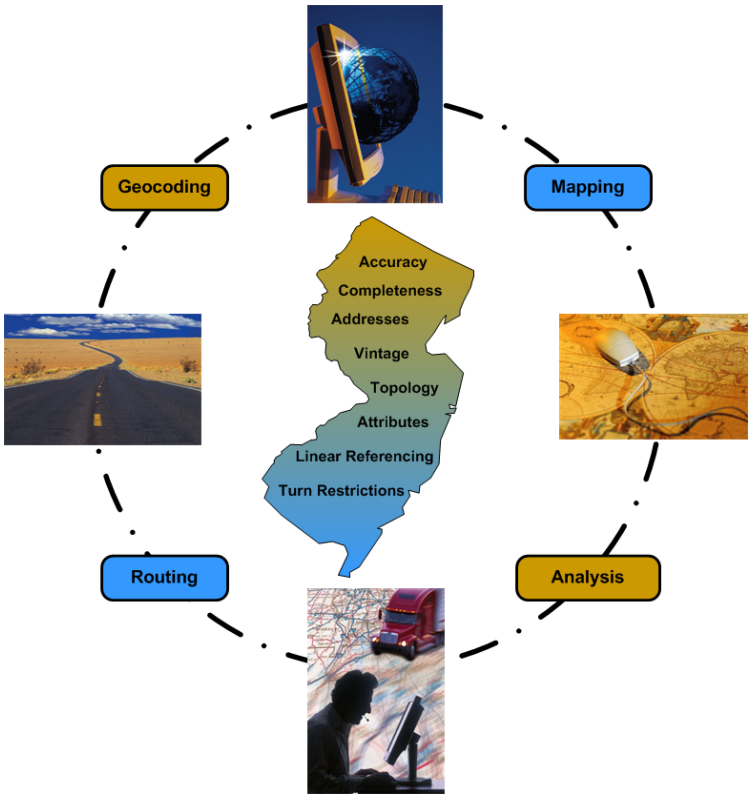
Feasibility Study for a Statewide Road Centerline Data Set



December 18, 2008

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Executive Summary

In November, 2006, the New Jersey Geospatial Forum Transportation Task Force finalized a report that provided an inventory and discussion of the various road centerline data sets used by public agencies throughout the state. The report indicated that there were a variety of different road centerline data sets being created and used, and that there is significant duplication of effort which leads to inconsistency and redundancy. The task force recommended a study be conducted to investigate the feasibility of developing and maintaining a single, comprehensive, statewide road centerline data set that could serve the needs of the entire GIS user community. Fountains Spatial, Inc (FSI) was contracted by the State of New Jersey to conduct the feasibility study, and is pleased to present this executive summary of the study.

Work Approach

FSI conducted a series of workshops with a number of organizations at the state; county and regional level, that currently use and/or maintain road centerline data. In addition to the workshops, FSI acquired a series of existing centerline data sets used by the stakeholders, and conducted an extensive analysis of the data. Finally, FSI researched the status and efforts of other states that are in varying stages of implementing a statewide road centerline data set.

Current Status

In general, there are two primary, centerline data sets currently in use on a state-wide basis, with many others being used on a more regional or local level. Users requiring road centerlines on a state-wide or regional level are using either a road centerline data set created and maintained by NJDOT or a commercially available centerline data set licensed from TeleAtlas, or in many cases both. Additionally, many counties maintain and use their own centerline data.

The Bureau of Transportation Data Development (BTDD) within NJDOT currently maintains a road centerline data set for the entire state under a requirement by the Federal Highway Administration (FHWA) to provide accurate mileage totals for each road classification to support and justify the level of federal funding received by the state. The advantages of this data set are the excellent spatial accuracy and topology, the vertical alignment with the latest municipal boundary layer, and the robust linear referencing system (LRS). However, there are several major limitations of the data set which present usability issues. First, the centerlines only represent publicly maintained roads, resulting in an incomplete data set. Second, address ranges are not associated with the centerlines, rendering the data insufficient for geocoding locations using addresses. Finally, the data does not include attributes to support routing such as turn restrictions or one-way roads.

The state also currently licenses a road centerline data set from TeleAtlas for the entire state, plus a one county “buffer” outside the state (includes the 17 neighboring counties from NY, DE and PA that are immediately adjacent to New Jersey). The State pays TeleAtlas an annual fee of $413,500 for use by any state, county or municipal government organization, as well as both the Port Authority of NY & NJ, and the Delaware River Port Authority. The TeleAtlas data set is complete having both public and private roads throughout the state. The spatial accuracy is good;

however, the NJDOT roads are more accurate. The road naming is not standardized and contains a significant number of unnamed roads. Unlike the NJDOT data, the TeleAtlas centerlines contain address ranges, and are used for geocoding by a large number of end users. This data set also contains turn restrictions and can therefore be used for routing. However, the data set does not contain a linear referencing system and does not align with the state municipal boundary data set.

Implementation Recommendations

Based on stakeholder responses, there is overwhelming agreement and support for a single, comprehensive road centerline data set. Given the level of effort associated with developing a statewide data set, coupled with the limited availability of existing staff resources within both NJDOT and OGIS, it would be unrealistic to consider developing the data set in-house. Therefore, an outside contractor would be required to develop the initial statewide data set. Based on the need for an outside contractor, there are two basic implementation options available:

1. Contract with a commercial data vendor (i.e., TeleAtlas) to make the required enhancements to their data set, then continue to pay an ongoing license for the use and maintenance of the data set; or,

2. Contract with a consultant to make the required enhancements to the NJDOT data set and develop a business model for an in-house maintenance program.

The most important factor in determining the best option was that the Bureau of Transportation Data Development (BTDD) within the NJDOT cannot entertain the possibility of using a different data set due to their federal mandate. Using a different centerline file such as TeleAtlas, which is less accurate and classifies their roads differently, would be unacceptable since federal funding is based on these mileages. Moreover, NJDOT expressed that they have approximately nine (9) other enterprise-wide management systems that heavily rely on the data structure of the NJDOT centerline file and linear reference system.

Therefore, it is recommended that the state contract with a consultant to make the required improvements and enhancements to the NJDOT data set and develop a business process and organizational model to support the on-going maintenance. For the seventeen (17) neighboring counties from other states, it is recommended that the state select the best publicly available data source for each county and arrange a partnership with the custodian organizations to acquire the data on a regular basis and make it available to the end users within New Jersey.

Prior to a full statewide implementation, it is recommended that a pilot project be conducted in which a contractor defines a methodology and performs the enhancements to the NJDOT centerlines for several municipalities to define the specific data processing procedures, identify issues, and more precisely define the costs.

Data Maintenance Program

Maintaining a statewide centerline data set will clearly require more resources at the state level. It is recommended that the maintenance efforts be a joint effort between BTDD and OGIS. BTDD should continue to be responsible for maintaining the detailed centerline geometry, QA/QC, assigning the NJDOT core attributes required for federal reporting, and integrating the roads into the linear referencing system. This responsibility will now be expanded to include private roads. A funding source must be identified to cover the additional cost of maintaining private roads.

OGIS would be responsible for maintaining the extended attributes (e.g., address ranges, postal codes, and alternate names) for all roads in the state. OGIS would require a dedicated staff person in the role of a maintenance coordinator to serve as the liaison with the county 911 coordinators and other local officials providing change requests, to manage the required changes and additions to the centerline data, and to coordinate all processing with BTDD.

Perhaps the most important factor in keeping the road centerline data set up-to-date is being aware of changes and additions to roads and addresses. The county 911 programs are already responsible for recording new roads and addresses. Therefore, it is important to align the notification process for the centerline management program as closely to the 911 programs as possible. Burlington County has a particularly robust program in place in which the municipalities are mandated to submit road and address changes to the county 911 coordinator. The state would be well served to put a business process in place that is as close to the mandate and workflow employed in Burlington County as possible.

Quantitative Analysis

The state currently pays an annual fee of $413,500 to license a statewide centerline file from TeleAtlas. The license fee does not provide the state with ownership of the data. Rather, it only provides the state with a license to use the data, and to receive updates for a single year.

The costs associated with implementing a statewide road centerline data set can be categorized into the one-time costs of enhancing the NJDOT road data set, and the on-going costs of maintaining the data set. The upfront costs of enhancing the NJDOT data set are estimated at approximately $970,000. The increase in annual maintenance costs associated with the a new staff member within OGIS to serve as the maintenance coordinator, as well as the additional funding required for NJDOT to maintain private roads is estimated at $106,000 per year. Once the new, statewide, road centerline data set were completed, the state could discontinue the license with TeleAtlas, resulting in annual savings of approximately $307,000. This would allow the state to recapture the initial upfront investment within approximately 3 years, after which the $307,000 savings could be fully realized each and every year.

Summary

In summary, it is recommended that the state initiate the development of a statewide, road centerline data set as set forth in this report. Implementing such a data set will result in a superior data product that will be owned by the state, with a reduction in annual costs that save the state approximately $307,000 each year. Moreover, developing and maintaining the road centerlines as an in-house product will leverage the existing NJDOT investment and business process and will not disrupt their federal reporting requirements. By maintaining the data set in-house, the state will have greater control over the content and accuracy, the data will be updated and distributed to the user community in a more timely fashion, and it will be the product of a coordinated effort of all levels of government, as well as the private sector, eliminating the redundancy and inconsistency that currently exists.

1. Introduction

In November, 2006, the New Jersey Geospatial Forum Transportation Task Force finalized a report that provided an inventory and discussion of the various road centerline data sets used by public agencies throughout the State. The information was collected using a survey distributed to state, county, municipal and regional organizations (i.e., stakeholders) having GIS-based transportation applications. Once the survey responses were collected, the task force had a series of meetings to discuss the responses and to identify issues regarding the use of road centerline data in the State.

The survey results indicated that there are a variety of different road centerline data sets being created and used throughout the State, and that these data sets differ greatly in their characteristics such as geographic extent, completeness, spatial accuracy, vintage, attribution, address ranges, linear referencing and turn restrictions. Moreover, while the existing road centerline data sets being created and maintained may adequately meet the needs of a single organization, there is significant duplication of effort which leads to inconsistency and redundancy. Additionally, some databases in use are proprietary and can only be used within a specific organization (e.g., NJ Transit).

The task force outlined a number of other issues of concern in their report, and ultimately recommended that a formal study should be conducted to thoroughly investigate the feasibility of developing and maintaining a single, comprehensive, statewide road centerline data set that could serve the needs of the entire GIS user community.

In June, 2007, Fountains Spatial, Inc (FSI) was contracted by the State of New Jersey to conduct the aforementioned feasibility study. FSI is pleased to present this final report of the feasibility study for a statewide road centerline data set to the New Jersey Office of Information Technology (NJOIT). The report that follows documents the results of the study, provides a series of recommendations, and outlines implementation strategies to guide the state.

2. Work Approach

The section that follows presents the general work approach and methodology that was used in conducting the study.

2.1 Project Initiation Meeting

The project was initiated with a meeting between members of the Fountains Spatial project team and the State project management team at the NJOIT Office of GIS (OGIS) offices in Trenton, NJ. This meeting focused on a number of project initiation activities such as:

- introduction of the Fountains Spatial and State project team members;
- review of project work plan and schedule;
- review of key findings from the Transportation Task Force Final Report;

- identification of organizations to participate in the requirements workshops; and,
- scheduling of initial requirements workshops.

2.2 Requirements Workshops

Following the project initiation meeting, FSI conducted a series of requirements workshops with a number of organizations at the state, county and regional level that currently use and/or maintain road centerline data. The objective of these workshops was to identify and understand the following:

- current and potential uses of road centerline data;
- characteristics of the existing centerline data;
- limitations and issues surrounding the use of existing centerline data;
- current maintenance procedures and related issues;
- potential issues surrounding a statewide centerline data set;
- needs and requirements regarding centerline data; and
- cost, legal and other issues.

The organizations that participated in the requirement workshops are listed in the table below.

New Jersey State Agencies
NJDOT • GIS • Trucking Services • Transportation Security • OEM Operations • Right of Way • Geotechnical Services • Traffic Operations • System Planning • Railroad Engineering • Transportation Data Development
NJ State Police • Computer-Aided Dispatch • Emergency Management
NJ Office of Homeland Security and Preparedness
NJ Office of Information Technology (NJOIT) • Office of GIS (OGIS) • Office of Emergency Telecommunication Services
Regional Planning/Management Organizations
Delaware Valley Regional Planning Commission (DVRPC)
New Jersey Transit
New Jersey Turnpike Authority
North Jersey Transportation Planning Authority
Port Authority of NY & NJ
South Jersey Transportation Planning Organization

County Agencies
County 911 Coordinators • Burlington • Camden • Gloucester • Mercer • Monmouth
County GIS Coordinators • Atlantic • Burlington • Hunterdon • Mercer • Monmouth • Morris • Passaic • Salem • Sussex • Union
Private Sector
Verizon (responsible for maintaining the Master Street Address Guide for the State)
Civil Solutions (data contractor for NJ State Police 911 Dispatch)
Geodecisions (data contractor for DVRPC road centerline project)

Organizations Interviewed During Requirements Workshops

Many workshops included multiple organizations having similar responsibilities or those that work together in a specific functional area. For example, a single workshop focused on the topic of 911 efforts at the county level, which included participation from the 911 coordinators of five (5) counties, representatives from Verizon's MSAG maintenance group, the Director of NJOIT's Office of Emergency Telecommunication Services, and NJOIT OGIS staff.

2.3 Data Analysis

In parallel with the requirements workshops, FSI acquired a series of data sets that were either currently used by the various stakeholders, or were relevant to the creation and maintenance of a statewide centerline data set. The data sets acquired and evaluated included:

- NJDOT Centerlines;
- TeleAtlas Centerlines;
- NavTEQ Centerlines;
- Burlington County Centerlines;
- Hunterdon County Centerlines;
- TIGER 2007 Centerlines;
- New Jersey Master Street Address Guide (MSAG);
- NJ Orthophotos; and,
- 2008 NJ Municipal Boundaries.

Upon receipt of these data sets, FSI conducted an extensive evaluation and analysis of the data regarding the feasibility of creating and maintaining a statewide road centerline data set that meets the needs and requirements of each stakeholder. Factors that were evaluated included completeness, spatial accuracy, topological integrity, physical segmentation, vertical alignment, attribution, address ranges, vintage, potential conflation issues, update procedures and others.

2.4 Research other State Efforts

In parallel with the requirements workshops, FSI also researched other states that are conducting similar activities with research, development and maintenance of a statewide road centerline data set.

2.5 Follow-up Workshops

After the initial round of requirements workshops were completed, FSI conducted follow-up workshops with several groups to clarify and expand upon the information gathered in the initial meetings.

2.6 Feasibility Analysis

Following the workshops, data analysis and research of other states, a thorough analysis was conducted to identify and evaluate the feasibility of the development and maintenance of a comprehensive, statewide road centerline data set. The analysis evaluated and compared several potential options, resulting in the recommendations outlined in the sections that follow. A conceptual framework outlining potential implementation strategies was developed and a quantitative analysis was performed on the strategies to evaluate the return on investment.

2.7 Development of Draft Report

Once the feasibility analysis was complete, FSI developed a draft version of the study report and provided the report to the state management team for review and feedback.

2.8 Draft Report Review

FSI provided the draft report to the State management team and reviewed the draft report with the state team to discuss and solicit feedback as well as any desired modifications to be incorporated in the final report.

2.9 Development of Final Report

Following the review of the draft report, FSI incorporated all feedback and changes required and produced a final report for the study. The final report was provided to the state in both hardcopy and digital (PDF) format.

3. Current Status Overview

This section will provide an overview of the various road centerline data sets currently being created, maintained and used throughout the state, including the characteristics and limitations identified during the analysis of each data set, as well as the issues discussed by the stakeholders during the requirements workshops.

In general, there are two primary, centerline data sets currently in use on a state-wide basis, with many others being used on a more regional or local level. Users requiring road centerlines on a state-wide or regional level are using either a road centerline data set created and maintained by the NJDOT or a commercially available centerline data set licensed from TeleAtlas, or in many cases, both. In addition to these statewide data sets, NJ Transit licenses a commercial centerline data set from NavTEQ for a forty (40) county area covering four (4) different states. Finally, many counties maintain and use their own centerline data. The subsections below provide a narrative of each of these data sets.

3.1 NJDOT Road Centerlines

The NJDOT currently maintains a road centerline data set for the entire state. The data set is maintained by the Bureau of Transportation Data Development (BTDD) within NJDOT as a requirement by the Federal Highway Administration (FHWA) to provide accurate mileage totals for each road classification to support and justify the level of federal funding received by the state. This data set is also an important element in a number of enterprise-level information systems within NJDOT. This data set was developed primarily via “heads up” digitizing from the 2002 high resolution orthophotography which has a scale of 1:2,400. The centerlines are continuously updated by BTDD with quarterly releases within NJDOT, and a yearly update provided to the rest of the state and the public. New roads are now captured using in-vehicle GPS via an outside contractor, added to the data set, attributed accordingly and integrated into the linear reference system. The table below provides an overview of the key characteristics and issues of the data set.

Characteristic	Description
Geographic Extent	Statewide
Completeness	The data set does not contain all roads within the state. All publicly maintained roads are included, but it does not contain privately maintained (but publicly traveled) roads. Contains 41,045 linear miles of roads.
Spatial Accuracy	The spatial accuracy is excellent; with centerlines aligning exceptionally well with the 2002 statewide orthophotography.
Road Naming	Each road is assigned a seventeen character, standard route identifier (SRI), which can uniquely identify each road as well as ramps. Each road is attributed with a primary road name; however, many stakeholders raised the issue that the primary road name is often a route number (e.g., County Route 634) rather than

	the local road name, which causes problems in many applications (e.g., geocoding). Additionally, the roads do not have any alternate names or aliases assigned, and have minor standardization issues.
Address Ranges	One of the biggest limitations of the data set is that the centerlines do not have address range information and therefore the data set cannot be used for address matching. This was one of the most important limitations noted by the stakeholders.
Linear Referencing	One of the most valuable aspects of the NJDOT centerline data is that it includes a linear referencing system (LRS) that is used by many organizations for dynamic segmentation and geocoding by milepost. However, stakeholders raised the issue that the physical milepost signs along highways do not always correspond with LRS measurements. In some cases this is because signs that are damaged may not be replaced in exactly the same location. But the more significant issue is that the milepost signs on secondary direction (southbound or westbound) roadways of divided highways are installed to match the signs on the primary direction roadway, as opposed to being placed by distance measurements on the secondary roadway. In cases where the roadway lengths are different, the mileposts on the secondary direction will not match the LRS values on the secondary direction. NJ State Police illustrated examples where the mismatch was nearly a half mile, which can cause issues when analyzing crash locations for mitigation efforts and can also cause confusion with jurisdiction when dispatching emergency services. The mismatch is the result of a policy issue and is not an error in the LRS, but it can lead to erroneous results if users are unaware of the mismatch between the LRS and field observations based on milepost signs.
Topology	The data set accurately represents divided highways with multiple centerlines. The connectivity of the data set is excellent, with no obvious issues.
Routing Attributes (Turn Restrictions, One-way roads, etc.)	The data set does not include attributes on turn restrictions, one-way roads or any other travel impedances and therefore cannot be used effectively for routing.
Attribute Accuracy	There are no additional attribute issues, other than those described within this table.
"Vertical" alignment with other data sets	NJ OGIS recently completed the development of a new municipal boundary data set which was created using the NJDOT centerline geometry as the municipal boundaries when they are coincident. Therefore, the NJDOT centerlines align precisely with the municipal boundaries. However, the NJDOT centerlines do not align with other boundaries such as census geography (tracts, block groups, blocks).
Segmentation	The data set contains 102,428 road segments, which is

	significantly less than the 596,783 segments in the TeleAtlas data set. This is due to the fact that the NJDOT centerlines are not segmented at intersections, or at municipal boundary/ZIP code changes. The limited segmentation represents another key issue for end users, and will clearly have to be modified if address ranges or other attributes are to be added to the data set.

Characteristics of NJDOT Road Centerlines

3.2 TeleAtlas Road Centerlines

The state currently licenses a road centerline data set from TeleAtlas for the entire state, plus a one county "buffer" outside the state (includes the 17 neighboring counties from NY, DE and PA that are immediately adjacent to New Jersey). The state pays TeleAtlas an annual fee of $413,500 for use by any state, county or municipal government organization within the state, as well as both the Port Authority of NY & NJ and the Delaware River Port Authority.

Unlike the NJDOT roads, the TeleAtlas data set is complete having both public and private roads throughout the state. The spatial accuracy is quite good, and generally aligns with the 2002 high resolution orthophotography; however, the NJDOT roads are clearly more accurate. The road naming is not standardized and contains a significant number of unnamed roads (approximately 4% compared to less than 1% of NJDOT roads). The TeleAtlas roads are attributed with address ranges, and are used for address matching/geocoding by a large number of end users. This data set also contains turn restrictions and can therefore be used for routing. However, the data set does not contain any linear referencing and does not align with the state municipal boundary data set where coincident. The table below provides an overview of the key characteristics and issues of the data set.

Characteristic	Description
Geographic Extent	Statewide
Completeness	Contains all roads within the state, including both public and private. The data set includes 50,435 linear miles of roads.
Spatial Accuracy	The spatial accuracy is good, but not excellent, with centerlines aligning reasonably well with the 2002 statewide orthophotography in most cases.
Road Naming	Each road segment is assigned a unique identifier (Dynamap_ID). Each road is attributed with a primary road name, which is separated into the typical address fields such as name, road type, prefix, suffix, etc. Additionally, the attribute table supports up to 6 alternate names. Finally, the road names are not completely standardized resulting in inconsistent field values.
Address Ranges	The attribute table contains address ranges to support address matching (From and To addresses, ZIP code and municipality on left and right side of the road).

Linear Referencing	The data set does not contain any linear reference system.
Topology	The data set represents divided highways with multiple centerlines. The connectivity of data set is good, with no obvious issues.
Routing Attributes (Turn Restrictions, One-way roads, etc.)	The data set includes attributes on turn restrictions, one-way roads, average speed limit, and "cost" of travel and therefore can be used effectively for routing.
Attribute Accuracy	The FCC code is inconsistent and inaccurate in many cases.
"Vertical" alignment with other data sets	The centerlines do NOT align with the newly created municipal boundary data set for the state. However, they do align with census geography (tracts, block groups, blocks).
Segmentation	The data set contains 596,783 road segments, and is segmented at each intersection, as well as segmented at municipal and ZIP code boundary changes.

