GIS Implementation Plan
USDA Service Center Agencies

March 2003

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1 Executive Summary

The USDA is developing new business processes and an improved information technology infrastructure to support over 25,000 field staff through the Service Center Modernization Initiative (SCMI). Geographic Information Systems (GIS) and geospatial data play a key role in enabling many of the more dramatic benefits identified for the SCMI's Common Computing Environment (CCE). This document presents a plan for implementing GIS as part of the larger SCMI.

This implementation plan was written in late 2002, and it examines GIS implementation at a point in time when the SCMI and GIS are both partially implemented. It is, therefore, a mid-course view that examines both the current status of implementation as well as the work that remains to be done to fully implement SCMI and Enterprise GIS.

Enterprise GIS Business Case

The business case driving the GIS Implementation Plan has been analyzed at various stages in the design and development of CCE GIS. Early analysis of GIS in the SCMI documented the expected benefits of GIS. In this business case GIS implementation accounted for over 34 percent (or $168 million) of the annual savings that were possible through business process reengineering. Subsequent piloting proved that these benefits were achievable, and in fact identified other areas where additional savings could be achieved. A recent reevaluation of the business case for GIS implementation reconfirmed these results and documented a payback year of 2005.[1] Section 3.2 of the GIS Implementation Plan discusses this business case in greater detail.

Geospatial Database Construction and Acquisition

Geospatial database construction is an expensive and time-consuming process for USDA's SCMI as well as for most GIS development projects. Geospatial data is typically over fifty percent of the cost of a GIS development project for an organization, like USDA, that has historically maintained manual maps and land records. The service center agencies have identified four core geospatial data types and a total of fourteen priority geospatial data types. The four core types of geospatial data include:

Common Land Unit

- Demographics
- Digital Orthophotos (Orthoimagery)
- Common Land Unit (CLU)
- Soils (Digitized Soil Maps)

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[1] USDA Service Center Agencies GIS Strategy, 2001, (USDA: Washington, DC) p. iv

Wetlands are also a high priority.

Production of some of the core geospatial databases requires a multiyear investment by USDA. Demographics data is an exception as the Bureau of the Census produces this type of data on a nationwide basis. USDA has been a major partner to USGS as well as partners with other levels of government in investing in production of digital orthophoto quads (DOQs) and quarter quads (DOQQs). USGS produces the initial DOQ, which USDA data centers process to provide county mosaics and DOQQs that are enhanced to be more useful for interpretation of agricultural features. While these digital orthophotos are now available for the entire country, production of county image mosaics will continue until they are available for all required areas. DOQQs are old in some areas and collection of new data and production of a more current DOQQ is planned to occur every five years. The Common Land Unit (CLU) is USDA's agricultural cadastre (i.e., agricultural land ownership and use data type). CLU data are being provided by the Farm Services Agency (FSA) at a variety of digitizing centers across the country. In addition, some CLU data are or will be produced by contractors. Soils maps have been and are being digitized to provide this type of data in geospatial data formats. The Natural Resources Conservation Service (NRCS) is responsible for soil maps and soil map digitizing. Figure 1-1 summarizes geospatial data production status and reports production goals through FY2004.

Figure 1-1 USDA SCA Geospatial Data Production Status

Geospatial Data Type	FY 2002	FY 2003	FY 2004
Orthoimagery			
# counties completed	2,970	3,056	3,141
percent of total (3,141 counties)	94.6%	97.3%	100%
# counties refreshed (yearly)	—	433	714
Percent of total	—	13.8%	22.7%
Common Land Units			
# counties completed	600	1,300	3,141
Percent of total (3,141 counties)	19.1%	41.4%	100%
Soil Surveys Digitized			
# counties completed	1,380	1,650	2,055
Percent of total (2,900 counties)	47.6%	56.9%	70.9%

The time to complete production of the core geospatial databases is partially a function of the levels of funding that will be available to support this activity. FSA and NRCS are currently projecting accelerated, increased funding plans to complete production of the core geospatial data bases. Under these accelerated scenarios, geospatial databases are completed for the core data types sometime in the FY2005 to FY 2007 timeframe. With accelerated production, county mosaic DOQs are completed in FY2004, CLUs are done in FY2005 and Soils are completed in FY2007.

As GIS applications are dependent on geospatial data to function, the availability of geospatial databases is critical for deployment of GIS. To better visualize areas where geospatial data are available, status maps of available data are posted on USDA websites. The NRCS Soils Status map is available at the following location:

http://data4.ftw.nrcs.usda.gov/website/archived_ssurgo/viewer.htm

The CLU and mosaic DOQ status maps are available at the following location:

http://www.apfo.usda.gov/statusmaps/mosaic.gif

The CLU status map is available at the following location:

http://www.apfo.usda.gov/statusmaps/clustat.gif

NAIP Imagery and Compliance Applications

For many years, FSA has acquired 35mm slide images to use to check producer compliance with USDA subsidy agreements, which are administered by FSA. For example, images might be used to determine whether or not a field is planted and whether or not it is planted with the crop that was specified in an agreement with USDA. Compliance checks are required to limit program fraud and abuse.

FSA plans to use aerial and satellite image sources, rather than 35mm slides, and expand the area of coverage for compliance monitoring under the National Agricultural Imagery Program (NAIP). NAIP pilots were conducted in 2001 and 2002 to better understand the benefits and costs of this new imagery data collection strategy. NAIP addresses FSA's needs for current DOQ orthorectified imagery for various mapping purposes and compliance. NAIP pilots were conducted in 2001 and 2002 to better understand the benefits and costs of this new imagery data collection strategy.

FSA requirements for NAIP can be summarized as follows:

- Acquired annually during growing season
- Supports measurement of planted acreage
- Supports visual differentiation between crop types
- Provides a source of new ortho imagery
- Supported in FSA GIS environment
- Imagery placed in public domain[2]

[2] Shirley Hall, email communication

The following goals have been formulated for NAIP:

- Provide new photography/digital imagery on an annual basis
- Update ortho-imagery base on a 1-5 year cycle depending on the local Service Center need
- Aerial film is archived at APFO and made available for photographic products
- Digital imagery is made available to the USGS National Map in place of or to augment the National Aerial Photography Program/National Digital Orthophotography Program
- Federal, State and local partners participate in the acquisition program use the products to support their own program needs[3]

Current NAIP plans are to collect over 800 counties of image data in 2003 and over 1,200 counties of image data in 2004.

Geospatial Data Architecture

The following two geospatial data centers provide a variety of data support services to the service center agencies:

- FSA's Aerial Photography Field Office (APFO) in Salt Lake City, Utah
- NRCS's National Cartographic and Geospatial Center in Fort Worth, Texas

Both centers receive Digital Orthophoto Quad (DOQ) image data from USGS and apply value added image processing techniques to improve the utility of the image for interpretation of agricultural features. The centers also archive various types of geospatial data and assemble geospatial databases for distribution to service centers. While compact discs have traditionally been used to distribute data, ftp downloads of data are increasingly used. The Resource Data Gateway provides a portal for service centers and the public to search for geospatial data from USDA data centers and other sources. Geospatial data warehouses, which are currently being piloted, will provide future, improved methods for archiving and distributing geospatial data to service centers and the public. Deployment of geospatial data warehouses and data marts is scheduled for 2003.

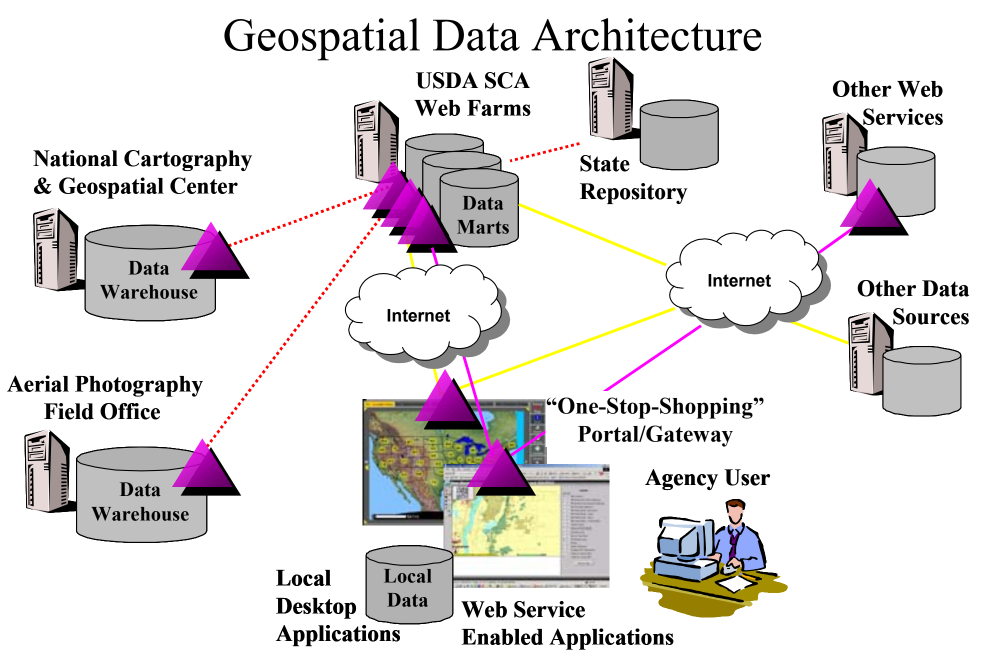
Some geospatial data are also stored on servers in the service centers. The Geospatial Data Provisioning Team, which includes members of the GIS and Data Management Teams, established standard geospatial data folder and file naming conventions and data migration tools. The data migration tools help move geospatial data files from desktop PC storage to the correct location on the servers. During 2003, standards will be developed for Enterprise Geospatial Data Management using ArcSDE and SQL Server.

Geospatial data will also be stored on state servers. State geodata administrators will be responsible for keeping the state geospatial data files current and will help service

[3] Ibid

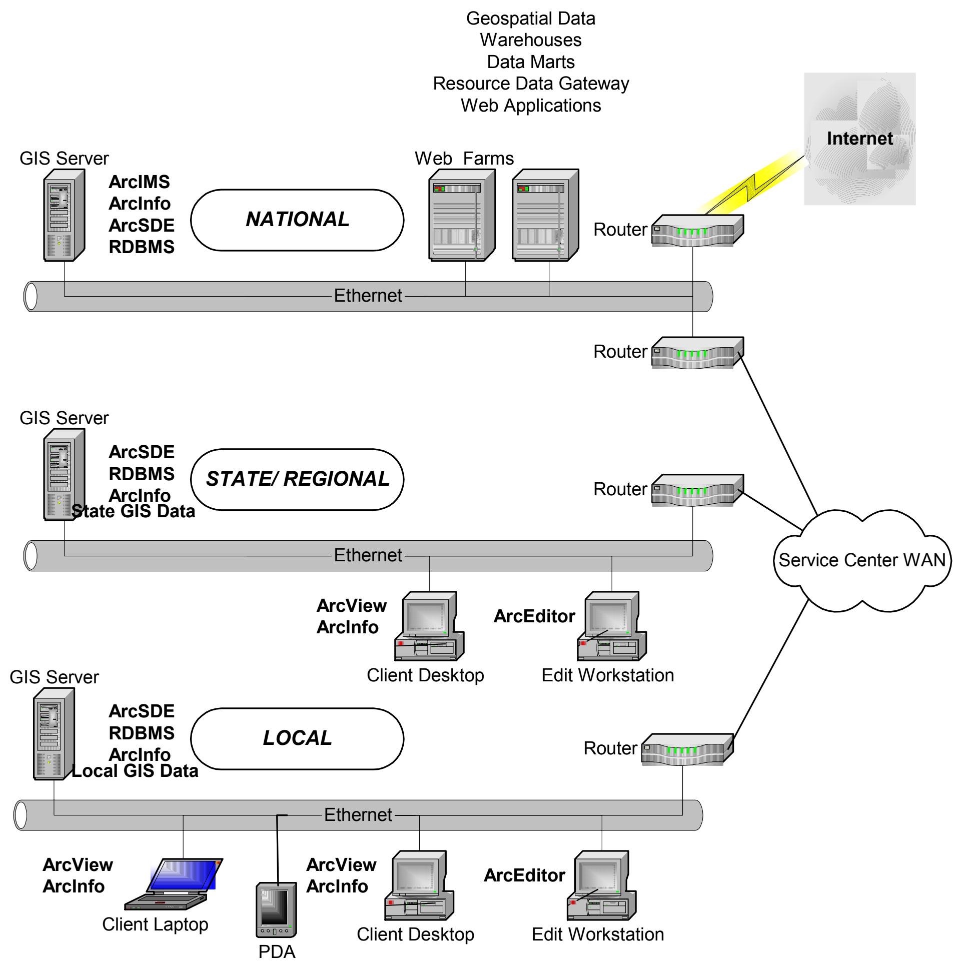
centers acquire, install and maintain geospatial data on their local servers. The geospatial data architecture is presented in Figure 1-2. The Service Center Agency User will access local geospatial data on their local server. Data access will also be provided through the Resource Data Gateway, which will provide access to geospatial data in USDA SCA Web Farm Data Marts. Users will also have access to geospatial data that is publicly available over the Internet (e.g., TerraServer).

Figure 1-2 USDA Geospatial Data Architecture



While many USDA geospatial data types are static, some data are dynamic and change fairly frequently (e.g., CLU, easements, etc.). Current development plans are to manage CLU data locally and replicate changes to regional and/or central data archives. Easements data are managed through a single web services application and database, which will also manage all changes to the easements data. The overall GIS architecture is presented in Figure 1-3. The Service Center WAN currently provides service centers with access to state archives and national web farms. The planned upgrade to T1 communications will provide improved bandwidth between service centers, state offices and national web farms, which will host geospatial data marts, the Resource Data Gateway and various geospatial web applications (e.g., WebEasements).

Figure 1-3 USDA Geospatial Architecture



GIS Software and Architecture

The USDA negotiated and executed a department wide enterprise license agreement with the Environmental Systems Research Institute (ESRI) for enterprise GIS software following an in depth CCE GIS market research process. This agreement allows USDA agencies to use unlimited quantities of ESRI ArcView 3.x and ArcGIS 8.x software, including many extensions. Access to limited quantities of ArcIMS, an Internet GIS tool, and ArcPad, a mobile GIS tool, are also authorized by the agreement. The agreement also provides ESRI software maintenance for a period of five years and help desk support. Figure 1-4 lists the ESRI enterprise GIS products.

Figure 1-4 ESRI Enterprise GIS Products

Product Type	Product Names
Professional GIS	ArcInfo
Desktop GIS	ArcView
GIS Data Editing	ArcEditor
Enterprise Spatial Data Management	ArcSDE
ArcGIS Extensions	3D Analyst, Spatial Analyst, Geostatistical Analyst, StreetMap, ArcPress, Network Analyst
Geographic Software Components	MapObjects and ArcObjects
Web GIS	ArcIMS
Mobile GIS	ArcPad
GIS Data Viewing	ArcExplorer and ArcReader

The ArcView 3.x product is ESRI's traditional desktop GIS tool. FSA and NRCS developed their initial GIS desktop applications (e.g., CLU digitizing, Customer Service Toolkit, etc.) using this product. The ArcGIS software is based on an object relational data model that provides more advanced spatial data management functionality, a more robust enterprise suite of tools as well as other advantages. The enterprise configuration of tools includes a desktop ArcGIS tool (ArcInfo, ArcEditor or ArcView) plus ArcSDE and a compatible relational database. SQL Server was selected to be the CCE relational database tool. ArcIMS and ArcPad extend the enterprise to the Internet and mobile platforms.

Alternative CCE applications architectures have been evaluated and discussed in a number of versions of the CCE Information Technology Architecture (ITA) and other documents. The three basic alternative enterprise applications architecture are:

- Distributed Client Server Architecture: Windows client personal computers connected to a service center local area network and network and data servers provides the basic distributed client server architecture in a CCE context. From a GIS perspective, this implies ArcGIS desktop GIS software on clients and ArcSDE plus SQL Server relational database software on the servers.
- Centralized Architecture: Web services and/or Internet hosted applications and Citrix terminal server connections to centralized applications are current options for centralized architectures. Local clients in service centers use available communications bandwidth to connect to central web or terminal server applications. Internet browsers and/or Citrix terminal server software on the clients enable connections over communications to centrally hosted applications and data servers. If Internet applications are hosted on the server, ArcIMS plus

ArcSDE and a relational database will be installed, possibly with supplemental geospatial web services (e.g., webEasements application).

- Hybrid Architecture: Hybrid architecture implies a mix of distributed client server and centralized applications with choices made on an application by application basis.

Two different studies have both concluded that a hybrid architecture provides the best mix of applications functionality and cost effectiveness. Key limitations of the distributed client server approach for GIS include the challenge of administering the ArcSDE plus SQL Server geospatial database and the difficulty of implementing an effective geospatial data replication solution for dynamic data (e.g., CLU). The centralized architecture limitations include performance and reliability problems with the Internet, limited USDA service center agency communications bandwidth and limited applications functionality available with Internet GIS and geospatial web services tools. Over time, the viability of the centralized architectural approach will likely improve and bandwidth increases and geospatial Internet GIS and web services functionality increases.

Geospatial Data Management

While the implementation of an enterprise-wide GIS solution will result in large annual savings, there are three main issues that need to be addressed to enable successful implementation:

- **Requirements for Advanced Geospatial Data Management**—Advanced geospatial data management functionality (e.g. versioning, disconnected editing, replication and history tracking) is needed to support multi-user editing and mobile data edits to maintain dynamic geospatial data (e.g., common land unit data) and make that data available to the enterprise.
- **Enterprise Geospatial Data Tracking Issues**—As the availability of geospatial data files varies from one location to another, it is especially important that the specific data hosted on service center servers be carefully tracked. Comparison of data available at data centers and geospatial data warehouses with service center data will help identify data sets that need to be distributed to service centers and put to use.
- **Operational Geospatial Data Management Issues**—Accurate, current geospatial data is essential for effective geographic analysis and decision making. Geospatial data are also a major investment, which must be protected by effectively updating dynamic data types and providing access to and maintaining static data types.

Applications and Applications Development Issues

The application development groups of FSA, NRCS, and RD each develop GIS applications. The Business Process Reengineering (BPR) Labs generated many of the concepts and requirements for desktop GIS pilot applications, which have since been further developed by the agency applications development groups. All three Service

Center Agencies have developed GIS applications and have plans to develop additional applications as well as migrate desktop GIS applications to an enterprise GIS architecture. Chapter 5 of the GIS Implementation Plan discusses applications and their development plans for each of the three Service Center Agencies in greater detail. Applications programmers at service center agency development centers may need GIS training, SQL Server training, as well as training in the ESRI development environment and Visual Basic for Applications.

