7.0 General Requirements

As the teams captured business processes, it became necessary to make some preliminary assumptions about the fundamental system functionality that would be provided. Several use cases were identified repeatedly in different workshops. After the use cases were jointly reviewed by the core team it was decided to handle many of these generic functions as system requirements and utilities.

The concept for the NILS software system would include general features and functionality as described in the section below.

7.1 Cadastral / Land Records Data Architecture

One of the essential requirements of NILS is to provide a common data model that operationally integrates surveying (measurements) and cadastral land record data. There are several aspects to this requirement as described in the following sections.

7.1.1 Object-oriented Data Model

The NILS Project is pursuing an Object-Oriented data modeling approach because the implementation of NILS requires an extensible data architecture to model the real-world objects that NILS must manage as software objects (that are processed by an application). The data architecture must provide a common conceptual standard that supports data class extension for modeling the many variations of object properties, behavior and interfacing required for custom deployment.

7.1.2 FGDC Compliance

The NILS data architecture must comply with the Federal Geographic Data Committee's (FGDC) *Cadastral Data Content Standard*. It is expected that the NILS data architecture would extend the FGDC *Cadastral Data Content Standard*. (See Figure 7.1.)

7.1.3 Tiered Network

NILS must support the management of map geometries (features) as topologically-integrated, seamless map layers (feature fabrics). The NILS data architecture and production tools should manage measurements and parcel-based features as a multi-tiered network of associated object features. NILS should support topology association to share geometry dimensionally within and across fabric tiers - this implies two-dimensional topology (area features), zero-dimensional (point features) and one-dimensional (line features). See Figure 5.1 for a visual example. [NOTE: the discussion above is not intended to preclude a data model that captures measurements in three dimensions (i.e. X, Y and Z) or one that manages and represents rights or interests that occur beyond the surface estate.]

