The Z39.50 Interoperability Testbed

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Realizing the Vision of
Networked Access to Library Resources:
An Applied Research and Demonstration Project to Establish and Operate a Z39.50 Interoperability Testbed

Interim Report for the Z-Interop Project
The Z39.50 Interoperability Testbed

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1. Introduction

The U.S. Federal Institute of Museum and Library Services awarded a National Leadership Grant in 2000 to support the research and demonstration project, *Realizing the Vision of Networked Access to Library Resources: An Applied Research and Demonstration Project to Establish and Operate a Z39.50 Interoperability Testbed*. The goal of the project was to improve Z39.50 semantic interoperability among libraries for information access and resource sharing. The Z-Interop Project, as it became known, was the first systematic attempt to establish a reliable interoperability testbed for assessing Z39.50 clients and servers. From December 1, 2000 through September 30, 2003, the Principal Investigator and staff working on the Z-Interop Project carried out a wide range of anticipated and unanticipated activities to address the challenges in this ground-breaking endeavor. This document serves as an interim report for the Z-Interop Project.

2. The Problem Addressed by the Z-Interop Project

To better serve their users' needs, libraries have been purchasing and implementing sophisticated integrated information systems to provide increased access to global information resources. A key technology to improve integrated access to distributed resources is the national and international information retrieval protocol, ANSI/NISO Z39.50/ISO 23950, *Information Retrieval (Z39.50): Application Service Definition and Protocol Specification* (National Information Standards Organizations, 1995). The ANSI/NISO Z39.50 information retrieval protocol allows two computer systems to communicate via a network connection to support search and retrieval transactions.

Although Z39.50 was approved in 1988 as an American National Standard, serious implementation of the protocol did not occur until a revised standard was approved in 1995. The vision for Z39.50 was to enable interoperability, where interoperability refers to the ability of different types of computers, networks, operating systems, and applications to exchange information, without prior communication, in a useful and meaningful manner. The standard was developed under the auspices of the National Information Standards Organization (NISO), and was intended to be used for searching and retrieving bibliographic records held in library catalogs.

The 1995 revision of the protocol generalized the functionality provided, and since then, Z39.50 has been implemented in systems handling a broader range of information types beyond library catalog bibliographic records. (For a history of the development and evolution of Z39.50, see Moen, 1998b.) The 1995 standard included many more options and choices when implementing the protocol, and this resulted too often in Z39.50 clients and Z39.50 servers not achieving acceptable levels of interoperability. In the late 1990s, a number of studies evaluating Z39.50 interoperability and effectiveness indicated librarians' concern about the reliability of Z39.50 to provide effective search and retrieval across library catalogs. Evaluation studies of Z39.50 projects in Iowa, Canada, and the Committee on Institutional Cooperation (see Blue Angel Technologies, 1998; Lunau, 1998; and Hinnebusch, 1998) provided empirical evidence that interoperability was a critical issue facing information systems implementing Z39.50 access to library resources. Improvements in interoperability between systems would substantially increase users'—especially librarians and other information professionals—confidence that Z39.50 products provide reliable results when searching across multiple resources.

The Z39.50 standard specifies is a computer-to-computer protocol for information retrieval. Based on a client/server architecture, it defines a way for information stored in large databases (e.g., library catalogs, and abstracting and indexing services records) to be searched and retrieved through a standardized interface. The Z39.50 standard masks the differences between information retrieval systems, since users interact with their system's familiar user interface to search multiple resources as if they were locally available, and to retrieve and display records from those resources in a common format.

Even with the proliferation of the World Wide Web, communications protocols, and commercially available search engines, Z39.50's functionality has not been matched. Z39.50 offers a level of interoperability that is at the heart of a library's mission: it allows a library's resources and holdings to be accessed and shared widely, and in a sense, provides an *open door* to a library's collection.

In the early 1990s, as vendors and libraries began developing Z39.50 implementations, the Coalition for Networked Information sponsored the first Z39.50 interoperability testbed. Its focus was to jump start use of Z39.50 and assist developers in resolving basic, technical protocol interoperability issues (e.g., being able to get two systems to communicate, create and interchange properly structured protocol messages, etc.). Protocol interoperability testing verifies that Z39.50 messages are being exchanged consistently. We now take such basic Z39.50 protocol interoperability for granted, but a new set of interoperability barriers emerged. The basic, technical level is a critical foundation, but it leaves open the question of how implementations working within a common context like library catalogs interpret Z39.50 messages. Unless the interpretation is consistent, users cannot rely on the responses. The term semantic interoperability refers to this level of interoperability issues.

An important step to address interoperability problems was the development of Z39.50 profiles. Profiles detail technical Z39.50 specifications for use in particular applications (e.g., search and retrieval across library catalogs). Z39.50 implementations conforming to profile specifications will have improved likelihood for interoperability. The profiles also assist librarians when purchasing Z39.50 client and server products and assist vendors when developing and configuring their Z39.50 products. The Principal Investigator was involved in several of these profiling efforts including the Z Texas Profile (Moen, 1999), the Bath Profile (Miller, 1999), and the U.S. National Z39.50 Profile for Library Applications (National Information Standards Organization, 2003).

As with any standard, a vendor's claims to conformance cannot be assured until it is tested. When the Z-Interop Project began, there were no accepted testing methodologies, formal processes, and interoperability benchmarks by which customers and vendors could assess conformance to profile specifications or demonstrate effective interoperability between systems that claim conformance. Interoperability between diverse systems presents complex and at times confounding challenges. The Z-Interop Project addressed many of these challenges by designing and demonstrating a Z39.50 interoperability testbed that included methods to test and measure levels of interoperability between systems implementing Z39.50. The focus of the Z-Interop Project was on semantic interoperability between Z39.50 implementations. Prior to the Z-Interop Project, there existed no reliable test methodology or benchmarks that could be used to assess the integrity of a vendor's Z39.50 products or the level of interoperability achieved between two implementations of Z39.50.

3. Z-Interop Project Goals and Objectives

The primary goal of the Z-Interop Project was to improve Z39.50 semantic interoperability among libraries for information access and resource sharing. A set of objectives guided project work to achieve this goal:

- Develop and document a reliable interoperability testing methodology
- Develop and establish an interoperability assessment model with valid metrics for assessing interoperability of Z39.50 implementations
- Develop and operate an interoperability testbed
- Produce a best practices guide and model for interoperability testbeds
- Produce a best practices guide for configuration of Z39.50 implementations to achieve improved semantic interoperability.

A secondary goal was to offer an educational and training opportunity in networked information access and retrieval for graduate students in the School of Library and Information Sciences at the University of

North Texas. These research assistants worked on various aspects of the project, and they developed skills and competencies related to networked information retrieval, research methods, analysis, report writing, and presentation.

The following sections describe the activities and accomplishments of the Z-Interop Project, and provide an assessment as to the realization of the project's goals and objectives.

4. Research and Development for the Interoperability Testbed

The Z-Interop Project's approach for addressing Z39.50 interoperability was to establish a testbed through which interoperability testing could be carried out. A testbed is an accepted approach for interoperability testing. Preston and Lynch (1994) noted that:

> Because the emphasis is on implementations, testbeds lead to a "whole system" approach to testing rather than one focused on individual standards conformance or interoperability and can be very useful not only in dealing with problems directly related to a given standard but in identifying problems that arise from the interaction between different standards or at the boundaries between standards and implementor agreements often needed to produce real-world interoperating systems.

The Z39.50 interoperability testbed consisted of the following components (additional details about these components are included in subsequent sections):

- **Test dataset:** Approximately 400,000 MARC 21 bibliographic records comprised the test dataset used for interoperability testing. The Z–Interop staff used various tools and procedures to "understand" the content of the records to determine records that should be returned in test searches.
- **Reference implementations:** Three components comprised the reference implementations:
    - An integrated library system that provided the information retrieval system (in the form of its online catalog)
    - The Z39.50 server (integrated with the library system)
    - The Z39.50 client (a stand-alone software product)
- **Test searches and benchmarks:** For bibliographic database searches defined in two Z39.50 profiles, Z–Interop staff created a set of test searches with search terms. Analysis of the test dataset identified records that met the search criteria. Benchmarks for Z–Interop testing were established by executing the test searches using the testbed reference implementations. Z–Interop test searches were based on selected specifications from the *Bath Profile: An International Z39.50 Specification for Library Applications and Resource Discovery* (National Library of Canada, 2003). and the *U.S. National Z39.50 Profile for Library Applications* (National Information Standards Organization, 2003). These profiles were being developed and approved during the time of the Z-Interop project.
- **Policies and procedures:** Provides detailed instructions and systematic procedures, along with published policies, for the operation of the testbed and for Z-Interop participants who submitted their implementations (Z39.50 clients and Z39.50 services) for interoperability testing.

4.1 The Z-Interop Test Dataset

The test dataset was a key testbed component, since it allowed the Z-Interop Project to control the data against which the test searches was submitted. OCLC Online Computer Library Center, Inc. contributed the dataset to the Z-Interop Project (see Section 7. Z-Interop Project Resources: Funds and Contributions, for list of organizations supporting the project). OCLC produces a very large bibliographic database called WorldCat. Discussions with OCLC staff at the outset of the project led to agreements on the size and characteristics of the test dataset.

The first step in creating the test dataset was to extract a sample of records from the WorldCat database.

At the time the records for the test dataset were extracted from WorldCat it contained approximately 42,000,000 bibliographic records. OCLC extracted a 1% sample of WorldCat MARC 21 records, with the sampling based on the number of holdings associated with an individual record. The result of the extraction procedure was 419,657 records. The test dataset would be used by the Z-Interop staff to establish benchmarks for the test searches, and it would be made available to Z-Interop participants that wanted to submit their Z39.50 server implementations for interoperability testing.

The second step in using the test dataset for interoperability testing was to examine the records in an automatic manner to identify candidate records that should be retrieved for a specific test search. The Z-Interop staff created several documents that detailed the analysis procedures for preparing and "understanding" the contents of the test dataset records (see Appendix B for a list and brief description of all technical reports and documents produced as part of the Z-Interop Project, and which are available on the project website).

Analysis Logic and Procedures for Creating a Test Dataset of MARC 21 Records for the Z39.50 Interoperability Testbed, Phase 1 Testing (revised draft dated January 1, 2002)

Decomposing MARC 21 Records for Analysis (revised draft dated January 1, 2002)

Data Normalization Procedures on Decomposed MARC 21 Records (revised draft dated January 1, 2002)

The test dataset records needed to be analyzed at a "word" level to identify which records contained specific words, words that would be terms to search the records during interoperability testing. It was necessary to identify which records contained a specific word but also to identify where the word appears in the record (e.g., is a word in a title-related field or a subject-related field). For purposes of the analysis, a word was defined as a "string of characters bounded by spaces." Such a definition has some problems when it comes to MARC records since there are fields (e.g., 008) that have strings of characters but also blanks as part of the data in the field. Therefore, we treated the content of MARC fields 001-009 as a single word regardless of spacing since these fields are coded and not subfielded. The other complication was the occurrences of punctuation in the fields. An additional qualification for the definition of "word" was: "any string of characters, including all punctuation and other special characters, bounded by spaces." Because a string of characters might include leading, internal, and ending punctuation, data normalization to remove specific punctuation (e.g., leading and ending punctuation) would be necessary. This was carried out in separate procedures carried out on the decomposed records.

Each of the MARC records in the test dataset was decomposed based on the occurrence of words in the record. The structure for the decomposed records was defined to include the following data elements:

- **OCLC Number (OCLC#)** – Necessary for identifying in which record a word appears
- **Field Tag (Field)**
- **First Indicator Value (1st Indicator)**
- **Second Indicator Value (2nd Indicator)**
- **Subfield Value (Subfield)**
- **Field Position in Record (Field Position)** – Necessary in cases where a field is repeated
- **Subfield Position in Record (Subfield Position)** – Necessary in cases where a subfield is repeated
- **Word Position in Field/Subfield (Word Position)** – Necessary to be able to identify "phrases" where several adjacent words are a search term
- **Specific Character String (Word)**

OCLC staff parsed the 400,000 MARC 21 in the dataset records that resulted in a tab delimited file of approximately 33,000,000 subrecords. These subrecords or decomposed records were imported into a MySQL database. To show the decomposition of a MARC record, the following is an example of a complete MARC 21 bibliographic record, and this is followed by a table of the subrecords resulting from the decomposition.

```
LDR01019cam  2200265   4500^
001ocm00000003^
003OCoLC^
00520010925133908.0^
008690414s1963    nyu      b    000 0 eng  ^
010  _a   63064323^
019  _a7124033 _a10654585 _a14218190^
040  _aDLC _cDLC^
049  _aOCLC^
0500 _aHV700.5 _b.N37^
0820 _a362.7/3^
1102 _aNational Study Service.^
24510_aIllegitimacy and adoption in Maine : _breport of a study made for the Maine Committee on Children and Youth.^
260  _a[New York], _c1963.^
300  _a24 p. ; _c28 cm.^
500  _aCover title.^
504  _aBibliographical footnotes.^
650 0_aIllegitimacy _zMaine.^
650 0_aAdoption _zMaine.^
7101 _aMaine. _bCommittee on Children and Youth.^
```

OCLC#	Tag	1st Ind	2nd Ind	Subfield	Field Position	Subfield Position	Word Position	Word
3	1				1	1	1	ocm00000003
3	3				2	1	1	OCoLC
3	5				3	1	1	20010215000003.0
3	8				4	1	1	690414s1963 nyu b 000 0 eng
3	10			a	5	1	1	63064323
3	40			a	6	1	1	DLC
3	40			c	6	2	1	DLC
3	19			a	7	1	1	7124033
3	19			a	7	2	1	10654585
3	19			a	7	3	1	14218190
3	50	0		a	8	1	1	HV700.5
3	50	0		b	8	2	1	.N37
3	82			a	9	1	1	362.7/3
3	49			a	10	1	1	OCLC
3	110	2		a	11	1	1	National
3	110	2		a	11	1	2	Study
3	110	2		a	11	1	3	Service.
3	245	1	0	a	12	1	1	Illegitimacy
3	245	1	0	a	12	1	2	and
3	245	1	0	a	12	1	3	adoption
3	245	1	0	a	12	1	4	in
3	245	1	0	a	12	1	5	Maine
3	245	1	0	b	12	2	1	report
3	245	1	0	b	12	2	2	of
3	245	1	0	b	12	2	3	a
3	245	1	0	b	12	2	4	study
3	245	1	0	b	12	2	5	made
3	245	1	0	b	12	2	6	for
3	245	1	0	b	12	2	7	the
3	245	1	0	b	12	2	8	Maine
3	245	1	0	b	12	2	9	Committee
3	245	1	0	b	12	2	10	on
3	245	1	0	b	12	2	11	Children
3	245	1	0	b	12	2	12	and
3	245	1	0	b	12	2	13	Youth.
3	260			a	13	1	1	[New
3	260			a	13	1	2	York]
3	260			c	13	2	1	1963.
3	300			a	14	1	1	24
3	300			a	14	1	2	p.
3	300			c	14	2	1	28

OCLC#	Tag	1st Ind	2nd Ind	Subfield	Field Position	Subfield Position	Word Position	Word
3	300			c	14	2	2	cm.
3	500			a	15	1	1	Cover
3	500			a	15	1	2	title.
3	504			a	16	1	1	Bibliographical
3	504			a	16	1	2	footnotes.
3	650		0	a	17	1	1	Illegitimacy
3	650		0	z	17	2	1	Maine.
3	650		0	a	18	1	1	Adoption
3	650		0	z	18	2	1	Maine.
3	710	1		a	19	1	1	Maine.
3	710	1		b	19	2	1	Committee
3	710	1		b	19	2	2	On
3	710	1		b	19	2	3	Children
3	710	1		b	19	2	4	And
3	710	1		b	19	2	5	Youth.

Additional details on the analysis logic, the preparation of the test dataset, the decomposition, and the data normalization can be found in the respective Z-Interop documents.

4.2 Z-Interop Server-Side Reference Implementations

Once the test dataset was created and prepared, it was then ready to be loaded into the Z-Interop reference implementation of the information retrieval system. For interoperability testing, Sirsi Corporation contributed its Unicorn integrated library system to the Z-Interop Project. The integrated library system included an online catalog module, which comprised the information retrieval system to which the Z39.50 server (see below) interacted. Sirsi had supported the development of the Z39.50 profiles, in particular the Bath Profile, and the underlying information retrieval system in the Unicorn product was programmed to support the searches defined in the Bath Profile.

The other component on the server-side reference implementation is the Z39.50 server. Sirsi provided this component and it is fully integrated into the Unicorn system. A Z39.50 server communicates with an information retrieval system or database system; typically in a library context, one of those IR or database systems provides access to records in the online catalog. The Z39.50 server was configured to support the Z39.50 specifications contained in the Bath profile.

To help illustrate the model that Z39.50 assumes when discussing Z39.50, online catalogs, and related aspects, the following text from the *U.S. National Z39.50 Profile for Library Applications* (National Information Standards Organization, 2003) is very helpful:

> The specifications for search and retrieval in an online library catalog environment assume a model of a bibliographic database and an information retrieval system that provides access to one or more databases. A valuable contribution of Z39.50 is providing an abstract view of information retrieval. The following describes the logical components and concepts of an online library catalog model. Actual implementations of library catalogs, bibliographic databases, and information retrieval systems may differ.
>
> - Bibliographic Database: A logical component for storing data that represent bibliographic items. Typically these representations are created according to cataloging rules, where the representations include information about the title, author, subject, and other salient features of a bibliographic item. The representations when stored in a database are structured for machine processing using the framework of the MARC Bibliographic Format. The MARC format enables discrete data in the representations to be separately coded for machine processing and manipulation (e.g., title information is coded with field tag 245 and subfield a). A record in the database is comprised of the data associated with a single bibliographic item. Although the database may not physically store all associated data together in a record, the database is able to present the associated data as a record upon request. (The

physical structure of the database, i.e., whether the data are stored in a relational database, a flat file, etc., and how the data are stored are not addressed by this model.)

- Access Points and Indexes: A logical component for searching the database is an index. An index is a list of values with a pointer to the database records that contain those values. In a library catalog, searchable areas of a record are considered access points. A catalog with, for example, a title access point, an author access point, and a subject access point allows a user to search for titles, authors, and subjects. An access point index is created by selecting values for the index from specific areas of the database record. For example, an author access point index consists of values (i.e., words and phrases) that occur in the MARC fields and subfields that contain author information with a pointer to the database records containing those values. (The internal structure of an index and how it associates the list of values with pointers to database records are not addressed by this model.)
- Information Retrieval System: A logical component that manages the search of the database and retrieval of records from the database. The system provides an interface to receive a query and processes the query against one or more access point indexes. When values in the index(es) match the query criteria (e.g. a search for records where the author's name is Mark Twain), the system selects and retrieves the relevant records from the bibliographic database for presentation to the user. The search is a mechanism to select bibliographic records from the database that matches the query criteria.

Each online catalog implementation indexes specific fields/subfields in the MARC record to create access points. A key aspect for interoperability is based on the indexing policies established for a bibliographic information retrieval system. If two systems select different fields/subfields in the MARC record to index, the search results from the same set of MARC records could vary substantially. The Z-Interop staff continued work that the Principal Investigator had begun in 1999 to identify all MARC fields/subfields that could contain author, title, or subject data. The result of this work was the following Z-Interop document:

> **Indexing Guidelines for MARC 21 Records to Support Z39.50 Profile Searches**(revised draft dated February 1, 2002)

Z-Interop staff used the Z-Interop indexing guidelines to set up the indexing policies on the Unicorn system, a task that was both time consuming and subject to close supervision and validation. The results of the indexing work was then verified the resulting indexing policies using a special program provided by Sirsi staff. The following document contains the output of this special program:

> **ZDoctor Report of SIRSI Indexing Policies for Interoperability Testing, Phase 1 Testing** (revised draft dated January 1, 2002)

After the indexing policies were established, the test dataset of MARC 21 records was then loaded into the Unicorn system. The records were indexed per the indexing policies, and the server-side reference implementation was ready for use.

4.3 Z-Interop Client-Side Reference Implementation

The other Z39.50 component for the Z-Interop Project was a reference implementation of a Z39.50 client. Sea Change, Inc. contributed its Bookwhere Z39.50 client product to the project for use as a Z39.50 client reference implementation. Bookwhere is widely used as a stand-alone Z39.50 client to search Z39.50 accessible library catalogs and other resources.

As with the Sirsi server-side reference implementation, the Bookwhere product allowed the Z-Interop staff much control over the configuration of the software. Specifically, the staff could configure the software to communicate with Z39.50 servers, and most importantly, configure the Z39.50 messages sent from the client to a server. The software was loaded on desktop computers acquired by the Z-Interop Project for use in interoperability testing. Once the software had been loaded, it was tested by sending searches to the Z-Interop server-side reference implementation.

4.4 Test Searches and Benchmarks

Once the test dataset had been prepared, the decomposed records loaded into a MySQL database, and the reference implementations set up, the Z-Interop staff could then begin the process of creating test searches for interoperability testing and identifying the benchmark records that should be returned for any given test search. Much effort went into conceptualizing this process of creating test searches and benchmarks as well as implementing the processes. It was here that much of the original research and development for the project occurred, and where unanticipated challenges emerged. In part, this work attempted to automate the processes of systematically determining search terms and identifying candidate record groups for those search terms. The following are the primary logical steps in creating test searches and benchmarks:

1. Normalize the decomposed record data in test dataset in the MySQL database
2. Run frequency count of all words appearing in test dataset records in MySQL database and select relatively low-frequently occurring words to use as search terms
3. Submit SQL queries to decomposed records using search terms identified in #3 to determine aggregate and candidate record groups for the specific types of searches to be used in interoperability testing
4. Submit search terms selected in #3 from Z-Interop client reference implementation to Z-Interop server reference implementation and compare results from #4 and #5 to determine benchmark records for each search type and search term.

The following sections provide additional details on the logic and processes for each step,

4.4.1 Data Normalization

Initially, the Z-Interop staff ran a frequency count of all “words” appearing in the decomposed records. The rationale for this will be discussed in the next section. It was apparent in the results of the initial frequency counts that a variety of punctuation in the MARC bibliographic records was skewing the counts. Since the unit of analysis in preparing the test dataset was a “word,” data normalization provided reliability for the subsequent analysis. As an example, the following “words” were counted as separate strings of characters:

computer
computer.
computer?
computer—
computer/
--computer

Therefore, it was necessary to normalize the data in the decomposed records to remove various non-alphabetical characters. The process for normalization of the records was described in the document:

> **Data Normalization Procedures on Decomposed MARC 21 Records** (revised draft dated January 1, 2002)

The data normalization processes used pattern-matching techniques to eliminate and/or generalize anomalous characters and terms. First, general patterns were identified by inspecting frequency counts of words in the decomposed records. The Z-Interop staff developed a number of logical normalization rules based on the identified patterns. Normalization included several operations:

- Eliminate leading and training punctuations
- Eliminate non-word strings
- Disregard capitalization
- Treat fragmented words.

The Z-Interop document for data normalization contains complete details and explanation of the procedures.

4.4.2 Frequency Count to Select Potential Search Terms

The frequency count of the words in the decomposed records identified a set of words that occurred in a limited set of the more than 400,000 MARC records. The threshold for selecting these words was set at 300; that is, a list of words that occurred 300 or less times in records was created. The reason for this decision was to identify words that could serve as search terms where the resulting records when using one of these terms would be a manageable number of records for analysis during interoperability testing. It was assumed that during interoperability testing, manual inspection of retrieved records would be required, and having a set of no more than 300 records for any given search term was desirable.

The result of the frequency count processes was a list of words that would subsequently serve as search terms for interoperability testing.

4.4.3 Identifying Aggregate and Candidate Record Groups through SQL Queries

Since the focus of the Z-Interop Project was on semantic interoperability, it was critical that the Z-Interop staff not only know which MARC record a particular word (i.e., search term) appeared in but also know if the term appeared in author, title, or subject-related fields/subfields in the MARC record. Therefore, the Z-Interop staff developed the concept of aggregate and candidate record groups, defined as follows:

- **Aggregate Record Group:** All records in the test dataset in which a search term appeared anywhere in the record
- **Candidate Record Group:** All records in the test dataset in which a search term appeared in selected MARC fields/subfields that can contain author, title, or subject data.

These record groups were created by issuing sometimes very complex SQL queries to the decomposed records in the MySQL database. The procedures creating these groups and the details of the SQL queries were documented in:

> **SQL Data Analysis Procedures to Create Aggregate and Candidate Record Groups on a Sample of Decomposed MARC Records, Phase 1 Testing** (revised draft dated January 1, 2002)

Sample reports from the SQL queries were also included in the document.

To prepare for interoperability testing, the Z-Interop staff was aware that a server might return records that contained the search term, but did not contain the term in a semantically appropriate MARC field/subfield. The Aggregate Record Group enabled the staff to know all records, and which MARC fields/subfields the search term appeared in. The following is a sample of the output of an SQL query to create an Aggregate Record Group for the term “Charles”. The output lists the OCLC number, the field and subfields in which the term occurs, and the term.

OCLC Number	Field	Subfield Code	Term
225	245	a	Charles
740	504	a	Charles
740	600	q	Charles
872	440	a	Charles
1154	700	c	Charles

The term Charles appears in four different records in the test dataset (and twice in one record); it appears as a word in a title field (245), a subject field (600), and an author field (700, added entry for personal name).

Since the Z-Interop testing would include author, title, and subject searches, it was necessary to identify when a search term appeared in author-, title-, or subject-related fields. The Candidate Record Groups concept was a response to this need. Again, SQL queries were created to look for a search term in specific MARC fields/subfields. The basis for determining which fields/subfields to examine was the indexing guidelines document:

> **Indexing Guidelines for MARC 21 Records to Support Z39.50 Profile Searches**(revised draft dated February 1, 2002)

This document, developed for establishing the indexing policies for the Z-Interop server-side reference implementation, identified all potential fields/subfields that might hold author, title, or subject data. To give a sense of the complexity of the MARC bibliographic record, the following summarizes the number of fields/subfields that are defined to hold author, title, or subject data:

Type of Data	Number of MARC Fields/ Subfields
Author Only	119
Author and Title	21
Subject Only	144
Title Only	253
Total	**537**

For example, to create the Candidate Record Group for an author search, the SQL query commanded the database to look in 119 specific MARC fields/subfields. This resulted in very complex SQL queries as can be seen in the SQL data analysis procedures document. The following is a sample of the output of an SQL query to create a Candidate Record Group for the term “College” where the term appears as a title word. The output lists the OCLC number, the field and subfields in which the term occurs, and the term.

OCLC Number	Field	Subfield Code	Term
421	245	b	College
442	245	a	College
442	490	a	College
834	505	a	College

In this report, one can see that the term appears in three different records, but in all records, it appears only in title-related fields.

Candidate Record Groups were developed initially for four types of searches as defined in the Bath and the U.S. National Z39.50 profiles. Both profiles define basic author, title, subject, and general keyword searches. These were the focus of the Z-Interop Project’s interoperability testing and are defined in the U.S. National Z39.50 Profile as follows:

- **Author Search – Keyword:** Selects bibliographic records that have an author name access point in which any complete word matches the search term (single word).
- **Title Search – Keyword:** Selects bibliographic records that have a title access point in which any complete word matches the search term (single word).
- **Subject Search — Keyword:** Selects bibliographic records that have a subject access point in which any complete word matches the search term (single word).
- **Any Search — Keyword:** Selects bibliographic records that have a general keyword access point logically available (as defined by the server) in which any complete word matches the search term (single word).

For each of the four types of searches, five search terms were selected:

- **Author Keyword Search Terms**
  - aleksandrovich
  - elena
  - garrison
  - jessica
  - picasso
- **Title Keyword Searches**
  - astronomical
  - nepal
  - root
  - terror
  - treasures
- **Subject Keyword Searches**
  - dragons
  - mobile
  - semiconductors
  - supernatural
  - varieties
- **Any Keyword Searches**
  - mobile
  - nepal
  - picasso
  - root
  - varieties

SQL queries using these search terms examined the decomposed records to identify the total number and specific record number in which each search term appeared in appropriate MARC fields/subfields depending on the type of search. For example, the results for the five search terms for the author keyword search were:

Aleksandrovich: 237 records
Elena: 141 records
Garrison: 116 records
Jessica: 103 records
Picasso: 36 records

The reports from the SQL queries identified the specific records in which the terms appeared along with the specific MARC fields/subfields that contained the term.

Although the basic keyword searches were the primary focus of the initial interoperability testing, Z-Interop staff at a later phase in the project developed aggregate and candidate record groups for additional test searches. These searches were based on the specifications in the Bath and U.S. National Z39.50 profiles for Boolean searches; and author, title, subject, and any keyword searches with right truncation. These searches allowed testing of the server and information retrieval system's Boolean and right truncation functionality. The following table presents the test searches for Boolean keyword searches using AND, OR, NOT operators.