Desktop GIS applications that have been deployed include NRCS's Customer Service Toolkit, which is a conservation-planning tool, and FSA tools to digitize and maintain CLU data and calculate acreages. RD has also deployed its web based MAP application, which provides RD managers with the ability to map the locations of RD grants and loans and generate geospatial queries and reports. NRCS has deployed a number of other applications including the Resource Data Gateway, Wetlands Determination Toolkit, webEasements, and the Soil Data Viewer. Resource Data Gateway is a geospatial data portal, which allows users to identify available geospatial datasets of interest and places orders for delivery of data via CDs or ftp. WebEasements is the most advanced application from an architectural standpoint; webEasements makes innovative use of NRCS developed web geospatial services and ESRI's Internet GIS tools to provide geospatial data capture and editing capabilities over the web. Figure 1-5 presents a tabular listing of implemented GIS applications by service center agency.

Figure 1-5 Service Center Agency Implemented GIS Applications

FSA Implemented GIS Applications	**NRCS Implemented GIS Applications**	**RD Implemented GIS Applications**
CLU Digitizing Tool	Customer Service Toolkit	Mapping Analysis Program (MAP)
CLU Maintenance Tool	Wetland Determinations Toolkit	
CLU Crop Reporting Tool Prototype	Soils Data Viewer	
CLU Compliance Tool	Resource Data Gateway	
CRP Soil Calculation Tool (April, 2003)	Conservation Easements	
	Office Information Profile	
	Smartech Electronic Field Office Technical Guide	
	Performance & Results Measurement System (PRMS)	
	Plant Distribution Module	

Future plans include development of a number of new enterprise GIS applications. For example, FSA will develop the Customer-Land link in a new GIS based version of SCIMS. In addition, FSA will migrate existing CLU digitizing and maintenance applications from the desktop to a local client server architecture. This migration will provide support for editing by multiple users, versioning, history tracking and other advanced geospatial data management techniques. Future service center agency GIS applications development plans are presented in Figure 1-6, Figure 1-7 and Figure 1-8.

Figure 1-6 Future FSA GIS Applications

Future FSA GIS Applications	Design/Develop	Pilot	Implement
CLU Land Use Tool	Until March, 2003	March, 2003	November, 2003
CLU Compliance Tool	Until September, 2003	September, 2003	TBD
SCIMS Customer-Land Link[4]	December, 2002	November, 2003	November, 2003
CLU Digitizing Tool	Until May, 2003	May, 2003	November, 2003
CLU Maintenance Tool	Until March, 2003	March, 2003	September, 2003
Measurement Services Tool	Until March, 2003	March, 2003	TBD
CRP Tool			

Figure 1-7 Future NRCS GIS Applications

Future NRCS GIS Applications	Design/Develop	Pilot	Deploy
ProTracts	Thru April, 2003		April, 2003
Soils Data Warehouse	Thru May, 2003		May, 2003
Smartech Runof Curve/Object Modeling System	Thru September, 2003		September, 2003
ArcGIS Customer Service Toolkit	FY 2004		FY 2004

[4] Jim Heald, FSA, : SCIMS Customer-Land Link is a database table that is used by many applications rather than an application per se.

Figure 1-8 Future RD GIS Applications

Future RD GIS Applications	Design/Develop	Pilot	Implement
RHS Single Family Housing Program Eligibility Locator	In process	TBD	TBD
Environmental Hazard Reporter	In process	TBD	TBD
Spatially Enabling the RD Data Warehouse	In process	TBD	TBD
Spatially Enabling the Preservation Information Exchange	In process	TBD	TBD

GIS Training Issues

GIS is a relatively complex technology, so successful enterprise implementations of GIS require fairly ambitious training programs, which must address a variety of topics, skills, tools and applications. A series of GIS training plans have been developed over the years but the most complete GIS training plan was prepared in 2002[5]. A GIS Training Team was formed by the GIS ITWG Team to develop recommendations for GIS training at various levels of the enterprise. The draft document summarizes the plan that was developed by this GIS Training Team. The GIS training plan identifies different types of staff, at various levels of the organization within the USDA organization who need GIS training as well as alternative options for delivering training. Chapter 6 of the GIS Implementation Plan presents the GIS Training Plan in greater detail. The GIS training schedule is presented in Figure 1-9.

[5] Draft Statement on GIS Training for USDA Service Center Agencies, 2002, (USDA, Beltsville, MD)

Figure 1-9 GIS Training Schedule

Training Course	Develop	Train
GIS for Program Staff	1st Quarter, 2003	March, 2003
Understanding SCA GIS Data	Ist Quarter, 2003	TBD
Introduction to ArcGIS I for SCA	June, 2003	August, 2003
Introduction to ArcGIS II for SCA	January, 2004	TBD
Introduction to GPS and Digital Cameras	TBD	TBD
Advanced GPS and Mobile Data Collection	April, 2003	TBD
SCIMS	November, 2003	TBD
ArcIMS at 9.0	Fall, 2003	TBD
AecSDE with SQL Server	March, 2003	June, 2003
Understanding GIS for Soils (Virtual Campus)	FY 2004	TBD

GIS User Support

USDA Service Center Agency GIS users are currently supported using a tiered approach. A GIS user in a field office who has a GIS question or problem contacts the state office for help. If the state office is unable to resolve the question, the six authorized callers to ESRI at the USDA CCE help desk are contacted. If the CCE help desk staff cannot resolve the question, ESRI's is contacted for resolution of the issue. The information is then communicated back to the original questioner in the field office. To improve responsiveness and effectiveness, it is recommended that GIS specialists be added to the CCE Help Desk. It is anticipated that seven CCE Help Desk GIS specialists be added with one of these specialists an actual ESRI employee. If necessary, the field office GIS users could contact the GIS specialists on the CCE Help Desk directly for assistance. It is expected that this flatter and more specialized structure will make it easier for users to quickly get the right GIS information to continue working without long delays and communication problems.

GIS Implementation Plan Phases

This document discusses the following four key phases of Enterprise GIS Implementation:

- **Phase One: FY2003**—The first phase involves the continued implementation of Desktop GIS technology, construction of geospatial databases (e.g., CLU, soils, etc.) and deployment of business re-engineered GIS applications. Geospatial data warehouses are in design and development phases. Individual ArcGIS applications may be available for testing by mid-2003 on a limited basis. GIS training expands to include a broader cross section of service center users as well as developers. Section 7.1 of the GIS Implementation Plan discusses this phase in detail.

- **Phase Two: FY2004—**The second phase largely consists of activities related to transitioning to enterprise GIS. The current CCE transition plan is to install ArcSDE and SQL Server in each of the service centers during 2003[6]. Individual ArcGIS applications may be available for testing by mid-2003 on a limited basis. Section 7.2 of the GIS Implementation Plan discusses the activities involved in this phase.
- **Phase Three: FY2005**—The third phase primarily involves implementation of enterprise GIS. During this phase, the design and development activities planned in the previous phase are deployed on an enterprise-wide basis. This implementation initially applies to the distributed client server enterprise GIS configuration contained within the service center environment. Core geospatial databases are largely complete by the end of this phase. This implementation phase is discussed in detail in Section 7.3 of the GIS Implementation Plan.
- **Phase Four: FY2006 and beyond**—The fourth and final phase includes further implementations. After the basic enterprise GIS infrastructure is available in the service centers, access to geospatial data and GIS applications needs to be extended to USDA personnel from other service center locations and to the public. In addition, mobile GIS implementation with wireless communications can make anytime, anywhere access to data a more realistic option. This will occur through the implementation of Enterprise GIS with mobile computing, geospatial data warehouses and implementation of the anytime, anywhere access vision of the Virtual Service Center. Section 07.4 of the GIS Implementation Plan highlights additional information regarding further implementations.

Future GIS Vision

The longer-term goal is to use GIS to help achieve the Vision of the Virtual Service Center[7]. The Virtual Service Center would support anytime, anywhere access to geospatial data and applications. When the Virtual Service Center vision is realized, agricultural producers would be able to visit any service center to transact business that accesses geospatial data. Anytime, anywhere access also implies mobile geospatial data access for USDA service center staff as well as public access to geospatial data through geospatial data portals and geospatial data warehouses.

The plan discusses a variety of technology improvements that will be required to realize the promise of the Virtual Service Center. For example, the bandwidth of the USDA communications network must be upgraded and USDA management has recently committed to implementing a major communications upgrade. In addition, the GIS must be migrated to a true Enterprise GIS from its initial desktop configuration. This migration will be multifaceted and will include development of geospatial data warehouses, mobile GIS, GPS data collection in the field and other new initiatives.

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[6] The CCE Quarterly Oct-Dec 2002 states that deployment will occur during the third quarter of FY2003

[7] SCI Modernization Plan, November 19, 1999

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2 Introduction

The role of the Geospatial Information Systems (GIS) Implementation plan is to provide a roadmap to transition from the current environment to the Virtual Service Center target environment. It discusses the key issues associated with the successful design, development, and deployment of Enterprise GIS hardware, software, applications, and data. In addition, the plan addresses issues key to successfully operating and maintaining the system such as data migration and conversion, training, and testing.

2.1 Background

The USDA Deputy Secretary, under the aegis of the National Food and Agriculture Council (NFAC), has charged the administrators of the current field service agencies to provide USDA customers with the best possible service at the least possible cost. The strategy is to accomplish this via "one-stop shopping" at the USDA Field Service Centers. The three major USDA agencies represented at the service centers are:

- **Farm Service Agency (FSA)**
- **Natural Resources Conservation Service (NRCS)**
- **Rural Development (RD)**

These three agencies provide a variety of programs and services to a wide and partially overlapping clientele base. The role of the field service center is to be a new delivery mechanism for the programs, products, and services offered by the Partner Agencies (FSA, NRCS, and RD).

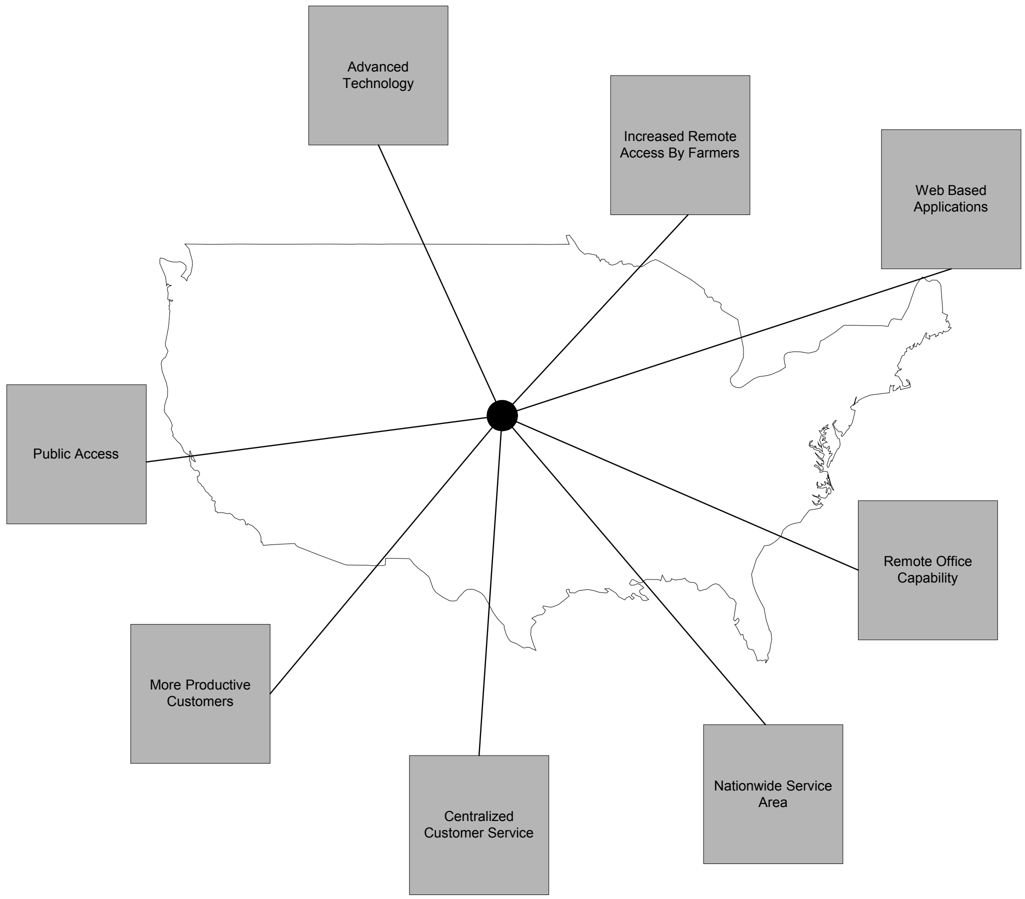
FSA, NRCS, and RD have completed the process of restructuring and collocating field offices into local field service centers. Although these agencies serve the same regions, work with overlapping groups of customers and perform many similar processes, they have existed as separate entities with their own operations, data, information systems and service delivery processes. This delivery mechanism will use redesigned work processes, integrated systems, and data to provide the best possible service at the least possible cost. Implementation of the field service center concept will improve customer service by providing collocated agencies that can easily share information.

The Virtual Field Service Center Vision

The Virtual Field Service Center vision is to enable a USDA customer to walk into any Field Service Center (FSC) and conduct business by talking with any USDA employee in that office. This vision reflects the views of both UDSA customers and senior management of the partner agencies, as well as the Secretary of Agriculture's vision of the department as a "place where our customers are going to know, and want to know, about a broad variety of things, and where our first responsibility is the effective delivery of programs to our customers." The four key strategic goals of this vision are: one-stop service, quality customer service, cost reduction, and partnership.

The model Virtual Service Center will have the ability for the public to access and conduct business with USDA electronically. The USDA will use technology to better understand the demographics and needs of its customers and to service the public's changing needs quickly. The USDA will partner with the community to better understand local and regional requirements. The infrastructure will provide the flexibility for USDA to provide creative delivery mechanisms while accomplishing back-office activities at reduced cost. The Virtual Service Center Vision is shown in Figure 2-1.

Figure 2-1   USDA Virtual Service Center Vision



The Virtual Service Center realizes the vision of the One-Stop service from anywhere-anytime. USDA services are accessible electronically with seamless access to information for customers. The Virtual Service center focuses on service to the customer and the community.

The Virtual Service Center Vision depends on technology to collect, analyze, and distribute information. This infrastructure includes common computing equipment, integrated data, and a common telecommunications backbone. The goal is to allow employees to focus their primary effort on core business processes by reducing the amount of time they spend on administrative information management and related activities. This is being accomplished primarily through reengineering of Service

Center business processes. Technology improvements that enable reengineering of business processes include infrastructure support; communications; hardware; desktop software; and integrated shareable customer, land, and program information.

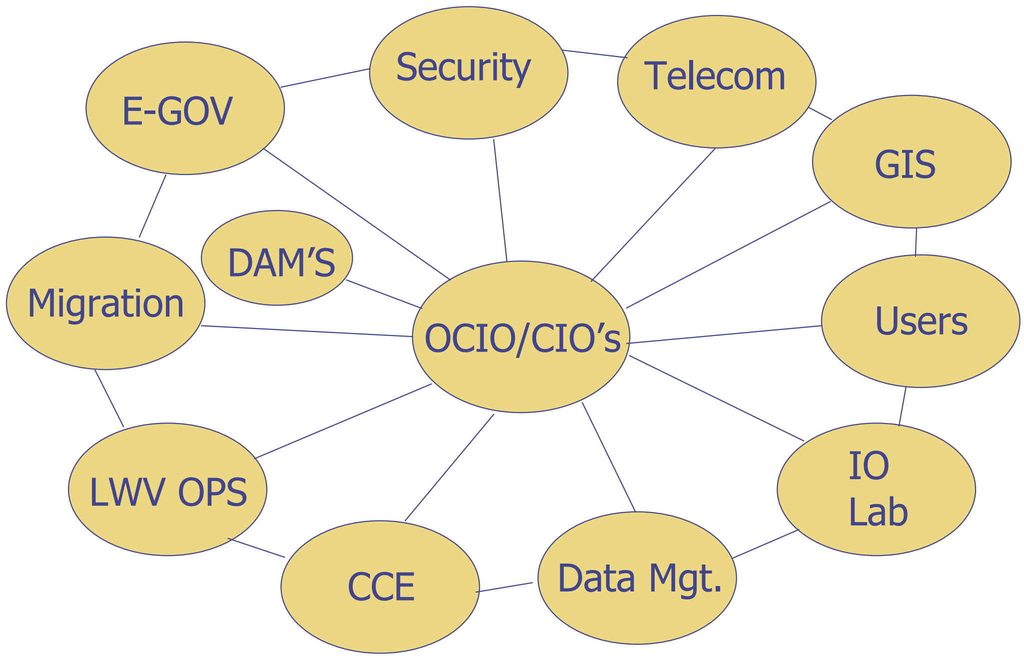
The overall technology goals for the Virtual Service Centers are based on the following business requirements:

- Administrative Convergence
- Sharing information with customers
- Common office automation tools
- Integrate geographic information systems into Service Center activities
- Collecting information only once
- Mobility for Service Centers
- Customer access to information

2.2 Information Technology Working Group

The USDA has established the Information Technology Work Group (ITWG) to ensure success in implementing the USDA Virtual Field Service Center Vision. At its core is the CIO/OCIO office, which is responsible for providing IT oversight to the FSA, NRCS, and RD agencies. Each of the individual workgroups within the overall structure is responsible for a specific component of the Service Center implementation. The structure of the USDA Service Center IT Work Groups is shown in Figure 2-2. Each Service Center IT Work Group is in contact with USDA users to ensure that initiatives address user requirements in a practical way.

Figure 2-2 Structure of the Service Center IT Work Group



2.3 Geospatial Data

The goal of the ITWG GIS Team is to add significant value for Service Center customers by enabling the reengineering and improvement of labor-intensive manual mapping process to automated processes. A key component of the Virtual Service Center Vision is universal access to the USDA's geospatial data. Geospatial data is the digital equivalent of geographic maps, images, and records. Geospatial data has traditionally been used by various organizations to manage land as well as geographically distributed assets and information. In the case of the USDA, aerial photos, soil maps, demographic data, land ownership data, crop, and conservation practice data are all key types of geographic information that have been used for many years. There are two key components to geospatial data:

Key Geospatial Data Components

- **Geospatial Data**—Geospatial data is any information about the location, shape, and topological relationships among geographic features. This includes remotely sensed data as well as map data.
- **Geospatial Data Attributes**—Geospatial data attributes are a characteristic of a geographic feature described by numbers and characters; typically stored in tabular format and linked to the feature by a user-assigned identifier (e.g., the attributes of a water well might include depth and gallons per minute).

