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## IPWorks ENUM Front End Function Overview

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# 1 Introduction

## 1.1 Document History

Rev	Date	Sign.	Comment
A	2015-12-16	EGANYAN	Initial Draft
B	2016-04-20	EJIAHLU	Update the comments from Stephen.  - Section 3.4  - Section 4.4
C	2016-07-25	ECIAMAO	Update for IPWorks 1.0 release.  Add an example in Section 3.5.
D	2016-10-03	ECIAMAO	Fix some typos.
E	2017-01-10	EQUUWWT	HU97289. Update Section 3.2 based on Terry Cai's input.
F	2017-04-19	EJIAHLU	Add a new section 3.2.

## 1.2 Purpose

The purpose of this document is to describe the IPWorks ENUM Front End functions supported by IPWorks.

## 1.3 Scope

The scope of the document is limited to the specification of the ENUM Front End functions.

# 2 Overview

This section provides a brief description of the ENUM Front End (FE) supported functions.

## 2.1 Architecture overview

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IPWorks ENUM Front End (FE) is a component of data layered architecture (DLA), where application data and user data are separated in different layers that are implemented in different network functional entities. The role of ENUM FE is to provide the application logic and enable ENUM server to access to CUDB instead of local NDB. CUDB is an extensible, high-performance, subscriber-centric database system, which communicates with IPWorks by LDAP protocol and SOAP protocol.

IPWorks plays the role of application Front End in the User Data Consolidation (UDC) solution.

If ENUM FE is enabled, ENUM FE plays a role of LDAP client to query data from CUDB. For more details about LDAP protocol model, refer to [RFC 4511](#).

Figure 1 ENUM FE Architecture shows ENUM FE Architecture in DLA. ENUM FE acts as application layer while CUDB (the back end) acts as data layer. Data query request is sent by ENUM FE and CUDB returns the result. Data provisioning is provided by Provisioning Gateway (PG). The connectivity between ENUM FE and CUDB, CUDB and PG is based on LDAPv3 protocol.