Characteristics of the TeleAtlas Road Centerlines

3.3 NavTEQ Road Centerlines

NavTEQ road centerline data are currently used by NJ Transit on a regional basis. The license is solely for use by NJ Transit, therefore no other organization uses this data set. NJ Transit provides service in 40 counties across four (4) different states (New Jersey, New York, Pennsylvania, and Delaware). They selected NavTEQ as their road centerline data approximately 10 years ago after a thorough comparison with GDT Dynamap data, and license it specifically for their use. Their evaluation found that the attributes were more accurate than the GDT/Dynamap data which was more important for their use. Although they will occasionally utilize the NJDOT roads for a specific analysis, they require a comprehensive set of road centerlines across a 4 state area (beyond New Jersey), and therefore required a commercially available data set covering their required geographic extent.

3.4 County Maintained Centerlines

A number of counties maintain their own road centerline data set. Eleven (11) counties have centerline files that are either GPS derived (Burlington, Hunterdon), aligned to the 2002 orthophotos (Atlantic, Cumberland, Mercer, Monmouth, Morris, Somerset, Sussex, Union) or aligned to parcel boundaries (Bergen, Camden). The GPS derived centerlines in Burlington and Hunterdon do not have address ranges, however they are highly accurate and have a significant number of other attributes such as speed limits, striping and number of lanes that are quite valuable. These counties typically use their own data for most purposes, however are forced to use the TeleAtlas data for address matching. The counties that have aligned centerlines to the orthophotos, typically have started with TIGER files and therefore have address ranges for geocoding. Most counties have continued to improve the data quality over time.

3.5 OGIS Routing Service

The Office of GIS (OGIS) currently provides a web-based routing service based on ArcIMS Route Server. The ArcIMS Route Server engine utilizes TeleAtlas road centerlines as the underlying data set. This routing service supports state agency web mapping applications.

3.6 Comparison of NJDOT and TeleAtlas Centerlines

As noted previously, the majority of users requiring statewide road centerline data use either the NJDOT data set or the licensed TeleAtlas data. This section will provide a brief comparison of the major characteristics of the two data sets.

The table below presents a side-by-side comparison of the major characteristics of the NJDOT and TeleAtlas road centerline data sets.

Characteristic	**NJDOT**	**TeleAtlas**
Completeness	Incomplete, contains publicly maintained roads only	Complete, contains both public and private roads
Spatial Accuracy	Excellent	Good
Address Ranges	No	Yes
Linear Referencing	Yes	No
Routing Attributes	No	Yes
Alternate Road Names	No	Yes
Vertically aligns with NJ municipal boundaries	Yes	No
Centerlines segmented at all intersections	No	Yes
Number of Segments	102,428	596,783
Linear Feet	216,715,749	266,298,002
Linear Miles	41,045	50,435
Percentage of Segments with blank or "Unnamed" road name	.4%	3.9%

Comparison of NJDOT and TeleAtlas Road Centerlines

As listed in the table above, the NJDOT data has excellent spatial accuracy, aligning very well with the 2002 orthophotography, while the TeleAtlas data are more generalized in many areas and therefore less accurate. The graphic below shows an area in Monmouth County with both TeleAtlas centerlines (green) and NJDOT centerlines (red) displayed with the state orthophotography. This area illustrates an example of how the NJDOT centerlines align extremely well with the orthophotos, while the TeleAtlas centerlines are more generalized and do not align as well.

As described earlier, one of the major issues with the NJDOT centerlines is that privately maintained roads are not included in the data set, while TeleAtlas includes all roads. The graphic below illustrates an area where two small neighborhoods are present in the TeleAtlas data (green) but not present in the NJDOT centerlines (red).

4. Needs/Requirements Summary

As described in the methodology, the FSI project team conducted requirements meetings with a significant number of state, county and regional agencies that utilized and/or maintained road centerline data within New Jersey. The section that follows will present an overview of the key requirements outlined by the stakeholders, as well as important issues and limitations that were identified regarding the existing centerline data sets. A detailed description of the requirements of each stakeholder interviewed can be found in Appendix A.

4.1 Geographic Extent

Although many organizations require road centerlines solely within their primary jurisdiction (e.g., state/county), a significant number of organizations require centerlines that extend beyond their jurisdiction. As mentioned earlier, the current TeleAtlas license provides centerline data for each of the 17 counties (from 3 states) that are immediately adjacent to New Jersey. The table below lists each of the adjacent counties.

County	State
Kent	DE
New Castle	DE
Sussex	DE
Bronx	NY
Kings	NY
New York	NY
Orange	NY
Queens	NY
Richmond	NY
Rockland	NY
Westchester	NY
Bucks	PA
Delaware	PA
Monroe	PA
Northampton	PA
Philadelphia	PA
Pike	PA

County 911 dispatch centers require road centerlines for neighboring counties. For “border” counties that are adjacent to another state, the centerlines from the neighboring state are required to properly dispatch certain calls. For example, over 50% of 911 calls are now coming from a wireless caller. Wireless calls result in the dispatcher receiving an X,Y coordinate of the caller location (rather than an address of the land line). For border counties, an incoming wireless call can originate from outside of New Jersey (based on the orientation of the cell tower with respect to the signal). When a wireless call from a neighboring state (such as New York, Pennsylvania

and Delaware) is received, the dispatcher must have the road centerlines available for that state in order to assist the caller based solely on their incoming X,Y coordinate.

Similarly, state agencies such as NJ State Police, NJ Office of Homeland Security and Preparedness, and Port Authority of NY & NJ all have mutual aid arrangements with neighboring states requiring centerline data in these states for geocoding of address data, and other spatial analysis such as incident mapping, evacuation routing and resource allocation. Finally, the NJ Turnpike Authority requires data from adjacent states to assist with a variety of emergency response efforts since the NJ Turnpike and Garden State Parkway extend into other states.

Based on the stakeholder responses, it is clear that if the state were to create, maintain and distribute a comprehensive, road centerline data set, it is important to continue to provide (similar to the existing TeleAtlas license) centerlines for the adjacent counties from the neighboring states. However, if the TeleAtlas license were discontinued, the state would need to identify other sources for this data.

4.2 Completeness

Although the NJDOT centerlines currently contain only publicly maintained roads, it is clear from the stakeholders that this is one of the major limitations of the data set and precludes it from being used for a wider set of applications. A statewide, centerline data set would have to include all roads within the state, both publicly and privately maintained. Additionally, several stakeholders would benefit greatly if "internal" roads for larger facilities such as airports and shopping malls were included in such a data set. These roads are not always available in commercial data sets and do not currently exist in the NJDOT centerline data set.

These internal roads are important to properly represent the "infrastructure" for a large facility and can be critical for planning, emergency response and homeland security applications. Many organizations such as NJ State Police, county 911 coordinators, NJ Office of Homeland Security and Preparedness, NJDOT and the Port Authority of NY & NJ requested that facility roads be available in a road centerline data set. In fact, the Port Authority of NY & NJ manages 22 facilities across the state and already has mapped the roads for these facilities that can be immediately contributed to a centerline data set.

4.3 Spatial Accuracy/Alignment

Generally, most uses of centerline data are adequately addressed with the existing spatial accuracy of the NJDOT centerlines which align extremely well with the 2002 orthophotography. The most significant requirement of spatial accuracy was that of NJDOT themselves, who report their mileage totals for each road classification to the FHWA based on the centerline geometry. In essence, the level of federal funding provided to the state is based on the accuracy of the NJDOT centerline data set. Therefore, NJDOT is extremely dependent on this data set, and simply cannot consider using another centerline data set (i.e., TeleAtlas) that is maintained by a third party entity, with inferior spatial accuracy.

The NJ Office of Homeland Security and Preparedness also requires a high level of spatial accuracy since roads are considered "critical infrastructure" which they are responsible for protecting and managing. Having a complete and spatially accurate record of all the roads in the state is important from a homeland security perspective.

Regarding alignment, stakeholders require roads to properly align with other data sets when features are coincident, such as municipal/county boundaries, census boundaries, and bridges. As mentioned previously, the recently updated municipal boundary data set utilized the NJDOT road centerline geography when roads comprised a boundary, therefore the municipal boundaries and NJDOT centerlines have precise alignment. The TeleAtlas centerlines do not align with the new municipal boundary data set. Applications ranging from general map production, to planning and analysis require spatial alignment between roads and coincident features in other data sets.

4.4 Core Attributes

Most stakeholders interviewed expressed similar requirements for the core attributes required for all centerlines. At a minimum these included the following:

Road Name

While road name is an obvious attribute that is already present in both the NJDOT and TeleAtlas data sets, many stakeholders pointed out that the road names for county and state routes in the NJDOT centerline data set are the route number (e.g., Route 533) rather than the local name. This was one of the most significant issues expressed during the requirements workshops, and was clearly an issue that must be resolved if a statewide centerline data set is to be developed. The stakeholders would prefer if the primary name was the local road name, while the county or state route number were stored in alternate name fields and/or in a separate route number attribute.

Of those stakeholders currently using the TeleAtlas road centerlines, several raised the issue that the primary road names in the TeleAtlas data are inconsistent and not completely standardized. Similar to the NJDOT data, the primary road name often contains the route number rather than the local name (although the local name may be stored in an alternate name field). Moreover, often the values in the primary name field and alternate name fields are swapped from segment to segment along the same road.

For state and county routes, the route numbers are stored inconsistently, where names can vary from "County Route X", to "County Hwy X", to "County Road X". Additionally, the NJ State Police raised the issue that circles are often attributed inconsistently with each segment of the circle named differently.

Alternate Names

While the TeleAtlas data does provide for up to six (6) alternate names for each centerline, several users pointed out that the alternate names are not comprehensive.

However, nearly all stakeholders that currently use the NJDOT road data set, raised the issue that this data set does not contain any alternate naming in the core attributes for each segment. Rather, alternate names are stored in a related table that is dynamically linked to the centerlines based on mileposts, which is difficult to use in many operations such as geocoding. The alternate names are stored in this fashion since the NJDOT centerlines are not segmented at every intersection.

This was clearly a priority among the stakeholders. If the NJDOT data set were to be enhanced for use as a single, centerline data set, comprehensive alternate names within the core attributes (associated at the segment level) would be required. As discussed earlier, the preference is for the local road name to be stored as the primary name, with county/state/federal route identifiers stored in alternate name fields.

Road Type Classification

Both the NJDOT road data set and the TeleAtlas data contain a road type classification attribute. NJDOT centerlines contains an attribute named ROUTE_SUBTYPE which classifies the roads into eight categories including interstate, US, state, toll route, county 500 series, county 600 series, local route and ramp. The TeleAtlas data contains a feature class code (FCC) with a detailed breakdown of road type; however, there are many errors within this field. NJDOT raised the issue that TeleAtlas classifies their roads differently, and that it can be difficult to distinguish between a county and state road in certain situations, which would not be adequate for meeting federal reporting requirements.

The existing road type classification of the NJDOT data appears to be adequate for most stakeholders, as there was little in the way of issues raised with classifications. The primary input provided from the stakeholders was that the functional classification of each road was a core attribute that would be required for effective use.

Address Ranges

Perhaps the most important attributes of a statewide, road centerline data set is the need for comprehensive and accurate address ranges (and postal codes) for the left and right side of each road segment to allow address matching/geocoding. Nearly all users that currently perform address matching utilize the TeleAtlas data for this purpose, as it is available for the entire state, as well as the surrounding counties in neighboring states. Those that do not use TeleAtlas data for address matching (such as the North Jersey Transportation Planning Authority), are using a TIGER derivative data set.

This is one of the most significant elements missing from the NJDOT data set. This causes issues for many users as they are forced to address match to the TeleAtlas or TIGER data, however, when geocoding based on milepost, they must use the NJDOT data set due to the availability of the linear referencing system. For example, the North Jersey Transportation Planning Authority geocodes crashes using both TIGER (via address matching) and the NJDOT centerlines (via milepost). This causes points to be geocoded using two different centerline geometries which results in point locations that do not align with a single centerline data set for display and analysis.

It was nearly unanimous among stakeholders, that a single, comprehensive road centerline data set that contained both address range attributes to support address matching, as well as a linear referencing system to support milepost geocoding is required to adequately meet the needs of the end users.

4.5 Additional Attributes

In addition to the "core" attributes described above, there were several other attributes that, although not required by everyone, would assist with more specialized applications for a number of stakeholders. These attributes include the following:

Number of Lanes

The NJ Office of Homeland Security and Preparedness and NJ State Police both identified the number of lanes as an additional attribute that would be helpful in a centerline file. For example, in emergency situations, it could be helpful in identifying those roads that should be reduced to a single lane to check vehicles. Additionally, the Office of Emergency Management within NJDOT develops lane reversal plans for emergency purposes which can be assisted with this attribute.

This attribute is not available in the NJDOT data or the TeleAtlas data. Both Burlington County and Hunterdon County have number of lanes as an attribute in their centerline file. This is primarily due to the fact that both centerline files were created by driving the roads with GPS, where the roads could be split "on the fly" at changes in the number of lanes. Typically, since the number of lanes can change between intersections, this attribute is best stored using dynamic segmentation based on the LRS rather than physical segmentation.

Average Speed

This would be helpful primarily for routing purposes. The TeleAtlas data currently contains average speed as an attribute for each segment, while the NJDOT data has speed limits in a related file based on the LRS dynamic segmentation. The NJ State Police requested that, in addition to typical average speed, an additional attribute of average speed at peak volume (i.e., rush hour) would be helpful as well, especially in emergency situations.

Height and Weight Restrictions

A significant number of stakeholders requested that height and weight restrictions would be helpful for applications such as truck permitting (NJDOT), resource allocation (NJDOT, NJ State Police, NJ Office of Homeland Security and Preparedness), diversion and evacuation routing, and others. Often height and weight restrictions can be stored as point locations in a separate data set since they are related to the presence of other features or conditions that impose these restrictions. These features/conditions that often

restrict height or weight include bridges, tunnels, under passes (e.g., railroad crossings), and toll booths.

4.6 Vintage/Timeliness

One of the most important issues for many applications, most importantly 911 dispatch/emergency response, is having the centerlines updated in a timely fashion to insure the completeness of the data set. The current update/release cycle of the TeleAtlas and NJDOT data sets (quarterly) is not sufficient to meet the needs of many users. It is not guaranteed that new roads will be present in an upcoming quarterly update with either data set. For example, if a new road is privately maintained, it will not be added to the NJDOT data set. Moreover, given the level of effort of maintaining the TeleAtlas data on a nationwide basis, it may take several update cycles for new roads to appear in this data set. The insufficient timeliness of updates to both data sets is one of the primary reasons that counties as well as other agencies are compelled to maintain centerline data of their own.

According to the county 911 coordinators, and NJ State Police, timeliness of data updates is even more critical for 911 dispatch operations. Since accidents and emergencies can occur in areas where roads are brand new, requiring the dispatch of police, fire, or ambulance services, they require that new roads and address ranges be available in their computer aided dispatch systems immediately. In fact, it is desirable for new roads and addresses to be integrated into their dispatch systems **prior** to construction (e.g., upon approval of a subdivision plan) so that once construction commences, they already have a record of the new road in their system and can effectively dispatch emergency services early in the construction phase if necessary.

It was important to nearly all stakeholders that a statewide centerline data set would be maintained in such as way that the custodians could be informed of new roads and addresses very early in the process so that they could be integrated into the data set immediately and provide these updates to the end users in a timely fashion.

Emergency dispatch operations are clearly one of the most mission critical applications for a centerline data set. Since a business process is already in place to provide 911 centers with updates for the dispatch systems, it is clear that leveraging these existing business processes is a key element in transferring change notifications from the local to the state level. In short, aligning the maintenance workflow with the existing 911 business processes will be critical to a successful statewide centerline program.

4.7 Linear Referencing

The linear referencing system (LRS) that is integrated with the NJDOT centerline data set is an important component and is widely used both within NJDOT and a large number of stakeholders. The TeleAtlas data does not have any linear referencing data.

Users perform milepost based geocoding (e.g., accident locations) using the NJDOT LRS as well as maintain and use dynamically segmented attributes based on the LRS (e.g., speed limits). The

LRS is clearly an important component which must be available in a statewide road centerline data set.

However, as mentioned in an earlier section, the stakeholders raised the issue that the physical milepost signs along highways do not always correspond with LRS measurements. There are several potential reasons for this, the most significant of which is that the milepost signs on secondary direction roadways of divided highways are installed to match the signs on the primary direction roadway (rather than being placed by measurements along the secondary roadway). However, the LRS values in the centerline data set are calculated based on the actual distance along the primary and secondary centerline representations (which can be quite different). In fact, as noted earlier, the NJ State Police illustrated examples where the mismatch between the LRS and physical milepost placement was nearly a half mile, which can cause issues when analyzing crash locations for mitigation efforts and can also cause confusion with jurisdiction when dispatching emergency services. It is important to note that the mismatch is the result of a policy issue and is not an error in the LRS. User education and perhaps some system redesign are necessary to mitigate this issue, since the discrepancy can lead to erroneous results if users are unaware of this issue.

4.8 Routing Attributes

The majority of stakeholders do not currently conduct routing, but many were interested in performing routing in the future if a data set is available. Routing applications of interest included evacuation planning/routing (NJ State Police, NJ Office of Homeland Security and Preparedness and counties), traffic diversion routing (NJ Turnpike Authority), drive time analysis (NJ State Police), resource allocation (NJ State Police, NJ Office of Homeland Security and Preparedness, NJDOT), traffic modeling and flow analysis (Port Authority of NY & NJ, NJ Turnpike Authority, SJTPO, NJTPA, NJDOT), and trucking and freight movement (NJDOT). The routing attributes that would be required to support this would include turn restrictions, one way streets, and impedances such as speed limits and height or weight restrictions.

The TeleAtlas data contains the attributes necessary to perform routing, while the NJDOT data set does not. NJ OGIS provides a web service for statewide routing using an ArcIMS Route Server engine, which utilizes the TeleAtlas centerline data as the base map. Very few stakeholders currently take advantage of this. The NJ Turnpike Authority is currently looking into a web based application that can route (divert) people around major accident locations.

4.9 Segmentation

All stakeholders were in agreement that a statewide centerline data set would be required to have roads segmented at every intersection, in addition to changes in road name, municipality and ZIP code. The TeleAtlas data are currently segmented in this manner; however, the NJDOT data set is not.

4.10 Related Features

When discussing requirements of a road centerline data set, many related features (those that have a topological/connectivity relationship with roads) were identified as being important for many applications. Having a comprehensive, statewide data set of these features would significantly enhance the value of a road centerline data set for many stakeholders. These additional feature data sets include the following:

Bridges

Many stakeholders identified bridges as being an important feature to compliment a statewide road centerline file. It was noted by NJDOT, that they have point locations for bridges with reliable attributes; however, the spatial accuracy of the points is unknown. Additionally, not all bridges in the state are available in the data set. Having a comprehensive, reliable bridge data set for the entire state would be an important component for many stakeholders. As mentioned previously, having height and weight restrictions associated with bridges would be an important attribute for many applications. Additional attributes such as whether over- or underpasses exist at road intersections could also be added to a related table.

Rail Crossings

Several groups within NJDOT (RR Engineering, Trucking Services, Office of Emergency Management, etc.) requested that railroad crossings would be a feature that would compliment a statewide road centerline file and assist many applications. The railroad engineering group is currently capturing all public "at grade" crossings using handheld GPS, having captured approximately 900 out of 1,600 within the state. The remainder of the state is estimated to be completed by the end of 2008. This data set will be important for many applications including resource allocation, traffic diversions, truck routing and general map production. To have the maximum impact, this data should ideally be geographically aligned with the geometry of the road centerlines.

Toll Booth Locations

A number of stakeholders, including the New Jersey Turnpike Authority, NJ State Police and NJ Office of Homeland Security and Preparedness identified toll booth locations as a related feature that is needed due to the effect of traffic flow, as well as height restrictions. Understanding the locations of toll booths can assist in resource allocations during emergencies when large vehicles or vehicles carrying large equipment are being deployed to various locations across the state. These large vehicles and equipment often cannot fit through toll booths and need to be routed accordingly. Similarly, trucking and freight movement have similar constraints.

4.11 Other Requirements

Many stakeholders raised the issue that if a comprehensive centerline file was to be developed and maintained by the state, then they would expect that the state should document and convey a

series of standards on how to collect and organize data in the future to best support the maintenance of the new data set.

Additionally, the users indicated that if a single centerline file was developed, in addition to the creation and maintenance of the data set, a series of web services should be provided by the state to assist end users with common tasks such as geocoding, map display, and routing. For example, a single web service that could provide "multi-level" geocoding using either address matching or mileposts would be helpful, rather than the users needing to continually acquire the data set updates and configure locators in ArcGIS desktop.

5. Implementing a Statewide Road Centerline Data Set

Based on stakeholder responses, there is overwhelming agreement and support within the user community for a single, comprehensive road centerline data set for the state of New Jersey. Moreover, most of the requirements for centerline data described in the previous section are shared among many stakeholders, resulting in a significant amount of synergy and consensus.

The section that follows will outline a number of recommendations and potential strategies for implementing a statewide road centerline data set that addresses the requirements expressed by the stakeholders interviewed.

5.1 State Centerline Program Research

FSI conducted research into the road centerline programs in other states and found that in general, states have approached the concept of a statewide centerline data set in a variety of fashions. This section will provide a brief overview of the centerline programs in other states, while more detailed descriptions of each state can be found in Appendix B.

Several states such as Vermont, Maine, Kentucky and Wisconsin, have issues similar to New Jersey, in that they have a centerline data set developed by the state DOT that contains a linear referencing system and often focuses primarily on state and county roads. They also have a second centerline data set that contains local roads with address ranges that is used for address matching and mapping. Although these states have shown interest in moving towards a single centerline data set, and in many cases have initiated work groups to develop plans for future efforts, these states continue to maintain and use multiple centerline files.

A number of states including New York, Illinois, Massachusetts and Connecticut, have developed (or are in the process of developing) a single centerline data set by partnering with a commercial vendor (e.g., TeleAtlas or NavTEQ). The vendor is responsible for enhancing their commercial centerline file based on state-provided data such as linear referencing systems. The state then licenses the data and contracts the on-going maintenance efforts to the vendor.

Finally, states such as Montana, Arkansas and Kansas have followed an entirely different model, where they have created a comprehensive centerline data set by integrating and enhancing multiple input sources and maintain the data "in-house", without the assistance of a commercial data vendor. In these cases, the states retain ownership of the data, are responsible for the on-going maintenance, and do not pay annual license fees.

In short, many of the states researched have successfully implemented a single, statewide centerline data set. Moreover, states have had success with both a partnership with a commercial vendor, as well as developing and maintaining the data set "in-house". Given the successful implementations in other states using several different models, it is apparent that the implementation model selected within New Jersey can be based solely on the characteristics of the existing data sources and the needs and requirements of the stakeholders.

