ISOCOR

MetaConnect™

Technical Overview

November 1999

Contents

Introduction

Being competitive in today's business environment depends on having up-to-the-minute information about personnel, network resources, suppliers and customers. Yet organizations today are challenged with maintaining needed information in multiple locations through various applications such as email, network operating systems and human resources systems.

In a highly diverse and distributed operation, it would not be unusual to find multiple mail systems, accounting packages, office productivity tools, and databases, each containing their own directory. In fact, a recent study by the Gartner Group revealed that the average number of directories in a Fortune 500 organization is 181. Additionally, a great deal of information in an organization may be duplicated elsewhere in the organization, creating a management nightmare.

Meta-directories solve this problem by merging data from different data sources into a single, accessible and manageable infrastructure.

The Meta-directory solution

During 1996, the Burton Group coined the term meta-directory. The meta-directory is defined as the join of all the directories in an organization. This concept of the "join" is the key element of meta-directory technology. It refers to the capability of building a directory entry for an object (person or otherwise) which contains information (attributes) from many different data sources. This might involve building the directory namespace from existing human resources directories, and then populating this namespace with attributes from disparate application directories including network operating systems, and messaging databases.

MetaConnect provides the flexibility to address data ownership issues within an organization. It allows data to be maintained by the right people in the right location, and then be propagated throughout the environment through a series of rules that organizations establish to meet their own information flow needs.

MetaConnect

Although many directory solutions call themselves meta-directories, ISOCOR's MetaConnect family of products is one of the few true meta-directory solutions providing join capabilities. This join creates a single directory entry containing information from the various applications and systems connected to the meta-directory. The single directory entry provides a complete, consistent view of all related data. For example, this entry could contain an individual's email address from the email system, a phone number and office location from personnel, and user account information from the network operating system.

The following diagram illustrates how MetaConnect joins together the information from several diverse data sources into a single directory entry.

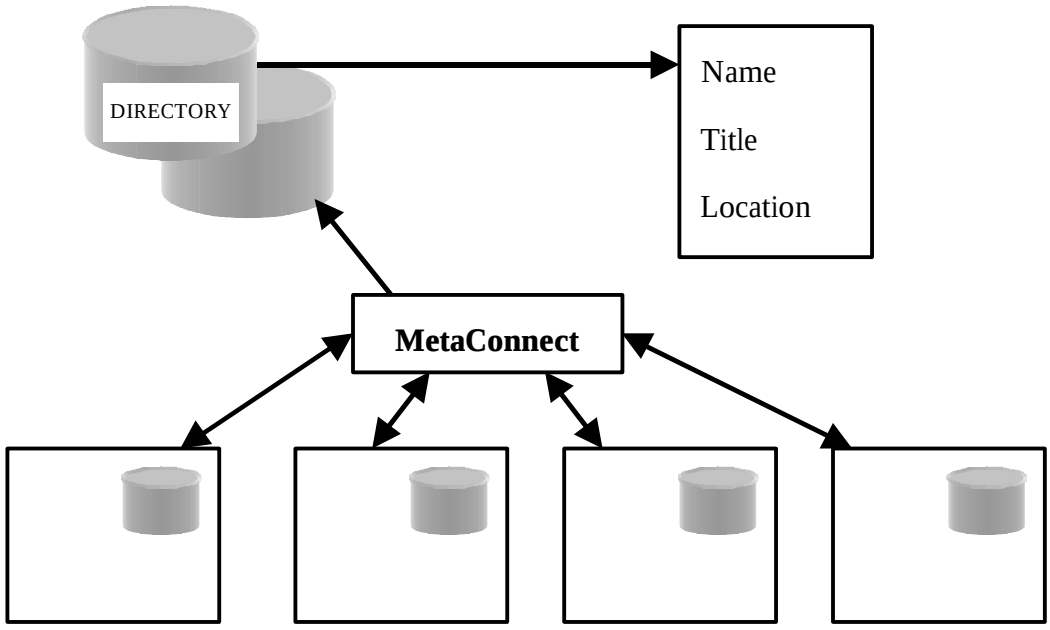

Figure 1 – MetaConnect Overview

MetaConnect unifies existing corporate data for effective Intranet and Internet use and enables an organization to provide accurate, up-to-date information to employees, customers and trading partners. The MetaConnect product family manages the connections to dissimilar databases, applications and directories and joins the information together in one meta-directory that provides integrated management and a unified resource across the enterprise.

