Yugandhar

Open Master Data Management (MDM) Hub

Development and Customization Guide

Yugandhar Open MDM Hub Release - V1.0.0
Date – 27/12/2017

1. About Yugandhar Open MDM Hub Project

Master Data Management came a long way in last decade or so. There are currently more than 20 MDM solutions catering to various specializations of MDM like Customer Data Integration (CDI), Product Information Management (PIM), vendor and supplier management etc. However most of these solutions come with licensing costs amounting to thousands of dollar. To offer a completely free solution which would be made available through Apache 2.0 license, A Project is started in 2017 under the name 'Yugandhar Open MDM Project' to build Open Source MDM solutions catering to CDI, PIM and Data Governance Capabilities. Yugandhar in Sanskrit means Ever Lasting and the strongest of its time. Our vision is to build the strongest, Open Source, Multi Domain, Cross Industry and completely free MDM Solution.

We are happy to announce that the first release of the Yugandhar MDM Hub catering to CDI solution is built with Open source technologies like Spring and Hibernate etc, inbuilt data Model, 400+ ready to use services and having incredible Out of the Box capabilities is currently being distributed. We aim to make the current CDI offering the strongest and Planning to bring Data Stewardship and PIM solutions in upcoming years.

2. About this document

This is the development and customization guide of the Yugandhar Open MDM Hub. This is intended for the use of developers.

3. Before reading this document

Please refer the 'Yugandhar Open Master Data Management (MDM) Hub Architectural Overview' document.

4. Understanding Java Projects and Workspace

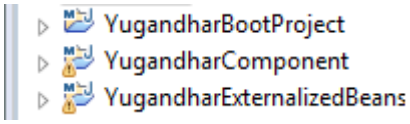
The Yugandhar Open Master Data Management (MDM) Hub codebase is shared on github at below location

1. Github public repository - https://github.com/yugandharproject/YugandharMDMHub
2. Javadoc – <github repository>\resources\javadocs
3. Dbdocs – <github repository>\resources\dbdocs
4. Documentation -<github repository>\resources\documentation
5. Database setup scripts -<github repository>\resources\dbsetupscripts

You may choose to download the projects using 'clone and download' option available online or checkout using github client.

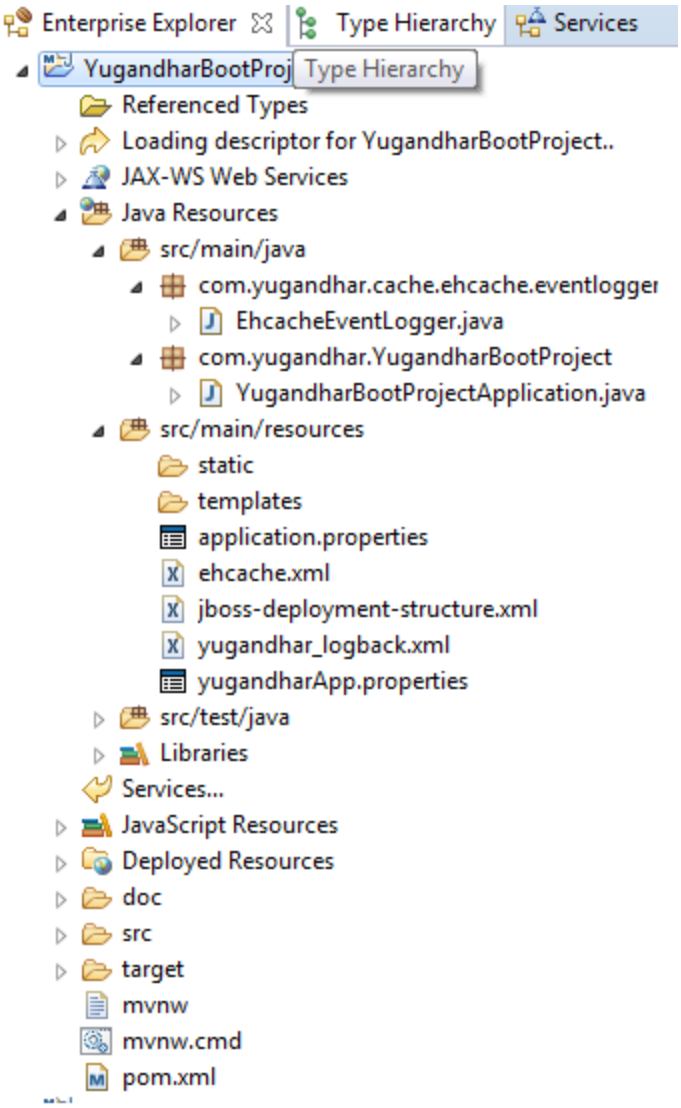
I. Project structure

The Yugandhar Open MDM Hub currently has three projects as shown in below screenshot