Type of Search	Boolean Operator	Search Term #1	Search Term #2
Author Search – Keyword	OR	Aleksandrovich	alexandra
Author Search – Keyword	OR	Laurel	josiah
Author Search – Keyword	AND	Jessica	stirling
Author Search – Keyword	AND	Elena	gelfand
Author Search – Keyword	NOT	Garrison	hyslop
Author Search – Keyword	NOT	Picasso	rubin
Title Search – Keyword	OR	Nepal	festivals
Title Search – Keyword	OR	hotels	clubs
Title Search – Keyword	AND	astronomical	almanac
Title Search – Keyword	AND	terror	war
Title Search – Keyword	NOT	treasures	museum
Title Search – Keyword	NOT	root	america
Subject Search – Keyword	OR	mobile	robots
Subject Search – Keyword	OR	academia	algorithms
Subject Search – Keyword	AND	semiconductors	congresses
Subject Search – Keyword	AND	varieties	plants
Subject Search – Keyword	NOT	dragons	monsters
Subject Search – Keyword	NOT	supernatural	literature
Any Search – Keyword	OR	inspector	interviewing
Any Search – Keyword	AND	nepal	everest

Type of Search	Boolean Operator	Search Term #1	Search Term #2
Any Search – Keyword	AND	picasso	work
Any Search – Keyword	NOT	mobile	homes
Any Search – Keyword	NOT	varieties	james

For the right truncation searches, the Z-Interop staff used the same search terms that had been used in the basic author, title, subject, and any keyword searches. Reusing these terms allowed the staff to readily determine the validity of the results for regular keyword and keyword with right truncation searches. Twenty keyword with right truncation Candidate Record Groups were developed for interoperability

As a result of the processes for creating aggregate and candidate record groups, a total of 20 author, title, subject, and any keyword Candidate Record Groups were defined; a total of 23 Boolean Candidate Record Groups were defined; and a total of 20 author, title, subject, and keyword with right truncation Candidate Record Groups were defined. The next step in preparing for interoperability testing was to establish Benchmarks for each of the search terms.

4.4.4 Establishing Benchmarks for Interoperability Testing

To assure the reliability of the Z-Interop procedures for determining which records should be returned from the test dataset for specific types of searches and specific search terms, one final phase of developing the testbed was undertaken. The Candidate Record Groups were defined based on SQL queries against the decomposed MARC records in the MySQL database. Establishing benchmarks used the original test dataset loaded on the Z-Interop server-side reference implementation along with the Z-Interop client reference implementation. This allowed the staff to check the accuracy of the Candidate Record Group by seeing if the appropriate records would be retrieved using an actual library online catalog and Z39.50 server (the reference implementation).

Each of the search terms for the keyword, keyword Boolean, and keyword with right truncation searches was sent from the Z-Interop client reference implementation to the Z-Interop server reference implementation. The retrieved records from the reference implementation for each type of search and search term were compared to the respective Candidate Record Group. Differences in results were analyzed and the Z-Interop staff determined the final set of records for each search that would be used as the Benchmark Record Set for actual interoperability testing. This phase allowed the development of manual and automatic comparison procedures that would be used during interoperability testing. In addition, it was during this process that new issues related to interoperability emerged.

The Principal Investigator assumed that the Candidate Record Group had identified all potential records in the test dataset that should be returned for a specific type of search with a specific search term. The results of one of these searches on the Z-Interop reference, acting on the same set of MARC records, would fall into one of two cases:

- Return a set of records that matched exactly the records in the Candidate Record Group for a specific search and search term
- Return a set of records only some which matched the records in the Candidate Record Group.

In the second case, a result set might include some records that matched those in the Candidate Record Group as well as records that did not.

An automatic process was set up where the result set of records from the reference implementation was compared with the appropriate Candidate Record Group, and a report would be generated that provided the following three pieces of data:

1. Total number of retrieved records matching those in the Candidate Record Group
2. Total number of records in the Candidate Record Group that were not retrieved
3. Total number of records retrieved that were not contained in the Candidate Record Group.

For #2 and #3, the OCLC record numbers were provided in the automatic report. These differences would then be manually inspected by Z-Interop staff to try to understand what might have caused Candidate Record Group records not to be returned or caused other records to be returned that were not in the Candidate Record Group. In the latter case, the Aggregate Record Group would be used to help diagnose the reasons for a record being retrieved.

Using the basic keyword test searches with the search terms identified in defining the aggregate and candidate record groups, the following provides an example of what the Z-Interop staff produced to determine the Benchmark Record Sets for these searches. Appendix C has a longer extract from a Z-Interop document, **Establishing Benchmarks for Test Searches,** that details the establishment of benchmarks. (Note: This document is not a public document since it contains details about retrieval results for interoperability testing that participants in the testbed were not to see prior to actual testing.)

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1. Keyword Author Search for Search Term "garrison"
The number of records in the Candidate Record Group where Author equals **garrison** is 116. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **garrison** was 116. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There were 0 records retrieved by the Z-Interop client that are not in the Candidate Record Group.

Exact matched records = 116
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 0

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **garrison** is 116.

2. Keyword Author Search for Search Term "elena"
The number of records in the Candidate Record Group where Author equals **elena** is 141. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **elena** was 142. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There was 1 record retrieved by the Z-Interop client that is not in the Candidate Record Group.

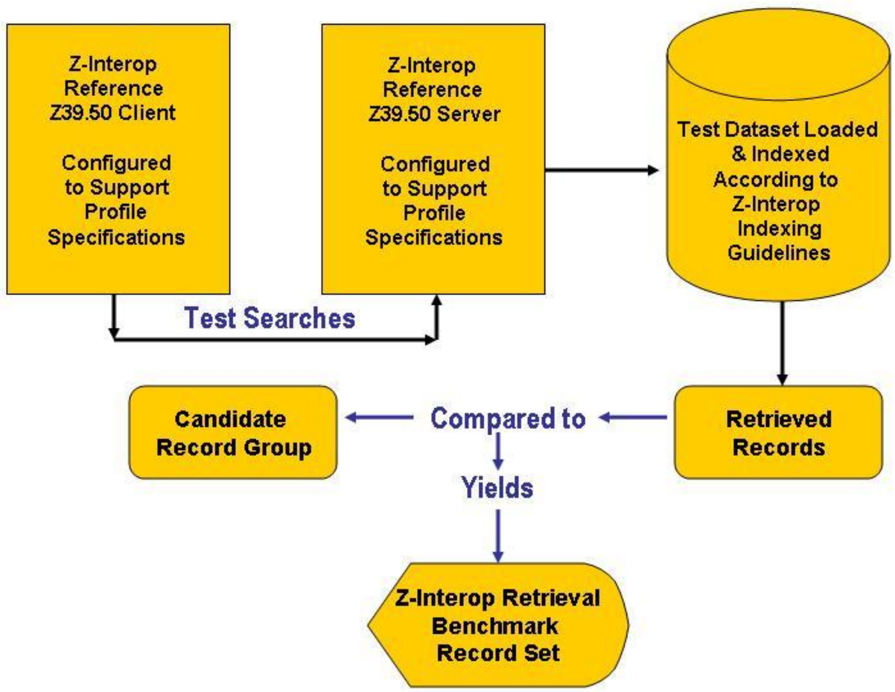
Exact matched records = 141
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 1

OCLC Record	Field/Subfield in which Term Appears	Notes/Comments
ocm01349561	100 1 $a La Souchère, Éléna de.	Search term appears in legitimate field/subfield for search type. Character set issues may account for the appearance of this record in result set. **Should be included in benchmark.**

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **elena** is 142.

For #1 above, the Z-Interop reference implementation retrieved exactly the same records as in the Candidate Record Group. Therefore, the Benchmark Record Set for the search was equivalent to the Candidate Record Group. These results indicated that the entire set of processes used in setting up the testbed and the test searches was sound and provide the Z-Interop staff with a good level of confidence in the processes and procedures.

In the case of #2 above, the Z-Interop staff encountered the first of several issues that emerged through the process of establishing the benchmarks. Different information retrieval systems will handle special characters in different ways. In the MySQL database, the character strings Elena and Éléna (with the diacritics) were handled as distinct words. The Z-Interop reference implementation applied its own normalization on the data and treated Elena and Éléna as equivalent terms for searching. These and other issues prepared the Z-Interop staff well for interoperability testing once the testbed was ready. The following illustration presents the logic of the processes to establish the Benchmark Record Sets.



Overall, the differences between the Candidate Record Set and the records retrieved from the Z-Interop reference implementation were usually only a few records. The largest difference occurred with the Title Keyword Search with the search term “root.” For that search, the Z-Interop reference implementation retrieved all records in the Candidate Record Group and 9 additional records. After an examination of those 9 records, the Z-Interop staff recognized a pattern. The records that were returned had terms such as “root-infecting,” “root-rot,” “root-knot,” “river-root,” and “grass-root” – all hyphenated words with “root” (the search term) as part of the word. The reference implementation did not use the same definition of “word” as used by the Z-Interop Project (i.e., “any string of characters, including all punctuation and other special characters, bounded by spaces”).

Determining the records that would comprise the Benchmark Record Set was decided by a thoughtful examination of each case. For the search term “Elena,” the Z-Interop staff decided that the record retrieved from the reference implementation should be included in the benchmark. For the search term “root,” however, the records containing a hyphenated word with a component part of “root” should not be included in the benchmark. The reasoning was that for semantic interoperability, a user searching for the term “root” did not have the same semantic intention as represented by words such as “grass-root” or “root-knot.” These are key issues for interoperability and will be taken up in Section 8.1 The Continuing Threats to Interoperability.

4.5 Policies and Procedures for the Interoperability Testbed

A major consideration in establishing the Z-Interop testbed was that it would be a trusted and reliable environment for participants to have their products assessed and tested. There were several activities carried out by Z-Interop staff to build trust and ensure the reliability of the testbed. As evident in previous sections of this report, Z-Interop staff created a number of documents that described in detail the many steps involved to set up the test dataset, to configure indexing policies for the reference implementation, and to establish valid test scenarios and benchmarks. Most of the documents were publicly available for review by potential testbed participants. A limited number of the documents were for internal use by Z-Interop staff (e.g., the document describing the Benchmark Record Sets for interoperability testing).

A key document developed for the project was:

> **Z-Interop Interoperability Testing Policies and Procedures, Phase 1 Testing** (revised draft dated February 1, 2002)

This document provided an overview of the Z39.50 Interoperability Testbed. Specifically, the document spelled out the responsibilities and obligations of the Z-Interop Testbed and the organizations that wanted to participate in interoperability testing. Because of this document's centrality to the Z-Interop Project, it is included in Appendix D.

4.6 Concluding Thoughts on the Initial Research and Development

This section has described the activities engaged in by Z-Interop staff to prepare the interoperability testbed. One can consider these activities as primarily research and development to prepare a reliable and trustworthy testing environment. At the outset of the Z-Interop Project, it was not possible to anticipate all the challenges related to setting up the various components of the testbed. Addressing these challenges are reflected in the time it took the Z-Interop staff to complete the necessary activities, test the procedures, and feel confident that the interoperability testbed would operate as anticipated.

One specific aspect of the research and development deserves note at this point. It was clear that the Z-Interop Project had to exploit automatic analysis if the resulting testbed could be operated in an efficient manner. Throughout the duration of the project, one or more Z-Interop staff members worked on automatic processes for data analysis and other tasks. This was a significant programming effort that resulted in a large number of automated scripts and programs. Appendix E summarizes the procedures that Z-Interop staff created. As in many research and development projects, the logic of the project may be relatively well designed, but it is not possible to identify all tasks and activities that would be required to carry out the objectives and goals of the project. The automatic procedures created for the Z-Interop Project were critical, yet the extent of the development work was not anticipated. The result, however, was a solid technical infrastructure to support an operational testbed.

5. Operation of the Testbed and Interoperability Testing

By Spring 2002, approximately 15 months into the Z-Interop Project, the Z39.50 interoperability testbed was ready for use. Early in 2002, the Principal Investigator worked with the Z-Interop staff to make sure all relevant documents for the project were in final draft form. These were loaded on the Z-Interop website for public access.

In March 2002, the project issued an announcement that the testbed was ready for use. The document containing the announcement was (see Appendix F):

> **Call for Participation** (March 2002)

As noted in the call, the initial interoperability testing focused on validating Z–Interop methodologies, policies, and procedures. Although the Z-Interop staff had confidence in the research and development on the testbed, we were aware that actual interoperability testing of vendor products would encounter new issues. This phase of testing used test searches for the following types of searches defined in the Bath and U.S. National Z39.50 profiles:

- Author Search – Keyword (Bath/US Profile)
- Title Search – Keyword (Bath/US Profile)
- Subject Search – Keyword (Bath/US Profile)
- Any Search – Keyword (Bath/US Profile)

To ensure all parties participating in the interoperability testbed were treated equally and to ensure proper documentation for the Z-Interop Project, Z-Interop participants were required to fulfill a number of responsibilities:

- **Indicate interest in being a participant:** Send an email to the principal investigator, Dr. William E. Moen <wemoen@unt.edu> stating interest in participating in the testbed.
- **Read the Z-Interop Policies and Procedures document:** Upon receipt of email indicating participant's interest, Z-Interop staff pointed the participant to this document and other relevant documents for review. Participants were to read the policies and procedures document to understand the roles and responsibilities of the testbed and participants.
- **Supply preliminary information requested by Z-Interop:** Upon receipt of email indicating participant's interest, Z-Interop staff supplied the potential participant to an online data collection form. Participants had to complete all parts of the data collection forms and supply the requested information. Participants were asked to indicate on the data collection forms that they had read and agreed to the testbed policies and procedures.

Participants could choose to have interoperability testing done for either their Z39.50 servers or Z39.50 clients. The following sections summarize the activities involved in testing servers and clients.
Further details about the testing activities can be found in Appendix D, **Z-Interop Interoperability Testing Policies and Procedures**.

5.1 Interoperability Testing of Participant Z39.50 Server and Online Catalog System

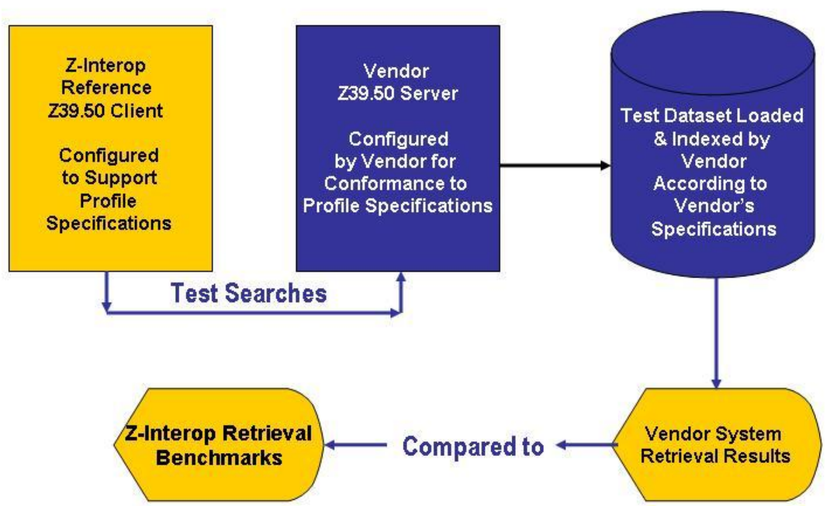
Z-Interop participants who wanted to test a Z39.50 server implementation had to carry out the following tasks:

- **Sign agreement for appropriate use of OCLC WorldCat MARC 21 test records:** The Z-Interop Project had obligations to OCLC to ensure the appropriate use of the test dataset of MARC 21 records contributed by OCLC. Z-Interop participants had to sign an appropriate use agreement that described how they could use these MARC 21 records. A signed copy had to be received by Z-Interop Project prior to making the test dataset of records available.
- **Load the MARC 21 test dataset:** Z-Interop participants were to load the test dataset on their systems.
- **Configure Z39.50 server to support the following Bath Profile and US National Profile searches:**
  Title Search – Keyword
  Subject Search – Keyword
  Author Search – Keyword
  Any Search – Keyword
- **Prepare the database to support test searches:** Z-Interop participants could choose how to index the MARC 21 records to support the test searches. Z-Interop staff informed participants

about the availability of the indexing guidelines, **Indexing Guidelines to Support Z39.50 Searches**, but participants were not obligated to use these guidelines.

- **Contact Z-Interop when ready to receive searches:** After configuration and indexing were completed, the Z-Interop participants contacted Z-Interop staff to indicate readiness to accept test searches and provide the following information:
  - Hostname for Z39.50 Server
  - IP Address for Z39.50 Server
  - Port Number for Z39.50 Server
  - Database Name Note

When the participant was ready, Z-Interop staff would send the test searches from the Z-Interop client reference implementation to the participant's system, analyze the search results by comparing them to the Benchmark Record Sets, and develop a report that detailed the findings of the interoperability testing (analysis and reporting by Z-Interop staff are described Section 5.3. The figure below illustrates the logic of the interoperability testing of a participant's Z39.50 server and online catalog information retrieval system.



5.2 Interoperability Testing of Participant Z39.50 Client

Z-Interop participants wanting to test a Z39.50 client implementation against the Z-Interop server reference implementation had to carry out the following tasks:

- **Configure Z39.50 client to send the following Bath Profile and US National Profile searches:**
  - Title Search – Keyword
  - Subject Search – Keyword
  - Author Search – Keyword
  - Any Search – Keyword
- **Contact Z-Interop when ready to send searches:** When the participant's Z39.50 client was configured, the participant contacted the Z-Interop to indicate readiness for interoperability testing. In response, Z-Interop staff provided the participant with the test searches.
- **Send the test searches:** Z-Interop participants sent the test searches in the order prescribed by Z-Interop staff instructions.

- **Indicate to Z-Interop the results of the test searches:** Participants needed to indicate to Z-Interop staff the results received from the reference implementation, the number of records retrieved, and the adequacy of the Z-Interop participant's Z39.50 client application to display MARC 21 records.

Z-Interop staff did not use the participant's Z39.50 client for testing. Sending the test searches was completed by the participant. Analysis and reporting of the Z39.50 client interoperability testing results is described in the Section 5.3.

5.3 Analysis and Reporting of Interoperability Testing Results

Detailed reports of the results of interoperability testing were provided by the Z-Interop staff to each participant. Upon completion of an interoperability testing session, Z-Interop staff analyzed the results and provided a detailed written report to the Z-Interop participant. The results were stored in a secure area of the Z-Interop website accessible only to Z-Interop staff and individual participants. Only the Z-Interop participant received the reports, and individual participant's results were not publicly available.

Participants were informed that the Z-Interop staff might use the test results in publications and reports, but only aggregate results would be used (i.e., no individual participant's name would be associated with specific test results). The participants could use their individual test results in any manner. If Z-Interop participants made their test results public (e.g., in marketing a product), any inquiries to the Z-Interop Project about a participant's claim of interoperability test results would be responded to only after Z-Interop had consulted with the individual participant.

The goal of Z-Interop Project was to improve interoperability. The testbed policies and procedures document stated that the interoperability test results do not imply any legal conformance or certification of individual products or implementations. Z-Interop participants were cautioned against claiming conformance to the Bath or US National Z39.50 profiles based on Z-Interop test results or otherwise claim their products had been certified by the Z-Interop testbed.

The following two sections describe the type and contents of the documents created by the Z-Interop staff to report results of interoperability testing.

5.3.1 Analysis and Reports for Interoperability Testing of Z39.50 Server Implementations

Once the test searches had been sent to the participant's system and the records for each search had been retrieved, Z-Interop staff compared the retrieved records with the Benchmark Record Sets for each search. Similar to the procedures described in Section 4.4.4 Establishing Benchmarks for Interoperability Testing, Z-Interop staff analyzed the differences between the retrieved results and the benchmarks. This was a primarily manual process. The automatic processes described in Appendix E reduced the amount of manual inspection to only those records that were not in the benchmark. Depending on the number of records involved, this could be a very time consuming process. Z-Interop staff tried to determine patterns when there were differences, and the reports described our understanding of why the differences occurred.

The following is an excerpt from one of the reports for a participant. It indicates how Z-Interop staff reported the results and provided the participant with information to explain the differences in retrieved results compared to the benchmark. This was part of the Z-Interop Project's objective of improving semantic interoperability. The first part of the extract below shows the results of the author keyword test searches for two of the search terms.

1. Keyword Author Search for Search Term "elena"
The number of records in the Benchmark where Author equals **elena** is 142. The number of records retrieved by the Z-Interop client from the participant's product where Author equals **elena** was 119. There are 26 records in the Benchmark that were not retrieved from the Z39.50 server. There were 3 records retrieved from the Z39.50 server that are not in the Benchmark.

Exact matched records = 116
Records in Benchmark not retrieved from the Z39.50 server = 26
Records retrieved from the Z39.50 server not in Benchmark = 3

Records in Benchmark not retrieved from the Z39.50 server

Field/Subfield	# of records	OCLC Record
245 $c	19	ocm00214463 ocm00825547 ocm01046258 ocm01153912 ocm01583912 ocm01832223 ocm02695148 ocm12714646 ocm13539672 ocm15018057 ocm16093914 ocm19400501 ocm20222276 ocm21038542 ocm22590314 ocm26127966 ocm36280185 ocm40403064 ocm40784628
505 $r	5	ocm21038542 ocm21375427 ocm35229448 ocm36590111 ocm38055826
508 $a	1	ocm17816180
511 $a	2	ocm30517513 ocm39655726

Records Retrieved from the Z39.50 Server not in Benchmark

Field/Subfield	# of records	OCLC Record
245 $a	1	ocm02912186
600 $a	3	ocm02912186 ocm19809747 ocm22910958

2. Keyword Author Search for Search Term "jessica"
The number of records in the Benchmark where Author equals **jessica** is 103. The number of records retrieved by the Z-Interop client from the participant's product where Author equals **jessica** was 91. There are 16 records in the Benchmark that were not retrieved from the Z39.50 server. There were 4 records retrieved from the Z39.50 server that are not in the Benchmark.

Exact matched records = 87
Records in Benchmark not retrieved from the Z39.50 server = 16
Records retrieved from the Z39.50 server not in Benchmark = 4

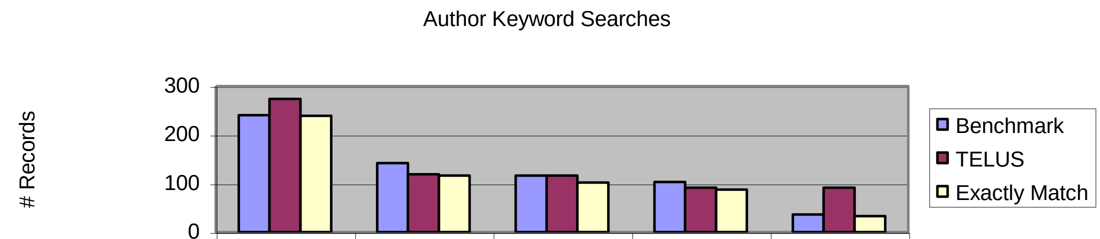
Records in Benchmark not retrieved from the Z39.50 server

Field/Subfield	# of records	OCLC Record
245 $c	7	ocm01249682 ocm06890065 ocm19627269 ocm22004021 ocm37603558 ocm38894670 ocm41580407
505 $r	4	ocm36301408 ocm36368070 ocm40933098 ocm42911731
508 $a	1	ocm38087721
511 $a	4	ocm26066062 ocm28311174 ocm29179566 ocm31258636

Records Retrieved from the Z39.50 Server not in Benchmark

Field/Subfield	# of records	OCLC Record
245 $b	3	ocm17874078 ocm29517581 ocm34233327
600 $a	4	ocm17874078 ocm20167842 ocm29517581 ocm34233327

For each type of search (e.g., author, title, subject, any keyword searches), the report would include a summary chart to indicate overall interoperability between the Z-Interop client reference implementation and the participant's Z39.50 server system. The chart below is an example that summarizes the results for the author keyword test searches used in the interoperability testing. As the above detailed section of the report and the chart show, it was not simply a matter of total number of records retrieved but the extent to which the retrieved records exactly matched those in the benchmark.



	aleksandrovic	elena	garrison	jessica	picasso
Benchmark	240	142	116	103	36
TELUS	274	119	116	91	91
Exactly Match	239	116	102	87	33

Search Terms

For each participant where there were differences between the retrieved records and the benchmark, Z-Interop staff diligently worked to identify patterns and to provide possible explanations for why the differences occurred. In the case of the participant whose data above are used to illustrate the contents of the Z-Interop's interoperability testing reports, staff included in the report the following statement that summarized our understanding of why differences occurred with the author keyword searches:

> The results from these searches suggest that the participant's implementation uses indexing policies that include or exclude MARC fields/subfields that are different from the indexing policies used for the Z-Interop Testbed reference implementation. Specifically, the participant appears to index the 245$a and 600$a for author searches. The 245$a is a title field and the 600$a is a subject-related field (for personal names as subjects). From a user perspective, a search for author should return records where the search term appears in an author-related field. Returning records where the search term (i.e., an author name) is in a title or subject field may not lead to optimal results for the user.

The interoperability testing reports included a list of all OCLC numbers for all records retrieved for each of the test searches from the participant's system. These were included in case the participant wanted to verify records retrieved and for further diagnostic and tweaking of the system.

Typical reports were approximately 35-70 pages in length, with the variance in length due to the extent of differences in retrieved records compared with benchmarks that needed to be documented and explained. Another reason for differences in length was due to adding more test searched for Boolean and right truncation functionality for testing done later in the Z-Interop Project.

5.3.2 Analysis Reports for Interoperability Testing of Z39.50 Client Implementations

Interoperability testing of a participant's Z39.50 client involved a completely different set of analysis and reporting activities. For client testing, the Z-Interop staff provided the participant with a list of searches to send to the Z-Interop server-side reference implementation. The primary focus of interoperability testing was to assess the extent to which the participant's client sent the correctly structured Z39.50 queries to the Z-Interop server.

Again, the Bath and U.S. National Z39.50 profiles provided the specifications for the assessment. In a Z39.50 query, a combination of query attributes is sent along with the search term. The query attributes are defined in terms of attribute sets, and the primary attribute set for searching library catalogs is the Bib-1 Attribute Set. Bib-1 defines six attribute types:

Use
Relation
Position
Structure
Truncation
Completeness

The Bib-1 Attribute Set defines values for each attribute type. For example, a Use attribute value could be "title," a Relation attribute value could be "equal to," and a Truncation attribute value could be "do not truncate." Attribute types and values are assigned integer values, and a Z39.50 query passes attribute type/value pairs to represent a search.

Significant progress towards better interoperability was made through the profiles which defined a set of searches and prescribed the attribute type/value combination that a Z39.50 client would send to a Z39.50 server to represent a particular search type. For example, the Bath and U.S. National Z39.50 profiles specify the following attribute combination for an author keyword search.

Author Search – Keyword: Selects bibliographic records that have an author name access point in which any complete word matches the search term (single word).

Attribute Type	Attribute Values	Attribute Names
Use (1)	1003	Author
Relation (2)	3	Equal
Position (3)	3	any position in field
Structure (4)	2	Word
Truncation (5)	100	do not truncate
Completeness (6)	1	incomplete subfield

The Z-Interop reference server implementation recorded the attribute combination sent by a Z39.50 client. This was recorded in log files on the server, and the Z-Interop staff analyzed the files to determine if the participant's Z39.50 client was sending the correct attribute combination for the searches as defined by the Bath and U.S. National Z39.50 profiles. A sample from one of the log files follows.

```
20021022102503|216.243.233.107|aleksandrovich|1003|3|3|2|100|1|
20021022102528|216.243.233.107|elena|1003|3|3|2|100|1|
20021022102605|216.243.233.107|garrison|1003|3|3|2|100|1|
20021022102633|216.243.233.107|jessica|1003|3|3|2|100|1|
20021022102722|216.243.233.107|picasso|1003|3|3|2|100|1|
```

The log file contains the following information, separated by the **|** delimiter:

Date Time Stamp of Query	Example: 20021022102503
IP Address of Z39.50 Client	Example: 216.243.233.107
Search Term	Example: aleksandrovich
Use Attribute Value	Example: 1003
Relation Attribute Value	Example: 3
Position Attribute Value	Example: 3
Structure Attribute Value	Example: 2

Truncation Attribute Value Example: 100
Completeness Attribute Value Example: 1

In the example from the log file, the Z39.50 client was sending the Z-Interop test searches for Author Keyword searches. Z-Interop staff compared the profile-prescribed attribute combination with what was actually sent. It is clear from the log file that the participant's Z39.50 client sent the correct attribute type/value combination for Author Keyword searches.

Once the analysis was completed, Z-Interop staff prepared a report of the test results. Similar to reports for Z39.50 server testing, the Z39.50 client report summarized the results for each search and identified any discrepancies between profile-defined attribute combinations and what was received by the Z-Interop server reference implementation. The following is an extract of a report for Z39.50 client interoperability testing.

