

Developing an LTER Network Information System for the 21st Century

Version Spring 1996, includes input from IS and DataTask groups

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1. Introduction ([back to TOC](#))

The necessity of intersite research has driven the LTER mandate since intersite workshops in the early 1980's. Since then the LTER data managers have been focusing on facilitating this research. Recently, the maturation of environmental information management, and advances in technology provide an impetus to accomplish more effectively the long-standing goal of facilitating intersite research (Stafford, et al. 1994). Although computers have come a long way, the fundamentals of managing research information and developing an appropriate system for management have remained relatively stable. What has changed drastically in the last decade is researcher and community expectations. With the explosion of Internet connectivity and the birth of the World-Wide Web (WWW), scientists, administrators, and the general public have come to expect greater access to the products of valuable research dollars. The LTER research network has a wealth of long-term data that are being collected by LTER investigators. With the publication of the LTER Catalog of Core Data Sets in 1990, this resource became more widely known within the ecological research community.

2. LTER Network Information System (1990-1995) ([back to TOC](#))

During the same period of time that the office and data managers developed the catalog of core data sets, the work of the LTER Connectivity Committee and by the sites resulted in nearly full Internet connectivity across the LTER Network. This infrastructure foundation for electronic communication and data exchange substantially enhanced the traditional means of networking. Based on this rapidly evolving infrastructure, electronic versions of the Core Dataset Catalog and the LTER Personnel Directory became available to most researchers in 1991. The evolution of those data repositories from hardcopy versions to on-line databases accessible by e-mail, FTP, Gopher, WAIS, SQL and Web information servers reflects the successful use of the latest communications technology in the integration of individual sites into a coherent research network. When the LTER All-Site Bibliography was created in 1993, a hardcopy version was no longer considered an economical or even desirable implementation (Chinn and Bledsoe, submitted). Instead, it was implemented as a searchable on-line database from the very beginning.

Improved accessibility and ease of use highlighted existing gaps in the LTER information infrastructure. While the Gopher and Web information servers installed at LTERnet in 1992/93, together with servers installed subsequently at most sites, simplified access to information that is widely geographically dispersed, queries are still unwieldy. The All-Site Bibliography, for example, although on-line and seeing increasing use ([Figure 1](#)), has limitations in the type and number of queries that are possible. In many cases (other than with the Core Dataset Catalog, Bibliography and Personnel Directory), to find out what data are available on LTER site information servers, you need to make connections to each of the site servers individually.

Many LTER datasets are available via WWW and other network information servers, but it is difficult to analyze and synthesize data from different sites because most site servers return data in different formats. **The LTER data managers are committed to building a system that facilitates cross-site data exchange for intersite research, the LTER Integrated NETWORK Information System (LINIS) for the 21st Century.**

3. Philosophy and Goals of LINIS (1996-2002) ([back to TOC](#))

The fundamental philosophy of the effort is **Development from a Research Perspective**. The primary function of the

LINIS will be support of intersite research, therefore, all technical implementations will be driven by this philosophy. Development of the LINIS will be closely linked to efforts by various LTER cross-site and synthesis research groups. Each intersite research effort will include at least one member from the LTER information management group. Initially, intersite research groups will provide the main pool of users of new system functions and they will provide the feedback required for testing. In addition, development will be made with the recognition that information management systems are always evolving, due both to technological changes and to improvements in our understanding of how scientists most efficiently use data. The goals for this development effort are:

Goal 1: Increase Utility of Existing System

A basic network information system (NIS) is available to LTER researchers (eg. catalog, personnel directory, bibliography, integrated mail forwarding, and direct links to most site systems). A modular, step-by-step approach to the LINIS development will ensure that existing functions will be seamlessly integrated with the future system. With the objective of fulfilling its mission in information management, the Network Office will be responsible for further development of the LTERnet Network Support System to maintain and expand the following core activities:

- LTERnet Information Server with links to site and international servers
- Personnel Directory
- Core Dataset Catalog
- Cross-site Bibliography
- Satellite Imagery Archive
- Electronic Connectivity
- Query and retrieval systems to integrate these functions

Goal 2: Increase Access and Query Capability on Intersite Data

Develop here based on discussions from Snowbird.

Goal 3: Maintain Local Autonomy Research Data Management at U.S. LTER sites is carried out with common objectives in mind, but under a variety of different circumstances and constraints. There is a number of heterogeneous approaches taken to meet research objectives. Meeting standardized goals with a variety of solutions has built strength into this system. This strength needs to be maintained in the development of the LINIS.

4. System Characteristics ([back to TOC](#))

The Network Information System working group has developed the following functions for the LINIS based on input from the data management committee and researchers in attendance at the Snowbird meeting in 1995. An advanced access and query capability will facilitate:

- a search for data available anywhere in the LTER network,
- combining and analyzing data from different sites,
- answering standard information requests (those requests that occur >80 of the time)
- economically building query systems for specific projects and special information requests
- automatic retrieval of data and documentation
- query, analysis and display tools that are intuitive to researchers (user-friendly)

In addition, the system should integrate site information systems, not replace them. The envisioned system will be a distributed system using advanced network tools that will ensure the system is useful into the coming decade. For example, network client/server technology is well suited to this application and can be implemented independent of the specific computer platform.

5. Participation in Standards Development and Organizations ([back to TOC](#))

Members of the U.S. LTER Network Data Management Committee are actively participating in developing standards for non-spatial ecological data ((Michener, et al., in review). In addition, standards being adopted at the federal level are being closely scrutinized for implementation with the LTER Network (eg. FGDC, NBII, GILS, etc.)

