

Persistent Systems Directory Solutions Strategy Paper



enSure™ Synchronization Server

White Paper

Technology: Directory and Database Integration

Version: 3.5

Contact: <http://www.PersistentData.com>
Directory Products and Services
Persistent Systems Private Limited
“Bhageerath”, Senapati Bapat Road
Pune 411 016 India
Tel: +91 20 567 8900
Email: ensure@persistentdata.com

Persistent Systems Directory Solutions Strategy Ensure Synchronization Server

The Persistent Data Infrastructure Group is one of the groups at Persistent Systems Pvt. Ltd. engaged in developing directory related products and solutions. The group specializes in database integration with directory services and offers products and professional services to make it easier for its customers to deploy directories while leveraging their investments in database technology. The group has developed three different products in this area, *viz.*, Enlist, Enquire, and Ensure. Persistent System Pvt. Ltd. is based in Pune, India and specializes in server-side data management.

Contact details

Persistent Systems Private Limited,
"Bhageerath" Senapati Bapat Marg
Pune, India 411 016
Telephone: +91 (20) 567 8900
Fax: +91 (20) 567 8901
Email: ensure@persistentdata.com
Web: <http://www.PersistentData.com>

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1. Data Synchronization

1.1 Situation Analysis

Enterprises, outsourced messaging services, and e-commerce application builders have their important infrastructure data about users/groups, security, and network stored in different data stores, like databases and directories. This infrastructure data, spread across multiple data stores, is required to be unified in a central data store, which is needed to be kept in sync with the changes taking place in the local data stores.

Databases and directories, that are repositories of critical infrastructure data, must have easy build up and maintenance. When deploying a new data store, two major problems arise, *viz.*, *loading* the data from other data stores into the new one, and subsequently *synchronizing* the data to keep all copies of the data consistent. The complexity is increased by the fact that organizational processes and policies dictate what parts of the data in the data stores must be replicated, and what are the authoritative data stores for different data. The local administrators maintain the data stores while the replicated data needs to be kept in sync with the changes.

1.2 Need for Ensure Synchronization Server

The need for Ensure, which is a database-directory replication and synchronization server, stems from the situation described above. Persistent Systems realized that the key problem to solve is to produce a replication and synchronization tool that can be configured for any number of point-to-point replications using different replication *policies* defined based on the requirements of the various business processes.

Ensure is labeled as a *Synchronization Server* because it is built to replicate and synchronize data between a variety of databases and LDAP-enabled directory servers. The data replicated in various data sources is kept *in sync* by Ensure using changelog-based notification to detect changes on the data in the data sources. In addition, the user can define *policies* to specify the rules to be applied while flowing the changes during replication. This approach ensures the following key features in an Ensure-based directory-database infrastructure:

- The data replicated in various data sources is kept *in sync* with near real time latency.
- The directory hierarchy can be built incrementally in terms of the number of nodes in the hierarchy as well as the number of attributes of each entry.
- Replication *policies* can be specified to satisfy the enterprise business processes. This makes *pulling attributes* possible from a database into an existing LDAP hierarchy, or from the LDAP directory to an existing database.
- Multiple hierarchies can be created from the same sources of data, so that the schema requirements of different directory applications can be met. Similarly multiple tables can be created from the same LDAP data, as per the requirements of different ODBC applications.
- Multiple authoritative sources of data can be configured for different parts of the data in an enterprise.

- The extensive built-up infrastructure in form of databases (relational or otherwise) can be leveraged, maximizing the return on new investment on a directory, as well as reducing the cost of ownership.

2. Aim and Intended Audience

This white paper gives details about the following aspects of Ensure: architecture and main features, deployment considerations, and product plans. It assumes that the reader is familiar with database systems, LDAP, and directories.

The intended audience for this document falls under various categories based on the stage in which the reader's organization finds itself in directory deployment and the role played by the reader.

- **CTO's and Technical Managers:** This audience is concerned with incorporating different data sources as part of the desired directory service. They are the early planners, architects, and strategists for directory-based systems. This is also the audience that *evaluates* various directory-based infrastructure solutions.
- **Deployment Engineers and Support Professionals:** The primary concern of this audience is *deployment* of a directory-based infrastructure. The tasks managed by this audience include installation, configuration and maintenance of the directory system.
- **Developers, System Administrators, IT staff:** This audience takes on the responsibility of developing applications and scripts for using the directory data. They carry the responsibility of keeping the directory system functional and usable with the required service guarantees. They are most concerned with the manageability of the directory service.