2.4 Enterprise Geographic Information Systems

A Geographic Information System (GIS) is an organized collection of hardware, software, and geospatial data that attempts to store, update, edit, and analyze both geospatial data and geospatial data attributes. An enterprise GIS is an organizationally focused method of approaching the design and development of a GIS solution. Enterprise GIS includes a variety of types of GIS and RDBMS software, geospatial data, hardware, applications software, communications infrastructure and people trained to use and manage the GIS.

Enterprise GIS software is comprised of a variety of products that address the needs of different levels of client-based users (e.g., professional GIS user, desktop GIS user, etc.) in addition to separate products that offer Web or mobile interaction with geospatial data. Additional products allow geospatial data to be effectively stored and managed in an object relational database management system (ORDBMS) environment. USDA selected ESRI's enterprise GIS software products for use in CCE after a rigorous, nine-month market research process. USDA has negotiated a department wide enterprise license with ESRI to provide extensive access to most of their enterprise GIS tools.

There are five categories of USDA enterprise GIS software:

- **Desktop GIS**—This software, installed on a USDA desktop or laptop, presents users with a desktop-based graphical user interface through which they can create maps and perform mapping functions using a variety of types of geospatial data. It provides tools allowing users to work with maps, database tables, charts, graphics, and other multimedia. The USDA will also use desktop GIS to create reports and perform complex analyses. Desktop GIS tools vary in their level of functionality. Desktop GIS tools can also be used either as "standalone" tools or as a component of an enterprise GIS.
- **Server-side GIS**—This server-based software facilitates the communications between the desktop or web-based GIS software and an organization's internal spatial databases. These tools allow the use of more advanced GIS functions such as data editing, data replication, and transaction management.
- **Web-based GIS**—This software enables users to integrate local data sources with Internet data sources for display, query, and analysis through a Web browser interface. Web-based GIS software can be used to either deploy USDA applications or to provide access to USDA GIS data through Geospatial Data Warehouses. Web-based GIS will allow the USDA to interact with a customer remotely, without their needing to make visits to the service center. In addition, it will allow future e-gov applications to be enabled with GIS functionality and geospatial data.

- **Geospatial Data Warehouses and Data Marts**—These systems provide archival storage for geospatial data and allow access to that data through data marts. For the USDA, geospatial data warehouses will be located at USDA service center agency data centers in Salt Lake City, Utah and Ft. Worth, Texas.
- **Mobile GIS and GPS**—Mobile GIS tools with global positioning systems (GPS) allow the user to display, collect, and edit geospatial data in the field. GPS are used to collect the geographic coordinates that are associated with various features in the field. The USDA will use these images as a backdrop for interpretation of features (e.g., wetlands) by analysts performing resource inventory and analysis tasks in the field. Versioned geospatial data can be downloaded to a mobile device in the field service center and edits to versioned databases can be checked in and posted to the database after the analyst returns to the office.

The business requirements for integrating geographic information systems into Service Center activities are based on the need for automating the retrieval of geospatial data, which is critical for reengineering Service Center business processes. While the majority of Service Center processes use map-based information, almost all of this information is still held in paper format in manual systems. Often, this paper is duplicated for use within several processes and is maintained simultaneously by several of the Service Center agencies. This leads to customers receiving different information from each agency for the same area of land.

There are two key requirements for making Geospatial data available to field service centers:

- **Geospatial Data Warehouses/Data Marts and Web Farms**—Geospatial Data Warehouses(GDW) house the authoritative source for SCA national geospatial data. In addition, the GDW archive national geospatial data produced by non-USDA Federal departments to provide better access to these data sets for USDA users. In addition, some USDA geospatial data types that are managed at the local level (e.g., common land unit data) will also be archived in the GDW. They provide the important function of archiving and managing data sets, providing data and metadata to both internal and external customers, and delivering data to data marts and web farms for on-line web applications.
- **High capacity communications**—Due to the large size of most geospatial data, high capacity communications lines are key to making geospatial data available at each service center.

2.5 USDA Technology Policy and GIS

The integration of GIS is not only driven by the Virtual Field Service Center Vision, but also by policy at a USDA and Federal Government level. The USDA 2001 Food and Agriculture Policy document articulates the importance of both GIS and Integrated Programs for effective customer service and program management. It identifies the following specific types of GIS applications that are or will be useful for USDA:

- Improve agricultural productivity
- Improve environmental stewardship
- Protect food safety and reduce animal diseases
- Improve rural community planning
- Improve emergency response
- Improve record keeping for improved program implementation[8]

GIS and geospatial data also play a significant role in President Bush's e-Government initiatives, which include the Geospatial One-Stop portal.[9] Geospatially-enabled e-Government applications will likely become more prevalent after the geospatial data infrastructure improves both within and between federal agencies and other levels of government.

2.6 Purpose and Objectives

The initial deployment of Desktop GIS applications began in 2000. In order to transition to an enterprise-wide GIS environment the USDA must address several potential roadblocks:

- **Communications Infrastructure**—The existing USDA service center network has extremely limited bandwidth. The planned upgrades to communications, network, and hardware infrastructure must continue as approved in 2002 by USDA management.
- **Build on Existing GIS Applications**—The USDA must continue development and implementation of enterprise GIS software applications.

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[8] Ibid, p. 107

[9] The Geospatial One-Stop is one of 24 OMB E-Government initiatives to improve effectiveness, efficiency, and customer service throughout government. It provide a geographic component for use in all Internet-based E-Government activities across local, state, tribal and federal government agencies. Among other contributions, the Geospatial One-Stop will provide a portal to reliable geospatial data of uniform quality.

- **Geospatial Data Accumulation—**The USDA must continue Geospatial database construction and conversion, geospatial data provisioning, and geospatial database design.
- **Business Processes**—The USDA must continue reengineering the existing business processes using GIS as an enabling technology.

The purpose of this Enterprise GIS Implementation Plan is to provide the roadmap for the USDA to transition from the current environment to the Virtual Service Center target environment. It discusses the key issues associated with the successful design, development, and deployment of Enterprise GIS hardware, software, applications, and data. In addition, the plan addresses issues key to successfully operating and maintaining the system such as data migration and conversion, training, and testing.

In addition, this document discusses the following key stages in the lifecycle of an Enterprise GIS:

- Design, development, and maintenance of geospatial databases
- Development and deployment of GIS applications
- Design and implementation of an information technology architecture including GIS
- User training

The implementation roadmap will address each agency separately, due to the variations in business requirements between the participating agencies. While at the highest-level GIS will allow USDA to record and manage customer and program information relating to the land, each agency will use the Enterprise GIS for specific business purposes:

- **FSA**—For FSA, GIS will process land records that are the basis for determining eligibility for billions of dollars in farm payments annually.
- **NRCS—**For NRCS, GIS will not only help prepare conservation plans but will also map and track wetlands and easements.
- **RD—**For RD, GIS will be used to analyze demographic and utility infrastructure data to better locate housing, ensure that housing programs are nondiscriminatory, and minimize the environmental impact of new facilities.

For a more complete discussion of CCE GIS business requirements and their relationships to technical requirements, please refer to the report entitled, "USDA Common Computing Environment (CCE) Enterprise GIS Business Requirements."[10]

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[10] USDA Common Computing Environment (CCE) Enterprise GIS Business Requirements, September 3, 1999

Goals of the GIS Implementation Plan

The remaining chapters of the Enterprise GIS Implementation Plan shall:

- Provide a recommended phased implementation plan for transitioning from the initial Desktop GIS based deployment to the future Enterprise GIS environment.
- Discuss the key issues that should be addressed to successfully design, develop, and deploy Enterprise GIS hardware, software, applications, and data.
- Discuss the data migration and conversion involved in transitioning to Enterprise GIS.
- Provide a management tool for measuring progress against plan.

2.7 Document Organization

This document is organized into the following chapters:

- **Chapter 3, Enterprise GIS Architecture**
- **Chapter 4, Geospatial Data Management Issues and Plans**
- **Chapter 5, Applications and Applications Development Plans**
- **Chapter 6, GIS Training Plans and Issues**
- **Chapter 7, GIS Implementation Plan Phases**

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3 Enterprise GIS Architecture

This section provides an overview of the USDA Service Center Architecture. It describes the existing business, data, application, and technical architecture as they relate to geospatial data and presents an overview of the target GIS architecture.

3.1 USDA Service Center Enterprise Architecture

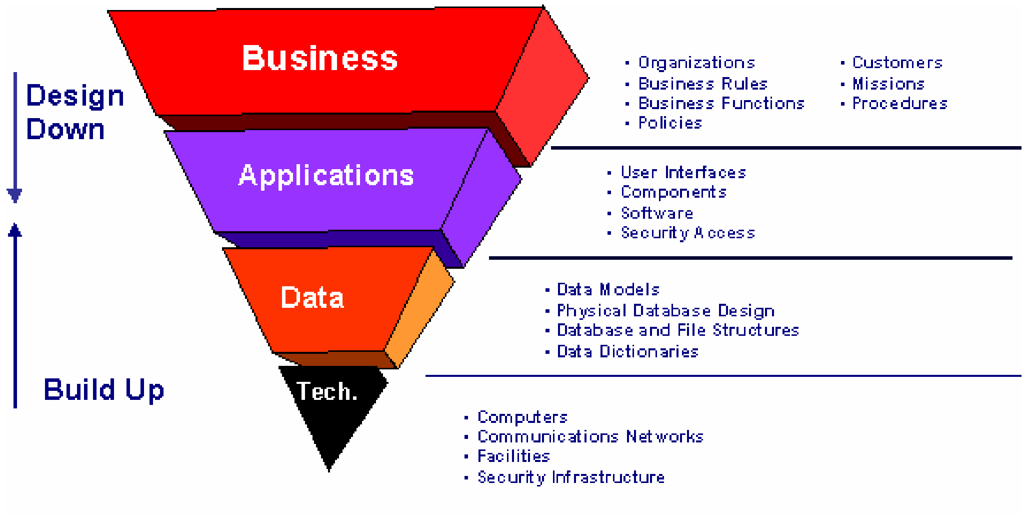
The USDA Service Center architecture adopts a “design down”, “build up” approach, which emphasizes business process re-engineering as the driver for architectural decisions. In this approach, architectural design decisions for each architecture layer are dependent on the higher layers (e.g., reengineered business processes will determine what applications are needed). In turn, each higher layer is dependent on the lower layers as infrastructure for development and deployment (e.g., PCs must be in the field in order to deploy a new application).

The four layers of the Service Center architecture are:

- **Business Architecture**—Defines the mission, organizations, business rules, business functions, policies, customers, and customer interactions for the envisioned process, required to support the Virtual Service Center Vision.
- **Applications Architecture—**Describes the integrated framework for the “target” applications environment the USDA wishes to create and maintain. This includes user interfaces, application software, and security access to the various applications.
- **Data Architecture—**Describes the location and distribution of enterprise data, data models, physical database design, and file structures.
- **Technology Architecture**—Describes the hardware, software, and network components of the common computing architecture. It includes descriptions of the computers that will be used, the communications networks, physical facilities, and security infrastructure that will be required to support the desired architecture.

Figure 3-1 below shows the four layers of the Service Center architecture.

Figure 3-1 Service Center Architecture Components



This figure illustrates the "design down", "build up" approach. For example, the technology architecture can only address those areas in which the Business, Applications, and Data teams have made decisions.

A primary goal in designing the common computing architecture is to reduce the workload on Service Center program staff. Other goals include improving user productivity, development efficiency, interoperability between systems, security, and manageability.

3.2 GIS Business Architecture

The USDA Service Center Agencies have traditionally made extensive use of air photos, various types of hard copy maps (e.g., soils, topography, etc.) and various land records to prepare conservation plans, determine eligibility or compliance, calculate acreages, and a variety of other purposes. In addition to the cost of collecting and preparing aerial photos, maps, and records, the manual retrieval and analysis of this data is a very time intensive process. Therefore, the USDA CCE GIS will deliver major productivity benefits by allowing the USDA to re-engineer business processes to take advantage of this enabling technology.

The business case for GIS has been analyzed at various stages in the design and development of CCE GIS. The *USDA Service Center Agencies GIS Strategy* provides a review of the GIS business case analysis.

Early analysis of GIS in the Service Center Modernization Initiative business case documented the expected benefits of GIS. In this business case GIS implementation accounted for over 34 percent (or $168 million) of the annual savings that were possible through business process reengineering. Subsequent piloting proved that these benefits were achievable, and in fact identified other areas where additional savings could be achieved. A recent reevaluation of the business case for GIS implementation reconfirmed these results and documented a payback year of 2005.[11]

The *USDA Service Center Agencies GIS Strategy* presents the following summary of the GIS benefits identified in the BPR business case analysis:

The USDA Service Center BPR Business Case documented cost savings to the Service Center Agencies. Figure 3-2 presents the estimated annual savings of conducting business operations with enabling GIS technology based on this document.

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[11] USDA Service Center Agencies GIS Strategy, 2001, (USDA: Washington, DC) p. iv

Figure 3-2 Annual Savings From GIS Usage

Activity	Annual Savings (in millions)
DETERMINE ELIGIBILITY	
Determine Area	$14.8
Determine Cropping History	$16.1
Determine Land Eligibility	$34.5
DEVELOP PLAN	
Complete Onsite Inspection	$11.5
Develop Schedule of Application	$27.1
PREPARE/APPROVE CONTRACT	
Process AD 245	$1.8
Provide NRCS with AD 862	$1.7
Perform Onsite Inspection	$5.6
Complete AD 862	$3.5
MONITOR COMPLIANCE	
Perform Status Review (NRCS)	$6.4
Notify FSA	$2.1
Manipulate Spatial Data	$38.1
Perform Damage Assessment	$1.8
Process FOIAs	$3.5
Committee Elections (15% of Service Centers)	$0.4
Total Annual Savings	**$168.9**

In addition to the analysis presented in the USDA Service Center BPR Business Case, an FSA-specific business case analysis also found the following major benefits of GIS implementation:

FSA could save about $79 million annually by integrating GIS in Service Center Program Delivery.

Benefits from implementing GIS include:

- Ability to implement streamlined compliance process which will have greater consistency between Service Centers, reduce errors, and make available a permanent digital record of the compliance activities.
- Faster reconstitution of farms and updates of farm and tract boundaries along with the associated tabular data.

- Supports submission of complete NAP disaster requests, allowing timely establishment of NAP disaster areas.
- Timely identification of potential HEL and more accurate definition of Wetlands Conservation boundaries.
- Ability to continue development of the Service Center Information Management System (SCIMS) linked to the GIS.
- Ability to create high quality, accurate, customized maps for customers on demand, instead of distributing outdated, poor quality photocopies.
- Ability to identify rental land for borrowers, and assistance in production planning and property management.
- Ability to link to and display Farm Program information currently in the System 36.
- Ability to maintain and share farm records maps digitally.
- Access to up-to-date, shared data, resulting in lower long-term costs for data acquisition and maintenance.
- Improved coordination and data sharing between Federal, state, and local agencies.
- Assists in determining eligibility for the Conservation Reserve Program (CRP) by being used to evaluate the following spatial scoring criteria:
    - Federal and State listed Target and Endangered (Non-migratory) plant or animal species
    - Proximity to Permanent Water
    - Proximity to Federal, State, Local, or other protected wildlife habitats within 1 mile of offered acres
    - State wellhead and groundwater recharge areas
    - "National Register of Historic Places"
    - Designated agricultural zones that contribute to the nonattainment of air quality standards
    - Conservation Priority Areas
- Conservation Reserve Enhancement Program areas (CREP) could be identified separate from regular CRP acres.
- Continuous CRP, Farmable Wetlands Pilot Program, and Conservation Reserve Enhancement Program involve smaller, more environmentally sensitive acreage, often found in irregularly shaped areas. GIS/GPS supports the administration of by providing a more accurate, streamlined, and faster method for program processing.
- Assists loan officers in appraisals. For example, appraisers are using a review software with GPS units to determine boundaries for the Debt for Nature program. New York has used this program on more than 1000 acres at cost savings in excess of $100,000.
- Assists loan officers in needs assessment and cash flow planning.

- Provides loan officers with the ability to digitally identify dwellings, buildings, structures, inventory property and hazardous waste sites or areas for customers purchasing properties.
- Assist loan officers with inventory of foreclosure properties and the information used to support the advertisement of these properties.
- Begin to accrue benefits from the $120 million USDA has invested in GIS.
- Begin to deliver significantly higher quality services faster.
- Begin to implement a common Service Center Farm Program delivery infrastructure.
- Better graphical display of information leads to improved decisions by land users and managers.
- Expanded tracking and analysis of program participation.
- Develop employee leadership at the local level in the use and application of GIS for farm program delivery and natural resource analysis.
- Replace wheel and chain manual field acreage measurement with more accurate GPS equipment. Efficient integration with GPS (Global Positioning System) ground measurement and remote sensing (Satellite) information for compliance verification, disasters, and other program needs, and accurate area calculations of affected crops, acres, and producers.
- Standardized accurate measurements of fields from a digital orthophotography base and digital compliance aerial photography for determining acreage for contracts, verification of land eligibility, acreage reports, and compliance work.
- Eliminate obsolete planimeter hardware for using 35mm slides in compliance. This could save FSA as much as $500,000 annually in maintenance costs.
- Eliminate printing, distribution, and storage of hard copy maps.
- Fully capitalize on the agency investment in CCE hardware by using GIS.
- Support the continued development and application of geospatial data sets for farm program delivery and resource planning."[12]

An application specific cost benefit analysis was performed for NRCS's Customer Service Toolkit (CST) during the Business Process Reengineering analysis. This analysis indicated that over a ten year application life cycle CST would deliver annual benefits of $12-15 million, for a total life cycle benefit of $120-150 million. This contrasts with life cycle costs of $31.01 million over this same ten year period.[13]

By service center agency, GIS will deliver the following functionality:

- **Farm Service Agency—**FSA is responsible for administering various agricultural commodity price support and subsidy programs. GIS will simplify

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[12] GIS Implementation Blueprint, 2001, (USDA: Washington, DC) pp. 90-92

[13] Customer Service Toolkit Benefit Cost Summary

the process of screening properties to determine their eligibility for different programs (e.g., lands that are highly erosive may not be eligible for a particular program). Because payments are a function of acreage, calculation of acreage is a key FSA GIS requirement. Compliance with program requirements (e.g., were crops grown on land as promised on program application) is also a key monitoring function for FSA. Both GIS and remote sensing are key tools for compliance with this requirement. GIS and the Common Land Unit (CLU) allow FSA to create and track geospatial customer land and land ownership records for use in program administration.