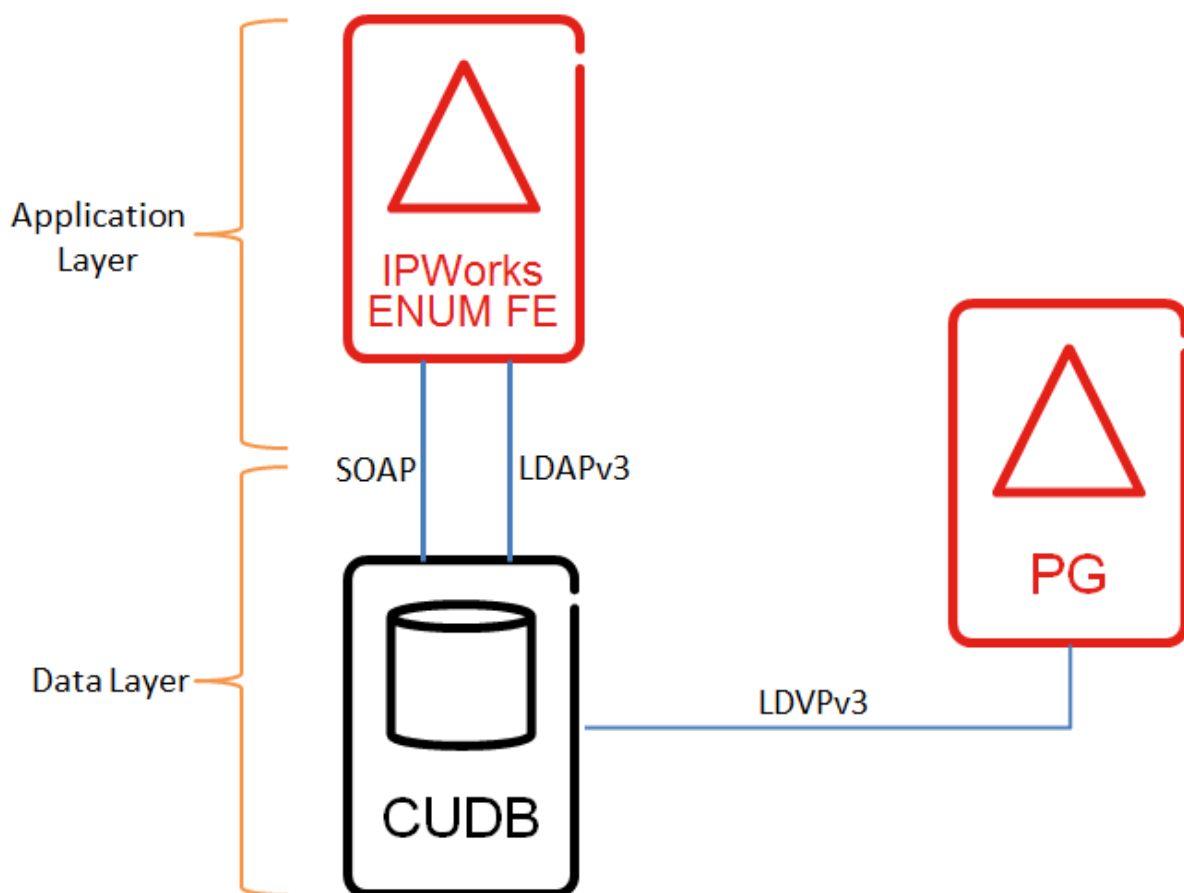


Figure 1 ENUM FE Architecture

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## 2.2 Data Model in CUDB

The user data in CUDB is described as a Directory Information Tree (DIT). The tree is made up of entries that have names. One or more attribute values form the entry's relative distinguished name (RDN), which must be unique among its all siblings. The concatenation of the RDNs of the sequence of entries from a particular entry to an immediate subordinate of the tree root forms that entry's Distinguished Name (DN), which is unique in the tree. When ENUM FE sends a query to CUDB, CUDB replies the ENUM FE with entries including the user profile attributes according to the DN and filters.

The ENUM User Data, including ENUMDNSCHED, ENUMDNRAGNE, are stored as entries. Figure 2 ENUM Directory Information Tree illustrates the relationship of the entries. For more information about the objects ENUMDNSCHED and ENUMDNRAGNE, refer to *IPWorks DNS, ASDNS, ENUM Parameter Description*.

From the LDAP modeling perspective in ENUM FE, the DIT is built into the following separated structures under the root entry:

- Service associated to ENUM

`(serv=enum, ou=servCommonData, <root_DN>)`

- Data of branch EnumDnSched

`(ou=EnumDnSched, serv=enum, ou=servCommonData, <root_DN>)`

- Data of branch EnumDnRange

`(ou=EnumDnRange, serv=enum, ou=servCommonData, <root_DN>)`

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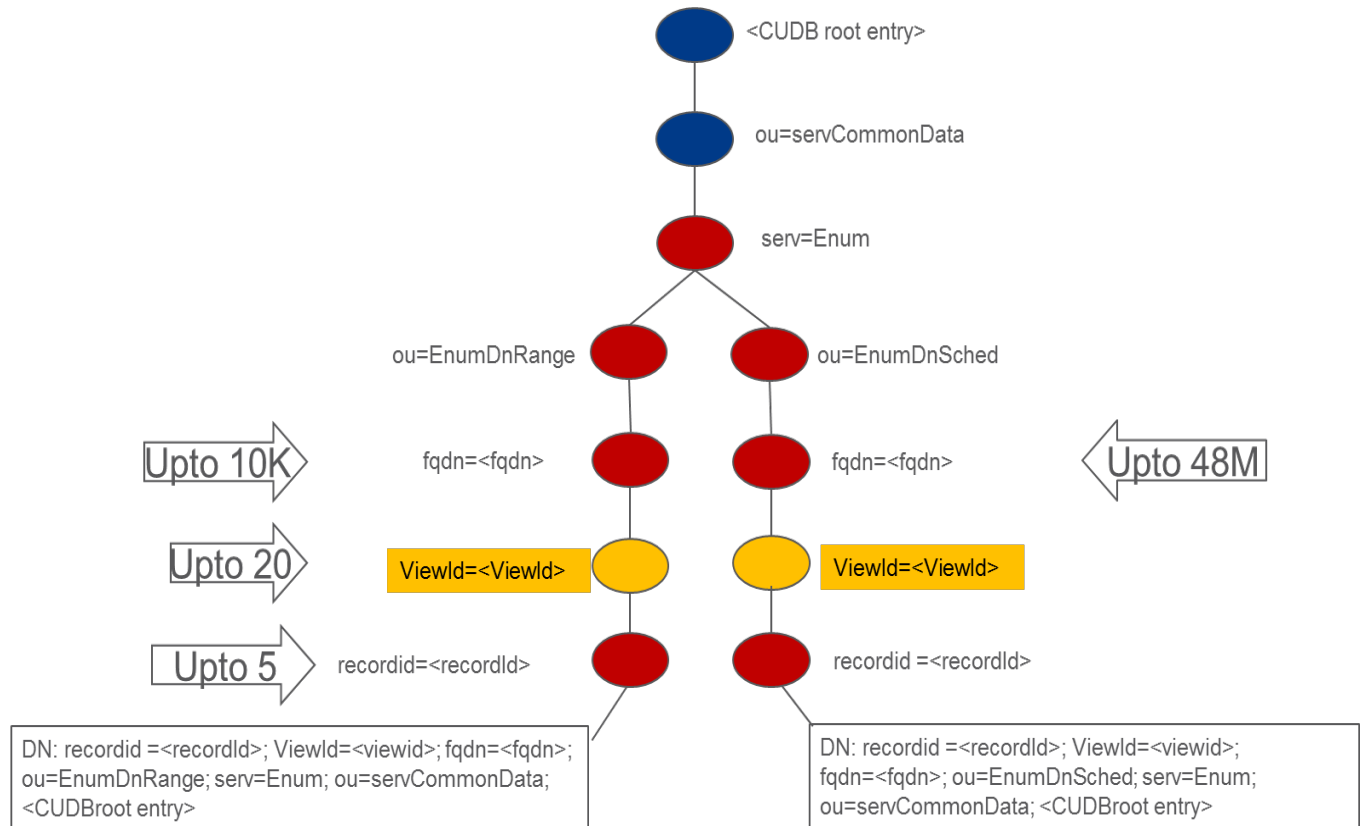


Figure 2 ENUM Directory Information Tree

## 2.3 Interface with CUDB

IPWorks ENUM FE provides two kinds of interface with CUDB, SOAP Interface and LDAP interface.