Author Keyword Searches

A total of five Author keyword searches were issued from participant's Z-client to the Z-Interop server. ZATR (refer to Appendix A, #7-11) and ZHIS (refer to Appendix B, #41-76) files recorded query information, and it is summarized in the following table. The number of records in the database that should be retrieved by the participant's Z-client from the Z-Interop server is provided in the last column.

Search Term	ZATR	ZHIS	# of records from Z-Interop server
aleksandrovich	aleksandrovich|1003|3|3|2|100|1|	|("aleksandrovich"){BATH1003}|	240
Elena	elena|1003|3|3|2|100|1|	|("elena"){BATH1003}|	142
garrison	garrison|1003|3|3|2|100|1|	|("garrison"){BATH1003}|	116
Jessica	jessica|1003|3|3|2|100|1|	|("jessica"){BATH1003}|	103
Picasso	picasso|1003|3|3|2|100|1|	|("picasso"){BATH1003}|	36

The Author keyword searches sent from participant's Z-client to the reference implementation Z-Interop server contain the proper attribute combinations. Therefore, the number of results received by the participant's Z-client should be equal to those listed in the table.

In addition, the Z-Interop report included as appendixes the complete log files pertinent to the Z39.50 client transactions on the Z-Interop server. The following are extracts from the log files as referenced in the summary listed above.

ZATR file

```
7  20021022102503|216.243.233.107|aleksandrovich|1003|3|3|2|100|1|
8  20021022102528|216.243.233.107|elena|1003|3|3|2|100|1|
9  20021022102605|216.243.233.107|garrison|1003|3|3|2|100|1|
10 20021022102633|216.243.233.107|jessica|1003|3|3|2|100|1|
11 20021022102722|216.243.233.107|picasso|1003|3|3|2|100|1|
```

ZHIS file

```
41 20021022102503|216.243.233.107|1527|start|search|2812|142|
42 20021022102504|216.243.233.107|1527|end|search|0||("aleksandrovich"){BATH1003}|
43 20021022102505|216.243.233.107|1527|start|present|2954|47|
44 20021022102506|216.243.233.107|1527|end|present|0|||
45 20021022102507|216.243.233.107|1527|start|present|3001|48|
```

```
20021022102507|216.243.233.107|1527|end|present|0|||
20021022102528|216.243.233.107|1527|start|search|3049|133|
20021022102532|216.243.233.107|1527|end|search|0||("elena"){BATH1003}|
20021022102533|216.243.233.107|1527|start|present|3182|47|
20021022102533|216.243.233.107|1527|end|present|0|||
20021022102541|216.243.233.107|1527|start|present|3229|48|
20021022102541|216.243.233.107|1527|end|present|0|||
20021022102605|216.243.233.107|1527|start|search|3277|136|
20021022102608|216.243.233.107|1527|end|search|0||("garrison"){BATH1003}|
20021022102609|216.243.233.107|1527|start|present|3413|47|
20021022102609|216.243.233.107|1527|end|present|0|||
20021022102610|216.243.233.107|1527|start|present|3460|48|
20021022102610|216.243.233.107|1527|end|present|0|||
20021022102610|216.243.233.107|1527|start|present|3508|48|
20021022102611|216.243.233.107|1527|end|present|0|||
20021022102633|216.243.233.107|1527|start|search|3556|136|
20021022102635|216.243.233.107|1527|end|search|0||("jessica"){BATH1003}|
20021022102636|216.243.233.107|1527|start|present|3692|48|
20021022102637|216.243.233.107|1527|end|present|0|||
20021022102638|216.243.233.107|1527|start|present|3740|49|
20021022102638|216.243.233.107|1527|end|present|0|||
20021022102638|216.243.233.107|1527|start|present|3789|49|
20021022102639|216.243.233.107|1527|end|present|0|||
20021022102722|216.243.233.107|1527|start|search|3838|137|
20021022102722|216.243.233.107|1527|end|search|0||("picasso"){BATH1003}|
20021022102723|216.243.233.107|1527|start|present|3975|49|
20021022102723|216.243.233.107|1527|end|present|0|||
20021022102724|216.243.233.107|1527|start|present|4024|50|
20021022102724|216.243.233.107|1527|end|present|0|||
20021022102724|216.243.233.107|1527|start|present|4074|50|
20021022102724|216.243.233.107|1527|end|present|0|||
```

The objective was to provide sufficient data in the interoperability testing report to assist the participant in understanding the results and to verify the details contained. The length of reports for Z39.50 client interoperability testing was approximately 25-50 pages, with the length varying by the amount of discrepancies discovered and the number of test searches being issued by the participant.

5.4 Concluding Thoughts on the Interoperability Testing and Reporting

Section 5 has described how the Z-Interop testbed operated and the mechanisms put in place to produce a reliable and trustworthy testing environment. The effort by the Z-Interop staff in research, development, testing, and documenting the testbed prior to publicly announcing the interoperability testbed's availability paid off. New technical and procedural issues, however, did arise once the testbed began to be used by participants. Throughout the initial testing phase, Z-Interop staff worked on the best ways to produce reports that would be helpful to the participants. Feedback from the participants was solicited, and responses were incorporated into revised documentation and improved procedures for the testbed.

Few models for operating an interoperability testbed were available at the outset of the Z-Interop Project, and in many respects the research, development, and operation of the testbed explored unknown territory. The attitude of the Principal Investigator through this entire process and project was that we needed to operate in the spirit of continuous improvement, learning as we went through the steps to establish and operate an interoperability testbed. Following sections provide discussions about the products, results, outcomes and impact, and lessons learned from the Z-Interop Project.

6. The Z-Interop Project: Products, Participation, Dissemination, and Outcomes

The preceding sections in this report have described the background to the project, the research and development of the Z39.50 interoperability testbed, and how the testbed operated. It is now time to take stock of the project and its contributions to improving interoperability.

6.1 Interoperability Testbed Products

The primary effort in the Z-Interop Project was to conduct the necessary research and development to establish a Z39.50 interoperability testbed. As described in preceding sections, the research and development activities were varied and complex. The result, however, of these activities was an operational Z39.50 interoperability testbed. By the end of the project, the testbed included the following components:

- **Test dataset:** The test dataset comprised 419,657 MARC 21 bibliographic records contributed y project partner, OCLC.
- **Reference implementations:** The reference implementations comprised three components
    - An integrated library system that provided the information retrieval system (in the form of its online catalog) contributed by project partner Sirsi, Inc.
    - The Z39.50 server (integrated with the library system) contributed by project partner Sirsi, Inc.
    - The Z39.50 client (a stand-alone software product) contributed by project partner Sea Change, Inc.
- **Test searches and benchmarks:** Z-Interop staff developed the following test searches based on the specifications for searches defined in the *Bath Profile: An International Z39.50 Specification for Library Applications and Resource Discovery* and the *U.S. National Z39.50 Profile for Library Applications*:
    - Twenty test searches for Author, Title, Subject, and General Keyword search types (Bath and U.S. National Profile Level 0 specifications)
    - Twenty-three test searches for Boolean search types using AND, OR, NOT Boolean operators with Author, Title, Subject, and General Keyword searches (Bath and U.S. National Profile Level 0 specifications)
    - Twenty test searches for Author, Title, Subject, and General Keyword with Right Truncation search types (Bath and U.S. National Profile Level 1 specifications)

  Benchmark Record Sets were established and validated for each of the 63 searches to be used for interoperability testing.
- **Testbed policies and procedures:** Z-Interop staff developed detailed instructions and systematic procedures, along with published policies, for the operation of the testbed and for Z-Interop participants who submitted their implementations (Z39.50 clients and Z39.50 services) for interoperability testing.

The components listed above provided both the technical and organizational infrastructure for an operational Z39.50 interoperability testbed.

Appendix B lists the various technical reports and documents created by the Z-Interop staff during the project. Several of these need to be highlighted because they address important Z-Interop Project objectives.

- **Analysis Logic and Procedures for Creating a Test Dataset of MARC 21 Records for the Z39.50 Interoperability Testbed**
- **Z39.50 Interoperability Testbed: Establishing Benchmarks for Test Searches**
- **Procedures for Z39.50 Server Interoperability Testing**
- **Procedures for Issuing Test Searches from Z-Interop Testbed Participant's Z-Client**

These documents provide the logical model for the interoperability testbed descriptions for conducting interoperability testing.

Another project objective was to develop a guide for configuring systems to improve interoperability. The Bath and U.S. National Z39.50 profiles (which the Principal Investigator participated in developing and publishing) serve as the basic guide for configuring the Z39.50 component of a library system for improved interoperability. The specifications provided by these profiles were used as the basis for the functionality tested through the interoperability testbed.

Interoperability, however, required more than adherence to the profile specifications. The key area the Z-Interop Project addressed was the machine-indexing of the bibliographic records to support the profile-defined searches. Although some work in the area of indexing guidelines had been undertaken by the Principal Investigator and colleagues in work pre-dating the Z-Interop Project, it was through the project that these guidelines were finalized and put to work. The following Z-Interop Project document:

- **Indexing Guidelines to Support Z39.50 Profile Searches**

resulted from additional work by the Z-Interop staff. This document was publicly available both to participants in the testbed and the general public. The importance of local indexing decisions cannot be underestimated for their effects on interoperability. Additional discussion of the challenges of interoperability, including issues of indexing MARC records, will be discussed in a subsequent section.

6.2 Participation and Use of the Interoperability Testbed

The Z-Interop Z39.50 Interoperability Testbed was the first formal testbed for assessing Z39.50 semantic interoperability. A testbed sponsored by the Coalition for Networked Information in the early 1990s focused primarily on mechanical protocol-level interoperability at an early stage of Z39.50 implementation. The goal of the Z-Interop testbed was to improve semantic interoperability, a challenge that went far beyond the issues of protocol compliance (although that was a necessary condition to achieve to be able to assess semantic interoperability).

While there are hundreds, if not thousands, of Z39.50 client and server implementations in libraries in the U.S. and internationally, most of these local implementations are using products from a small number of library automation and other companies. The testbed was open to both vendors and libraries (see the Appendix F, Call for Participation). Participation in the testbed, was for the most part, by vendors rather than individual libraries.

At the time this Interim Report for the Z-Interop Project is being written (although the official end of the project was September 30, 2003) a total of eight participants representing nine separate products went through (or are in the process of) interoperability testing. The following indicates the number of participants testing Z39.50 server and Z39.50 client products:

Z39.50 Server Products/Implementations
- InQuirion
- OCLC
- Dynix
- Horizon
- Innovative Interfaces Incorporated
- Follett
- Telus

Z39.50 Client Products
- Fretwell-Downing
- Saskatchewan Provincial Library (using Blue Angel Technologies Product)

Sirsi, Inc. contributed its Z39.50 server product to the Z-Interop Project, and by default was a participant in the testbed.

The list of companies with Z39.50 server products that went through the Z-Interop testbed covers much of the installed base of library automation systems in the U.S. There are several companies, however, that have Z39.50 server implementation in libraries in the U.S. that did not participate, notably, Endeavor Information Systems, The Library Corporation, Ex Libris, Gaylord, and Sagebrush. The Principal Investigator made contact with all of these companies to ensure they knew about the testbed.

The Principal Investigator had assumed at the time of submitting the proposal that individual libraries would be interested in submitting their Z39.50 server implementations to interoperability testing. This assumption proved incorrect for two primary reasons. First, the size of the test dataset (over 400,000 records) was too large to be accommodated by individual libraries. Second, most individual libraries' Z39.50 implementations did not include a test environment in which the test dataset could be loaded and indexed separately from the production bibliographic database of the individual library. This made it impossible for most libraries to participate in the testbed. As part of a project the Principal Investigator carried out in 2002 for the Illinois State Library, these barriers to participation became clear. The Illinois State Library encouraged the Illinois Regional Library Systems that hosted large shared bibliographic systems to go through the interoperability testbed to improve statewide resource discovery and sharing. Yet, even with encouragement and support by the Illinois State Library, the Regionals were not able to go through the testbed for the reasons listed above.

Use of the testbed, however, was not limited to only those eight organizations that formally submitted their products for interoperability testing. During 2002 and 2003, as part of a Texas virtual library initiative, the Z-Interop testbed was used for assessing proof-of-concept applications for metasearching (i.e., cross database searching via Z39.50 and other protocols from a single search interface), and for technical assessment of responses to a formal Request For Proposal (RFP) by the Texas State Library and Archives Commission for a metasearch application for the Library of Texas (LOT) Resource Discovery Service. The Principal Investigator was involved in the design and development of the LOT Resource Discovery Service, and offered the interoperability testbed as a formal mechanism to assist the Texas State Library and Archives Commission to 1) assess the extent to which proof-of-concept metasearch applications conformed to the specifications for searching as defined in the Bath and U.S. National Z39.50 profiles; and 2) assess the technical conformance to specifications included in the RFP to procure a metasearch application for the LOT. The results of both sets of assessments provided information to the Texas State Library and Archives Commission as to the conformance to standards and profile specifications of Z39.50 client implementations integrated into a metasearch application. The results of these assessments were for internal use by the Texas State Library and Archives Commission, but for additional information about the Library of Texas design and the role of Z39.50 and interoperability see Moen and Murray, 2002.

6.3 Dissemination

The Principal Investigator has been involved with the Z39.50 standard for over ten years. He was instrumental in the development of the Z39.50 profiles, most recently as chair of the National Information Standards Organization's standards committee that developed the U.S. National Z39.50 Profile for Library Applications. He also served as acting chair of the international Z39.50 Implementors Group from 2000 through the present. Throughout this time, he has been an advocate for improving Z39.50 interoperability.

The Z-Interop Project provided a context for exploring assumptions about interoperability issues and developing methods to improve semantic interoperability. During the project period, the Principal Investigator attempted to disseminate information about the project, discuss the challenges of reliable interoperability, and provide the library community with new information from the research and development resulting from the project. There were three primary vehicles for disseminating information about the testbed and its findings: a project website, papers resulting from or informed by the project, and presentations to a wide variety of audiences that focused on the testbed or interoperability issues informed by experiences of the testbed.

The project website <http://www.unt.edu/zinterop> was established shortly after the award of the National Leadership Grant for the project. It has served as a primary vehicle to publish the publicly available technical reports, documents, and other relevant project information.

Appendix G contains a list of papers (9) and presentations (14) related to the Z-Interop Project. Some of these focus specifically on the Z-Interop testbed while others describe the testbed in the broader context of networked information retrieval, interoperability, and Z39.50. Two of the most recent papers and presentations address two important issues (discussed in Section 9. Next Steps and Future Research) that emerged from the Z-Interop project: 1) usability assessment in a metasearch context, and 2) MARC content designation use and indexing policies.

Through these papers and presentations, the Principal Investigator attempted to increase the knowledge of librarians and others about the issues of interoperability and the solution paths for improving interoperability. As noted in the paper and presentation for the 2001 Joint Conference on Digital Libraries, "Mapping the Interoperability Landscape for Networked Information Retrieval" interoperability is a multi-faceted concept and there are many factors that can affect the interoperability of systems. The Z-Interop Project provided an opportunity to address a set of these factors such as Z39.50 configuration and indexing policies. Yet the results from the project also point to other areas of work remaining such as the affect of character sets, normalization, and word extraction policies on individual information retrieval systems. The Principal Investigator is committed to continuing disseminating information gained from the Z-Interop Project and developing methods to address the many interoperability challenges that remain.

6.4 Outcomes of the Z-Interop Project

One of the more difficult aspects encountered in a research and demonstration project such as Z-Interop was developing and executing an outcomes-based evaluation plan to assess the results of the project. Two Z-Interop staff members attended the IMLS workshop on outcomes evaluation in 2001 when the project was in its initial stage. We used the information gained from the workshop to develop an outcomes-based evaluation plan that was submitted to IMLS:

> **Outcomes Based Evaluation Plan for the Z39.50 Interoperability Testbed Project** (October 2001)

The Principal Investigator assumes the responsibility for not being able to execute the evaluation plan as it was originally structured. Several factors influenced this situation. While not meant to excuse this deficiency in the overall project, it is intended to explain the situation.

First, the evaluation plan was overly ambitious and based on assumptions about the testbed that turned out not to be correct. The Principal Investigator assumed that individual libraries would be able to use the interoperability testbed to assess their Z39.50 implementations. As noted previously, this turned out to be an incorrect assumption because of the lack of test environments in individual library systems to load the Z-Interop test dataset. A number of the evaluation criteria related to assessing changes in library participants in the testbed. Further, in attempting to carry out the spirit and letter of an outcomes-based assessment methodology, the evaluation plan was overly ambitious in the type and amount of data that needed to be collected to carry out the assessment.

Second, Z-Interop staff turnover resulted in several initial members leaving the project within a few months of project startup. Two of these staff were involved in the creation of the evaluation plan and had been charged with carrying out tasks associated with the plan. Subsequent recruits to the project were primarily systems- and programmer-oriented staff, who were needed when it became clear that the project would need people with a high-level of computer programming skills to carry out the preparation for the testbed. Initial staff on the project did not have those required skill.

Third, and possibly the most influential factor, was the amount of time needed by the staff to carry out all the activities and tasks related to the research and development of the testbed, and the actual interoperability testing. As described in Sections 4 and 5 above, the level of effort to carry out these tasks had not been anticipated at the time the proposal for the interoperability testbed project was submitted.

The Principal Investigator's original expectations for impact of the project were very high, in part because he saw the importance of assisting in improving a standards-based approach to searching across library catalogs. The Principal Investigator believes that the Z-Interop Project has had important impacts on vendor's awareness of Z39.50 interoperability issues. It is important to note that some of the vendors that participated in the testbed did achieve high levels of interoperability with the reference implementations, in part because they configured their systems according to the profile specifications and used the indexing guidelines promulgated by the Z-Interop Project. Further one participant used its participation in the testbed in its marketing of its Z39.50 client product, and another participant sent an unsolicited message to the Principal Investigator commenting on the usefulness of the testbed (see Appendix H).

7. Z-Interop Project Resources: Funds and Contributions

The research, development, and resulting operational Z39.50 interoperability testbed was a human and computational resource intensive undertaking. Without funding from IMLS, such a project could not have been initiated. Total direct costs requested from IMLS was $142,245, plus indirect costs of $35,269, for a total request from IMLS of $177,874. In addition, several organizations including the Principal Investigator's university contributed cash and other resources to support this project. When the proposal was submitted, the project had commitments of approximately $260,000 from these organizations. In the case of contributing organizations, the project did not require all the resources committed by those organizations. Yet, the contributions from all organizations were critical to the success of the Z-Interop Project. This section describes the type of contributions made by the organizations.

<u>Data</u>
OCLC Online Computer Library Center, Inc., a library services organization, supplied the project with a test dataset of approximately 400,000 MARC library catalog records from its WorldCat database. OCLC also offered to provide software for an additional testing environment (estimated value $50,000); however, the project did not need to use this for its research and demonstration. The project did receive 400,000 MARC library catalog records from OCLC and also received services from OCLC for extracting and preparing the records for our project. As indicated in the letter of commitment from OCLC (dated January 24, 2000 and included in the proposal), the value of the records, their extraction, and other services to prepare the records was $30,000.

<u>Software</u>

Two commercial firms offered contributions of software and related services to the project.

Sirsi Corporation originally committed contributions in the amount of $105,000. For the project, we received from Sirsi the following items with associated values (based on the letter of commitment from Sirsi dated Jan 31, 2000 that was included in the project proposal):

- WebCat-Z-client and Unicorn Z-server software: $31,261
- Sirsi support for configuring the software: $6,000
- Sirsi-provided training on the software: $6,000

Sirsi also was willing to provide two additional software licenses at a cost of $31,261 each, but the project did not need to acquire additional software licenses. The total contribution from Sirsi was valued at $43,261.

Sea Change Corporation provided us a copy of its Z39.50 client software project, with the understanding that we could load this software on up to ten computers at UNT for purposes of interoperability testing. The value of the individual licenses for the software was approximately $250. The total contribution from Sea Change was valued at: $2,500.

The total value of the software and service contributions received by the project from Sirsi Corporation and Sea Change Corporation was $45,761.

Course Release Time

The School of Library and Information Sciences (SLIS) at the University of North Texas (UNT) provided a course release for two semesters (Spring 2001, Spring 2002). The amounts were estimated as follows:

Spring 2001 Salary & Wages: $5,425 & $1,750 for Total = $7,175
Spring 2002 Salary & Wages: $5,590 & $1,790.50 for Total = $7,380.50

The course release contribution by SLIS to the project was valued at $14,555.50 (based on the estimates in the proposal).

Equipment

At the time of preparing the proposal, the Principal Investigator requested Texas HEAF funds to provide computers for the project. The amount of the HEAF request was for $8,568 with the UNT Provost allocating $5,712 and the SLIS Dean allocating $2,856. This request was approved.

The equipment contribution through HEAF funds totaled $8,586.00. These funds were used to purchase desktop workstations and a notebook computer.

In addition, the Principal Investigator submitted a grant proposal to Sun Microsystems Worldwide Education and Research Grants/AEG Program for a Sun server. The estimated cost of that machine was $18,915. Although this proposal was not successful, the SLIS Dean provided funding through a special allocation by the UNT Provost for computing resources to purchase the Sun server. This was purchased at a 50% discount through Sun's Mindprint program. The total cost of the server was $9,818.

The contribution of funds from the University of North Texas and the School of Library and Information Sciences for equipment necessary for the project totaled $18,404.00.

Indirect Costs

At the time of developing the original proposal, UNT agreed to charge IMLS a 28% indirect rate, a reduction from the 46% federal rate for indirect costs in effect at that time. This was presented in the proposal as a cost sharing by UNT to support the project. In the original project proposal's Summary Budget sheet, the total amount requested from IMLS was $127,245, with an indirect amount (figured at 46%) of $58,533. Actual rate to be charged to IMLS was 28% for a total of $35,629. The difference between the full indirect and what was charged is $22,904, which was considered a match from UNT for cost sharing purposes. In addition, the indirect amount on the contributions by the Applicant as reflected on the Summary Budget sheet was $6,696. Therefore, the amount of indirect costs contributed by UNT was expected to be $29,600. Some changes occurred in the amount of the indirect charges due to a budget revision requested by IMLS that added $15,000 to the amount requested by the Principal Investigator, and some of the expenses included in the proposal that had been identified as being subject to indirect charges (student aid in the form of tuition scholarships) were not actually subject to indirect charges. For purposes of this summary, the total contribution by UNT related to indirect costs is valued at $29,600.

To summarize the contributions received by this project for UNT and the other organizations:

Course Release Time:	**$ 14,555.50**
Equipment:	**$ 18,404.00**
Software:	**$ 45,761.00**
Data:	**$ 30,000.00**
Indirect:	**$ 29,600.00**
Total	**$138,320.50**

Although this is less than the amount of matching funds originally projected on the proposal, actual contributions amounted to almost a one-to-one match for the direct costs amount requested for the project from IMLS. It is certainly well beyond the one-third matching that was requested for a demonstration project and encouraged for a research project.

The bulk of the direct funds from IMLS supported research assistants on the project. For many of the research assistants, the Z-Interop Project offered an stimulating learning experience. These graduate student research assistants along with the Principal Investigator comprised the Z-Interop staff. Various staff engaged with website development and maintenance, programming, analysis, interoperability testing, report writing, and documentation. Some IMLS funds supported travel by the Principal Investigator and other Z-Interop staff to meetings and conferences to present information about the project. It should be noted that travel expenses for most of the presentations listed in Appendix G were supported by non-IMLS funds (i.e., the conference or meeting supplied the Principal Investigator with support to attend the meetings and conferences).

The funds (non-IMLS) expended for equipment and software helped to build a robust technical infrastructure that will continue beyond the project. New research activities related to issues identified during the Z-Interop project (discussed below) will utilize the existing technical infrastructure. It is a solid technical foundation for future research related to interoperability and other related topics, thus increasing the institutional capacity for new research.

8. Issues of Interoperability and the Future of the Interoperability Testbed

Throughout the preceding sections, we have mentioned some of the new challenges to interoperability discovered or identified through the Z-Interop Project. In this section, we reflect on the work needed to continue the improvements in semantic interoperability resulting from the project.

8.1 The Continuing Threats to Interoperability

The Z-Interop Project goal was to improve semantic interoperability for Z39.50 clients and servers used in conjunction with library online catalogs. The development and adoption of the Bath and U.S. National Z39.50 profiles for library applications have made a significant contribution to assisting vendors and librarians to configure Z39.50 clients and servers. The profile specifications were critical to serve as a baseline for improving interoperability.

Through the Z-Interop Project, we were able to assess the extent to which participants in interoperability testing supported the profile specifications. However, several key threats to interoperability emerged or were clarified through the project: local indexing policies; data normalization and character set policies; and system word-extraction policies. Each of these are discussed briefly.

8.1.1 Indexing Policies

Machine indexing bibliographic records needs to be done to provide search or access points in an information retrieval system (see Section 4.2 above). Each local implementation can have its own indexing policies, and the policies direct the system to extract data from specific MARC fields/subfields to put in an index file. To improve cross-catalog searching, libraries should consider implementing common or standard indexing policies. To this end, the Z-Interop Project produced:

Indexing Guidelines to Support Z39.50 Profile Searches

This document focuses on indexing policies for Author, Title, Subject, and General Keyword searches. It identifies all possible fields/subfields in MARC 21 bibliographic records that contain either author, title, or subject data.

The example in Section 5.3.1 Analysis and Reports for Interoperability Testing of Z39.50 Server Implementations, shows how local indexing decisions can result in inappropriate or non-relevant records being retrieved for a search. In that example, data from MARC title fields were included in the index for author searches.

The National Information Standards Organization (NISO) contacted the Principal Investigator to discuss whether the Z-Interop indexing guidelines could be made into a NISO technical document to help librarians and vendors set up indexing policies. This could be a possible approach to continue educating vendors and librarians about the critical issues related to indexing and interoperability. Yet, based on some additional investigation during the Z-Interop Project (see below about MARC content designation use), the Principal Investigator determined that additional research is needed to refine the guidelines for indexing policies. Further, the indexing document needs to be expanded to include guidelines for indexing MARC bibliographic records to support other Bath and U.S. National profile-defined searches. This work can be seen as yet another area in which the Z-Interop Project results will have impacts long after the close of the project.

8.1.2 Data Normalization and Character Set Policies

Another area where there is little standardization across information retrieval systems is data normalization. During the preparation of the Z-Interop's test dataset decomposed records for analysis, it was clear that our procedures needed to include some data normalization. Data normalization attempts to bring consistency to otherwise heterogeneous data. Yet, there were few guidelines available to direct the Z-Interop normalization procedures.

Since individual systems may normalize the same data differently, search and retrieval results from these systems using the same test dataset may differ. Section 4.4.1 Data Normalization gave examples of the types of normalization procedures for the Z-Interop Project, and Section 4.4.4 Establishing Benchmarks for Interoperability Testing showed the impact on retrieval results because of how specific characters were or were not normalized.

An important response to this issue is a doctoral dissertation being worked on by one of the Z-Interop senior researchers, Ed Kim. The title of his dissertation is "Normalization of Non-alphanumeric Characters for Bibliographic Information Retrieval Systems," and the dissertation proposal is available at: <http://web2.unt.edu/isdocs/resources/EunKimProposal.pdf>.

Data normalization and character set handling policies is another area for new community agreements to improve interoperability when searching across library catalogs and other resources.

8.1.3 Word Extraction Policies

The third area of threats to interoperability that emerged during the interoperability testing relates to how an information retrieval system defines and processes a "word" in a MARC record. The Z-Interop Project in its document:

Decomposing MARC 21 Records for Analysis

defined a word as "any string of characters, including all punctuation and other special characters, bounded by spaces." For the test dataset, this meant that strings of characters such as "root-rot" and "grass-roots" were considered as words. This was in keeping with a user-centered perspective in that a user might want to search for "grass-roots" rather than one of the component parts of the hyphenated string.

Again, through the interoperability testing it was clear that, in general, systems handle a hyphenated word by splitting it into its component parts for indexing purposes. In these systems, a search for "root" brought back records that included terms such as "grass-root" and "root-rot," not terms that the user was searching for.

Whether or not this is an arena for guidelines and recommendations remains an open issue. But it is important for systems developers to recognize the impact of system word-extraction policies on users' searches, and for users to be aware of such confounding influences on search results from these policies.

8.2 The Future of Interoperability Testbed

As noted in previous sections, the Principal Investigator assumed incorrectly that individual libraries would be interested and able to participate in interoperability testing with their local implementations. The approach of the Z-Interop Project was to use a large test dataset to provide a more real-world exercise for systems and interoperability testing. Yet, it was precisely this large dataset that presented a barrier to individual libraries' participation, along with the fact that most libraries' local systems do not have test environments in which to load this or any other test dataset. To address the issue of the size of the test dataset, the Z-Interop staff developed a 100,000 record subset of the Z-Interop test dataset, and during the last period of the project, the staff began to redo test searches and benchmarks using this smaller dataset. However, individual library participation would still be limited by the lack of test environments available in local systems.