5.2 General Implementation Options

Prior to the requirements workshops, the FSI and state project team discussed potential options for the development and maintenance of a statewide centerline data set given the availability and status of existing data sets. Given the level of effort associated with developing a statewide data set, coupled with the limited availability of existing staff resources within both NJDOT and OGIS, it would be unrealistic to consider developing the data set in-house with existing resources. Therefore, an outside contractor would be required to develop the initial statewide data set. To this end, it was determined that if a single, statewide centerline data set was indeed feasible, the business model would likely fall into one of the following two general categories:

1. Contract with a commercial data vendor (i.e., TeleAtlas or NavTEQ) to make the required improvements and enhancements to their data set (e.g., add the LRS, improve spatial accuracy, increase alternate names, etc.), then continue to pay an ongoing license for the data set including maintenance costs (similar to the current license); or,

2. Contract with a consultant to make the required improvements and enhancements to the NJDOT data set and develop a business process and model for the on-going maintenance.

One of the initial requirements workshops was conducted with the Bureau of Transportation Data Development (BTDD) within the NJDOT. As mentioned earlier, the BTDD is responsible for maintaining the NJDOT road centerline data set. The NJDOT centerlines are maintained as part of the mandate from the FHWA to provide accurate mileage totals for each road classification to support and justify the level of federal funding received by the state.

It was immediately clear that BTDD could not entertain the possibility of using a different base map for the centerline geometry due to their federal mandate. The existing geometry of their centerline file is the basis for all mileage totals reported to the FHWA. Using a different centerline file such as TeleAtlas or NavTEQ, which is less accurate and would have significantly different mileages for each road type, would be unacceptable since federal funding is based on

these mileages. Accuracy in these mileage totals is extremely important to both NJDOT and FHWA. In addition to differences in centerline geometry and spatial accuracy, TeleAtlas classifies their roads differently and the distinction between a state and county road is not always clear. Having a clear and accurate breakdown between the road classifications is also extremely important to the FHWA.

Moreover, NJDOT expressed that they have approximately nine (9) other enterprise-wide information systems that heavily rely on the data structure of the NJDOT road centerline file and linear reference system, including the Straight Line Diagrams (SLD) and the Highway Performance Monitoring System (HPMS), which is a federally funded program.

Following the NJDOT requirements workshop, it was immediately apparent that the first implementation option of partnering with a commercial data vendor such as TeleAtlas to enhance their data set with the linear referencing system from NJDOT would not be feasible.

Rather, if the state were to move towards a single, comprehensive road centerline data set, it would clearly have to be based on enhancements to the existing NJDOT data set (option 2) such that there would be little or no impact on the existing data maintenance for the FHWA reporting, as well as no impact on the existing information systems that are based on the NJDOT road data.

Finally, BTDD indicated that it is open to adding privately maintained roads to the centerline data set and expanding their maintenance responsibilities, as long as the appropriate funding and staffing is in place to support these efforts.

5.3 Implementation Recommendations

Based upon the availability of the NJDOT road centerline data set and other data sets from which to draw upon, as well as the centerline maintenance program which is already in place within the BTDD, the creation and maintenance of a single, statewide road centerline data that can meet most of the requirements of the stakeholders is certainly feasible. However, with that said, it is anticipated that attempting to create and maintain a data set that includes the additional attributes required to support full automated routing (e.g., one way roads, turn restrictions, etc.) would be challenging and likely cost prohibitive. Routing attributes do not exist in publicly available data sets such as TIGER, and therefore the development of this component of the centerline data would prove costly. Additionally, attempting to maintain attributes such as turn restrictions at a statewide level would be difficult.

Automated routing (e.g., shortest path) is a fairly specialized network operation that is not currently conducted by many of the stakeholders. Moreover, the state already provides a routing web service to end users (based on the TeleAtlas data), that is currently used by NJDOT and others. It is recommended that the state simply continue to provide this web service which can likely serve most of the automated routing needs. It is further recommended that the state share the geography from the NJDOT centerline data set with TeleAtlas on a regular basis in an effort to improve the completeness and accuracy of the TeleAtlas data set on which the routing web

service would be based. If desired, the state could revisit the concept of adding routing attributes at a later date, as nothing would be done that would supersede the addition of routing attributes.

In summary, it is recommended that if the state wishes to pursue the development of a single, statewide road centerline data set that it contract with a consultant to make the required improvements and enhancements to the NJDOT data set (excluding routing attributes) and develop a business process and organizational model to support the on-going maintenance. The subsequent sections will outline further recommendations and a conceptual framework for implementing this approach.

6. Creating a Statewide Road Centerline Data Set

In creating a statewide centerline data set, there are many enhancements that will need to be performed on the existing NJDOT data set. Many of the enhancements will require the integration of other data sets. Due to the significant amount of effort required, it is recommended that the state hire a contractor to perform these enhancements in creating the centerline data set.

The subsections that follow will describe the major components required in developing a statewide road centerline data set by enhancing the existing NJDOT centerlines. The components described below are not intended to be a precise, step by step procedure, but rather a conceptual framework to provide general guidance.

6.1 Data Model Design

Prior to any enhancements being performed, it is important that the state review the existing data model for the NJDOT centerlines, as well as the requested enhancements set forth by the stakeholders and develop a data model for the new centerline data set. The data model will need to expand upon the existing data set to accommodate the new attributes required (e.g., address ranges). However, the new data model should minimize any impact on both the data maintenance for federal reporting requirements, as well as the existing NJDOT information systems that are based upon the centerline data.

In reviewing the requested enhancements, the state will need to select those attributes that will be included in the initial data set and those that will not. It is recommended that the attributes to be added be limited to those listed in the section entitled **Core Attributes**. The attributes in the section **Additional Attributes** are not critical to most applications and would be challenging and costly to be added for the entire state. However, the data model should be designed such that users can integrate these and other additional attributes for specific geographic areas as needed using related tables.

Although routing would not be supported in the initial data set, it would likely be beneficial to include fields for routing attributes such as turn restrictions and one-way streets in the data model for potential use in the future. This would provide a “placeholder” for routing fields that

would allow a County to populate the fields to accommodate routing, as well as allow the state to expand into routing in the future if desired.

Once the enhancements and attributes to be included in the centerline product are selected, the state can design a physical data model that will accommodate these enhancements, while minimizing the impacts on NJDOT as described earlier. It is recommended that the data model contain a unique segment id attribute that will never change similar to the Dynamap_Id field in the TeleAtlas data. This field can be used to uniquely identify each segment (intersection to intersection) in the centerline file, allowing end users to develop and maintain additional "static" attributes for each segment for their geographic area based on this known feature identifier.

The SRI numbering standard should be extended to allow the designation of privately maintained roads. Additionally, the linear referencing system will inherently allow users to develop and maintain additional "dynamic" attributes based on measurements along routes.

By publishing the data model and the standards surrounding the centerline data set, end users will have the flexibility of adding additional attributes (both static for physical segments, and dynamic based on the LRS measures) in related tables for their geographic areas of interest.

6.2 Segmenting Centerlines

Since NJDOT centerlines are not segmented at intersections or at other feature changes, the roads will need to be split at real world intersections, ZIP code boundary changes, and municipal boundary changes. This more refined physical segmentation is required to extend the attributes with data such as address ranges and ZIP code on the left and right side of the road which are tagged to each physical segment.

Since the data set will not be used for routing, the state can leave the data fully segmented at every intersection described above, regardless of whether the roads physically intersect in the real world. In fact, since the TIGER data (from which the address attributes will be conflated) is also fully segmented, it is ideal to fully segment the NJDOT roads prior to conflation. This will cause the data sets to be segmented similarly, allowing a higher success rate with automatic conflation.

However, if in the future, the state were to move towards using the centerlines for routing purposes, any segmentation that occurs at a point where the roads do not physically intersect, should be removed and the centerlines should be merged. For example, to model the real world properly, either the overlapping centerlines should <u>not</u> be split in the cases of overpasses, underpasses, and ramps that result in multiple levels of roadway, or if left fully segmented, the centerlines can be tagged with attributes that designate turn restrictions in cases where traffic cannot flow from one road to another due to overpasses/underpasses.

The segmentation of the NJDOT centerlines will be required to be conducted as one of the initial steps, such that address ranges and postal codes can be conflated from other data sources in subsequent processing.

6.3 Adding Private Roads

In order to complete the NJDOT centerlines, the privately maintained (but publicly traveled) roads must be added. While the TeleAtlas data cannot be used as a source due to the licensing restrictions, there are several data sources from which private roads can be added. The graphic below illustrates an area of Hunterdon County where private roads (blue) would need to be added to the NJDOT road centerline data (red).

First, for those counties that maintain centerlines, the county data will represent an important option. However, it should be noted that while some county centerlines will represent the best available geography, especially for those with GPS derived roads (e.g., Hunterdon, Burlington), many will not have address range data, and therefore will need to have address ranges conflated from another source similar to the existing NJDOT centerlines. Therefore, the private roads should be added prior to conflation of additional attributes.

A second source for private roads is the latest TIGER data from the US Census Bureau. The Census Bureau recently completed a major modification to TIGER, creating a new data product called the Master Address File (MAF)/TIGER files, or TIGER 2007. The TIGER 2007 data has improved geometry and attributes. Moreover, another release of TIGER is scheduled within the next year to eighteen months. This next release will be based on the integration of the updated address information compiled by the Census Bureau during the recent local update of census address (LUCA) efforts for the 2010 census. While the geometry will not be altered significantly, the address ranges will be updated based on the latest information provided by the municipalities and counties throughout the country. While the existing TIGER 2007 files would be adequate to use for this project, depending on the timing of the states efforts, it is possible that the post LUCA TIGER data could be used.

A final source for private roads would be the statewide orthophotography. Private roads that are not present in any available centerline data set (i.e., County data, TIGER 2007) could be heads-up digitized using the orthophotos as a visual backdrop.

It is recommended that the state evaluate the available centerline data sources for each county to determine which provides the best source for adding the private roads. The selected source file should then be analyzed to determine which roads will be added and those attributes that will be transferred to the master centerline data set. When adding the roads, it is important for the final geometry to be as spatially accurate and topologically correct as the existing centerlines in the NJDOT data set. Therefore, as part of this process, it is recommended that the centerlines that are added be aligned to the high resolution orthophotography. While the geometry of some of the county data will likely require little alignment, those counties where TIGER 2007 is used as the source for the private roads, are likely to require significant re-alignment. Additionally, great care should be taken when adding the roads to insure proper connectivity to the existing NJDOT centerlines in an effort to maintain the topological integrity of the data set. As a final part of this process, once the private roads have been added, SRI numbers will need to be assigned to these roads as necessary.

There are currently 41,045 linear miles of centerlines in the NJDOT data, while the TeleAtlas data for the entire state contains 50,435 miles. Therefore, it appears that there could be as many as 9,000 miles of private roads that need to be added. While this figure will be used as a conservative estimate throughout the remainder of this report, it is likely an overestimate based on an analysis of the centerlines included in the TeleAtlas data set. More specifically, the TeleAtlas data includes approximately 2,200 miles of unnamed roads, as well as many segments with inconsistent feature classifications such as “driveways” and many miles of segments that are not road centerlines such as ferry crossings.

6.4 Conflation/Attribute Population

Once the private roads have been added, the road names, address ranges and postal codes will need to be added to the master centerline data set. Depending on the process used for adding private roads, it is possible that the names and address ranges will have been transferred with the geometry for those private roads added from a TIGER 2007 source. However, for the majority of the state, the public road names and address ranges will need to be conflated from TIGER 2007. It is anticipated that a significant portion of the state can be conflated in an automated fashion, while the remainder of the state will require operator-assisted conflation.

However, as described in the section above, there may be as many as 4,500 of the estimated 9,000 miles of private roads that will be added by heads-up digitizing from the statewide orthophotos. For these roads, there will be no corresponding segments in the TIGER data set from which to conflate attributes. Therefore, in this case, an additional step will be required to manually enter attributes such as road name, address ranges and ZIP code, rather than conflating from the TIGER data set. These attributes will be determined using other reference data sets such as ZIP code boundaries, tax parcel boundaries and assessment data, postal data, and E911 databases.

6.5 Primary and Alternate Road Names

When the road names and address ranges are conflated from the TIGER 2007 centerlines, there will be an opportunity to employ a technique to add alternate names to the master centerline file when the primary name in the master centerline file does not match TIGER 2007. For example, if the existing road name in the NJDOT centerlines is "County Hwy 623" but the road name conflated from TIGER 2007 is "Brass Castle Road", then the TIGER road name can be stored in an alternate name field(s). Additionally, this will also present an opportunity to swap the primary name and alternate name to address the issue that was raised by many stakeholders that the state or county route number is typically the primary name rather than the local name. In the above example, this would allow "Brass Castle Road" to be swapped as the primary name, while "County Hwy 623" is stored as an alternate name. Finally, the names can be standardized as well during this process.

The NJDOT database currently includes a related table containing alternate names that are based on dynamic segmentation (using the LRS) since the roads are not segmented at each intersection. This table can likely be used as an additional source for assigning primary and alternate road names.

It is important to note that the primary name and alternate name(s) will likely need to be stored in separate fields from the "DOT Road Name", which should likely remain as its original value from the NJDOT centerline attributes. This will allow new road names to be used by other users, yet not disrupt the original NJDOT attributes on which their federal reporting and enterprise information systems are based.

6.6 Neighboring Counties

As described in an earlier section, the current TeleAtlas license includes data for the seventeen counties immediately surrounding New Jersey. These counties are from the states of New York, Delaware and Pennsylvania. Many stakeholders have expressed the need for these neighboring counties. Therefore, if the state proceeds with the development of a statewide centerline data set, it will need to continue to provide centerline data for these neighboring counties to the end users within the state.

It is recommended that the state select the best data available for each county and arrange a partnership with the custodian organizations to acquire the data and make it available to the end users within New Jersey. This likely can be done through a data cooperative arrangement for little or no cost. For example, eight (8) of the seventeen (17) counties are from New York State, which has statewide centerlines readily available as the "New York Streets and Address Database" (formerly called ALIS). Additional resources include the DVRPC, PennDOT and the counties themselves. For those counties in which the primary centerline data in use is a commercial source such as TeleAtlas (e.g., Delaware), then TIGER 2007 data can be used.

In general, the NJ OGIS can take the lead on working on agreements to collect and redistribute the data (with documentation) for these 17 counties. This will allow the state to provide the NJ statewide centerline data set as two components: NJ centerlines and the neighboring counties.

6.7 Pilot Project

As a means of evaluating the enhancements made to the NJDOT centerlines, identifying any issues with the input data sources, defining the specific data processing procedures, as well as to more precisely define the cost for performing the enhancements on the entire state, it is recommended that the state engage a contractor to perform a pilot project. Once the data model has been established by the state, a pilot project could be conducted in which a contractor defines a methodology and performs the enhancements to the NJDOT centerlines as described in the sections above for several municipalities.

It is recommended that the study area for the pilot project include between 3 - 5 municipalities that total approximately 1,500 miles of roadway. The selected municipalities should contain, in total, a reasonable sample of each of the major road types within the state (e.g., NJ Turnpike, Garden State Parkway, county roads, local roads, private roads, airports, shopping malls, etc.). Also, the study area for the pilot project should include at least one municipality from a county that has an existing centerline data set (e.g., Hunterdon, Burlington) from which the private roads are added, and at least one municipality from a county that does not have an existing centerline data set (where private roads will be added exclusively from TIGER 2007 data). Finally, for those municipalities in the study area where TIGER data will be used, the study area should include areas where the TIGER data appears to align very well with the existing NJDOT centerlines, and areas where the TIGER data does not align as well.

6.8 Review and Refine LRS

Optionally, OGIS may wish to work with NJDOT to review the issues that stakeholders raised regarding the existing linear referencing system. Any potential adjustments that need to be made to the LRS can be reviewed at this time.

7. Maintaining a Statewide Road Centerline Data Set

Developing the statewide centerline data set as described above, while challenging, represents a one-time effort and cost. The long term value and success of this data set will be entirely dependent on a successful maintenance program. It is critical that a maintenance program insure that changes and additions to the road infrastructure are effectively communicated to the state in a timely manner, and that an organizational structure and business process is employed that allows the modifications to be processed efficiently. In short, an effective maintenance program will insure that the centerline data are up-to-date, allowing end users to have confidence in the data, recognize the value, and in turn continue to contribute to the maintenance process.

7.1 Organizational Structure and Business Process

Maintaining a statewide centerline data set will clearly require more resources at the state level. It is recommended that the maintenance efforts be a joint effort between BTDD and OGIS. BTDD should continue to be responsible for capturing new roads (via GPS), adding the roads to the data set, QA/QC, assigning the NJDOT core attributes required for federal reporting requirements, and integrating the roads into the linear referencing system. This responsibility will now be expanded to include private roads. A funding source must be identified to cover the additional cost of maintaining private roads.

OGIS would be responsible for maintaining the extended attributes (e.g., address ranges, postal codes, road names, alternate names) for all roads in the state. OGIS would require a dedicated staff person in the role of a maintenance coordinator to serve as the liaison with the county 911 coordinators and other local officials providing change requests, to manage the required changes and additions to the centerline data, and to coordinate all processing with BTDD. It is important to note that this entire effort is dependent on having an experienced candidate in the maintenance coordinator position. This position will work closely with the stakeholders throughout the state to insure that the required changes are effectively communicated, received, reviewed and implemented, resulting in a timely and accurate data set.

Perhaps the most important factor in keeping the road centerline data set up-to-date is simply being aware of changes and additions to roads and addresses. It is critical to have one or more mechanisms in place to be informed of these changes in the real world. It became apparent early in the requirements workshops that the county 911 programs are essentially already responsible for capturing (and recording) new roads and addresses. Therefore, it is important to align the notification process for the centerline management program as closely to the 911 programs as possible.

Burlington County has a unique and robust 911 program in place in which the municipalities are mandated to submit road and address changes to the county 911 coordinator. The legislation can be found at the following URL:

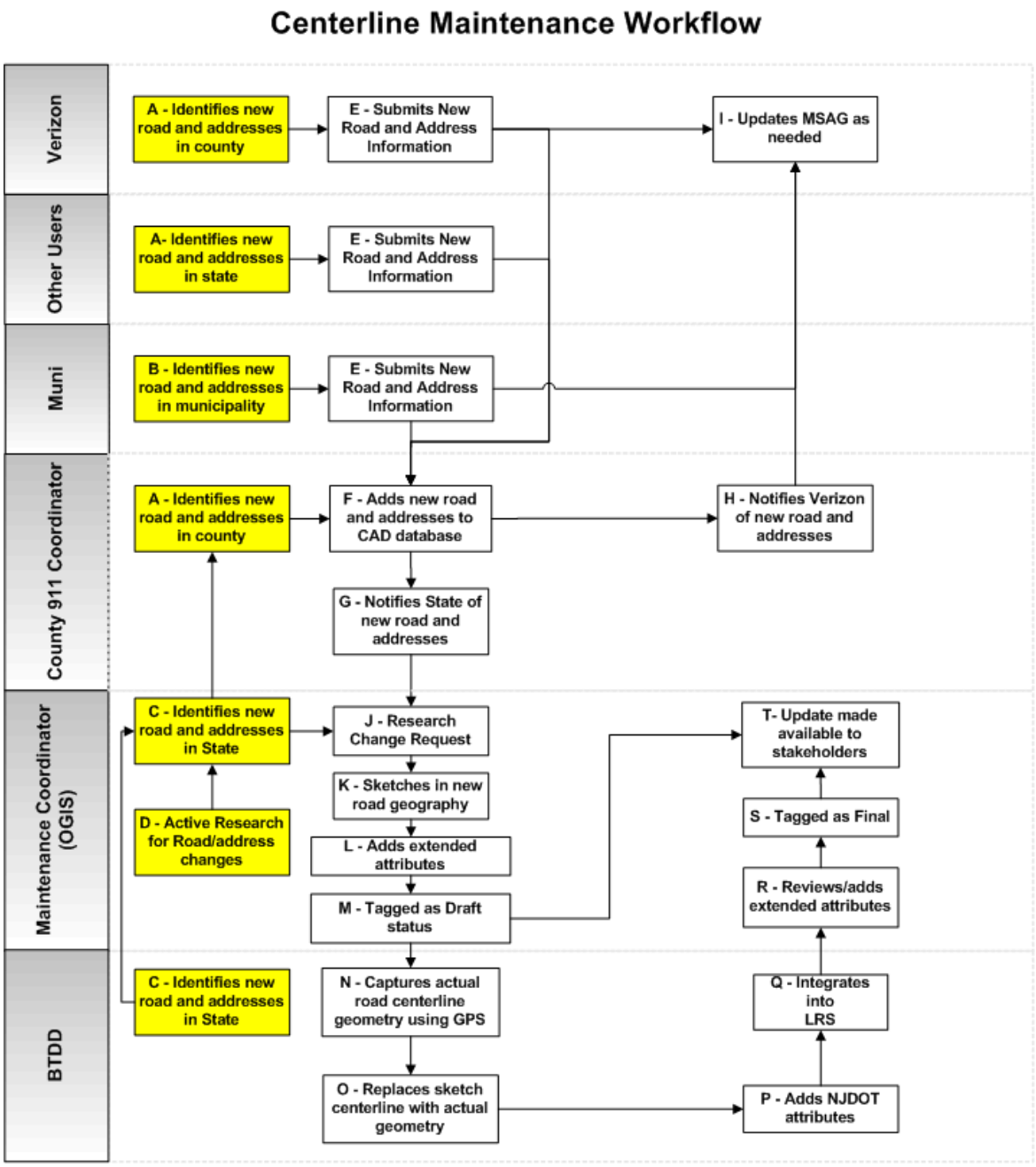
http://www.co.burlington.nj.us/departments/public_safety/communications/addressinglaw/law.doc.

Unfortunately, this is not the case with other counties who must have a much more proactive role in learning about road and address changes for their 911 programs. While it is understood that New Jersey is a “home rule” state, where it is difficult to mandate actions for the municipalities, the state would be well served in a road centerline maintenance program to put a business process in place that is as close to the mandate and workflow employed in Burlington County as possible. This business process is highly successful, and would insure that all changes are effectively communicated to the state using an existing workflow.

Once the data set is completed, it is recommended that State hold one or more workshops with county and local governments to educate them on the format and specifications of the new data

set and assist them in understanding their role in providing feedback and information in support of the maintenance.

In the future, another strategy for change detection that can be employed is to query the assessor databases (e.g., MODIV and PAMS) on a regular basis to identify new developments which will yield new roads and addresses. The diagram below outlines the basic workflow associated with the maintenance of the centerline data set, followed by a brief narrative of each step in the workflow.