Persistent Systems believes that Ensure is a high-value infrastructure product for the following types of businesses.

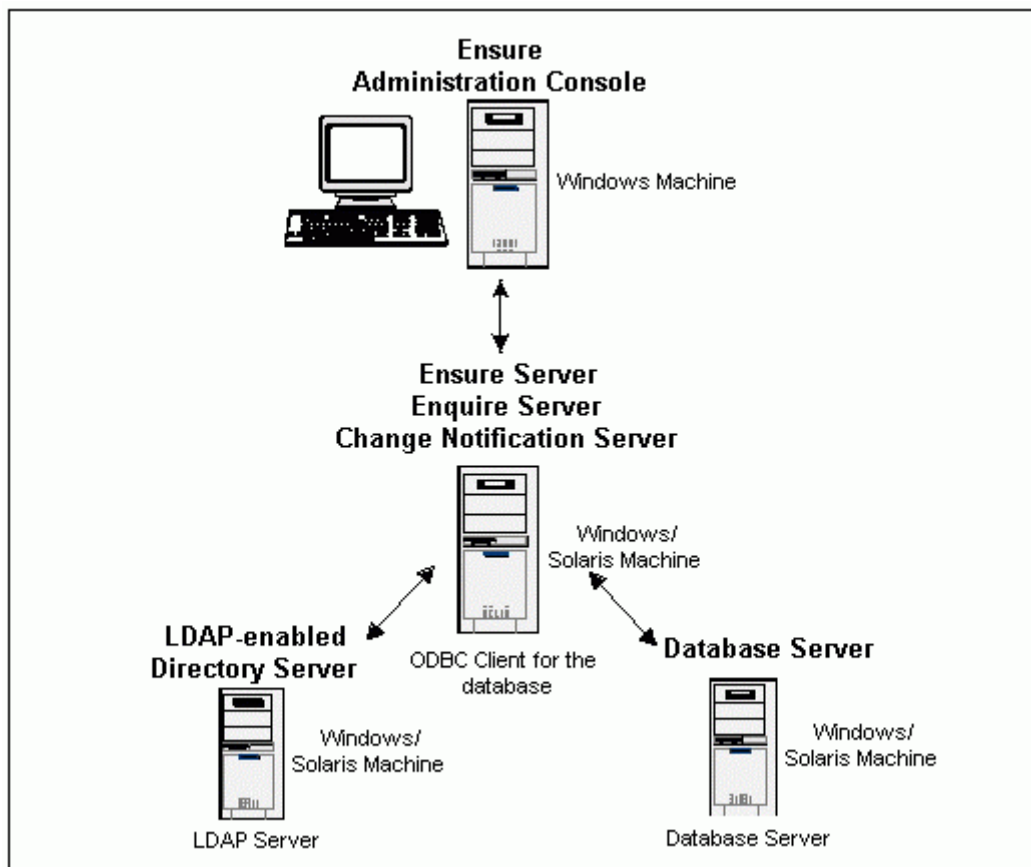
- **Infrastructure Service Providers:** These businesses benefit from the incremental directory deployment made possible by Ensure. Various services that cater to the customer needs at such as corporate email, unified messaging, calendaring, value-added telephony services, and other outsourced services can all be directory-enabled as the service provider's offerings as well as customer needs grow. This segment of the industry also stands to benefit from the operational reliability made possible by leveraging the existing data sources.
- **E-commerce and enterprise application builders:** These businesses rely heavily on relational databases for their customer and business data. Ensure helps them build their directory infrastructure from existing databases.
- **OEM and Partners:** These businesses need to provide maximum flexibility and easy integration into existing systems to their customers in the directory-enabled solutions to be supplied. Ensure helps them provide this flexibility and ease of integration.

3. What Is Ensure?

The Ensure Synchronization Server helps build up a new data store by replicating data from *existing* data repositories. Ensure provides changelog-based synchronization to keep the copies of the data in different data stores *in sync*. Applications working with data in different data stores make changes in the data in the respective data stores. These changes are detected, and the other data stores are synchronized according to the policy configured for synchronization.