## 2.4 SOAP Interface with CUDB

This interface is between ENUM FE and CUDB. When provisioning is performed on PG, data is stored in CUDB and then CUDB sends SOAP notification to ENUM FE. In this notification, data of impacted ENUMDNSCHED or ENUMDnRange is included.

For more information about the interface, refer to *IPWorks ENUM SOAP CUDB Interface*.

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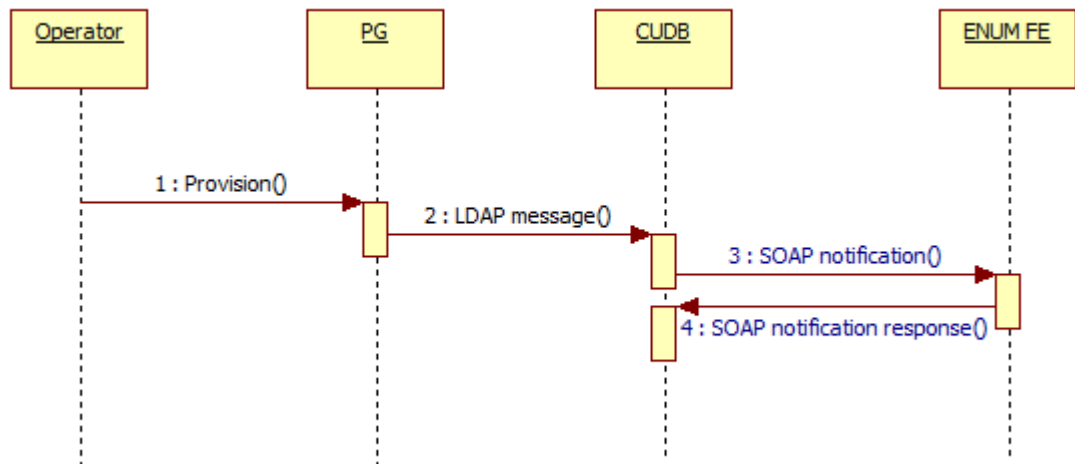


Figure 3 SOAP Interface between ENUM FE and CUDB

In SOAP body,

- notificationEvent

Value is "EnumDnSchedEvent" or "EnumDnRangeEvent".

- modificationInformation

Value includes "dN" and "operation" (create/delete/modify).

- affectedLdapAttribute

- ldapAttributeName

Value includes "recordid", "naptrtxt", "ttl", "naptrorder", "naptrpreference", "naptrservice" and "naptrflags".

- newLdapAttributeValue

This is optional, used when operation is "create" or "modify".

- oldLdapAttributeValue

This is optional, used when operation is "modify".

## 2.5 LDAP Interface with CUDB

This interface is between ENUM FE and CUDB. ENUM FE can get ENUMDnSCHED/ENUMDnRange from CUDB by LDAP interface.

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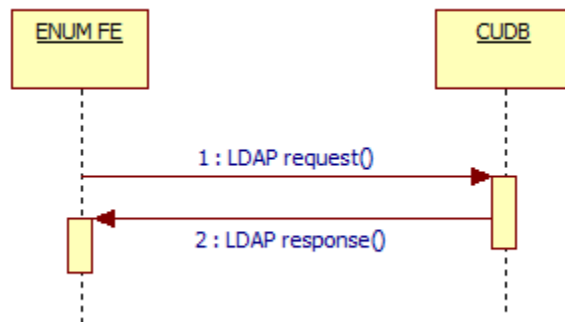


Figure 4 LDAP Interface between ENUM FE and CUDB

ENUM FE uses LDAP protocol v3 to access CUDB for data query. TCP/IP is used as transport protocol on the interface towards CUDB nodes.

Currently ENUM FE provides two kinds of data query from CUDB: EnumDnRange and EnumDnSched.

For more information about the interface, refer to *IPWorks ENUMLDAP CUDB Interface*.

### 2.5.1 Searching for All Data of a Subscriber for ENUMDnRange

The ENUMDnRange subscriber data is an entry of the ENUMDnRange structural Object Classes. To search for ENUMDnRange subscriber data, an LDAP search operation must be performed.

ENUMDnRange can contain 10K FQDNs. One FQDN can contain 20 views. One view can contain 5 NAPTRRecord records.

Searching for all data of a subscriber can be performed from the ENUMDnRange branch with the scope set to wholeSubtree.

The following scenarios trigger this operation:

- ENUM FE gets all ENUMDnRange data when it initializes.
- ENUM FE refreshes the cache data in 7 days.