The Principal Investigator had also assumed a business model could be developed to provide a sustained revenue stream to continue and expand the Z39.50 interoperability testbed. This assumption was based on the incorrect assumption about individual library participation. Since there are a very limited number of vendors that produce Z39.50 products for the library market (and many of those went through the Z-Interop testbed), there is not a broad market of vendors to sustain the interoperability testbed as it is currently configured and operated.

However, in the last two months of the project, the Principal Investigator discussed this issue with Sebastian Hammer, a principal in Index Data, a premier company that develops Z39.50 server and client toolkits and source code. Hammer suggested that what is needed is a "radioactive" MARC record (or a limited number of such records) through which the types of interoperability assessments done in the Z-Interop testbed could be carried out without putting a burden on the libraries' local system implementations. This idea will be discussed in Section 9.3 A Radioactive MARC Record for Interoperability Testing.

A “radioactive” record approach for interoperability testing does not invalidate the work accomplished in the Z-Interop Project. All of the ground-breaking work in data analysis, testing procedures, test searches, and identification of continuing interoperability challenges would inform this alternative approach for interoperability testing.

9. Next Steps and Future Research

The Z-Interop Project successfully conducted research and development for establishing a trustworthy and reliable Z39.50 interoperability testbed. In the three years since the project began, the networked environment has become the central context for much of the work of libraries and users of libraries. New insights into interoperability gained through the project have translated into framing issues for future work (see Section 8.1 The Continuing Threats to Interoperability). Z39.50 continues to be a technological underpinning for networked information retrieval, but it too is evolving with initiatives such as the Z39.50 International: Next Generation (ZING) and the development of a web services implementation for Z39.50 functionality (see <http://www.loc.gov/z3950/agency/zing/zing-home.html>). In addition, the first generation of commercial metasearch applications, many of which use Z39.50 and need reliable interoperability between clients and servers, started to appear during the period of the Z-Interop Project. These activities, the continuing challenges to interoperability, and the experiences from the Z-Interop Project suggest a number important future research activities.

9.1 Interoperability, Usability, and the Metasearch Environment

The Principal Investigator was requested by IMLS to add a component to the project that would investigate user assessment of the protocol and software. Over the course of the project, we continued to consider how to bring users into the assessment of interoperability. The Z-Interop staff and the Principal Investigator developed two documents pertinent to the question of usability assessment and interoperability (see Appendix I for complete documents). The first, User Task Level Interoperability: Preliminary Suggestions for Usability Assessment, was completed in February 2001. The second, Optimizing Resource Discovery Service Interfaces in Statewide Virtual Libraries: The Library of Texas Challenge was completed in September 2003. The second paper was peer-reviewed and presented at the Libraries Without Walls 5 Conference (forthcoming in the published proceedings from the conference).

From the outset, the Principal Investigator anticipated that user assessment of interoperability across systems would be confounded by many different factors, such as the user interface, the functionality available, and system performance. At the heart of this usability was a user-oriented definition of interoperability developed by the Principal Investigator in the past several years. A systems-oriented definition of interoperability is something along the lines of:

> The ability of different types of computers, networks, operating systems, and applications to exchange information, without prior communication, in a useful and meaningful manner.

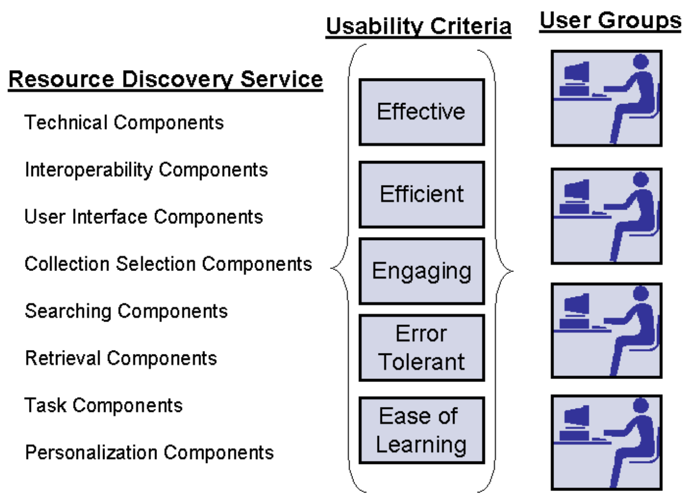
A user-oriented definition puts the user rather than the systems central:

> A user’s ability to successfully search and retrieve information in a meaningful way and have confidence in the results.

Technical and semantic interoperability are necessary conditions to provide users with the appearance of interoperability, but other factors need to be accounted for in user assessments of interoperability.

One of the important advances in search applications in the past several years is now referred to as “metasearching.” In the past, people in the Z39.50 community used terms such as cross-database searching, federated searching, or distributed searching. The essence of each of these was that a user, from a single interface, could interact with multiple information retrieval systems concurrently – sending a search to these systems, retrieving results, identifying useful resources, etc. The library community has coalesced around the term "metasearching" to describe this sort of user experience and the applications that enable it. For information about metasearching, see NISO's new initiative on metasearching at: <http://www.niso.org/committees/MetaSearch-info.html>.

As noted before, the Principal Investigator was involved in work on the Library of Texas (LOT) Resource Discovery Service (RDS) at the same time the Z-Interop Project was underway. Prototypes of the LOT RDS were assessed through the Z-Interop interoperability testbed, and the Principal Investigator had the opportunity to interact with many of the available metasearch products through the LOT RDS work. Interoperability is a necessary condition for these metasearch applications, and it was clear that the complexity of the distributed information landscape as presented by the metasearch applications and the various functions that a metasearch application offered to the user is really where the focus of usability and interoperability should be.



As the above illustration shows, a metasearch application (in this case called the Resource Discovery Service) comprises a number of components. Only some of these are obviously visible to the end user. These components and the user criteria for different user groups present a framework for usability assessment of metasearch applications. A key component is that of interoperability, but interoperability is contextualized by the other components a user engages with. Development of appropriate methodological approaches and procedures for carrying out usability assessment within this framework will require additional research and testing. The framework for usability assessment, however, lays the groundwork for moving ahead in this research and testing. The Principal Investigator will be pursuing funding for this research.

9.2 Indexing and MARC Content Designation Use

A key area of consideration when addressing Z39.50 interoperability is the indexing policies in effect in different online catalog systems. These indexing policies prescribe which fields/subfields in a MARC 21 record (i.e., MARC content designation) are included to populate an individual index. The Z-Interop Project developed indexing guidelines to use in the reference implementation of an online catalog system and Z39.50 server:

Indexing Guidelines to Support Z39.50 Profile Searches

Establishing and setting up indexing policies, however, can be a time consuming task; for the Z-Interop Project's online catalog reference implementation, setting up the indexing policies for author, title, and subject keyword indexes took approximately forty person-hours. More importantly from the user's perspective is whether such extensive indexing has meaningful consequences for search and retrieval. These questions motivated an analysis of the actual occurrence of the MARC 21 fields/subfields in the Z-Interop dataset.

Although not originally part of the work plan for the Z-Interop Project, this analysis resulted in findings about the use of MARC content designation that may have important implications for a variety of people including catalogers, systems designers, and standards developers. The findings were presented in a peer-review paper delivered at the 2003 Dublin Core Conference. Appendix J contains the full text of the paper, Assessing Metadata Utilization: An Analysis of MARC Content Designation Use.

Several important findings need to be highlighted. First, the analysis of the Z-Interop test dataset of 419,657 MARC records indicated that only 36 MARC fields/subfields (about 4% of field/subfields occurring in the test dataset) accounted for 80% of all occurrences. While the analysis focused on one sample of MARC records, the results suggest important research questions to determine if the complex MARC encoding scheme is being underutilized and if so, why. Also, there is a question as to whether the most frequently occurring MARC fields/subfields contain data useful to users. The following gives a quick summary of the most frequently occurring 36 fields/subfields:

- Most frequently occurring: 650 $a [Subject data]
- 2nd most frequently occurring: 040 $d [Cataloging source]
- 3rd & 4th most frequently occurring: 260 $a & $b [Publication information]
- 5th most frequently occurring: 245 $a [Title]
- Contain data useful to end users: 28
- Contain control numbers, etc.: 5
- Contain data useful to catalogers: 3

The extent and quality of the MARC bibliographic records have indirect implications for system interoperability, but have direct implications from a user-oriented perspective on interoperability.

More directly related to issues of interoperability are the implications for indexing policies. The Z-Interop document that provided indexing guidelines for the interoperability testbed identified 537 MARC fields/subfields that could contain author, title, or subject data. The following table provides a breakdown of those fields/subfields.

Keyword Index Guidelines	Fields/ Subfields in Indexing Guidelines	Indexing Guidelines Fields/Subfields Occurring in Dataset	Percent Occurring
Author Only	119	86	72%
Author and Title	21	16	76%
Subject Only	144	101	70%
Title Only	253	178	70%
Total	**537**	**381**	71%

The table also shows that about 71% of the fields/subfields in the indexing guidelines occurred at least once in the test dataset. However, only 19 of these (approximately 5%) accounted for 80% of all occurrences. We have discussed earlier in this report the importance of common indexing policies on local implementations of library catalogs to improve interoperability. The findings from this analysis suggests that the indexing guidelines might recommend only a small subset of the 537 fields/subfields that are critical to include in the indexing policies for local systems. Z-Interop staff conducted some tests to determine the effects on search results if only the 19 fields were indexed. Preliminary results showed that using only the 19 fields/subfields, we achieved between 95% - 100% of the correct records from the

Benchmark Record Sets for the test searches. These are startling results and point to the need for more systematic research.

As noted previously, the Z-Interop Project has resulted in a robust technical and software infrastructure for future research on interoperability testing. It can also be used for the types of analysis needed to further understand the use of MARC content designation and the implications for indexing policies and information retrieval.

The paper presented at the 2003 Dublin Core Conference has generated substantial interest from catalogers, systems designers, people working in the area of automatic metadata generation, and people who train and educate catalogers. The Principal Investigator will be submitting a proposal to IMLS in February 2004 for a National Leadership Grant to pursue this research.

9.3 A Radioactive MARC Record for Interoperability Testing

In Section 8.2 The Future of Interoperability Testbed we discussed some of the issues that emerged in the Z-Interop approach for interoperability testing. We suggested a possible alternative approach for interoperability testing that would use the concept of a “radioactive” MARC records. The credit for this idea goes to Sebastian Hammer, a principal in Index Data, a company specializing in Z39.50 and networked information retrieval. The Principal Investigator has discussed this idea with Hammer, and we both have an interest in pursuing this concept for interoperability testing. It may provide an approach that would reduce the barriers to participation in interoperability currently encountered by individual libraries.

The idea for a radioactive MARC record is based on current medical diagnostic techniques for people. When a person has a particular medical condition, there may be two approaches for diagnosis. One could be considered invasive, where the person would undergo some surgical technique to physically examine the problematic area or anomaly. The other approach could be considered less invasive, where the patient is injected with a dye, possibly radioactive, and once it has spread throughout the body, scanning techniques allow a medical professional to identify structural or mechanical problems or anomalies.

A “radioactive” MARC record approach for interoperability testing would be less “invasive” for a local library. It would not require loading a large test dataset such as used in the Z-Interop Project. Nor would it require a separate testing environment on the local implementation. Instead, one or more diagnostic MARC records would be created where the data in the MARC fields/subfields would consist of specific patterns of character strings. Such records could be created for each of the various formats of bibliographic materials (e.g., monographs, electronic resources, cartographic materials, etc.) using the full set of MARC content designation available for each format. So, instead of hundreds of thousands MARC records to load into a system, a small set of these “radioactive” records, maybe less than 20, could be loaded into the production level online catalog system of a local library.

Another step in this approach would be similar to what was done in the Z-Interop Project. Namely, a set of test searches would be developed to “find” these radioactive records under various search criteria. Once these diagnostic records are loaded into the local library’s catalog database, the test searches would be sent to the implementation, and the results would be analyzed. In this scenario, instead of hundreds of records being returned, successfully interoperating systems would return the appropriate MARC diagnostic record for each test search. At the end of interoperability testing, the local library could easily remove the diagnostic MARC records from its production system.

Conceptually, this approach for interoperability testing with library catalogs has several key advantages over the approach of the Z-Interop Project. Research and development would be needed to create these special “radioactive” MARC records, develop the test scenarios, and develop analysis procedures to ensure that the diagnosis of indexing or other structural or mechanical problems affecting interoperability was reliable. Again, the technical and software infrastructure that resulted from the Z-Interop Project could be re-used in this approach for interoperability testing. Further, a “radioactive” record approach could be generalized for other metadata environments. It is easy to imagine Dublin Core radioactive records, or such records for other metadata environments.

The Principal Investigator will be pursuing these ideas as an alternative approach for interoperability testing, and will seek funding to support this research and development. He will work with Sebastian Hammer to develop these ideas further.

10. Concluding Thoughts

Improving semantic interoperability of Z39.50 implementations providing access to online library catalogs necessitates understanding the factors that can affect interoperability. The Z-Interop Project expanded the understanding of how semantic interoperability can be improved and established a robust and trustworthy testing environment to assist improvement. This report has described the many activities and tasks the Z-Interop staff carried out in support of the research, development, and operation of a Z39.50 interoperability testbed.

Like so many instances in the networked information environment and standards application, one tries to understand problems, develop solutions, and learn about the new problems that are made visible through the process of solving the original problems. Certainly, in terms of Z39.50 interoperability, the development and adoption of Z39.50 profiles have set the stage for improved interoperability. Yet we also discovered that vendors who claimed their implementations supported certain profile specifications have additional work to do on their implementations to fully support selected specifications. The emergence of the profiles during the Z-Interop Project period meant that a number of vendors were just beginning to revise their software to support the profiles. The timing for the Z-Interop Project was appropriate to work with these vendors as they developed and tested new Z39.50 client and server products. However, development work by some vendors to support profile specifications was only beginning during the project period.

Working with the profile specifications allowed the Z-Interop staff to identify or clarify factors beyond Z39.50 specifications affecting interoperability. The interoperability testbed experience clearly noted the importance of local indexing policies on search results. Further, we identified issues of data normalization, character set handling, and word-extraction policies on interoperability. While not completely unanticipated, little in the way of research had addressed these factors in any systematic way.

We feel proud of our accomplishments during the project, and we are cognizant of areas of work that were not addressed to the extent anticipated. The Principal Investigator believes that the resources provided by IMLS and the contributing organizations were husbanded effectively to produce the new understandings, technical documents, interoperability framework and methods, and published papers and presentations.

Acknowledging that interoperability is multi-faceted means that no one project will solve or even address all factors affecting interoperability. The Z-Interop Project focused on Z39.50 implementations providing access to library catalogs containing bibliographic records. Yet many of the issues addressed by the Z-Interop Project will help others – within and outside of the library community – to focus their attention on high-value interoperability problems. Even within the library community, there are other types of data that are exchanged. For example, specifications are now complete for exchanging holdings information and for exchanging authority records. To fully realize the vision of networked access to library resources will require ongoing research, testing, and improvement related to interoperability of systems and data. The Z-Interop Project has laid a solid conceptual, methodological, and technical foundation for such research and testing. In addition, Principal Investigator anticipates future use of the Z-Interop technical and software infrastructure to pursue research problems uncovered through this valuable project.

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Appendix A: Glossary of Technical Terms

This glossary defines a number of the key terms and concepts referenced in the main body of the Interim Report.

Benchmark: A measure of success. The retrieval results of the different implementations provide the benchmarks for a Z39.50 testbed to test further scenarios against.

Client: An application or the software that runs on a user's computer that interacts with a remote server and its associated database(s). Within the context of Z39.50, the Z–client is the software the user uses to communicate with a Z–server. The Z–client initiates a Z39.50 information retrieval session and submits requests to the Z–server. The Z–client software translates the query into Z39.50 messages, contacts the Z–server(s) software on the remote database(s), negotiates the session rules, and receives the records, all behind the user interface.

Client/Server: Client/Server is architecture for representing interaction between software operating on two separate systems. The Z39.50 standard identifies specific roles and responsibilities for both the Z–client and Z–server in performing certain processes in the information retrieval session.

Computer communication: The interaction and transmission of data from one computer to another via a telecommunications media.

Conformance testing: Verifies that an implementation conforms to the established specifications of the standard and in software and hardware development it is seen as a means to increase the probability that systems will interoperate. See also **Interoperability testing**. From the literature: "a single implementation is compared to the standard to be sure that the implementation does what the standard specifies. If the implementation conforms to the specifications set out by the standard, then it is considered to be interoperable" (Preston & Lynch, 1994).

Information retrieval protocol: A protocol that enables one system acting as origin to conduct a search for records held in the database of another system acting as target, and to retrieve those records that meet the search criteria.

Interoperability: The ability of different types of computers, networks, operating systems, and applications to exchange information, without prior communication, in a useful and meaningful manner.

Interoperability testing: May be viewed as a supplement to or next logical progression after conformance testing. It verifies that diverse implementations work together effectively to deliver the expected results. From the literature: "a procedure in which two or more implementations are tested against each other, with the standard used primarily as a reference to judge problems and incompatibilities, and secondarily as a guide to the functions that should be tested and the general behavior to be expected" (Preston & Lynch, 1994).

Profiles: A set of implementor agreements specifying the use of a particular standard (or group of standards) to support a particular application, function, community, environment, or class of information. A profile selects options, subsets, values of parameters, etc., where these choices are left open in the standard, and where these selections are necessary to accomplish identified functions. A profile may also specify aspects of client and server behavior that are beyond the scope of the base standards. Purpose of a profile includes: (1) to provide a specification for vendors to build to, resulting in products that will interoperate; and (2) to provide a specification that customers may reference for procurement purposes.

Protocol: Established agreements on the requirements of how information/data will be made accessible. Communication protocols such as Z39.50 are detailed specifications that establish how computers systems will communicate over a network by defining the format and meaning of data being exchanged.

Reference implementation: Outlines the reference implementation of a specific Z-server and Z-client use in a testbed. Participants may choose to provide a single reference implementation or several different implementations depending on the scope of the testbed project. It is also important to note that since the reference implementation will also be used as test collection, it is important to be aware of what the collection contains, so search and retrieval scenarios can be developed.

Semantic Interoperability: The level of interoperability concerned with maintaining the meaning or intention of a user's query and appropriate search results between client and server during the search and retrieval transactions.

Server: An information server that provides access to one or more databases or information resources. A server answers requests for information from clients in a networked environment.

Standard: A standard represents an agreed upon response to a recurring problem—perceived, anticipated, or "real," and codifies the response for the purpose of communication. The standard is the result of a problem–solving process. It involves agreements among stakeholders who have an interest in adopting specific responses to the problem. Conformant use of the standard leads to predictable results and a reduction of uncertainty.

Testbed: A testbed is a set of implementations of a protocol based upon the same set of standards. Usually planned and operated with the active participation by software developers/vendors and standards' developers.

Z39.50 Implementors Group (ZIG): A forum for implementors of Z39.50 that has overseen the development of Z39.50 since 1990.

Z39.50 Maintenance Agency: The official maintainer of the Z39.50 standard located at the Library of Congress.

Z39.50 Standard: Z39.50 is the formal designation of an international standard protocol that facilitates communication between a local software client and a remote information retrieval system.

Appendix B: Z-Interop Technical Reports and Documents

The following is a list of technical reports and other documents that describe various aspects and operation of the Z-Interop testbed and project. These are available on the project website and are not included in this Interim Report.

Analysis Logic and Procedures for Creating a Test Dataset of MARC 21 Records for the Z39.50 Interoperability Testbed, Phase 1 Testing (revised draft dated January 1, 2002)
Available:
<http://www.unt.edu/zinterop/ZinteropNew/Documents/AnalysisLogicProceduresFinalJan2002.pdf>
This document explains the overall logic by which records were selected for the test dataset from OCLC's WorldCat database and introduces key concepts used in the Z-Interop testbed methodology: Aggregate and Candidate Record Groups. In addition, there is an explanation of the procedures for determining the aggregate and candidate record groups for specific test searches. These record groups provide the foundation for Z-Interop benchmarks and for analysis of interoperability testing results.

Call for Participation (March 2002)
Available: <http://www.unt.edu/zinterop/ZinteropNew/Documents/CallForParticipationMarch2002.pdf>
This document announced that the Z-Interop testbed was ready for use.

Data Normalization Procedures on Decomposed MARC 21 Records (revised draft dated January 1, 2002)
Available:
<http://www.unt.edu/zinterop/ZinteropNew/Documents/NormalizationProceduresFinalJanuary2002.pdf>
No data normalization was done on the MARC 21 records or during the decomposition of those records. Normalization was necessary to more efficiently carry out the procedures to create the aggregate and candidate record groups. This document describes the normalization procedures carried out on the decomposed records.

Decomposing MARC 21 Records for Analysis (revised draft dated January 1, 2002)
Available:
<http://www.unt.edu/zinterop/ZinteropNew/Documents/DecomposingMARCRecordsFinalJan2002.pdf>
The first step in creating the aggregate and candidate record groups involved the decomposition of the 400,000 MARC 21 records into subrecords based on character strings bounded by spaces (i.e., words) in fields and subfields in the MARC 21 records. This document explains the logic and procedures for decomposing the records. The result of decomposing the 400,000 records was approximately 33,000,000 subrecords. OCLC carried out this decomposition according to guidelines prepared collaboratively by the Z-Interop staff and OCLC.

Indexing Guidelines to Support Z39.50 Profile Searches (revised draft dated February 1, 2002)
Available:
<http://www.unt.edu/zinterop/ZinteropNew/Documents/IndexingGuidelines1Feb2002.pdf>
To assure rigor in the testbed, Z-Interop staff developed a set of guidelines for indexing the MARC 21 records to support Z39.50 profile searches. Z-Interop staff used these guidelines to index the 400,000 MARC 21 records that comprise the Z-Interop reference implementation of the Z39.50 server and online catalog. The guidelines reflect input and revisions based on public review. At this point, indexing guidelines are available for author, title, and subject, and any keyword searches. The guidelines can be used by interoperability testbed participants.

Outcomes Based Evaluation Plan for the Z39.50 Interoperability Testbed Project (October 1, 2001).
Available: <http://www.unt.edu/zinterop/ZinteropNew/Documents/EvaluationPlanFinalSep2001.pdf>
Describes an outcomes-based plan for evaluating the Z-Interop Project.

SQL Data Analysis Procedures to Create Aggregate and Candidate Record Groups on a Sample of Decomposed MARC Records, Phase 1 Testing (revised draft dated January 1, 2002)
Available:
<http://www.unt.edu/zinterop/ZinteropNew/Documents/SQLAnalysisProceduresFinalJan2002.pdf>
Once the decomposed records had undergone data normalization, they were now ready for the procedures to create aggregate and candidate record groups. For Phase 1 testing, four US National and Bath Profile searches (Functional Area A, Level 0) searches are being tested. The procedures documented here describe how aggregate and candidate record groups were created for Author Keyword, Title Keyword, Subject Keyword, and Any Keyword searches for specific search terms. The procedures described were informed by the indexing guidelines developed as part of the Z-Interop project, the Texas Z39.50 Profile, and the Bath and US National Profiles.

ZDoctor Report of SIRSI Indexing Policies for Interoperability Testing, Phase 1 Testing (revised draft dated January 1, 2002)
Available:
<http://www.unt.edu/zinterop/Documents/ZDoctorReportFinalJan2002RevisedFeb2003.pdf>
This report identified the MARC fields and subfields that are indexed in the Unicorn system to support various Z39.50 Bib-1 Use Attributes. This serves as a confirmation of the actual indexing policies set up on the reference implementation.

Z-Interop Interoperability Testing Policies and Procedures, Phase 1 Testing (revised draft dated February 1, 2002)
Available: <http://www.unt.edu/zinterop/ZinteropNew/Documents/PoliciesProceduresFinalFeb2002.pdf>
This document provides an overview and the details of the policies and procedures of the Z39.50 Interoperability Testbed Project. Specifically, the document lays out the responsibilities and obligations of the Z-Interop Testbed and the organizations that participate in interoperability testing. It includes an agreement for the appropriate use of the test dataset.

Appendix C: Example of Establishing Benchmark Record Set

The following is an extract from a Z-Interop document, **Establishing Benchmarks for Test Searches.** This document was for internal use by the Z-Interop staff and is not publicly available since it contains a list of the MARC records from the test dataset that should be retrieved by a system going through the interoperability testing. It was important for reliability and validity of interoperability testing of Z39.50 servers that testbed participants would not know in advance the Benchmark Record Sets for the test searches.

The purpose of including this extract here is to demonstrate the efforts by the Z-Interop staff to rigorously define the benchmarks for interoperability testing.

3.1.1 Author Keyword Searches

A total of five author keyword searches were issued from the Z-Interop client to the Z-Interop server. As indicated by the data from the ZATR file, the Z-Interop server received the following queries:

Date/Time of Query	Client IP	Search Term	Attributes
20020725144946	68.1.228.156	aleksandrovich	1003|3|3|2|100|1|
20020725145659	68.1.228.156	elena	1003|3|3|2|100|1|
20020725145810	68.1.228.156	garrison	1003|3|3|2|100|1|
20020725145850	68.1.228.156	jessica	1003|3|3|2|100|1|
20020725150321	68.1.228.156	picasso	1003|3|3|2|100|1|

3.1.1.1 aleksandrovich

The number of records in the Candidate Record Group where Author equals **aleksandrovich** is 237. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **aleksandrovich** was 240. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There were 3 records retrieved by the Z-Interop client that are not in the Candidate Record Group.

Exact matched records = 237
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 3

OCLC Record	Field/Subfield in which Term Appears	Notes/Comments
ocm00383831	100 1 $a Korff, Sergiei Aleksandrovich	Search term appears in legitimate field/subfield for search type. Character set issues may account for the appearance of this record in result set. **Should be included in benchmark.**
ocm02804467	100 1 $a Sholokhov, Mikhail Aleksandrovich	Search term appears in legitimate field/subfield for search type. Character set issues may account for the appearance of this record in result set. **Should be included in benchmark.**
ocm03142349	100 1 $a Solomon, Georii Aleksandrovich	Search term appears in legitimate field/subfield for search type. Character set issues may account for the appearance of this record in result set. **Should be included in benchmark.**

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **aleksandrovich** is 240. A complete list of the OCLC numbers for these records can be found in Appendix A.

3.1.1.2 elena

The number of records in the Candidate Record Group where Author equals **elena** is 141. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **elena** was 142. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There was 1 record retrieved by the Z-Interop client that is not in the Candidate Record Group.

Exact matched records = 141
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 1

OCLC Record	Field/Subfield in which Term Appears	Notes/Comments
ocm01349561	100 1 $a La Souchère, Éléna de.	Search term appears in legitimate field/subfield for search type. Character set issues may account for the appearance of this record in result set. **Should be included in benchmark.**

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **elena** is 142. A complete list of the OCLC numbers for these records can be found in Appendix A.

3.1.1.3 garrison

The number of records in the Candidate Record Group where Author equals **garrison** is 116. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **garrison** was 116. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There were 0 records retrieved by the Z-Interop client that are not in the Candidate Record Group.

Exact matched records = 116
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 0

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **garrison** is 116. A complete list of the OCLC numbers for these records can be found in Appendix A.

3.1.1.4 jessica

The number of records in the Candidate Record Group where Author equals **jessica** is 103. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **jessica** was 103. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There were 0 records retrieved by the Z-Interop client that are not in the Candidate Record Group.

Exact matched records = 103
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 0

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **jessica** is 103. A complete list of the OCLC numbers for these records can be found in Appendix A.

3.1.1.5 picasso

The number of records in the Candidate Record Group where Author equals **picasso** is 36. The number of records retrieved by the Z-Interop client from the Z-Interop server where Author equals **picasso** was 36. There are 0 records in the Candidate Record Group that were not retrieved by the Z-Interop client. There were 0 records retrieved by the Z-Interop client that are not in the Candidate Record Group.

Exact matched records = 36
Records in Candidate Record Group not retrieved by the Z-Interop client = 0
Records retrieved by the Z-Interop client not in Candidate Record Group = 0

Based on the search, retrieval, and analysis, the total number of records in the Benchmark for the Author Keyword search for the search term **picasso** is 36. A complete list of the OCLC numbers for these records can be found in Appendix A.

3.1.1.6 Author Keyword Test Searches Benchmark Summary

Based on the above procedure and analysis, the following table summarizes the benchmarks for the Author Keyword test searches.

Search Term	aleksandrovich	elena	garrison	jessica	picasso
Benchmark	240	142	116	103	36

Appendix D: Z-Interop Interoperability Testing Policies and Procedures

[See following pages.]