With MetaConnect, an organization can easily and consistently maintain information duplicated and stored across multiple directories. Because MetaConnect uses industry standard protocols such as LDAPv3 and Open Database Connectivity, it is server independent and is compatible with most common Lightweight Directory Access Protocol (LDAP) directory servers, including Microsoft® Active Directory, Netscape® Directory Server, and ISOCOR Global Directory Server.

MetaConnect provides access to a variety of information sources and can also be customized using standard scripting languages, such as Perl. This allows an organization to use existing programming resources to further reduce the cost of enterprise-wide meta-directory deployment.

To ensure accurate and current information from the meta-directory, MetaConnect supports near real-time information updates. A Directory Change Notification Service (DCNS) provides notification of any changes in the meta-directory or from any of the connected data sources.

Benefits of MetaConnect

MetaConnect provides an enterprise-class meta-directory solution that allows organizations to unify their existing corporate information without introducing new directories into their environments. Enterprises that implement MetaConnect gain a wide range of benefits:

- By integrating smoothly with an organization's environment, using existing information and programming resources, and using existing LDAP servers, MetaConnect reduces the expense of information infrastructure development.
- By consolidating and automatically updating data, MetaConnect reduces the administrative cost of information management.
- By ensuring that all information for employees, suppliers and customers are up-to-date and consistent throughout the organization; MetaConnect improves information security and reduces the risk of security breaches.
- By merging data from diverse sources, MetaConnect ensures that people and applications can access the information they need when it is needed.
- By unifying data from a variety of sources into a single authoritative, up-to-date data repository, MetaConnect improves information reliability.
- By maintaining accurate email addresses, phone numbers, and location information, MetaConnect improves corporate communications both within the organization and externally.
- By providing secure, accurate data access for corporate resources, suppliers, and customers, MetaConnect paves the way for electronic commerce.

How MetaConnect works

MetaConnect is based on the integration of multiple LDAP directories and SQL databases. The contents of each directory or database are joined to create a single consolidated view of the information. The JoinEngine, combined with the connectors, builds the MetaView.