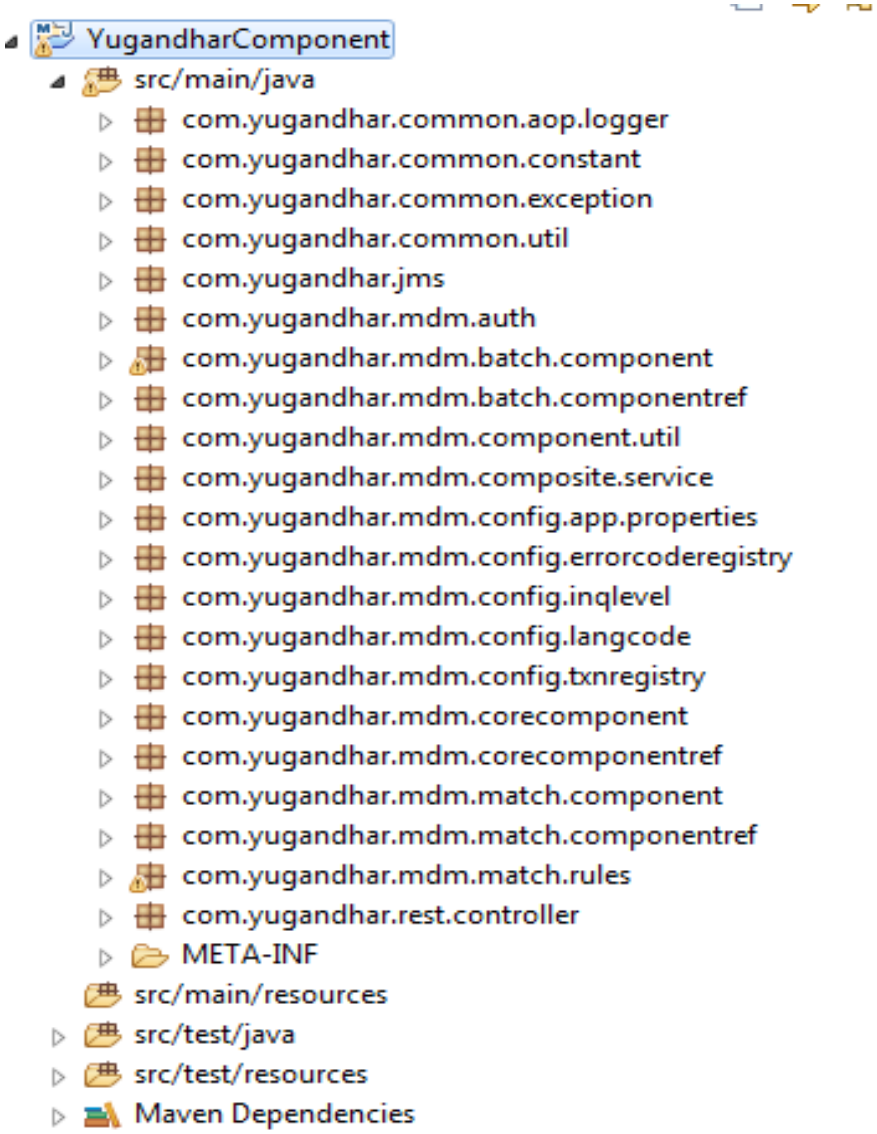
- **YugandharBootProject -**

This is spring boot project application project having the configuration of Yugandhar Open MDM Hub. The below screenshot shows the structure of the YugandharBootProject. The class com.yugandhar.YugandharBootProject.YugandharBootProjectApplication has the spring boot initialization configuration which is used in conjunction with application.properties file. ehcache.xml and yugandhar_logback.xml files are used to configure ehcache and logback respectively.



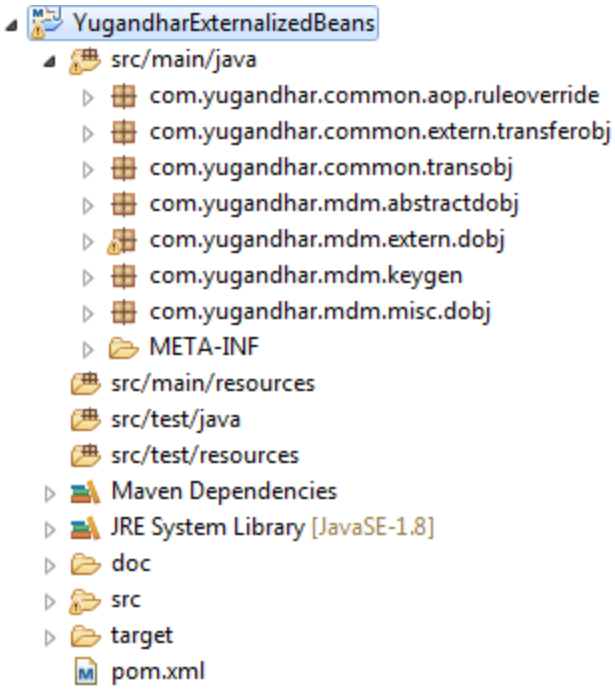
- **YugandharComponent**

This project is the core of all the transactions. The Component, service, repository and rule classes of every entity are placed in this project.



- **YugandharExternalizedBeans**

This project is primarily used to externalize the DOs, rules and unique key generator and transfer objects.



II. Externalization of java classes for customization

This project YugandharExternalizedBeans makes few classes available for customization to the users of the Yugandhar Open MDM Hub so that the behavior of the out of the box DOs, rules or services are modified. This is done so that the modifications of the Yugandhar project team and the user development team does not mess up with each other while upgrading to latest version of the Yugandhar Open MDM Hub.

Let's understand it by use case - The v1.0 of Yungandhar Open MDM Hub has table LE_PERSON which provides multiple attributes. In your project there may be requirements wherein there is a need to store an attribute which is not currently present in LE_PERSON table e.g. Ethnicity of the person. So you made the customization in the code by adding new attribute in LePerson entity DO. In the meantime, Yugandhar team also introduced additional feature which required to store height of the person in LE_PERSON table so LePerson entity DO is modified and released in v2.0 of Yungandhar Open MDM Hub. Now if you upgrade your code to V2.0 then it might mess the code between both the teams. So there was a genuine need to separate the code for the Yugandhar team and user team to work on. This is achieved by using abstract class and child classes.

There are two DOs provided for one entity, the abstractDO and the child DO e.g. LePersonDO AbstractLePersonDO. The thumb rule is that Yugandhar Development team will modify AbstractLePersonDO and user development team will modify LePersonDO so to keep the change separate which will help to do code merging simple.

The below packages have the objects which can be used to extend or override the product behavior.

- com.yugandhar.mdm.extern.dobj – All the entity data objects

- com.yugandhar.common.extern.transferobj – The transfer object encapsulating the entity object
- `com.yugandhar.mdm.keygen.YugandharKeygenerator - to override default key generation`
- com.yugandhar.common.aop.ruleoverride – This is Aspect Oriented Programming (AOP) based rule to override the default behavior of transaction at pre and post level with before, after, around or proceedingJointPoint. You should copy and make as many aop rules as needed.

Its best practice to avoid making changes to any other class than that of mentioned above. Also keep in mind that there is no restriction on introducing new service, entities and rules in your own project which will make use of Yugandhar projects mentioned above.

III. Understanding Java classes

- **<entity>Component.java**

The Component beans handle the entity level data CRUD (Create, Update, Retrieve, Delete) operations. This bean refers and makes use of Entity Data Objects (DO), entity manager and JPA repository classes.

Component Bean primary have below methods

- Persist() –This method is used to create a new record in a database entity.
- merge() –This method is used to update existing record in a database entity based on primary key.
- findById() –This method is used to retrieve existing record in a database based on primary key.
- findByBusinessKey() – This method is used to search a database table based on business key e.g. firstname and lastName from Person table.