Some de facto standards that can help ensure hardware and software independent functionality have emerged in this area and would be considered in our design (e.g. ODBC). There are also some recent developments with potentially major implications for the way future network information systems are implemented independently of any specific hardware or software platform. In particular, executable content on Web servers by the Java language (an open

standard for programming on the Web) could be used to package data together with their metadata.

6. Plan for Development of an LTER-Wide IS ([back to TOC](#))

Design and implementation of the LINIS in a modular, step-by-step fashion will require that teams of information specialists accomplish specific system parts in a coordinated way and in a predictable period of time. Such task will include implementation of access and retrieval functions for datasets that are standardized in terms of content and apparent format. For example, measurement procedures of net primary productivity can vary considerably among such different ecosystems as lakes (NTL) and forests (AND, LUQ) and deserts (SEV, JRN). Correspondingly the raw data reflecting those measurements may not be comparable. In this case, a team of researchers and information specialists would work with the sites to add to the IS the capability to access from all sites productivity data and metadata in a consistent format, with consistent tools.

The development of an LTER-wide Information system will depend on the efforts of many critical players: The LTER Coordinating Committee, site researchers, Network Office Staff, Data/Information Management Committee, and Collaborators (e.g., SDSC). These efforts will be focused at a continuing series of workshops that will form the basis for the design, funding, and implementation of an LTER-Wide IS.

Annual meetings of the Data Management Committee and the NIS working group will serve to coordinate the effort. NIS task groups composed of researchers, data managers, and occasional consultants will provide the labor necessary to design, fund, and implement various components of the system.

The NIS working group will solicit interest from a couple of intersite research groups and hold workshops to assess researchers needs - what works, what doesn't. These workshops can be organized in conjunction with workshops that investigate specific intersite research questions, such as climate patterns, biodiversity distribution, litter decomposition processes (LIDET) or hydrology. The CC will determine which areas to cover first and the subjects initially chosen would relate to core areas. The workshops will also address and attempt to resolve outstanding standardization issues that are relevant to how data and information are presented and distributed by the Information System.

Data of interest to the group, such as the Climate Committee will be used by a task group to demonstrate present capabilities. For example, compile a Web page of all climate data available on LTER site servers, download them into spreadsheets or other applications, and graph them. The group will then evaluate the present approach for what works and what doesn't. Why is it insufficient in supporting the groups intersite research? Propose solutions to fix the shortcomings and use positive aspects in other work groups, develop an information model for the data and set a time table for implementation. The process would then proceed with mechanisms built in for testing and feedback.

1996

1. Workshops:

- NIS Working Group
- Data Management Committee

2. Goals for the year:

- Solidify basic design and implementation strategy.
- Solicit participation from intersite and synthesis groups.
- Adopt metadata standards for ecological data.
- Begin development of ``distributed" bibliography.
- Continue expansion and utility of existing WWW based system.

1997

1. Workshops:

- NIS working group
- NIS task groups (4) (2 research, 1 bibliography, 1 publication)
- Data Management Steering Committee
- Data Management Committee

2. Goals for the year:

- Develop information model for test research groups.
- Submit proposal to implement test group model and query system.
- Begin development of distributed data catalog.
- Continue distribution of bibliography database.
- Continue expansion and utility of existing WWW based system.

1998

1. Workshops:

- NIS working group (2)
- NIS task groups (4)
- Data Management Committee / National-International Symposium/Workshop

2. Goals for the year:

- Implement synthesis group's data model and query system.
- Distributed Bibliography on-line.
- Submit proposal to distribute data catalog (and meta-data standards).
- Continue expansion and utility of existing WWW based system.

1999

1. Workshops:

- NIS working group
- NIS task groups (4)
- Data Management Steering Committee
- Data Management Committee

2. Goals for the year:

- Thoroughly test synthesis group's system.
- Continue implementation of distributed data catalog.
- Re-evaluate design and implementation strategy.
- Submit proposal to develop, integrate, and distribute additional data components.
- Focus development efforts on refined design and implementation strategy.

2000

1. Workshops:

- NIS working group (2)
- NIS task groups (4)
- Data Management Committee / National-International Symposium/Workshop

2. Goals for the year:

- Implement information model and query system for additional research groups
- Distributed data catalog on-line.
- Submit proposal to develop, integrate, and distribute additional data components.
- Solicit feedback on design and implementation.

2001

1. Workshops:

- NIS working group
- NIS task groups (4)
- Data Management Steering Committee
- Data Management Committee

2. Goals for the year:

- Continue Implementation of additional data components.
- Submit proposal to extend information system to other networks.

2002

1. Workshops:

- NIS working group
- NIS task groups (4)
- Data Management Committee / National-International Symposium/Workshop

2. Goals for the year:

- All major LTER data components on-line.
- Solicit feedback on functionality of entire system

7. Resources Needed from LTER Network Office ([back to TOC](#))

The LTER Network Office will support expansion of the existing NIS and advanced query and information systems which integrate data from the individual site information systems. The Office will support planning activities, aid in coordination of site activities, promote standards development, develop Network data sets, and provide access to software, storage and network resources. The Office funds annual meetings of the Data Managers Working Group where continued development will occur on this important project.

The Network Office will fund a lead person for each of the Network Data Sets to work with LTER sites to develop standard formats for access to data in the site information management systems.

8. Resources Needed from LTER Network Sites ([back to TOC](#))

The development of a distributed system will depend upon the readiness of the site to participate but will not exclude the site's information. Sites that do not yet have full capabilities can have their contributions supported by the Office server.