A – Identifies new road and addresses in county
The organization/individual identifies either a new road or a new address within their county, and needs to notify the appropriate party.

B – Identifies new road and addresses in municipality
The organization/individual identifies either a new road or a new address within their municipality, and needs to notify the appropriate party.

C – Identifies new road and addresses in state
The state identifies either a new road or a new address within the state, and needs to notify the appropriate party.

D – Active research for road/address changes
The maintenance coordinator will continually conduct research to identify potential new roads and addresses.

E – Submits new road and address information
Once a change to a road or address is identified, the organization/individual submits the new information to the appropriate party.

F – Adds new road and addresses to dispatch database
When a new road or address is received by the county 911 coordinator, the computer-aided dispatch database is updated with the change.

G – Notifies state of new road and addresses
Once the dispatch database is updated, the county 911 coordinator will notify the state maintenance coordinator of the new road and address.

H – Notifies Verizon of new road and addresses
Once the dispatch database is updated, the county 911 coordinator will notify Verizon (if necessary) of the new road and address.

I – Update MSAG as needed
Verizon will update the master street address guide (MSAG) with any incoming address changes as needed.

J – Research Change Request
When a new road or address (or modification) request is submitted to the maintenance coordinator, the request will be researched to validate that the change is correct, and to determine the precise addition/modification to the data set that needs to be performed. If the request is deemed to be invalid, the request will be rejected and the submitter will be notified.

K – Sketches in new geography
When a new road or geographic modification to an existing road is submitted, the maintenance coordinator will add the new centerline geography as a “sketch” in draft form. Although it will

be deemed a draft sketch, the geography will be digitized as accurately as possible from all available source documents and resources.

L – Add Extended Attributes
Once the draft sketch of the new road or modification is added to the centerline data set, the road(s) will be attributed with the extended attributes that will be managed by OGIS such as road name, address ranges, etc. Any of the core attributes and LRS data maintained by NJDOT for federal reporting will NOT be added at this time.

M – Tagged as Draft Status
The new or modified road centerlines will be initially tagged with an attribute indicating draft status.

N – Capture Actual Road Centerline geometry using GPS
After the new centerlines have been added as "Draft" status, NJDOT BTDD staff will then initiate the formal capture of the actual road centerline geometry using GPS as part of their core business process.

O – Replace Sketch Centerline with Actual Geometry
Once the actual centerline geometry has been captured in the field with GPS, the BTDD staff will integrate the GPS derived centerline into the data set, replacing the draft centerline.

P – Adds NJDOT Attributes
All core NJDOT attributes required for federal reporting will be added at this point (SRI, Route Subtype, etc.)

Q – Integrates into LRS
The new/modified roads will then be integrated into the linear referencing system with the appropriate measures.

R – Reviews/Adds Extended Attributes
After the BTDD staff has added the actual GPS derived geometry of the roads, added the core attributes and integrated the road into the LRS, the maintenance coordinator will review the roads and their extended attributes added in process (I) and make any necessary attribute modifications.

S – Tagged as Final
Once the road geometry and attributes have been reviewed and approved by the maintenance coordinator, the roads are updated from "Draft" to "Final" status.

T –Update Made Available to Stakeholders
Once new roads have been added as either "Draft" or "Final", an updated centerline data set will be made available to the stakeholders with these latest revisions.

8. Additional Implementation Strategies

The previous sections set forth a framework for the development and maintenance of a statewide road centerline data set. However, it is important to note that there are several additional implementation strategies that are recommended to maximize the utility and value of a statewide centerline data set.

8.1 Statewide Web Services

The state already provides a number of web services including a routing service (as previously mentioned) and a number of map services (including a service specific to the display of road centerlines). It is recommended that the state continue to expand its web service offerings. Many stakeholders requested that in addition to managing and providing a statewide centerline file, that the NJ OGIS should provide additional web services associated with the centerlines to maximize the utility of the data set. To this end, it is recommended that the state continue to offer the existing routing service as well as a service for map display of road centerlines and offer a geocoding service as described below.

Geocoding Web Service

This web service would allow end users to geocode a single address, or batch of addresses against the statewide road centerline file. The service would allow the user to either; enter a single address, and receive a single x/y coordinate as a result, or upload a table of addresses and return a table containing additional fields with the coordinates for each row. Additionally, this web service would also allow the user to geocode using mileposts against the linear referencing system, returning one or more x/y coordinates in a similar fashion. This web service would provide a single geocoding service that is capable of both address matching and milepost geocoding using the LRS.

8.2 Standards for Data Capture and Management

Arkansas has developed a robust series of published standards for capturing and maintaining data. It is recommended that the state also publish a set of standards for developing and maintaining centerline related data. These standards would be based upon the data model of the centerline data set and would guide counties and municipalities in areas such as capturing and storing additional attributes in related tables (both static as well as dynamically segmented attributes). These standards can also discuss the state maintenance procedures and the roles that municipalities and counties are expected to play in providing updated information to the state. These standards and any additional documentation should be utilized as a means for building a partnership with the New Jersey GIS community in the maintenance and usage of the statewide centerline data set.

8.3 Coordinating with the Census Bureau

As mentioned earlier, the NJDOT centerline data set has a high degree of spatial accuracy, and vertically aligns with the new municipal boundary data set developed by OGIS. However, since

the census boundaries (blocks, block groups and tracts) are based on the TIGER files, they do not align with the NJDOT roads. There are several stakeholders such as the NJ Turnpike Authority that utilize census data for transportation planning and would benefit greatly if the statewide road centerline data set aligned with the census boundaries. Therefore, as part of the on-going maintenance program, it is recommended that OGIS coordinate with the US Census Bureau to provide regular updates of the centerline data set such that the Census Bureau can integrate the geography into all of their data sets. This will allow the Census Bureau to ultimately align the census boundaries and other data sets with the New Jersey statewide road centerline data.

9. Quantitative Analysis

This section provides a quantitative analysis of the estimated costs and benefits of implementing a statewide road data set. It is important to note that the figures presented in this analysis are general estimates to be used as an initial comparison. It is highly recommended that the state engage a consultant to perform a pilot project. The pilot project will not only result in a better understanding of the required workflow, techniques and issues, but it will assist the state in arriving at more detailed cost estimates, from which budgetary decisions can be made.

9.1 Estimated Costs

The costs associated with implementing a statewide road centerline data set can be generally categorized into the one-time costs of enhancing the NJDOT road data set, and the on-going costs of maintaining the data set. The subsections below outline the estimated costs for each category.

9.1.1 Enhancing the NJDOT Centerlines

The costs of enhancing the NJDOT data set are estimated below for the major tasks described in Section 6. The cost estimates were based on an hourly rate of $60, which was the highest rate for the *GIS Data Conversion* line item on the New Jersey State Contract. If a contractor with a lower hourly rate is ultimately selected, the costs below will decrease accordingly.

Segmenting Centerlines

Road centerlines will need to be split at real world intersections, ZIP code boundary changes, and municipal boundary changes such that the roads can be properly attributed with address ranges, names and ZIP codes. This will need to be one of the first tasks conducted, since adding private roads and conflation of attributes from TIGER data will require proper segmentation.

This task can be done in a fully automated manner. Since this data set will not be used for routing, full segmentation can be applied, without consideration given to overpasses and underpasses where the roads do not physically intersect in the real world. Therefore, the cost of this task assumes full, automated segmentation. A very conservative estimate would be 80 person hours (it is highly likely this task would take less effort). Based on a $60 hourly rate, this task is estimated at approximately $5,000 (rounded from $4,800).

Adding Private Roads

As stated in an earlier section, based on the difference in mileage between the TeleAtlas roads and the NJDOT roads, there appear to be as many as 9,000 miles of private roads to be added to the NJDOT data set. Once again, based on an analysis of the TeleAtlas data, this is likely an overestimate, however, in an effort to arrive at a conservative estimate for budgeting purposes, the 9,000 mile figure will be used. It is estimated that private roads can be identified, added to the NJDOT data set with the proper topological connectivity to existing centerlines, aligned to the underlying orthophotography, assigned an SRI number and LRS measure at the rate of approximately 30 minutes per road mile. At this rate, it will take 270,000 minutes (30 x 9,000), or 2,250 hours (270,000/60) to complete. At a rate of $60 per hour, this results in a total cost of $270,000.

Since TIGER 2007 contains approximately 4,500 more miles than the NJDOT data set, it is anticipated that approximately half of the 9,000 miles of private roads can be added from centerlines in the TIGER 2007 or County road data sets. Therefore, the other half of the private roads to be added (4,500 miles) will likely need to be heads up digitized from the orthophotos.

Conflation/Attribute Population

One of the most time consuming tasks will be to populate key attributes (address ranges, road names, ZIP codes) for all roads in the NJDOT centerline data set. The primary task in this process will be to conflate the attributes from the TIGER 2007 centerline data set to the NJDOT centerline data set. The conflation task will need to be performed on the entire state. Therefore, using the total mileage of the TIGER 2007 centerlines, estimates of the conflation task will be based on approximately 45,000 miles.

Conflation is a time intensive process when performed manually, and therefore it is desirable to conflate as much of the study area as possible using an automated routine. Automated routines can do a very high percentage of the study area when the data sets are segmented in a similar fashion, and align well spatially. If the NJDOT centerlines are fully segmented as described above, such that they match the segmentation of the TIGER data, given the reasonable spatial alignment, it is estimated that an automated routine will be able to conflate the attributes for approximately 80% of the state (36,000 of the 45,000 miles). Therefore, operator-assisted (manual) conflation would need to be performed on approximately 20%, of the state, or 9,000 miles of centerlines. While it is difficult to estimate work rates for manual conflation, due to the wide variety of issues that arise, based on previous experience and results in other states, a rate of 30 minutes per linear mile is reasonable. Based on an estimate of 9,000 miles, at an average of 30 minutes per mile, conflation will require 270,000 minutes, or 4,500 hours to complete. At the rate of $60/hr, this results in a cost of $270,000.

As mentioned above, half of the private roads to be added (4,500 miles) will be created by heads-up digitizing from the statewide orthophotos. These roads will not have corresponding centerlines in the TIGER data set from which to conflate. Therefore, road names, address ranges and ZIP codes will have to be manually entered for these road centerlines. Using a similar rate of 30 minutes per mile as a general calculation, this manual attribute entry will require 135,000 minutes or 2,250 hours to complete. At the rate of $60/hr, this results in a cost of $135,000.

Therefore, the total cost to attribute the entire centerline data set based on both conflation and manual attribute population is $405,000 ($270,000 + $135,000).

Primary/Alternate Names

Once the road names have been conflated from the TIGER data, the state will have an opportunity to standardize road names, add alternate names, and swap the primary and alternate names for those where the NJDOT name is different from the TIGER name. This task is primarily a database manipulation task, and will likely require the development of scripts to be executed against the attribute tables to resolve these issues. Therefore, this task is estimated as a general level of effort for a contractor to analyze the existing NJDOT road names with respect to the conflated road names (from TIGER), and to develop of a series of scripts to perform the desired field standardizations and manipulations. This task is estimated at approximately $50,000.

Quality Assurance/Quality Control

In addition to the above major tasks that will need to be performed, there will be a significant amount of quality assurance and quality control (QA/QC) required throughout the project. Additionally, there are likely to be minor miscellaneous tasks that arise during processing that require effort. It is difficult to estimate the amount of QA/QC required, however, given the number of hours allocated for the two major operator-assisted tasks, using a ratio of approximately 25% of these hours is reasonable. Therefore, an estimate of 1,500 hours is allocated for QA/QC efforts throughout the data enhancement project. At a rate of $60/hr, this results in an estimate of $90,000 for QA/QC.

Pilot Project

As described earlier, it is highly recommended that the state hire a contractor to conduct a pilot project prior to full implementation. The pilot project would allow a contractor to assist the state in defining methodologies and techniques for performing the enhancements to the NJDOT centerlines as outlined above. Assuming that the study area contains approximately 1,500 miles of roadway, it is estimated that the pilot project would cost $150,000. The vast majority of this cost (80%) would be in the design and development of techniques and tools for performing the enhancements to the data. The actual amount of operator-assisted time required to process 1,500 miles of roadway using the metrics outlined above would be less than $30,000. It should be noted that this estimate is based on a typical hourly rate for a senior GIS consultant for the design and development efforts, rather than the hourly rate for GIS data conversion services used in the tasks above.

Upfront Cost Summary

The table below provides a summary of the estimated one-time costs associated with enhancing the NJDOT road data set (including the pilot project). As shown below, the total cost of this effort is estimated at $970,000.

Segmentation	$5,000
Adding Private Roads	$270,000

Conflation/Attribute Population	$405,000
Primary/Alternate Names	$50,000
QA/QC	$90,000
Pilot Project	$150,000
Total	**$970,000**

9.1.2 Maintenance Costs

As previously described, it is recommended that the maintenance program for a single road centerline data set be a joint effort between NJDOT BTDD and NJOIT OGIS. In this business model, BTDD would continue their data maintenance practices. However, their responsibility will now be expanded to include private roads.

BTDD updates approximately 1,500 miles of road centerlines each year at a cost of $158.59 per mile. This cost includes field data collection of all public roadway attributes, post-processing of collected data, GIS mapping updates, data validation, QA/QC, and data base management. Therefore, the current annual cost of updating the NJDOT data set is approximately $237,885.

However, it is important to note that NJDOT BTDD will NOT be responsible for re-inventorying existing private roads. Rather, the only additional responsibility for BTDD will be to add new private road geometry. Based on the annual road mileage reports provided by NJDOT, the average annual increase in road mileage within the State from 2004 – 2007 is 187 miles. Since private roads appear to represent approximately 20% of the mileage, applying this percentage to the 187 miles of new roadway results in an estimate of 37 miles of private roads to be added to the data set each year (on average). At the rate of $158.59 per mile, this results in an additional cost of $5,947.12 to BTDD each year.

Additionally, OGIS would require a dedicated staff person in the role of a maintenance coordinator. This position would be responsible for managing the changes and additions to the centerline data for OGIS, and updating the extended attributes of the road centerlines (address ranges, alternate names, ZIP codes, etc.). This staff member would also serve as the liaison with the county 911 coordinators and other local officials, and coordinate all data processing with BTDD. An estimate of the total annual cost of salary and benefits for this position is approximately $100,000.

The table below lists the total annual estimated cost increase associated with an in-house maintenance program.

Adding Private Road Update Responsibility to BTDD	$6,000 (rounded up)
Maintenance Coordinator Position at OGIS	$100,000
Total	**$106,000**

9.1.3 Cost/Benefit Summary

The state currently pays an annual fee of $413,500 to license a statewide centerline file from TeleAtlas. The license fee does not provide the state with ownership of the data. Rather, it only provides the state with a license to use the data, and to receive updates for a single year.

The upfront costs of enhancing the NJDOT data set are estimated at approximately $970,000. The increase in annual maintenance costs associated with the new staff member within OGIS to serve as the road maintenance coordinator, as well as the additional funding required for NJDOT to maintain private roads is estimated at $106,000 per year. Once the new statewide road centerline data set is completed, the state could discontinue the license with TeleAtlas, resulting in annual savings of approximately $307,000. This would allow the state to recapture the initial upfront investment in approximately 3 years, after which the $307,000 in savings would be fully realized each and every year.

Some of this potential savings represents expenditures that are currently made from federal funding sources. In the first years of the TeleAtlas site license, the full cost was paid from federal homeland security funds. More recently, the cost has been shared between the federal homeland security funds and state funds through NJOIT Office of Emergency Telecommunications Services. For the fiscal year 2009 renewal of the license, federal funds covered approximately 40% of the total. It is unclear whether federal funds could be used to support an in-house data maintenance program. In any case, some of the $307,000 estimated savings would be from federal sources.

It should be noted that if the TeleAtlas license is discontinued, the existing routing applications, although not pervasive, would require modifications. First, the current ArcIMS Route Server applications which are now based on the TeleAtlas data pack, would likely utilize the standard ESRI provided data which should be sufficient. Any desktop GIS routing that uses the TeleAtlas data would require an alternative solution to continue, such as utilizing an ArcGIS Online service, or an ArcGIS Server solution.

From a quantitative perspective, implementing and maintaining a statewide road centerline data set represents an excellent return on investment. However, in addition to the quantitative benefits, there are many additional benefits to be realized if a statewide road centerline data set is implemented. The state will own the data set, and therefore have greater control over the content and accuracy. The user community will receive more timely updates, which can be critical in many applications, especially emergency management, 911 dispatch, and homeland security. The effort will leverage the significant investment already made by NJDOT in developing a high quality data product. The data set will provide the GIS community with a single, reliable source for nearly all their needs and applications, eliminating the redundancy and inconsistency that currently exists. Finally, the data set will be based on a strong collaboration between all levels of government as well as the private sector.

10. Conclusions

There are many different road centerline data sets being maintained throughout the state which results in redundant effort and cost, and breeds inconsistency and confusion. Many users currently utilize multiple centerline data sets to meet their various needs which is inefficient and can be ineffective. Based on stakeholder responses, there is overwhelming agreement and support within the user community for a single, comprehensive road centerline data set for the State of New Jersey.

This study has arrived at the conclusion that the development of a single, statewide road centerline data that can meet most, but not all, of the requirements of the stakeholders is feasible. A conceptual framework has been presented to guide the development and maintenance of this data set if the State of New Jersey elects to pursue this initiative.

In conclusion, developing and maintaining a statewide centerline data set as set forth in this report offers the following advantages to the state:

- provides a single, comprehensive centerline data set;
- provides a single source for address matching and milepost geocoding;
- the State of New Jersey owns the data rather than licensing from a commercial vendor;
- it is more cost effective;
- offers more control over the data model design and attribution;
- affords a significantly quicker turnaround time on the integration of new roads and addresses;
- leverages the existing investment by NJDOT and does not disrupt federal reporting requirements;
- aligns with the new municipal, county and state boundaries data sets;
- provides more control over defining primary versus alternate road names;
- will comport with TIGER and other census bureau data sets;
- provides control over name standardization; and,
- the data set is extensible (new attributes can be added as needed).

Appendix A – Stakeholder Requirements

This appendix contains details from the requirements workshop interviews with the participating stakeholders. The workshop participants for each organization are listed. In addition to the participants listed, two representatives from Fountains Spatial were present at each workshop. A narrative for each organization that attended the workshop is included.

New Jersey Department of Transportation (NJDOT)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Todd Hirt	NJDOT – Railroad Engineering
Cindy Dey	NJDOT - GIS
Donald O. Perry	NJDOT – BTDD
Will Day	NJDOT – BTDD
Simon Nwachukwu	NJDOT – System Planning
Paul Truban	NJDOT – Trucking Services
Edward Rogacki	NJDOT –Transportation Security NJOHSP
Kamlesh Shah	NJDOT - DPPD
Jay Jeyamohan	NJDOT – DPPD
Terry Garvey	NJDOT – OEM
Walt Sharpe	NJDOT – ROW
Nicole Einthoven	NJDOT – PMO
John Jamerson	NJDOT – GEOTECH
Jim Hadden	NJDOT – Statewide Traffic OPS
Andrew Ludasi	NJDOT – Trucking Services
Mike Castaldo	NJDOT – BTDD
Chris Zajac	NJDOT – BTDD
Mark Gulbinsky	NJDOT – GIS
Gary Zayas	NJDOT – IT

Overview

The NJDOT is responsible for all aspects of planning, designing, building, operating and maintaining the State's transportation system. The Department works closely with other state, federal and local agencies to meet changing and growing travel needs.

The Bureau of Transportation Data Development (BTDD) within NJDOT is responsible for maintaining a road centerline data set in support of a federal requirement for accurate mileage reporting for different road classes (Federal highway mandate). In addition to the highway mileage reporting, the federal requirements also include reporting of traffic counts (regulated by the Highway Performance Management System, or HPMS) and reporting of bridge maintenance. Based on the reported mileage and other information, the Federal Highway Administration

provides annual funding to the NJDOT and other organizations that operate and maintain New Jersey highways.

The Linear Referencing System (LRS) was added to the road centerline data set at a later date. It is not explicitly a federal requirement, but the introduction of the LRS led to various enterprise management systems that currently utilize this functionality. Currently there are approximately nine (9) management systems that utilize dynamic segmentation, including the mission critical standard route identifiers (SRI).

The road centerline data set maintained by the BTDD is now a central component of many applications implemented by the NJDOT and other organizations within the State of New Jersey. Some of the units within the NJDOT that actively utilize the road data set include: GIS, Transportation Security, Freight Services, Office of Emergency Management, Traffic Operations, and Planning.

Current Status

Considering the scope of work performed by the NJDOT in maintaining the state's roadway network, it is not surprising that the road data set is required to support a very wide range of different applications. The applications can be broken down into the following three categories:

1. Applications utilizing Dynamic Segmentation
   Dynamic segmentation is used by approximately nine different management systems, including the crash management system (featuring point accident locations), pavement management system (featuring linear analysis), and the mission critical SRI. Dynamic segmentation is also used in non-management systems, such as the tracking of deer/auto collisions.

2. Applications utilizing mapping
   Mapping applications include formal hardcopy and softcopy map production for internal and external use, including:

   - Specialized maps (state road maps);
   - Ad-hoc map requests;
   - Maps used for analysis; and,
   - Map services.

3. Applications involving general analysis using the road data set

Routing is not supported by the NJDOT road data set due to the lack of routing attributes such as turn restrictions and one-way streets. The NJDOT has access to the OGIS routing service to support their routing needs.

Unit Overview

The subsections below will provide a brief overview of several units within NJDOT that participated in the requirements workshops.

Office of Emergency Management (OEM)

The NJDOT OEM is utilizing the road data set for general reference purposes, but is not taking advantage of the GIS capabilities. Currently GIS work is not performed by OEM. However, they receive assistance from the NJDOT GIS unit, mostly in the form of hard copy map production used for general reference.

The main focus of the OEM is emergency detour and traffic diversion. Currently their traffic diversion plans rely on state highways and county highways only (local roads are not being used for diversion planning).

The OEM is also responsible for diverting trucks. This task requires information about capacity characteristics such as weight/height restriction, bridge characteristics, etc. The NJDOT has weight and height restrictions in a non-digital format. Currently they do not have or use any turn restriction information. Rail crossings are another important data set that would help traffic diversion. These data are being collected by the Railroad Engineering unit, but has not been incorporated into emergency applications at this point.

Another responsibility of the OEM is resource allocation. The OEM has access to the master statewide database that includes major resources (the Resource Directory Database, or RDDB). The same data set is utilized by the OEM at the NJ State Police. Currently no routing is being used to automate resource allocation.