- **Natural Resources Conservation Service**—NRCS is responsible for providing soil conservation planning technical assistance to farmers. NRCS is also responsible for soil mapping, watershed engineering, and assessment of the status, condition and trends of soil, water, and related resources through the National Resources Inventory (NRI). GIS will primarily be used by NRCS as a soil conservation planning tool as well as a tool to support various resources mapping (e.g., wetlands, easements, etc.) and analysis tasks.
- **Rural Development**—RD is responsible for economic development in rural areas of the country. RD economic development programs address rural American needs for affordable housing and utility infrastructure. Economic development aid is targeted in areas with the greatest need for economic development due to low incomes, high unemployment, inadequate infrastructure, etc. RD uses demographic data, a key type of geospatial data, to assess economic development issues. RD may also use GIS to analyze proposed utility infrastructure and its environmental impact.

3.3 GIS Data Architecture

There are two principal types of USDA Service Center Agency data: geospatial data and tabular data. Although both types of data are essential for service center modernization, this implementation plan focuses specifically on the issues surrounding geospatial data only.

3.3.1 Geospatial Data

With current technology, both geospatial and attribute data can be stored using a relational database management system (RDBMS). The recent USDA enterprise license procurement of ESRI GIS software includes ArcSDE, which is a GIS gateway that facilitates the management of geospatial data in a database management system.[14] During the summer of 2002, the USDA conducted a market research process to identify the RDBMS product that best meets USDA CCE requirements. Through this process, Microsoft SQL Server 2000 was determined to best meet CCE requirements through this process. The USDA purchased this database in September 2002.

[14] http://www.esri.com/software/arcinfo/arcsde/index.html

Accumulation of GIS Data

Currently, hard copy maps, images, and records have been or are being converted to geospatial data using GIS map digitizing and data conversion techniques. Until this process is complete, most service center offices will continue to use a variety of hard-copy geospatial data formats to support business processes like conservation planning. As GISes are implemented across the CCE agencies, online geographic tools will replace these hard-copy maps. One major factor inhibiting the migration to GIS is the availability of digital geospatial data.

Geospatial Data Types

The following geospatial data types are integral components needed for GIS implementation:

- **Common Land Units (CLUs)—**Common land units are a USDA-defined geospatial cadastral data type that includes property boundaries and ownership of agricultural lands, field boundaries, definition of farms, and farming operations.
- **Land Use**—Planting of crop, ground cover, conservation practices, erosion control practices, and compliance with program agreements.
- **Demographic Data**—Demographic data is obtained at no cost from the Bureau of the Census. Demographic data include population, income, and other data collected during the census. These data are available in Bureau of Census TIGER GIS format files that also include digital street and address range data. Demographic data are available by census geographies (e.g., census tract).
- **Digital Orthophoto Quads (DOQs)**—DOQs are optimized digital images of aerial photographs, combining the image characteristics and clarities of a photograph with the geometric accuracies of a map. This geospatial data type can be manipulated with software, offering significant flexibility over traditional hard-copy aerial photos.
- **Soils—**Soils data are files that represent GIS compatible forms of soil maps. Soil maps are converted to digital form using standard GIS map digitizing techniques. Soil types are related to very extensive soil properties attributes.
- **USDA Wetlands——**FSA and NRCS jointly manage USDA certified wetlands. These wetlands boundaries are delineated by NRCS and recorded on the FSA official aerial photos in Service Centers. FSA and NRCS are currently examining methods to digitize these wetlands boundaries.

Fourteen Priority Geospatial Data Themes

The Manual for Managing Geospatial Data in Service Centers identifies the following fourteen priority geospatial data sets and divides them into first and second priority categories. These fourteen data sets include and supplement the six geospatial data sets that were discussed in the previous paragraph of this document.

The highest priority geospatial data sets are:

1st Priority for Data Themes:

1. Digital Orthophotography
2. Soils

3. Common Land Unit (CLU)
4. Topographic Images
5. Public Land Survey (PLSS)
6. Flood Zones—FEMA
7. Demographics—Census (blocks/tracks)
8. Administrative Boundaries (County Boundaries)

2nd Priority for Data Themes

a. TIGER roads and streams (1:100,000K)
b. Hydrology (1:24,000K partially available from USGS)
c. Hydrologic Units
d. Elevation
e. Mean Annual Precipitation
f. Wetlands

Sources for each priority data set are also identified in the Manual for Managing Geospatial Data in Service Centers.[15]

Geospatial Data and Services Requirements Analysis

Requirements are currently being collected for parcel maps as well as geocoding and transportation/vehicle routing services.

Geospatial Data Base Construction Costs

The USDA's acquisition and construction of geospatial data is an expensive and time-consuming process. The USDA has already spent over $130 million to acquire and develop geospatial data and plans to spend an additional $87.5 million are in place.[16] In addition to these direct expenditures, the USDA has used cost sharing strategies to defray costs by working cooperatively with other Federal and state agencies.

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[15] Manual for Managing Geospatial Data in Service Centers, 2002, (USDA, Beltsville, MD) p.33

[16] Dennis Lytle, USDA GIS ITWG Leader, Personal Communication

Geospatial Data Transfer and Management

There are two primary issues related to the efficient management and transfer of geospatial data:

- **Geospatial data size**—The large size of geospatial data places high demands on the USDA's communications and data storage infrastructure. Therefore, performance problems are often associated with transferring these files over the network.
- **Geospatial data management capabilities**—The developmental status of some USDA required geospatial data management capabilities.

Geospatial Data Size Issues

Geospatial data files are exceptionally large. Therefore, the management of geospatial data places high demands the USDA's communications infrastructure and performance problems are often associated with transferring these files over the network. Data storage for the large data sets also have to be accommodated.

Figure 3-3 presents 27 spatial data types (5 integral and 22 anticipated) needed to support anticipated GIS applications that are expected to be used in the service centers. For each type of data, it presents the typical data type sizes for a one square mile area (the approximate size of study area that might be involved in preparation of an average-sized farm conservation plan) and indicates whether the data is dynamic.

Figure 3-3 USDA GIS Data Types and Typical Sizes

Geospatial Data Type	Dynamic Data	KB per Square Mile
Common Land Unit	Yes	7.06 KB
Land Use Land Cover	Yes	18.18 KB
Demographics	No	7.36 KB
DOQs (uncompressed)	No	3,160.72 KB
Soils	No	74.43 KB
Five integral data types total		**3.35 MB**
Cadastral	No	0.38 KB
Climate-Precipitation	No	16.14 KB
Climate-Temperature	No	0.00 KB
Digital Raster Graphics (compressed)	No	82.56 KB
Elevation	No	25.94 KB
FEMA	No	3.72 KB
GNIS	No	0.14 KB
Government Units	No	0.20 KB
Hydrography	No	5.16 KB

Hydrologic Units	No	10.24 KB
Ortho Imagery (compressed)	No	170.68 KB
Photo Index	No	0.05 KB
Plants	N/A	0.00 KB
Quad Boundaries	No	0.05 KB
Transportation-Roads	No	3.03 KB
Transportation-Rail	No	1.01 KB
Wetlands-NWI	No	21.43 KB
Legends	No	0.10 KB
Metadata	No	0.16 KB
Conservation Plan Maps	Yes	1,024.00 KB
Wetlands Delineation Layer	Yes	256.00 KB
Total MB		**4.77 MB**

3.3.2 Service Center Agency Geospatial Data Centers

The USDA Service Center agencies operate two primary data centers that support geospatial database development and distribution to the service center field offices. These data centers are:

- FSA's Aerial Photography Field Office (APFO)
- NRCS's National Cartographic and Geospatial Center (NCGC)

Both APFO and NCGC distribute DOQs and other geospatial data to service centers and other offices within their agencies. While distribution of large geospatial databases by the data centers has most commonly been performed using CDs, other methods of electronic data transmission (e.g., FTP) are growing in popularity. Most NCGC data are now distributed using FTP.

Both APFO and NCGC receive DOQs from the USGS. In cases where the USGS produced DOQs do not meet USDA standards, additional processing is performed to improve the quality of the image and generate an enhanced DOQ. Mosaicking with tonal balancing and digital feathering is an example of an improved image quality product that may be generated by these two data centers with additional image processing. In addition to DOQs, aerial image slides and air photographs have been used by the USDA for compliance monitoring with distribution through the data centers.

APFO and NCGC Responsibilities

The APFO and NCGC data centers each have unique responsibilities within USDA. APFO is "responsible for the procurement of aerial photographic services and related materials for the USDA and other Federal Agencies."[17] APFO maintains a large archive of historic aerial photos and generates a variety of photo and digital products. Conventional and digital photogrammetric techniques are also applied to geographically rectify aerial photos. For new requests for aerial images, APFO provides flight planning and contracting services. APFO also has image processing capabilities that are applied to production of mosaicked ortho imagery as well as processing of satellite image data. APFO provides the following three digital services [18]:

- Mosaicking of Digital Orthophotography
- Scanning Field Service Center Photomaps
- Quality Assurance Inspection of Common Land Unit (CLU) Data

NCGC serves as a "…technical leader for NRCS in cartography, remote sensing, global positioning systems and Geographic Information Systems (GIS). NCGC is a clearinghouse for geospatial data sets and the preparation of maps and map products."[19] NCGC acquires, processes, packages and distributes a variety of different types of geospatial data including:

- Soil Survey Geographic (SSURGO) database
- State Soil Geographic (STATSGO) database
- Parameter-elevation Regressions on Independent Slopes Model (PRISM)
- Hydrologic Unit (HU) data base
- Digital Orthophoto Quarter Quadrangles (DOQQ)
- Digital Elevation Model (DEM)
- Digital Raster Graphics (DRG)
- National Land Cover data set
- Federal Emergency Management Agency flood data (FEMAQ3)
- Conservation practices and technical materials[20]

In addition to packaging and delivering geospatial data sets to service centers, NCGC supports GIS implementation by providing training in GIS. NCGC also uses geospatial data and analysis to create national program maps. NCGC acquires conventional and digital images to support NRCS programs; aerial photos are

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[17] USDA/FSA/APFO, Aerial Photography Field Office FY 2000 Annual Report, p. 19

[18] Ronald Nicholls, APFO Overview Presentation, 2001

[19] USDA/NRCS/NCGC, National Cartography & Geospatial Center Annual Summary- FY 2000, p.3

[20] Ibid, p.7

acquired through APFO. NCGC also supports data collection for the National Resource Inventory (NRI) and provides support to the soils survey.

3.3.3 Geospatial Data Conversion and Development

The most costly component of an Enterprise GIS implementation is data conversion and database construction. For organizations like the USDA that build and maintain paper maps and land records, GIS data conversion is typically over 50 percent of the cost of developing a GIS. USDA planning indicates that GIS data are 70 percent of the cost of USDA's planned GIS. The costs to develop CLU, convert soil maps, build digital orthophotos, and construct other USDA GIS databases are estimated to total approximately $300 million[21]. In many instances, USDA has controlled database construction costs through partner agreements with other levels of government that need the same information (e.g., State of Florida agreements with Water Management Districts, National Cooperative Soil Survey and National Digital Orthophoto Programs).

Initial deployment of GIS will focus on counties that have the key GIS databases available for use. While there are other criteria for initial deployment readiness, GIS data conversion is critical, as it is a costly, time intensive process.

As of November 2002, DOQs are available for 99% of the country so the DOQ focus has shifted from initial production to updates.

As of July 2002, 1,300 SSURGO soils datasets were available in digital form with funding available for an additional 1,800. At the end of FY2002, 1,368 surveys were SSURGO certified. Of these certified surveys, more than 250 have been re-certified with data in the new SSURGO Version 2 format, which is suitable for use in the Customer Service Toolkit and Soil Data Viewer (CST/SDV). Given current funding levels, the expected date for completion of SSURGO in digital form is 2008 with a projected cumulative 2,800 surveys. According to Russ Kelsea, an accelerated production schedule with three years of funding increases to $20 million per year could complete SSURGO production in 2005 versus 2008.[22] An alternative and more likely schedule for accelerated production would complete production at the end of FY2006 with $10 million of funding for FY2003 and $15 million per year for FY2004, FY2005 and FY2006. This latter scenario assumes SSURGO production at a rate of 350 per year.

According to Russ Kelsea, NASIS soil survey data tables can be used for the Customer Service Toolkit Soil Data Viewer application while the SSURGO digital data files are in production:

> "Even without digitized maps however, the CST/SDV can utilize soil survey data tables exported from the National Soil Information System (NASIS) in

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[21] GIS Strategy for Service Centers

[22] Russ Kelsea, Personal Communication via email

> SSURGO Version 2 format. Since the same data file used in CST/SDV is also being used by RUSLE2, Pesticide Screening Tool, and many other applications; and since these data files are used as the official soils data; the SSURGO Version 2 data files will be available to 3rd party vendors and others through the electronic Field Office Technical Guide website. Given current estimates, soil data files for all field offices can be available on the eFOTG website by the August 5, 2003 deadline."[23]

The longer term digital SSURGO data access solution is the geospatial data warehouses, which are currently being piloted and will be constructed at APFO and NCGC.

To accelerate CLU production, FSA also established a program to contract out mosaicking and digitizing work to private sector vendors. The seven states selected were Arizona, California, Idaho, New York, South Carolina, Vermont, and Washington. To pilot the effort, APFO sent source data from 31 counties in Idaho and Washington to six vendors in August 2001. By the end of FY 2001, FSA had CLU data for over 300 Service Centers deployed or ready for deployment. By the end of 2002, this production will grow to over 575 total CLU datasets. Production will increase in 2003 to 850 CLU datasets per year until production is complete in 2005.

A similar production and deployment schedule applies to DOQ mosaics with production also complete in 2005. At the end of FY2002, 2,400 DOQ mosaics were projected to be complete. With production of 600 mosaics planned for FY2003, only 100 mosaics will remain to be completed during FY2004.

Figure 3-4 summarizes the current geospatial data development.

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[23] Ibid

Figure 3-4 Geospatial Data Theme Progress

Geospatial Data Type	FY 2002	FY 2003	FY 2004
Orthoimagery			
# counties completed	2,970	3,056	3,141
percent of total (3,141 counties)	94.6%	97.3%	100%
# counties refreshed (yearly)	—	433	714
Percent of total	—	13.8%	22.7%
Common Land Units			
# counties completed	600	1,300	3,141
Percent of total (3,141 counties)	19.1%	41.4%	100%
Soil Surveys Digitized			
# counties completed	1,380	1,650	2,055
Percent of total (2,900 counties)	47.6%	56.9%	70.9%

3.3.4 Geospatial Data Warehouses

The ITWG Data Management Team has planned and is in the process of piloting Geospatial Data Warehouses. Geospatial data will be made more broadly available to internal and external users through geospatial data marts that will be associated with the geospatial data warehouses. A user interested in finding geospatial data would likely find the data using the Resource Data Gateway, which completely automates the data ordering and packaging process by allowing the user to place an order for the data. Data is then "ftp-ed", downloaded, or copied to CD and mailed to the user's location. Due to the large file sizes of high-resolution image data, CDs may remain a commonly used method of distribution until higher bandwidth communications are more widely available.

The Geospatial Data Warehouses will be located at the two geospatial data centers:

- FSA's APFO in Salt Lake City, Utah
- NRCS's NCGC in Fort Worth, Texas

The APFO Geospatial Data Warehouse will archive DOQ data as well as Common Land Unit (CLU) data. As the CLU data are dynamic, a replication strategy will need to be developed to regularly update CLU files.

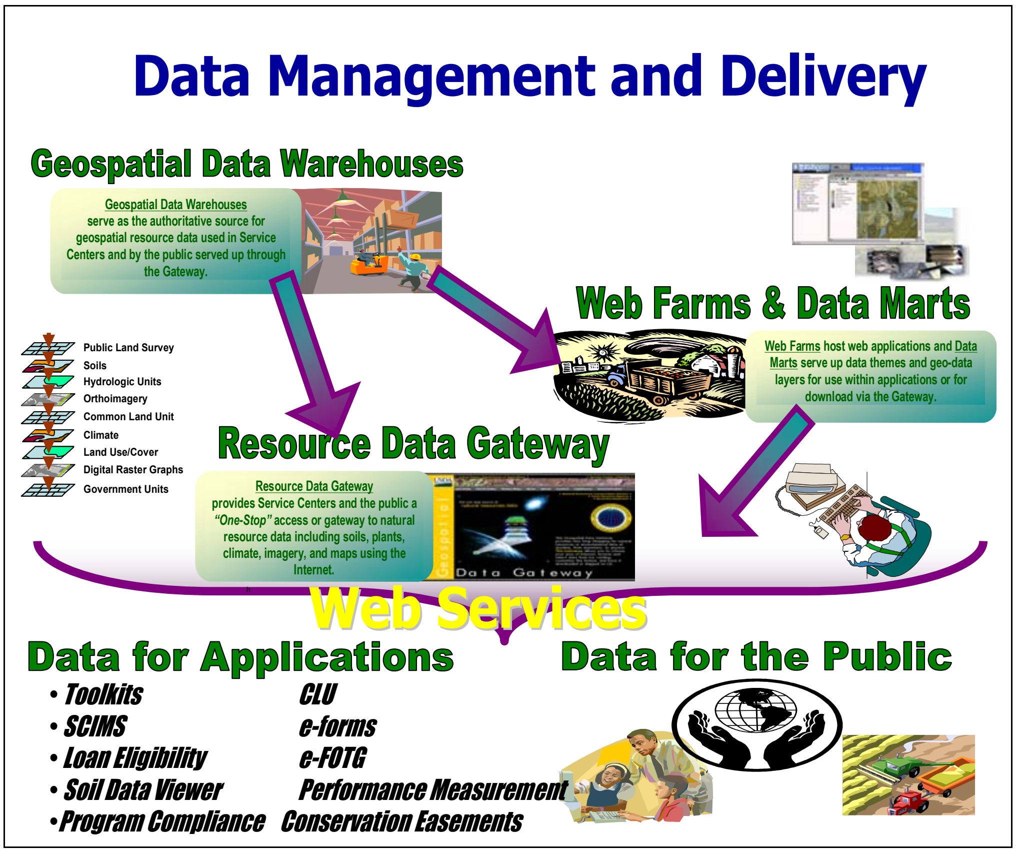
The NCGC Geospatial Data Warehouse will archive DOQ data, soils data, and a variety of other types of geospatial data. Over 100 different types of data will be stored in the geospatial data warehouses.[24]

[24] Dave Anderson,NRCS, ITWG Data Management Team Lead, personal communication

The Data Management Team also intends the two Geospatial Data Warehouses to replicate each other's data to provide backup and fail over capability for each other. Alternative strategies for implementing replication between the two geospatial data warehouses are under evaluation.

The GDW is an infrastructure for managing geospatial data to meet the growing needs of Service Center Agencies, conservation partners, Technical Service Providers, other government agencies, and the public. This infrastructure consists of large capacity servers, data storage devices, enhanced telecommunications, staff with the IT skills required to manage large data holdings, and policy and procedures needed to manage the data. The GDW exists as large data warehouses in Data Centers and data marts that support on-line business applications in Web Farms.