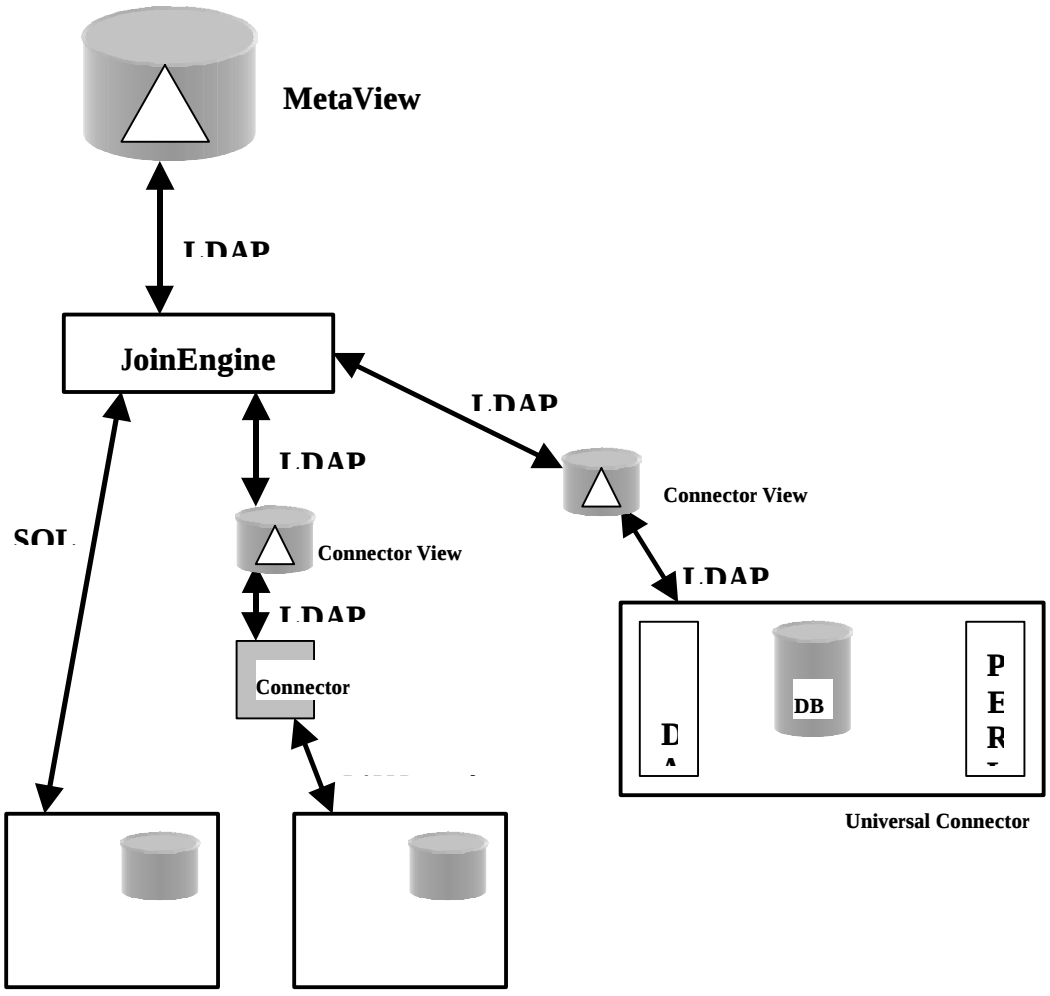

Figure 2 –MetaConnect Join Process

The JoinEngine

The JoinEngine manages the transformation and joining of data from databases and directories. It is responsible for managing and controlling the flow of information into and out of a consolidated master view, or the MetaView. It maintains the MetaView by synchronizing and organizing its information with the external directories in its network environment. Collections of entries, or ConnectorViews, on various data sources, such as an LDAP directory or an SQL database, are grouped and then joined into the MetaView, through LDAP.

Once the MetaView is created, you can browse the entries using the ISOCOR Management Center or any suitable LDAP browser. And through access control mechanisms for the directory and data flow rules in MetaConnect, organizations can ensure that only changes stemming from authorized data sources can take effect throughout the system. The JoinEngine uses LDAP and SQL (OLE/dB) protocols to link the entries in specified ConnectorViews with their corresponding entries in a single MetaView.

The use of LDAP, SQL, and other tools, including Perl scripting, allow changes to be propagated to similar fields in other directories or databases automatically. In this way, the MetaConnect meta-directory keeps all of the individual data sources in line with each other. The MetaConnect JoinEngine is a dynamic application that detects and propagates changes using the Data Change Notification Service (DCNS). Changes can then be propagated between the MetaView and the various data sources according to an established set of rules.

The MetaConnect JoinEngine can be configured to support the following actions:

- **Incremental updates.** External data repositories are updated as modified data is detected.
- **Object creation.** Objects are created in the MetaView and in the ConnectorViews or data repositories connected to the MetaConnect JoinEngine.
- **Object deletion.** Objects are deleted from the MetaView and subsequently from their originating, or connected ConnectorViews or data repositories.
- **Object modification.** Objects are modified in the MetaView and those modifications are reflected in the corresponding entry of any external data repositories.

The ConnectorView

A ConnectorView is a representation of a set of entries in a data source such as an LDAP directory or an SQL database that are exposed to the JoinEngine. In order to link entries in a data source to a MetaView through the MetaConnect JoinEngine, the entries must be defined within the scope of a ConnectorView, which is configured as a specific subtree in an LDAP server, or as an instrumented table in a database server. There are two types of ConnectorViews:

- **Direct ConnectorViews.** Direct ConnectorViews are composed of entries held in a directory accessible by the LDAP protocol (such as ISOCOR Global Directory

Server) or a database accessible by SQL protocol (such as Oracle, Sybase, or Microsoft SQL Server). Since the MetaConnect JoinEngine uses LDAP and SQL protocols, it can directly access the entries from these data repositories in a ConnectorView.

- **Indirect ConnectorViews.** Indirect ConnectorViews are composed of entries replicated from external data repositories that the JoinEngine cannot access directly. The entries in an Indirect ConnectorView allow the MetaConnect JoinEngine to indirectly interact with entries held in external data repositories that are not capable of supporting a Direct ConnectorView. A Directory Connector is used to replicate the entries from the external data repository into the Indirect ConnectorView.