- **<entity>ComponentRule.java**

The component rule class used to write the business rules for a specific entity transaction based on the method from component bean is invoked. The entity transaction can have rules. The business rules are defined at below levels based on the transaction

- Rule cross points for Persist() method:
  - prevalidatePersit
  - preExecutePersist
  - postExecutePersit

- Rule cross points for Merge() method
  - PrevalidateMerge
  - preExecuteMerge

- postExecuteMerge

- Rule cross points for FindById()
  - postExecuteFindById
  - prevalidateFindById

- Rule cross points for FindByBusinessKey() method
  - postExecuteFindByBusinessKey
  - prevalidateFindByBusinessKey

This rule class is carved out separately so that the users make the changes in the rule class instead of the Component class itself. This way any future changes in the component class made by Yugandhar Development Team will not mess up with the changes of users.

- **<entity> JPA Repository.java**

The JPA repository is implementation of org.springframework.data.jpa.repository.JpaRepository interface used primarily to search the data from the single database based business keys.

- **<entity>Service.java**

This is a Service type of Spring bean. The request from request Processor would always come to Service bean for further processing. The Service bean is a logical layer between RequestProcessor and Component bean introduced to create base or composite transaction and infuse any additional business logic so that Component beans are kept intact.

- **Entity Data Object Classes**

The entity data objects are used by hibernate to map the DO to database entities. We have bifurcated the DOs in AbstractDO and Child DO wherein the Yugandhar team will extend the Abstract DOs in upcoming releases. The users of the Product must always add additional attributes in Child DO objects so that the changes of Yugandhar Team and users are kept independent. Refer section 'Externalizing the classes for customization' for more details.

IV. Cache configuration

Yugandhar Open MDM Hub cache the Reference Data values (List of values stored as key-value pairs) so to improve transaction response time. It uses ehcahce as ehcache is an open source, standards-based cache that boosts performance, offloads your database, and simplifies scalability. It's the most widely-used Java-based cache because it's robust, proven, full-featured, and integrates with other popular libraries and frameworks. The ehcache configuration file is kept in /src/main/resources/ehcache.xml of the YugandharBootProject of the code base. The default

ehcache expiry time is configured as 1296000 seconds (15 days) in the ehcache.xml configuration file. This may be revisited as per the requirements.

Ehcache is configured in Spring boot project application.properties file using below property

```
 #ehcache
spring.cache.jcache.config=classpath:ehcache.xml
```

Visit www.ehcache.org for understanding ehcache in further detail.

V. Spring boot properties

Yugandhar Open MDM Hub users application.properties present at /YugandharBootProject/src/main/resources folder. The Datasource, logging, ehcache, JTA transaction manager and Json configuration are currently configured in this property file.

5. Understanding different Components

I. Data Model

Yugandhar Open MDM has below types of entities in the database

- **Data entities**
- **Reference data entities (For storing list of values as key – value pairs)**
- **Configuration tables**
- **Audit log tables**

All the above entities are covered in comprehensive details in Data Model Guide.

II. Understanding Application Configuration

- **Application Properties**

The application properties are stored in CONFIG_APP_PROPERTIES table.

- **Error Codes registry**

The error codes are stored in CONFIG_ERRORCODE_REGISTRY table. This table have CONFIG_LANGUAGE_CODE_KEY attribute which is used to store multilingual support for the error code. By default Yugandhar Open MDM Hub take the language code from the header object

(txnHeader.requesterLanguage attribute) of the request message and retrieve the error code on language code – error code combination.

- **Transactions Registry**

Every transaction is registered in CONFIG_TXN_REGISTRY table so to get picked by the request processor. The transaction name, class and method needs to be registered in the table.

- **Multilingual support for reference tables**

The list of languages considered for multilingual support is configured in CONFIG_LANGUAGE_CODE. This table should not be confused with REF_LANGUAGE_CODE which is used to store the LOV of worldwide languages available or served by enterprise.

The application configuration entities are covered in more detail in Data Model guide.

III. Extending Data Model

- **Extending existing Data Object**

The existing data and reference data entities are extendable i.e. new persistent as well as non-persistent attributes can be added to existing Data Objects (DO). As mentioned in section 'Externalization of java classes for customization' there are two DOs provided for one entity, the abstractDO and the child DO e.g. LePersonDO AbstractLePersonDO. The thumb rule is that Yugandhar Development team will modify AbstractLePersonDO and user development team will modify LePersonDO so to keep the change separate which will help to do code merging simple.

Below is the process to add new attribute to existing entity

1. Add an attribute in the database in the base table which needs to be extended (e.g. LE_PERSON).
2. Modify <entity>DO class of the entity (e.g. LePersonDO) and add the new attribute manually. Generate getters and setters for the same using eclipse IDE.
3. If you want to add any business validation or logic around this attribute then use Aspect oriented programming to add the business logic of pre / post / around the existing services as mentioned in section 'Understanding Java classes' in the class <entity>ComponentRule.java.
4. Do not modify the OOTB product classes to add any business logic as this will defeat the externalization purpose. Also it will create trouble while upgrading the product to next version of Yugandhar Open MDM Hub.

A sample aop rule 'com.yugandhar.common.aop.ruleoverride.YugandharRuleOverrideAspect' is provided in the

- **Introducing new Data Object**

Introduction of New data Object is done when a completely new database entity needs to be created in database. The details of this step are covered in Code Generation Guide.

IV. Optimistic Lock

To avoid concurrent update of the same record, MDM Hub use optimistic lock based on VERSION attribute of the database. MDM hub relies heavily on Hibernate Optimistic lock feature.

Optimistic locking assumes that multiple transactions can complete without affecting each other, and that therefore transactions can proceed without locking the data resources that they affect. Before committing, each transaction verifies that no other transaction has modified its data. If the check reveals conflicting modifications, the committing transaction rolls back. When your application uses long transactions or conversations that span several database transactions, you can store versioning data, so that if the same entity is updated by two conversations, the last to commit changes is informed of the conflict, and does not override the other conversation's work. This approach guarantees some isolation, but scales well and works particularly well in Read-Often Write-Sometimes situations. * (The definition is as per Hibernate website)

So while updating a record in database through CDI services, the version attribute needs to be provided in the request having the value matching with the value in the database. e.g. For updating LE_PERSON table having idpk x, provide the legalentityDO. lePersonDO.version attribute the same as that in the database for idpk x.