Figure 3-5 Data Management and Delivery



The two primary data centers, FSA's Aerial Photographic Field Office (APFO) and NRCS' National Cartographic and Geospatial Center (NCGC) are responsible for managing the "authoritative" or official source of the SCA national geospatial data. APFO would be responsible for imagery data and NCGC would be responsible for Natural Resource data as well as other important geographic themes. The primary role of Data Centers is to distribute data directly to Service Centers and other users, and provide data to web farms for use in on-line access. Web farms will host internet business and e-gov applications. The GIS data required for these on-line applications is provided by data marts. Data marts are subsets of the data warehouse that is designed to meet the specific performance and business requirements of the applications. A primary requirement of the GDW is to automate the management of the content of the distributed data marts.

A Geospatial Data Warehouse pilot project, which was initiated in mid-2002, is scheduled for completion by December, 2002. This pilot project is testing alternative replication strategies for geospatial data. Assuming successful completion of the pilot project, development of the Geospatial Data Warehouses will follow with completion scheduled for Fall, 2003.

3.3.5 Service Center Offices

The 2,700 USDA service centers represent very important locations for storing, managing, and using geospatial data. Updates and edits for many of the dynamic or changing geospatial data types (e.g., CLU) will be performed at service centers. The GIS and Data Management Teams jointly formed a Geospatial Data Provisioning Team to develop standard subfolder and file naming conventions for geospatial data. The results of this effort were published in the "Manual for Managing Geospatial Data in Service Centers".

Automated tools were also developed to set up the folder, subfolder, and file naming conventions for storing geospatial data on the network servers in the service centers. In addition to the standard geospatial data types and sources, service centers also store and use supplemental data that are provided to them by state and local government and private sector sources. In some areas, more detailed data are available from local sources.

Service centers obtain most of their geospatial data through the service center agency data centers. This geospatial data may be obtained through the state geodata administrator or the local geodata administrator may order data directly from the data centers.

Common land unit (CLU) data, a dynamic type of geospatial data, will be updated locally and the updated data will be replicated to other USDA locations (e.g., geospatial data warehouses, states, etc.). Wetlands and easements will be centrally hosted and data editing web services developed by NRCS in Fort Collins, CO will provide the capability to update these dynamic geospatial data types.

3.3.6 State Offices

The states play an important role in helping the service centers install and manage their geospatial data files. The state geodata administrators help ensure that each service center has access to the most current and complete sources of geospatial data for their area. State-wide data sets will allow states to use geospatial data to perform state-wide, watershed and other large area studies of areas of interest. The state geodata administrators and state IT staff may also provide remote administration services to help manage business and geospatial data in the service centers.

3.3.7 Federal Geospatial Data Resources

The Federal Government has recently defined the responsibilities of each Federal department to build geospatial data and to make that data available to other agencies and the public. This new policy was issued in a new version of Circular No. A-16. The Federal Geographic Data Committee (FGDC) plays an important role coordinating the various Federal agencies and their geospatial data plans.

The Bush Administration has an e-Gov agenda that includes development of a geospatial data portal called Geospatial One Stop. Users of Geospatial One Stop will be able to access geospatial data that will be stored in geospatial data archives that will be built and maintained by the Federal departments that are responsible for that data. The initial version of Geospatial One-Stop is planned for deployment in 2003.

USDA NRCS has lead responsibility for soils data and vegetation data and shares responsibility for climate and watershed boundaries data. FSA has the lead responsibility for Common Land Units (CLU), which include farm field boundaries; the Common Land Units are also known as the Agriculture Cadastre. These data will also become available through Geospatial One-Stop.

3.4 GIS Software and Applications: Status and Architecture

3.4.1 Introduction

The purpose of this section is to review the enterprise GIS software that was selected for procurement by USDA as well as the Service Center Agencies' GIS applications and their architectures.

Application development plans, include development of new applications as well as migration of existing desktop applications to an enterprise GIS configuration, are presented in Chapter 6.

3.4.2 ESRI Enterprise GIS Software

Environmental Systems Research Institute's (ESRI's) Enterprise GIS product suite was selected by the Enterprise GIS Team to be recommended to USDA management for procurement. The procurement of an enterprise GIS license was negotiated by USDA with ESRI and executed. The Service Center Agencies are in the process of continuing desktop deployment as well as planning their future GIS implementations now that the enterprise license agreement with ESRI is in place. Preferred products for future development may shift now that there is no cost differential between the different ESRI desktop GIS products.

The ESRI Enterprise GIS product suite available to SCA, named ArcGIS, includes the products shown in Figure 3-6. One of these products, ArcView, was used as the first step towards providing the service centers and service center agencies with standard GIS capabilities.

Figure 3-6 ESRI ArcGIS Product Suite

Product Type	Product Names
Professional GIS	ArcInfo
Desktop GIS	ArcView
GIS Data Editing	ArcEditor
Enterprise Spatial Data Management	ArcSDE
ArcGIS Extensions	3D Analyst, Spatial Analyst, Geostatistical Analyst, StreetMap, ArcPress, Network Analyst
Geographic Software Components	MapObjects and ArcObjects
Web GIS	ArcIMS
Mobile GIS	ArcPad
GIS Data Viewing	ArcExplorer and ArcReader

While these products historically used a geo-relational data structure, the new ArcGIS products use a geo-object model while continuing to support the geo-relational model. The geo-relational and geo-object products can both store spatial data and attribute data in RDBMS products that provide extensions with support for spatial data storage. The ESRI supported RDBMS products include DB2, Informix, Oracle, and SQL Server. In all cases, the spatial data in the RDBMS is managed by ESRI's ArcSDE, which provides a variety of functions for spatial data management support (e.g., spatial indexing functionality for more rapid search and retrieval capabilities). However, some advanced data management functionality, such as versioning, is only available with the new object relational geodatabase. The geodatabase also allows behaviors to be attached to geo-objects. This capability limits the need to add behavior later in customized applications code.

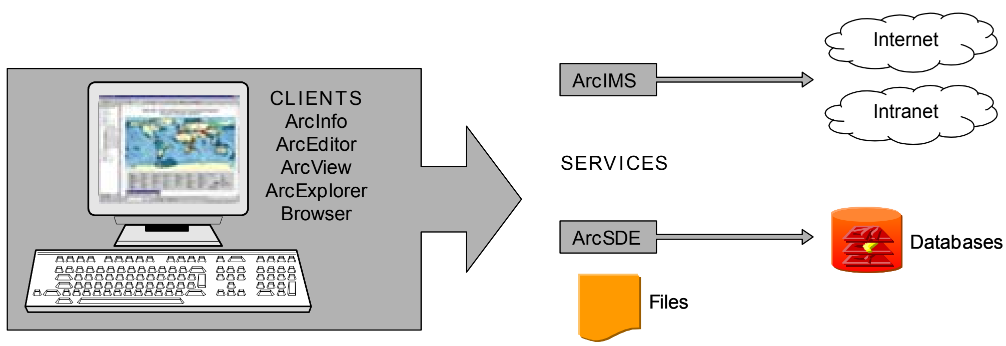
An RDBMS market research was conducted during the summer of 2002. The purpose of this survey was to evaluate the ability of alternative RDBMS products that support ArcSDE (i.e., DB2, Oracle, and SQL Server) to meet USDA requirements for an

RDBMS to be installed on servers in the service centers. Following scoring of compliance statements and live demonstrations and completion of the RDBMS market survey report, USDA management made the decision to acquire Microsoft SQL Server 2000. Acquisition of Microsoft SQL Server was initiated in September 2002.

3.4.2.1 ArcGIS Product Suite

The current ArcGIS suite of products and their relationships to one another are presented in Figure 3-7. Two products, ArcSDE and ArcIMS, provide services to a series of client products. ArcSDE functions as an application server that provides a GIS gateway to relational databases. In contrast, ArcIMS provides an Internet and Intranet gateway to GIS applications functionality and data. Clients can use a variety of products such as ArcInfo, ArcEditor, ArcView, ArcExplorer, and a standard web browser to perform tasks ranging from simple geospatial data viewing to spatial queries and map composition to very complex analytic tasks, such as watershed analysis. The ArcInfo product provides the most extensive GIS functionality. The ArcGIS desktop products (i.e., ArcInfo, ArcEditor and ArcView) are all built with the same component GIS software. ArcInfo has the most extensive functionality and ArcView has the least functionality of these primary desktop products.

Figure 3-7 ArcGIS System



ArcGIS extensions provide ArcInfo and ArcView users with advanced spatial analytic functionality. The new ArcGIS extensions, unlike previous extensions, can be used with either product. This is now possible because ArcView is a subset of ArcInfo; both products use the same component software. The following ArcGIS extensions have been released as of December 2002:

- **3D Analyst**—3D Analyst supports 3D CAD models of buildings as well as a variety of functions that are applied to 3D landscapes constructed from digital elevation model data.

- **Spatial Analyst**—Spatial Analyst enables complex analytic models to be applied to raster GIS data files. This extension could be used to develop Revised Universal Soil Loss Equation (RUSLE) II models.
- **Geostatistical Analyst**—Geostatistical Analyst takes point data and builds a continuous surface from that data. The planned extensions include remote sensing image processing functionality (Image Analyst), connected network functions (Network Analyst), and vehicle tracking functionality (Tracking Analyst).
- **StreetMap**—StreetMap incorporates digital street network data combined with vehicle routing functions.
- **ArcPress**—The ArcPress extension rasterizes map plot files and makes them more efficient to communicate and plot at the service center level. As Customer Service Toolkit and other GIS users are likely to prepare many map plots, the ArcPress extension would be very helpful at the service center level.
- **Mr. SID Encoder for ArcGIS—**Mr. SID is raster compression software that was developed by Lizard Tech that allows full resolution DOQs to be significantly compressed.
- **ArcGIS Publisher and ArcReader**—The Publisher extension converts map documents (MXD) to published map files (PMF). Published map files contain "…instructions about the location and symbology of data layers (rendering rules, scale dependencies, etc.) including geodatabase connectivity, Internet connections, and Geography Network layers."[25] The PMF files can be viewed using ArcReader.
- **Schematics**—The Schematics extension automatically generates schematic diagrams of GIS networks. This capability is used most frequently for utility applications.
- **ArcScan for ArcGIS**—The ArcScan extension supports scanning of maps and conversion of scan maps to vector geospatial data files. Both operator assisted and automatic conversion routines are provided.
- **Network Analyst——**Network Analyst is a planned ArcGIS extension, which provides improved functionality for management and analysis of connected networks of geospatial data (e.g., roads, utility infrastructure, hydrography).

ArcView

The primary client software component of the USDA GIS Architecture for the service centers has been ArcView 3.2 and 3.3 desktop GIS. ArcView is ESRI's most widely used desktop GIS solution. USDA GIS desktop users will also use ArcInfo, ArcEditor, and web browsers to perform geospatial processing and analysis tasks. Some desktop functionality required by USDA is not supported in the ArcView product. For example, versioning and history tracking are geodatabase functions that are not available with ArcView 8. ArcView 8 users can view and use data stored in the geodatabase but they will not be able to fully modify data in this format. They are

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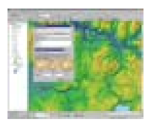
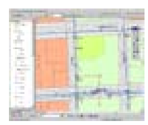
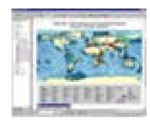
[25] http://www.esri.com/software/arcgis/arcgisxtensions/publisher/index.html

only able to edit shapefiles and simple features data. Due to these limitations, the Enterprise GIS license was negotiated to permit unlimited access to all desktop GIS tools.

Full geodatabase editing and versioning is available with the ArcInfo and ArcEditor ArcGIS products combined with ArcSDE. For this reason, USDA will require a mix of products in the future to provide the full range of USDA required Enterprise GIS capabilities. The terms of the Enterprise GIS license eliminate a cost differential in acquiring desktop GIS products. In May 2001, ESRI released a new product, called ArcEditor, to provide full function geospatial data editing for desktop GIS users. Figure 3-8 presents the varying functionalities associated with ArcView, ArcEditor, and ArcInfo.

Figure 3-8 ArcGIS Desktop Functionalities

ArcView	ArcEditor	ArcInfo
		
Data access Mapping Customization Spatial query Simple feature editing	ArcView **PLUS** Coverage and geodatabase editing	ArcEditor **PLUS** Advanced geoprocessing Data conversion Workstation

In 2000, USDA decided to deploy desktop GIS products as a temporary fix for the Service Center Agencies; with migration to a more mature, enterprise capable suite of products to occur later. The ArcView 3.2 desktop GIS software is the primary GIS software that was initially deployed within the SCA field offices.

The enterprise suite will use ArcSDE, plus an SQL Server as the RDBMS to support storage, management, and retrieval of GIS spatial and attribute data. It is anticipated that ArcSDE will be located on local servers as well as state or regional GIS servers. To meet requirements for performance, reliability, and versioning at the service center level, FSA plans to use ArcInfo or ArcEditor plus ArcSDE on a server to maintain Common Land Unit (CLU) data. CLU data will be replicated from service centers to a central server. Due to likely performance and reliability problems with Web GIS options, the FSA SCIMS developers believe that SCIMS and CLU maintenance functions will need to be supported at the local service center level. Installation of the suite of ArcGIS products, including ArcSDE, plus an RDBMS on service center servers is planned for the middle of 2003. An application server may also be acquired and installed to better support geospatial and other applications processing requirements at the service centers.

ArcInfo

ArcInfo, the professional GIS product, will likely be located at service centers, state offices, development centers, and map digitizing production sites to provide access to more advanced functionality than offered with ArcView. For example, ArcInfo has more advanced spatial topology than ArcView and either ArcInfo or ArcEditor is necessary for digitizing CLU data. ArcEditor is an additional option for users who only need advanced spatial data editing functionality. ArcEditor is a subset of ArcInfo code that includes data editing functions.

ArcPad

The ArcPad product works on Pocket PC Windows CE devices (e.g., Compaq IPAQ), and provides limited but powerful mobile data collection and editing capabilities. For example, National Park Service fire fighters have effectively used ArcPad on a Compaq IPAC with expansion packs for GPS and high capacity data storage to map the boundaries of forest fires from a helicopter. DOQs for all of southern California were stored locally on a pocket PC with 2 gigabytes of storage. ArcPad 6 provides more extensive functionality and improved customization options; future releases will provide full access to geodatabase data with check-in and check-out functionality (i.e., disconnected editing). SCA will use ArcPad as part of a mobile data collection system. A series of mobile computing pilots are in process and/or planned to address the different needs of various types of users.

With regard to GIS application development, the early GIS applications were developed using ArcView in a standalone rather than enterprise configuration. These applications may need to be migrated to the new generation ESRI tools and they will need to be reengineered to take advantage of Enterprise GIS capabilities like versioning. As of November 2002, FSA is in early stages of GIS application development using the new ESRI ArcGIS products. In contrast, NRCS expects to migrate over a longer period. FSA deployment of ArcGIS based applications is planned to begin in the Fall of 2003. In addition to the client/server architecture described above, ESRI products can also be deployed using Web GIS tools and terminal server technology. Web GIS is a powerful tool, but the current state of the technology is view-oriented and does not support data editing over the Web. ESRI is developing web-based data editing technology, but this is not supported in either released or beta versions of products. ArcIMS 4.0, the current version of ESRI's Web GIS tool, supports limited spatial data editing functionality through the use of edits notes and mapnotes. These functions allow a user to perform edits, which are posted to a folder for review and processing by a spatial database administrator. Web-based data editing capabilities may also become available from third party sources,[26] and Web GIS may better fit USDA requirements in the future.

The ESRI terminal server option uses Citrix MetaFrame to provide a connection between a distributed client and a terminal server located at a regional or national

[26] Heald, Jim, Personal Communication based on ESRI 2000 User's Conference Announcement

level. After the USDA communications infrastructure is upgraded, there may be an expanded role for the Web GIS and terminal server alternatives. These IT infrastructure upgrades will make it more likely to achieve the anytime, anywhere requirements of the National Service Area Vision. However, neither Web GIS nor terminal server offer an effective means of communicating plot files from a central location to local service centers. Since hard copy plots of conservation plan map files are very popular with Toolkit customers, plot file communication is a barrier to adoption of a centralized model for Toolkit and possibly other applications. In addition, performance and reliability are additional potential problems with centralized options that require additional evaluation. BLM has recently completed some initial successful pilot tests of the terminal server technology approach to GIS deployment. The results of the BLM tests will be evaluated in detail to determine their implications for CCE. Similarly, the Tennessee Valley Authority (TVA) has successfully migrated their GIS applications from a client server configuration to a centralized Internet GIS architecture. The recent success of more centralized architectures at a variety of agencies suggests that site visits, further evaluation and possible pilot testing may be worthwhile to better understand their potential utility in a USDA CCE context.

Therefore, the following are the four GIS architectural options:

- Client/server within service centers
- Web GIS
- Centralized terminal server
- Hybrid architecture with local client/server supplemented with either Web GIS or terminal server

3.4.3 Need for Client/Server Architecture at Service Center Level

The large size of GIS datafiles, especially DOQs, the static nature of most USDA GIS data types, the highly distributed structure of USDA's 2,600 service centers and the limited existing USDA communications infrastructure all suggest a need for client/server architecture at the service center level. The dynamic GIS data layers (e.g., CLU, etc.) need to be locally maintained with changes incorporated into either central or regional databases. This local data maintenance, with changes posted to either regional or national databases, can be accomplished in several different ways. Using Web GIS and terminal server, local clients can connect with regional or national databases and changes can be made and posted to those databases. Alternatively, changes can be made to local dynamic databases and those changes can be replicated to databases at either the regional or national level. As GIS applications have been developed for the desktop and the Internet, the USDA CCE architecture will be a hybrid architecture but the architectural specifics of the hybrid need to be addressed on an application-by-application basis. For example, the NRCS WebEasements application permits dynamic easements geospatial data to be updated using geospatial web services with centralized management of geospatial data in ArcSDE and an RDBMS.