For Indirect ConnectorViews, once a change has been propagated from the MetaView into the ConnectorView, then a Directory Connector (Lotus Notes, Microsoft Exchange, or Universal) transfers the change to the corresponding data source.

Each ConnectorView contains information about a single data source.

The MetaView

The MetaView is the administrator's view of the consolidated directory information. It is a virtual representation of the appropriate contents of the ConnectorViews. A graphical interface is provided for managing the meta-directory at this level. Once the information is processed in the MetaConnect JoinEngine, it is transferred to the MetaView, using LDAP, where it can be viewed and modified.

The Connectors

Connectors are used to manage the interfaces between MetaConnect and the individual data sources. They provide the necessary protocol conversion for the exchange of information between the ConnectorViews and the data stores for a variety of products including:

- Lotus Notes
- Microsoft Exchange
- cc:Mail
- Fischer TAO
- ISOCOR N-PLEX
- Oracle
- Sybase
- SQL Server
- DB2

ISOCOR also provides connectivity toolkits for accessing SAP and PeopleSoft data.

Additional connectors are being developed constantly, so check with ISOCOR for the latest information.

Connectors can also be used to exchange information between the tools in a more direct fashion, which becomes more important as more information is stored in directories and this information needs to be managed and synchronized.

In addition to connectors for common messaging systems, there are connectors available for network operating systems and databases. The Universal Database Connector provides a direct view of the contents of a database, while the Universal Connector makes use of replication to provide information to the ConnectorView. In this latter case, Perl can be used to perform data management functions during the replication process. This combination of direct and indirect access to the underlying directory enables the features of relational databases to be used, and also gives some choice as to the way in which the meta-directory contents are handled.

Connector components

Connectors rely on the following components in order to transfer information:

- **Tasks.** Define how the directory connector synchronizes the external data repository.
- **Attribute flow.** Defines, through configurations, how particular user attributes are mapped for storage in the ConnectorView.
- **Default attributes.** Define a value to use for a destination attribute when the value of the source attribute is empty or the attribute itself is not present.
- **Filters.** Designate particular domains, containers, or user entries to exclude from the replication process.

These components may be configured to control the flow of entries from external data repositories into the Indirect ConnectorViews and on to the MetaView, and to control the flow of entries from the MetaView to the Indirect ConnectorViews and then into the source data repositories. The connectors may be configured to accept or reject entries into the source data repository from the ConnectorView, or out of the source data repository to the ConnectorView.

The Join Process

When creating a MetaView and flowing entries between it and its associated ConnectorViews, a joining process links entries in the ConnectorView to corresponding entries in the MetaView and entries in the MetaView to corresponding entries in the ConnectorView. The join allows information to flow easily between all the views and the external data repositories. Rules are specified to control the join process and to assure accuracy of the linked entry information between the MetaView and the ConnectorView. These configuration rules allow an administrator to manage how entries are joined between a MetaView and its associated ConnectorViews. There are five different types of configuration sets available for use in MetaConnect.

- **Join Rule.** Allows rules to be specified for the joining of entries between the MetaView and ConnectorView.

- **DN Mapping Rule.** Allows specification of a location in the target view (ConnectorView or MetaView) to store an entry
- **Constructed Attribute.** Allows creation of attributes in the MetaView or ConnectorView by combining or abstracting attribute information.
- **Attribute Flow.** Allows mapping of entry attributes between a ConnectorView and a MetaView.
- **Filter.** Allows exclusion of entries from a ConnectorView or a MetaView or a number of MetaViews by a subtree or a specific entry in a subtree.

Join Rules, DN Mapping Rules, and Constructed Attributes, can be either grammar-based or script-based.

- **Grammar-based rules**. These are based on the names and values of an attribute. During the join process, the MetaConnect Join Engine searches for entries using only the values of an entry as defined in the rule.
- **Script-based rules.** These are based on Perl scripts provided by the administrator. Script-based rule sets allow the administrator to define rules based on more than the attributes of an entry. For example, a script based constructed attribute rule could be used to generate target values from a lookup table.