V. Building Services

Service is a spring bean class which can be integrated with Yugandhar Open MDM Hub request response framework so that set of business logic is executed as one transaction.

Logically there are three types of entity services

1. Base entity services
   Base entity services perform CRUD (create, retrieve, update and delete) operations on single database entity.
2. Composite Services
   Composite entity services perform CRUD (create, retrieve, update and delete) operations on multiple database entities as single transaction. Also composite services can have composition of create/ retrieve/ update or delete in single services. e.g. updateLegalEntity service update the legal entity record along with person, corporation, address and identifiers etc. also you may associate new address or identifier through this service itself.
   Also, search services can also considered as composite services.

Samples –

1. Base entity Service – Refer
   com.yugandhar.mdm.corecomponent.PersonnamesComponent.findByLegalEntityIdPk() method

which is registered as transaction. You may skip writing the code to rule class (e.g. PersonnamesComponentRule.prevalidatexxx()) and directly write the logic in your method.

2. Composite Service – Refer OOTB service class com.yugandhar.mdm.composite.service.CreateLegalEntityService
3. Search Service – Refer OOTB Service class com.yugandhar.mdm.composite.service.SearchLegalEntityByLEAttributesService

After writing the code you need to register this as a transaction in Configuration transaction registry CONFIG_TXN_REGISTRY table. You may use below sql to register the transaction

```
Insert into <SCHEMA_NAME>.CONFIG_TXN_REGISTRY
   (ID_PK, VERSION, TXNSERVICE_NAME, TXNSERVICE_CLASS, TXNSERVICE_CLASSMETHOD,
DESCRIPTION,CREATED_TS, UPDATED_TS, UPDATED_BY_USER, UPDATED_TXN_REF_ID)
 Values
   (YUG_REGISTRY_SEQ.nextval, 0, '<name of transaction>', '<fully qualified name of
the class which have the method> , '<method name>',
    '<description of the service>', CURRENT_TIMESTAMP,CURRENT_TIMESTAMP,'<user
name>', '<transaction id>');
COMMIT;
```

The MDM Hub request response framework invokes the given method using Spring ReflectionUtils framework.

The TxnTransferObj is the default transfer object of MDM request and response. The TxnTransferObj encapsulates TxnPayload object which is the wrapper for all the objects. So if you are introducing a whole new object as request or response then you need to define this in TxnPayload object. Please refer Code Generation guide to understand how to define an object in TxnPayload object.

VI. Modifying Business Rules using Aspect Oriented Programming

Validation and Business rules are defined in Component rule classes. Yugandhar Open MDM Hub provides several Out of the Box (OOTB) business validations for Create, update, retrieve, find and search transactions of every entity. These rules are extendable so a developer can use Aspect Oriented programming (AOP) feature of Spring to add completely new logic or change the logic already written in OOTB code base. The join points for the rule modification are mentioned in '<entity>ComponentRule.java' section of 'Understanding Java classes' section.

A sample rule override aspect YugandharRuleOverrideAspect is provided in the package com.yugandhar.common.aop.ruleoverride along with code base which have ProceedingJoinPoint on the preExecuteLegalentityCompMerge method of com.yugandhar.mdm.corecomponent.LegalentityComponentRule class.

Refer Spring Documentation for detailed understanding of AOP

https://docs.spring.io/spring/docs/4.3.x/spring-framework-reference/html/aop.html

https://docs.spring.io/spring/docs/current/spring-framework-reference/core.html

VII. Authorization Framework (Access Control)

Authorization framework is used to provide access to the user or group to a particular transaction service. The authorization framework consists of below data entities

- AUTH_ROLES_REGISTRY -This Table stores the Authorization roles
- AUTH_USER_REGISTRY - This table stores the user names
- AUTH_USER_ROLE_ASSOC - This table stores the user to role association.
- AUTH_USERROLE_ACCESSCONTROL - This table stores the user/role to txn mapping so that execution of the transaction is controlled based on the transaction being invoked from the request. PROFILE_TYPE can be either USER or ROLE, mention the IDPK of the AUTH_ROLES_REGISTRY if PROFILE_TYPE is role else mention the IDPK of AUTH_USER_REGISTRY if PROFILE_TYPE is USER
- CONFIG_APP_PROPERTIES – the property com_yugandhar_authorization_framework_enabled must be set to true in this table. The authorization framework can be disabled altogether if the value is set to false. There might be a need to disable the authorization framework in non-production environment or in production for some specific business scenario. If so, this property must be set to false so that the framework is disabled.

Before invoking the transaction, the request processor performs the authorization based on txnHeader.userName or txnHeader.userRole and txnHeader.transactionServiceName attributes.

The searchAuthAccessControl service is used to perform the authorization based on below rule

1. If username and userRole are present in the request then authorization if all of the below conditions are satisfied
   - ✓ The given user must be present in AUTH_USER_REGISTRY table.
   - ✓ The given role must be present in AUTH_ROLES_REGISTRY table.
   - ✓ The user must be associated with the given role in AUTH_USER_ROLE_ASSOC table
   - ✓ The role has access to the transaction invoked i.e. AUTH_USERROLE_ACCESSCONTROL have entry for given role and transaction service name.
2. If userRole is present and username is null in the request then role is authorized to perform the given transaction if all the below conditions are satisfied
   - ✓ The given role must be present in AUTH_ROLES_REGISTRY table.
   - ✓ The role has access to the transaction invoked i.e. AUTH_USERROLE_ACCESSCONTROL have entry for given role and transaction service name.
3. If username is present and userRole is null in the request then user is authorized to perform the given transaction if all the below conditions are satisfied
   - ✓ The given user must be present in AUTH_USER_REGISTRY table.
   - ✓ The user has access to the transaction invoked i.e. AUTH_USERROLE_ACCESSCONTROL have entry for given user or role and transaction service name.

