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Inventions on LDAP - A study based on US Patents

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Available at: https://works.bepress.com/umakant_mishra/52/
1. Introduction:

A directory service stores data on users, computers and other resources in the network and serves that data to the clients on request. There are various directory services including DNS (Domain Name Service), which stores domain names for the Internet servers, NDS (Novell Directory Services) for Novell NetWare, X.500 the popular directory for OSI model etc. used for different purposes in different environments. LDAP is a directory service based on X.500 directory architecture, intended to provide directory services in Internet compatible environments.

LDAP is an open standard and is used to provide directory services to applications ranging from e-mail systems to distributed system management tools. Popular web browsers such as Internet Explorer, Netscape Navigator etc. are all LDAP enabled. LDAP is becoming more and more popular with the wide usage of Internet.
1.1 Background of LDAP:

Before getting into the details of the study it is worth noting a few key information on LDAP to create a flow in the sequence for the future discussions.

- The complexity of X.500 tempted innovators to develop a lightweight version of it, which was known as LDAP. LDAP was initially developed at the University of Michigan with an objective to include most of the features of X.500, while eliminating the burdens and difficulties of the same.

- Lightweight Directory Access Protocol (LDAP) is an IETF open standard to provide directory services in the network.

- LDAP works on a client server model on the TCP/IP network. In the client server model, an LDAP client makes a TCP/IP request to an LDAP server and the server responses to the client’s request.

- Unlike other proprietary directory access systems, LDAP is an open industry standard protocol.

- The current Version of LDAP is LDAP V.3 released in December 1997 (RFC 2251). Other specifications of LDAP can be found in different RFCs on the IETF (Internet Engineering Task Force) website.

- In LDAP, the basic unit of information is an entry. Every entry has a unique Distinguished Name (DN). Each entry can have several pairs of attributes (such as “cn” for common name, “mail” for email address etc.) and values.

- The data structure in LDAP is like that of a hierarchical tree. LDAP protocol does not specify anything about a data storage mechanism for the LDAP server. Different vendors follow different mechanism to store the tree structure.

- The LDAP protocol specifications provide three types of functions for the LDAP directory, viz., (i) interrogation operations that allow questions to be asked to the directory, (ii) update functions to add, delete and modify data in the directory, and (iii) authentication and control operations.

- In addition to the three main groups of operations, the LDAP protocol defines a framework for adding new operations to the protocol via LDAP extended operations. Extended operations allow the protocol to be extended in an orderly manner to meet new marketplace needs as they emerge.
1.2 Data structure in LDAP

In LDAP, the basic unit of information consists of an entry. Entries are stored in directories. Directory entries are arranged in a hierarchical tree-like structure. Every entry has a unique Distinguished Name (DN). Each entry has several pairs of attribute and values. The attributes are like “c” (for country), “o” (for organization), “ou” (for organizational unit), “cn” (for common name), “mail” (for email address) etc.

Data in LDAP is organized in a hierarchical tree-like structure. The users navigate through the tree to search the desired resources like users, computers, printers, routers etc. The user can search LDAP entries based on a given condition, for example, “ou=sales and cn=John”.

1.3 Data storage in LDAP

As LDAP does not provide any specification on the data storage, different vendors can implement different mechanism for data storage as found suitable to the specific vendor or environment. Although underlying data storage system between different LDAP servers can differ, this disparity does not affect the functionality or interaction of LDAP clients. LDAP protocol does not expose this disparity in data storage to the LDAP clients or users of LDAP interface.

For example, an LDAP server may store data in a Flat file, or in RDBMS. The LDAP client applications such as LDAP enabled web browsers like Netscape communicator and Internet Explorer can use LDAP directory interface without having knowledge on the underlying data storage mechanism.
1.4 How LDAP works

LDAP works on a client server model on the TCP/IP network. In a client server model the client makes a TCP/IP connection and sends requests to an LDAP server. The LDAP server authenticates the client and does the necessary operation based on client’s requests. Finally the LDAP server returns a response containing any results or errors to the requesting client. LDAP servers provide their service using a default port 389.

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When a client sends a request to the LDAP server, it also sends a set of credentials along with the request for authentication. The server checks whether the credentials are correct for the given DN (distinguished name). If the credentials are correct then the client is authenticated and the server executes client’s request. If the credentials are not correct then the server discards the request and terminates the connection.

1.5 Application of LDAP

LDAP supports representation of heterogeneous real world entities in a single instance of the directory. LDAP directories are being used to store address books, contact information, customer profiles, network resource information, user policies etc. which are useful in applications like email, groupware etc.