Search for all data of a subscriber from the ENUMDnRange entry according to **Error! Reference source not found.**:

SearchRequest	
BaseObject	dn: ou= EnumDnRange, serv = enum, ou = servCommonData, dc = <CUDB root entry>
Scope	wholeSubtree
DerefAliases	neverDerefAliases
Filter	(objectclass= *)

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Attributes	NULL
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Table 1 Searching for All Data of a Subscriber from ENUMDnRange Entry

### 2.5.2 Searching for Individual Subscriber Data of EnumDnSched

The EnumDnSched individual subscriber data is an entry of the EnumDnSched structural Object Class. To search for EnumDnSched individual subscriber data, an LDAP search operation must be performed.

Searching for the individual subscriber data of a subscriber can be performed from the enum branch with the scope set wholeSubtree.

Search for the individual subscriber data of a subscriber from the ENUM entry according to Table 2.

SearchRequest	
BaseObject	dn: viewid = <viewid>, fqdn=< fqdn> , ou= EnumDnSched, serv = enum, ou = servCommonData, dc = <CUDB root entry>
Scope	wholeSubtree
DerefAliases	neverDerefAliases
Filter	(objectclass= *)
Attributes	NULL

Table 2 Searching for Individual Subscriber Data of a Subscriber from "enum" Entry

## 3 ENUM Front End Functions

ENUM Front End server is constructed by different modules.

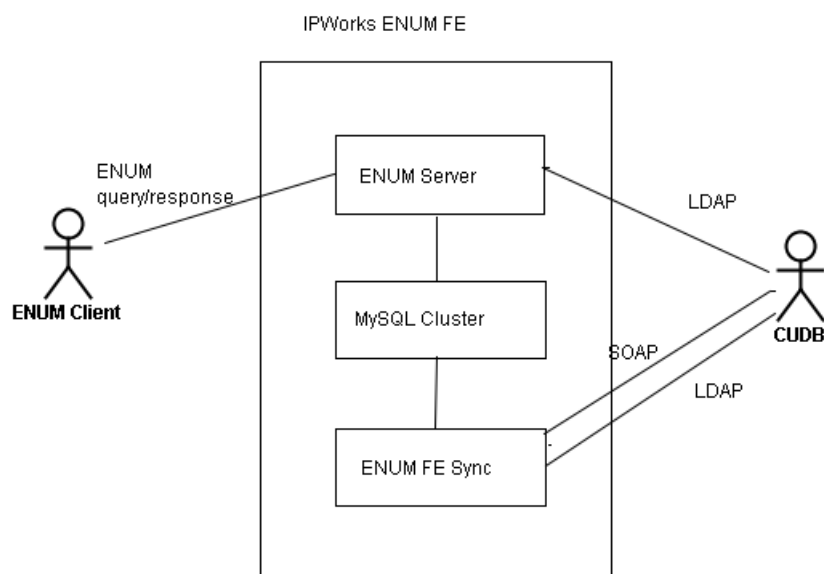


Figure 5 ENUM Front End Generic Architecture



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ENUM Server, it implements a business logic layer, and provides the database query interface with CUDB by LDAP.

ENUM FE Sync, it implements cache mechanism of ENUMDnRange and ENUMDnSched.

- a. ENUM FE Sync acts as SOAP server to handle SOAP notifications from CUDB when ENUMDnRange & ENUMDnSched provisioning.
- b. ENUM FE caches ENUMDnRange in the local and re-cache them when timer has expired.
- c. If cache of ENUMDnSched is enabled, ENUM FE caches ENUMDnSched in the local and re-cache them when timer has expired. To enable cache of ENUMDnSched, refer to 4.1.
- d. ENUM FE manually refreshes the cached ENUMDnRange & ENUMDnSched.