The Z39.50 Interoperability Testbed

U.S. Federal Institute of Museum and Library Services
National Leadership Grant

Realizing the Vision of
Networked Access to Library Resources:
An Applied Research and Demonstration Project to Establish and Operate a Z39.50 Interoperability Testbed

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Z-Interop Interoperability Testing Policies and Procedures

Phase 1 Testing

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February 1, 2002

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Appendix A: Information To Be Supplied by Participants
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Z-Interop Testbed Interoperability Testing Policies and Procedures

1. Introduction

This document provides an overview and the details of policies and procedures of the Z39.50 Interoperability Testbed Project (referred to as Z-Interop). Specifically, the document lays out the responsibilities and obligations of the Z-Interop testbed and the organizations that participate in interoperability testing. For purposes of this document, **Z-Interop staff** refers to all members of the Z39.50 Interoperability Testbed Project. **Z-Interop participant** refers to an individual or organization who tests its Z39.50 client or Z39.50 server through the Z39.50 Interoperability Testbed.

2. Overview of the Testbed

Z-Interop is funded by a National Leadership Grant from the U.S. federal Institute of Museum and Library Services. The goal of the testbed is to improve semantic interoperability among Z39.50 implementations for library applications. Details about the project, its goal, and objectives can be found in other documents available on the project website: <http://www.unt.edu/zinterop>.

To summarize, the Z-Interop testbed consists of and uses the following components:

- **Z39.50 profiles:** Current initiatives have produced the Bath Profile: An International Z39.50 Specification for Library Applications and Resource Discovery and the U.S. National Z39.50 Profile for Library Applications. Z–Interop testing is based on the specifications in these profiles.
- **Test dataset:** OCLC has provided a weighted sample of approximately 400,000 MARC 21 records from its WorldCat database. The Z–Interop staff used various tools and procedures to "understand" the content of the records to determine records that should be returned in test searches.
- **Reference implementations:** SIRSI and Sea Change corporations have contributed products that serve as reference implementations. SIRSI's Unicorn integrated library system serves as a reference implementation for the Z39.50 server and the information retrieval system (in the form of its online catalog). Sea Change's Bookwhere 2000 product serves as a reference implementation for the Z39.50 client. The Z–Interop staff, SIRSI, and Sea Change configured the reference implementations according to the Z39.50 profiles.
- **Test searches and results:** For bibliographic database searches defined in the profiles, Z–Interop provides a set of test searches with search terms. Analysis of the test dataset identified records that meet the search criteria.
- **Benchmarks:** Benchmarks for Z–Interop testing are established by executing the test searches using the testbed reference implementations.
- **Policies and procedures:** Provides detailed instructions and systematic procedures, along with published policies, for the operation of the testbed and for Z-Interop participants who want to go through interoperability testing.

Although this document discusses these various components, its primary purpose is to detail the policies and procedures for the testing.

3. Resources Available from Z-Interop

The Z-Interop testbed has a set of resources that is used during interoperability testing. Z-Interop makes these resources available to serve the purposes of the testbed. Organizations (e.g., integrated library system vendors, Z39.50 developers, and individual libraries) participating in interoperability testing (i.e. Z-Interop participants) can use these resources, and Z-Interop staff will work with the testbed participants in their use of these resources.

3.1 Reference Implementation of a Z39.50 Server

Z-Interop provides a reference implementation of a protocol machine in the form of a Z39.50 server (also known as a "target"). For interoperability testing, SIRSI Corporation provided Z-Interop with its Z39.50 server product. This server is configured to support the Bath Profile.

3.2 Reference Implementation of an Information Retrieval System

A Z39.50 server communicates with an information retrieval (IR) system or database system; typically in a library context, one of those IR or database systems provides access to records in the online catalog. For interoperability testing, SIRSI Corporation provided Z-Interop with its Unicorn integrated library system that includes an online catalog module. The online catalog has been configured to support searches defined in the Bath Profile. Indexing policies in the Unicorn system of the dataset of 400,000 MARC21 records were set up according to the indexing guidelines published on the Z-Interop website. See the Z-Interop document **Indexing Guidelines for MARC 21 Records to Support Z39.50 Profile Searches.** See also the Z-Interop document **ZDoctor Report of SIRSI Indexing Policies for Phase 1 Interoperability Testing**, which provides verification of the indexing policies.

3.3 Reference Implementation of a Z39.50 Client

Z-Interop provides a reference implementation of a Z39.50 client (also known as an "orgin"). For Phase 1 testing, Sea Change Corporation provided Z-Interop with its Bookwhere 2000 Z39.50 client product. This Z39.50 client is configured to support the Bath Profile. Z-Interop staff will use versions 3 and 4 of the Bookwhere Z39.50 client for testing.

3.4 Test Records

For Z-Interop participants that want to conduct interoperability testing of its Z39.50 server and information retrieval system (specifically, an online catalog implementation of an information retrieval system), Z-Interop makes available the test dataset of MARC 21 records. For Phase 1 testing, OCLC provided approximately 400,000 MARC 21 records from its WorldCat database. Z-Interop staff have analyzed and prepared the records to form a test dataset. These records have been loaded onto the online catalog reference implementation and indexed according to the MARC 21 indexing recommendations. Documents related to the preparation of the test dataset are:

- **Analysis Logic and Procedures for Creating a Test Dataset of MARC 21 Records for the Z39.50 Interoperability Testbed, Phase 1 Testing**
- **Decomposing MARC 21 Records for Analysis**
- **Data Normalization Procedures on Decomposed MARC 21 Records**
- **SQL Data Analysis Procedures to Create Aggregate and Candidate Record Groups on a Sample of Decomposed MARC Records, Phase 1 Testing**

For Z-Interop participants wanting to test their Z39.50 server implementations, Z-Interop staff will provide to the participants a copy of the test dataset. To use the test dataset, Z-Interop participants must sign an appropriate use agreement prior to Z-Interop delivery of the test dataset (see Attachment B).

3.5 Test Searches

Z-Interop has a set of test searches and search terms for use in interoperability testing. The searches are those defined in the Bath and U.S. National Profiles, Functional Area A, Level 0:

- Title Search – Keyword (Bath/US Profile)
- Subject Search – Keyword (Bath/US Profile)
- Any Search – Keyword (Bath/US Profile)
- Author Search – Keyword (US Profile)

For Z-Interop participants wanting to test their Z39.50 client implementations, Z-Interop staff will provide the search terms. Z-Interop participants will use their Z39.50 clients will send the search terms for the prescribed searches. For Z-Interop participants testing Z39.50 clients, Z-Interop staff will check the incoming Z39.50 query to compare to the profile's prescribed attribute combination.

For Z-Interop participants wanting to test their Z39.50 server implementations, Z-Interop staff will issue the test searches from the client reference implementation to the Z-Interop participant's Z39.50 server. For Z-Interop participants testing Z39.50 servers, Z-Interop staff will issue the test searches and receive the results. Z-Interop staff will check the results to compare to the Z-Interop benchmarks for the specified search.

3.6 Analysis and Reports of Test Search Results

Upon completion of an interoperability testing session, Z-Interop staff will analyze the results and provide a written report to the Z-Interop participant. Analysis results will be provided online in a secured area of the Z-Interop website. Results will only be given to the Z-Interop participant. Individual Z-Interop participant's results will not be published publicly.

3.7 Purpose of Test Results

The goal of Z-Interop is to improve interoperability. Z-Interop test results do not imply any legal conformance or certification of individual products or implementations. Z-Interop participants should not claim conformance or certification to the Bath or US National Profiles based on Z-Interop test results.

4. Z-Interop Responsibilities

To ensure proper functioning and utility of the interoperability testbed, the Z-Interop staff and the project have specific responsibilities and obligations. The following itemize the responsibilities of the Z-Interop testbed to support interoperability testing:

- **Provide all relevant documents:** Z-Interop will make available all documents that describe methodology, policies, and procedures relating to the interoperability testbed. See the Z-Interop website for the page **Z-Interop Testbed Documents -- Phase 1.**
- **Public availability of reference implementation configuration:** To the extent allowable by the Z-Interop partners who have contributed software for the reference implementations, Z-Interop will provide configuration details and specifications for the reference implementations. Significant changes to the publicly available configuration will be announced to interoperability testing participants.
- **Availability of the reference implementation server and information retrieval system:** Z-Interop will provide access to the reference implementation Z39.50 server and associated online catalog on an ongoing basis for Phase 1 testing. The reference implementation should be available 7 days a week, 24 hours a day. In the event of needing to do maintenance on the reference implementation and making it unavailable, Z-Interop will alert participants in a timely manner (i.e., in advance of taking the reference implementations offline).
- **Availability of test dataset:** Z-Interop will provide a copy of the test dataset of MARC 21 records to organizations interested in interoperability testing after they have completed the online information summary form (see Attachment A) and signed the appropriate use agreement (Attachment B).
- **Conduct interoperability testing:** As Z-Interop participants are ready for testing, Z-Interop will send the specified test searches to participants that want to test Z39.50 server implementations, and will be ready to receive test searches from Z-Interop participants that want to test Z39.50 client implementations.
- **Prepare interoperability test results:** Z-Interop staff will prepare individual reports for each Z-Interop participant after testing is completed. Z-Interop staff will analyze testing results of Z39.50 queries from Z-Interop participants testing their client implementations and will analyze testing results from Z-Interop participants testing their server implementations.

- **Assist participants' understanding of the test results:** Z-Interop will provide analysis assistance to Z-Interop participants to understand the test results and make suggestions for possible changes to improve test results.
- **Confidentiality and use of interoperability testing results:** Individual Z-Interop participant's test results analysis and reports will not be shared other than with the individual Z-Interop participant. Z-Interop will provide test results and reports for individual Z-Interop participants on a secure website with access to the individual reports limited by access control through userid and password to a specific directory associated with the participant. Because of the nature of this publicly funded project, Z-Interop reserves the right to use interoperability test results in the aggregate for public dissemination and project reports. Z-Interop participants may choose to allow Z-Interop to associate test results with their names, and will sign a release agreement for the results.

5. Interoperability Testbed Participants' Responsibilities

To ensure all parties participating in the interoperability testbed are treated equally and to ensure proper documentation for the Z-Interop project, Z-Interop participants are required to fulfill a number of responsibilities. The following itemize the responsibilities of the Z-Interop participants:

- **Indicate interest in being a participant:** Send an email to the principal investigator, Dr. William E. Moen <wemoen@unt.edu> stating your interest in participating in the testbed.
- **Read the Z-Interop Policies and Procedures document:** Upon receipt of email indicating participant's interest, Z-Interop will point the participant to this document and other relevant documents for review. Participants should read this policies and procedures document to understand the roles and responsibilities of the testbed and participants.
- **Supply preliminary information requested by Z-Interop:** Upon receipt of email indicating participant's interest, Z-Interop will supply a URL to online data collection forms. Participants must complete all parts of the data collection forms and supply the requested information. The information requested is listed in Attachment A. You will be asked to indicate on the data collection forms that you have read and agree to these policies and procedures.

5.a. Z-Interop Participants Testing Z39.50 Client

Z-Interop participants who want to test a Z39.50 client implementation against the Z-Interop server reference implementation need to do the following:

- **Configure Z39.50 client to send the following Bath Profile and US National Profile searches:**
  - Title Search – Keyword
  - Subject Search – Keyword
  - Author Search – Keyword
  - Any Search – Keyword
- **Contact Z-Interop when ready to send searches:** After configuration is completed, contact Z-Interop to indicate Z-Interop participant's readiness to send searches. At that point, Z-Interop staff will provide the specific test searches.
- **Send the test searches:** Z-Interop participants will send the test searches in the order prescribed by Z-Interop instructions.
- **Indicate to Z-Interop the results of the test searches:** Z-Interop participants should indicate to Z-Interop the results received from the reference implementation, the number of records retrieved, and the adequacy of the Z-Interop participant's Z39.50 client application to display MARC 21 records.

5.b. Z-Interop Participants Testing Z39.50 Server

Z-Interop participants who want to test a Z39.50 server implementation need to do the following:

- **Sign agreement for appropriate use of OCLC WorldCat MARC 21 test records:** Z-Interop has obligations to OCLC to ensure the appropriate use of the test dataset of MARC 21 records contributed by OCLC. Z-Interop participants must sign an appropriate use agreement that describes how they may use these MARC 21 records. Attachment B includes the agreement. A signed copy must be sent to the Principal Investigator (fax or mail). A copy of the agreement is available on the Z-Interop website to print out.
- **Load the MARC 21 test dataset:** When Z-Interop has received the signed agreement, the Z-Interop participant will be sent a file of the test dataset (approximately 400,000 MARC 21 records). Z-Interop participants will load these records on their systems and name the Z39.50 database **zinterop**.
- **Configure Z39.50 server to support the following Bath Profile and US National Profile searches:**
    - Title Search – Keyword
    - Subject Search – Keyword
    - Author Search – Keyword
    - Any Search – Keyword
- **Prepare the database to support test searches:** Z-Interop participants can choose how to index the MARC21 to support the test searches. Z-Interop has developed guidelines for indexing MARC 21 records to support profile-defined searches (see Z-Interop document **Indexing Guidelines to Support Z39.50 Searches**). These guidelines are available on the Z-Interop website. Z-Interop participants are not obligated to use these guidelines.
- **Contact Z-Interop when ready to receive searches:** After configuration and indexing are completed, the Z-Interop participant will contact Z-Interop to indicate readiness to accept test searches. The Z-Interop participant will provide the following information:
    - **Hostname for Z39.50 Server**
    - **IP Address for Z39.50 Server**
    - **Port Number for Z39.50 Server**
    - **Database Name** Note: Z-Interop participants should name the database **"zinterop".**
- When this information is received, Z-Interop staff will issue the test searches from the Z39.50 client reference implementation.

6. Interoperability Test Results

As noted in Section 4, Z-Interop will maintain the confidentiality of test results. Individual Z-Interop participant's test results will be made available on a secure website. Z-Interop may use the test results in publications and reports, but only aggregate results will be used (i.e., no individual participant's name will be associated with specific test results).

Z-Interop participants may use their individual test results in any manner. If Z-Interop participants make their test results public (e.g., in marketing a product), any inquiries to Z-Interop about the accuracy of a Z-Interop participant's claim of interoperability test results will be responded to only after Z-Interop has consulted with the individual participant.

Attachment A: Information To Be Supplied by Participants

All Z-Interop participants must provide the Z39.50 Interoperability Testbed Project information through the online data collection forms at: **http://www.unt.edu/zinterop/zParticipants/**. The following indicates the information Z-Interop participants will need to provide.

Organization Information

Organization Name
Homepage URL
Mailing Address
Type of Organization (Integrated Library System Vendor, Z39.50 Developer/Vendor, Library)

Your Information

Your Name
Your Job Title/Position
Your Email
Your Telephone Number
Your Fax Number

Information About Contact Person For Testing

Name
Email Address
Telephone Number
Fax Number

Are You Interested In Testing

Z-server
Z-client
Both

Questions Related To Knowledge Of And Support For The Bath Profile

To what extent are you familiar with the Bath Profile: an international Z39.50 specification for library applications and resource discovery (Very Familiar, Somewhat Familiar, Not Familiar).

To what extent do you think your Z39.50 server is conformant with Bath Profile, Functional Area A, Level 0, at this time? (Fully Conformation, Somewhat Conformant, Not Conformant At This Point, None of the Above)

If you answered Somewhat Conformant in, please indicate the specifications to which your Z39.50 server does not conform

If you answered Not Conformant At This Point, please describe your plans to bring your Z39.50 server into conformance.

To what extent do you think your Z39.50 client is conformant with Bath Profile, Functional Area A, Level 0, at this time? (Fully Conformation, Somewhat Conformant, Not Conformant At This Point, None of the Above)

If you answered Somewhat Conformant, please indicate the specifications to which your Z39.50 client does not conform

If you answered Not Conformant At This Point, please describe your plans to bring your Z39.50 client into conformance.

To what extent are you familiar with the draft US National Z39.50 Profile for Library Applications? (Very Familiar, Somewhat Familiar, Not Familiar)

What are the two most important reasons for conforming to Z39.50 profiles such as the Bath Profile or the U.S. National Profile?

Which specifications of the Bath Profile, Functional Area A, Level 0, were or will be most difficult to achieve conformance?

Attribute combinations required for specific searches: All searches are Keyword. You may choose more than one answer.

Author Search
Title Search
Subject Search
Any Search
Not a problem

Record Syntaxes Required

MARC 21
SUTRS
XML
Not a problem

Specific searches because of limitations in current online catalog system (e.g., search functionality or indexing constraints) All searches are Keyword. You may choose more than one answer.

Author Search
Title Search
Subject Search
Any Search
Not a problem

Named results sets

What are the three most important benefits a Z39.50 interoperability testbed offers your organization?

If interoperability testing results point to specific changes that need to be made in your Z39.50 client, Z39.50 server, or online catalog system configuration, will your organization make the necessary changes?

If you answered No, please explain.

Do you have the capability and resources to reconfigure your Z39.50 client, Z39.50 server, or indexing policies of your online catalogue to better conform to the Bath Profile, Functional Area A, Level 0 specification? Please explain.

For Participants Testing Z-Clients

Name of Z-client product
Version of Z-client product
Operating system
Protocol version
Z39.50 services supported
Attribute sets supported
Record syntaxes supported

Code base of client (e.g. YAZ, ICONE, other?)
Is your Z-client a commercial product? (Yes, No)
Is your Z-client available for public download? (Yes, Yes for evaluation, No)

For Participants Testing Z-Servers

Name of Z-server product
Version of Z-server product
Operating system
Protocol version
Z39.50 services supported
Attribute sets supported
Record syntaxes supported

Code base of server (e.g. YAZ, ICONE, other?)
Is your Z-server a commercial product? (Yes, No)
Is your Z-server available for public download? (Yes, Yes for evaluation, No)

Information Retrieval or Online Catalog System Details:

Name of system product
Version of system product
Underlying database management system(s)

Attachment B: Agreement for Appropriate Use of OCLC WorldCat MARC 21 Test Dataset

Z-Interop participants who want to test their Z39.50 server implementations will be sent the test dataset of approximately 400,000 MARC 21 records from the OCLC WorldCat database. Before Z-Interop provides the test dataset, Z-Interop participants must sign and return to the Principal Investigator the following appropriate use agreement. Go to the Z-Interop website to print a copy of this agreement, sign, and return to Dr. William E. Moen at the address specified in the agreement.

****

Agreement for the Appropriate Use of Test Dataset
by Participants in the Z39.50 Interoperability Testbed

This agreement prescribes the appropriate use of Test Dataset by participants in the University of North Texas Z39.50 Interoperability Testbed Project (Z-Interop). The Test Dataset comprises approximately 400,000 MARC 21 records from OCLC's WordCat database. Z-Interop has signed an agreement with OCLC for the use of these records, the use of which includes providing a copy of the test dataset to organizations who participate in the Z-Interop testbed for evaluating their Z39.50 server implementations. The agreement between OCLC and the University of North Texas includes the following:

> "UNT may grant access to copies of WorldCat Records, or derivative works from or compilations including such Records to libraries and educational institutions for noncommercial, research purposes as described herein. Should UNT make WorldCat Records available to for-profit entities, UNT shall enter into a third party agreement similar to the form of OCLC's third party agreement hereto as Attachment A."

For-profit organizations wishing to participate in the Z-Interop testbed to test Z39.50 server implementations will receive a full copy of the test dataset to load on their systems upon receipt by Z-Interop of a signed copy of the following Third-Party Vendor Agreement.

THIRD-PARTY VENDOR AGREEMENT

This agreement ("Agreement"), effective as of the date on which executed by both parties hereto, by and between the University of North Texas ("UNT") a not-for profit institution organized and existing under the laws of the State of Texas, and ____

____,

a corporation organized and existing under the laws of the State of ____________, (hereafter referred to as "Vendor").

Whereas, Vendor has indicated its interest in testing its Z39.50 server implementation in the Z39.50 Interoperability Testbed Project ("Project"), and has read the Z39.50 Interoperability Testbed (Z-Interop) Policies and Procedures; and

Whereas UNT will make available to Vendor a copy of the Z-Interop Test Dataset of bibliographic records derived from the online database of such information maintained and owned by OCLC Online Computer Library Center, Incorporated (hereinafter "OCLC-Derived Records"); and

Whereas for UNT to make OCLC-Derived Records available to Vendor, it is necessary that Vendor provide assurances concerning its use of such records.

Now, therefore, in consideration of the premises and other valuable consideration, UNT and Vendor agree as follows:

1. During the term of this agreement, all present and future contracts between UNT and Vendor will be deemed amended to include the terms of this agreement as to all OCLC-Derived Records furnished hereunder.

2. Vendor will make no copies and no use of the OCLC-Derived Records except as necessary to prepare its systems for interoperability testing through the Z-Interop testbed.

3. Vendor acknowledges that delivery of the OCLC-Derived Records to Vendor des not represent a transfer of ownership or license of said records or any copies thereof, other than provided herein.

4. Vendor agrees that it will not transfer or otherwise make available OCLC-Derived Records or copies thereof or derivative works made therefrom to any third party, and will promptly return to UNT at the termination of this agreement all OCLC-Derived Records received in connection with the Project.

5. This Agreement is terminable by either party hereto at any time, with or without cause, by thirty (30) days prior written notices sent by prepaid registered or certified first-class mail, with return receipt requested, to:

Dr. William E. Moen
The Z39.50 Interoperability Testbed Principal Investigator
School of Library and Information Sciences
ISB, Room 205
205 Chestnut Street
P.O. Box 311068
Denton, Texas 76203-1068

and to OCLC Online Computer Library Center, Incorporated
6565 Frantz Road
Dublin, OH 43017
Attention: General Counsel

Such addresses may be changed by UNT and by OCLC by written notice to Vendor sent by prepaid registered or certified first-class mail, with return receipt requested, to:

____________________________________ (Vendor)

____

____

Attention: ____________________________

All notices given in accordance with this Section 4 shall be deemed given on the date of proper deposit in the U.S. mail.

6. OCLC Online Computer Library Center, Incorporated is intended to be a third party beneficiary of this Agreement.

7. Vendor's obligations under this Agreement, as they affect any Contract which has become effective prior to the termination hereof, shall survive any such termination.

8. This Agreement is the final, complete and exclusive statement of agreement between UNT and Vendor with respect to the Project, and may not be terminated (other than provided in Section 4 above), amended or canceled except by a writing signed by both parties hereto and, as a condition precedent to the effectiveness thereof, with a copy thereof furnished by UNT to OCLC by the same means and at the same address as provided in Section 4 above. No waiver of any provisions of this Agreement or of any right hereunder shall be deemed a further waiver of such provision or right, or a waiver of any other provision or right hereunder.

In WITNESS WHEREOF, the parties have executed this Agreement as of the dates indicated below.

University of North Texas

Date: ______________________ By: _____________________________

Title: ____________________________

___________________________ (Vendor)

Date: ______________________ By: _____________________________

Title: ____________________________

Appendix E: Automating Interoperability Testbed Procedures

This appendix presents information about the automatic procedures that were developed as part of the research and development for the Z-Interop interoperability testbed.

SYSTEM PLATFORM AND ENVIRONMENT

The Z-Interoperability testing system was originally implemented on a Unix machine procured by funds from the School of Library and Information Sciences and the University of North Texas. The Unix machine is a Sun E200 rack-mounted computer running the Solaris 2.8 operating system. The following are the required utilities and software modules that was used for this project: Perl5, MySQL, Textutils, MARC.PM, and GNU Plot.

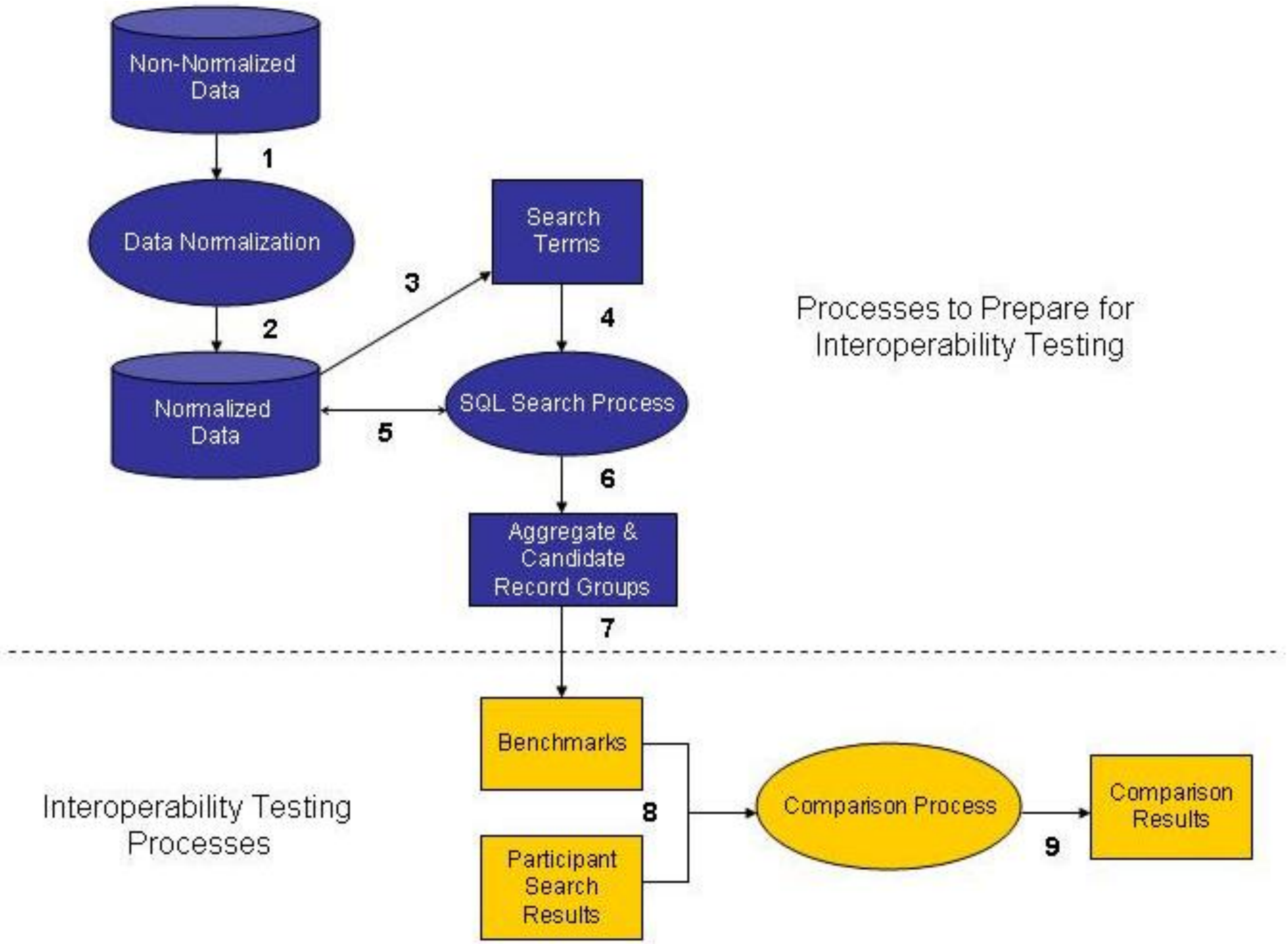
THE Z INTEROPERABILITY SYSTEM DIRECTORIES

The programmer for the Z-Interop Project organized the data and programs used in the interoperability system into a set of directories. These are named and described in the following table.

Directory	Description of Contents
/bookware-data	This directory contains the entire search results from Bookwhere, which is used for storage purpose only.
/comparison-data	This directory is a working directory used by the system to compare the search results from the MySQL database to the Bookwhere results.
/comparison-results	This directory contains the comparison results.
/incoming-data	This directory contains the newly retrieved Bookwhere results that need to be compared with the MySQL database results.
/norm-data	This directory contains the normalized data in a text file format, which is loaded to the MySQL database.
/menu	This directory contains files that relate to sub-menus.
/plot	This directory is used to plot the decomposed data based on its frequency count.
/report	This directory contains the query results from the MySQL database that contains the 33+ million decomposed records that were used in this study. This report directory contains both keyword and truncation types of searches.

Directory	Description of Contents
/report-boolean	This directory contains the Boolean query results from the MySQL database.
/report-freq	This directory contains files that are related to the various types of frequency count that are related to this study.
/report-plot	This directory contains various files that plots the decomposed data.
/report-misc	This directory contains miscellaneous reports.
/report-phrase	This directory contains phrase based search results from the MySQL database.
/report-word	This directory contains various keyword-based database views. The word based database views are used for improving search speed where searching through the entire MySQL database takes too long.
/script	This directory contains the various Perl and Unix Shell scripts that are need by the system.
/se	This directory contains the MySQL queries needed by the system.
/source-data	This directory contains the original un-normalized decomposed data.
/sql-data-view	This directory contains the title, author, subject, and any search database views.
/term	This directory contains the selected terms based on the frequency count.
/tmp	This directory is a system temporary directory.
/tmp-bench	This directory contains temporary files that are used to establish the benchmark.
/tmp-misc	This directory contains misc. files that are related to making the reports.

The logic of the interoperability testing system is presented in the following illustration. The numbers labeling the different processes serve as references in the tables that follow the illustration. Each of the numbers are referred to as "steps" in the tables.