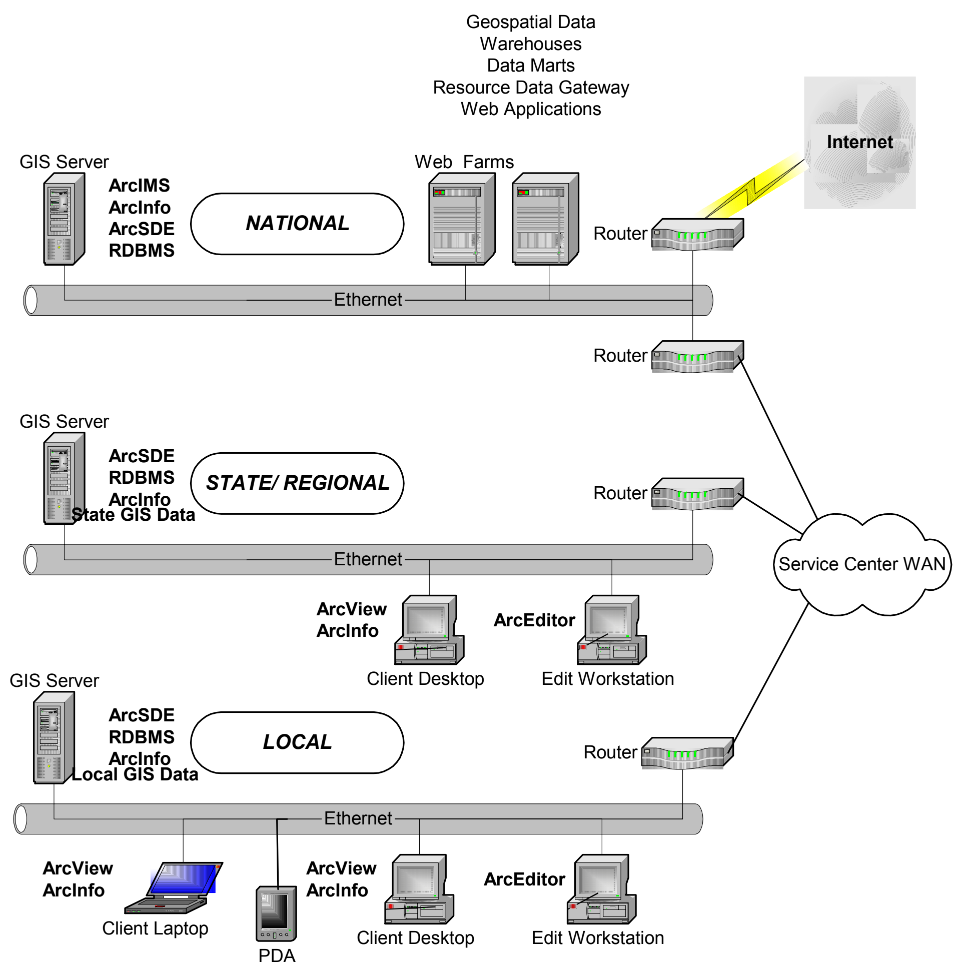
Replication of Geospatial Data

RDBMS based replication of spatial data is currently supported by SQL Server 2000, which was selected for CCE procurement during the Fall of 2002. GIS applications processing will primarily occur on high-end workstations and laptops located in the local service centers. Desktop GIS software will be installed on this hardware to provide COTS GIS functionality. A local Windows service center server is also a recommended component of the GIS architecture. Initially, the CCE network servers will host geospatial data. As more GIS applications are available, these applications will be performance tested in a pilot service center configuration to determine whether or not there is a need for an additional geospatial application and data server. A CCE network server or supplemental geospatial application server will host geospatial data, ArcSDE, and SQL Server 2000 when the Enterprise GIS software is fully deployed. Initially, geospatial data files will be stored on the network servers at the local offices to improve access and provide for management of customer information. Even though no GIS processing will occur on these servers, their role as a repository for this common data is important. As of July 2002, geospatial data are being consolidated and migrated from workstations to the network servers. This activity was planned and coordinated by the Geospatial Data Provisioning Team.

State and regional office GIS data servers are an additional recommended component of the GIS architecture. These state office servers would store regional data for state wide geospatial analysis. The state geodata administrators would also use the state geospatial data archive as a source of data when preparing geospatial databases for field office use.

Strategies to evaluate new technology and products and insert them into the USDA CCE solution will be formulated as technology and the ESRI Enterprise GIS products continue to evolve over time. For example, tablet PCs and ESRI's Location based services (LBS) connector are examples of emerging technology that should be evaluated to determine their potential utility in future CCE architectures. Figure 3-9 illustrates the role of each Enterprise GIS product within the evolving CCE technical architecture.

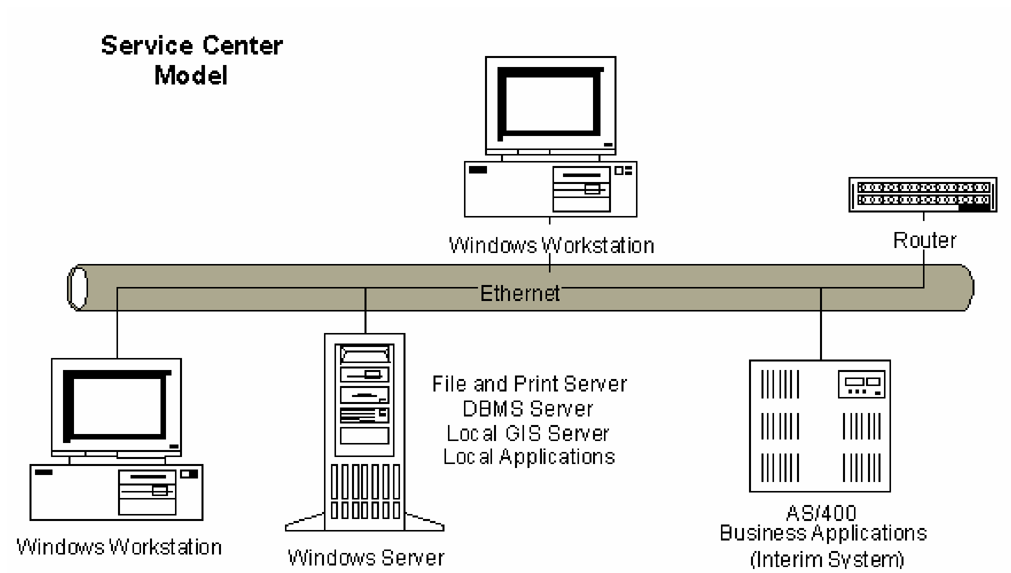
Figure 3-9 GIS Architecture Diagram

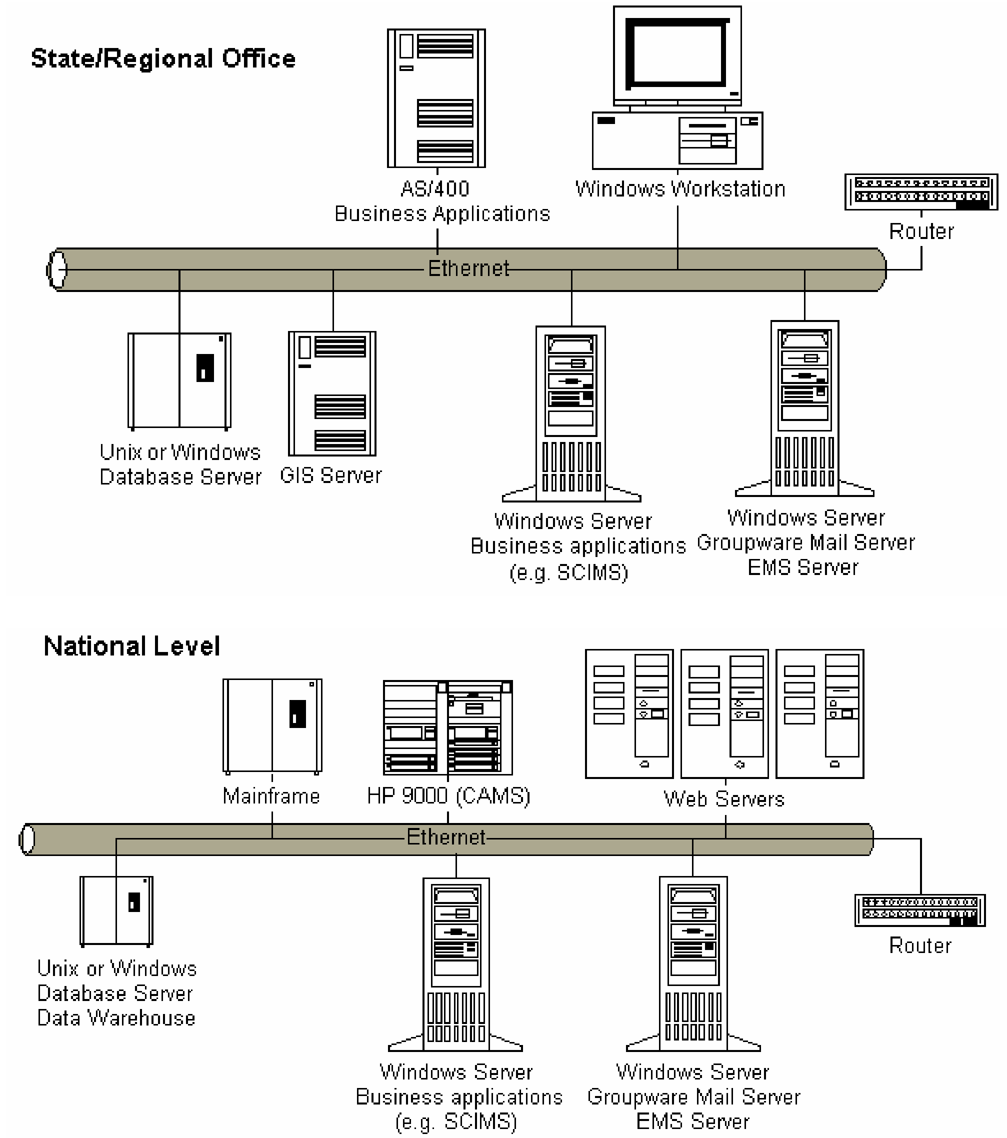


3.5 GIS Technical Architecture

Figure 3-10 shows the CCE technical architecture at the service center, state office, and national levels.

Figure 3-10 Common Computing Environment Technology Architecture





At the Service Center level, desktop PCs and laptops will run Windows-based stand-alone office automation tools and client side portions of reengineered business applications. Intel-based servers or high-end workstations will provide local file, print, and network services. These servers will also host reengineered business applications, database management system, network management services, messaging services, and locally cached and managed data. The PCs and laptops will host Desktop GIS software (i.e., ArcInfo, ArcEditor, ArcView and extensions) and applications (e.g., Customer Service Toolkit). GIS spatial data management software (i.e., ArcSDE and Microsoft SQL Server) will reside on the Service Center server. In smaller Service Centers, a high-end workstation may be used as a server as well as a workstation. When a Server Center server is available, all server functions will be hosted on that hardware.

At the state or regional level, Enterprise GIS applications are hosted on Windows servers, and relational database management systems share data such as customer or land data via data replication. Re-engineered applications, transaction servers, and mail servers are also hosted at this level. These servers provide middleware services such as load balancing, replication, directory services, and other infrastructure utilities.

At the national level, agency mainframe systems and national applications, such as Combined Administrative Management System (CAMS), reside. Clustered web servers provide data for internal and external customers, and data warehousing operations provide access to centralized national databases. National GIS applications may include SCIMS and geospatial data warehouses.

During the initial Desktop GIS phase, geospatial data will primarily be stored locally on service center servers. As USDA moves to an Enterprise GIS system architecture, geospatial data will increasingly be warehoused at the national USDA geospatial data centers, APFO and NCGC.

3.6 Target GIS Architecture

The target architecture for CCE overall is a services based architecture. This services based architecture is expected to be hybrid with a mix of central web based services and distributed client server services. It is expected that over time more of the services will be supported centrally using web technology and improved bandwidth communications. The webEasements application is an early example of a geospatial web services application with advanced functionality.

Improvements in the functionality of GIS web services will also be necessary to meet the full range of USDA CCE requirements with a centralized Internet approach. ESRI's ArcIMS v.4.0, the current release of its Internet GIS tool, allows versioned databases to be copied out of ArcSDE and posted back to update the master database. However, ArcIMS does not currently support on-line editing of geospatial data. ESRI's goal is to provide the full range of geoprocessing functionality over time with a web-based approach. However, it will be multiple years before ESRI reaches this goal.

When the Internet web services tools are mature and bandwidth communications meet CCE requirements for performance and reliability, it is likely that more geospatial applications will migrate to this platform to save on the higher administration and maintenance costs that are associated with widely distributed client server applications.

3.7 Transitional or Interim GIS Architecture

The transitional or interim GIS architecture will be a hybrid of desktop GIS, some Internet GIS, and initial migrations to and implementations of enterprise GIS in various forms. From a geospatial data architecture perspective, the transitional architecture will store geospatial data on service center servers using the folder structure and naming conventions that were developed by the Geospatial Data Provisioning Team working in collaboration with the Data Management Team. Geospatial data warehouses are expected to be deployed during the transitional GIS architecture phases. Over time, these geospatial data warehouses will become increasingly important and support an expanding number of types of data as well as an increasing volume of data.

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4 Geospatial Data Management Issues

Geospatial data management issues are the joint responsibilities of the ITWG Data Management Team and GIS Team. The Geospatial Data Provisioning Manual was produced through the collaboration of these two ITWG teams. This chapter addressed the issues surrounding the data management requirements of the USDA.

4.1 Requirements for Advanced Geospatial Data Management

Advanced geospatial data management functionality is needed to support multi-user editing to maintain dynamic geospatial data (e.g., common land unit data). The least complex requirement is to permit different users to check out different versions of the geospatial data for editing. After editing of versioned databases, the data needs to be posted back to the database and conflicts between different versioned databases need to be flagged for resolution. If editing or data collection needs to be performed in the field, there is an additional requirement that disconnected editing also be provided.

Furthermore, history tracking, which is the ability to recreate the state of the data at a particular point in time, also needs to be supported. Finally, replication of geospatial data is also required to allow current versions of a particular type of dynamic data to be made available to users from locations other than the service center that updates that data. Either the RDBMS or ESRI’s ArcSDE may support replication of geospatial data. While the current version of ArcSDE does not support replication of geospatial data, this functionality is scheduled for release with ArcSDE v. 9. Microsoft SQL Server, which is the RDBMS that was selected for use in service centers, supports replication of geospatial data.

The Common Land Unit (CLU) data type is the dynamic geospatial data type that will be altered or edited most frequently. This editing will occur locally in the service centers with replication to other locations conducted overnight. There are plans to centrally host CLU data at FSA’s geospatial data warehouse, which will be located at APFO in Salt Lake City, Utah.

4.2 Enterprise Geospatial Data Tracking Issues

As the availability of geospatial data files varies from one location to another, it is especially important that the specific data hosted on service center servers be carefully tracked. USDA continues to actively fund production of geospatial data files so the availability of data will continue to increase significantly each year. The state geodata administrators will play an important role in helping service centers locate and install geospatial data for their area of interest. The Geodata Provisioning Manual describes a standard folder, subfolder and file naming convention for storing the geospatial data files in a consistent manner.

The Data Management Team is in the process of developing a geodata tracking tool, that will run on the network servers, to inventory what geospatial data is available to GIS users in the service centers. The deployment of the geodata tracking tool is planned for the spring of 2003.

4.3 Operational Geospatial Data Management Issues

Accurate, current geospatial data is essential for effective geographic analysis and decision making. Geospatial data are also a major investment, which must be protected by effectively updating dynamic data types and providing access to and maintaining static data types.

State and local geodata administrators and national data stewards will all play important roles in ensuring that geospatial data are properly stored, maintained and available for effective use. National data stewards, who are often employees at the APFO or NCGC data centers, are responsible for planning for acquisition, storage and maintenance of specific types of geospatial data. National data stewards will update data center metadata records to ensure that users can access new geospatial data sets for their areas of interest as these data sets become available. State geodata administrators will maintain current archives of geospatial data for their state, install geospatial data at local service centers and assist local geospatial data administrators in managing geospatial data sets. State geospatial data administrators will frequently use remote administration tools to accomplish these tasks. State geodata administrators will be well trained in ESRI's ArcSDE and SQL Server and methods of managing geospatial data with this combination of tools. Local geodata administrators will be trained to handle tasks that are associated with day to day management of geospatial data at the service center level. This will include geospatial data replication, backup and recovery and related data management tasks.

5 Applications and Applications Development Issues

The application development groups of FSA, NRCS, and RD each develop GIS applications. The Business Process Reengineering (BPR) Labs generated many of the concepts and requirements for desktop GIS pilot applications, which have since been further developed by the agency applications development groups. All three service center agencies have developed GIS applications and have plans to develop additional applications as well as migrate desktop GIS applications to an enterprise GIS architecture. This chapter discusses the application activities and plans of each service center agency.

5.1 Farm Service Agency

FSA has a number of GIS applications which support digitizing and construction of the Common Land Unit (CLU) data type in CLU digitizing centers and the capacity to update and maintain the CLU datafiles in the service center environment. Specific CLU applications include:

- CLU Digitizing Tool
- CLU Maintenance Tool
- CLU Crop Reporting Tool Prototype
- CLU Compliance Tool
- CRP Soil Calculation Tool (April 2003)
-

The CLU Digitizing Tool and CLU Maintenance Tools are in the early stages of a development project that will migrate them to an ArcGIS configuration. This will include the use of ArcSDE and SQL Server to store geospatial data. As of November 2002, this new application is in a conceptual design stage. Development and testing of the ArcGIS version of CLU Digitizing Tools will occur through August 2003. Assuming a decision to proceed with implementation, national deployment will likely occur in the fall of 2003.

One high-end workstation is also being installed in each service center to support CLU maintenance processing. GIS applications are also planned and/or under development to support various FSA programs. The planned geospatially enabled FSA applications include:

- CLU Land Use Tool
- CLU Compliance Tool
- Service Center Information Management System (SCIMS) Customer-Land Link

- CLU Digitizing Tool
- CLU Maintenance Tool
- Measurement Services Tool

Figure 5-1 FSA Implemented GIS Applications

FSA Implemented GIS Applications
▪ CLU Digitizing Tool
▪ CLU Maintenance Tool
▪ CLU Crop Reporting Tool Prototype
▪ CLU Compliance Tool
▪ CRP Soil Calculation Tool

Figure 5-2 Future FSA GIS Applications

Future FSA GIS Applications	Design/Develop	Pilot	Implement
CLU Land Use Tool	Until June/July, 2003	June/July, 2003	November, 2003
CLU Compliance Tool	Until September, 2003	September, 2003	TBD
SCIMS Customer-Land Link	December, 2002	November, 2003	November, 2003
CLU Digitizing Tool	Until May, 2003	May, 2003	November, 2003
CLUMaintenance Tool	Until March, 2003	March, 2003	September, 2003
Measurement Services	Until March, 2003	March, 2003	TBD
CRP Tool			

CLU Land Use Tool

The CLU Land Use (i.e., acreage and crop reporting) Tool was deployed as a beta/pilot application built on ArcView 3.2 in Spring, 2002. An ArcGIS 8.x tool is under development; it is expected to be deployed in beta/pilot form in June/July, 2003. The reengineered version will be more efficient, eliminate manual entries to aerial maps and provide improved capabilities for generating a variety of types of reports (e.g., FOIA requests, OIG/GAO audits, etc.).