### 3.1 ENUM Query Main Flow with ENUMDNSchedCache in ENUM Front End Solution

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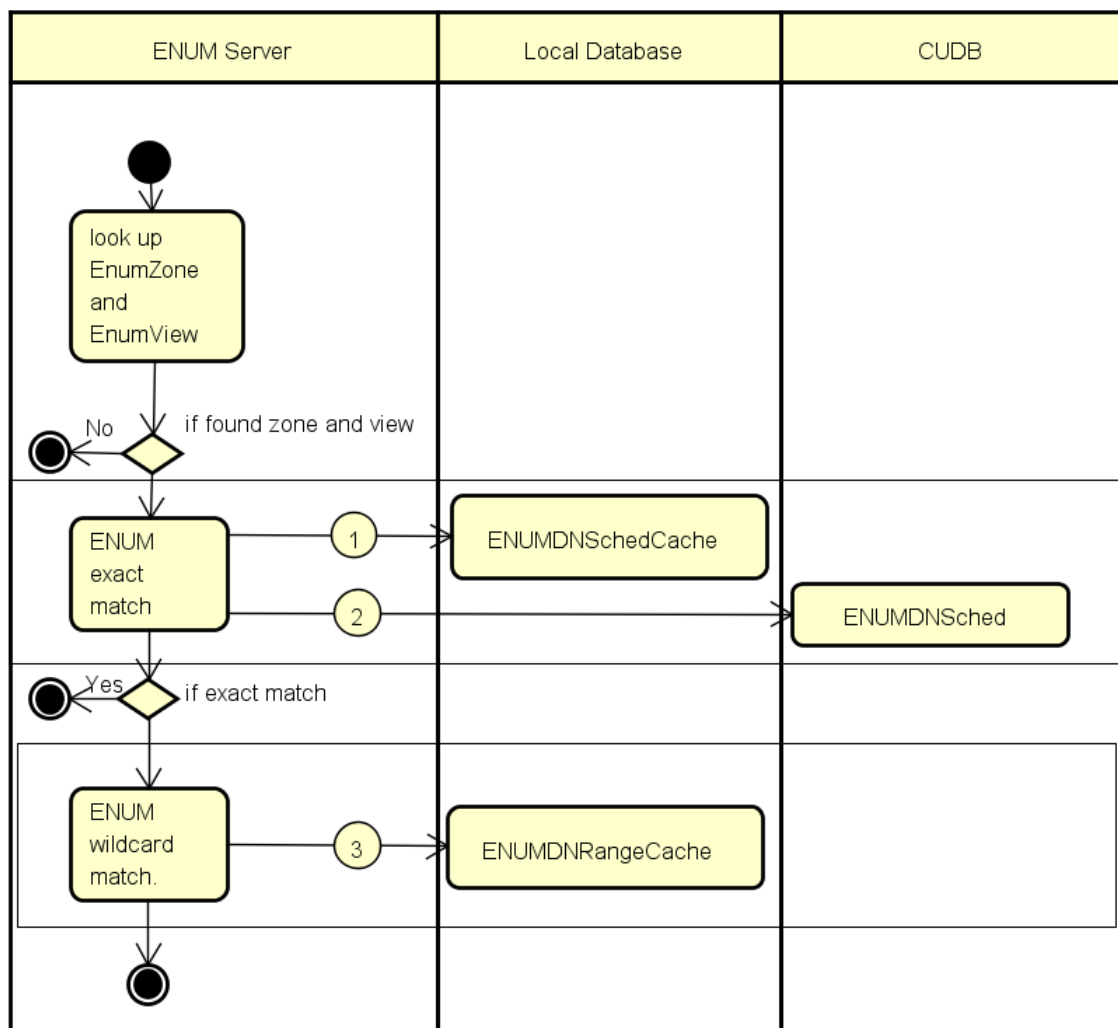


Figure 6 ENUM Query Flow with ENUMDNSchedCache in ENUM FE Solution

Figure 6 describes the procedures of the ENUM query main flow with ENUMDNSchedCache in ENUM FE solution activated as below:

1. Search this record from the table ENUMDNSchedCache in local NDB database.
2. If this record does not exist in the local NDB database, search this record from CUDB by LDAP, if this record is found in CUDB, then cache this record response data in talbe ENUMDNSchedCache in local NDB database.
3. If exact match fails to match the record, wildcard match is performed to match this record from ENUMDNRangeCache in local database, ENUMDNRangeCache is initialized and periodically synchronized from CUDB.

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### 3.1.1 Cache Mechanism for ENUMDnRange and ENUMDnSched

ENUM FE caches the records of ENUMDnRange and EnumDnSched to the local. But the cache mechanism for ENUMDnRange and EnumDnSched are different. All ENUMDnRange records are cached to the local when ENUM FE initializes (It's the first time for ENUM FE to connect to CUDB.). However, the ENUMDnSched records are cached to the local only when ENUMDnSched is hit during traffic time.

There are three ways to refresh the caches of ENUMDnRange and EnumDnSched. They are listed as below:

- Reloading when a Pre-Configured Live Time Expired, for detail refer to 3.1.2
- Updating Cache Data by SOAP Notification, for detail refer to 3.1.3.
- Manual Refreshing Cache Data, for detail refer to 3.1.4

### 3.1.2 Reloading when a Pre-configured Time to Live Expired

All locally cached ENUMDnRange and ENUMDNSCHED have a pre-configured time to live information, reload is needed if expired:

For ENUMDnRange, if any ENUMDnRange record expired, then a transaction deletes all locally cached ENUMDnRange, and then all the local ENUMDnRange from CUDB will be re-cached. If this transaction fails, the original ENUMDnRange records will be rolled back.

For EnumDnSched, if any EnumDnSched record expired, this record will be deleted in local. It will be re-cached from CUDB when query this record in traffic time.

### 3.1.3 Update Cache Data by SOAP Notification

Update the locally cached EnumDnSched and ENUMDnRange when provisioned ENUM data modification is submitted to BE-DB (CUDB) by Soap notification.

The following list describes the behavior of each EnumDnSched SOAP notification operation type:

- create type: Delete all records of this EnumDnSched in local cache.
- modify type: Delete all records of this EnumDnSched in local cache.
- delete type: Delete all records of this EnumDnSched in local cache.