The configuration for data flow can be done through the bundled Ensure Administration Console or by writing simple textual commands to the Ensure control port. Replication between multiple existing databases and LDAP directory servers can be achieved by mapping multiple existing databases to a generate a single LDAP hierarchical view, using the *Local Enquire Directory Server* provided with the Ensure Administration Console. The administrator-supplied configuration to the *Enquire Administration Console* maps tables and columns from different databases to object classes and attributes to create an LDAP Data View. *Data Views* are created using Ensure Administration Console to select the part of the physical directory servers between which replication is to be configured. The administrator-supplied data flow configuration to the *Ensure Administration Console* specifies the data views and replication policies, used by the Ensure Server in either direction of replication between the two data views, to execute the replication then keeping the data *in sync*.

Figure 1. Ensure Deployment Scenario



Ensure is designed as a critical piece of a carrier-class, scalable directory server deployment. Figure 1 shows a deployment scenario for real time deployment of its modules.

Ensure connects to multiple external data repositories, referred to as data stores, over a universal Data and Change Access (DCA) layer. Ensure supplies a DCA module to access each supported external data store, such as standard databases and LDAP-compliant directories. Proprietary systems can be connected to Ensure by writing a specific DCA for them.

If a data store supplies changelog facilities, the DCA layer provides access to the changelog. This changelog is used to determine changes in the data and synchronize the changes to other data stores where copies of the data exist, thus maintaining consistency across various copies of the data in different data stores. Ensure provides *Change Notification Server* to create a changelog for standard databases through Enquire. In the absence of changelog support, Ensure can maintain consistency across various copies of the data in different data stores by doing a smart data migration where the entire data is read to determine the changes, which are subsequently synchronized.

3.1 Benefits of Ensure

Ensure offers unique benefits as described next.

- *Ensure eases deployment of directory infrastructure.* When an organization starts deploying a directory, Ensure enables easy loading of directory data from other existing data stores. It also enables pulling attributes from data stores into an existing directory hierarchy.
- *Ensure enables easy maintenance of data in directories.* By keeping replicated copies of enterprise data lying in data stores in sync, Ensure eliminates the need for ad-hoc scripted solutions for maintaining directory data.
- *Ensure fits into existing business processes and rules for data management.* Business processes govern points of control of data and differences in representation of data in different data stores. Ensure is controllable in this respect, enabling the user to decide authoritative data stores, as well as facilitating filtering and user-defined transformations for attributes.
- *Ensure enables data massaging and cleaning:* Using runtime modules, customized transformations can be applied to the data being synchronized. This enables handling the inconsistencies with respect to different data storage formats during data synchronization.

3.2 Ensure as a Data Connector

3.2.1 Notes Connector

Ensure Connector for Lotus Notes can be used to replicate data between Lotus Notes Server and iPlanet Directory Server. The user entries can be migrated from Notes to iPlanet directory server

and vice versa. While adding user entries from iPlanet Directory Server to Notes the user entries need to be registered so that the corresponding mailbox file is created. The Notes group entries can also be migrated from Notes to iPlanet Directory Server and vice versa. Notes API calls are used for registering the user entries and for accessing the group entries in addition to LDAP calls to Notes Directory Server for accessing user entries.