With the growing use of Internet, LDAP is becoming more and more popular to provide directory services to a wide range of applications. There have been attempts to integrate LDAP to other directory services and serve various other corporate data through LDAP.
2. The present study on LDAP

LDAP is becoming more and more popular to provide directory services to applications ranging from e-mail systems to distributed system management tools. With the growing use of LDAP for maintaining various corporate data, there is a need for improving LDAP to meet the requirements of the corporate networks. In fact there has been a lot of inventions on different aspects of LDAP during last 10 years.

If we analyze the patents on LDAP we find that there have been a lot of inventions on various aspects of LDAP, including data storage in LDAP, data security in LDAP, data searching in LDAP, integrating LDAP with other services etc. In order to make further developments on LDAP it is necessary to know what exactly are the inventions made on each of these aspects, what is the degree of advancement in the technology, how much is yet to be achieved in different aspects of LDAP technology.

The present study is based on 60 selected patents related to LDAP issued by US Patent Office. The objective and methodology of the study is as follows.

2.1 Objectives of the study

The objective of the study is to know:

- How many inventions and what type of inventions have been patented on LDAP. Who are the major assignees?

- Exploring the key components of LDAP.

- Which aspects of LDAP have been treated as hot or addressed more often by the inventors.

- Is there any trend in the series of inventions?

- Which areas of LDAP are yet unexplored? In other words, which aspects are potential to be addressed in future inventions.

- How can TRIZ be used in analyzing the patents? Is there any TRIZ method, such as Principles, Contradictions, Ideality, S-Fields or something that applies to the analysis effectively?
2.2 Methodology followed in the study

Criteria for selection of Patents:
- The USPTO database was given a query to list all patents having “LDAP” in the ‘title’ or ‘abstract’ of the patents. About 100 patents were found in the search results as of July 2006.

- All the above 100 patents were examined and 60 of them were selected for the current study based on their relevance to LDAP.

- The ‘assignee’ or ‘year of issue’ is not considered for criteria of selection. However, the distribution according to ‘assignee’ and ‘year of issue’ are presented in the findings of the report.

Distribution of Patents:
- For the purpose of analysis the inventions are distributed into different topics on LDAP, such as on LDAP data Storage, Integration of LDAP with other Services, Improving the LDAP interface for data access, Improving performance of LDAP data searching, Using LDAP for storing various other data etc.

- The distribution of patents into the above categories is not mutually exclusive. Some patents cover more than one of such topics.

Using TRIZ for patent analysis:
- The patents were analyzed using TRIZ techniques. The major TRIZ techniques used are Ideality, Contradictions, Inventive Principles, and Trends of Evolution. Besides Evolutionary Potential (EP) was also used to analyze the evolutionary potential in some cases.

- The analysis of each group of patents is presented in separate reports.

Presentation of reports:
- This is the summary report for the study, which contains Background of LDAP, Study Objectives, Methodology and Summary of Findings.

- The details of patent analysis different groups of patents are presented in separate reports for convenience of publication.

- The TRIZ based analysis of different groups of patents is presented in separate reports for convenience of publication.
2.3 Study of inventions on different aspects of LDAP

As there are several inventions on LDAP the inventions were strategically grouped under the following heads for ease of analysis. Each group of patents are analyzed with specific focus on the topic and presented in separate articles.

- Inventions on improving the LDAP data storage
- Inventions on LDAP data processing and security
- Inventions on LDAP maintenance and administration
- Inventions on improving data searching in LDAP
- Inventions on improving LDAP interface for data access
- Inventions on extending functionality of LDAP
- Inventions on Integrating multiple LDAP services
- Inventions on Integrating LDAP with other Directory services
- Integrating LDAP with other Systems/ Environments/ Business Processes
- Inventions on Implementing LDAP for different purposes

3. Summary of Findings of the study

The study finds that LDAP was born as an open standard, but it is getting caught by patents from all angles. There are people who write RFCs for Internet Protocols and Open Standards for public use. On the other hand the corporate firms and business organizations are rushing to patent anything and everything that is patentable and yet not patented.

This report will present some interesting findings of the study on LDAP, starting with some statistical breakup of patents to some hot topics of invention.
3.1 Distribution of patents according to assignees

Out of the 60 patents analyzed for the study, International Business Machines Corporation (IBM) holds a major share (25 nos), followed by Sun Microsystems, Oracle International Corporation, Cisco Technology Inc and others. The following table shows a break up of patents according to assignees.