The following list describes the behavior of each ENUMDnRange SOAP notification

- create type: Create this record in local cache
- modify type: Modify this record in local cache
- delete type: Delete this record in local cache

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### 3.1.4 Manual Refreshing Cache Data

The operator can enforce the resetting of the IPWorks FE related locally stored data by using the command: “manual\_refresh ENUMDnRange” or “manual\_refresh EnumDnSched”.

For example: PL-X:~ # /opt/ipworks/enumfe/scripts/manual\_refresh ENUMDnSched

For ENUMDnRange, a transaction of deleting all locally cached ENUMDnRange, re-caching all the ENUMDnRange in local from CUDB will be executed, if this transaction fails, the original ENUMDnRange records will be rolled back.

For ENUMDNSCHED, just delete all ENUMDNSCHED records in local. It will be re-cached from CUDB when query this record in traffic time.

## 3.2 ENUM Query Main Flow without ENUMDnSchedCache in ENUM Front End Solution

ENUM Server supports to disable ENUMDnSchedCache in local. The ENUM query flow in ENUM FE solution is shown as below:

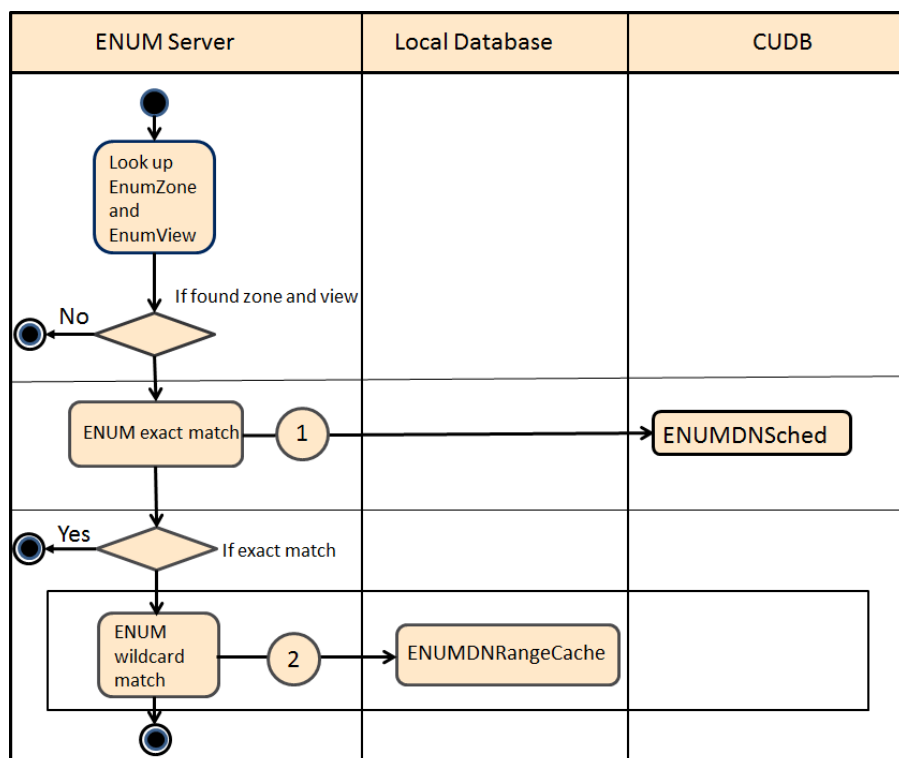


Figure 7 ENUM Query Flow without ENUMDnSchedCache in ENUM FE Solution

Figure 7 describes the procedures of the ENUM query main flow without cache in ENUM FE solution activated as below:

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1. Search this record from CUDB by LDAP, if this record is found in CUDB, this record response data will not be cached in talbe ENUMDnSchedCache in local NDB database.
2. If exact match fails to match the record, wildcard match is performed to match this record from ENUMDnRangeCache in local database, ENUMDnRangeCache is initialized and periodically synchronized from CUDB.

### 3.2.1 Cache Mechanism

For ENUMDnSched, ENUM FE will not cache it to the local.

For ENUMDnRange, all ENUMDnRange records are cached to the local when ENUM FE initializes (It is the first time for ENUM FE to connect to CUDB.). There are three ways to refresh the caches of ENUMDnRange as below:

- Reloading when a Pre-Configured Live Time Expired, for detail refer to 3.2.2.
- Updating Cache Data by SOAP Notification, for detail refer to 3.2.3.
- Manual Refreshing Cache Data, for detail refer to 3.2.4.

### 3.2.2 Reloading when a Pre-configured Time to Live Expired

All locally cached ENUMDnRange have a pre-configured time to live information, reload is needed if expired.

If any ENUMDnRange record expired, then a transaction deletes all locally cached ENUMDnRange, and then all the local ENUMDnRange from CUDB will be re-cached. If this transaction fails, the original ENUMDnRange records will be rolled back.

### 3.2.3 Update Cache Data by SOAP Notification

Update the locally cached ENUMDnSched and ENUMDnRange when the provisioned ENUM data modification is submitted to BE-DB (CUDB) by SOAP notification.

For ENUMDnSched, since no ENUMDnSched is cached locally, the ENUMDnSched SOAP notification will be ignored.