Sample header objects are as below

Sample 1 - username and roleName both are present in header	"txnHeader": {
	"userName": "rakesh",
	"userRole": "admin",
	"transactionServiceName": "createLegalEntity"
	}

Sample 2- Only roleName present in header	"txnHeader": {
	"userRole": "admin",
	"transactionServiceName": "createLegalEntity"
	}

Sample 3 - Only username is present in header	"txnHeader": {
	"userName": "rakesh",
	"transactionServiceName": "createLegalEntity"
	}

Note – As Yugandhar Open MDM Hub is built on SOA framework, authentication (user credentials validation) framework is not provided. The application heavily depends on Application Server features (e.g. LDAP or webseal integration, SSL handshake etc) for user authentication. It is considered that the user or role name coming in the request is valid and authenticated.

The rules for authorization are defined in com.yugandhar.mdm.auth.searchAuthAccessControlService class. So if there is a need to change the above mentioned rules then write a new service for authorization and replace the TXNSERVICE_CLASS and TXNSERVICE_CLASSMETHOD with appropriate values as per new rule class.

TXNSERVICE_NAME	TXNSERVICE_CLASS	TXNSERVICE_CLASSMETHOD
searchAuthAccessControl	com.yugandhar.mdm.auth.searchAuthAccessControlService	process

VIII. Inquiry Level Framework

Inquiry level framework provides capability to define different levels of output for the same transaction based on inquiry level. e.g. for OOTB transaction, retrieveLegalentity transaction provides different level of output based on inquiry level 101, 102 and so on.

The Data Model:

The Inquiry level framework consists of single data entity CONFIG_INQUIRY_LEVELS.

OOTB Service: findAllConfigInquiryLevelsByBusinessKeyBase – this service search the CONFIG_INQUIRY_LEVELS table based on INQUIRY_LEVEL and APPLICABLE_DOBJ attributes.

The model is very simple wherein you need to define the applicable Data object and child object which would be part of that object as a result. E.g. as mentioned in 'currently configured Inquiry levels for Legal entity' section, you can see that for inquiry level 102 the application Data object is LegalentityDO which would have LeSystemKeysRegistryDO, LePersonDO or LeCorporationDO if the data for these object is present. No other data will be pulled for this inquiry level.

102	LegalentityDO	LeSystemKeysRegistryDO
102	LegalentityDO	LePersonDO
102	LegalentityDO	LeCorporationDO

Also it's very much possible to define multilevel inquiry levels for the same transaction e.g. as shown in the below snippet, the retrieveLegalEntityByLegalEntityId have legal entity inquiry level as well as account inquiry level set. So LE inquiry level 106 includes AccountDO and while retrieving account for the LE the account inquiry level is used. Currently multilevel inquiry levels are NOT widely used in OOTB services so you may need to do customization for additional level of inquiry levels.

```
{"txnHeader": {
            ……
              "transactionServiceName": "retrieveLegalEntityByLegalEntityId"
            },
            "txnPayload": {
            "legalentityDO":      {
                        "idPk": "77776663666777799dg",
                        "inquiryLevel": "106",
                        "accountInquiryLevel":"103"

}}}
```

Introducing new inquiry level

For introducing new inquiry level you need to define new inquiry level and insert the rows in CONFIG_INQUIRY_LEVELS table with applicable_DOBj and child DOBJ.

e.g. if you want to retrieve only the LePersonDO and address of the legal entity then you may create a new inquiry level (e.g. 200001) and create these rows.

200001	LegalentityDO	LePersonDO
200001	LegalentityDO	LeCorporationDO
200001	LegalentityDO	LeAddressAssocDO

The above example will work for the OOTB transactions where inquiry level is used. (Please note that the data object names are case sensitive in OOTB services). However if you are creating a new composite service then you must write the logic to return the response based on inquiry level, you may refer the code of *com.yugandhar.mdm.composite.service.RetrieveLegalEntityByLegalEntityIdService* class and retrieveConfigInquiryLevelChildObjList() method in the same class.

Configuring Default Inquiry levels for Legal Entity and Account

The properties of the CONFIG_APP_PROPERTIES have below properties for defining the default inquiry level value if inquiry level is not provided in the request. You may change the default inquiry level if needed.

Property Name	Value
com_yugandhar_inqlevel_defaultvalue_retrieve_AccountDO	101
com_yugandhar_inqlevel_defaultvalue_retrieve_LegalentityDO	102
com_yugandhar_inqlevel_defaultvalue_search_LegalentityDO	101
com_yugandhar_inqlevel_defaultvalue_search_AccountDO	101

Currently configured Inquiry levels for Legal entity

INQUIRY_LEVEL	APPLICABLE_DOBJ	CHILD_DOBJ
101	LegalentityDO	LeSystemKeysRegistryDO
102	LegalentityDO	LeSystemKeysRegistryDO
102	LegalentityDO	LePersonDO
102	LegalentityDO	LeCorporationDO
103	LegalentityDO	LeSystemKeysRegistryDO
103	LegalentityDO	LePersonDO
103	LegalentityDO	LeCorporationDO
103	LegalentityDO	LeAddressAssocDO

103	LegalentityDO	LePhoneAssocDO
103	LegalentityDO	LePreferencesDO
104	LegalentityDO	LeSystemKeysRegistryDO
107	LegalentityDO	LePersonDO
107	LegalentityDO	LeCorporationDO
104	LegalentityDO	LePersonDO
107	LegalentityDO	LeAccountAssocDO
108	LegalentityDO	LePersonDO
108	LegalentityDO	LeCorporationDO
108	LegalentityDO	LeAddressAssocDO
104	LegalentityDO	LeCorporationDO
104	LegalentityDO	LeAddressAssocDO
104	LegalentityDO	LePhoneAssocDO
104	LegalentityDO	LePreferencesDO
104	LegalentityDO	LeIdentifierKycRegistryDO
104	LegalentityDO	MiscellaneousInfoDO
105	LegalentityDO	LeSystemKeysRegistryDO
105	LegalentityDO	LePersonDO
105	LegalentityDO	LeCorporationDO
105	LegalentityDO	LeAddressAssocDO
105	LegalentityDO	LePhoneAssocDO
105	LegalentityDO	LePreferencesDO
105	LegalentityDO	LeIdentifierKycRegistryDO
105	LegalentityDO	MiscellaneousInfoDO
105	LegalentityDO	LeAccountAssocDO
106	LegalentityDO	LeSystemKeysRegistryDO
106	LegalentityDO	LePersonDO
106	LegalentityDO	LeCorporationDO
106	LegalentityDO	LeAddressAssocDO
106	LegalentityDO	LePhoneAssocDO
106	LegalentityDO	LePreferencesDO
106	LegalentityDO	LeIdentifierKycRegistryDO
106	LegalentityDO	MiscellaneousInfoDO
106	LegalentityDO	LeAccountAssocDO
106	LegalentityDO	LePropertyAssocDO
106	LegalentityDO	LeVehicleAssocDO
106	LegalentityDO	LeToLeRelationshipDO
107	LegalentityDO	LeSystemKeysRegistryDO
108	LegalentityDO	LePhoneAssocDO
108	LegalentityDO	LeIdentifierKycRegistryDO