The OEM also utilizes data from the straight line diagram system (SLD), such as medians, curbing, mowing operations, etc.

Railroad Engineering

The railroad engineering unit is currently compiling a statewide database of public bridges and rail crossings. Location information is being collected using GPS, along with the structure data being captured in dispatch format. This database should be completed by the end of 2008. The department also maintains tunnel information, but in non-digital format.

Project Planning and Development

Many of the applications that Project Planning and Development is working on are part of the regional growth study. Depending on population growth, changes to the state's transportation infrastructure need to be planned, including the addition of new lanes and the building of new roads.

One of the central components of their analysis is census data. They use census data to extract population information and integrate it with the current transportation network. Other data utilized by the unit include public transportation layers, such as Park and Ride facilities, NJ Transit stops, and other public bus stops.

The Project Planning and Development unit uses traffic counts at intersections for traffic analysis. They use data provided by Traffic Operations, and sometimes request additional research. All traffic counts are GIS compatible.

Traffic Operations

The Traffic Operations unit is currently working on finalizing a central database with information on all incidents, accidents, and construction that occur on state highways. They are also working on several other initiatives including utilizing Google Maps to make information on current highway conditions (incidents, constructions, etc.) publicly available.

Another initiative that they participate in is Transcom – a consortium of 18 transportation agencies that share incident information and other data (including travel times) on a regional basis. Currently Transcom's agreement only covers northern New Jersey, but they are working to replicate the system for the entire state.

Planning

The main focus of the Planning unit is congestion management and traffic diversion. They are working with such features as interchanges, ramps, lane number change, etc. Most of these data are available through the LRS. One attribute that they are currently missing is information on the change in number of lanes.

A challenge that they face is the fact that some routes are not included in the road data set if they are coincident with other routes (e.g., when the same highway is a part of several routes). When two or more routes are coincident, only the route with the highest hierarchy is included in the data set to make sure that they do not double count mileage for the mandated reporting. This creates a problem from a planning perspective since part of a route is missing, and they do not have alternate road names to find out if a road segment is a part of more than one route.

The Planning unit is very interested in any geometry changes that occur because this affects congestion management decisions. In particular, the unit requires current and detailed information on ramps and where they merge with highways.

An application used by the unit, which utilizes the TeleAtlas road data set, is the Land and Building Assets Management application (LBAM).

Bureau of Transportation Data Development (BTDD)

The BTDD is responsible for conducting the yearly roadway inventory program and maintaining the NJDOT centerline data set in support of the federal mandate by the FHWA. The inventory and maintenance program includes all public roads within the state (private roads are not inventoried or maintained). The BTDD inventories 1/3 of the public roads each year such that it covers the entire state every three years. Based on the inventory and feedback from other organizations, they update approximately 1,500 miles of road centerlines in the database each year.

Most common updates include: addition of new roads, geometry changes, and name changes. NJDOT has dedicated staff members that conduct data updates and edits using ArcGIS software. The data set is updated quarterly for internal use, and annually for the public release version (available via CD and web applications).

Orthoimagery was used to develop the original data sets, but were not used for on-going road updates. Rather, the road centerline geometry attributes are collected in the field using GPS technology. Orthoimagery for the state is being updated every five years, which is not often enough to be the sole source of information. However, the BTDD is now beginning to use the orthoimagery as a source for identifying new roads within the state.

As previously mentioned, BTDD does not inventory or maintain data on private roads, since they do not receive any federal funding to do so. Therefore private roads are not reported as part of the federal mandate. However, the maintenance program could easily be expanded to inventory and collect data on private roads, since the basic business process is already in place. Additional funding would be required to support this effort.

In addition to the road data, the NJDOT utilizes the public bridges data set. Bridges are stored as points, and are not spatially linked to roads or other features. The accuracy and comprehensiveness of the data set is unknown. NJDOT staff believes the data includes some restriction attributes, however it is not clear whether private bridges are included in the data set.

Needs / Requirements

The following summary provides major reasons for maintaining the existing NJDOT road data set:

1. Compliance with the Federal highway mandate. Total highway mileage determines federal maintenance funding. The NJDOT is required to provide accurate highway mileage under federal highway mandate regulations. The data must be highly accurate; therefore using commercially available data might not satisfy Federal accuracy requirements.
2. The NJDOT data set classifies roads in a different way than commercial data sets. Current road classification is critical for generating highway mileage to comply with the federal

mandate. The fact that the commercial data sets classify road segments in a different way creates difficulties in calculating total highway extents.

3. Current management systems rely heavily on the existing data structure (including linear referencing). It does not seem possible that disruption of the current management systems and applications could be avoided if changes are made to the existing road segment data. It is, however, possible to add more data to the existing data set.
4. Other agencies have been utilizing the NJDOT road data set, and their current operations depend on it. Some examples include MPOs and other agencies that also depend on the federal highway funding, and rely on the NJDOT to provide accurate highway mileage. Several agencies, including the NJ State Police, NJ Office of Homeland Security and Preparedness, and the counties' 911 services, rely on the current LRS to locate incidents along the highways and for other emergency response applications. Changes in the road data set would potentially cause critical service disruptions for these organizations.
5. Other data sets have been spatially aligned with the NJDOT data set, including the municipal boundaries developed by the NJ Office of GIS.
6. The NJDOT road data set is owned by the state. There is no dependency on outside sources, funding for data licenses, etc.
7. The maintenance procedures employed by the BTDD have been continually improved and now been in place for several years and seem to be working well.
8. NJDOT staff expressed overall satisfaction with the current data set, and a readiness to maintain it in-house.

One area within the NJDOT that would benefit from enhancements to the current data set is Emergency Management. The OEM, transportation security, freight services and other units would take advantage of attributes supporting emergency evacuation and traffic diversion applications such as weight/height restrictions, turn restrictions, and bridge characteristics. Additions such as rail crossings and updated bridge information would also be very useful. Finally, including data for the neighboring states (e.g., bridges leading to Pennsylvania) will benefit the emergency response operations as well as freight management and other applications.

Data Collection and Maintenance Notes

As noted above, collecting and maintaining data on private roads would be possible since procedures and equipment are already in place. Collecting one-way and turn restriction would be challenging but may be able to be integrated into the traffic count process. Traffic counting takes place approximately 1,000 times per year at random locations (including local roads).

It is possible that bridge crossing information could be maintained through permits for bridge crossings. The Motor Vehicle Commission (MVC) currently issues permits for bridge crossings, but this function will be transferred to NJDOT.

NJDOT would use 2007 orthoimagery to map new roads if they had access to more current data. Orthoimagery is currently being updated every five years; this schedule would need to be shortened in order for the imagery to be useful for road data maintenance.

Applications	**Current**	**Potential**
Geocoding by Addresses		✓
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	
Geocoding Attributes	SRI, Mileposts
Routing Attributes	Turn restrictions, one-way information, weight/height restrictions, additional data sets for bridges, crossovers, rail crossing, etc. are desirable.
Accuracy (Alignment)	The data must comply with the federal highway mandate requirements.
Completeness	Required to maintain information for highways, but some units would take advantage of local and private roads.
Geographic Extent	State of New Jersey.

NJ State Police – Computer Aided Dispatch Unit

Participants

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Karen Mitchell	Civil Solutions
Sgt. Kevin Walls	NJSP – Computer Aided Dispatch
Sgt. Michael Nordstrom	NJSP – Computer Aided Dispatch
Raymond Bunn	NJSP – Computer Aided Dispatch
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Tom Rafferty	NJOEM

Overview

The Computer Aided Dispatch/Records Management Systems unit is part of the New Jersey State Police Identification & Information Technology Section. The unit is responsible for the proper implementation and operation of the computer aided dispatch and RMS (Record Management System) utilized by the operational dispatch units.

The dispatch unit is currently in the process of migrating away from the existing dispatch system that did not utilize spatial data, to a Power CAD system, which is based on GIS technology. The new Power CAD system will be using an in-house enhanced version of the TeleAtlas data set licensed by the State of New Jersey. The unit is also using the NJDOT road data set for milepost referencing.

Current Status

As mentioned above, the dispatch unit is currently implementing a new Power CAD system. The new system will utilize the NJ State license of the TeleAtlas road data set for most of the geocoding and mapping applications. The NJDOT road data set is also being utilized to geocode cases based on milepost information. Current geocoding tasks performed by the dispatch systems include:

- Regular address matching;
- Address matching for phone landlines;
- Plotting of cellular calls; and,
- Milepost geocoding.

The dispatch unit is working on enhancing the TeleAtlas data set and adding custom road and exit names that match existing names being used by the NJ State Police. When customizing road names, two factors that will have major impact are local knowledge and how easily the name can be entered into the dispatch system.

One significant challenge that the dispatch unit faces is keeping data current and in sync with TeleAtlas updates. Customized road names will need to be recalculated four times per year, every time a new TeleAtlas data release becomes available.

Another challenge related to road data is discrepancies between milepost information provided in the NJDOT data set, and the reference markers on the ground. This mismatch between the GIS data and ground locations has a negative impact on the geocoding results. This, in turn, affects the results of the NJDOT's crash location analysis, the results of which are aimed at improving road coverage and infrastructure based on the accident information. In addition, the discrepancies in the milepost locations near jurisdictional boundaries might cause difficulties in the dispatching of emergency vehicles since it might be unclear which jurisdiction is responsible when using the GIS data versus the actual ground location.

Needs / Requirements

The dispatch unit within the NJ State Police is currently utilizing the TeleAtlas road data set and the NJDOT data set for emergency dispatch geocoding. While most of their needs are satisfied by the combination of the data sets, any enhancements to the existing geocoding process would help their operations.

Emergency response geocoding relies heavily on road data, spatial and attribute accuracy, and completeness. Some of the desired enhancements that would help improve geocoding performed by the dispatch unit include:

1. enhancing road names and providing alternate road names;
2. enhancing milepost location accuracy;
3. enhancing data update procedures to ensure that the most recent and accurate data are available for emergency dispatch; and,
4. enhancing the way road segments are split. Current road data sets (especially TeleAtlas) have segments split in a way that does not always allow road addresses to be interpolated correctly. Addressing this issue would help improve geocoding results significantly.

The dispatch unit would also benefit from having a single road data set that could be used for all types of geocoding, rather than having to use two different reference data sets. Having a single comprehensive and reliable data set would be extremely valuable for emergency management in general. Emergency management including emergency response is a group effort that involves multiple agencies and their divisions. Having a single reference data set that is used by all emergency management participants would significantly improve coordination of their actions.

Although no routing is currently being performed by the unit, they would like to take advantage of it in the future. Emergency dispatching could benefit from routing, especially in rural areas.

Applications	Current	Potential
Geocoding	✓	
Routing		✓
LRS	✓	
Mapping		
911 Dispatch	✓	
Planning		

Data Requirements

Characteristics	Description
Attributes	n/a
Geocoding Attributes	Attribute accuracy (address ranges and mileposts) is critical Milepost data needs to be enhanced Alternate road names are critical.
Routing Attributes	n/a
Accuracy (Alignment)**	Important.
Completeness	Critical. Need information on local and private roads.
Geographic Extent*	State of New Jersey and adjacent counties.

NJ State Police - Office of Emergency Management (NJOEM)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Tom Rafferty	NJOEM
Jennifer Michalchuk	NJOHSP

Overview

The Office of Emergency Management (NJOEM), housed within the Division of State Police is the State's primary operational agency in terms of managing the consequences of emergencies and the post-event response to emergencies. The NJOEM is responsible for planning, directing and coordinating emergency operations within the State that exceed local control.

The NJOEM works closely with the NJ Office of Homeland Security and Preparedness; their needs and applications in terms of road data are similar in many ways.

Two major tasks of the NJOEM are developing evacuation plans and performing incident location analysis. GIS applications that support these tasks include geocoding, spatial analysis, and cartography.

Current Status

The NJOEM performs geocoding using both milepost and road address information. Since there is currently no single road data set that contains both address and milepost references, both the TeleAtlas and NJDOT road data sets are necessary in order to geocode incident locations.

Requirements for geocoding accuracy and the percentage of successfully geocoded records are relatively low considering that these data are being used for regional analysis and planning. An 80% match rate for records geocoded is sufficient for their needs.

A significant challenge when utilizing the NJDOT linear referencing system is that the coordinate locations of GIS milepost data do not always correspond to the actual location of milepost signs on the ground. In many cases where multiple routes go along the same highway, mileposts on the ground might follow one route, while LRS follows a different one.

A major cartographic task is incident mapping. Maps are being generated using geocoded incident locations on a "by request" basis. The maps are then used to perform spatial analysis and planning using incident data. Planning and analysis are done on a general level, and usually do not require detailed road information (e.g., local and private roads.)

Additional data sets the NJOEM is utilizing include NJDOT bridge data (used primarily by Special Operations) and demographic data which are used for analysis and planning purposes.

Currently the NJOEM is not taking advantage of routing, mostly due to the lack of staff expertise and a comprehensive data set. All of the police cars are currently equipped with GPS units that are used for navigation, but not for AVL purposes.

Needs / Requirements

The current GIS tasks performed by the NJOEM are being successfully supported by the NJDOT and TeleAtlas data sets. The combination of the data sets provides sufficient coverage and accuracy for both geocoding and mapping applications. However, any enhancement to the existing geocoding process would save a lot of time and effort, and potentially improve the results of geocoding and consequently the location analysis. A major enhancement that would help improve current operations would be the introduction of a single road data set that supports geocoding based on both road addresses and milepost locations.

The NJOEM could potentially take advantage of routing. One of the applications for routing would be resource distribution and management using the database of public resources maintained by the NJOEM. Desired routing attributes, in addition to standard one-way information and turn restrictions, include weight and height restrictions. Having the ability to perform real time routing (AVL) for vehicle management in emergency situations would be desirable if it were cost-effective.

In addition to routing, the NJOEM could take advantage of the drive time analysis for emergency management tasks. To facilitate this analysis, some traffic flow attributes such as speed limits, average speed during rush hour traffic, real time flow speed (impedance), etc. would be necessary.

Applications	**Current**	**Potential**
Geocoding by Addresses	✓	
Routing		✓
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	n/a
Geocoding Attributes	Address ranges and mile posts.

Routing Attributes	One-way, turn restrictions plus weight and height restrictions.
Accuracy (Alignment)	Attribute accuracy, connectivity.
Completeness	Information on local and private roads is not critical.
Geographic Extent	State of New Jersey and adjacent counties.

NJ Office of Homeland Security and Preparedness

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Tom Rafferty	NJOEM
Jennifer Michalchuk	NJOHSP

Overview

The mission of the NJ Office of Homeland Security and Preparedness is "to administer, coordinate, lead, and supervise New Jersey's counter-terrorism and preparedness efforts." The executive order that created the office also set the office's goal as coordination of "emergency response efforts across all levels of government, law enforcement, emergency management, nonprofit organizations, other jurisdictions, and the private sector, to protect the people of New Jersey.

Some office functions include investigations, as well as information and intelligence gathering and analysis, and intelligence and information-sharing functions.

The office has a mission to coordinate its activities among state department and agencies, and between:

- State and county government and agencies;
- State and local governments and agencies;
- State and various federal departments and agencies; and,
- State and private sector.

The NJ Office of Homeland Security and Preparedness works closely with the NJ Office of Emergency Management (NJOEM), housed in the Division of State Police. While the office has responsibility for overseeing statewide emergency response coordination, the NJOEM continues as the state's primary operational agency in terms of managing the consequences of emergencies and the post-event response to emergencies.

As a part of the counter-terrorism and emergency response coordination efforts, the NJ Office of Homeland Security and Preparedness is responsible for vulnerability analysis and planning. GIS applications that support these tasks include geocoding, mapping and modeling.

Current Status

The NJ Office of Homeland Security and Preparedness is utilizing both NJDOT and TeleAtlas data sets in order to geocode incident locations using road address and milepost information. The geocoded data are used for in-depth mapping, spatial analysis, and reporting on a daily basis.

Since the scope of projects vary from regional to local level, geocoding accuracy and the percentage of successfully geocoded records fluctuates. For regional efforts, an 80% match rate for records geocoded is adequate. However, local level analysis may require more accurate match rates. In terms of the spatial accuracy and completeness of road data, the NJ Office of Homeland Security and Preparedness does not require any more detail than current road data sets provide, except for the areas that surround critical infrastructure. Minimal road data are being collected by the NJ Office of Homeland Security and Preparedness for vulnerability analysis of critical infrastructure objects, but this is not a state-wide comprehensive process.

Some of the mapping and analysis projects performed by the agency include incident mapping, infrastructure analysis, and geographic modeling. The scale and level of detail of the mapping and/or analysis being performed is the determining factor for which dataset is used. Road data for the entire State of New Jersey, as well as adjacent counties in neighboring states is required. In addition, the office uses data for the areas that cover key infrastructure and resources in the neighboring states (e.g., New York, Delaware, Pennsylvania). The TeleAtlas data set licensed by the state includes New Jersey road data as well as data for adjacent counties.

In addition to the road data sets, the NJ Office of Homeland Security and Preparedness is utilizing the NJDOT bridge and airport data sets for mapping and reference purposes.

In terms of the spatial accuracy and completeness of road data, the NJ Office of Homeland Security and Preparedness does not require any more detail than current road data sets provide, except for the areas that surround critical infrastructure. Some road data are being collected by the NJ Office of Homeland Security and Preparedness for vulnerability analysis of critical infrastructure objects, but this is not a significant or continuous process.

Routing is currently not used by the NJ Office of Homeland Security and Preparedness. However, this will be useful for upcoming projects that include tasks such as, shortest drive time, optimal routes, and road block planning.

Needs / Requirements

Current GIS business needs at the NJ Office of Homeland Security and Preparedness is being supported by the NJDOT and TeleAtlas data sets. The combination of the data sets allows staff to geocode incidents, although a single set would be desirable; TeleAtlas data also serve as the primary mapping base. Existing road data sets provide sufficient attribute and spatial accuracy, while more detailed and accurate data are desired for the areas surrounding critical infrastructure objects. The NJ Office of Homeland Security and Preparedness is able to collect and maintain this data in-house.

Another main focus of the agency is incident geocoding and mapping and any enhancements to the geocoding process would be beneficial. If a single data set that includes both road address and milepost information was available, it would help make the geocoding workflow much more

efficient and potentially improve geocoding results and consequently location analysis in relation to incidents.

Additional enhancements that would benefit the NJ Office of Homeland Security and Preparedness include information pertaining to traffic flow, road characteristics, and coordinated vehicle inspections. For example, an attribute containing the number of lanes would allow identification of all multilane roads in the vicinity that might need to be closed in order to limit traffic flow to one lane and allow for vehicle inspections. In addition, any information involving traffic obstruction (e.g., medians or landscaping around shopping malls that might be in the way of traffic) would be desirable.

Routing capabilities would benefit the NJ Office of Homeland Security and Preparedness in drive time analysis for protection planning, setting road blocks for restricted access, and other types of similar application.

Other information of value to the NJ Office of Homeland Security and Preparedness pertains to road infrastructure, as well as connectivity between road data and other related data sets. It is crucial for the agency to be able to use roads in combination with other data sets such as building footprints, public transportation data, etc. Data set alignment and connectivity are important characteristics for the vulnerability analysis.

Applications	**Current**	**Potential**
Geocoding: Addresses	✓	
Routing		✓
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	Number of lanes; Traffic obstructions.
Geocoding Attributes	Address ranges; mileposts.
Routing Attributes	One-way, turn restrictions, restricted access
Accuracy (Alignment)	Positional accuracy is important around critical objects. Connectivity between data sets is important.
Geographic Extent	State of New Jersey, adjacent counties and key infrastructure in adjacent states (New York, Delaware, Pennsylvania). Additional projects include Regional focus where Federal analysis is involved.

NJ Transit

Participants

Doug Schleifer	NJOIT - OGIS
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Glenn Newman	NJ TRANSIT
Louis Millan	NJ TRANSIT

Overview

NJ TRANSIT is the nation's third largest public transportation corporation, providing bus, rail and light rail transportation services. NJ TRANSIT provides services in four states (Delaware, New York, New Jersey and Pennsylvania) and links the major metropolitan areas of New York, Philadelphia and New Jersey.

NJ TRANSIT is currently the only agency utilizing the commercial NAVTEQ road data set. Commercial nation-wide road data sets are currently the only source of seamless road data that covers the extent of the NJ TRANSIT service area. The extent of the service area, which includes four states, is a critical factor that puts NJ TRANSIT on a different level from all other agencies described in this report.

Current Status

NJ TRANSIT has been licensing the NAVTEQ road data set since 1997, and is currently using the data set in seven major applications including: a routing system, AVL (Automatic Vehicle Location), linear referencing, mapping, and geocoding applications.

Before selecting NAVTEQ as their primary road data set, NJ TRANSIT compared several commercial data sets including TeleAtlas in terms of their attribute accuracy, connectivity and positional accuracy. NAVTEQ provided the best attribute accuracy and connectivity, which were the most important characteristics. Additionally, it provided better ramp, overpass and connectivity information, and was specifically designed for transportation and routing needs.

NJ TRANSIT is currently using NJDOT data for reference in state jurisdictions, since NAVTEQ does not coincide with official state jurisdiction and road classifications. However, the NJDOT data set is only being used for general reference purpose and is not integrated with any of the applications. NJ TRANSIT has not been able to take full advantage of the NJDOT road data set or any other local data since these do not provide coverage for the entire service area. Integrating data from different sources would not be a feasible task considering the extent and complexity of the road data application.

Another concern when using non-commercial road data sets (e.g., NJDOT data) is the fact that their maintenance relies heavily on funding (agency, state, or federal budgets). Insufficient funding might have a negative impact on the quality of the data.

NJ TRANSIT data are extremely dynamic and is required to be continuously updated. Bus schedules, as well as other supporting information including road data, stops, addresses, etc., are being updated four times per year. Keeping data up-to-date is a critical task for NJ TRANSIT.

NAVTEQ maintenance procedures are able to address this need. In addition to the NAVTEQ data set updates, NJ TRANSIT is able to use temporary patches to get the most recent data while NAVTEQ is preparing a new data release. Patches are usually used to add private roadways (hospitals, shopping plaza driveways, etc.) Orthoimagery is currently being used in custom applications and for general reference.

Needs/Requirements

NJ TRANSIT requirements for a road data set are driven mostly by the extent of their service area covering four states. Nationwide commercial road data sets are currently the only source of reliably maintained, detailed road network for the full extent of the service area.

NJ TRANSIT has been using the NAVTEQ road data set for over ten years, and has a well established business process in place. Considering the extent to which the NAVTEQ road data set is integrated into NJ TRANSIT's operations, switching to a different data set would be undesirable and highly labor intensive. Additionally, NJ TRANSIT would not be able to take advantage of the TeleAtlas state license since it only includes data for the State of New Jersey and adjacent counties.