For ENUMDnRange, the following list describes the behavior of each ENUMDnRange SOAP notification:

- Create type: create this record in local cache
- Modify type: modify this record in local cache
- Delete type: delete this record in local cache

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### 3.2.4 Manual Refreshing Cache Data

The operator can enforce the resetting of the IPWorks FE related locally stored data by using the command: “manual\_refresh ENUMDnRange”.

For example: PL-X:~ # /opt/ipworks/enumfe/scripts/manual\_refresh ENUMDnRange

For ENUMDnRange, a transaction of deleting all locally cached ENUMDnRange, re-caching all the ENUMDnRange in local from CUDB will be executed, if this transaction fails, the original ENUMDnRange records will be rolled back.

### 3.3 Load Sharing

ENUM FE supports multiple simultaneous LDAP connections in load sharing mode in one site. The load sharing mechanism allows the ENUM FE to distribute the needed capacity between two identical CUDB nodes and/or among several CUDB nodes in one site.

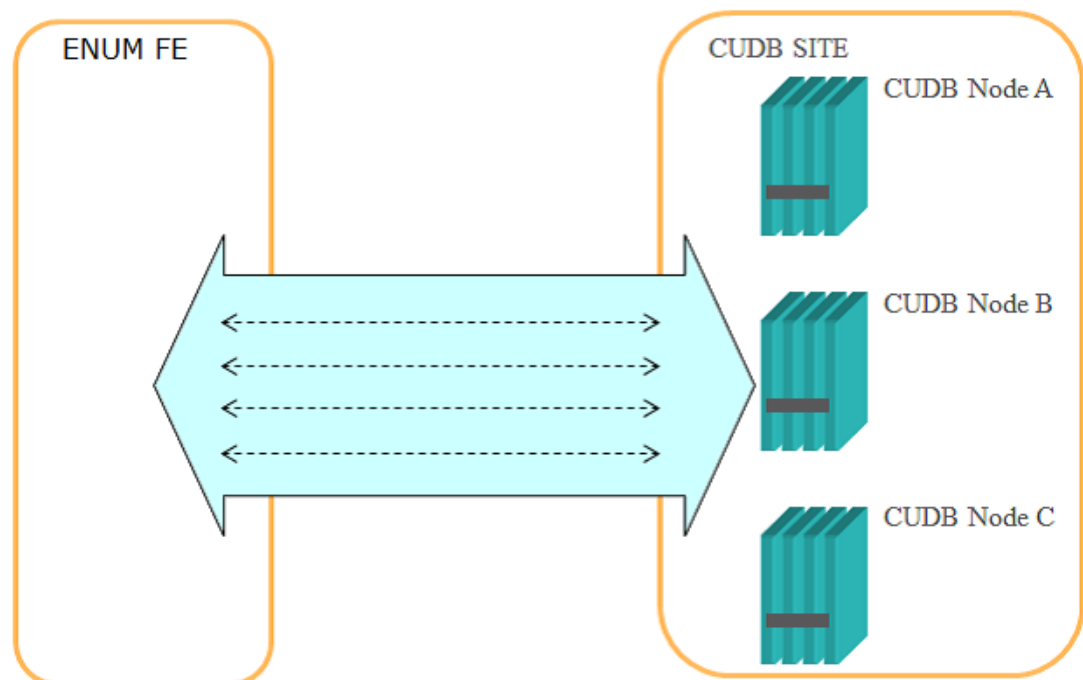


Figure 8 ENUM FE Connections to CUDB Node

For example, CUDB site1 contains two CUDB nodes (node1 and node2). ENUM-FE will establish connection with all the nodes in site1 and sends search requests to these nodes.

### 3.4 High Availability

CUDB is a high availability database, supporting geographical redundancy (several sites in different places) and node redundancy (several nodes in one site). For details, refer to *CUDB High Availability*.

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ENUM FE supports CUDB site failover and fallback. ENUM FE checks the connected status of all sites at intervals by sending the CUDB polling request (LDAP Bind).

Failover happens when all the connections of the higher priority site are lost. The CUDB site with a lower string name has a higher priority. Fallback happens when the higher priority site is recovered.

See the following example regarding CUDB connection pool with multi-sites:

Site priority: site1 > site2 > site3, which means:

1. ENUM-FE connects to the nodes in site1 by default.
2. If site1 is unreachable, then it connects to site2.
3. If both site1 and site2 down, then it connects to site3.
4. If site1 has recovered, then it switches back to site1.

ENUM-FE does not send LDAP search to a lower priority site if a higher priority site (like site1) is available or recovered.

### 3.5 Result Code Behavior

The following table describes the behavior of ENUM server that corresponds to the abnormal LDAP response:

Abnormal LDAP Response	ENUM Server Behavior
<i>No available LDAP connection</i>	<i>Server fail</i>
<i>LDAP_BUSY</i>	<i>Server fail or NXdomain or discard, config by comcli</i>
<i>Timeout</i>	<i>Server fail or NXdomian or discard, config by comcli</i>
<i>other server response error code</i>	<i>Server fail or NXdomian or discard , config by comcli</i>
<i>USER NOT FOUND&lt;32&gt;</i>	<i>Go to next business logical</i>

Table 3 Result Code Behavior of ENUM Server

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## 4 Operation and Maintenance

### 4.1 Configuration Management

ENUM Front End Configuration Management is based on CBA CM Component.