The following table lists the various procedures and associated processes

PROCEDURE	EQUIVALENT STEPS IN FIGURE 1	MENU ITEM	DESCRIPTION	COMMENT
DATA NORMALIZATION STEPS (DATA NORMALIZATION MENU)	1 & 2	1. data normalization step 1	This is the first data normalization procedure.	Run Menu #1,2,3 sequentially.
		2. data normalization step 2	This is the 2^{nd} data normalization procedure.	
		3. data normalization step 3	This is the 3^{rd} data normalization procedure. It also generates the frequency report of words.	
		4. treat internal character .-- for phrase searching	This option is used to normalize dot hyphen hyphen, ".--", for phrase searches	
LOAD DATABASE (DATA CREATION/LOAD MENU)	Omitted	1. create sample1 SQL table 3. load/reload sample database	Option #1 allows the system to create a MySQL table that contains entire test dataset. Our test dataset is referred as "sample1". Option #3 is used to load/reload decomposed Marc records into MySQL table called "sample1".	Refer to /z/se/create_sample1 for the table definition
		2. create sql views for search terms 4. load/reload search views to database	Option #2 is used to create MySQL tables that is based on each search term. The load/reload option is used to import the results of queries into these MySQL tables. The searches will be done against these views instead of sample1 for faster processing.	Refer to /z/se/search_view for the table definition

PROCEDURE	EQUIVALENT STEPS IN FIGURE 1	MENU ITEM	DESCRIPTION	COMMENT
		51. create phrase title view 52. create phrase subject view 53. create phrase author view 54. create phrase subject view-650x 61. load/reload phrase title view 62. load/reload phrase subject view 63. load/reload phrase author view	Options #51 through #54 are used to create database views that are used for phrase searches. Options #61 through #64 are used to load/reload concatenated data into the MySQL database.	Refer to /z/se/phrase-title-view, /z/se/phrase-subject-view, /z/se/phrase-author-view for the table definition.
	Omitted	71. create smaller sample size index number (100,000) 72. create smaller sample dataset	Option #71 and #72 are required steps to reduce the size of original 419,657 MARC records to 100,000 MARC records.	Reducing MARC records are an optional component of Z-Interoperability test.
SEARCH PROCESS (SEARCH PROCESS MENU)	5	2. search term 3. search term -truncation 31. search term -boolean	These options are used to perform queries against MySQL database using the selected search terms. The results are saved under /report, /report-truncation, /report-boolean	Refer to documentation that contains actual search terms that are used for this study
		410 search title phrase - exact match 411 search title phrase - 1st words in field 412 search title phrase - 1st characters in field 420 search author phrase - exact match 421 search author phrase - 1st words in field 422 search author phrase - 1st characters in field 430 search subject phrase - exact match 431 search subject phrase - 1st words in field 432 search subject phrase - 1st characters in field	These options are used to perform the phrase searches: title, author, and subject. For each basic type of phrase search, additional type of searches are performed: exact, 1st words in field, and 1st characters in field.	

PROCEDURE	EQUIVALENT STEPS IN FIGURE 1	MENU ITEM	DESCRIPTION	COMMENT
COMPARISON PROCESS (DATA COMPARISON MENU)	8	1. compare Bookware results with benchmark results 3. summarize comparison report	Option #1 is used to compare the Bookwhere results with the benchmark. Option #3 is used to produce comparison report summary. The summary file saved as /z/name of the participant/summary	Perform this step after completing the search process.
DATA TRANSFORMATION (DATA TRANSFORMATION MENU)	Omitted	1. transform title field for phrase searching 2. transform subject field for phrase searching 3. transform author field for phrase searching	These options are used to transform decomposed data set. As a result of transformation, the decomposed records are concatenated based on MARC fields.	
		4. transform original marc dataset to ascii		
		5. extract 100,000 marc records from original marc dataset and save in marc 6. extract 100,000 marc records from original marc dataset and save in ascii		
MISC TASKS (MISCELLENEOUS REPORT MENU)	8	9. create benchmark record by combining candidate record and Z+ record	This option is used to create the final benchmark.	
	3	10. select candidate records for phrase search - title exact 11. select candidate records for phrase search - author exact 12. select candidate records for phrase search - subject exact	This option helps to select potential phrases for the phrase searches.	
	omitted	31. MARC records that do not contain 650a	This option is used to retrieve subject related records that do not contain MARC field 650 with subfield code a. This option is only used for analyzing MARC records.	
	omitted	50. system backup to /usr/local/backup	This option is used to making backups.	

PROCEDURE	EQUIVALENT STEPS IN FIGURE 1	MENU ITEM	DESCRIPTION	COMMENT
	omitted	51. cleanup temporary directory	This option is used clean temporary directory /tmp	
FREQUENCT REPORT (FREQUENCY REPORT MENU)	omitted	2. freq. report of dataset 4. freq. count of misc records 21. freq. count of field 22. freq. count of phrases - title field 23. freq. count of phrases - author field 24. freq. count of phrases - subject field 25. freq. count of encoding (leader 17) 30. freq. count of MARC records - at least one occurrence of 650a 31. freq. count of MARC records - at least one occurrence of 650x 200. freq. count of .-- 201. freq. count of words in sample, title, author, and subject	These options are used generate various frequency reports.	

The following table lists the procedures and the associated scripts and output files generated as a result of the processes.

PROCEDURES	MENU ITEMS	SCRIPTS/MYSQL FILES	OUTPUT DIRECTORIES/FILES
Data normalization Steps (Data Normalization Menu)	1. data normalization step 1	/z/script/norm.7-1	/z/norm-data/w1.fil2
	2. data normalization step 2	/z/script/norm.7-2	/z/norm-data/w1.fil3
	3. data normalization step 3	/z/script/norm.7-3	/z/norm-data/sample_norm /z/norm-data/sample.freq.report
	4. treat internal character .-- for phrase searching	/z/script/treatphh	/z/sql-data-view/title-phrase-conc-fin /z/sql-data-view/author-phrase-conc-fin /z/sql-data-view/subject-phrase-conc-fin
Load Database (Data Creation/Load Menu)	1. create sample1 SQL table 3. load/reload sample database	/z/se/create_sample1 /z/se/reload_s	MySQL table: SAMPLE1 MySQL table: SAMPLE1
	2. create sql views for search terms 4. load/reload search views to database	/z/se/create_search_view_int /z/se/search_view_int /z/se/load_searchview_int	MySQL tables: aaggregate_int, baggregate_int, title_int, author_int, subject_int, any_int MySQL tables: aaggregate_int, baggregate_int, title_int, author_int, subject_int, any_int
	51. create phrase title view 52. create phrase subject view 53. create phrase author view 54. create phrase subject view-650x 61. load/reload phrase title view 62. load/reload phrase subject view 63. load/reload phrase author view	/z/se/phrase-title-view /z/se/phrase-title-view1 /z/se/phrase-subject-view /z/se/phrase-subject-view1 /z/se/phrase-author-view /z/se/phrase-author-view1 /z/se/phrase-subject-view-650x /z/se/phrase-subject-view-650x1 /z/se/load-phrase-title-view /z/se/load-phrase-subject-view /z/se/load-phrase-author-view	/z/sql-data-view/title-phrase /z/sql-data-view/title-phrase1 /z/sql-data-view/subject-phrase /z/sql-data-view/subject-phrase1 /z/sql-data-view/author-phrase /z/sql-data-view/author-phrase1 /z/sql-data-view/subject-phrase /z/sql-data-view/subject-phrase MySQL table: title_phrase_view MySQL table: subject_phrase_view MySQL table: author_phrase_view
	71. create smaller sample size index number (100,000) 72. create smaller sample dataset	/z/script/rand.pl /z/script/sample_reduce	/z/report-misc/randsample1 /z/norm-data/sample_reduced'
SEARCH PROCESS	2. search term 3. search term -truncation 31. search term –boolean	/z/se/search_int /z/se/search_int_tr /z/script/search_Boolean	./z/report/myterm directory /z/report/myterm.TR directory /z/report-boolean directory

PROCEDURES	MENU ITEMS	SCRIPTS/MYSQL FILES	OUTPUT DIRECTORIES/FILES
	410 search title phrase - exact match 411 search title phrase - 1st words in field 412 search title phrase - 1st characters in field 420 search author phrase - exact match 421 search author phrase - 1st words in field 422 search author phrase - 1st characters in field 430 search subject phrase - exact match 431 search subject phrase - 1st words in field 432 search subject phrase - 1st characters in field	/z/script/search_title_phrase_ex /z/se/search2_title_ex /z/script/search_title_phrase_1stw /z/se/search2_title_1stw /z/script/search_title_phrase_1stc /z/se/search2_title_1stc /z/script/search_author_phrase_ex /z/se/search2_author_ex /z/script/search_author_phrase_1stw /z/se/search2_author_1stw /z/script/search_author_phrase_1stc /z/se/search2_author_1stc /z/script/search_subject_phrase_ex /z/se/search2_subject_ex /z/script/search_subject_phrase_1stw /z/se/search2_subject_1stw /z/script/search_subject_phrase_1stc /z/se/search2_subject_1stc	/z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory /z/report-phrase directory
COMPARISON PROCESS	1. compare Bookware results with benchmark results 3. summarize comparison report	/z/script/copytodata1 /z/script/summarizecomparison	/z/comparison-results directory /z/comparison-results/nameofparticipant/summary
DATA TRANSFORMATION	1. transform title field for phrase searching 2. transform subject field for phrase searching 3. transform author field for phrase searching	/z/script/transf-tit /z/script/transf-sub /z/script/transf-aut	/z/sql-data-view/title-phrase-conc-fin /z/sql-data-view/subject-phrase-conc-fin /z/sql-data-view/author-phrase-conc-fin
	4. transform original marc dataset to ascii	/z/script/transf-MARC	/z/source-data/Sample.marc.ascii

PROCEDURES	MENU ITEMS	SCRIPTS/MYSQL FILES	OUTPUT DIRECTORIES/FILES
	5. extract 100,000 marc records from original marc dataset and save in marc 6. extract 100,000 marc records from original marc dataset and save in ascii	/z/script/sample_reduce_MARC /z/script/sample_reduce_MARC_ascii	/z/source-data/Sample.marc.reduced.usmarc /z/source-data/Sample.marc.reduced.ascii
MISCELLENSOUS TASKS	9. create benchmark record by combining candidate record and Z+ record	/z/script/bench-make	/z/report, /z/report-boolean directory
	10. select candidate records for phrase search - title exact 11. select candidate records for phrase search - author exact 12. select candidate records for phrase search - subject exact	/z/se/select_can_pr_t /z/se/select_can_pr_a /z/se/select_can_pr_s	/z/report-misc/candidatephrase_ex_title directory /z/report-misc/candidatephrase_ex_author directory /z/report-misc/candidatephrase_ex_subject directory
	31. MARC records that do not contain 650a	/z/script/650-not	/z/report-misc/650a-not
	50. system backup to /usr/local/backup	/z/script/backup	/usr/local directory
	51. cleanup temporary directory	None	

PROCEDURES	MENU ITEMS	SCRIPTS/MYSQL FILES	OUTPUT DIRECTORIES/FILES
FREQUENCY REPORT	2. freq. report of dataset 4. freq. count of misc records 21. freq. count of field 22. freq. count of phrases - title field 23. freq. count of phrases - author field 24. freq. count of phrases - subject field 25. freq. count of encoding (leader 17) 30. freq. count of MARC records - at least one occurrence of 650a 31. freq. count of MARC records - at least one occurrence of 650x 200. freq. count of .-- 201. freq. count of words in sample, title, author, and subject	none /z/script/misc.1 /z/script/count-field /z/script/count-phrase /z/script/count-phrase /z/script/count-phrase /z/script/encoding-freq /z/script/transf-sub-650a /z/script/transf-sub-650x /z/script/count-phh /z/script/count-words	/z/report-freq/sorted.freq.report /z/misc.report /z/report-misc/freq-field1 /z/report-freq/phrase/title-phrase-conc directory /z/report-freq/phrase/author-phrase-conc directory /z/report-freq/phrase/subject-phrase-conc directory /z/report-misc/encoding-freq /z/report-misc/650a-1 /z/report-misc/650x-1 /z/report-misc/freq-phh /z/report-misc/freq-words

Appendix F: Call for Participation in Z39.50 Interoperability Testbed

[See following pages.]

The Z39.50 Interoperability Testbed

Call for Participation

The Z39.50 Interoperability Testbed (Z–Interop) Project <http://www.unt.edu/zinterop> invites integrated library system vendors, Z39.50 developers, and individual libraries to participate in Phase 1 interoperability testing.

Z–Interop is an applied research and demonstration project funded by the U.S. federal Institute of Museum and Library Services <http://www.imls.gov> through a National Leadership Grant awarded the School of Library and Information Sciences <http://www.unt.edu/slis> and the Texas Center for Digital Knowledge <http://www.txcdk.org> at University of North Texas (UNT). The goal of Z–Interop is to improve Z39.50 semantic interoperability among libraries for information access and resource sharing.

The mission of Z–Interop is to:

- Provide a technically and organizationally trusted environment for vendors and consumers of Z39.50 products to demonstrate and evaluate those products
- Develop rigorous methodologies, test scenarios, and procedures to measure and assess interoperability
- Demonstrate and operate a Z39.50 interoperability testbed.

Z–Interop provides a testing environment for Z39.50 clients and servers used in library applications. Specifically, Z–Interop will provide testing for Z39.50 clients and servers configured to support the *Bath Profile: An International Z39.50 Specification for Library Applications* <http://www.nlc-bnc.ca/bath/bp-current.htm> or the *U.S. National Z39.50 Profile for Library Applications* (current draft <http://www.unt.edu/zprofile/Profile/specifications.htm>).

Phase 1 testing focuses on validating Z–Interop methodologies, policies, and procedures. Phase 1 will test the following searches from the two profiles:

- Author Search – Keyword (Bath/US Profile)
- Title Search – Keyword (Bath/US Profile)
- Subject Search – Keyword (Bath/US Profile)
- Any Search – Keyword (Bath/US Profile)

Required retrieval record syntax is MARC 21. The search and retrieval requirements are derived from the profiles' Functional Area A, Level 0 conformance specifications.

Interoperability testing will be governed by policies and procedures (available on the Z–Interop website). The policies and procedures detail the responsibilities of the Z–Interop project and interoperability testing participants. Individual participant's Phase 1 test results will be shared only with the participant and will not be publicly available.

Zinterop Research, Test & Improve

The Z39.50 Interoperability Testbed

Testing Z39.50 Client Products

If you are interested in testing a Z39.50 client implementation, please send an email message stating your interest to the Principal Investigator <wemoen@unt.edu>. You will be asked to complete and online form to provide information about your organization and Z39.50 product. You will also need to:

- Review the Z–Interop policies and procedures
- Configure your product to send the Z39.50 queries specified in the profiles and to receive MARC 21 records.

When you have completed these steps, Z–Interop will provide you with the test searches to use and the address of the Z–Interop reference implementation Z39.50 target. Z–Interop will analyze the queries sent by your Z39.50 client and provide the results of the testing.

Testing Z39.50 Server Products

If you are interested in testing a Z39.50 server implementation, please send an email message stating your interest to the Principal Investigator <wemoen@unt.edu>. You will be asked to complete and online form to provide information about your organization and Z39.50 product. You will also need to:

- Review the Z–Interop policies and procedures
- Sign an agreement on the appropriate use of the test dataset
- Configure your product to receive the Z39.50 queries specified in the profiles and to return MARC 21 records.

After you have completed these steps, Z–Interop will provide you with the test dataset of 400,000 MARC 21 records to load and index on your system. When you are ready, Z–Interop will send a set of test searches from the Z–Interop reference implementation Z39.50 origin. Z–Interop will compare results of the searches with the benchmarks for the individual searches. Z–Interop will provide you with an analysis of the results.

Z–Interop's goal is to improve interoperability between Z39.50 clients and servers in library applications. Phase 1 testing is a critical step in establishing a trustworthy and useful interoperability testbed. We will do our best to assess your products and implementations, and provide you with reliable information for understanding the extent of your conformance with the profiles' specifications.

[March 12, 2002]

Appendix G: Presentations and Publications

Throughout the Z-Interop Project the Principal Investigator and Z-Interop staff prepared and delivered presentations and papers that disseminated information about the project. Appendix B listed technical reports developed by the project that were publicly available or used internally by the Z-Interop staff. The following list includes all presentations and publications that discussed the Z39.50 interoperability testbed or were informed by work carried out during the project.

Papers

Moen, William E. (2003, December). No longer under our control: The nature and role of standards in the 21st century library. Library of Congress, Luminary Lecture Series, December 3, 2003. Washington, DC. Available URL: <http://www.unt.edu/wmoen/presentations/LuminaryLectureDecember2003.pdf>

Moen, William E. and Benardino, Penelope. (2003, September). Assessing metadata utilization: An analysis of MARC content designation use. In *Proceedings of the 2003 Dublin Core Conference*, Seattle, WA. Available URL: <http://www.siderean.com/dc2003/502_Paper58.pdf>

Moen, William E., Murray, Kathleen R., and Lopatovska, Irene. (forthcoming in 2004). Optimizing resource discovery service interfaces in statewide virtual libraries: The library of Texas challenge. In *Libraries Without Walls 5: The Distributed Delivery of Library and Information Services*. London: Facet Publishing.

Moen, William E. (2001). Interoperability and Z39.50 Profiles: The Bath and U.S. National Profiles for Library Applications. *ALCTS Newsletter Online, From Catalog to Gateway*, 12(4) Winter 2001.

Moen, William E. (2001, November). The Z39.50 interoperability testbed, phase 1 testing. *(In Brief) D-Lib Magazine,* 7(11). Available URL: <http://www.dlib.org/dlib/november01/11inbrief.html#MOEN>

Moen, William E. (2001). Improving Z39.50 interoperability: Z39.50 profiles and testbeds for library applications. (August 2001). In *Conference Papers from the 67th International Federation of Library Associations Council and General Conference on CD*. Boston, MA, August 23, 2001. Available URL: <http://www.ifla.org/IV/ifla67/papers/050-203e.pdf>.

Moen, William E. (2001). Mapping the interoperability landscape for networked information retrieval. In *Proceedings of First ACM/IEEE-CS Joint Conference on Digital Libraries*. Roanoke, VA, June 24-28, 2001 (pp. 50-52). New York: The Association for Computing Machinery, 2001.

Moen, William E. (2001). Assessing interoperability in the networked environment: Standards, evaluation, and testbeds in the context of Z39.50. In *Evaluating Networked Information Services: Techniques, Policy, and Issues* (pp.85-109), edited by Charles R. McClure and John Carlo Bertot, Publisher: ASIS thru Information Today, Inc.

Moen, William E. (2001, January). Realizing the vision of networked access to library resources: An applied research and demonstration project to establish and operate a Z39.50 interoperability testbed. *(In Brief) D-Lib Magazine,* 7(1). Available URL: <http://www.dlib.org/dlib/january01/01inbrief.html#MOEN>.

Presentations

Moen, William E. (2003, December). No longer under our control: The nature and role of standards in the 21st century library. Presentation at the Library of Congress, Luminary Lecture Series, December 3, 2003. Washington, DC.
Available URL: <http://www.unt.edu/wmoen/presentations/LuminaryLectureDecember2003.ppt>

Moen, William E. (2003, October). MARC content designation use: Implications for indexing & interoperability. Presentation at South Central Unicorn Users Group Annual Conference, October 17, 2003. Austin, Texas.
Available URL: <http://www.unt.edu/wmoen/presentations/SCUUGConferenceOct2003.ppt>

Moen, William E. (2003, October). Users and metasearch applications: New challenges for usability assessment. Presentation at Access 2003 Conference, October 3, 2003. Vancouver, British Columbia, Canada. Available URL: <http://www.unt.edu/wmoen/presentations/Access2003_Usability_Oct2003.ppt>

Moen, William E. (2003, October). Assessing metadata utilization: An analysis of MARC content designation use. Presentation at Dublin Core Conference 2003, October 1, 2003. Seattle, Washington.
Available URL:
<http://www.unt.edu/wmoen/MoenWork/DublinCore2003/DC2003_MetadataUtilization.ppt>

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Appendix H: Indications of Z-Interop Project Impact

The following are two documents that serve as indicators of the utility of the Z39.50 interoperability testbed. The first is a press release issued at ALA Midwinter 2003 by Fretwell-Downing after completing interoperability testing through the testbed. The second is an email from Ed Riding of Dynix (formerly Epixtech) on its experience with the interoperability testbed.

FRETWELL-DOWNING INC. COMPLIES WITH Z-INTEROPERABILLITY TESTBED PROJECT

Improving Z39.50 semantic interoperability among libraries for information access and resource sharing is the goal behind the Z39.50 interoperability testbed project. Fretwell-Downing Inc. (FD) is pleased to announce that it is the first vendor to successfully test its z-client against a set of structured Bath profile searches in order to comply with the testbed.

In order to comply with the testbed, FD carried out a set of 64 searches taken from Functional Area A Level 0 and Level 1. The results indicate that FD's Z39.50 client can issue the proper attribute combinations for the test searches. In addition, the results also indicated that the FD Z39.50 client could issue appropriately constructed simple Boolean searches using a single operator.

Principal Investigator of the Z39.50 interoperability testbed project, Dr. William E. Moen, comments: "We are pleased that specifications defined in the Bath and U.S National Z39.50 profiles for library applications are being supported by Z39.50 client and server vendors such as Fretwell-Downing. Early interoperability test results demonstrate that interoperability improvements are achievable. We hope that the testbed is providing a valuable service to the broader library and Z39.50 implementation communities."

Commenting on FD's commitment to standards and involvement with the project, Matthew Goldner, Executive Vice President at FD comments: "FD has always pioneered the use of standards and open architecture within its entire product suite. We recognize that vendor interoperability is a key issue in the current marketplace as Librarians are recognizing that you can implement Z39.50 in so many ways. This level of suspicion over the interoperability of Z39.50 implementations is the key reason FD chose to comply with the testbed."

Goldner adds: "We are already finding that customers are insisting that vendors comply with the testbed. The National Capital Region Library Consortium recently selected ZPORTAL software from FD to power its Sm@rtLibrary project due to the company's compliance with the testbed. We are delighted that through complying with a third party certification process such as the testbed, we are now able to have an objective verification of our ability to demonstrate effective interoperability between Z39.50 accessible systems."

Funded by the National Leadership Grant from the U.S. Federal Institute of Museum and Library Services, the testbed are still refining their analysis and reporting mechanism. For further updated information, please visit www.unt.edu/zinterop.

For more than ten years, Fretwell-Downing, Inc. (FD) has been a global leader in the evolution of digital libraries. Delivering unmatched service and flexibility, FD offers libraries a seamless choice of standards-based solutions. Building toward a solid vision of a "library without walls," FD Inc. boasts the unique ability to integrate with disparate electronic library systems, as well as creating and managing entirely new digital systems.

Contact / Further Information From: Fretwell-Downing, Inc., Matt Goldner, Executive Vice President, 1605 East Highway 34, Suite C, Newnan, GA 30265 888-649-6542, E-mail: matt.goldner@fdgroup.com

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Subject: RE: Interop test results for Horizon
Date: Mon, 2 Dec 2002 08:53:12 -0700
Message-ID: <2C69449295950A499F7F89ECF2438E7947761F@usamail1.usa.corp.epixtech>
From: "Ed Riding" <ERiding@epixtech.com>
To: "William E. Moen" <wemoen@unt.edu>,
"Rob Madsen" <RMadsen@epixtech.com>

Bill,

We thank you and your staff for the thorough testing and reporting of test results. You have provided very valuable information for us in refining our Zserver software. We look forward to the results of the Dynix test.

Thanks again for all the planning and execution you've done to provide greater accuracy in cross-system search and retrieval.

- Ed

Appendix I: Usability Assessment for Interoperability

This appendix contains two documents that were developed by the Z-Interop Project and the Principal Investigator that address approaches for conducting user assessment of interoperability. The first in this appendix is User Task Level Interoperability: Preliminary Suggestions for Usability Assessment. It was completed early in the Z-Interop Project. The second document was a result of the intersection of the Z-Interop Project and the work by the Principal Investigator on the Library of Texas Resource Discovery Service. Its title, Optimizing Resource Discovery Service Interfaces in Statewide Virtual Libraries: The Library of Texas Challenge, reflects the influence of the Library of Texas work on the Principal Investigator's evolving ideas on usability assessment procedures.

The Z39.50 Interoperability Testbed

U.S. Federal Institute of Museum and Library Services
National Leadership Grant

Realizing the Vision of
Networked Access to Library Resources:
An Applied Research and Demonstration Project to
Establish and Operate a Z39.50 Interoperability Testbed

User Task Level Interoperability: Preliminary Suggestions for Usability Assessment

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February 2001

User Task Level Interoperability: Preliminary Suggestions for Usability Assessment

Introduction

As stated previously (Moen, 2000), interoperability addresses the extent to which different types of computers, networks, operating systems, and applications work together effectively to exchange information in a useful and meaningful manner. Interoperability can be viewed using a multi-level perspective. The one level that this research has concentrated on is the highest level, the user task level. This level attempts to examine interoperability from the user perspective. The primary goal of this research is to identify factors that may affect the user's assessment of the information retrieval systems interaction, either from research or based on actual user input. Then, using these factors, have the users assess whether or not two systems interact enough to support the information retrieval tasks of one or more user groups.

The Z39.50 protocol underpins interoperability in information retrieval applications, but it can not guarantee it. Other factors can have an affect on interoperability at the user task level. The types of skills, biases, experiences, and expectations the user brings to the system he/she is using can affect their assessment of interoperability. Thus, demographics can play a part in their assessment of systems. The local system can impede interoperability through its design or interface (usability issues). For example, local indexing practices may be different than those of the system being searched, and this may result in "false" results. The quality of a database and the amount of information provided about each database that can be accessed by the local system can affect interoperability. A user may choose the wrong database for searching and thus receive no "hits" and assume that the system is not interoperable. Response times of the system can affect the user's view of interoperability. These are just a few of the factors that have already been identified or are suspected of having an effect on interoperability at the user task level.

The heart of this research has been to look specifically at user satisfaction and usability literature and to identify additional criteria than those stated above that might affect how users assess the interoperability of two systems. This research and any criteria uncovered can then inform the researchers as to what questions should be asked and how to measure the answers to these questions. User satisfaction relates to how well a person thinks/feels about the system(s) they are using. Usability relates to how well a system is designed and implemented.*

User Satisfaction

There certainly has been no research completed on user satisfaction with the type of systems that are going to be the center of this project. Much of the research available has centered on user satisfaction assessments of a single system, whereas, our project involves the assessment of the interaction of a multitude of systems at the same time. This researcher tried to focus on user satisfaction and/or information seeking on OPACs and information retrieval systems, specifically online systems. General user satisfaction studies in the library and information science field were also consulted.

There is a lot of disagreement on how user satisfaction is constructed and how it should be measured. Two researchers, Bruce (1998) and Applegate (1993), seem to come to a similar definition, however. Bruce (1998) states it as "satisfaction with information seeking is a state of mind which represents the composite of a user's material and emotional responses to the information seeking context." Thus, we start to see that satisfaction is not a simple variable to be measured, but a complex one that has a material component and an emotional one.

The conclusion reached is that the best approach is a synthesizing of several different ideas. One approach uses mental models to capture the different aspects of user satisfaction (Applegate, 1993).

Applegate categorizes satisfaction research as following a material satisfaction model approach, emotional satisfaction model-simple path approach, or an emotional satisfaction model-multiple path approach.

Material satisfaction refers to the match between what the user requested and what the user received (Applegate, 1993). The material satisfaction model argues that system features determine system performance, which determines material satisfaction. Applegate (1993) goes on to say that researchers following this model tend to identify and measure system features first, then system performance, and finally material satisfaction. The four traditional variables of system performance measurement are relevance, pertinence, precision, and recall. This model argues that material satisfaction alone informs behavior and it does not allow for the emotional component of satisfaction.

Applegate (1993) states that attempts to measure emotional satisfaction involve attempting to measure the user's actual feeling of "satisfaction." The emotional model - simple approach allows for the emotional component of satisfaction. However, it assumes that emotional satisfaction is determined by material satisfaction only. See the enclosed diagram.

Many researchers have discovered that a user's material satisfaction may be met and that all four system variables listed above may score high, but that the user is still not satisfied with the system. This points to the fact that the user is somehow not emotionally satisfied with using this product and it contradicts the emotional model - simple path. Or, vice versa, the user may be really satisfied with the product, but not have material satisfaction. This is known as a "false positive" and the simple model can not account for this (Applegate, 1993).

Applegate (1993) explains that emotional satisfaction is not just dependent on material satisfaction, but the product setting and disconfirmation. Disconfirmation is defined by Applegate (1993) as, "the difference between a person's expectations of product performance and the actual performance." Thus, there are multiple variables that can affect emotional satisfaction and that is how the model arrived at its name. Applegate (1993) advocates the use of the emotional model - multiple path as seen in the enclosed diagram.