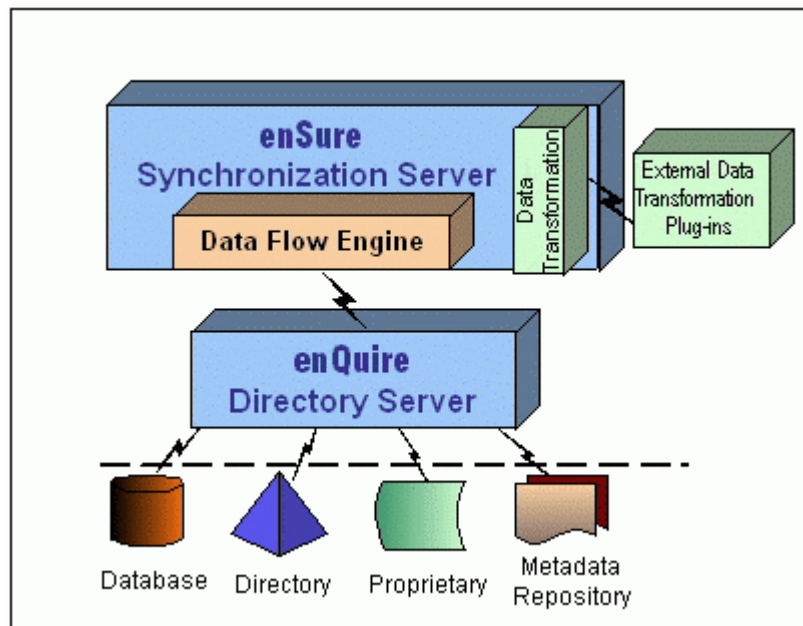
3.2.2 Exchange 5.5 Connector

Ensure Connector for Exchange 5.5 can be used to replicate data between Exchange and iPlanet Directory Server. The Exchange Global Address List can be migrated from Exchange to iPlanet Directory Server and vice versa. While adding recipient entries from iPlanet to Exchange, each entry needs to be associated with the corresponding Windows NT user. If the corresponding Windows NT user is not present then a new user is created. The Windows NT user-related operations are performed using its Security and Account Management API. The Exchange Address Book View entries can also be migrated to iPlanet Directory Server with some required transformation of data. The Exchange Address Book View contains Distinguished Names of the recipient entries which are grouped according to some criteria. Exchange Address Book View contains only references to the actual recipient entries. Ensure converts the Address Book View entries to LDAP entries with objectclass 'groupOfNames', and its multivalued attribute 'member' contains all the Distinguished Names of recipient entries for that group entry.

3.3 Ensure Concepts

The Ensure architecture embodies several significant concepts described next. Ensure has standards-based architecture, that is, it is ODBC-compliant on database side and LDAP-compliant on directory side. Figure 2 shows the architecture of Ensure.

Figure 2. Ensure Architecture



3.3.1 Data Model Mappings

Replicating data between two data stores entails *mapping* the schema of one data store to the schema of the other data store. This is achieved by using the *Enquire Directory Server*, embedded in the Ensure Administration Console. The mapping information provided is referred to as Data Model Mapping in Ensure. The *Enquire Directory Server* facilitates generating a unified LDAP directory view from multiple databases. It enables you to map the RDBMS data model to the LDAP data model. Concepts specific to the Data Model Mappings are described in the following sections.

3.3.1.1 Custom Mapping

A *Custom Mapping* is a representation of data that does not exist in the data stores but is created by Ensure during replication. In this kind of mapping, fixed string are entered for the attribute values while creating the DN for a mapped level using the *Enquire Administration Console*. In case of *Custom Mapping*, the actual value of the attribute is stored along with the attribute in the mapping created, and is displayed in the hierarchy in the *Enquire Administration Console*.

3.3.1.2 Table Mapping

A *Table Mapping* is a representation of mapping where the attributes of a set of entries in the directory hierarchy are mapped to data in a table in the relational database. Ensure fetches the data according to the mapping on the fly while replicating the data. Subsequently the copies of data in the data stores are kept in synch by Ensure according the mapping. It is represented by attribute value = '?' in the *Enquire Administration Console*.

3.3.1.3 Query Mapping

A *Query Mapping* is a special case of Table Mapping where the attributes of a set of entries in the directory hierarchy are mapped to a SQL query fired on a database. This query is evaluated against the data store at the time the hierarchy is generated. Use of Query Mapping enables Ensure to create hierarchies while using the powerful filtering applied by queries evaluated natively against the data stores. It enables the directory hierarchies to be generated from its own views as well as database defined views and tables. However, Query Mapping does not allow you to write on database views.

3.3.1.4 Join Mapping

A *Join Mapping* is a special case of Table Mapping where the attributes of a set of entries in the directory hierarchy are mapped to more than one related tables across different databases. Use of Join Mapping enables Ensure to fetch the related data spread across different data stores joining it to form a Universal Entry in the directory hierarchy.

3.3.2 Data Views

A view of the data, where the data is being served from a physical data server. The data server could be a database server or a directory server. The data views used by Ensure may be served by the LDAP directory server or *Enquire Directory Server*. Data Views are subsets of the data in a data store formed by selecting a part of the entire data. The concepts related to Data Views are explained in the following sections.