New class, which presents ENUM FE, will be introduced. "ManagedElement=1,IpworksFunction=1,IpworksDnsRoot=1,IpworksEnumRoot=1,enumFE=1". Below parameters will be introduced in "enumFE".

- enableEnumFE

Switch "EnumFE" is to indicate FE feature active or not.

- enableEnumDnSchedCache

Switch "EnumDnSchedCache" is to indicate EnumDnSched will be cached in local or not.

- EnumDnSchedExpiration

Cached EnumDnSched will be deleted automatically per EnumDnSchedExpiration (7 days default).

- EnumDnRangeExpiration

Cached EnumDnRange will be deleted automatically per EnumDnRangeExpiration (7 days default).

- HandleLDAPFailure

Indicate how ENUM server responds to ENUM client when receiving a busy LDAP response or timeout. enumeration<NXdomain, Discard, Serverfail>, NXdomain is default.

### 4.2 Fault/Alarm Management

ENUM Front End Fault Management is based on CBA FM Component.

Alarms include:

- MySQL NDB clusters connection failure in ENUM FE Sync

This alarm is raised when the connections between ENUM FE Sync server and MySQL NDB clusters are unavailable.

- All CUDB connection failure in ENUM FE Sync



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This alarm is raised when the connections between ENUM FE Sync server and CUDB clusters are unavailable.

- CUDB site failure in ENUM

This alarm is issued by ENUM server when the ENUM server fails to access any specific CUDB site.

- CUDB node failure in ENUM

This alarm is issued by ENUM server when the ENUM server fails to access any specific CUDB node.

For details about alarms, refer to *IPWorks Alarm List*.

### 4.3 Performance Management

ENUM Front End Performance Management is based on CBA PM Component.

Counters include:

- The number of total LDAP requests for DNSCHED
- The number of total LDAP responses for DNSCHED
- The number of total target hits in cache for DNSCHED
- The number of total SOAP requests received for DNSCHED
- The number of total SOAP requests received for DNRANGE
- The number of total ENUM DNSCHED cached
- The number of total ENUM DNRANGE cached

For details about counters, refer to *IPWorks Measurement List*.

### 4.4 License Management

ENUM Front End license control is based on CBA LM component, use following license:

Feature Name	License Management Aspect	License Type	Quantity	Description
FAT 102 3219/2	ENUMDNSCHED Capacity	Capacity	N	When ENUM-FE feature is not activated, the license indicates the maximum number of the telephone number records stored in IPWorks System Control VMs (Storage Server). When ENUM-FE feature is activated, the license indicates the maximum number of the telephone number records in ENUM Server cached from CUDB.

Table 4 ENUM FE License Overview

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Both the ENUM Server and ENUM FESync validate this license. If the license is invalid, ENUM server will not provide service.

Only ENUM FESync reports the current ENUMDNSCHED Capacity to CBA LM server, When cached EnumDnSched is over than maxium Capacity (defined in LM), IPWorks does not reject new service requests. Meanwhile, a corresponding alarm *License Management, Capacity Usage Threshold Reached* is raised to remind the operators, when cached EnumDnSched decreases below than maxium capacity, this alarm will be ceased automaticlly.

For details about counters, refer to *IPWorks License Management*.

## 4.5 Data Provisioning

ENUM FE does not support data provisioning to CUDB. The data provisioning is implemented by Provisioning Gateway (PG). PG does not have any interface with IPWorks directly but CUDB, whereas, EMA is responsible for the provisioning in classic deployment by communicating with IPWorks through CLI interface.

## 5 Standard Compliance Statement

- RFC4511 Lightweight Directory Access Protocol (LDAP) : The Protocol

## 6 Glossary

CADB	Centralized User Data Base
DIT	Directory Information Tree
DLA	Data Layered Architecture
DN	Distinguished Name
FE	Front End
LDAP	Lightweight Directory access Protocol
PG	Provisioning Gateway
RDN	Relative Distinguished Name

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## 7 References

### 7.1 Requests for Comments (RFCs)

- [1] Lightweight Directory Access Protocol RFC4511  
(LDAP) : The Protocol

### 7.2 Ericsson Documents

- [1] IPWorks Alarm List 2/006 51-AVA 901 33/2 Uen A
- [2] Performance Management 9/1551-AVA 901 33/2 Uen A
- [3] License Management 10/1551-AVA 901 33/2 Uen A
- [4] IPWorks DNS, ASDNS, ENUM  
Parameter Description 3/190 84-AVA 901 33/2 Uen A
- [5] IPWorks ENUM SOAP CUDB Interface 52/155 19-AVA 901 16 Uen B
- [6] IPWorks ENUM LDAP CUDB Interface 30/155 19-AVA 901 16 Uen B
- [7] CUDB High Availability 7/155 34-HDA 104 03/9 Uen D