Additionally, **Event Scripts** may be defined. Event Scripts are Perl Scripts that allow interfacing of the JoinEngine to external systems. At strategic points in the join process, the JoinEngine may invoke these external Perl scripts.

Join Rules

In order to create a MetaView, the JoinEngine employs sets of Join Rules to determine how ConnectorView entries are represented in the MetaView. When searching for entries in the ConnectorView or MetaView, the Join Rules use a search string consisting of values and attributes from the source entry. The string is applied to the target view to find a matching entry and a link is created to the target view from the source view.

In LDAP directory hosted views the Join Rules must produce an LDAP search string. In Database hosted ConnectorViews the Join Rules must produce an SQL query. Search strings will generally consist of substituted values from the source entry.

Rules are placed in Rule Sets that are used to join entries from a ConnectorView to a MetaView or from a MetaView to a ConnectorView. These Rule Sets define the order that the Join Rules are applied. The joining process goes through the sequence of rules in a Rule Set until it finds a match in the MetaView or ConnectorView and creates a link.

DN mapping rules

If Join Rules fail to identify a suitable entry in the target view to link to the source entry, the JoinEngine replicates the entry to the target view. DN Mapping rules are used to compose a Distinguished Name within the target view to host the replicated entry.

The input for a DN Mapping rule is the source entry and the output is a partial DN that is appended to the view's base DN to formulate the DN of the created entry.

Multiple DN Mapping rules may be grouped into a DN Mapping Rule Set to allow for ordered testing of rules. These rules can be defined differently for the entries coming from each different ConnectorView connected to the meta-directory.

Constructed attributes

A constructed attribute is any attribute that is derived from a source entry that is not explicitly specified in the source entry. Often a source entry contains several pieces of information.

For example, a Comments field may contain three pieces of information: department, job title, and phone extension. These bits of information can be broken out into Constructed Attributes as part of a created entry in a MetaView. Similarly, there may be three different attributes listing automobile make (Dodge), color (white), and type of transmission (automatic). These three attributes can be added together to make a single attribute containing all of this data in a MetaView.

Constructed Attributes are created from different source entries or taken from multiple source entries and placed in a single created entry.

Attribute flow

An Attribute Flow rule consists of attribute mapping pairs and selection criteria applied to the source entry to determine whether or not to apply an attribute flow table. Multiple attribute flow rules may be grouped together into an Attribute Flow Rule Set. The MetaConnect JoinEngine scans through the Attribute Flow Rule Set and selects the first Attribute Flow Rule that matches the selection criteria. The MetaConnect JoinEngine then applies all of the attribute flow pairs from the rule. For example, the following table is a sample Attribute Flow Rule mapping configuration:

Source Attribute (MetaView)	Destination Attribute (ConnectorView)
Sn	LastName
GivenName	FirstName
Cn	FullName
Title	Position
TelephoneNumber	PhoneNumber

When linking a specific entry or entries between the two views above, the attribute, sn, in the MetaView, maps to the attribute, LastName, in the corresponding entry in the ConnectorView. This mapping continues for the remaining attribute in the list. If an attribute is missing from the source entry, the corresponding attribute is deleted from the target entry.

The selection criteria for an attribute flow are based on two types of attributes, Context Attributes and Entry Attributes. Context Attributes are concerned with the context of the JoinEngine operation and are based on a selection of:

- Ownership of entry.
- Membership of entry.
- Operation (add, update, delete).
- Flow direction (source view to target view).

Entry Attributes deal with the source entry and the target entry.

Filtering

Filters are used to prevent particular subtrees and/or entries form participating in the replication process between a MetaView and a ConnectorView. By default, the JoinEngine includes all user entries in the replication process.

Event scripts

Event Scripts allow external modules to act upon significant events. For example, an event script may log all new entries to the MetaView to a proprietary transaction log database. Events are defined upon which scripts may be configured.

A script set associates defined scripts with some or all defined events. A script set may then be assigned to a ConnectorView in association with a particular MetaView.

Conclusion

ISOCOR's MetaConnect product family provides powerful meta-directory middleware that is widely recognized by industry analysts as the leading product in this space. The combination of open standards, high performance and flexible, rules based configuration provides a solution that meets the needs of even the most demanding environments.

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