It seems logical for NJ TRANSIT to keep using NAVTEQ road data set considering the agency's unique needs, its well-established business process, and the fact that its operations are relatively independent and do not impact other agencies. NJ TRANSIT is unlikely to benefit from the creation of a new state-wide road data set.

However, NJ TRANSIT might benefit from the enhanced orthoimagery program. Orthoimagery could be used for road data enhancements. Other data sets that might be of benefit include parcel data and point addresses.

Applications	Current	Potential
Geocoding	✓	
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	N/A
Geocoding Attributes	Address ranges.
Routing Attributes	One-way, turn restrictions? (everything that NAVTEQ has)
Accuracy (Alignment)	Attribute accuracy, connectivity.
Geographic Extent	States of New York, New Jersey, Pennsylvania, Delaware.

The Port Authority of New York and New Jersey (PANYNJ)

Participants

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Paul Carris	PANYNJ – Engineering Management Services Division
Greg Aiello	PANYNJ – Traffic Engineering
Kevin Maddox	PANYNJ – Office of Policy and Planning
Chiu Kun Wu	PANYNJ – Traffic Engineering

Overview

The Port Authority of New York and New Jersey manages and maintains transportation infrastructure critical to the region's trade and transportation network. The transportation infrastructure data maintained by the PANYNJ are listed below.

1. The region's six aviation facilities:
   - Newark Liberty International Airport (EWR) – New Jersey
   - Teterboro Airport – New Jersey
   - John F. Kennedy International Airport (JFK) – New York
   - LaGuardia Airport (LGA) – New York
   - Stewart International Airport (SWF) – New York
   - Downtown Manhattan Heliport – New York

2. The region's five port facilities:
   - Auto Marine Terminal – New Jersey
   - Port Newark/Elizabeth Port Authority Marine Terminal – New Jersey
   - Howland Hook Marine Terminal – New York
   - Port Authority Brooklyn Marine Terminal – New York
   - Red Hook Container Terminal – New York

3. The region's three passenger and freight rail facilities:
   - Port Authority Trans Hudson (PATH) – Passenger Rail Transit System
   - AirTrain JFK, AirTrain Newark – Airport Monorail System
   - ExpressRail – Intermodal Freight Rail System

4. The region's six Hudson River crossing facilities:
   - Holland Tunnel
   - Lincoln Tunnel
   - George Washington Bridge

- Bayonne Bridge
- Goethals Bridge
- Outerbridge Crossing

5. The region's two bus facilities
   - Port Authority Bus Terminal – New York
   - George Washington Bridge Bus Station – New York

6. Journal Square Transportation Center

7. The World Trade Center Site

In total, the PANYNJ manages 22 facilities. The service area of the PANYNJ covers the New York/New Jersey Metropolitan Region, which consists of the five New York boroughs, four suburban New York counties, and eight northern New Jersey counties. The New Jersey Counties served by the PANYNJ include Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, and Union.

Three units that are currently utilizing road data and GIS functionality include Traffic Engineering, Planning, and Emergency Management. The PANYNJ maintains their own data for the roads within their facilities, while the TeleAtlas data set is used for the external roads coverage. The PANYNJ is licensing TeleAtlas separately from the States of New Jersey and New York, since they require data for multiple counties in both states. LRS is not currently being used in any of the applications.

Current Status

The needs and applications vary a great deal between different departments within the PANYNJ. The Office of Emergency Management (OEM) and Traffic Engineering have GIS applications geared toward facility analysis, while the Office of Policy and Planning typically focuses on more regional analysis.

The PANYNJ maintains its own road data sets collected through surveying and aerial imagery. These data are stored in dispatch format and has spatial references. Collected information mostly covers the PANYNJ facilities, but also includes buffer zones that vary for different facilities. For example, the bridge data includes surrounding road networks.

Since the small roads and roadways maintained by the PANYNJ tend to change frequently during various construction projects, road information is being continuously updated. The PANYNJ is collecting information about small roads within and outside of their facilities using surveying and aerial photography. They are continually surveying roads and do flyovers every 1-2 years to collect information about their facilities. Collected data are stored in dispatch format and is spatially referenced.

For regional analysis, the PANYNJ is using TeleAtlas data. The TeleAtlas data set is licensed separately from other agencies due to their unique service area that covers the metropolitan area in New York and New Jersey.

The Office of Policy and Planning is utilizing the TeleAtlas road data set and ArcGIS software for most of their applications. The TeleAtlas data set supports geocoding within the Office. Geocoding is performed using only road addresses; no milepost geocoding is used. Other applications implemented at the Office of Policy and Planning include modeling for planning purposes, and mapping. Mapping requires road name attributes for labeling, therefore the TeleAtlas data set is also used for mapping applications.

The Office of Emergency Management (OEM) works with security and incident data. They collect data on incidents within the PANYNJ facilities, and perform spatial analysis on the incident locations.

Within the Engineering Management Services Division, Traffic Engineering does significant geocoding to locate their traffic crash data; with spatial analysis of crash locations being one of their most important applications. The geocoding is based on address information; no LRS is currently being used.

Traffic Engineering is developing and maintaining several traffic data sets. They are starting a new initiative to create an information system that would include all of their data. They are currently working on an inventory of their data, and collecting missing information using maps and other references. Transitioning from dispatch to ArcGIS software is a part of this project.

The Engineering Management Services Division is using GIS to manage spatial information related to its facilities. This system is based on Autodesk MapGuide software.

Needs / Requirements

The PANYNJ has a well-established business workflow that is being successfully supported by the current applications and existing road data sets. Regional analysis relies on the TeleAtlas road data set, while the facilities maintenance and analysis applications are fully supported by the PANYNJ's own road data set.

PANYNJ will take full advantage of a statewide road data set within the State. Applications would include, but are not limited to:

- evaluating the effects of construction closures of any PANYNJ facilities on the region's infrastructure and determining diversion routes;
- identifying truck access routes in the region; and,
- improving regional goods movement.

However, it should be noted that due to the service area covering the metropolitan region within two states (NY and NJ), the PANYNJ will need to continue to use an additional centerline data set for the State of New York.

Some of the road attributes that the PANYNJ would benefit from include:

- number of lanes, lane types, lane usages, and time restrictions on lanes;
- speed limits;
- height and weight restrictions; and,
- turn restrictions and traffic controls at intersections.

Even though Traffic & Engineering is mostly interested in roads within their facilities, they are also concerned about maintaining adequate connectivity between roads inside and outside of their facilities. Any enhancements to the road data set that will allow better connectivity between internal and external roads would be particularly beneficial for traffic volume analysis.

It could be possible for the PANYNJ to share some of their data with the State of New Jersey for the development of a statewide road centerline data set.

Applications	**Current**	**Potential**
Geocoding by Addresses	✓	
Routing	✓	
LRS		
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	Road names, characteristics of the road ways, number of lanes, lane types, speed restrictions, etc.
Geocoding Attributes	Address ranges.
Routing Attributes	Turn restrictions (especially at the PANYNJ facilities, such as airports), height restrictions.
Accuracy (Alignment)	Very important within the PANYNJ's facilities.
Completeness	Very important within the PANYNJ's facilities.
Geographic Extent	New York/New Jersey Metropolitan Region.

Delaware Valley Regional Planning Commission (DVRPC)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Will Stevens	DVRPC
Chad Lauderbaugh	GeoDecisions

Overview

The Delaware Valley Regional Planning Commission (DVRPC) is a regional planning organization that facilitates regional cooperation in a nine-county, two-state area. The service area of the DVRPC includes Burlington, Camden, Gloucester and Mercer Counties in New Jersey; and Bucks, Chester, Delaware, Philadelphia and Montgomery Counties in Pennsylvania.

Some of the major issues that are being addressed include transportation, land use, environmental protection and economic development. The DVRPC provides services to member governments and others through planning analysis, data collection, and mapping services. The online Information Services Center provides publicly available demographic, economic and other data as well as online mapping applications and other services. In addition, the DVRPC provides funding to the counties and operating agencies to build GIS capacity, develop a regional road centerline data set, and share transportation data among all member agencies including NJDOT and PennDOT.

Currently DVRPC is utilizing four road centerline data sources: NJDOT road data set, county road data sets, TeleAtlas road data set (for PA), and the TransCAD data pack. The DVRPC is working with a contractor, GeoDecisions, on a transportation data model project for the DVRPC service area. The project's goal is to evaluate existing data sets and develop recommendations on creating and maintaining a single road data set.

Current Status

The DVRPC is utilizing road data sets for a wide range of mapping and planning applications. The DVRPC works with the counties within its service area to provide them with GIS support in the form of data, maps, mapping applications and other services.

Currently the DVRPC is working with four different road data sets:

- NJDOT road data set for dynamic segmentation, accident information and other utilities;
- County road data sets for cartography (these are the most spatially accurate data);
- TeleAtlas road data set (9 county DVRPC area); and,
- TransCAD data pack for modeling (the road data set is a part of the software license).

The Counties' road data sets tend to have better positional and attribute accuracy than any other available data sets. These data sets are used mostly by the DVRPC for general mapping, as they usually provide the best road reference.

Most of the counties within the DVRPC service area used the TeleAtlas data set as the foundation for their own road files. They have since updated and enhanced the data through GPS data collection and by synchronizing road data with tax parcel information. Depending on the local 911 regulations, some counties are maintaining information on private roads. In addition to that, some counties' road data sets support emergency routing.

The NJDOT and PennDOT data sets are heavily used by planners in various transportation studies. Some of the DVRPC mapping applications also utilize the NJDOT data set, especially when other NJDOT layers are used, to ensure their alignment.

TeleAtlas is the only road data set that provides coverage for the entire extent of the DVRPC service area. This data set is currently utilized for road address geocoding. The goal of the DVRPC is to eventually incorporate road address information into the counties' and/or NJDOT road data set and make the TeleAtlas data set obsolete.

The TransCAD data pack is used solely for the transportation modeling within TransCAD software. This data set is not used in any other applications.

Needs / Requirements

The extent of DVRPCs service area and its role as a regional coordinator determines their priorities in terms of the road data set selection. The DVRPC is working to enable current GIS applications used by the counties, as well as coordinate development of new data sets and help improve county operations.

One of the main focuses of the DVRPC is compilation of a single, region-wide road data set based on the counties' current road data sets. Creation of such a data set will ensure seamless and consistent data coverage for the entire service area. The main requirements for the new road data set would include support of all current county GIS applications. The new road data set would have to incorporate road addresses for geocoding purposes, as well as satisfy connectivity requirements for routing. Having turn restrictions, one-ways, and other routing attributes would be desirable but it is not crucial; these data elements would not be maintained by the counties.

Consistent and reliable data maintenance procedures are also at the center of attention for the counties and the DVRPC. It is suggested that both state DOTs will play a central part in the maintenance process.

Applications	Current	Potential
Geocoding by Addresses	✓	
Routing		✓
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	Description
Attributes	Attribute accuracy is very important from 911 operations perspective. *
Geocoding Attributes	Address ranges. *
Routing Attributes	n/a
Accuracy (Alignment)	Connectivity is important for routing applications. *
Completeness	Information on local and private roads is required. *
Geographic Extent	9 counties: 5 counties in Pennsylvania 4 counties in NJ (Mercer, Burlington, Camden and Gloucester)

* these requirements refer to the counties, rather than the DVRPC, as the "end users"

South Jersey Transportation Planning Organization (SJTPO)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Joshua Rocks	South Jersey Transportation Planning Org.
Elizabeth Johnson	NJ Turnpike Authority
Susan Lutin	NJ Turnpike Authority
Keith Miller	North Jersey Transportation Planning Auth.
Zenobia Fields	North Jersey Transportation Planning Auth.
Will Stevens	DVRPC
Chad Lauderbaugh	GeoDecisions
Paul Carris	PANYNJ
Brian Jacob	PANYNJ

Overview

The South Jersey Transportation Planning Organization (SJTPO) is the Metropolitan Planning Organization (MPO) serving Atlantic, Cape May, Cumberland, and Salem Counties in southern New Jersey. As an MPO, the SJTPO coordinates the planning activities of participating counties and facilitates coordination between state and local officials, public and private transit operators, and the general public.

The SJTPO is dedicated to providing guidance for transportation investment decisions; the agency works to maintain the eligibility of its member agencies to receive federal transportation funds for planning, capital improvements, and operations.

The SJTPO is currently relying on the NJDOT road data set and the county road data sets to support their planning applications.

Current Status

The scope of current planning applications utilized by the SJTPO varies from accident location analysis to traffic demand model and capital planning. The SJTPO works closely with the member counties and utilizes their road data sets, which provide information on local roads.

The SJTPO works both with local roads as well as highways. Data completeness is important for local analysis, including accident locations. However, many of the programs only utilize data that is required by federal regulations.

Geocoding is not currently performed by the SJTPO. They maintain their own crash database, but also receive more complete crash data at the end of the year from the NJDOT, containing the XY coordinates ready to be mapped.

There are several planning applications that utilize road data. One such application is the South Jersey Travel Demand Model (SJTDM) that allows the agency to project traffic flows along different highways. Unfortunately, it is not known which road data set was used as a base for this model. Another planning application used by the SJTPO is a congestion planning system. Emergency evacuation plans are also being developed, although routing is not currently being implemented.

Needs / Requirements

Currently SJTPO's applications are supported by the existing road data sets. The NJDOT road data set, along with the county road data, satisfy both federal highway program requirements and the need for local road information for detailed analysis.

The SJTPO relies heavily on the NJDOT data set accuracy and compliance with the federal regulations, since the counties and other participating agencies are eligible for federal transportation funds. Another critical component for the SJTPO is the LRS included with the NJDOT data.

Routing is one of the applications that the SJTPO would like to take advantage of in the near future. They are especially interested in evacuation routing and transit analysis. In addition to the standard routing attributes, such as one-way road information and turn restrictions, it would be very helpful to obtain road elevation information to support emergency evacuation routing.

The SJTPO would like to have road data as complete as possible, including local and private roads. These data are critical for accident location analysis and some planning applications. Information on sidewalks along state highways would also be helpful to analyze whether there are safe sidewalks and road crossings for school traffic.

Finally, the SJTPO could take advantage of the detailed road data for the regions outside of their service area, especially southeastern Pennsylvania. One of the current initiatives includes incorporating data for the DVRPC's service area into the travel demand model, since this area plays a critical role in the traffic load on the southern New Jersey region.

Applications	**Current**	**Potential**
Geocoding by Addresses		
Routing		✓
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	n/a
Geocoding Attributes	No geocoding done in-house.
Routing Attributes	Standard routing attributes and road elevation information.
Accuracy (Alignment)	Critical to comply with the federal highway regulations.
Completeness	Require information on local roads (varies by project).
Geographic Extent	Southern part of New Jersey and potentially the DVRPC service area.

North Jersey Transportation Planning Authority (NJTPA)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Joshua Rocks	South Jersey Transportation Planning Org.
Elizabeth Johnson	NJ Turnpike Authority
Susan Lutin	NJ Turnpike Authority
Keith Miller	North Jersey Transportation Planning Auth.
Zenobia Fields	North Jersey Transportation Planning Auth.
Will Stevens	DVRPC
Chad Lauderbaugh	GeoDecisions
Paul Carris	PANYNJ
Brian Jacob	PANYNJ

Overview

The North Jersey Transportation Planning Authority (NJTPA) is a federally authorized Metropolitan Planning Organization (MPO) for a thirteen (13) county region in northern New Jersey. NJTPA oversees investments into transportation improvement projects, and facilitates interagency cooperation and public input into funding decisions. It also sponsors and conducts studies, assists county planning agencies, and monitors compliance with national air quality goals.

NJTPA relies on both the TIGER data and the NJDOT data set as its road centerline layers. The TIGER data are used primarily for address geocoding and projects requiring demographic analysis. The NJDOT data set is used for mapping and planning on higher-level roads (state and county highways). The NJDOT data set is also used for geocoding by mileposts and other tasks requiring linear referencing.

Current Status

The NJTPA is utilizing road data to support its transportation analysis and planning applications. GIS tasks performed by the NJTPA include mapping, geocoding and routing. One of the principal components of the NJTPA applications is demographic analysis, which relies on census data.

As previously mentioned, NJTPA is currently utilizing two road data sets: the NJDOT data set and the TIGER road centerlines. NJTPA has not taken advantage of the TeleAtlas data set because they were unaware it was available at no cost through the statewide license.

The NJTPA uses data on roadway crashes to support safety planning for the transportation system within northern New Jersey. Some of the accident data records come already geocoded

by the NJDOT, while the remaining accident locations are processed by the NJTPA. The TIGER data set is used for accident geocoding using road address information. Records that are referenced by mileposts need to be geocoded using the NJDOT data set. This has been an inconvenience, since geocoding needs to be performed twice, using each of the data sets.

The NJTPA is primarily concerned with county level roads and higher, and does not usually require detailed information on local roads for planning purposes. However, road address geocoding is dependent on the completeness and accuracy of the road data set. One of the problems that the NJTPA experienced with geocoding is that some accidents cannot be geocoded to internal facility roads such as mall roads or parking lots, because these roads are missing from the TIGER data set.

The TIGER data are also used to support transportation planning. One such example is the mapping of all federally funded transportation projects. The projects are located, mapped and assigned scores based on several parameters ranging from physical attributes of the project to surrounding demographics and land use. In order to assign scores, the NJTPA matches projects with census geography to identify the block groups, municipalities, and congressional districts of the project study area. The TIGER road data provides the road reference, and is aligned with other census layers necessary for the scoring system.

The TIGER roads are also used as a base for the travel demand model (the North Jersey Regional Transportation Model). The model utilizes census demographics such as population, household, and income data to model transit demand in the region. The model is also taking advantage of routing for trip generation based on the NJDOT data set. Routing performed as part of the analysis is fairly simple, and only takes into account major highways.

Needs / Requirements

Most of the current needs of the NJTPA are satisfied by the combination of NJDOT and TIGER road data sets. At the same time, having to switch between data sets or use both in the same application affects the efficiency of the current business workflow. Another challenge is that the two data sets are hard to reference together geographically. The TIGER data set is less accurate geometrically, while the NJDOT data set is lacking private roads and does not coincide with census boundaries.

Unfortunately, there is currently no single data set that could accommodate all of the applications supported by the NJTPA, which range from accident location geocoding using road addresses and mileposts, to routing, to demographic mapping and analysis.

Having a single road data set that addresses of all their needs would make the NJTPA's business workflow easier, as well as more efficient and effective. The characteristics of such a data set would include alignment with census geography, which would enable economic and demographic analysis. In addition, the new data set should support geocoding using both address ranges and milepost information.

Having a single data set capable of different types of geocoding would be particularly effective. It would reduce time and effort required to geocode accident records that currently need to be geocoded twice using the TIGER and NJDOT data sets. Geocoding results could also be improved by increasing the spatial and attribute accuracy and completeness of the road data set.

Applications	**Current**	**Potential**
Geocoding by Addresses	✓	
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	n/a
Geocoding Attributes	Address ranges and mileposts
Routing Attributes	n/a (routing is done on a very generic level)
Accuracy (Alignment)	The most important factor is alignment with census geography
Completeness	Require information on local roads (varies by project)
Geographic Extent	Northern New Jersey

New Jersey Turnpike Authority

Participants

Doug Schleifer	NJOIT - OGIS
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Joshua Rocks	South Jersey Transportation Planning Org.
Elizabeth Johnson	NJ Turnpike Authority
Susan Lutin	NJ Turnpike Authority
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Paul Carris	PANYNJ
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Overview

The New Jersey Turnpike Authority (NJTA) controls operations and maintenance of the New Jersey Turnpike and the Garden State Parkway. The NJTA is a subsidiary agency to the NJDOT. They work closely with the NJDOT on multiple projects related to highway information maintenance, and utilize the NJDOT data set for most of their current applications. Similar to the NJDOT, the NJTA has to comply with federal requirements for accurate mileage reporting for the roads that they operate (federal highway mandate).

The NJTA is just starting to take advantage of GIS technology. They have recently completed a GIS Needs Assessment and Conceptual System Design, and are looking to start implementing an enterprise GIS. As part of the system implementation, the NJTA will be starting to utilize the TeleAtlas data set for routing and other purposes.

Current Status

The Turnpike Authority is responsible for all aspects of operations on the New Jersey Turnpike and the Garden State Parkway. Various activities performed by the Authority could be supported by GIS, including roadway network mapping, planning, asset inventory and management, construction and maintenance management, traffic management, etc. Some of the GIS applications that would support these operations include:

- linear referencing;
- mapping;
- routing;
- travel demand models;
- travel predictions; and,
- diversion analysis, etc.

The NJDOT road data set is currently being used to support most of the NJTA's operations. The Turnpike Authority is working with the NJDOT on enhancing the road data along the New Jersey Turnpike and the Garden State Parkway. For example, the NJTA has been working on road segmentation, extending the highways' segments through the toll plaza areas. The updated information will be included in the NJDOT data set.

The NJTA relies heavily on the Linear Referencing System (LRS). Two LRSs currently used by the NJTA include the NJDOT LRS, which is mostly used as a reference for the state routes adjoining to the Authority, and one of their own.

The NJTA's LRS is based on the NJDOT LRS, but with some modifications. The ramp and interchanging information used by the NJTA is more complicated than what is included in the NJDOT data set. The LRS was calibrated to NJTA's commonly accepted mileposts, route, spur and ramp designations. In addition, the NJTA is utilizing dual centerlines and has four reference marker systems.

The NJTA's LRS has been enhanced with additional attributes to be able to uniquely identify each location. This has been implemented in cooperation with the NJ State Police in order to improve accident geocoding. The NJTA is responsible for the original processing of crash reports before they get forwarded to the NJDOT. The challenge that they face when dealing with the crash reports is the confusion about local naming conventions that exists between different agencies and data sets.

The NJTA maintains its own assets management system, and is maintaining and expanding an asset inventory that includes buildings, transportation facilities, service areas, etc. In addition to facility assets, the NJTA is maintaining data sets for bridges, toll plazas, and tunnels.

Bridge data are particularly important for the NJTA operations, including construction, maintenance, planning, and especially emergency response. Furthermore, maintaining bridge information is mandated by the federal highway program regulations. The NJTA works closely with the NJDOT to collect and maintain bridge data and generate federal reports. The NJTA collects information on bridges along the NJ Turnpike and Garden State Parkway. They also utilize bridge data available from the NJDOT that includes information on public bridges for the entire state. In addition, the NJTA uses the data available though GOS (Geospatial One Stop) that provides information on private bridges.