A second approach comes from the information seeking literature. Sugar (1995) talks about the holistic approach to searching behavior, and cites studies that postulate searching is a combination of the user's physical (sensimotor), affective, and cognitive domains. *The physical domain deals with the physical part of searching such as how a user interacts with the system and tools of the system. The affective domain deals with issues such as the user's interests, attitudes, values, and emotions during a search (Sugar, 1995). The cognitive domain is well researched. Sugar (1995) points out studies that suggest certain things are part of the cognitive domain and affect searching behavior such as conceptual, task, visual, verbal, world, system, and domain knowledge. Other cognitive studies that Sugar (1995) cites show that logical reasoning ability, visualization skills, and cognitive style may affect behavior as well. These three domains in information seeking literature overlap, or have a lot in common with usability and the models of user satisfaction that Applegate (1993) discusses.

For example, the material satisfaction model attempts to measure satisfaction based on system performance (as judged by the user) which comes from the cognitive and physical domains of the user in information seeking behavior. Knowing what type of constructs or things that make up these domains and the satisfaction models can help researchers identify specific questions that can specifically identify the part of these domains that are affecting the user's assessment of satisfaction.

Specifically, my recommendation is to develop a set of questions to ask the user based on the physical, affective, and cognitive areas of the search process and the satisfaction models Applegate (1993) discusses. This can be done using a pre-experimental survey or focus group of users before the experiment even begins. For example, physical questions might involve measuring the user's satisfaction with the interface, the design of the system, the usability (which will be discussed in the next section), and with interoperability (as it pertains to the working of the actual system). This pre-testing of users with criteria that we suspect as having an effect on their satisfaction will give us insight as to whether or not the criteria adequately represent/explain their satisfaction levels. If it does not, then user input should be gathered to increase the likelihood that the criteria will.

From the research thus far, we have identified many criteria that may have an effect on user satisfaction. A brief list of these are listed below:

- skills of the user
- biases of the user
- past experience of the user
- expectations of the user
- demographics (age, gender, race, etc.)
    - usability issues (local system design, interface design, local indexing practices, quality of databases, response times, etc.)
    - relevance
    - pertinence
    - precision
    - recall
    - product setting
    - disconfirmation
    - user's interests
    - user's attitudes
    - user's values
    - user's emotions
    - The four different types of knowledge (world, domain, task, system)

Additional research has found that a user's academic discipline in an academic setting can effect a person's searching performance (Borgman, 1988). Ryker (1997) has an interesting article on the relationship between expectations and user satisfaction that may be worth a further glance.

This researcher recommends that several methods be used for testing the criteria. An interview or a questionnaire should be used to obtain demographic information and personal characteristic type information. A questionnaire/survey with Likert scales (for closed questions) should be used for the satisfaction questions during or immediately following the experiment.

The questions themselves (on the survey) should be multivariate, univariate, direct, indirect, and closed with a few open-ended questions. The reason for this, as Applegate (1993) explains, is that definition and measurement for emotional satisfaction are tightly intertwined around two issues: direct vs. indirect and multivariate vs. univariate questions. Direct questions use the word "satisfaction" whereas, indirect questions ask another question that is presumed to reflect on satisfaction. Using both of these and observing whether or not they correlate would be good experimental design. Multivariate questions ask questions about a variety of components and univariate questions ask a universal question. Of course, closed questions are questions that ask for a specific answer and open ended questions allow the user to record their thoughts.

An observer or something to record each session should be in the room with the subject to record any observations that may further explain their satisfaction levels or to record comments made by the subject. A focus group immediately following the experiment might also increase the amount of data (feedback) that is obtained from the users, instead of or in addition to the open-ended questions.

Usability

As stated previously, usability relates to how well a person can use or navigate through a particular system to find what they are looking for. Another definition (Park, 2000) states that the usability of a system refers to the ease of use, ease of learning, and user assessment of specific features. The inclusion of usability as a criterion for interoperability is just as, if not more, important as user satisfaction for this new "product." Interoperability is dependent on usability just as interoperability is dependent on the user's attributes (expectations, experience, etc.), and level of satisfaction. For a user, if a system is not very usable then it will be difficult or near impossible to determine if it is interoperable.

Usability and usability testing are hot topics currently. Most research and information is centered around usability studies of web sites (usually commercial) using consumers. Recently, there has been more information on usability studies for OPACs and databases in the library community. The information that is available on usability testing varies from heuristics to formal prescribed formats. It seems from research that the knowledge surrounding usability testing has arisen from experienced web designers and repeated user experiments.

There are several things that a researcher should be aware of when researching usability. The first is that there is such a thing as "usability inspection" and that it is different than "usability testing." Usability inspections are tests usually conducted by experts in human factors, or other similar usability experts, before the system in question is ever created. Inspections are meant to inform designers/creators of potential problems or flaws in the design of the system. Usability testing is also usually conducted before the final version of the system is made available to the public. Yet, it uses real users, performing real tasks, and is often conducted in a laboratory setting. It also informs the designers of potential problems from the user's point of view. Nielsen and Mack (1994) provide more in-depth descriptions of the differences between inspections and testing.

A second thing to remember is that usability testing is usually conducted before the final version, as stated just previously. For our project, we will be conducting the usability test *after* the system has been created and in use for the public. This may or may not have an effect on how the test will be set up, but it should be kept in mind.

The satisfaction questions that will be asked about the physical areas of the search process (discussed in the User Satisfaction section) can be incorporated into this part of the experiment as well. These questions will tend toward the user's feelings of satisfaction concerning things such as the interface, design, searching mechanisms, etc. Whereas, the usability questions will tend toward the user's ability to operate within the design of the system, comprehend elements of the interface, and their overall ability to complete tasks in the environment of the system.

Suggestions for Future Research

There are some additional readings that are recommended before continuing on this project. The following are more general in nature and/or are about user interfaces:

- Designing the User Interface by Ben Shneiderman. 1998 edition. (Available in the UNT Sci/Tech Library, Call No. QA76.9 H85S54 1998)

- The Psychology of Everyday Things by Donald Norman. 1988. (Available in the UNT Sci/Tech Library, Call No. TS171.4 N67 1988)

- "Information Needs and Uses: Fifty years…" by T.D. Wilson. 1994. In B.C. Vickery (Ed.) Fifty Years of Information Progress: A Journal of Documentation Review. London: Aslib, 15-51. (Available through ILL)

- "Information behavior: an interdisciplinary perspective," by T.D. Wilson. 1997. Information Processing & Management, 33(4), 551-572. (Available through ILL)

The following are highly recommended reading for information concerning usability testing and methodologies:

- Usability Engineering by Jakob Nielsen. 1993. Boston: Academic Press. (Available through ILL)

• A Practical Guide to Usability Testing by Joseph Dumas and Janice Redish. 1993. Norwood, NJ: Ablex. (Available through ILL)

• Handbook of Usability Testing: How to Plan, Design and Conduct Effective Tests by Jeffrey Rubin. 1994. New York: John Wiley & Sons, Inc. (Available through ILL)

As for further thoughts on user satisfaction, the diagram in Applegate's (1993) article on page 55 provides an alternative way of looking at the factors that make-up a user's satisfaction. Her approach is different, but we are basically attempting to get at the same thing. Her diagram may be worth taking a look at.

With any measurement device, there are flaws. The user satisfaction questionnaire is no exception. There has been a lot of criticism of late concerning the use of this device. Opponents argue that it measures the user's own opinion of their satisfaction and not their actual satisfaction. This may be true, but it is still widely used as an accepted means for measuring satisfaction. Bruce (1998) argues for using magnitude estimation as an alternative. This may be a method worth a deeper look.

Due to time constraints, not all of the research on usability is complete. Therefore, the research effort on usability needs to be continued. From what has been uncovered thus far, it seems that the usability testing will involve some type of question development, usually with input from actual users. These questions will then instruct the user to perform certain tasks that are representative of user tasks in general. Some questions will need to be added that purposefully make the user look at some aspect of the site. Chisman's (1999) case study provides a good example of how a usability test was ran in an academic library setting and is good background reading before continuing the research on this topic. The actual testing methods and methodologies need to be researched further and the recommendations listed above are a good place to begin.

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Optimizing Resource Discovery Service Interfaces in Statewide Virtual Libraries: The Library of Texas Challenge

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Introduction

State library agencies in the United States are expanding their traditional services by building statewide virtual libraries offering resource discovery services that take advantage of the intersection of metasearch technology and user demand for access to networked resources. Understanding the information behaviors of various user groups and optimizing resource discovery interfaces for users are critical to the success of statewide virtual libraries.

The Texas Center for Digital Knowledge at the University of North Texas began a multiphase applied research project in 2001 in support of the Library of Texas, a statewide virtual library (www.tsl.state.tx.us/lot/index.html). Working under contract for the Texas State Library and Archives Commission, we addressed the design, configuration and system implementation of the Library of Texas Resource Discovery Service. This work became known as the ZLOT Project (www.unt.edu/zlot). The resource discovery service is one component of the broader Library of Texas initiative.

This paper provides an overview of the Library of Texas Resource Discovery Service, its development and current status. More importantly, we identify usability issues of such resource discovery services and suggest possible approaches for improving and optimizing user and search interfaces of these applications through usability assessment.

The context: resources, services, users

The 21st Century Library, sometimes referred to as a digital or virtual library, involves the deployment of technologies to enhance access to a wide variety of analog and digital information resources. Available technologies and applications have the potential to extend the reach and range users to information resources while reducing the barriers to information access. Libraries have tried various approaches to improve information access in the networked environment. Concepts for these approaches include virtual libraries, resource discovery services, metasearch applications and portals.

There is a wealth of networked information resources available to library users including:

- online catalogs
- licensed databases from commercial vendors
- locally developed databases
- digital repositories
- web resources.

Until recently, these resources were typically offered through separate interfaces. The result was a plethora of resources with the attendant challenges of training users on multiple interfaces. While extending the reach and range of users to networked information resources, the multiple interfaces can be viewed as barriers to effective and efficient information access.

State library agencies have been actively involved in making the resources of their public and academic libraries available to citizens. This effort often involved creating a state library portal. Technology now enables the building of virtual library services that respond to users' needs to access resources more effectively and efficiently regardless of the geographic location of users or resources.

A resource discovery service offered by a virtual library is another innovation to help users connect with information. Resource discovery services can take the form of metasearch applications; users can search multiple targets concurrently through a single search interface. Improving resource discovery tools can directly affect the capability of users to find information from an array of digital and analog resources. The first generation of commercially available resource discovery applications have been implemented by single libraries to provide integrated access to local and remote resources, by consortia to leverage access to consortium members' resources and by statewide virtual library initiatives (e.g., the Library of Texas, the Colorado Virtual Library and the Illinois Find It! application).

With several virtual libraries now in place, there is an opportunity to assess their use and usability by citizens and to understand changing patterns of information need, use and information seeking behaviors supported by these initiatives. One of the first challenges is to identify and characterize potential users of resource discovery services. While it may be assumed that current library users will use the resource discovery service, there may be an untapped market of users who rely on networked information for resolving information needs but who currently do not visit libraries and use their resources. With a clearer understanding of potential users of a resource discovery service, it may be possible to expand the current constituent and service base of bricks and mortar libraries through the virtual library.

Diversity in users' information seeking behaviors and needs requires developers to design effective and efficient interfaces for resource discovery services. Both user selection of resource collections to search and user selection of specific resources from search results are critical tasks that engage users of the virtual library. The usability of the resource discovery service directly impacts the successful fulfillment of user information needs and, by extension, the overall success of a virtual library.

Given a resource discovery service as an entry point to networked information, new usability issues emerge. Users may be comfortable with searching a single database or single library catalog or other single system. They may have an understanding of the authority, coverage, quality and other important facets of the single resource. The metasearch environment, however, potentially requires users to develop a new mental model for interacting with multiple distributed resources through a metasearch interface.

We are entering a new era of information access that takes as its starting point access to distributed resources. There is a need for a better understanding of user information needs and information seeking behaviors in the context of distributed search and retrieval. Much as we might transfer many of the services of a physical library environment to a virtual library, the interfaces to virtual library service are quite different from physical library access of the past. Our initial conception both of the services and the interfaces to the virtual library are based in large part on our collective experience in the traditional library. We can expect that as access to the virtual library enters the homes of citizens, current and potential users will define new requirements. Now is an ideal time in the maturation cycle of the statewide virtual library concept to identify the characteristics of effective interfaces for virtual libraries and their resource discovery services.

The Library of Texas

The Library of Texas (LOT) is envisioned as a service-based virtual library. It is a project of the Texas State Library and Archives Commission (TSLAC) and the Texas Telecommunications Infrastructure Fund Board and was conceived both as a mechanism for extending the reach and range of Texans to the resources of Texas libraries and for expanding library services through the development and integration of new technologies. Although in its formative stages, the LOT enables Texans access to an extensive array of resources including Texas library catalogs and electronic databases licensed by the TSLAC for statewide use. The LOT initiative includes four basic components:

1. Providing a statewide resource discovery service
2. Offering a wide selection of commercial databases licensed for Texas academic and public library users
3. Indexing and preserving electronic government documents
4. Training librarians on electronic resources.

This paper focuses on the LOT Resource Discovery Service.

The LOT Resource Discovery Service

A virtual library can extend the reach and range of users across organizational, collection and format boundaries. Yet users face the same challenge they do with Web search engines: identifying relevant materials. A resource discovery service provides users with a variety of tools and approaches for discovering the existence of appropriate resources. Typically, a user will search one or more targets to find, identify, select and access/acquire resources. Two categories of searching can be identified:

- **Single database searching:** Users search a single target through a common interface.
- **Broadcast searching:** Users concurrently search two or more targets. These targets can be very similar or quite diverse:
    -

A primary goal of a resource discovery service is to provide users with a coherent view of disparate resources. Resource discovery approaches will likely require new levels of technology integration and enhanced interoperability among systems. The Library of Texas Resource Discovery Service (LOT RDS) corresponds with the foregoing description.

Requirements for the LOT RDS

To support the design of the LOT RDS, ZLOT Project staff conducted a series of focus groups in Spring 2002. Focus group participants were selected from stakeholder groups representing a spectrum of potential users of the LOT. All participants were library and information professionals from Texas, including reference librarians in small public libraries, library directors in large academic libraries, interlibrary loan service specialists and an executive director of a medical research library.

The needs and expectations discussed in the focus groups informed draft requirements for the LOT RDS. A ZLOT Project Advisory Group reviewed and discussed the draft requirements, and ZLOT staff refined the functional requirements. The result was a list of 53 functional requirements for the resource discovery service prioritized subsequently by the advisory group into three levels: 1) must meet requirements, 2) should meet requirements, 3) desirable that systems meet requirements. The process of defining the requirements was of equal importance to the specific requirements themselves. The iterative process used to identify, clarify and prioritize the requirements enabled a wide range of librarians to be involved and to help shape the emerging resource discovery service.

A full description of the 53 functional requirements is available in the document *Functional Requirements for the Library of Texas Resource Discovery Service* (Moen & Murray, 2002). Functional requirements fell into two main categories:

- Requirements for Texas library catalogs for interoperable searching
- Requirements for the resource discovery service's search and retrieval interface.

Multiple online catalogs may be searched using the resource discovery service. To improve the effectiveness of searches and the utility of results, there is a need to provide common search capabilities across library catalogs and to use technical standards to improve interoperability. The LOT uses standards as a basis for interoperability among systems.

Another important aspect to the resource discovery service is the creation of a common user interface to search and retrieve across different online catalogs and other databases. A common interface to these resources minimizes user training; users will learn only one interface rather than separate interfaces for different online resources. An intuitive, web-based, simple-to-use interface was imperative.

Current status of the LOT RDS

In January 2003, TSLAC issued a Request for Proposal (RFP) for the LOT RDS application. In late Spring 2003, TSLAC awarded a contract for the application to Index Data (http://indexdata.dk/). By August 2003, the first version of the LOT RDS was completed. TSLAC will begin deployment of the LOT RDS in Fall 2003. Table 1 provides a summary of key features and functionality of the service.

<table>
<tr><th>Search targets available</th><th>Search target selections options</th></tr>
<tr><td rowspan="3">• 20+ academic library catalogs
• 50+ public library catalogs
• 40+ licensed databases
• Other special collections</td><td>• By type of library
• By subject area
• By strength of collection in subject area
• By geographic proximity</td></tr>
<tr><td>Search capabilities</td></tr>
<tr><td>• Simple Google-like keyword search
• Advanced, fielded searching
• Date of publication qualifying search</td></tr>
<tr><td>Retrieval display capabilities</td><td>Accessing and obtaining actual object</td></tr>
<tr><td>• Brief record hit list grouped by:
  o Search target
  o All records sorted by title
  o All records sorted by date
• Full record display
• MARC display option</td><td>• If free online resource, direct connection to the object
• If licensed online resource, authenticated connection to the object
• If non-digital (e.g., printed book), connection to online bookstores to order
• If non-digital (e.g., printed book), initiation of an interlibrary loan request</td></tr>
<tr><td>Persistent authorization</td><td>Personalization</td></tr>
<tr><td>• Single login for session
  o IP authorization
  o Username/Password authorization</td><td>• Persistent user-defined sets of search targets
• Search history</td></tr>
</table>

Table 1
Summary of LOT RDS Key Features and Functionality

Usability framework for resource discovery services

The purpose of this section is to propose a framework for addressing the multiple aspects of usability for the LOT RDS. The authors assert that a range of factors will impinge on the user's assessment of the usability of the service. The goal of usability assessment must be: *Contribute to the improvement of resource discovery tools and applications that will ultimately provide users with more efficient and effective access to information resources in the distributed search environment.* Three key areas comprise the framework: 1) users, 2) the application and its interacting components, 3) usability criteria and measures.

Users and user groups

The first area that needs attention is the individual users or user groups. The LOT RDS focus groups indicated that different user communities exist within the state, that the needs of these communities may differ radically and that an individual user could belong to more than one group. Additionally, we anticipate that both existing library users and people who do not currently use libraries may interact with the LOT RDS. This expectation predicates the following questions:

- Who are the users of resource discovery services?
- In addition to existing library users, what new market segments can be reached?
- How do the resource discovery patterns and information needs of various user groups differ?
- Are there user group differences based on information literacy variables, demographic variables, or technology adoption variables?
- What design characteristics will optimize utilization of a resource discovery service across a wide range of citizenry?

Answering these questions can result in a categorization of potential user groups for the LOT RDS. Sample users from among these groups could be subjects for usability assessment, bringing to bear their information needs, problems, resulting information behaviors and expectations for the LOT RDS.

The application and its components

The second area that needs attention is the application and the user interfaces. A focus on the user interface must acknowledge separate and interacting components that power the LOT RDS. The following provides a preliminary listing of the components:

- **Technical components:** Includes underlying hardware and software providing functionality.
- **Interoperability components:** Includes the use of standards and customized scripts to present the user with seamless search and retrieval from multiple resources.
- **User interface components:** Includes all aspects of user interfaces that assist users in making sense of and using the service.
- **Collection selection components:** Includes the features that assist users in selecting appropriate search targets.
- **Searching components:** Includes the availability of appropriate search functionality.
- **Retrieval components:** Includes presentation of results and their manipulation.
- **Task components:** Includes functionality that supports users to find, identify, select and access/acquire resources.
- **Personalization components:** Includes features that enable the user to customize the service.

Users may or may not understand how each of the above affects their experience with the service. For various user groups, or for specific information needs, one or more of these components may be more critical than others. What is at issue is the extent to which each of these components needs to be optimized for specific user groups. Usability assessment will require methods to identify potential problems from the perspective of users for any and all of these components and to suggest improvement to provide users with the optimal experience with the service.

Usability criteria and measures

The third area of attention is the development of usability criteria, measures, and methods of assessment. Various writers have identified usability criteria (e.g., Nielsen, 1993). Quesenbery's (2002) five E's of usability appears to provide a useful point of departure for thinking about usability criteria:

- **Effective:** How completely and accurately the work or experience is completed or goals reached.
- **Efficient:** How quickly this work can be completed.
- **Engaging:** How well the interface draws the user into the interaction and how pleasant and satisfying it is to use.
- **Error Tolerant:** How well the product prevents errors and can help the user recover from mistakes that do occur.
- **Easy to Learn:** How well the product supports both the initial orientation and continued learning throughout the complete lifetime of use.

Each of these usability criteria needs to be operationally defined and measures specific to the service need to be developed. Various user groups may differ in the relative importance of the criteria for the same service, and this may require customization of usability measures for specific user groups.

Figure 1 presents the framework for usability assessment that incorporates the multiple user groups, a set of usability criteria and the application and its components. The complexity for usability assessment will revolve around the intersection of the usability criteria and the application's components. The criteria may be used to assess the overall user experience with the service, but addressing the criteria to the separate components may yield more benefits for informing improvements in the service. Although this framework is geared to the LOT RDS, it could easily be adapted to other virtual library services (e.g., virtual reference services) or other metasearch and portal environments.

Key Usability Issues for the LOT RDS

The authors suggest that the following three aspects of the LOT RDS are priorities for usability assessment: 1) user understanding of the service, 2) user selection of search targets, 3) system performance.

User understanding of the service

The initial interface for the LOT RDS offers the user the immediacy of searching. The design is simple and uncluttered. The design goal for the interface was to enable the user to begin searching without having to make many initial decisions. Yet a first-time user may experience uncertainty since there is little to orient the user to the service. Help pages will be available to assist users. Usability assessment can assist the developers in refining the interface to support first-time users while not cluttering the screen with instructions for seasoned users. Another issue relates to the various user groups whom this service may serve. Usability assessment of the existing interface by representatives of different users groups could inform the customization of the features and functionality to better serve these groups.

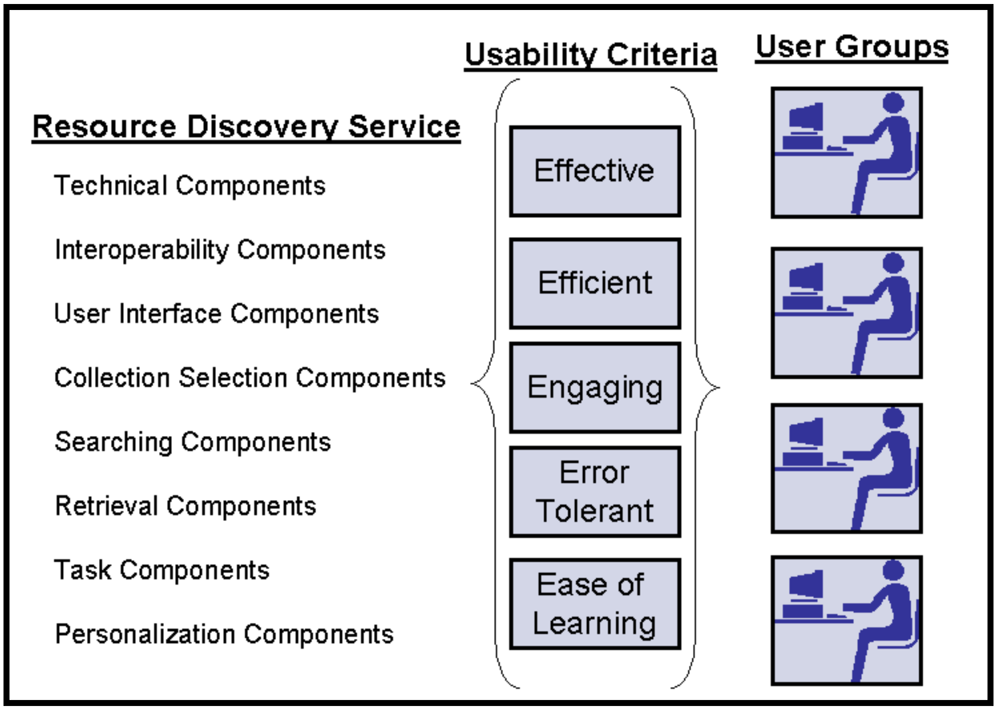

Figure 1
Framework for Usability Assessment of the Resource Discovery Service

User selection of search targets

One of the most important differences between a resource discovery service and other portal/gateway web sites or web search engines is the availability of multiple and diverse search targets that can be made available. In the initial deployment, the LOT RDS will provide access to over 100 separate search targets. These can be searched individually, all at once, or in groupings defined by the system or the user.

When a user logs into the LOT RDS, the system presents a selected set of search targets (i.e., public and academic library catalogs and licensed databases). Target library catalogs are determined by the system based on the proximity of those catalogs with the user's home library and the strength of the general collection of those libraries. The system also presents a selected set of licensed databases chosen by their strength of subject coverage. Users can also select to "Search by Subject" and when the user chooses one of the ten pre-defined subject areas, the system presents a set of subject-appropriate search targets. Users can also define their own sets of search targets. They simply check the targets they want to search and save that set of favorites persistently across sessions.

Probably the key challenge in optimizing users' engagement with the resource discovery service is to assist them in searching targets that have potentially relevant information. Usability assessment of the initial interface and its collection selection features will be vital to ensure that users will be presented with appropriate search targets that they can successfully search. As more and different types of search targets become available through the LOT RDS (e.g., databases of archival material, digital image libraries, etc.), helping users to select search targets will be critical.

System performance

The third area that will affect LOT RDS users' perception of its usability relates to performance. In a metasearch environment where searches are sent to multiple and diverse search targets, a number of factors affect the success of searches. Some factors can be minimized by adherence to national and international standards such as the ISO 23950/ANSI Z39.50 standard protocol for information retrieval Not all search targets are accessible via Z39.50 server; this requires specialized scripts to send queries to those individual search targets, and these scripts can be rendered dysfunctional because of changes at the search targets. All searches are sent over the Internet; network congestion can reduce response time. More problematic is when a particular search target is consistently not available or not responding properly. Quality of service from each of the search targets as well as the LOT RDS is important.

Users who have become used to nearly instantaneous responses from web search engines may find the response time from multiple search targets problematic. Helping users construct an appropriate mental model of the metasearch environment could ameliorate negative reactions to system performance.

Concluding thoughts

This paper has described the LOT RDS, a new and exciting approach to helping users find, identify, select, and access/acquire information through a statewide virtual library. The LOT RDS is an innovative metasearch application that was informed by user requirements and built on a basis of national and international standards. Due to the constrained timeline for its development, user-centered activities were limited to focus groups and discussions about requirements. As the LOT RDS is deployed in its first version, we have an opportunity to refine and inform future development through usability assessment. The paper presented a preliminary framework for usability assessment that acknowledges the several components of the LOT RDS that will affect users' experience of the system. In addition, three key areas for usability assessment were discussed to indicate priorities for assessment. Finally, metasearch applications such as the LOT RDS may require new mental models on the part of users to contextualize the resources, capabilities and performance of metasearch applications.

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Appendix J: Analysis of MARC Content Designation

This appendix contains a copy of the full text of a peer-reviewed paper, Assessing Metadata Utilization: An Analysis of MARC Content Designation Use, presented at the 2003 Dublin Core Conference.

Assessing Metadata Utilization: An Analysis of MARC Content Designation Use

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Abstract

Metadata schemes emerge to meet community and user requirements, and they evolve over time to meet changing requirements. This paper reports results of an analysis of a large sample of MARC 21 bibliographic records. MARC 21 is an encoding scheme related closely to metadata elements occurring in library bibliographic records. The records were analyzed for the utilization of content designation available in MARC 21. Results indicate that less that 5% of available content designation accounts for over 80% of occurrences .The implications of these findings affect indexing policies, system design, and can inform setting requirements for extending a metadata scheme based on a threshold of community requirements.

Keywords: *Metadata Utilization, MARC 21, Cataloging Practices, Indexing Policies, Interoperability*

1. Introduction

Communities develop and evolve metadata schemes to serve their current and emerging needs. In its first incarnation, the Dublin Core Metadata Element Set comprised thirteen elements to assist in resource discovery. Subsequently two additional elements were added. Over the past six years, the metadata scheme has evolved to provide more specific encoding through the use of qualifiers, and the extensibility of Dublin Core has been exercised by a number of communities (as reflected in the application profiles created by several communities) [1]. Two significant questions emerge: When is a need significant enough to warrant additional capability in the metadata scheme? To what extent will the additional refinements and enrichment of the metadata scheme be utilized?

The Machine Readable Catalog record (MARC) provides a structure for content designation used in resource description, typically in the context of library materials [2]. Its development since the late 1960s reflects capability for content designation. The availability for rich encoding and content designation does not necessarily imply utilization of that richness. This paper reports preliminary findings from an analysis of approximately 400,000 MARC 21 records from OCLC's WorldCat database. This analysis was carried out for a specific purpose as part of the Z39.50 Interoperability Testbed Project. The examination of the dataset revealed the extent to which various fields and subfields are actually used in practice.