<table>
<thead>
<tr>
<th>Name of Assignee</th>
<th>No of patents</th>
<th>Name of Assignee</th>
<th>No of patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Business Machines</td>
<td>25</td>
<td>BellSouth Intellectual Property Corporation</td>
<td>1</td>
</tr>
<tr>
<td>Sun Microsystems</td>
<td>5</td>
<td>Alcatel</td>
<td>1</td>
</tr>
<tr>
<td>Oracle International Corporation</td>
<td>5</td>
<td>Avaya Technology Corporation</td>
<td>1</td>
</tr>
<tr>
<td>Cisco Technology</td>
<td>5</td>
<td>Novell Inc</td>
<td>1</td>
</tr>
<tr>
<td>Telefonaktiebolaget LM Ericsson</td>
<td>2</td>
<td>Netscape Communication Corporation</td>
<td>1</td>
</tr>
<tr>
<td>Nortel Networks</td>
<td>2</td>
<td>Hewlett-Packard Development Company</td>
<td>1</td>
</tr>
<tr>
<td>Sprint Communications</td>
<td>2</td>
<td>Esker Inc</td>
<td>1</td>
</tr>
<tr>
<td>Switchboard Inc</td>
<td>1</td>
<td>Schlumberger Technology</td>
<td>1</td>
</tr>
<tr>
<td>Mitel Corporation</td>
<td>1</td>
<td>Bull S.A.</td>
<td>1</td>
</tr>
<tr>
<td>Commerce One Operations</td>
<td>1</td>
<td>Inventor himself</td>
<td>1</td>
</tr>
<tr>
<td>America Online</td>
<td>1</td>
<td><strong>TOTAL</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

As we see from the above table, two third of the patents are held by only 4 companies whereas the rest one third is held by 17 others. As many as 14 assignees hold single patents each. A graphical presentation of this distribution is as below.

Distribution of Patents according to their Assignees

3.2 Distribution of patents according to year of issue

As LDAP is a recent concept, all the inventions on LDAP are made during the last decade only. The earliest issued patent in the study is issued in 1999. However, the filing of patents started 4-5 years before that.
The above table shows the distribution of 60 patents taken for the study according to their year of issue. The figures show that the number of inventions is more in the recent years than in the past.

### 3.3 Hot areas of inventions on LDAP

Most features of LDAP are developed in open environment and articulated in RFCs. Because of its openness the number of patents are comparatively less on LDAP. However when we look at the patents on LDAP we find that the inventions are broadly revolving around the following heads.

- **Improving the LDAP data storage**
  - Storing object oriented data in RDBMS used for LDAP
  - Storing semi-structured or unstructured data in LDAP
  - Storing all possible types of information for an LDAP entry

- **Inventions on LDAP data processing and security**
  - Improving data processing
  - Achieving speed in query processing
  - Instant updating or automatic updating of data
  - Improving security for LDAP storage and transmission
  - Implementing access controls
  - Data backup

- **Inventions on LDAP maintenance and administration**
  - Simplifying LDAP administration scripts
  - Simplifying user configuration and administration
  - Users configuring access rights to their own data
  - Automatic maintenance of data
  - Simplifying server configuration
  - Automatic server configuration
  - Easy server administration by LDAP administrator
  - Automatic LDAP server administration

- **Inventions on improving data searching in LDAP**
  - Implementing cache for faster searching
  - Creating intermediate tables for faster searching
  - Reverse indexing for wildcard searching
  - Achieving speed in data searching
- Inventions on improving LDAP interface for data access
  o Simplifying user interface for LDAP data access
  o Interface to manage multiple LDAP
  o Automatic distinguished name lookup
  o Obtaining directory data in different formats

- Inventions on extending functionality of LDAP
  o Implementing filtered roles
  o Implementing bulk import to LDAP
  o LDAP administration scripts/ LDAP access control language
  o XML-LDAP adapter

- Inventions on Integrating multiple LDAP services
  o Data replication and data synchronization in LDAP
  o Integrating multiple LDAP with heterogeneous database schema
  o Automatic recognition of other LDAP directories in the network
  o Easy or automatic integration of multiple directories in the network
  o Integration of different versions/ implementations of LDAP
  o Import and export of LDAP data

- Inventions on Integrating LDAP with other Directory services
  o Automatic recognition of other directory services in the network
  o Easy method of integration with other directory services
  o Integration with telephone, fax, email, DNS and other directories

- Integrating LDAP with other Systems/ Environments/ Business Processes
  o Automatic integration with different LDAP clients
  o Integration with different OS, protocols and environments
  o Extended feature on LDAP Application Programming Interface

- Inventions on Implementing LDAP for different purposes
  o Storing ACL, policies etc. in LDAP
  o Using LDAP for web browsing
  o Storing Java classes in LDAP server
  o Representing CORBA object references in LDAP
  o Using LDAP as a Network Information Service
  o Storing other corporate data for different purposes

The study finds that the number of patents are increasing on the application and controlling aspect of LDAP. The details of finding on each of the above topics will be presented as separate papers.
Reference to patents analyzed for the study:


Other references:


65. Website on LDAP by the University of Michigan at http://www.umich.edu/~dirsvcs/ldap/ldap.html