The NJTA is also working on collecting data related to congestion and incident and safety management, such as traffic volume, incidents, and toll revenue.

Census data are being used for transportation analysis. Census data are used to analyze population and how and where it is moving. Eventually these data will be combined with transit data such as routes and transit facilities.

The NJTA is looking to start utilizing the TeleAtlas data set. The data set provides detailed local road data as well as information for adjoining states that could be used for emergency management planning and traffic diversion. The data set could be used for routing and other related applications such as travel time. In addition, the TeleAtlas data set provides road names and address ranges.

Needs / Requirements

The NJTA is in the process of implementing an enterprise GIS, and starting to utilize GIS data and functionality for a wide range of applications.

The NJTA is working in close connection with the NJDOT, and utilizing the NJDOT road data set as their major reference layer. Both agencies are part of the federal highway program and are required to report accurate mileage to receive federal funding. The NJDOT data set provides higher spatial accuracy and complies with the federal requirements. For that reason the NJTA will continue using the NJDOT road data set as its primary road data source. Changes introduced to the data set by the NJTA will be incorporated into the data set by the NJDOT. This workflow provides the opportunity for cooperation and data sharing between the two agencies.

The LRS is essential for the NJTA since most of the information pertaining to the highway coverage and its infrastructure is linked using milepost reference. The LRS serves a central function of tying together all of the NJTA data sets.

The NJTA is looking toward utilizing GIS as a planning tool for creating traffic models, planning new highways and related infrastructure, for traffic management, etc. Routing functionality would play a central part in such applications. The TeleAtlas data set is currently being evaluated by the NJTA as a reference data set for routing.

One of the priorities for routing applications would be evacuation routing. This would require information on local roads as well as road coverage in the adjacent states that the TeleAtlas data set provides. Some work has already been done in cooperation with the NJ State Police. Additional data sets such as bridges would also play an important part in evacuation routing.

Additional routing attributes that do not exist in the TeleAtlas data set include weight and height restrictions. The NJTA is working with the NJDOT on issuing track permits. Freight routing and modeling is an important part of operations.

It is unlikely that the NJTA will be taking advantage of the TeleAtlas or any other commercial data sets, since most of the geocoding is done through the LRS and utilizes customized attributes and naming conventions that the NJTA has implemented in cooperation with the NJ State Police.

Applications	**Current**	**Potential**
Geocoding by Addresses		✓
Routing		✓

LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	Most of the desired attributes are collected and maintained in-house (e.g. traffic characteristics, customized names, etc.)
Geocoding Attributes	Mileposts, customized local names.
Routing Attributes	Weight and height restrictions.
Accuracy (Alignment)	Spatial accuracy is important for Federal highway mandate reporting.
Completeness	Would be important for traffic diversion.
Geographic Extent	State of New Jersey and adjacent counties.

County GIS Coordinators

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Steve Rice	Morris County
David Kunz	Sussex County
Patty Leidner	Hunterdon County
Merrilee Torres	Burlington County
Miyuki Kawada	Passaic County
Dominic Juliano	Salem County
Matthew Duffy	Atlantic
Barry Hackett	Atlantic
Matthew Lawson	Mercer County
Jim Lex	Camden County
Eric Anderson	Monmouth County
Matt Mathan	Union County

Overview

GIS offices within the counties provide a wide range of GIS services, data and support. Generally, GIS offices are responsible for maintaining a series of county-wide data sets, supporting existing GIS applications, and providing general GIS support.

The State of New Jersey includes twenty-one (21) counties, eleven (11) of which were available for the requirements workshop. Responses received from the counties regarding the road data sets they utilize varied significantly. Very few counties use the NJDOT data. Most counties utilize enhanced versions of the TeleAtlas road data set that they maintain in-house. Other road data sources mentioned included TIGER-based and GPS-derived road data sets. Nearly all of the counties use a combination of road data sets to satisfy all of their GIS needs.

Current Status

GIS applications utilizing road data vary among the counties. Mapping is the only application fully supported by all GIS units. A common GIS task is transportation management support, in particular routing. Other applications include planning and land use, 911 services support, engineering, and law enforcement. Supported applications and other factors, such as available funding and local regulations, determine the counties' road data selection to a large degree.

None of the counties reported use of the NJDOT road data set as their only road reference. Some counties use the NJDOT roads as a reference outside of their own jurisdiction.

Most counties use the TeleAtlas road data set as their primary or secondary data source. For many of the counties, the TeleAtlas data set serves as a foundation for their own road data sets that they have been maintaining and enhancing in-house. In the case of Atlantic County, the TIGER road data set was used as a foundation for building their own road data set. Other data sources include road data sets developed by the counties through digitizing over orthoimagery, GPS data collection, or by using tax parcel information. Often a combination of these methods was used to develop road data. For example, Burlington County used a combination of a GPS-derived network and TeleAtlas. Morris County realigned TeleAtlas roads using various orthoimagery sources.

The road data used by the counties vary in terms of spatial and attribute completeness. Some counties collect information on private roads, but the degree of completeness is unknown for these data sets.

Most of the counties utilize routing. Two major routing applications are local transportation support (bus and para-transit routing) and emergency routing. Bus routing takes advantage of the original TeleAtlas road data set that is usually used with the commercial routing software (e.g. Trapeze). Only Union County reported utilizing routing for emergency response. The county is using their own GPS-derived road data set to support this application.

Few counties are maintaining any routing attributes such as one-way information or turn restrictions.

Many counties perform geocoding to support various county needs for address matching. Reference data utilized for geocoding varies from county to county, and often includes more than one data set. Usually one of the following data sets or a combination is used: address points, road data set (usually based on TeleAtlas) and tax parcel information. No geocoding using mileposts was reported.

Nearly all of the counties are facing the challenge of keeping their geocoding reference data up-to-date and in sync with other data sources. One such challenge is a mismatch between road names and address information between the MSAG (Master Road Addressing Guide) and the other reference data.

The MSAG database contains address information collected by the phone companies and utilized mostly by the 911 services to identify caller location for the emergency response. Mismatches between the data sets, which are often due to the different naming conventions, make it difficult to geocode emergency calls and provide timely responses. Some counties are working to eliminate the mismatches between the MSAG and reference data (road lines or address points). For example, the county of Monmouth has been trying to match their address points with the MSAG data, and Union County is enforcing national address naming standards, both within the county and in the MSAG to bring their data sets in sync.

In addition to the road data set, counties maintain other data such as bridge points. Most counties reported having bridge point data sets; however, it appeared that most of the data sets only

contained county-maintained bridges. Some counties maintain routing attributes. For example, Hunterdon County collects information on one-way roads as well as over- and underpasses. Sussex and Atlantic Counties have weight restriction information, while Morris and Burlington maintain one-way attributes.

Current Data Maintenance

All of the counties interviewed are working on maintaining their road data sets in-house. However, there is usually no formal update procedure established. Road centerline updates are usually driven by multiple sources, mostly by notifications from the 911 services and through tax parcel updates.

911 offices usually notify the counties' GIS services about new road developments. Most of the 911 updates come from municipal 911 coordinators. Currently there is almost no formal workflow established to ensure that all of the updates get reported to the counties' GIS offices and are incorporated into the road data sets. Only Burlington County has a well established business workflow for pushing updates from municipalities to the county officials.

Updates to the road geometry often rely on orthoimagery that is being provided on a 5-year basis. Other counties use subdivision information for updates, while the rest rely on updates from parcel mapping projects.

Needs / Requirements

County GIS services vary significantly in terms of their road data sources, maintenance efforts, and supported applications. Even within the same county, different data sets are often used for different purposes. It is not uncommon for a county to use TeleAtlas data for routing, parcel data for geocoding, and enhanced TeleAtlas data set for mapping and other needs.

Having access to a single data set that could be utilized for multiple purposes would help improve the counties' GIS operations. All of the counties that took part in the interview expressed a strong interest in having an improved statewide road data set. The following three attributes that are currently missing from the road data sets, but could help improve their performance, were considered most important:

- alternate road names as well as formalized primary road names;
- functional Classes including ramps (NJDOT has ramps info and classification); and,
- jurisdictional information.

Geocoding is one of the areas that many counties would like to improve. Right now most of them use a combination of data sets for geocoding, and struggle to maintain address consistency and formalize naming conventions between different data sets. Having a single data set that includes alternate road names for geocoding would be very desirable for all counties.

Routing is another area that needs improvement. Most of the counties utilize the original TeleAtlas data set for routing. However, there is no active mechanism for providing data updates to TeleAtlas, which means that routing often relies on outdated information. Having a statewide data set that is maintained and could replace TeleAtlas could help resolve this problem.

The counties have also expressed interest in turn restrictions and weight/height restrictions for routing purposes. Only a few counties maintain one-way and weight restrictions information, and none of the counties has turn restrictions data. Having these attributes on a state-wide level would be very desirable.

It was pointed out that information on functional road classes including ramps would be very important. This information is currently included in the NJDOT data set but is lacking from other road data sources. It was also suggested that adding attributes for unimproved and access roads would be very helpful, especially for 911 services.

One of considerations is compatibility between the centerline data and census data, since transferring address ranges from TIGER might become necessary. To improve compatibility between census data and the road data set in support of the current applications, it was suggested that the road segments need to be split using the following features:

- intersections and possibly railroad crossings;
- administrative boundaries; and,
- ZIP code boundaries.

All of the counties expressed interest in having specifications and guidance for data collection and maintenance. Ideally, they would like to adapt a general model that everyone could maintain and build upon. LRS would play an important part in creating such a model since it would allow each county to collect and maintain its own data within the same database design. Additional information that could be included in the road database through LRS include: striping, number of lanes, speed limits, etc.

Applications	**Current**	**Potential**
Geocoding by Addresses	✓	
Routing		✓
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning	✓	

Data Requirements

Characteristics	**Description**
Attributes	Functional road classes, classification for unimproved and access roads; striping, number of lanes, speed limits, other LRS attributes.
Geocoding Attributes	Address ranges, alternate road names.
Routing Attributes	One-way, turn restrictions plus weight and height restrictions.
Accuracy (Alignment)	Attribute accuracy, spatial accuracy.
Completeness	Information on local and private roads is critical.
Geographic Extent	State of New Jersey (individual counties).

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Burlington County

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Monica Gavio	Burlington County 911
David Rickert	Burlington County GIS

Overview

Burlington County is utilizing the road data set that was developed by the county's GIS unit in 1999. The data set was developed and is being maintained largely through GPS data collection. The data set includes some private roadways, but not all of them. Private roads are being collected as discovered if they are in an area designated for maintenance at that time, or needed for a particular project. The data collected by the county is very spatially accurate, and is used to georeference their parcel data.

The county has also entered into an agreement with TeleAtlas and utilizes their road data that comes with quarterly updates. The agreement benefits both the county and TeleAtlas in that the county provides TeleAtlas with road updates, while TeleAtlas collects information on address ranges, which the county does not maintain. The TeleAtlas data set is now used for geocoding since it provides address ranges and is also being used by the county transportation department for bus routing, and is being integrating into Public Safety's 911 mapping interface.

Burlington County is a pilot project unique in the State of New Jersey. The county falls under legislation that recommends following a formal routine to maintain their road and address data. The full legislation can be found at the following URL:

http://www.co.burlington.nj.us/departments/public_safety/communications/addressinglaw/law.doc

This is state level legislation introduced for Burlington County as a pilot; it includes protocols describing how to assign addresses and address requirements (e.g., not having duplicate names, etc.) At the beginning of this pilot project the county had to re-address some locations and standardize its address format.

Current Status

The current data maintenance routine dictated by the legislation requires every development in the county to be approved by several county officials, including the 911 coordinator, before it can be built.

When there is a new development being added, the involved municipality works with the county on road naming. The municipality then sends the address and building request to the county prior to actual construction as a part of obtaining a building permit. The municipality also sends the development drawing to the county, usually in computer-aided design format. The building permit gets approved by county officials, while the new address information is added to the computer-aided dispatch system and the spatial data are forwarded to the GIS unit to be incorporated into the road data set.

This way, before the new development is completed the county already has the new information in the computer-aided dispatch system where it is available to the emergency dispatch operators. The new road is also digitized into the road data set.

In addition to residential address information, the county maintains a common names table that includes business information. That allows emergency dispatch to geocode a business location by the business name.

The county established a business workflow for synchronizing their address information with the MSAG (Master Road Address Guide) database maintained by Verizon. Verizon requires the county 911 coordinator's permission to add new records or change existing ones in MSAG. The county is using special forms (one for street name additions or corrections, and one for street number discrepancies) to forward new address information to and from Verizon.

A different form is used to communicate about incorrect addresses. 911 operators forward any discrepancies they find with road addresses to the county's 911 coordinator, who compares multiple address sources including MSAG, the dispatch database, and tax parcel information to identify and correct the problem. If the MSAG is wrong, the information is sent to Verizon and they update their data. Otherwise, the dispatch database is updated.

Needs / Requirements

Burlington County sets an example of a successful business process for maintaining road information within a county. The county is pioneering in establishing cooperation between municipal governments, county government, and the phone service provider.

Other counties expressed strong interest in following the practice established at Burlington County. They would like to adopt the same legislation and utilize a similar business process. There are some concerns, however, about involving other counties in a similar process without first making necessary preparations that would involve changes to existing addresses. That in itself, will require a significant effort and dedication from the counties.

Another concern is the fact that current legislation does not establish any liability for failing to follow the requirements. There are currently no enforcing mechanisms built into legislation that might be required to ensure its successful implementation.

Applications	Current	Potential
Geocoding by Addresses	✓	
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch	✓	
Planning	✓	

Data Requirements

Characteristics	Description
Attributes	n/a
Geocoding Attributes	No road addresses, business addresses.
Routing Attributes	One-way, turn restrictions.
Accuracy (Alignment)	High spatial and attribute accuracy.
Completeness	Require information on local roads and private roads.
Geographic Extent	Burlington County + adjacent municipalities for the 911 center.

County Emergency Services

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS
Craig Reiner	NJOIT - OETS
Steve Watson	NJ Department of Treasury - OMB
Tom Mason	Gloucester County – 911
Neil Campbell	Monmouth County – 911
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Doug Raynor	Verizon –DBMC
Maria Soares	Verizon – DBMC
Hope Damato	Verizon – DBMC
Mike Giunta	Verizon – DBMC
Jeff Golomb	Mercer County – 911
Ian Gray	Mercer County – 911
Henry Birkenheug	Camden County – 911
David Rickert	Burlington County – GIS
Monica Gavio	Burlington County – 911

Overview

Counties' communication centers or 911 calling centers handle emergency calls and address emergency situations. Often the communication centers are part of the counties' Department of Public Safety and work along with Offices of Emergency Management, fire marshals, emergency services training centers, etc. to provide a wide range of preventive, protective and emergency services. The communication centers work closely with local municipal 911 coordinators to coordinate response to emergencies and avoid unnecessary duplication of services.

Communications divisions provide different coverage and emergency response services. For some counties the communications centers provide statewide response, while in other counties part of the 911 responsibilities fall on the municipal communications centers. County communication centers handle emergency calls for different agencies, including law enforcement agencies, and dispatch all fire and emergency medical services. The number of agencies varies from county to county. Some counties rely on other agencies, such as the New Jersey State Police, to handle emergency calls.

Five 911 coordinators from various counties, as well as Verizon representatives were available for the interview. It appeared that all counties utilize different approaches and systems to respond to 911 calls. Almost all counties utilize a computer aided dispatch software system. Some of these dispatch systems have a mapping component and some do not. Examples varied from Camden County, which only uses maps for general reference, to Mercer County where the map application is mission critical when responding to cellular phone calls. For most 911 call centers, however, mapping is not a critical application. Road maps are usually used as a general reference

while location information is being passed from a phone company to the 911 unit, and then to the dispatch system as a digital road address.

Current Status

The primary function of the 911 call centers is to correctly identify a caller's location and either direct the call to an appropriate agency or dispatch a response crew. The dispatch systems allow the 911 operators to receive emergency calls and identify the caller location using information provided by the phone company.

911 call centers receive two types of phone calls: land line calls and cellular calls. According to the 911 coordinators, more than 60% of all calls are now received from cellular phones. Both types of calls are received by the phone company and then forwarded to the 911 Center, along with the location information for the caller.

Calls coming from land lines are matched to the address information stored in the MSAG (Master Street Address Guide) database maintained by Verizon for the entire State of New Jersey. Address information from MSAG is then passed to the dispatch system and can be viewed by the operator.

Cellular calls also go through the phone service provider. The location of the caller is determined by triangulating the signal source between the closest cellular towers. The triangulated location is then passed to the dispatch system either as X,Y coordinates or as an address. In some cases when the location of a cellular caller cannot be determined, the operator needs to communicate with the caller to find his or her location.

Counties rely on different dispatch systems for their 911 response. Some dispatch systems depend heavily on their GIS component, while others do not use GIS at all. An overview of the Mercer County 911 call center is provided below.

Mercer County

Mercer County's 911 call center relies heavily on the GIS capabilities of their 911 system. The mapping application is separate from the dispatch system, however; the mapping application and the dispatch system are able to exchange information.

For incoming land line calls, the address of the building is automatically received and the location is displayed on the map. The combination of the map display and address information allows the operator to provide enough information to the emergency service provider regarding the location of the caller.

The mapping component is even more critical to the dispatch process when working with incoming cellular calls, since these calls are based entirely on an X,Y coordinate (rather than an address). In Mercer County, the incoming X,Y coordinate of a cellular call is immediately displayed on the map. The operation then uses the map to identify the location of the caller based

on other features on the map display. Mercer County displays road centerlines in addition to Pictometry images with parcel identifiers within the mapping application. More than half of incoming calls are cellular calls that require the map to provide the dispatcher with detailed and accurate road information.

Mercer County is planning on implementing automated vehicle location (AVL) in the future, with tracking of firefighter vehicles being their primary focus. The mapping component will also be critical for successful AVL implementation.

Maintenance

When new housing developments are under construction, there are currently three data sets that need to be updated:

1. the MSAG database maintained by Verizon;
2. the dispatch database maintained by the counties' communication centers; and,
3. the road data set usually maintained by the counties' GIS Unit.

In about 90% of the cases Verizon is first to find out about new developments. In most other cases it is the local municipalities that get this information first. Once Verizon is notified about a new development, they contact the municipality to get information about the address ranges. Verizon cannot change the MSAG unless there is a written authorization to do so from local authorities. There are times when local municipalities do not assign address numbers until the development is nearly competed; this holds back both Verizon and 911 services.

Except for Burlington County, none of the counties has a formal workflow established for updating their dispatch system and road data set, and communicating changes to Verizon.

Burlington County has a state-legislated pilot project with an established routine for updating all three data sets. Local municipalities are required to obtain approval from county officials for any potential development. Municipalities provide development plans, and work with the county on the assignment of new road names and address ranges. This way the county receives complete information about a development before construction begins. The county then forwards the address information to Verizon and updates its own dispatch data set. Development plans are forwarded to the GIS unit, which then sends out crews to GPS the new roads so the features can be added to the road data set.

The current workflow established in Burlington County has proven to be successful. The key component in this workflow is the fact that municipalities are required to provide updates to the county in the early stages of the development process; all three stakeholders, the county, the municipality and Verizon, work together. In other counties, municipal 911 coordinators do not always play a proactive role in keeping the county up-to-date. This has a negative impact mainly on the road data set, which is not kept in sync with the MSAG and dispatch data. The goal would be to update the road data set at the same time the data are sent to Verizon.

Needs / Requirements

As discussed above, different counties utilize various 911 systems that may or may not rely on GIS functionality and utilize a road data set. Counties that use mapping applications for 911 response usually use them for general reference. Operators might be able to see the caller's location on the map, but they do not use this information to generate a dispatch. The dispatch is usually being generated using electronic address information provided by the phone company. Some counties, such as Mercer, rely heavily on their mapping application when responding to cellular phone calls. Having accurate and complete data is critical for their mission.

Although different counties utilize mapping functionality to various extents, all of them expressed strong interest in having the most current and accurate information for their road centerline data sets.

In order for 911 services to have access to the most reliable information, data maintenance procedures need to be improved. Current data maintenance procedures in the counties do not a follow a well coordinated workflow, which causes data sets that support 911 operations to be out of sync. This is currently the case for the road data sets, which often do not get updated at the same time as the MSAG and dispatch data. Another challenge that the 911 services face is a mismatch in road naming conventions between MSAG/dispatch and the road data. This negatively affects geocoding results.

One way to address maintenance issues is to mandate that municipalities report new developments to counties as part of the building permitting process. This would allow counties to work with municipalities on new road names and address ranges, and to make sure that they follow requirements. It would also provide counties with information regarding future developments. At the building permitting stage, municipalities begin surveying the parcels, and should be able to report changes along with GIS information. If detailed information were not available right away, it would be possible for the county or municipality to sketch a draft of the new development; it could be mapped precisely when more substantial information becomes available.

It is important to note that improvements in maintenance procedures might benefit not only 911 services but counties in general, and potentially other agencies within the State of New Jersey. Gathering the most detailed and up-to-date information is a task that could be handled through cooperation between municipal and county governments.

911 call centers could also benefit from a collective effort to maintain road data by sharing data with each other. This would be especially important when addressing cellular calls that come from a neighboring county. When cellular phone calls come from outside a county's service area, many operators currently do not have any reference information (e.g., roads) outside their county to be able to locate the call. This is because counties usually maintain data only within their own jurisdiction. In these cases operators have to talk to a caller to identify their exact location, which

takes valuable time. An improvement that could be made to existing systems is to add data for adjacent municipalities to the dispatch systems. This would also help when emergency vehicles need to be dispatched to another county.

All counties would benefit from a road data set that could support routing. Currently most 911 response groups rely on local knowledge or GPS units in their cars. Utilizing routing could replace GPS units that use standard commercial road data sets, as long as routing data provide better accuracy. Fire chiefs especially would benefit from routing as well as any other information that could be provided to them, including building footprints, driveways, hydrants, chemical storage, etc. Pictometry would be another useful application that would allow access to detailed information about the area.

Applications	Current	Potential
Geocoding by Addresses	✓	
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch	✓	
Planning		

Data Requirements

Characteristics	Description
Attributes	n/a
Geocoding Attributes	Road addresses, alternate road names.
Routing Attributes	One-way, turn restrictions.
Accuracy (Alignment)	High spatial and attribute accuracy are critical.
Completeness	Information on local roads and private roads is required.
Geographic Extent	Extent of individual counties and adjacent municipalities.

Office of Geographic Information Systems (OGIS)

Participants

Doug Schleifer	NJOIT - OGIS
Andy Rowan	NJOIT – OGIS

Overview

The Office of Geographic Information Systems (OGIS) falls within the NJ Office of Information Technology (NJ OIT). OGIS plays the lead role in coordinating development and use of GIS data and technology throughout the State of New Jersey.

