Software Tools for Sharing and Integrating GIS Data

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Summary

The Washington Department of Transportation (WSDOT) in partnership with the Oregon Department of Transportation (ODOT) are establishing a consortia of public and private entities for the purpose of developing computer based tools that facilitates geo-spatial transportation data sharing and integration for a variety of purposes and uses. The Geo-spatial Integration and Sharing Data Consortium (GISDC) will be funded via a Pooled Fund arrangement and managed by WSDOT.

The goal of the consortia is to continue developing, implementing and providing a variety of tools for sharing and integrating of geo-spatial transportation data. Examples include:

- Translation
- Integration
- QA/QC
- Linear Referencing Integration

The initial timeline for this development is three to four years. Annual consortium meetings and electronic communication will be used to coordinate project activities. The specific product specifications and number of versions developed depends on annual funding available.

Background

For state transportation agencies location is an integral part of most data collected and utilized. When data has a location referencing element (e.g. address, route/milepost, GPS coordinate) it can be used with a Geographic Information System (GIS) and placed on the roadway or other parts of the transportation system. Much of the useable data about transportation is not maintained at the state DOT level, but at the local level or with other agencies (i.e. county, city or municipal level agencies). For planning, project scoping, environmental management, emergency management and other integral DOT functions there is a significant need to collect and combine this data to create a complete statewide transportation network and associated location referencing systems. The Oregon Department of Transportation (ODOT) and the Washington State Department of Transportation (WSDOT) have begun projects to collect and integrate this data statewide. They have identified several critical software tools, which will facilitate the collection and maintenance of this data. These software tool sets could be very useful to other state transportation departments if they are dynamic and developed with maximum flexibility. The tool sets could also be useful beyond developing and maintaining a statewide transportation network for GIS, known as a "transportation framework." In Washington the project is called "WA-Trans", for Washington State Transportation Framework. This pooled fund solicitation will be used to attract more states to participate in the development of these tools. The more participants and resources involved, the easier it is to develop the most dynamic and flexible tools. A description follows of each proposed tool, how it interacts with the other tools, and the potential data upon which it could operate.

Data to be managed with these tools include includes:

- Roads: location, number of lanes, federal functional classification, address ranges, zip codes, local road identifier, route number, road name(s), location along roadway (milepost), and their geographic representation;

- Railroads: location, type of track (mainline, siding, etc.), train stations location, classification, line identifier, type of crossing, and their geographic representation;
- Ferries: route location, terminal location, route name, federal functional class, staging areas, route length, international or domestic route, average sailing duration, etc.
- Aviation: Airport identifier, surface type. Instrument landing approach, arc code, runway width, use, elevation, FAA Classification, Airport name, terminal location, etc.
- Non-motorized: includes bikes, foot, horses, etc. Includes location, name, type of usage, etc.
- Ports: location, routes for water transportation (particularly river and Puget Sound)
- Other data as yet not defined.

Consortium Focus Areas

Translator (Phase I)

Various governmental entities collect and maintain GIS transportation networks to meet their business needs. Local governments frequently collect and maintain highly accurate GIS transportation data in a format that is useful to them. These systems currently require significant manipulation to work with any system that state agencies have developed. In order to use this data the OR/WA pooled fund project proposes development of a translator that will function to convert data from standard GIS and CAD systems used by various governments into a format that is useful to both of them. . A dynamic and flexible translator could translate data into a variety of formats, which could be useful in similar efforts taking GIS vector data with attribution and location referencing from one format into another.

The proposed translator would be bidirectional. That is, it would format and evaluate data from the data provider to the transportation framework (or other data user) and then also translate data from the transportation framework back to a format and projection or coordinate system to be used by they original data provider. This allows the combined dataset to be used by many governmental entities. The translator would have a friendly user interface that would facilitate setting up the initial data exchange process and store that setup structure so it could be reused in a maintenance mode to facilitate updating the data. The translator would check the data for simple constraints to ensure it met basic requirements as defined by the two parties involved in the exchange.

