatch	EAGLE/Elap TN Quantity is Mismatch	SYSM
1324	EAGLE/Elap NPANXX Quantity Mismatch	EAGLE/Elap NPANXX Quantity is Mismatched	SYSM
1325	EAGLE/Elap LRN Quantity Mismatch	EAGLE/Elap LRN Quantity is Mismatch	SYSM
1326	EAGLE RTDB Depth Alert	EAGLE RTDB Depth Alert	SYSM
1331	IP Route Table Entry Conflict	There is conflict in IP Route table	SYSM
1463	ENUM connection established	ENUM connection has changed to an IS-NR state.	LINK
1464	ENUM connection terminated	ENUM connection is no longer established.	LINK
1465	ENUM card exceeded threshold TPS	The ENUM card TPS is equal to or more than 4000.	CARD
1466	ENUM Dflt Prof & query type mismatch	Default ENUM Profile response type and incoming query type do not match.	APSS
1467	ENUM msg decode failed	ENUM message validation fails.	APSS
1468	ENUM rcvd invalid msg	ENUM query was received with unsupported field values.	APSS
1469	ENUM request rejected	ENUM request was rejected coming from invalid IP addresses.	APSS
1471	ENUM matching prof for qry not found	ENUM Profile Table is missing entry of matching ENUM query type.	APSS

Thermal Management Parameters

The ENUM card supports thermal monitoring to protect the temperature-sensitive hardware components. The processor on the ENUM card can overheat as a result of high ambient temperature or airflow blockage. If the junction temperature increases above operating limits, the CPU halts and the ENUM card shuts itself down to prevent permanent, catastrophic damage. In the event of thermal shutdown all processor activity ceases.

To minimize data loss due to overheating, a graceful shutdown is implemented to detect and alert the user to the increasing thermal conditions. When the CPU

temperature rises above nominal range and exceeds a thermal threshold (Temperature Level 1), a major alarm is raised against the ENUM card. If the temperature continues to increase and exceeds a second thermal threshold (Temperature Level 2), a critical alarm is raised against the ENUM card and traffic processing is stopped. When the second thermal threshold is exceeded, the application is notified from the operating system. The state of card will transition to the IN-ANR Restricted state. Table 6-3 shows the thermal events, actions, and alarms.

After the temperature decreases below the Temperature Level 2 threshold, the raised critical alarm is cleared and the corresponding major alarm is raised. When the temperature returns to its nominal range (below Temperature Level 1), a clearing alarm will be raised for the ENUM card and the ENUM card resumes traffic processing. These thermal thresholds (Temperature Level 1 and Temperature Level 2) are user-configurable using the `chg-thm-alm` command.

Table 6-3   Thermal Management Parameters

Board Temperature	Actions / Clearing Condition	UAM
Temperature Level 1 Exceeded on ENUM card; Major	Major alarm UAM 0078 raised on ENUM card	0078 Card temperature exceeds nominal lvl:T1
Temperature Level 2 Exceeded on ENUM card; Critical	Critical alarm UAM 0077 raised on ENUM card; State of ENUM card transitions to IS-ANR/ Restricted	0077 Card temperature is at critical lvl:T2
Temperature abated (cooling below Temp Level 2 but at level 1)	Major alarm UAM 0078 raised on ENUM card; State of ENUM card transitions to IS-NR/Active	0078 Card temperature exceeds nominal lvl:T1
Temperature abated (cooling below Temp Level 1)	Major alarm UAM 0078 cleared	0079 Card temperature again at nominal level