Three main directions in which the agency leads GIS development and coordination in the State of New Jersey are:

- Providing GIS solutions and helping integrate GIS technology in state and local agencies. OGIS is working to promote the use of GIS among state agencies and assist problem solving and decision making through GIS solutions
- Coordinating data development and sharing between agencies and building New Jersey's spatial data infrastructure
- Helping making GIS data and applications available to the public through web services.

OGIS is currently utilizing the NJDOT Roadway Network, the TeleAtlas road data set and TeleAtlas Route Server data with the ArcIMS Route Server extension in supporting their ongoing projects.

OGIS coordinates the TeleAtlas data set licensing for the State of New Jersey. Currently, OGIS licenses the TeleAtlas road data set covering the State of New Jersey and adjacent counties in neighboring states.

Current Status

OGIS is supporting a wide range of applications utilized by various state and local agencies as well as the general public. OGIS consults with individual agencies to improve their business processes through the use of GIS technology. OGIS also works to provide GIS functionality through interactive mapping applications, freely available on the OGIS website. The website also provides GIS layers and orthoimagery for viewing and downloading.

Currently, OGIS utilizes the TeleAtlas Route Server Data Pack for several routing and geocoding applications, and web services. To be precise, there are 4 applications and 1 geocoding web service in production that utilize this road data set. One of the routing applications developed by

OGIS is Travel Guide, developed for the NJ Division of Travel and Tourism. Travel Guide is available on the Division of Travel and Tourism's website and provides the general public with an interactive map of state tourist attractions, and is capable of routing and providing driving directions.

The NJDOT road data set is utilized by the Accident Records Information System for which development was coordinated by OGIS. The desktop application hosted by NJDOT allows batch as well as manual accident geocoding. Accident records are geocoded using SRI (standard route identifier) numbers and mileposts against the NJDOT road data set. There is no road address geocoding used for the accident locations. Geocoded accident records are utilized by NJDOT for traffic safety analysis.

OGIS also recently utilized the NJDOT road data set to generate a statewide municipal boundary layer, where road centerlines are coincident with municipal boundaries.

One of the main focuses of OGIS is statewide GIS coordination. OGIS implemented NJMapp (*The New Jersey Mapping Assistance Partnership Program)* to help county and municipal governments maintain and distribute spatial data consistently, and provide the required framework to build more effective enterprise systems, including 911 and emergency management, property assessment and management, etc. NJMapp is an innovative partnership and coordination program that provides a mechanism for developing spatial data statewide as well as an infrastructure to maintain and share data via the Internet.

In addition, OGIS is coordinating the New Jersey Geospatial Forum and the State Agency GIS User Group, which provide the state's GIS community with the opportunity to communicate, share experience, and provide information and support.

Needs / Requirements

OGIS' role as a statewide coordinator of GIS initiatives and provider of GIS services to other agencies is a key factor in determining the road data set that is most appropriate for the needs of the state. Being able to provide a wide range of services including routing, geocoding, mapping, etc. to various agencies as well as the general public requires a road centerline data set that is comprehensive, accurate and robust.

OGIS would benefit greatly from the creation of a single statewide road data set. The main areas where they would like to see improvements for the road data set include enhancements in address ranges, completeness, spatial accuracy, and an effective and efficient maintenance process.

Considering the coordinating role that OGIS plays among the NJ state agencies, they should be the lead organization in the creation of the statewide road data set and its maintenance process. An important consideration for the agency is the cost effectiveness of the new road data set. The

potential advantages need to be weighed against the costs of data set compilation and maintenance.

Applications	Current	Potential
Geocoding by Addresses	✓	
Routing	✓	
LRS	✓	
Mapping	✓	
911 Dispatch		
Planning		

Data Requirements

Characteristics	Description
Attributes	n/a
Geocoding Attributes	Address ranges; mile posts, SRI numbers
Routing Attributes	One-way, turn restrictions
Accuracy (Alignment)	Spatial accuracy is important. Connectivity is necessary for routing applications.
Completeness	Information on local and private roads is often required
Geographic Extent	State of New Jersey

Appendix B – State Centerline Programs

There is a critical need for states to coordinate and share GIS data resources amongst their state agencies. In particular, transportation and road centerline GIS data are critical to all factions of state and local government. Having one consistent GIS road centerline data set is proving to be a critical requirement for streamlining government planning, emergency response and decision making.

The National States Information Council (NSGIC) and the Federal Geographic Data Committee (FGDC) have formed a partnership called the Fifty States Initiative. This partnership aids states in an effort to coordinate their GIS initiatives across the various levels of local governments and agencies. The initiative provides funding and guidelines for enhancing data standardization and sharing, thus improving the efficiency of local government day-to-day operations. As states participate in the Fifty States Initiative, the resulting National Spatial Data Infrastructure (NSDI) becomes that much more robust.

Many of the states reviewed in this appendix have initiatives that were spawned from the NSGIC Fifty States Initiative. States now see the need to efficiently develop, share and maintain GIS data, and in a sense supporting the NSGIC concept of "collect data once and use it many times."

Other programs that have influenced statewide centerline development include the National Map, a U.S. Geological Survey (USGS) program aimed at providing a framework for public access to high-quality spatial data sets; and the Census Bureau's MAF/TIGER Enhancement Program (MTEP), which will both improve the spatial accuracy of TIGER road features and update the Master Address File (MAF) by 2010.

Below is a review of several states that are currently pursuing a statewide road centerline data set, and how they are moving toward a consolidated and standardized statewide spatial data infrastructure. Some states are in the initial stages, and still maintain multiple road centerline data sets, while others have already embraced the concept and have completed the development effort and are now in a phase of maintaining and updating a single, comprehensive data set.

ARIZONA

Overview
In 2008, the State of Arizona has implemented the Arizona GIS roundup which is an initiative to develop a statewide enterprise GIS. This initiative implements the National States' Geographic Council (NSGIC) Ramona GIS inventory system, which is a tool used to track the status of GIS in states and local governments in an effort to build a spatial data infrastructure. This tool enables Arizona agencies to incorporate their specific data sets and be able to facilitate a consolidated search for GIS data created by multiple agencies. There is no specific information regarding a comprehensive road centerline data set, however.

The Arizona Department of Transportation's (ADOT) Geographic Information Systems for Transportation (GIS-T) Section maintains the statewide road centerline GIS database for ADOT. The GIS centerline database is known as ATIS Roads. The centerline update process consists of data conflating and the addition of linear referencing and address information. Update information is provided by local agencies. Updates occur quarterly.

Arizona has another centerline data set maintained by the Arizona Geographic Information Council (AGIC) and the Arizona Land Resource Information System (ALRIS). This data set, the 2000 TIGER census road centerline layer, contains road centerlines, road names and address ranges for geocoding.

There is no information about the combining of these two data sets, or which of the two are being used for the Arizona GIS Roundup (Ramona) initiative. But it appears that the ATIS Roads layer is the primary focus for road centerline development.

Data Sources
ATIS Roads (ADOT) – Arizona DOT
ALRIS and AGIS Roads – TIGER 2000 Census data

Status
ATIS Roads (ADOT) - The ATIS Roads coverage is far from being complete.

Lead Agency
Arizona DOT – ATIS Roads - http://tpd.azdot.gov/gis/about.php
Arizona Geographic Information Council (AGIC) - http://agic.az.gov/

References and Links
Arizona GIS Roundup (Ramona) - http://sco.az.gov/ramona.htm
Arizona DOT – ATIS Roads - http://tpd.azdot.gov/gis/about.php
Arizona Geographic Information Council (AGIC) - http://agic.az.gov/

ARKANSAS

Overview
In 2002, Arkansas began the development of the Arkansas Centerline File (ACF) Program, which is a cooperative, statewide effort that integrates road centerline data from various local sources. This program was developed as part of a legislative initiative to establish the Arkansas Spatial Data Infrastructure. The goal in developing the ACF was to create a seamless statewide road centerline data set with address ranges and a horizontal accuracy of less than 10 meters. The ACF standards document was made a part of the Arkansas State Rules and Regulations. The document outlines the standards for road centerline data set attribute information and the methods for digitizing and GPS collection. This is to ensure consistency in data accuracy and format when local agencies contribute data.

Funding for the ACF program has been provided through one-time grants to individual counties, as part of an effort to develop a road centerline file that could be used to map physical locations of students with respect to schools and school district boundaries. The grant program, which began in 2002, requires that the newly created data sets adhere to standards established by the State.

At the county level, information is captured utilizing GPS techniques, digitizing from digital orthophotography (DOQQ), and by adjusting the Arkansas Highway and Transportation Department (AHTD) centerlines to match the DOQQs.

The ACF database is available free via the internet, through the Arkansas GIS data clearinghouse (GeoStor). There are currently no restrictions on sharing this data set. Efforts are being made to link the GeoStor project with a state Transportation Framework in cooperation with the Arkansas Highway and Transportation Department.

Maintenance of the data is an on-going issue, as the original funding was in the form of one-time grants for data development.

Data Sources
Features were digitized at a scale of 1:12,000 with horizontal accuracy better than 10 meters. Local sources have the option to capture road centerline data via GPS, and must adhere to the Standards for Collecting Mapping Grade Global Positioning System Positions. Sources for the road attribute data include: 911 MSAG files, subdivision maps, and real property assessment data.

Status
Of the 75 counties in the state:

- 64 already completed;
- 9 expected to be completed in 2008;
- 2 still do not have 911 addresses; and,
- completion date is estimated for 2009.

Lead Agency
Arkansas Geographic Information Office (AGIO)
http://www.gis.state.ar.us/Programs/Programs_current/ACF_index.htm

References and Links
The Arkansas Centerline File Program standards document:
http://www.gis.state.ar.us/Documents/ACFstan.pdf

CONNECTICUT

Overview
In 2007, Connecticut's Geographic Information System Council (CGISC) established a Data Inventory and Assessment Working Group to identify and prioritize statewide framework data sets. A transportation subcommittee was established, with a priority being the creation of a statewide road centerline data set.

During 2008, the transportation subcommittee has been developing a draft plan to acquire and/or develop a seamless centerline file for the State. This data set will contain complete road network, with attribution that will support address geocoding and routing capabilities. The Subcommittee also has plans to develop transportation-related data standards that will be forwarded for consideration by the state's Geospatial Information Systems Council (CGISC).

The Connecticut Department of Transportation (ConnDOT) has recently taken the lead in developing a statewide centerline file. Currently several GIS transportation data sets exist for the State of Connecticut. The primary data set used for road names, addressing and geocoding is hosted by The Department of Public Safety's Office of Statewide Emergency Telecommunications (OSET), which is based on TeleAtlas data and is updated quarterly. ConnDOT has a data set containing only state-maintained public roads, which has a linear referencing system but does not contain address attributes. The Department of Environmental Protection (DEP) has a statewide layer that includes local and private roads, but has minimal attribute information. Finally, there is a statewide file of TIGER roads containing address information (road names and address ranges).

The comprehensive road centerline data set is being developed by combining the linear referencing elements of the existing DOT data with road and address range attributes from TeleAtlas and the OSET data.

Data Sources
ConnDOT's state roads data set and related infrastructure elements; OSET's TeleAtlas data; various local and regional government entities; private transportation agencies including Amtrak and Metro North.

Status
Estimated two years to complete

Lead Agencies
Connecticut Geographic Information Council (CGISC)
Connecticut Department of Transportation (ConnDOT)

References and Links
CGISC Data Inventory and Assessment Working Group -
http://www.ct.gov/gis/cwp/view.asp?a=3034&q=404742

CGISC Transportation Subcommittee - http://www.ct.gov/gis/cwp/view.asp?a=3034&q=400030

CONNECTICUT GEOGRAPHIC FRAMEWORK DATA document (p. 45) - http://www.ct.gov/gis/lib/gis/Connecticut_Framework_Data_Themes_Final_Report_010708.pdf

ILLINOIS

Overview
In the State of Illinois, the Illinois Geographic Information Council (ILGIC) and the Illinois Department of Transportation (IDOT) began a collaboration to develop a statewide road centerline file. Initially begun as a means of enhancing homeland security and emergency response initiatives, I-ROADS (the Illinois Roadway, Operations and Address Database System) will result in the development of a geographic database of the entire road system, including addresses, for the State of Illinois. I-ROADS can be used for geocoding, incident management (linear referencing), and the development of other data layers.

When the I-ROADS project began, the existing road centerline layer maintained by IDOT was missing over 30,000 road segments and had no address information. IDOT hired a consultant to develop a comprehensive, statewide centerline file that could be used for geocoding.

The I-ROADS data set was developed by integrating the existing centerlines (which had complete attribute information) with NAVTEQ data, which contains more local and private road segments. IDOT is conflating the state data's link-node and attribute information to the NAVTEQ line segments.

Data Sources
I-ROADS is a combination of the IDOT existing road centerlines data set and the NAVTEQ premium road centerline data set, with quarterly updates.

Status
No current information available.

Lead Agency
The Illinois Geographic Information Council (ILGIC): http://www.illinois.gov/ilgic; and
The Illinois Geographic Information System Association: http://www.ilgisa.org

References and Links
ESRI Summer 2006 ArcNews article:
http://www.esri.com/news/arcnews/summer06articles/the-roots.html

KENTUCKY

Overview
Since 1991, Kentucky has had centerline data based on 1:24,000 USGS maps, stored and maintained by county. In 2001, Kentucky developed a spatial data standard that met both to Federal Geographic Data Committee (FGDC) geospatial data content standards and data sharing requirements of the National Spatial Data Infrastructure (NSDI).

As part of the State's data development efforts the existing centerlines are being replaced by GPS-based data with an accuracy of less than 4 meters. As of 2005, Kentucky DOT (KDOT) has created a complete road centerline file using GPS for data collection. The State maintains two separate versions of the centerline data set, one with address attributes and one that can be used for linear referencing, but which has few attributes.

Regarding updates, the State has identified standards for the collection of address locations throughout its agencies. The goal is to improve the quality of address data collected in all statewide information systems, enhancing the ability to map and analyze data.

Data Sources
KDOT road centerlines and GPS for updated road geometry

Status
The conversion process was completed in 2005

Lead Agency
Kentucky Transportation Cabinet

References and Links
Standards for KYTC Road Centerlines:
http://technology.ky.gov/NR/rdonlyres/FCF958CF-C66B-495B-A23C-2F1AA55E3BF7/0/GIAC_Road_Centerline_Standard_v1_1.pdf
ESRI ArcNews Article, Summer 2005, Commonwealth of Kentucky's Enterprise Implementation: http://www.esri.com/news/arcnews/summer05articles/commonwealth-of-kentucky.html

MAINE

Overview
Currently there is no comprehensive statewide maintained road centerline data set for the entire State of Maine. There are two main data sets in use: a transportation roads data set maintained by the Maine Department of Transportation (DOT); and an 911 roads data set (1:24,000) maintained by the Public Utilities Commission (MEPUC), the Emergency Services Communications Bureau (ESCB), and the State Office of Geographic Information Systems (MEGIS).

The DOT centerline data was developed from USGS quadrangle maps by the Maine Office of GIS. Currently the DOT is updating the file to integrate it with the DOT's link-node Linear Referencing System (LRS). While the DOT data does not include address information, the 911 centerline data set has road names and address ranges last updated as of 2006. Maintenance information is incorporated at the request of local municipalities.

Data Sources
DOT Road Centerlines: USGS quadrangle maps (scale 1:24,000). GPS data collection and local verification
ME DOQs (appended, compressed USGS Digital Orthophoto Quarter Quadrangles)
US Census Bureau TIGER/Line Files

Status
The State of Maine has identified the development of a statewide, comprehensive centerline data set as one of its data-related priorities. This will be done as a part of modernizing the State's TIGER data, and will involve coordination of efforts between the DOT, 911, and MEGIS. Planned acquisition of high resolution orthoimagery will enable accurate editing and updates.

Lead Agency
Maine Office of GIS (MEGIS): http://megis.maine.gov/

References and Links
Main GIS Data Catalog: http://megis.maine.gov/catalog/

MASSACHUSETTS

Overview
The State of Massachusetts has various centerline data sets maintained through the Highway Department and available through the MassGIS website. These include a 1:5,000 scale centerline file, used by the Office of Transportation Planning, which has accurate geometry but minimal attributes.

In order to improve geocoding processes throughout the State's various agencies, Massachusetts recently purchased an enterprise license for NAVTEQ data. These files can be used by any government or political agency in Massachusetts; however the data continues to be the property of NAVTEQ. The Massachusetts Highway Department, in conjunction with MassGIS, will be working to update and maintain the 1:5,000 road centerlines using the updated NAVTEQ data.

In summary, Massachusetts still maintains several road centerline data sets, but has focused on improving the geocoding/address data set by working with NAVTEQ and local resources to improve locational capabilities. While users within the State can utilize the NAVTEQ data, MassGIS only distributes TIGER-based road centerline data to the public via their website.

Data Sources
NAVTEQ Road Centerline Data

Status
Currently using NAVTEQ, and coordinating with local users for updates.

Lead Agency
Massachusetts Geographic Information System (MassGIS) - http://www.mass.gov/mgis/massgis.htm

References and Links
Description of the 1:5,000 state centerline file - http://www.mass.gov/mgis/eotroads.htm
MassGIS and NAVTEQ partnership - http://www.mass.gov/mgis/geocode_data.htm

NEW YORK

Overview
The State of New York has a comprehensive statewide road centerline data set that is a component of the New York State Accident Location Information System (ALIS). ALIS is a multi-agency initiative with the Office of Cyber Security and Critical Infrastructure Coordination as the lead for the Statewide GIS framework data set construction.

The statewide roads data set is maintained collectively by local governments and private sector partnership for statewide roads and addressing. New York has a partnership with TeleAtlas for maintenance of statewide roads and addresses. The features of this statewide roads data set include: up-to-date road centerlines, road names, route numbers and aliases, and address ranges. Separate linear referencing systems are maintained by the New York State DOT and New York Thruway Authority. In addition, there is a Web-based Map Maintenance and Notification Tool (MMNT) for distributed, collaborative editing of roads and address data sets by local government partners. Additional workflows allow counties and municipalities to provide batch updates of road data sets.

Part of the January 2008 State of New York Geographic Information System (GIS) Strategic Plan document published by the NYSGIS highlights the importance of streamlining the flow of road centerline updates from the local municipalities to the state level. The MMNT tool is used to obtain direct local input and involvement in the road updating process. The long-term vision for developing and maintaining roads GIS data in New York involves more tightly linking GIS data update activity with the fundamental local government business transactions, such as "road acceptance" and deed recording, which trigger the need for those changes.

Data Sources
ALIS Roads – data obtained through a partnership with TeleAtlas, and through updates made from local municipalities.

Status
ALIS Roads - Complete and under maintenance.

Lead Agency
Office of Cyber Security and Critical Infrastructure Coordination -
http://www.nysgis.state.ny.us/index.cfm

References and Links
NY ALIS Presentation - http://www.gis-t.org/files/EAPPb.pdf
Office of Cyber Security and Critical Infrastructure Coordination -
http://www.nysgis.state.ny.us/index.cfm

MONTANA

Overview
Montana began development of a comprehensive framework approach toward standardizing key GIS data layers, resulting in the creation of the Montana Spatial Data Infrastructure (MSDI). The MSDI contains various framework layers, one of which is the Transportation layer containing road centerlines.

The State has implemented an effort called the Montana Transportation Framework project, the main goal of which is to combine transportation data from available sources and integrate them into a seamless road centerline network. Other goals include improvement and facilitation of data exchange, data sharing initiatives, and ongoing planning efforts to ensure long-term support of state and local programs (e.g. E-911).

Short-term plans for 2008 include review of planned county updates, comparisons between county and state road data sets, data updates, improvements to framework elements (geometry and attributes), and integration of updated address range attributes.

Longer term goals include continued updates to road attribute information, the addition of other transportation and base features (e.g., railroads, trails, hydrography and aviation), distribution of the data via the internet, making improvements to the State's geocoding capabilities, and looking into the development of a routes layer to support transportation network applications.

Data Sources
Tiger data, GIS data sources

Status
The Transportation and Addressing Framework Team has completed conflation of TIGER address ranges and addition of county address ranges to the framework database. Currently the database is undergoing QC of the tabular and spatial data.

A personal Geodatabase in ArcGIS versions 9.1 and 9.2 is posted on the MSDI website.

Lead Agency
The Montana Spatial Data Infrastructure (MSDI) - http://giscoordination.mt.gov/

References and Links
Montana State Transportation Theme web site -
http://giscoordination.mt.gov/transportation/msdi.aspx

VERMONT

Overview
In 2007, the State of Vermont formed the Enterprise GIS Task Force (EGT) to develop plans for standardizing all statewide GIS data, including road centerlines. Currently, Vermont does not have one combined road centerline data set for the entire state. There is a state DOT (VTrans) centerline data set, as well as a road centerline layer maintained by the Vermont 911 Board.

While the VTrans data set has the most up-to-date transportation-based attributes, it does not include local or private road data. There may also be issues with the VTrans data including a mismatch with 911 road names, as these attributes were not incorporated into the VTrans data. VTrans data does not include address ranges.

The 911 data set, however, was originally developed from the VTrans data. The 911 data has been enhanced to include all public and private roads, with better road name and address name attribute information. The 911 Board receives geometric updates from the towns, which are digitized into the GIS centerline database. Field collection and verification is performed using GPS. Vermont is currently completing an update to address information statewide, based upon address information in a separate point file.

The VT Department of Transportation has taken over the update and maintenance of the road centerline data.

Data Sources
VTrans centerlines – local highway maps, updates based on 911 data, DOQ digitizing.
911 Board centerlines – GPS field collection, DOQ digitizing.

Status
- The data sets vary in terms of spatial completeness (ex: 911 includes all roads whereas VTrans does not);
- The VT 911 Board is in the process of actively reviewing and updating all the line work for the 911 roads data set. This process is expected to be complete in five years. This process involves snapping existing road centerlines to the current DOQs and using GPS to capture and verify road locations; and,
- The EGC just published their draft plan to start the standardization and combining of all GIS data.

Lead Agency
The EGC is co-led by the Vermont Center for Geographic Information (VCGI) and the Vermont Department for Information and Innovation.

References and Links
Status of VTrans and 911 road layers (VCGI):
http://www.vcgi.org/techres/white_papers/rdsfaq/VT_roadcenterline_FAQ.pdf

Information regarding the EGT:
http://www.vcgi.org/about_vcgi/default.cfm?page=./projects/egis/default_content.cfm
Vermont Center for Geographic Information:
http://www.vcgi.org/