Currently configured Inquiry levels for Account

INQUIRY_LEVEL	APPLICABLE_DOBJ	CHILD_DOBJ

101	AccountDO	AccountDO
102	AccountDO	AccountAddressAssocDO
102	AccountDO	AccountPhoneAssocDO
103	AccountDO	AccountAddressAssocDO
103	AccountDO	AccountPhoneAssocDO
103	AccountDO	LeAccountAssocDO

IX. Pagination Framework

The Pagination framework supports paged retrieval of the information. The txnPayload object have below attributes which needs to be provided while invoking the transaction.

Request Parameters -

paginationIndexOfCurrentSlice – used to provide the requested page number
paginationPageSize - Input parameter to define the size of the page (e.g. 25 elements or 100 elements

Response Parameters

The response returns additional information about the total number of pages, elements on current slice and total elements.

- **paginationIndexOfCurrentSlice**: Same as that of Input parameter
- **paginationPageSize**: Same as that of the request parameter
- **paginationInfoElementsOnCurrentSlice** - Output information on elements database rows on the current slice or page.
- **paginationInfoTotalElements**: Output information on total number of elements database rows) for given search/retrieve/find criteria. This attribute is returned only in case of retrieve transaction response and NOT in search response as search result may potentially be very large and it will degrade the transaction response time if total number of elements is to be calculated.
- **paginationInfoTotalPages**: Output information on total number of pages for given search/retrieve/find criteria. This attribute is returned only in case of retrieve transaction response and NOT in search response as search result may potentially be very large and it will degrade the transaction response time if total number of elements is to be calculated.

Sample request xml

```
{
        "txnHeader": {
         ……
          "transactionServiceName": "searchLegalEntityByLEAttributes"
        },
        "txnPayload": {
         "paginationIndexOfCurrentSlice":0,
   "paginationPageSize": 100,
         "searchLegalEntityRequestDO":     {
                        "displayName": "%ABC",
"personNameOne": "%Name",
"personLastName": "Last",
"corporationName": null,
"addressLineOne": "Line1",
"addressLineTwo": "Line2",
"city": "Pune",
"stateProvinceRefkey": "1",
"countryRefkey": "1",
```

```
"postalCode": "1",
"identificationTypeRefkey": "1",
"identificationNumber":"%111%",
"phoneNumber": "1",
"systemKeysRegistryReferenceId": "1",
"inquiryFilter":"ACTIVE",
"inquiryLevel": null
        }}}
```

At the entity manager level, Yugandhar Open MDM Hub uses the jpa repository in retrieve transactions and entity manager query parameters for search transactions. Refer the code of below class to understand at the code level

Configuring pagination for search transactions:
com.yugandhar.mdm.composite.service.SearchLegalEntityByLEAttributesService

Configuring pagination for retrieve transactions: LePreferencesComponent.findByLegalEntityIdPk()

X. Reference data management

XI. Pluggable primary keys

Pluggable primary key feature enables creating the record in the database with given primary key in the request. Generation of the primary key in MDM Hub happens as per below logic

1. If primaryKeyDO is present for a given DO then verify that no record having given idpk is present in the database and then create a new record in database.
2. If primaryKeyDO then generate the primary key based on default primary key generator and create a record in database.

The primary key generator is externalized in YugandharKeygenerator `class. You may override the default` generateKey() method if unique key generation logic needs to be customized.

Snippet: Create legal entity transaction with user provided idpk

```
"transactionServiceName": "createLegalEntity"
 },
 "txnPayload": {
                        "legalentityDO":      {
                       "primaryKeyDO": {
                       "idPk": "77776663666AAAA211"
                       },
                       "displayName": "JOHN MCLEAN",
```

Snippet: Create legal entity transaction with auto generated idpk

```
"transactionServiceName": "createLegalEntity"
 },
 "txnPayload": {
                        "legalentityDO":      {
                       "idPk": null
                       "displayName": "JOHN MCLEAN",
```

By default, every persistent data Object (DO) a primaryKeyDO is provided in the MDM Hub. This is also applicable for DOs generated using Yugandhar free-marker Generators.

XII. Application Logging

The MDM Hub application logging is configured using logback logging framework using below spring boot properties (application.properties file)

```
# logging
logging.pattern.console=%d{yyyy-MM-dd HH:mm:ss} %-5level %logger{36} - %msg%n
logging.level.org.hibernate.SQL=info
logging.level.org.hibernate.type.descriptor.sql=trace
logging.level.com.yugandhar.*=INFO
logging.config= classpath:yugandhar_logback.xml
#logging.file= #
```

Currently below loggers are defined in yugandhar_logback.xml

YugandharPerfSummaryLogger – This logger logs the performance summary of every transaction having success response.
YugandharPerfErrorSummaryLogger - This logger logs the performance summary of every transaction having failure response
YugandharCommonLogger – This is the common logger which logs the application processing.
YugandharCacheLogger - This logger logs the ehcache and caching framework related logs.
YugandharMQRequestResponseLogger – This logger logs the request and response messages received through MQ.
YugandharMatchEngineLogger – This logger is used to log the messages related to matching engine.

You may change the log levels, log file name pattern, appender type etc using logback xml.

XIII. Audit Logs

The Audit log framework consists of database tables to store the insert, update and delete operations performed on every single record of the database. Refer 'Understanding Audit Log table structure' of the data model guide for complete coverage of the functionality.

XIV. Match and Merge framework

The match and merge framework gets invoked at the end of create and update legal entity composite services. The matching can be performed in realtime, near-realtime and batch modes.

Match engine rule types

Currently deterministic and fuzzy matching rules can be defined in the matching

Deterministic – find the search candidates with exact matching the search attributes. Objects will be considered match if all the attributes match exactly.