3.3.2.1 LDAP Directory View

A type of Data View supported by Ensure, where the data is served from a directory server directly is called an LDAP Directory View. The view has parameters, which filter the data from the complete data of the directory server.

3.3.2.2 Enquire Directory Server View

A type of Data View supported by Ensure, where the data is served from disparate databases. The Local Enquire Directory Server embedded with Ensure provides a way of joining data from different databases to produce a unified LDAP data view.

3.3.2.3 Master View

Master view is the data view from which the migration starts. In case of unidirectional data flow, the source data view is the master view, and data flows from the master view into the target data view. In case of a bi-directional data flow, the master view indicates which data view becomes the source during the first migration. The master view has to be explicitly specified while creating the Data Flow Configuration for bi-directional replication.

3.3.3 Data Flow Policies

Replication of data between different data stores in an enterprise needs to take care of business processes and rules of data management. Some examples of such scenarios could be:

- A particular database might be the authoritative source for a part of the data.
- The directory may contain an existing hierarchy where some attributes may need to be pulled from databases, but no new entries need to be created.
- The existing hierarchy in the directory may not need to be modified but new entries may need to be created.

Such rules can be specified for a Data Flow Configuration and are referred to as Data Flow Policies.

3.3.4 Data Flow Configurations

Ensure is capable of replicating and synchronizing data between multiple data stores and multiple directory servers. A Data Flow Configuration contains all the information for replication and synchronization between two Data Views. It specifies the Data Flow Policies that must be used for replication of data in either direction. Thus one point-to-point data replication is identified by a single Data Flow Configuration. A Data Flow Configuration also provides the user with a point for controlling the replication and synchronization of data. For example, the user can start/stop data flow for a particular Data Flow Configuration. Ensure facilitates concurrent execution of multiple data flows through thread pool based architecture. Extensive status monitoring of the Data Flow Configurations is provided to the user through the Ensure Administration Console.

3.3.5 Data Transformations

In several cases of LDAP deployment, the attribute values for entries in the hierarchy need to be built by transforming the data residing in an existing data store. For example, the *uid* attribute of *inetorgperson* could be built as the first letter of the database column FIRST followed by the value of the database column LAST of the HR database. As a result, significant data massaging and cleaning is required before loading the directory. Ensure enables such data transformation by leveraging the powerful data transformation capability of the data store itself, as well as allowing the user-defined external Perl and binary plug-in transformations.

3.3.6 Data Synchronization

Ensure facilitates data loading and synchronization between multiple relational databases and directory server. The two Data Views selected in a Data Flow Configuration can be synchronized by three different mechanisms that are mentioned next.

3.3.6.1 Manually Initiated Synchronization

Multiple copies of data can be kept *in sync* by initiating the synchronization manually each time from the Ensure Administration Console for the Data Flow Configuration configured for replication between the two Data Views.

3.3.6.2 Automatic Synchronization

A Data Flow Configuration configured for replication between the two Data Views can be set to Automatic Synchronization. In that case, Ensure keeps the two Data Views *in sync* by periodically migrating the data automatically in the specified time interval.

3.3.6.3 Changelog-based Synchronization

Manual or Automatic synchronization can be configured to be changelog-based. In case of changelog-based synchronization Ensure enables detecting the changes in data in one data store, and updating only the changes in the other data store that is to be kept in sync. Changelog-based synchronization keeps various data sources *in sync* with near real time latency, provided the changes in the data are not too frequent, or not too many.

3.3.7 Exporting data to LDIF format

The LDIF format conveys directory information, or a description of a set of changes made to directory entries. LDIF is very commonly used to initially build a directory database, or to add a large number of entries to the directory all at once using the directory vendor-supplied tools. Ensure enables exporting set of directory entries, or a set of changes to be applied to directory entries to an LDIF File in the LDIF format.

3.3.8 Plug-n-Play Data and Change Access

Ensure uses industry standards such as LDAP v3 for directory access and Open Database Connectivity (ODBC) for database access. However, it provides the facility to add other data stores not supported by Ensure through the plug-n-play data and change access (DCA) layer. A third-party can use the published DCA API specification to support additional data stores.

This DCA specification also includes how Ensure expects to access the changelog for a data store. For standard databases, Ensure supplies tools to create changelog information.