The CLU Land Use Tool was developed as a proof of concept by ITSD, Remote Sensing Section. It will be used on an interim basis in service centers with CLUs until the Land Use application provides the acreage reporting functionality.

The CLU Land Use application, which will be fielded as a local client server application, can function with or without CLU data. The CLU Land Use application will provide the following functionality:

"Land Use will collect data and geospatial information at the field level and provide commodity history needed for eligibility, compliance, and disaster reports. A national data warehouse located in Kansas City will be populated on a daily basis with commodity reporting data uploaded from the Service Centers. The data warehouse will provide query capabilities, through the web, for Service Center Agencies, other agencies and partners."[27]

The Land Use application is scheduled for design and development during the first half of FY2003 with beta testing during the second half of FY2003.

CLU Compliance Tool

The first phase of the CLU Compliance Tool will evaluate assessment of digital compliance using alternative sources of compliance imagery. The traditional type of compliance imagery is 35mm slides. Digital rectified or map corrected imagery will replace the 35mm slides. The first CLU Compliance Tool was developed with ArcView 3.1 and deployed to 22 service centers in 2001 and to 80 service centers in 2002.

The second phase of the CLU Compliance Tool will develop an ArcGIS 8.x geospatial application to integrate compliance activities and possibly automate the compliance determination process.

SCIMS Customer-Land Link

The Service Center Information Management System (SCIMS) provides a database to store core customer information to be used by all service center agencies. The customer information includes names and addresses. A business data only version of SCIMS was initially deployed to the service centers. The SCIMS Customer-Land Link, which is under development, will provide and maintain customer-to-land relationships, which will include farm and tract information. The SCIMS Customer-Land Link will be a database table that will be used by other applications rather than an application per se.[28]

SCIMS will be developed and deployed as a local client server application. Geospatial data will be stored on service center servers using ArcSDE plus SQL Server.

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[27] FSA, 2001, GIS Implementation Blueprint, p. 67

[28] Jim Heald, FSA

CLU Digitizing Tools

The CLU Digitizing Tools provide the capability to convert paper maps to digital format for use in a GIS environment in the service centers. The current ArcView 3.x CLU Digitizing Tool captures spatial data (e.g., CLU boundaries) and adds associated tabular, attribute data (e.g., farm number, tract, etc.). The CLU Digitizing tool is in use in all of the FSA Digitizing Centers across the country. The new ArcGIS 8.x application, which is under development, will allow multi-user editing in a client server environment. The object relational structure of the new ESRI ArcGIS tools will also improve data integrity during data capture. A beta/pilot version of the application should be available in May, 2003.

CLU Maintenance Tools

The ArcView 3.x CLU Maintenance application is in use in many service centers. This CLU application maintains the digital farmer/producer information as changes occur. Both spatial data (e.g., field boundaries) and attribute data can be edited with this software. An updated ArcView 3.x application will be shipped during the Spring of 2003.

The ArcGIS 8.x software will support multi-user editing, including versioning of data. The beta/pilot version is scheduled for March, 2003 with implementation in September, 2003.

Measurement Services Tool

An ArcView 3.x CLU GPS tool is the first application within the category of Measurement Services. FSA business requires measurement of boundaries and distances. In some cases, buffer zones are recorded as well as direct feature boundaries. The CLU GPS tool allows points collected in the field to be downloaded to create spatial data.

An ArcGIS 8.x version of the application is currently under development with completion scheduled for February, 2003 and beta/pilot in March, 2003.

5.2 Natural Resources Conservation Service

NRCS is the CCE agency with the longest history of using geospatial technology. During the past five years, NRCS has reengineered their applications and made extensive use of GIS technology and geospatial data to spatially enable their new applications. The new NRCS Integrated Information System is composed of the following seven classes of applications:

- Customer Service Toolkit
- Cost-Share Contracting
- Gateway and Warehouse
- SmarTech eFOTG
- Management Applications
- Program Operation Information Tracking System
- Integrated Accountability System

GIS technology spatially enables applications in each of these seven classes.

The new NRCS geospatially-enabled applications vary in their complexity. The simplest applications use GIS to visualize the location of SCA facilities and generate reports relating to locations. The Office Information Profile (OIP) application is a good example of this type of application. It allows the user to generate maps of the location of USDA service center agency offices as well as generate a variety of types of reports. More complex applications use GIS to collect and/or edit geospatial data, generate maps, perform complicated spatial queries, generate location related reports, and conduct advanced forms of analysis. Customer Service Toolkit (CST) is an example of an advanced desktop GIS application. The webEasements application makes effective use of new web services technology to provide a GIS application with complex data collection and editing functionality over the Internet. The Resource Data Gateway provides users with a geospatial data portal that provides access to natural resources data. Planned geospatial data warehouses and associated data marts will allow USDA to provide internal and external users with access to soils and other types of geospatial data.

The following sections discuss several specific NRCS GIS applications.

Figure 5-3 NRCS Implemented GIS Applications

NRCS Implemented GIS Applications
■ Customer Service Toolkit
■ Wetland Determinations Toolkit
■ Soils Data Viewer
■ Resource Data Gateway
■ Conservation Easements
■ Office Information Profile
■ Smartech Electronic Field Office Technical Guide
■ Performance & Results Measurement System (PRMS)
■ Plant Distribution Module

Figure 5-4 Future NRCS GIS Applications

Future NRCS GIS Applications	Design/Develop	Pilot	Deploy
ProTracts	Thru April, 2003		April, 2003
Soils Data Warehouse	Thru May, 2003		May, 2003
Smartech Runof Curve/Object Modeling System	Thru September, 2003		September, 2003
ArcGIS Customer Service Toolkit	FY 2004		FY 2004

5.2.1 Customer Service Toolkit

The NRCS Customer Service Toolkit (CST) website provides the following description of the application:

> "Customer Service Toolkit is a collection of software tools for USDA field employees who work with the public, primarily with farmers and ranchers. It is also useful to partner agencies, such as Conservation Districts and Departments of Natural Resources, and others who provide conservation planning and resource assessment information.
>
> Toolkit helps natural resource planners provide information to the public, resulting in conservation of the land. The tools incorporate commercial software products that let conservationists provide natural resource information in professional-looking products.
>
> Toolkit also provides tools for mapping and analyzing natural resource information. Maps are a traditional method of communicating with customers, and Toolkit makes map development for customers easy."[29]

The Customer Service Toolkit application was developed to provide a digital "messy desktop" for conservation planning. "Messy desktop" recognizes that different conservation planners in different parts of the country may have different approaches to preparing a conservation plan. Due to this diversity in approach, the toolkit application provides a variety of tools but does not force the user to adopt a particular approach or workflow. Customer Toolkit folders store geospatial data files for the customer's land, scanned document images and other types of data. Toolkit folders can be very large (e.g., 30 of megabytes of data) and are stored locally on service center servers. Toolkit processing occurs on workstations.

Customer Service Toolkit uses the functionality of ESRI's ArcView 3.x GIS desktop software as well as the following Microsoft tools: Access, Excel, and Outlook.

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[29] http://www.itc.nrcs.usda.gov/toolkit/

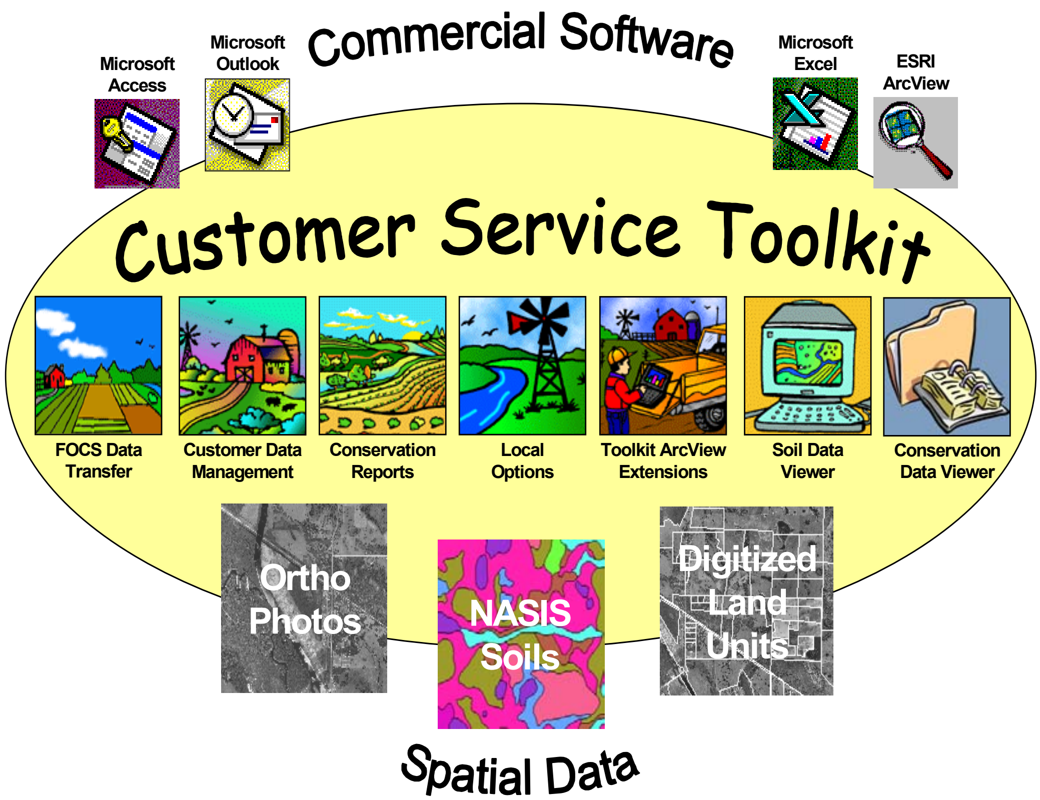
Figure 5-5 presents an overview of Customer Service Toolkit, the tools which are used in CST, and types of applications functionality that are provided by CST (e.g., Soil Data Viewer, Conservation Reports). The seven major components of Customer Service Toolkit are:

- "**FOCS Data Transfer** moves FOCS data to a Windows® NT computer, and prepares it for use with the Toolkit. This feature is not available on Windows 2000 computers.
- **Customer Data** is managed with Microsoft® Outlook® 98.
- **Conservation Reports** is a set of tools used to create and revise conservation plans and contracts.
- **Local Options** includes tools to customize the Toolkit.
- **Toolkit ArcView Extensions** make ESRI® ArcView® GIS easier to use for conservation planning and resource assessment. This component is optional and available if ESRI® ArcView 3.1 or greater is installed.
- **Soil Data Viewer** is used to view SSURGO version 2 soils data that has been downloaded into an Access® database from NASIS 5. Maps of soils interpretations may be created if ESRI® ArcView and SSURGO Version 2 data are available.
- **Conservation Data Roll Up** and **Conservation Data Viewer** tools collect customer, land unit, and practice data from individual customer conservation plan databases into a single database. The Viewer is used to create custom queries and view the data in Excel and ArcView."[30]

Customer Service Toolkit will be migrating to the Windows XP environment during the CCE upgrade this year. It will run on the Windows XP operating system, using Office XP.

[30] Customer Service Toolkit User's Guide, 2001, (USDA NRCS: Ft. Collins, CO) pp.1-1to 1-2

Figure 5-5 Customer Service Toolkit



5.2.2 Wetland Determinations Toolkit

The Wetland Determinations Toolkit, which is an ArcView application for USDA users who also have Customer Service Toolkit and Soil Data Viewer, provides nine additional tools that allow users to record and certify wetlands determinations. The Wetlands users perform some of the recording and certification functions using CST and SDV tools. The nine additional tools provided by the Wetlands Determinations Toolkit are:

- "**New Wetland Theme** to create a new Wetland Determination theme from land units with a specified tract number. Land units may be from a Common Land Units, District Land Units, or a Planned Land Units theme.
- **Wetland Determination** to add or edit information for a certified wetland determination.
- **Wetland Inclusion** to digitize wetlands easily.

- **Field Data Worksheet** to print a Corps Data Worksheet form to record wetland data on site.
- **Wetland Determinations Map Products** to create a map heading for a Certified Wetland Determination map.
- **Label Summary Report** to produce a report that lists wetland labels, acres and advisory statements.
- **Transmittal Letters** to select letters with wetlands information for customers or other agencies.
- **Label Maker** to easily label features for any point, line or polygon theme.
- **Hot Link** to link up to five photographs, documents or other types of files to a feature in any point, line, or polygon theme."[31]

5.2.3 Soil Data Viewer

There are two versions of the Soil Data Viewer, a web version and a desk top, client version. The desktop version is a tool built as an extension to ArcView ® that allows the user to easily create soil-based thematic maps. Soil Data Viewer shields users and applications from the complexity of the soil database and incorporates rules for appropriate use of soil data. It provides an easy to use tool for geospatial analysis of soil information for resource assessment and management. The soil survey attribute database associated with the spatial soil map is a complicated database with more than 50 tables. The Soil Data Viewer provides users access to soil interpretations and soil properties while shielding them from the complexity of the soil database. Each soil map unit (polygons) may contain multiple soil components that have different use and management. The Soil Data Viewer makes it easy to compute a single value for a polygon and display results, relieving the user from the burden of querying the database, processing the data and joining and linking to the spatial map. The Soil Data Viewer contains processing rules for appropriate use of the data. This provides the user with a tool for quick geospatial analysis of soil data for use in resource assessment and management.

5.2.4 Resource Data Gateway

The Resource Data Gateway is a USDA geospatial data portal that resides in the Enterprise Application Integration (EAI) web farm in Ft. Collins, CO. The Resource Data Gateway website describes its purpose as follows:

> "The Resource Data Gateway (Gateway) is intended to provide a single access point for resource data. It will provide a way to easily locate data that exist for selected geographic areas, find the types of data for that area, and deliver the data packaged in formats compatible with commercial and Service Center application formats.

[31] Wetlands Determination Users Guide, 2001, (USDA NRCS, Ft. Collins, CO) pp.1-1 to 1-2

One major purpose of the Gateway is to support the development, presentation, and dissemination of information by Service Center field staff working in the field with customers away from the office. However, the public will also have access to the Gateway to find and retrieve resource data."[32]

5.2.5 Conservation Easements

Conservation Easements uses geospatial web services and ESRI Internet GIS software to deliver an exceptionally innovative and powerful geospatial web application. The application allows the user to digitize the boundaries of easements over digital orthophoto quad images using a geospatial data editing web service developed by NRCS staff in the Fort Collins, Colorado development center. As of Fall 2002, neither ESRI's ArcIMS Internet GIS software nor their existing released geospatial web services support digitizing and editing of geospatial data. This application was named one of the top 100 software applications by InfoWorld magazine.[33]

5.2.6 Office Information Profile (OIP)

The USDA-Office Information Profile (OIP) system provides comprehensive information for Farm Service Agency, Natural Resources Conservation Service, Rural Development offices, plus partner organization offices. This information identifies office locations, maps of office locations, the agencies present, mailing and shipping addresses, phone numbers, and Agency representatives designated as points of contact

5.2.7 Smartech Electronic Field Office Technical Guide

This application provides a nationally consistant web interface for managing and providing Field Office Technical Guide Content. Technical guides are the primary scientific references for NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources.

Technical guides used in each field office are localized so that they apply specifically to the geographic area for which they are prepared. These documents are referred to as Field Office Technical Guides (FOTGs).

Appropriate parts of the Field Office Technical Guides are automated as data bases, computer programs, GIS layers, and other electronic-based materials

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[32] http://lighthouse.nrcs.usda.gov/gateway/design.html

[33] Jack Carlson, personal communication

5.2.4

5.2.8 Performance & Results Measurement System (PRMS)

The USDA-NRCS Performance & Results Measurement System (PRMS) is one part of a larger effort known as the new NRCS Integrated Accountability System (IAS). IAS aligns the NRCS performance measurement system with the Government Performance and Results Act (GPRA). It links field, state, and national performance to our strategic and performance plans. Its results enable the agency to quickly respond to questions regarding its performance by the U.S. House of Representatives Appropriations Committee, oversite agencies, partners, customers, and employees. The accountability system provides the agency with better information for internal management purposes and for external reporting. PRMS uses GIS is a process called map based data entry. The user simply points to a on-line map to locate the performance item and other spatial parameters such as state, county, soil conservation district, and congressional district are obtained from linked geospatial data layers.

5.2.9 Plants Distribution Update Module

The Plant Distribution Module was designed to provide a fast way to incorporate new information about invasive and weedy plants since their distributions often change quite quickly. This new module will be especially useful for state noxious weed coordinators and other invasive plant specialists to record occurrences of plants. The Plants Distribution Update Module is an application that allows users, to become direct participants in the PLANTS database by sharing information about where plants grow in the U.S. Users can report a population or observation of plants at just the county level, or more precisely using a Geographical Information System (GIS), Latitude/Longitude measurements, or Township Range & Section coordinates. Reports can be documented by voucher specimens, the literature, or personal observations. Photos or drawings can be uploaded that aid or confirm the plant identification.

5.2.10 ProTracts

ProTracts is a web-enabled application that eliminates several paperwork steps and streamlines the program contracting process. Program managers will use ProTracts to allocate and track funds to states, areas, and counties. USDA customers can go on-line to complete and submit a program contract application. Field conservationists and Technical Service Providers will use it to create and manage contracts containing practices and components. They certify completed practices and approve them for payment. Contracts are built using cost lists maintained in eFOTG. Cost-share contracts are geo-referenced for rapid and flexible reporting. ProTracts will be integrated with automated processes managed by the Farm Services agency, including eligibility determinations, payment limitations, and payment processing.

5.2.11 Soil Data Warehouse

The Soil Data Mart is a geodatabase storing the spatial and tabular National Cooperative Soil Survey data and information. The Soil Data Mart provides the single authoritative source for customer access of official soil survey data (certified for use in the Field Office Technical Guide). Access is through a web sites or application and provides the ability to choose an area of interest, the types of data needed and display a report or request the data as a download or order a CD.

5.2.12 Smartech Runioff Curve/Object Modeling System

RCN is a web based program that calculates the Runoff Curve Number for a small watershed. RCN is needed to calculate how much water runs off a watershed following a rain. RCN is required for most NRCS engineering practices such as waterways, terraces, diversions, ponds or any water control structure. RCN is a web based program that allows user to geographically navigate to their watershed. Digitize a small boundary over a digital ortho background with user defined layers such as contour lines or soil map units displayed for reference purposes. User then digitizes different land uses. Calculates Runoff Curve Number for the watershed based upon land use and soils.