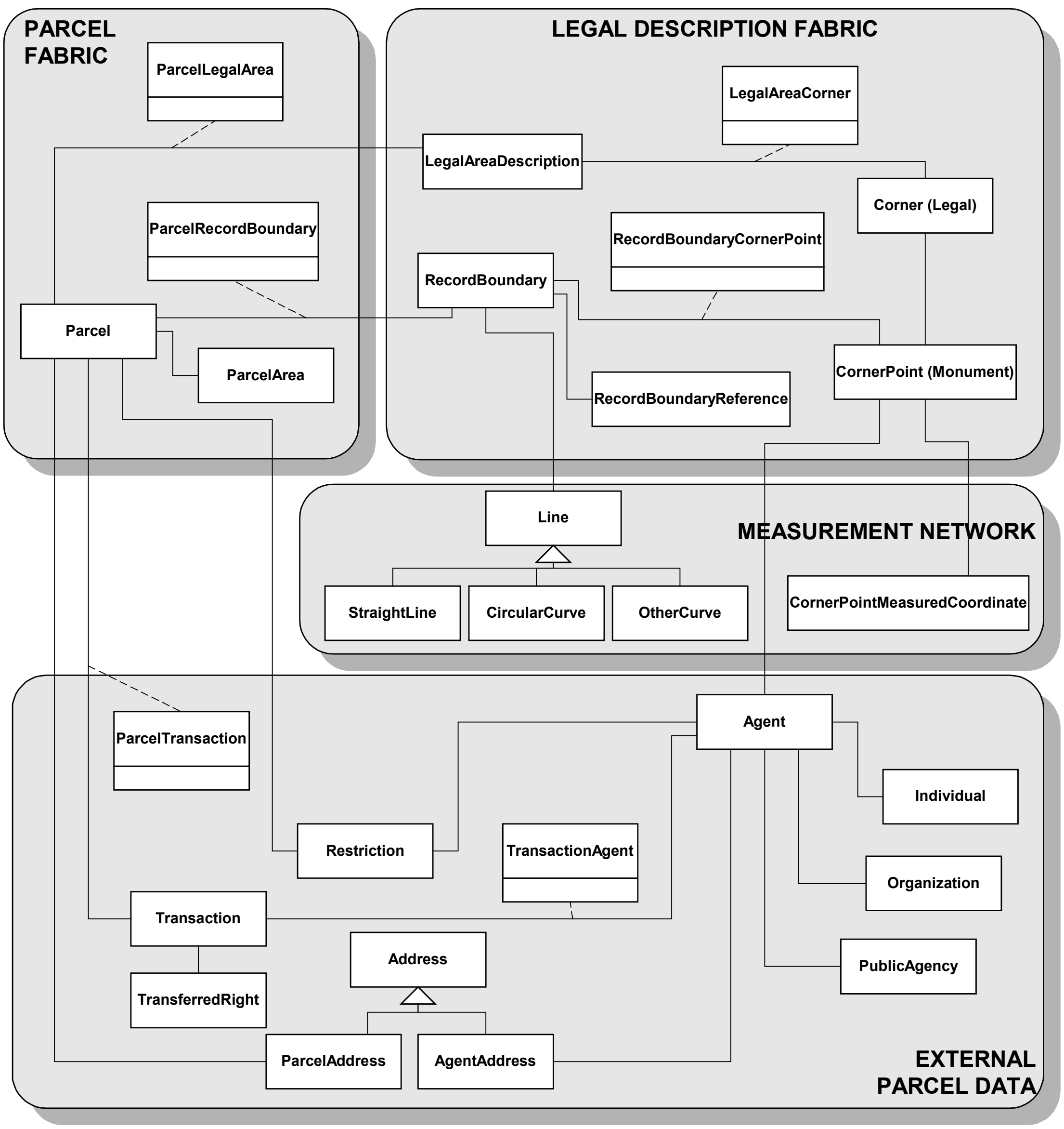
7.1.4 Feature-level Metadata

It is very clear that the NILS software system and data model must automatically capture metadata at the feature level. Individual features are created by construction and computation methods according to specific rules and regulatory environments. To enable data sharing, a user must be able to extract a set of features from a data set. The subset of features must be operationally complete, that is, the subset includes the features and all associated data objects as necessary to manage the data subset using the NILS software system. This means that metadata for each feature's associations and construction rules must persist when data is exchanged.

7.1.5 History/Lineage Management

For cadastral data, the maintenance of feature lineage is essential. For any given parcel, the system must automatically record relationships to its parents. The system must handle time and date information regarding the activation and deactivation (creating and retiring) of parcels. Inactive parcels must be indexed and stored accessibly to support historical searching and reconstruction of historical geometric/attribute configurations.

Figure 7.1
FGDC Cadastral Content Standard Entity-Relationship Diagram with NILS Data Tiers



7.2 Basic GIS

The NILS software system should include basic geographic information system functionality for map display, query, analysis, reporting and plotting. There are several aspects to this requirement, as described in the following sections.

7.2.1 Map and Data Display

It is fundamental to NILS that land records and cadastral data be managed as spatial data. Even when editing alpha-numeric attribute values in non-spatial data, the user should have the ability to see feature geography in a map view. The map view has all the tools necessary to add/remove reference layers, to modify symbology, to pan and zoom, to select features, etc.. Map display includes powerful tools for feature rendering and annotation. Display includes the rendering of raster files (grids, satellite images, digital orthophotos, etc.; may be geo-referenced), terrain models and document images.

The concept of managing a particular geographic area is an essential feature in cadastral/land records processing. The system must support the process of finding a spatial extent that is associated to the subject case, survey, parcel or project. This provides the user the ability to verify the status, location and context for the subject feature. These 'spatial extents' might be saved and re-used in other processes (further along in the workflow required to complete the processing of a case, deed, subdivision, etc.).

In addition to map viewing, the system must provide database displays (tabular reporting) that are interactive with the map view. As features are selected/unselected in one view, the appropriate features or records are likewise selected or unselected in the associated view.

7.2.2 Query

The system must provide the functionality to create and submit spatial or logical queries as a means to refine selected feature sets and to return information about the selected features.

7.2.3 Analysis

The system must provide tools to perform various types of spatial, temporal, mathematical, boolean and logical analysis. Examples of temporal analysis might include the reconstruction of a historical version of data or establishing a view to compare and contrast data sets. Historical analysis would include routines (1) to make graphic and textual comparison of new or proposed data sets with existing data sets, (2) to provide a report of the contrasts, and (3) to perform quality control.

7.2.4 Reporting and Plotting

NILS must provide a framework that enables users to create their required business reports. Examples include Subdivision Reports, Tax Map Sheets, Records of Survey, Survey Plats, Field Survey Notes, Master Title Plats, Derived Status, etc. The user may select a pre-defined template and apply this formatting to generate a report. The user may define and save a custom report format as a template. Reports may include (or be included as) elements in a plot file.

The system must provide high-end cartography tools to generate formatted map layouts (digital and hardcopy plots). As with reports, the user may select a pre-defined layout template and apply this formatting to generate a plot file. The user may define a custom layout and save it as a template. Layouts may include (or be included in) a report.

7.3 Database Management

The management of data is treated as set of system features and functionality. Operations include data set management procedures (by end-users) and database administration (by a database administrator).

7.3.1 Manage Data and Subsets

The system must provide tools to find and manage files, spatial data sets, feature classes (map layers), tabular data, images (scanned documents, geo-referenced images such as digital orthophotography), etc. Data management tools include the capabilities (1) to select data, (2) to manage data subsets by creating subsets, editing data sets, merging data set types and/or appending subsets into larger data sets.