Fuzzy - find the search candidates with phonetic matching the search attributes which increases the search candidates which may probably get rejected in deterministic searches. In the current fuzzy match, the Objects are considered match if all the attributes match exactly.

Modes of Match engine

Realtime Mode: in this mode the matching will be performed at the end of create/update transaction. As the matching gets performed as part of create/update transactions, the response time would be very high and it's not recommended to go for realtime mode unless strongly needed.

Near-Realtime mode: In this mode the legalentity matching will be performed in decoupled mode by doing the matching through JMS framework. At the end of create/update transaction, a message will be send to CDI request queue to invoke performLeMatch transaction to do le matching. This way the matching will be decoupled with the create/update transaction improving the response time of the transactions.

Batch mode: In batch mode, an entry will be made in BATCH_ENTITY_TO_PROCESS table with proposed action code as '2: SEARCH MATCH CANDIDATE'. Some batch processor job (e.g. ETL or custom job) to invoke the performLeMatch as per convenient time schedule.

The modes can be configured by setting the com_yugandhar_match_le_candidateSearch_processing_mode property in configuration properties

Configuration properties

Property Name	Value	description
com_yugandhar_match_le_framework_enabled	true	To enable or disable the match engine / framework.
com_yugandhar_match_le_engine_type	deterministic	The match engine type. Valid values fuzzy or deterministic
com_yugandhar_match_le_Deterministic_LePerson_RuleClass	com.yugandhar.mdm.match.rules.LePersonDeterministicMatchRule	Person match deterministic rule class
com_yugandhar_match_le_Deterministic_LePerson_RuleClassMethod	process	Person match deterministic rule class method name
com_yugandhar_match_le_Fuzzy_LePerson_RuleClass	com.yugandhar.mdm.match.rules.LePersonFuzzyMatchRule	Person match fuzzy rule class
com_yugandhar_match_le_Fuzzy_LePerson_RuleClassMethod	process	Person match fuzzy rule class method name
com_yugandhar_match_le_Deterministic_LeCorporation_RuleClass	com.yugandhar.mdm.match.rules.LeCorporationDeterministicMatchRule	corporation match deterministic rule class
com_yugandhar_match_le_Deterministic_LeCorporation_RuleClassMethod	process	corporation match deterministic rule class method name
com_yugandhar_match_le_Fuzzy_LeCorporation_RuleClass	com.yugandhar.mdm.match.rules.LeCorporationFuzzyMatchRule	corporation match fuzzy rule class
com_yugandhar_match_le_Fuzzy_LeCorporation_RuleClassMethod	process	corporation match fuzzy rule class method name
com_yugandhar_match_le_Deterministic_LePerson_inquiryLevel_default	108	Default Legal entity inquiry level for person match candidates in deterministic rule
com_yugandhar_match_le_Fuzzy_LePerson_inquiryLevel_default	108	Default Legal entity inquiry level for person match candidates in fuzzy rule
com_yugandhar_match_le_Deterministic_LeCorporation_inquiryLevel_default	108	Default Legal entity inquiry level for corporation match candidates in deterministic rule
com_yugandhar_match_le_Fuzzy_LeCorporation_inquiryLevel_default	108	Default Legal entity inquiry level for corporation match candidates in fuzzy rule
com_yugandhar_match_le_candidateSearch_processing_mode	near-realtime	define how the candidate search process runs, valid values are realtime,near-realtime or batch

Data Model

MATCH_CANDIDATE_LE_REGISTRY:

This table stores the match results after performing matching on particular legal entity. e.g. if legal entity A1 is being matched and identified to have A2 and A3 as candidate legal entities having match pattern with A2 as YYYNYY and with A3 as NYYYYN, identified to be manual reviewed before merging then two records would be created in this table with ID_PK of A1 legal entity to be mapped to LEGALENTITY_IDPK attribute and ID_PK of A2 being mapped to CANDIDATE_LEGALENTITYIDPK attribute. YYYNYY being mapped to MATCH_PATTERN, MATCH_PROPOSED_ACTION_REFKEY as defined in REF_MATCH_PROPOSED_ACTION, MATCH_ACTIONSTATUS_REFKEY mapped as defined in REF_MATCH_ACTIONSTATUS tables. The percentage match after performing the matching is stored inMATCH_PERCENTAGE_DESCRIPTION attribute.

MATCH_MERGED_LE_ASSOC:

This table stores the legal entity relation after performing the matching. e.g. if Legalentity A1 is merged with A2 where A1 is survivor then the ID_PK of A1 legal entity should be stored in SURVIVOR_LEGALENTITY_IDPK and ID_PK of A2 legal entity should be stored in MERGED_LEGALENTITY_IDPK attribute. The reason for the merge should be stored in MERGE_REASON_REFKEY attribute along with any comments in the COMMENTS column

REF_MATCH_ACTIONSTATUS: The match action status LOV

REF_MATCH_PROPOSED_ACTION: The match Proposed action LOV

REF_MATCH_RESULT: The match result LOV used to store if the match is exact match, close match etc

REF_MATCH_SCORE: The match score LOV used to store the match attribute pattern

REF_MATCH_THRESHOLD : This LOV stores the threshold of the match e.g. if an attribute match 80% then only it should be considered a close match etc.

Candidate search transaction Service

Service Name - searchMatchCandidateLE

Java Class - com.yugandhar.mdm.composite.service.SearchMatchCandidateLEService class