5.2.13 ArcGIS Customer Service Toolkit

The current version of Customer Service Tooklit runs in the ArvView 3.3 environment. Plans are to convert to the newer ArcGIS products to take advantage of the geodata, versioning, and topology enhancements in the in FY-2004.

5.3 Rural Development

Rural Development (RD) has recently developed ambitious plans for developing and deploying GIS applications to support their operations. The Mapping Analysis Program (MAP) is an existing application while the other applications are planned for development and deployment in the future. Dr. Dennis Crow provided the descriptions of the future geospatial applications[34].

Figure 5-6 RD Implemented GIS Applications

RD Implemented GIS Applications
▪ Mapping Analysis Program (MAP)

[34] Dr. Dennis Crow, November 19, 2002, email communication

Figure 5-7 Future RD GIS Applications

Future RD GIS Applications	Design/Develop	Pilot	Deploy
RHS Single Family Housing Program Eligibility Locator	In process	TBD	TBD
Environmental Hazard Reporter	In process	TBD	TBD
Spatially Enabling the RD Data Warehouse	In process	TBD	TBD
Spatially Enabling the Preservation Information Exchange	In process	TBD	TBD

5.3.1 Mapping Analysis Program

Rural Development's first deployed GIS application is the web-based Mapping Analysis Program (MAP). MAP "…allows program officials to view the location of USDA Rural Development's (RD) grants and loans on U.S., state and county maps. Simultaneously, MAP creates a table that gives details for the grants and loans shown in each map."[35]

The Phase I version of MAP achieved the following objectives:

- "No requirement for special desktop software, to keep the system inexpensive to deploy and maintain
- Intuitive and easily learned, minimizing the need for costly retraining or a time-consuming and burdensome learning requirement
- Able to display the location of program activities—in this case loans and grants—geographically
- Able to integrate data originating from multiple systems to provide the user with a seamless experience
- Allow users to capture their results and use them with other software
- Give users maximum flexibility in filtering the data to show just those records they wish to see."[36]

The vision for MAP in future releases includes the following capabilities:

- "Capacity to relate multiple data items
- Precise encoding of project locations
- Desktop access to a rich array of data

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[35] J. Norman Reid, 2001, "Managing Spatial Policy with Maps: USDA Rural Development's MAP System", Prepared for delivery at the ESRI Mid-Atlantic Users Group 2001 Annual Conference, 'GIS and Governments,' Washington, DC, November 28, 2001. p. 1

[36] Ibid, p.8

- Immediate access to updated data about changing conditions
- An entry point to other data systems
- The ability to access non-data information
- Access to non-USDA program data
- Ability to serve as a cross-departmental platform for data access
- Enhanced analytic capabilities
- A basis for distributed national inventories and databases
- A vehicle for public access to federal data
- Easy-to-use documentation
- A platform for data handling tools that enhance understanding."[37]

RD has also developed a single family housing locator prototype GIS application using ArcIMS and Apache. This application will allow a user to enter an address, get that address geocoded and then determine whether or not a property is located within the boundaries of areas that are eligible for RD housing assistance. The prototype application was developed using State of Michigan geospatial data.[38]

5.3.2 Rural Housing Service (RHS) Single Family Housing (SFH) Program Eligibility Locator

This is the first phase of the RHS Automated Underwriting Project, which will streamline and automate the application process, automate credit decision-making, and automate the eligibility determination for the SFH Guaranteed Rural Housing loan program. This system will ultimately be comprised of several components working together to automate the entire loan origination process to benefit low—to moderate-income families.

The extent of this program's eligible areas includes all of the States and the District of Columbia, as well as areas in Guam, American Samoa, Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands. Areas are rendered ineligible where there is an urban concentration.

Each ineligible area must be digitized, rendered into a map with common symbology, and built into a web-based application. Prospective borrowers, loan specialists, and lenders will be able to obtain an automated determination whether a specific street address is inside or outside an ineligible program area.

5.3.3 Environmental Hazard Reporter

This is a web-based application that would facilitate the timely evaluation of existing and prospective RD project sites in relationship to known environmental hazards. This applies to SFH Processing and Pre-foreclosure actions, Multifamily Housing

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[37] Ibid, pp.8-9

[38] Dennis Crow, 2002, personal communication

(MFH) Guaranteed loan program, and Rural Business Service liquidation actions. State Environmental Coordinators will be among the major users of the application.

The application will use EPA environmental data sources, USDA program data, and USDA spatial data technologies to provide environmental compliance information. Users will be able to assess the proximity of environmental hazards to the street address of any affected property.

5.3.4 Spatially enabling the Rural Development Data Warehouse

The purpose of the Rural Development Data Warehouse is to help make better decisions in managing and delivering the RD programs. The data warehouse stores historical data on RD programs as well as non-RD data such as Census data and RD-related spatial data. Reports can be created and data extracted to analyze RD program performance. Currently, the data warehouse contains information for the SHF programs, Rural Utilities Service Water and Environmental programs, Rural Utilities Service Telephone and Electric programs, and the Multifamily Housing programs.

Spatially enabling the data warehouse will require project address geocoding, spatial data quality control and maintenance, metadata creation, adding new geocoded records, system integration, and facilitating GIS-based analysis. The first step in this is obtaining access to high-quality national street and address data as well as geocoding services.

5.3.5 Spatially enabling the Preservation Information Exchange

RHS is required to notify nonprofit organizations and public bodies of the receipt of a borrower's requests to prepay their RHS MFH loans or offers their property for sale to a nonprofit or public body.

The Preservation Information Exchange (PIX) has been developed as a web-based application for the Multi-Family Housing (MFH) Office of Rental Housing Preservation (ORHP). PIX works with information extracted from the PRE-TRAC database and provides access to this information to the public. In addition, PIX will allow non-profit organizations to register to receive custom e-mail listings of properties that are for sale or have the potential to be sold.

By adding an internet mapping component, users of PIX would be able to locate multifamily properties in their communities where borrowers intend to prepay mortgages. Spatially enabling PIX, will entail project address geocoding, spatial data quality control and maintenance, application enhancement, metadata creation, adding new geocoded records, and facilitating GIS-based analysis.

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6 GIS Training Issues

GIS is a relatively complex technology so successful enterprise implementations of GIS require fairly ambitious training programs, which must address a variety of topics, skills, tools and applications. A series of GIS training plans have been developed over the years but the most complete GIS training plan was prepared in 2002[39]. A GIS Training Team was formed by the GIS ITWG Team to develop recommendations for GIS training at various levels of the enterprise. The draft document summarizes the plan that was developed by this GIS Training Team.

The GIS training plan identifies different types of staff, at various levels of the organization within the USDA organization who need GIS training as well as alternative options for delivering training. Training options range from ESRI tutorials to computer based training, classroom training, university courses, and other options. The specific types of training in GIS and related technologies, tools (e.g., SQL Server RDBMS) and applications (e.g., Customer Service Toolkit) are identified for these different types of USDA staff. The plan recognizes that the mix and depth of training required will vary with job responsibilities and location. For example, a service center FSA employee who processes applications may need an introduction to GIS course plus training in FSA GIS applications. In contrast, a state geodata administrator would need advanced training in GIS including ArcSDE and SQL Server. Applications programmers at service center agency development centers may need GIS training, SQL Server training, as well as training in the ESRI development environment and Visual Basic for Applications.

GIS training is an on-going activity. In locations where desktop GIS applications have been deployed, service center agency staff received training in those applications. During 2002, training in GPS, ArcSDE, ArcIMS, and ArcPad was received at ESRI training sites as well as USDA locations (e.g., NCGC in Fort Worth, Texas). GIS Help Desk staff also received training to better prepare them to handle questions from the field.

Planned GIS training for 2003 will expand in terms of the types of training that will be offered as well as the numbers of people who will be trained. Some standard ESRI GIS training courses will be modified to incorporate USDA geospatial data and example exercises; this will make training more relevant to USDA trainees. Training in 2003 will include the following courses:

- Fundamentals of GIS
- Understanding Service Center Agency Geospatial Data
- Introduction to ArcGIS I for Service Center Agencies

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[39] Draft Statement on GIS Training for USDA Service Center Agencies, 2002, (USDA, Beltsville, MD)

- Introduction to GPS and Digital Cameras
- Advanced GPS and Mobile Data Collection
- Service Center Information Management Systems (SCIMS)
- ArcIMS at ArcGIS 9.0
- ArcSDE with SQL Server
- GIS for soils data
- Building Geodatabases
- ArcPad Studio

Figure 6-1 GIS Training Schedule

Training Course	**Develop**	**Train**
GIS for Program Staff	1st Quarter, 2003	March, 2003
Understanding SCA GIS Data	Ist Quarter, 2003	TBD
Introduction to ArcGIS I for SCA	June, 2003	August, 2003
Introduction to ArcGIS II for SCA	January, 2004	TBD
Introduction to GPS and Digital Cameras	TBD	TBD
Advanced GPS and Mobile Data Collection	April, 2003	TBD
SCIMS	November, 2003	TBD
ArcIMS at 9.0	Fall, 2003	TBD
AecSDE with SQL Server	March, 2003	June, 2003
Understanding GIS for Soils (Virtual Campus)	FY 2004	TBD

7 Enterprise GIS Implementation Plan Phases

There are four phases to the USDA Enterprise GIS Implementation: Implementation of Desktop GIS, Transitioning to the Enterprise GIS, Implementation of the Enterprise GIS, and Further Implementations. This chapter describes each of these phases, focusing on the current USDA initiatives in each.

7.1 Phase One: FY2003

The first phase of the USDA's Enterprise GIS Implementation plan involves construction of geospatial databases and implementation of desktop GIS. This phase includes the deployment of ESRI's ArcView 3.x products with USDA custom developed desktop applications (such as Customer Service Toolkit).

Implementation of desktop GIS was initiated after ESRI's tools were selected for procurement but before the enterprise GIS software agreement was negotiated with ESRI. Desktop GIS implementation has continued since the enterprise GIS software agreement was established to expand deployment of desktop GIS applications. Desktop GIS implementation is targeted at field offices where the core geospatial databases are available. Figure 7.1 presents a table listing of the ESRI GIS software that has been installed by service center agencies as of January, 2003.

Figure 7-1 ESRI Software Deployed by USDA Service Center Agencies—— January 2003

Service Center Agency	FSA	NRCS	RD
ArcGIS 8.x	9	498	5
ArcView 8.x		82	1
ArcView 3.x	16,048	10,156	23
ArcIMS		10	
ArcSDE			
ArcPad		180	
Totals	16,057	10,926	29

7.1.1 FSA FY2003 GIS Implementation Status

ArcView GIS software was delivered to all FSA offices and staff in April 2002. Maintenance sites (service centers where FSA has deployed DOQ and CLU) each received a high-end workstation with ArcView 3.x and the CLU Maintenance application. High-end workstations with GIS were delivered to 819 state, county and digitizing center offices by the end of FY 2002. An additional 50 GIS workstations were delivered in early FY 2003. FSA has installed 16,048 copies of ArcView 3.x software as of January, 2003.

A series of tools within the CLU Maintenance application allow users to identify approximate wetland locations and capture limited CRP identification information. This allows sites to transition to digital imagery and ultimately stop using hard copy maps. Other tools, such as the crop reporting tool, compliance tool, HEL determination tool, and wetlands point digitization tool are prototypes being piloted and will be replaced by fully reengineered applications as BPR processes are completed.

FSA has a multi-level data and tool deployment strategy in place to ensure all levels of FSA are involved in GIS. In addition to Service Centers, FSA deploys copies of ArcView and CLU Maintenance Tools to State Offices. The APFO, Kansas City Development Center, Information Technology Services Division, and program divisions of FSA headquarters are all ArcView user sites and will be upgraded to ArcGIS products.

FSA is committed to migrating to ArcGIS. ArcGIS products, including ArcView 8 and ArcEditor 8, will provide FSA with the functionality needed to meet business requirements for program administration and compliance. Initial conversion of existing maintenance tools began in third quarter FY 2002.

7.1.2 NRCS FY2003 GIS Implementation Status

The NRCS desktop GIS implementation strategy provides the state offices with the flexibility to choose the service centers that will take part in the initial desktop GIS implementation. In addition to funding, the interest, expertise, and data availability profile of a service center all play a role in whether or not it is selected for initial desktop GIS implementation. This deployment requires that ArcView 3.2 be installed on a high-end workstation at the service center. Before the Enterprise GIS license agreement was negotiated, NRCS placed an order for 1,556 copies of ArcView 3.2 as well as additional copies of other ESRI products. NRCS installed 498 copies of ArcGIS 8.x, 82 copies of ArcView 8.x, 10,156 copies of ArcView 3.x, 10 copies of ArcIMS and 180 copies of ArcPad as of January, 2003.

The Toolkit application has finished deployment. The wetlands and easements applications are partially developed and scheduled for implementation. The Customer Service Toolkit Deployment Plan describes the history of its development as well as options and plans to install the application and train staff in its use. There is a version of Toolkit that uses GIS and a version that does not use GIS. However, many of Toolkit's benefits require GIS use. Initial training of state Toolkit coordinators occurred in September 2000.

Toolkit developers are reviewing issues and options that are involved in continuing to use ArcView 3.x versus moving to one of the ArcGIS 8 desktop tools. Final development plans have not yet been made.

7.1.3 RD FY2003 GIS Implementation Status

Rural Development is currently working to define their business requirements for GIS in several program areas. In 2002, RD hired a GIS specialist to assist in developing and implementing an RD GIS strategy. The Rural Utilities Service (RUS) is interested in using GIS to help evaluate the environmental impact of proposed expansions to rural utilities infrastructure. As this is a step in evaluation of rural utilities requests for loans, there is potential to improve the efficiency, effectiveness. and timeliness of this process. The Rural Housing Service has identified several potential GIS applications. In terms of ESRI GIS software, RD installed 5 copies of ArcGIS 8.x, 1 copy of ArcView 8.x, and 23 copies of ArcView 3.x as of January, 2003.

The first application would be to develop a local ArcView based GIS inventory of rural housing properties that are for sale, which could display property locations and their linked digital images. GIS could also be used to determine whether properties are located in a flood zone. In addition, GIS might also be used to analyze the utility infrastructure around a property or proposed development to determine whether or not there is adequate capacity.

Web GIS is also being used to host Mapping Analysis System that provides a variety of program evaluation and geographic data visualization capabilities (e.g., evaluate whether or not RD loans are being made on an equitable and nondiscriminatory basis). RD and Compaq have developed a prototype of this application and ESRI's ArcIMS software provides the application's Web GIS functionality.

7.2 Phase Two: FY2004

During FY2004, GIS activities will address a variety of tasks involved in transitioning to an enterprise GIS. These activities include:

- Migrating geospatial data into the ArcSDE and SQL Server geospatial data management environment
- Geospatial database design
- Continued construction of geospatial databases for USDA SCA
- Design and development of GIS applications which use the ESRI ArcGIS enterprise GIS suite of tools
- Design and development of mobile GIS applications to extend GIS use out of the office and into the field
- GIS training for future users at various levels of the organization
- Design and development of Intranet and Internet GIS applications
- Interoperability Lab testing of enterprise GIS software and applications

The current CCE plan is to install ArcSDE and SQL Server in each of the service centers during the Fall of 2003. According to Jim Heald of FSA, FSA enterprise GIS applications software will be ready for large-scale deployment no earlier than

September/October, 2003.[40] Individual FSA enterprise GIS applications may be ready for testing and/or pilot deployment on a limited basis as early as spring 2003. Interoperability Lab testing of enterprise GIS software, SQL Server and enterprise GIS applications must occur in 2003 before deployment of these new tools. Some geospatial data will also need to be migrated into the ArcSDE and SQL Server environment. While desktop GIS and enterprise GIS applications are both deployed in service centers, there may be a need to store some types of geospatial data in ArcSDE and SQL Server as well as to maintain some files outside of this environment. More detailed planning and coordination are needed between the GIS, Migration, IO Lab, and CCE ITWG teams and the Service Center Agencies' development teams to carefully sort out all of these issues.

7.3 Phase Three: FY2005

During FY2005, the predominant GIS activities relate to implementation of enterprise GIS. This implementation initially applies to the distributed client server enterprise GIS configuration contained within the service center environment.

The availability of geospatial data is a constraint on USDA's ability to comprehensively deploy enterprise GIS to all 2,700 CCE locations. Full implementation of enterprise GIS implies that the core geospatial datasets are available throughout the enterprise.

Individual service centers will be enterprise GIS ready when their geospatial data are stored in an ArcSDE and SQL Server configuration and a range of ArcGIS tools are used to support applications. GIS applications will need to be migrated from ArcView 3.x to ArcGIS to be enterprise ready. With implementation of the ArcGIS enterprise GIS geodatabase, more advanced geospatial data management functionality will be accessible for use. For example, versioning and disconnected editing will be available.

Full implementation of enterprise GIS will not be complete until all service centers have access to the core geospatial data. Even with an accelerated schedule of production based on increased funding, geospatial data for the four core types will not be completed until at least FY2005. Without increased funding, FY2008 would likely be the timeline for completion of core geospatial data.

7.4 Phase Four: FY2006 and Beyond

After the basic enterprise GIS infrastructure is available in the service centers, GIS activities in FY2006 and beyond access to geospatial data and GIS applications needs to be extended to USDA personnel from other service center locations and to the public on a broader basis. In addition, mobile GIS implementation with wireless

[40] Jim Heald, Personal Communication to Shirley Hall

communications can make anytime, anywhere access to data a more realistic option. This will occur through the implementation of Enterprise GIS with mobile computing, geospatial data warehouses and implementation of the anytime, anywhere access vision of the Virtual Service Center.

The Virtual Service Center vision would allow USDA Service Center Agencies' customers to conduct business at any service center location. For example, a farmer from Iowa who spends the winter in Florida would be able to conduct business from the latter location. The Florida service center personnel would access geospatial data from the geospatial data warehouses if geospatial data are needed to comply with the customer's request. Customer Service Toolkit folders, however, would need to be accessed from the "home" service center as these folders are only stored locally.

Public access to USDA geospatial data can occur through the Resource Data Gateway. After the Geospatial One-Stop portal is in place, the public will also be able to access geospatial data through that portal. USDA is a participant in the OMB-sponsored Geospatial One-Stop project.

Mobile GIS access to geospatial data and applications also expands the anytime, anywhere character of enterprise GIS. As of October 2002, USDA Service Center Agencies are involved in a number of mobile computing pilot projects to better understand the potential utility of these technologies to Service Center Agencies' operations. Location based services middleware can also be used to provide mobile access to geospatial data using thinner client PDA platforms.

Expanded access to geospatial data and applications, including mobile access via wireless communications, in an essential component of the Virtual Service Center target enterprise GIS architecture.