4. How Does Ensure Work?

This section briefly explains the run-time operations carried out by Ensure. As shown in Figure 2, the architecture of Ensure consists of two main layers: a *Data Mapper* layer (the layer consisting of the Enquire Directory Server in the figure) and a *Data Flow Engine* (shown as the Synchronization Server in the figure). The Data Mapper layer maps the data in a data store from its native data model to the *internal* data model used by Ensure, that is, the LDAP data model. The Data Flow Engine manages and executes the replication and synchronization between different data stores visible to it as a single data model.

The *Data Mapper* layer handles the complex task of mapping the underlying data store to the LDAP data model. This involves:

1. Building and submitting queries that apply data store-specific transformations and filtering,

2. Mapping attributes, that form each entry, from their respective data stores, and
3. Applying appropriate directory constraints and schema rules.

The ability to seamlessly integrate different data models is a key aspect of Ensure. Its strength lies in intelligent mapping of the critical differences between the relational database model and the hierarchical directory model.

Ensure supports multi-valued attributes. The *Data Mapper* layer submits queries on the mapped data stores and groups the result set based on the unique DN attribute (RDN) to generate multi-valued attributes.

5. Deploying Ensure

Deployment of Ensure as a replication and synchronization server requires several considerations. They are identified next for version 3.0.

5.1 Analysis

The directory administrator, along with the database administrator, must perform analyses with respect to the following points:

1. Design of the directory hierarchy and the structure of the tables in the database.
2. Mapping of the tables and views to the directory hierarchy using custom, table, query or join mapping based on the requirement.
3. Analysis of the replication process required to determine the *replication policies* to be used for either direction.
4. Determination of any data transformation required on the data while replicating.
5. Determination of the database and directory username and password for Ensure to use and ensuring that the appropriate permissions are granted, and
6. Determination of the interval for automatic repeated synchronization if it is required.

5.2 Installation Environments

Ensure Server 3.x has been tested on the following platforms:

- Windows NT 4.0 Workstation and Server, service pack 3, 4, 5.
- Windows 2000 Server, Advanced Server.
- Solaris 8.

The database servers it accesses can be on any platform as long as they are accessible through an appropriate ODBC driver from the machine where Ensure runs.

5.3 Data stores supported by Ensure

Ensure can migrate and synchronize data between different data stores like databases, LDAP-compliant directory servers, and various other proprietary data stores. The different data stores supported by Ensure are listed next:

- Oracle 8 and above using ODBC interface
- Native OCI support for Oracle
- MS SQL
- Microsoft Access
- iPlanet Directory Server 4.0 and above
- Active Directory Server
- Microsoft Exchange 5.5
- Lotus Notes

5.4 Managing Ensure

Ensure has a Windows NT Graphical User Interface as an Administration Console, which sends commands to the server control port. All operations possible in this interface can also be accomplished by sending simple textual commands to the control port. These commands help create new data flow configurations, change the configurations, control replications and synchronizations, and so on.

Ensure Administration Console can be used remotely to configure the Ensure Server for replication and synchronization of data between two physical data stores.

5.5 Performance of Ensure

Critical parameters for improving Ensure performance are indices on database columns and directory attributes, and the database query performance. The Ensure Server is optimized for high performance and large volume data replications and synchronizations.

A single installation of Ensure, running on a machine handles a million entry data migration in a little over 2 hours (average entry size 100 bytes).

Category	Value
Ensure server machine parameters	Windows NT 4.0, SP6, dual CPU, Pentium 600MHz, 256 MB RAM
Database server machine parameters	Oracle 8 on Windows NT 4.0, SP6, dual CPU, Pentium 600MHz, 256 MB RAM
Directory server machine parameters	Windows NT 4.0, SP5, single CPU, Pentium 500MHz, 256 MB RAM
Network parameters	100 mbps LAN
Size of the database in number of entries	1 million entries
Size of each entry	100 bytes, 5 attributes
Depth of the LDAP tree	2 levels
Direction of migration	From database to directory
Total time for migration	2 hours
Number of entries migrated per second	140 entries per second