7.3.2 Manage Data Properties and Relationships

Once data has been selected, the user must have the ability to edit the properties of the data. This functionality does not refer to editing data attribute values, but rather to the set of parameters over which the user has control. These data properties include metadata information about a data elements, and includes the management of object rules (validation, construction) and relationships (geometry-sharing, compositional associations).

7.3.3 Perform Datum Transformation

This is a general category of functionality that must be provided to transform data from its current projection and/or datum into a different projection and/or datum. Data conversion as necessary to support dataset import and export to a range of industry standard formats is required. This set of functionality specifically includes support for **X, Y, *and* Z** coordinate-value transformations as would be applied to measurements to convert to/from *orthometric height* and *ellipsoidal height* (GPS gives ellipsoidal heights, conventional vertical benchmarks give orthometric height).

7.3.4 Administer Access Rights

The system must support a multi-user environment in which data and databases are distributed. Some data would be stored and accessed via a central repository, and some data will be stored and accessed locally. Users would require various levels of access (read-only, read-write, etc.), perhaps even within an individual data set (i.e., the user may have write access only to a specified attribute in a table). The system must provide support for administering user permissions for a range of data types according to both individual- and group-level access restrictions.

7.3.5 Transactions and Versioning

The system must provide tools to manage database integrity in a multi-user editing environment. The system must:

- support long transactions (i.e., database transactions that persist beyond the user-session [*not to be confused with customer or case management transactions*])
- handle extraction (to create a working version of a data set or subset)
- manage feature locking (if required in the parent data set)
- track changes (in the new version)
- support rollback and commit points
- resolve version conflicts (merge working version into parent or other version).

7.3.6 Data Automation Support

This is a significant issue for all NILS users. The system must provide support for migrating from existing database schemas into the NILS data schema. The system must provide tools to assist the user in developing a translation routing (e.g., a wizard that produces a batch conversion routine, based on a source-target schema element mapping). Support must be provided for a range of automation processes, specifically including:

- Manual digitizing from a hardcopy map or plat (e.g., master title plat, subdivision plat)
- Scanning and vectorization from a hardcopy map or plat
- Manual data entry (building coordinate files, etc.)
- Conversion/Migration (import from another system or format, analyze and depict the source schema, and assist in the translation to the new schema). For example, BLM has already produced several routines to translate a Geographic Coordinate Database (GCDB) data set into an ArcInfo coverage format.

7.3.7 Import/Export

The ability to share data and to exchange data is a key feature for NILS. The system must provide tools to convert data to/from dissimilar systems and formats. This process is related to the Data Transformation process. NILS should support translation from and to industry-standard formats, including one or more open (published, non-proprietory) formats.

7.4 System Integration

7.4.1 Audit Support

The system must provide support for quality-control processes. Database commits and other operator actions should be logged into an event system to provide a means for process supervisors to review operations.

An example of this process would be for a registered surveyor to review a measurement network construction solution. Data validated by a registered surveyor might receive a higher source quality rating. Data representing survey measurements might have a higher quality rating than data vectorized from scanned survey plats.

The implementation of a quality-rating scheme would be user-defined. For example, the NILS audit process could be used to support a standardized quality rating scheme for data set certification.

7.4.2 Workflow, Document and Event Management

The effective processing of land records and databases must be performed within an integrated workflow management environment. This means that NILS must be seamlessly integrated with tools to guide and track business transactions from their inception through the necessary processing to their final completion. NILS should provide an intuitive set of tools to assist agents in processing transactions. The system should manage processing automatically and intelligently. Users should always be able to access the transaction and determine its status. The system should automate linkages to all source and reference documents. For example, the system should enable the linkage of case processing documents and legal descriptions to the appropriate spatial features and land transactions. Automating the transactions involved in accessing records, processing documents and linking them into the appropriate BLM Case File is an example of how strong workflow management tools could reduce redundancy and increase efficiency.

7.4.3 Architecture for Data Sharing

NILS must support operational deployments that have a variety of database management configurations. From smaller, single-database organizations to large, multi-site distributed enterprises, the NILS applications must provide tools to access, integrate and manage spatial datasets and tabular databases. One of the critical goals of NILS is that users may adopt a common data model and tools for sharing data to promote integration of land information systems. The vision of NILS is that data will be exchanged among users at various levels (local, state, federal, private) to better manage our land records and so to better manage our lands. See Section 11 for further detail concerning the data- and information-exchange functionality of the NILS GeoCommunicator.

7.5 Summary

The development of effective software to support NILS would require a wide range of system functionality. The infrastructure and tools provided at the system level must support the Cadastral/Land Records Data Architecture, Basic GIS functionality, Data Management, and System Administration and Integration.