2. Background for the Analysis

The Z39.50 Interoperability Testbed (Z-Interop) Project is an applied research and demonstration project funded by the U.S. federal Institute of Museum and Library Services through a National Leadership Grant awarded the School of Library and Information Sciences and the Texas Center for Digital Knowledge at University of North Texas [3]. The goal of Z–Interop is to improve Z39.50 semantic interoperability among libraries for information access and resource sharing. The mission of Z–Interop is to:

- Provide a trusted testing environment for vendors and consumers of Z39.50 products to demonstrate and evaluate those products
- Develop rigorous methodologies, test scenarios, and procedures to measure and assess interoperability
- Demonstrate and operate a Z39.50 interoperability testbed.

A critical component of the Z-Interop Project is a test dataset of 419,657 MARC 21 bibliographic records (hereafter referred to as the Z-Interop dataset). OCLC, a Z-Interop Project collaborator, provided these records from its WorldCat bibliographic database. At the time of extraction from the WorldCat database, the Z-Interop dataset comprised approximately a one percent sample of WorldCat records. The extraction algorithm used to select the sample was based on the number of holdings indicated for a single bibliographic item. Although the resulting sample was neither a random nor stratified sample, it comprised a relatively representative sample of bibliographic records based on frequency of holdings of OCLC member libraries.

A key area of consideration when addressing Z39.50 interoperability is the indexing policies in effect in different online catalog systems. These indexing policies prescribe which fields/subfields in a MARC 21 record are included to populate an individual index. The Z-Interop Project developed indexing guidelines to use in the reference implementation of an online catalog system and Z39.50 server [4]. Sirsi, another collaborator on the Z-Interop Project, contributed its

Unicorn system to serve as an online catalog and Z39.50 server reference implementation. Z-Interop Project staff had complete control over indexing decisions for the Unicorn system.

To develop the indexing guidelines for selected keyword indexes, the MARC 21 bibliographic format was examined and all fields/subfields that hold author, title, or subject data were identified as candidates for indexing. The number of fields/subfields identified in the indexing guidelines for several keyword indexes are:

- Author-related data: 119 fields/subfields
- Author- and title-related data: 21 fields/subfields
- Title-related data: 253 fields/subfields
- Subject-related data: 144 fields/subfields

Table 1 summarizes these fields/subfields in the various MARC 21 tag groups. MARC is a very rich format for content designation, and local system implementations choose which fields/subfields will be used for the various indexes established. One approach is to simply index each field/subfield that contains author-, title-, or subject-related data. Establishing and setting up indexing policies, however, can be a time consuming task; for the Z-Interop Project's online catalog reference implementation, setting up the indexing policies for author, title, and subject keyword indexes took approximately forty person-hours. More importantly from the user's perspective is whether such extensive indexing has meaningful consequences for search and retrieval. These questions motivated the analysis of the actual occurrence of the MARC 21 fields/subfields in the Z-Interop dataset.

Table 1. Fields/Subfields Identified for Indexing in Z-Interop Indexing Guidelines

MARC 21 Field Groups	Currently Defined	Fields/Subfields Unlikely To Be Used	Total
00x	0	0	0
0xx	0	0	0
1xx	54	2	55
2xx	65	1	66
3xx	0	0	0
4xx	5	39	44
5xx	8	0	8
6xx	136	4	140
7xx	145	4	149
8xx	73	2	75
Total	**486**	**52**	**537**

2.1. Brief Discussion of MARC

The Machine-Readable Catalog Record (MARC) was developed at the Library of Congress in the 1960s. A major requirement for the MARC structure was to accommodate bibliographic information contained on library catalog entries while making the information available for computer processing. Originally referred to as the MARC Communication Format, it was intended to provide a standard structure for exchanging bibliographic records among library automation systems. MARC originated as a means to communicate bibliographic data about printed texts, but has evolved to communicate data about books, computer files, maps, serials, music, visual materials and archival materials.

The structure of the record is specified by national and international standards, ANSI/NISO Z39.2 and ISO 2709 respectively [5,6]. The specifications for the record structure do not provide semantics for the content designation (i.e., the semantics of the field tags, subfield codes, etc.) and additional technical specifications have been developed to provide semantics and procedures for encoding bibliographic data into the record structure. The MARC 21 format is the latest iteration of MARC content designation. The content of the bibliographic records is governed by other rules and sources, typically cataloging rules in the form of the Anglo-American Cataloguing Rules [7], authority lists, and controlled vocabularies.

The MARC 21 Format for Bibliographic Data is a very rich encoding and content designation scheme with 1908 fields/subfields available [8,9]. Table 2 shows a breakout by MARC 21 tag groups for the fields/subfields included in the MARC 21 Format for Bibliographic Data. The extent to which this metadata structural richness is utilized and how to assess utilization of a metadata scheme and its encoding are the focus of this paper.

Table 2. Fields/Subfields in MARC 21 Bibliographic Format

MARC 21 Field Groups	Currently Defined	Obsolete *	Total
00x	6	1	7
0xx	238	7	245
1xx	66	1	67
2xx	137	32	169
3xx	109	32	141
4xx	69	0	69
5xx	323	38	361
6xx	184	5	189
7xx	452	47	499
8xx	141	20	161
Total	**1725**	**183**	**1908**

*Obsolete content designators are not to be used in new records but they may appear in records created prior to the time a content designator was defined as obsolete.

2.2. Methodology

As part of the Z-Interop Project, the original MARC 21 records were decomposed into multiple subrecords based on individual words in each field/subfield. For information describing the decomposition, see [10]. Each MARC 21 record was decomposed into separate subrecords that included: OCLC Number, Field Tag, First Indicator Value, Second Indicator Value, Subfield Value, Field Position in Record, Subfield Position in Record, Word Position in Field/Subfield, and Specific Character String (i.e. the "word"). Table 3 provides a sample of the decomposed records. Each row in the table represents a "subrecord" for the parent MARC 21 record. The data comprising the subrecords were loaded into a MySQL database for processing. The decomposed records were analyzed to produce a frequency count of occurrences of fields/subfields contained in the 419,657 MARC 21 records. The output was a sorted list of occurrences of individual fields/subfields. Table 4 contains a sample of the resulting frequency count data. Included in the sample list is an instance of the MARC 21 field 650 $a to demonstrate a repeatable field/subfield provided in MARC 21. A number of fields/subfields can occur multiple times in a single record, and therefore the occurrence of a field/subfield can be greater than the total number of records (e.g., 602,362 occurrences is greater than the 419,657 number of records). The focus of the analysis was on number of total occurrences in the dataset rather than number of records in which the field/subfield occurred. Certain fields are required to be in every record (e.g., the 001), and there is a one-to-one match between occurrences of these fields/subfields in the dataset and the total number of records.

Table 3. Components of a Z-Interop Dataset Subrecord

OCLC#	Tag	1st Indicator	2nd Indicator	Subfield	Field Position	Subfield Position	Word Position	Word
3	110	2		a	11	1	1	national
3	110	2		a	11	1	2	study
3	110	2		a	11	1	3	service
3	245	1	0	a	12	1	1	illegitimacy
3	245	1	0	a	12	1	2	and
3	245	1	0	a	12	1	3	adoption
3	245	1	0	b	12	2	1	report

Table 4. Sample Frequency Count Data

MARC 21 Field	MARC Subfield	Occurrence
001		419,657
003		419,657
005		419,657
006		652
007		30,556
008		419,657
010	a	305,407
010	b	2
010	z	6,627
650	2	15,361
650	6	9
650	a	602,362
650	b	28
650	c	4
650	d	16
650	f	1
650	k	2
650	v	83,607
650	x	326,867
650	y	32,728
650	z	231,459

The frequency count data were imported into a spreadsheet for subsequent analysis. Using the MARC 21 Concise Bibliographic Format, field/subfield names and semantics were added [11]. OCLC's Bibliographic Formats was consulted to account for MARC fields/subfields that could not be found in the MARC 21 documentation [12]. Linking fields were noted according to whether the field had a $6 (Linkage) field/subfield. For the fields/subfields whose definitions were taken from OCLC, linking information was not available. Repeatability of fields/subfields was noted. The repeatability indication was based on the repeatability of the subfield within the field rather than the repeatability of the field within the record. For example, field $650 (Subject Added Entry-Topical Term) is repeatable within a record, however within field $650, subfield $a is not repeatable; subfield $650a will show to be a non-repeating subfield in the analysis, even though it can occur as many times in a record as the cataloger deems necessary to adequately describe the entity. Because the occurrences in the frequency count list are broken down to the subfield level, the repeatability indication was based on the subfield's repeatability within the field. In addition, the review of MARC documentation showed 102 fields/subfields occurring in the Z-Interop dataset as "Obsolete", "LC use only", "OCLC use only", "Do not use", or "Unlikely to be used". Also, one field is used in specific cataloging software, and sixteen fields/subfields were assumed to be cataloging mistakes since there was no description for them in MARC 21 or in OCLC's MARC documentation (these fields/subfields occurred at the most 3 times).

Three sets of fields/subfields from the Z-Iinterop Indexing Guidelines (those candidate fields/subfields for author-, title-, and subject-keyword indexes) were also imported into a spreadsheet [4]. This spreadsheet was cross-referenced with the frequency count spreadsheet. The fields/subfields in the frequency count spreadsheet identified as candidates for author-, title-, and subject-indexing were indicated. The result was a set of spreadsheets with each field/subfield identified by name, semantics, source of information, as a linked field, its repeatability, miscellaneous information (e.g., not likely to be used for various reasons), and whether it was a candidate for keyword indexing for author, title and/or subject.

Two other spreadsheets clustered the frequency count fields/subfields into MARC tag groups (i.e., 0xx, 1xx, 2xx, etc.) and clustered candidate fields/subfields for indexing into MARC tag groups.

3. General Characteristics of the Bibliographic Records

The Z-Interop dataset contains 419,657 MARC 21 bibliographic records. These records describe bibliographic items in various formats. Table 5 lists approximate percentages of each format represented in the dataset.

Table 5. MARC 21 Formats Represented in Dataset

MARC 21 Format	Approximate Percent of Total
Book	91%
Cartographic Material	less than 1%
Visual Materials	1%
Sound Recording or Printed or Manuscript Music	4%
Electronic Resources	less than 1%
Archival/Mixed Materials	less than 1%
Serial	3%

In the 419,657 records, 926 fields/subfields occur at least once. As noted above, a total of 1908 fields/subfields are defined in the MARC 21 Format for Bibliographic Data (including those currently available for use and obsolete) [9]. A first indication of utilization shows that less than 50% of the content designation available in MARC 21 appears to be used in this set of records from OCLC WorldCat. Table 6 summarizes the number of fields/subfields in the Z-Interop dataset for each MARC 21 tag group (compare with Table 2 above that shows all available content designation).

Table 6. Fields/Subfields Occurring in Z-Interop Dataset

MARC 21 Field Groups	Currently Defined	Obsolete	Fields /Subfields Unlikely To Be Used	Total
00x	6	0	0	6
0xx	96	1	33	130
1xx	49	0	2	51
2xx	81	0	19	100
3xx	23	6	0	29
4xx	10	0	30	40
5xx	128	1	3	132
6xx	104	1	7	112
7xx	205	0	5	210
8xx	105	3	8	116
Total	**807**	**12**	**107**	**926**

Each of the 926 fields/subfields was examined using MARC 21 and OCLC MARC documentation as references. This review revealed that 119 (13%) of the fields/subfields were labeled as "obsolete" or unlikely to be used. Since these records were taken from the OCLC WorldCat database, it is important to note that a number of fields/subfields are specific to the OCLC MARC records. Thirty-three of the fields/subfields are specific to OCLC MARC records and 1 subfield (69$a) is described as a Local Call Number field in Dynix catalogs. Frequency of occurrence of these 119 fields/subfields range from 1 to 419,657 times.

Certain fields/subfields are applicable only to certain formats (see Table 5). For example, the MARC 21 field 255, Cartographic Mathematical Data, has seven subfields defined. These subfields address data specific only to the Cartographic Materials format. When considering the analysis of occurrences of fields/subfields, the raw count has to be seen in the context of format-specific content designation options. If a specific format of material occurs in a small percentage of the 419,657 records, the count of format-specific fields/subfields may be relatively small overall, but can actually be highly used within those format-specific records. For example, the 255$a occurs 1,289 times in the dataset (less than 1% of total occurrences). However, there are less than 1% of all records in the dataset that are designated as Cartographic Materials (1,677). We may assume that the approximately 77% of the records describing Cartographic Materials contain a 255$a. Future analysis will examine more specifically the occurrences of format-specific content designation.

3.1. Analysis of Content Designation Use

In the dataset, 926 fields/subfields are present and the frequency of occurrence ranges from 1 to

602,362 times. Table 7 summarizes the occurrences in the MARC tag groups.

Table 7. Occurrences per MARC Tag Group in Dataset

MARC 21 Field Groups	Number of Fields/Subfield Used	Total Occurrences of Fields/Subfields
00x	6	1,709,836
0xx	130	4,393,134
1xx	51	577,856
2xx	100	2,438,275
3xx	29	1,086,239
4xx	40	200,424
5xx	132	707,316,
6xx	112	1,919,409
7xx	210	560,769
8xx	116	259,273
Total	**926**	**13,145,215**

One approach to assessing utilization of the content designation available in the MARC 21 format is to analyze the number of occurrences of individual fields/subfields in the Z-Interop dataset. This analysis revealed that a very small number of fields/subfields account for the highest occurrences within the dataset. Table 8 summarizes the number of fields/subfields occurring in groups of approximately 100,000 occurrences. Total number of all content designation occurrences in the Z-Interop dataset is 13,840,499, and 36 of the most frequently occurring fields/subfields account for approximately 80% of occurrences of all fields/subfields. This means that only 4% of all fields/subfields present in the Z-Interop dataset account for 80% of the occurrences, or to state it another way, 96% of all fields/subfields account for less than 20% of occurrences.

Table 8. Number of Fields/Subfields by Range Frequency

Frequency	Number of MARC 21 Field/Subfields	Percent of All Occurrences
> 600,000	1	4.4%
500,000 – 599,999	0	0%
400,000 – 499,999	13	39.9%
300,000 – 399,999	6	14.3%
200,000 – 299,999	6	10.6%
100,000 – 199,999	10	10.3%
Total	**36**	**79.5%**

Table 9 provides a list of the 36 most frequently occurring fields/subfields in the dataset. Certain fields (e.g., 650) and certain subfields (e.g. 40 $d), can occur more than once in a single record. Four of these content designation structures are shown in Table 9; they are the only ones that occur at a frequency greater than the total number of records in the dataset. Several fields are mandatory and non-repeating in all MARC 21 records. These are listed in Table 9 with a frequency of 419,657. The frequency count for the occurrence of each of these fields is exactly the same as the total number of records in the test dataset.

The 36 most frequently occurring fields/subfields can be combined into their respective MARC 21 tag groups to represent the relative use of these field groups in the dataset (see Table 10). The table also provides the percent of all occurrences the 36 most frequently occurring fields/subfields account for.

Table 9. Top 36 Occurring Fields/Subfields in Z-Interop Dataset

Frequency	MARC 21 Field	Subfield	Field & Subfield Name
602,362	650	a	Subject Added Entry Topical Term Subfield a: Topical term or geographic name as entry element
454,451	40	d	Cataloging Source Subfield d: Modifying agency
451,808	260	a	Publication, Distribution, etc. (Imprint) Subfield a: Place of publication, distribution, etc
435,783	260	b	Publication, Distribution, etc. (Imprint) Subfield b: Name of publisher, distributor, etc
419,657	001		Control Number
419,657	003		Control Number Identifier
419,657	005		Date and Time of Latest Transaction.
419,657	008		Fixed-Length Data Elements
419,657	040	c	Cataloging Source Subfield c: Transcribing agency
419,657	049	a	Local Holdings Subfield a: Holding Library
419,641	245	a	Title Statement Subfield a: Title

Frequency	MARC 21 Field	Subfield	Field & Subfield Name
416,908	300	a	Physical Description Subfield a: Extent
415,423	040	a	Cataloging Source Subfield a: Original cataloging agency
410,790	260	c	Publication, Distribution, etc. (Imprint) Subfield c: Date of publication, distribution, etc.
391,899	300	c	Physical Description Subfield c: Dimensions
329,796	245	c	Title Statement Subfield c: Statement of responsibility, etc.
326,867	650	x	Subject Added Entry Topical Term Subfield x: General subdivision
318,692	100	a	Main Entry Personal Name Subfield a: Personal name
305,407	010	a	Library of Congress Control Number. Subfield a: LC control number
300,385	050	a	Library of Congress Call Number Subfield a: Classification number
285,578	050	b	Library of Congress Call Number Subfield b: Item number
274,313	082	a	Dewey Decimal Call Number Subfield a: Classification number
235,864	300	b	Physical Description Subfield b: Other physical details
231,459	650	z	Subject Added Entry Topical Term Subfield z: Geographic subdivision
228,173	020	a	International Standard Book Number Subfield a: International Standard Book Number
210,250	500	a	General Note Subfield a: General note
186,997	504	a	Bibliography, Etc. Note Subfield a: Bibliography, etc. note
176,916	700	a	Added Entry Personal Name Subfield a: Personal name
169,178	245	b	Title Statement Subfield b: Remainder of title
149,540	100	d	Main Entry Personal Name Subfield d: Dates associated with a name
144,261	082	2	Dewey Decimal Call Number Subfield 2: Edition number
141,409	043	a	Geographic Area Code Subfield a: Geographic area code
118,647	651	x	Subject Added Entry Geographic Name Subfield x: General subdivision
113,050	651	a	Subject Added Entry Geographic Name Subfield a: Geographic name
112,156	019	a	OCLC Control Number OCLC use only
110,257	850	a	Holding Institution Subfield a: Holding institution

Table 10. 36 Fields/Subfields Compared to All Occurrences in MARC 21 Field Groups

MARC 21 Field Group	Occurrences in Top 36 Fields/ Subfields	Occurrences of All Fields/ Subfields	Percent of All Accounted for by Top 36 Fields/ Subfields
00X	1,678,628	1,709,836	98%
0XX	3,500,870	4,393,134	80%
1XX	468,232	577,856	81%
2XX	2,216,996	2,438,275	91%
3XX	1,044,671	1,086,239	96%
4XX	0	200,424	0%
5XX	397,247	707,316	56%
6XX	1,392,385	1,919,049	73%
7XX	176,916	549,097	32%
8XX	110,257	259,273	43%
Total	**10,986,202**	**13,840,499**	**79%**

3.2. MARC 21 Content Designation and Indexing Analysis

The initial motivation for this examination of field/subfield occurrence was to assess indexing policies for the Z-Interop Testbed. The Z-Interop indexing guidelines identified a total of 537 author-, title-, or subject-related fields/subfields that could be candidates for indexing [4]. Only 381 of those fields/subfields actually occurred in the Z-Interop dataset (see Table 11).

The analysis also looked at the frequency of occurrences of the 381 fields/subfields in the dataset. Total occurrences of the 381 fields was 4,397,712. Nineteen of the most frequently occurring fields/subfields account for approximately 80% of this total. These nineteen fields/subfields occur a total of 3,489,198 times in the dataset. This means that approximately 5% of the fields/subfields identified as candidates for indexing account for 80% of all occurrences, or stated another way, 95% of the candidate fields/subfields account for only 20% of all occurrences. Table 12 lists the nineteen fields/subfields.

Table 11. Summary of Fields/Subfields in Indexing Guidelines

Keyword Index Guidelines	Fields/ Subfields in Indexing Guidelines	Indexing Guidelines Fields/Subfields Occurring in Dataset	Percent Occurring
Author Only	119	86	72%
Author and Title	21	16	76%
Subject Only	144	101	70%
Title Only	253	178	70%
Total	**537**	**381**	71%

Table 12. Summary of Fields/Subfields in Indexing Guidelines

# Occurrences	Marc 21 Field	Subfield	Description	Index
602,362	650	a	Subject added entry Topical Term Subfield a = Topical term or geographic name as entry element	Subject
419,641	245	a	Title Statement Subfield a = Title	Title
329,796	245	c	Title Statement Subfield c = statement of responsibility	Author
326,867	650	x	Subject added entry Topical Term Subfield x = General subdivision	Subject
318,692	100	a	Main entry Personal Name Subfield a = personal name	Author
231,459	650	z	Subject added entry Topical Term Subfield z = Geographic subdivision	Subject
176,916	700	a	Added entry Personal Name Subfield a = personal name	Author
169,178	245	b	Title Statement Subfield b = Remainder of title	Title
149,540	100	d	Main entry Personal Name Subfield d = dates associated with a name	Author
118,647	651	x	Subject added entry Geographic Name Subfield x = General subdivision	Subject
113,050	651	a	Subject added entry Geographic Name Subfield a = Geographic name	Subject
83,607	650	v	Subject added entry Topical Term Subfield v = Form subdivision	Subject
74,606	700	d	Added entry Personal Name Subfield d = dates associated with a name	Author
69,636	600	a	Subject added entry Personal Name Subfield a = personal name	Subject
66,375	710	a	Added entry Corporate Name Subfield a = corporate name or jurisdiction name	Author
64,433	440	a	Series Statement Added Entry Title Subfield a = title	Title
62,853	490	a	Series Statement Subfield a = Series statement	Title
56,229	600	d	Subject added entry Personal Name Subfield d = dates associated with a name	Subject
55,311	653	a	Index Term Uncontrolled Subfield a = the term	Subject

4. Discussion

This analysis has provided a description of the use of a metadata and content designation scheme. MARC 21 is a rich encoding scheme with nearly 2,000 discrete structures for content designation. Less than 50% of these structures actually occurred in a large dataset of these records, but more interesting is that only 4% of the occurring fields/subfields account for nearly 80% of all occurrences. Should this be of concern?

One might suggest that the rich encoding structure provides a capability in case we need it. In case there is a specific datum that needs to be recorded with a discrete MARC 21 content designation, the format has it available. From the vantage point of a system designer, whether or not these content designations are ever used, the system must be programmed to be ready in case one of the structures occurs in a record. There is a potential resource impact at the level of system design and implementation, with associated costs in the final product.

From the perspective of the Z-Interop Testbed Project, where semantic interoperability depends in part on common indexing practices, accounting for over 500 fields/subfields in the indexing policies has a resource impact on setting up the indexing policies.

Furthermore, as metadata schemes such as Dublin Core or Metadata Object Description Schema (MODS) [13] are developed and evolve, there will always be requirements to extend the capability of the metadata scheme to accommodate new requirements of communities and users. MARC has developed over thirty years, and the approximately 2,000 structures for content designation reflect a response to those community and user requirements. While it may only be possible after a scheme has been implemented for some time to analyze the extent to which the content designation is actually utilized, there may be lessons from the evolution of MARC that point to the need for policies that identify "thresholds of needs" before additional content designation capability is introduced. A balanced approach that allows a metadata scheme to be responsive to evolving needs while minimizing increasing capability that ends up being under-utilized would be most desirable.

5. Additional Analyses and Future Research

The analysis of one sample of MARC 21 records illustrates an approach to assessing and preliminary results of utilization of available content designation. Further analysis will be carried out to refine the results including:

- Investigating the encoding levels of the records since all records may not be full-level cataloging and this may affect use of content designation
- Identifying utilization of format specific content designation
- Examining the occurrence of the content designation at a record level rather than frequency counts of total occurrences in the dataset.

It will also be important to carry out this analysis on other collections of MARC bibliographic records. Using collections of bibliographic records from library catalogs of a university library and a large public library would allow a comparison of findings from the current analysis.

In addition to refining the analysis and conducting similar analyses on other collections of records, utilization analysis results can be linked to other investigations. The following are some planned next steps and questions in this stream of research.

5.1. Use of Content Designation Related to Cataloging Rules

The MARC record's content is created using a variety of rules and guidelines, particularly the Anglo-American Cataloguing Rules, Library of Congress Subject Cataloging Manual, and other associated tools. An analysis needs to be carried out that looks at infrequently occurring fields and subfields, and the cataloging rules and MARC input rules associated with these fields. Are there particular issues about these rules (very specialized, too obscure, etc.) that result in the minimal utilization of the associated MARC content designation?

5.2. National and Minimal Level Cataloging Guidelines

The Network Development and MARC Standards Office at the Library of Congress publishes MARC 21 Format for Bibliographic Data: National Level Record---Bibliographic Full Level & Minimal Level [14]. This document identifies specific fields/subfields that must occur (M), must occur if applicable (A), or are optional (O) in catalog records. Using the 36 most frequently occurring fields, Table 13 indicates how these are designated in the National Level Record document. A similar analysis could be carried out on additional fields/subfields to see the relationship of their occurrence and the national level record guidance published by the Library of Congress. Do the guidelines include requirements for fields/subfields that in practice are seldom used?

5.3. Analysis of MODS

The Metadata Object Description Schema (MODS) that is being developed is a subset of MARC

21 content designation [13]. It would be appropriate to examine the MODS structure from the perspective of the analysis done on the Z-Interop dataset. Data structures included in MODS that relate to seldom used MARC 21 content designation could be examined and reconsidered in light of actual use of these MARC 21 fields/subfields.

5.4. Functional Analysis of the MARC 21 Bibliographic and Holdings Formats

The Network Development and MARC Standards Office commissioned a study to analyze the MARC 21 format from the following perspectives:

- The Functional Requirements for Bibliographic Records (FRBR) model
- The Anglo-American Cataloging Rules model
- A set of user tasks that the format might logically support

The findings from the report provide the basis for another comparison between what exists in actual records and recommendations for bibliographic data to support user tasks and other activities [15]. The study mapped the attributes in the FRBR model to the MARC data elements, identified MARC data elements that fall outside the FRBR model, and analyzed the data content of the MARC format as it corresponds to the user tasks outlined in the FRBR model. It is interesting to note that the study found that approximately 50% of the MARC data elements corresponds to the FRBR and AACR models. This finding is similar to the results found in our comparison of actually occurring content designation in the Z-Interop dataset with all available MARC 21 content designation. Is this just a coincidence?

5.5. Impacts on Information Retrieval

The Z-Interop Testbed Project, for which the analysis reported here was initially carried out, will experiment with indexing policies based on the findings from this analysis. Currently, indexing policies for author-, title-, and subject-keyword searching address all 537 fields identified in the indexing guidelines. The testbed has defined test searches with known results to be returned based on the current indexing policies. The testbed will implement indexing policies only using the 19 fields/subfields that are most frequently occurring. Test searches can be issued and comparison in search results can be used to determine if information retrieval has suffered because of using a very small number of fields/subfields in the indexing policies. With this information, local library implementations of online catalogs can be in a better position to determine the extent of fields/subfields that must be included in their indexing policies for appropriate levels of retrieval.

6. Conclusion

This study presents a preliminary approach for assessing utilization of metadata schemes by examining actual records that implement the scheme. In the Z-Interop dataset, less the 4% of available MARC 21 content designation accounts for 80% of all occurrences of the content designation. MARC has evolved over thirty years, an evolution that responded to community and user needs. New content designation was added to the MARC format in response to those needs. The results of this analysis of actual use of the content designation provides a point of departure for discussions about when and to what extent should a metadata scheme's content designation capability be extended. As Dublin Core and schemes such as MODS evolve, the question of extensions and expansion needs to be addressed. Policies that address increasing content designation capability should be considered as well as mechanisms to review actual utilization of the content designation. The methodology of metadata utilization assessment presented in this paper provides a first step in developing robust and rigorous utilization assessments for a variety of metadata schemes.

Table 13. Top 36 Fields/Subfields and National and Minimal Level Cataloging Requirements

Frequency	MARC 21 Field	Subfield	National Level Cataloging	Minimal Level Cataloging		Frequency	MARC 21 Field	Subfield	National Level Cataloging	Minimal Level Cataloging
419,657	001		M	M		169,178	245	b	A	O
419,657	003		M	M		329,796	245	c	A	O
419,657	005		M	M			260		A	A
419,657	008		M	M		451,808	260	a	A	O
	010		A	A		435,783	260	b	A	A
305,407	010	a	A	A		410,790	260	c	A	A
112,156	019	a	[OCLC defined				300		M	M

Frequency	MARC 21 Field	Subfield	National Level Cataloging	Minimal Level Cataloging		Frequency	MARC 21 Field	Subfield	National Level Cataloging	Minimal Level Cataloging
			field]							
	020		A	A		416,908	300	a	M	M
228,173	020	a	A	A		235,864	300	b	A	O
	040		M	M		391,899	300	c	M	O
415,423	040	a	A	A			500		O	O
419,657	040	c	M	M		210,250	500	a	M	O
454,451	040	d	A	A			504		O	O
	043		A	O		186,997	504	a	M	O
141,409	043	a	M	O			650		A	O
419,657	049	a	[OCLC defined field]			602,362	650	a	M	O
	050		O	O		326,867	650	x	A	O
300,385	050	a	M	O		231,459	650	z	A	O
285,578	050	b	A				651		A	O
	082		O	O		113,050	651	a	M	O
144,261	082	2	M	O		118,647	651	x	A	O
274,313	082	a	M	O			700		A	O
	100		A	A		176,916	700	a	M	O
318,692	100	a	M	M			850		O	O
149,540	100	d	A	A		110,257	850	a	M	O
	245		M	M						
419,641	245	a	M	M						

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