6. Ensure Roadmap

6.1 Ensure 3.5 Features

- Windows NT, Windows 2000 and Solaris 8 support for Ensure Server.
- Support to execute bi-directional replication between multiple relational databases and directories. High performance multiple parallel data replications.
- Support for Changelog-based synchronization.
- Support to execute synchronization of data using automated repeated migrations.
- Implementation of business rules that govern the migration of data through configurable Data Flow Policies.
- Support for Rejected Entries Synchronization, which helps in synchronizing entries that could not be synchronized during earlier synchronization.
- Complete information of rejected entries in Administration Console so that the appropriate corrective action can be taken.
- GUI-based remote Administration Console to control and monitor the synchronization process from a central location.
- GUI-driven data model mapping using Enquire Directory Server.
- Enhanced Data and Change Access layer with call level interface support for leading relational databases, support for ODBC data stores, LDAP data stores, and multi-language plug-n-play data access support.

- Support for user-configurable data transformations or external Perl or binary transformations while replication.
- Additional support for accessing LDAP data stores so that the hierarchy of existing data can be maintained and entries can be added at any level in the hierarchy.
- Free-threaded architecture for scalability.
- Encryption of data store passwords.
- Mechanism to track the status of each entry.
- Extensive server activity logging.
- Remote logging to facilitate remote management.
- Comprehensive data type support.

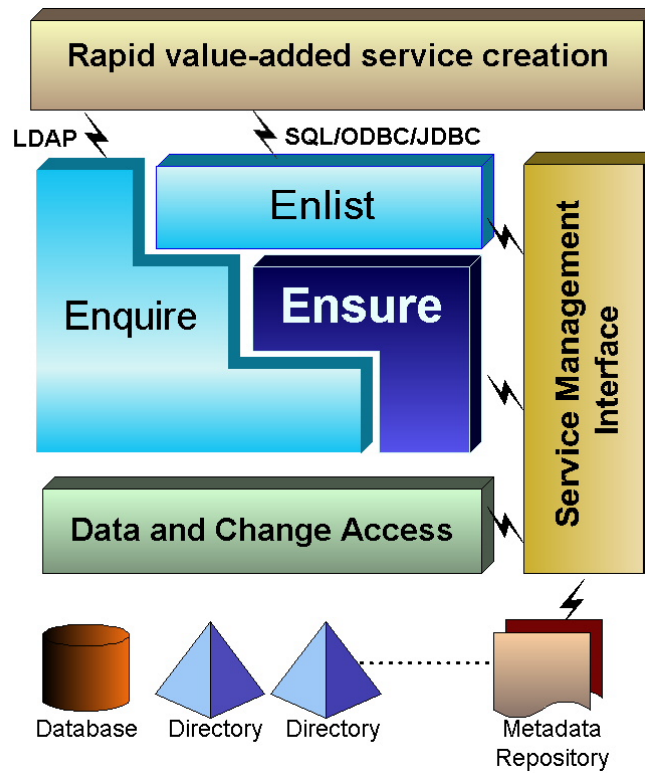
7. Persistent Systems' Data Infrastructure Suite

Persistent Systems Private Limited offers Ensure as part of a suite of three products that form a Data Infrastructure Suite for a seamless integration of directory and database servers as well as applications. The platform consists of Enquire, Enlist, and Ensure.

As depicted in Figure 3, Enlist is a reporting service that enables reporting solutions for LDAP directories. Enlist is based on a SQL engine and essentially provides a *virtual database* interface for LDAP data. In terms of the technical function it performs, it is exactly the reverse of Enquire.

Enquire is a virtual directory that builds a directory hierarchy by accessing *existing* data repositories. LDAP client applications use Enquire as an LDAP v3 compliant directory server to access these directory hierarchies. Multiple existing databases can be exposed as part of a single LDAP hierarchy using Enquire. Enquire Server generates the directory hierarchies *on the fly*.

Figure 3. Persistent Systems Data Infrastructure Suite



8. In Conclusion

Persistent Systems have developed scalable solutions for some key problems encountered by users of a directory-based infrastructure who have already invested in databases. With its 250-strong professional services arm, Persistent is uniquely positioned to help OEMs and service providers bring their solutions to the market more quickly or enhance their directory-based infrastructure.

Visit the Persistent Systems directory products web site for the details on our product range, as well as sales contact points and other useful information. Our Web address is:

<http://www.PersistentData.com>.