Match rules

The below rules are defined in com.yugandhar.mdm.match.rules package

Corporation Match Rules

- LeCorporationDeterministicMatchRule
- LeCorporationFuzzyMatchRule

Person Match Rules

- LePersonDeterministicMatchRule
- LePersonFuzzyMatchRule

Common Match rule

- LeAddressAndPhoneMatchRule

Services of match and merge framework

List of Base Services

Service Name	Description
findAllRefMatchScoreByMatchEntityObjectName	find All records by language code
createRefMatchThresholdBase	create record in the database
updateRefMatchThresholdBase	update the database record based on primary key i.e. idpk
retrieveRefMatchThresholdBase	retrieve the record from database based on primary key i.e. idpk
findRefMatchThresholdByBusinessKeyBase	find the unique record from dababase based on by business key
findAllRefMatchThresholdBase	find All records by language code
createRefMatchActionstatusBase	create record in the database
updateRefMatchActionstatusBase	update the database record based on primary key i.e. idpk
retrieveRefMatchActionstatusBase	retrieve the record from database based on primary key i.e. idpk
findRefMatchActionstatusByBusinessKeyBase	find the unique record from dababase based on by business key
findAllRefMatchActionstatusByLanguageCodeBase	find All records by language code
createRefMatchProposedActionBase	create record in the database
updateRefMatchProposedActionBase	update the database record based on primary key i.e. idpk
retrieveRefMatchProposedActionBase	retrieve the record from database based on

	primary key i.e. idpk
findRefMatchProposedActionByBusinessKeyBase	find the unique record from dababase based on by business key
findAllRefMatchProposedActionByLanguageCodeBase	find All records by language code
createRefMatchResultBase	create record in the database
updateRefMatchResultBase	update the database record based on primary key i.e. idpk
retrieveRefMatchResultBase	retrieve the record from database based on primary key i.e. idpk
findRefMatchResultByBusinessKeyBase	find the unique record from dababase based on by business key
findAllRefMatchResultByLanguageCodeBase	find All records by language code
createRefMatchScoreBase	create record in the database
updateRefMatchScoreBase	update the database record based on primary key i.e. idpk
retrieveRefMatchScoreBase	retrieve the record from database based on primary key i.e. idpk
findRefMatchScoreByBusinessKeyBase	find the unique record from dababase based on by business key
createMatchCandidateLeRegistryBase	create record in the database
updateMatchCandidateLeRegistryBase	update the database record based on primary key i.e. idpk
retrieveMatchCandidateLeRegistryBase	retrieve the record from database based on primary key i.e. idpk
createMatchMergedLeAssocBase	create record in the database
updateMatchMergedLeAssocBase	update the database record based on primary key i.e. idpk
retrieveMatchMergedLeAssocBase	retrieve the record from database based on primary key i.e. idpk
searchMatchCandidateLeRegistryBase	search all records of MATCH_CANDIDATE_LE_REGISTRY table based on legalentityidpk candidateLegalentityidpk or matchPattern or matchProposedActionRefkey or matchActionstatusRefkey or all attributes
searchMatchMergedLeAssocBase	search all records of MATCH_MERGED_LE_ASSOC table based on survivorLegalentityIdpk or mergedLegalentityIdpk or mergeReasonRefkey or all

Composite services

Service Name	Description
searchMatchCandidateLE	searchMatchCandidateLEService
performLeMatch	Performs the Legal Entity matching and create candidates

Note – the match and merge framework is currently in BETA mode. The merge and survivorship rules are yet to be introduced.

XV. JMS Integration

MDM hub provides uses Active MQ as messaging queue. Also it depends heavily on Jboss server resources to integrate with MQ Server.

The package 'com.yugandhar.jms' have the below listener and sender along with some sample and test classes.

Default Listener

MDM hub has default MQ Listener defined in YugDefaultRequestQueueListener class which listens to queue YUG.DEFAULT.REQUEST using JMS configuration. As jms destination 'java:jboss/com/yugandhar/default/requestQueue' is defined in jboss server configuration which creates connectivity with queue and listener. The connection factory 'yugJNDIDestJmsListenerContainerFactory' is also defined in jboss configuration

Default Sender

Default message sender for outbound messages is defined in YugJMSMessageSender class. The default response queue of MDM Hub is mapped to jms destination 'java:jboss/com/yugandhar/default/responseQueue"'. The physical queue corresponding to this jms destination is YUG.DEFAULT.RESPONSE.

The below entries in the jboss server defines the default request and response queues

```
<jms-queue name="YUG.DEFAULT.RESPONSE" entries="java:jboss/com/yugandhar/default/responseQueue"/>
<jms-queue name="YUG.DEFAULT.REQUEST" entries="java:jboss/com/yugandhar/default/requestQueue"/>
<pooled-connection-factory name="YugandharDefaultPooledConnectionFactory"
entries="java:jboss/com/yugandhar/DefaultPooledConnectionFactory"
connectors="yugConnectorInvm" statistics-enabled="true"/>
```

Refer section '4.3 Configure RedHat JBOSS EAP' of Development Environment Setup document to understand more about the jboss configuration.

XVI. Phonetic searches

MDM Hub provides support for Phonetic searches on Person and corporation names as well as address attributes. In order to support the phonetic searches MDM Hub stores the phonetic attributes of the actual attribute. E.g. for LAST_NAME of person, there is another attribute PHONETIC_LAST_NAME which stores the phonetic value of LAST_NAME

Phonetic attributes in PERSONNAMES tables

PHONETIC_LAST_NAME
PHONETIC_NAME_ONE
PHONETIC_NAME_THREE
PHONETIC_NAME_TWO

Phonetic attribute in CORPORATIONNAMES table

PHONETIC_CORPORATION_NAME

Phonetic attributes in ADDRESS table

PHONETIC_ADDRESS_LINE_FOUR
PHONETIC_ADDRESS_LINE_ONE
PHONETIC_ADDRESS_LINE_THREE
PHONETIC_ADDRESS_LINE_TWO
PHONETIC_CITY, PHONETIC_COUNTY
PHONETIC_DISTRICT_ZONE
PHONETIC_STREET_NAME

The configuration properties can be used to turn off the phonetic framework altogether. Also the default class to generate the phonetic value can also be changed if needed. Currently apache commons Nysiis class is used to generate phonetic values.

Property Name	Value
com_yugandhar_phonetic_framework_enabled	true
com_yugandhar_phonetic_algorithm_class	org.apache.commons.codec.language.Nysiis
com_yugandhar_phonetic_algorithm_class_method	encode

Note – Currently phonetic searches are used only for searching match candidates. We plan to have extend the existing search transactions for phonetic searches in upcoming releases. However you can build your own services to search entities based on phonetic values. You may refer SearchMatchCandidateLEService code to understand the writing phonetic queries.

6. Setting up the Development Environment (Workspace)

Please refer ‘Development Environment Setup Guide’ document.

7. Code Generation using Freemarker templates and Hibernate tools

Please refer ‘Code Generation Guide’ document.

8. Invoking the transactions

Please refer ‘API and Transaction Reference Guide’ Document.

9. Understanding Data Model

Please refer Data Model Guide and DB Doc.