Data Provider Internet Interface (Phase I)

The data provider Internet interface works with the translator and security system so the organization providing the data has a user interface for providing their data. This interface will allow them to access the translator for setting up the initial translator process, or for changing the process when their data has changed. It will provide feedback on data that is not useable and why. It will allow for regular updates of data based upon arrangements between data providers and data users. In the case of ODOT and WSDOT, it will be the local government providing the data and the transportation framework system. It will interface with the security system to make sure the provider is actually the authorized source for the data provided.

Data User Internet Interface (Phase I)

The data user Internet interface works with the translator and security system so an organization wanting to view or download data that has been translated and integrated into a combined database (transportation framework) can access the data. They will be able to:

- Select the geographic region for the data they wish to view/download,
- View the metadata for that selection (Metadata is information about data). In a GIS, metadata is critical because it describes the time when the data was collected (temporal accuracy), the spatial accuracy of the data, the projection and coordinate systems of the data. Because GIS data is placed on the earth's surface, this information is critical when combining data to provide consistency.
- View the actual data for that selection,
- Download the data.

The security system will make sure they are authorized to access that data. A disclaimer will be provided regarding the limitation of the data. The translator will be available for formatting the data and projecting it as needed by the data user.

Once they have downloaded the data they can then incorporate it back with their GIS transportation data and use it accordingly.

Data Integration (Phase I – requirements & feasibility, Phase II – implementation)

The data that ODOT and WSDOT expect to receive from the various agencies will be linear data (representing roads and other transportation modes) with data fields (called attribution) describing characteristics of the roads such as number of lanes, federal functional class, pavement type, etc. The data also includes location referencing information such as addresses, route names, and mileposts. Location referencing data helps "locate" things on specific places along the transportation line. Because the data comes from various sources and each source collects and stores their data differently it may not "match" at jurisdictional boundaries. For example a road in one county may appear to just end when the same road in another county may appear to just begin when that data is displayed on a map, instead of a continuous line just like the real road. Or one road is disjointed, and doesn't connect at all where it crosses a jurisdictional boundary, when in reality it is one continuous entity. Even within a specific jurisdiction there are multiple potential providers of road data causing similar problems. Fixing this problem is referred to as "edge matching" or horizontal integration.

There are other types of mismatch. Making sure that the most accurate and complete database attribution is correctly attached to the most accurate lines (representing roads, railroads, etc.) is referred to as vertical integration. Tools built to facilitate both horizontal and vertical integration will be useful on any linear based GIS data and related attribution, not just for transportation framework.

Quality Assurance and Quality Control (Phase II)

Quality assurance and quality control (QA/QC) are the processes and tools, which establish and enforce data consistency and data accuracy. In an environment where data is being integrated from multiple sources it is a critical function. Software can be built to enforce QA/QC in the following categories:

- Topological – checks regarding connectivity of the line work at intersections, overpasses and bridges represented as separate features, arcs meeting at jurisdictional boundaries, etc.
- Scale/Spatial – Does the location accuracy meet the planned business use of the data, does the "aesthetic" representation of the transportation feature meet the business requirements?
- Attribute – Are the minimum required fields included, are the field descriptions met, how many of the attributes are populated, are the attribute values valid?
- Metadata – Concerns regarding metadata include: has the required metadata been provided, is it complete, does it conform to established metadata standards; does the metadata match the layer?

All of these are standard GIS requirements for checking data and when the environment is one of handling data from a variety of sources it is critical that they be supported with software tools to facilitate efficient checking and validation.

Security (Phase II)

Security is necessary at the data provider level to make sure that once agreements are established for the providers of specific data those providers become the official providers and they send data through a secure system. In addition, while it is anticipated that the ODOT and WSDOT are building transportation framework so the data is generally publicly available, it is certain that some business needs (such as statewide E-911 dispatch) require that private data be used in certain situations. Thus security must be established at the data user side as well. For uses other than transportation framework it is important that security be available.

Location Referencing Integration (not yet scoped)

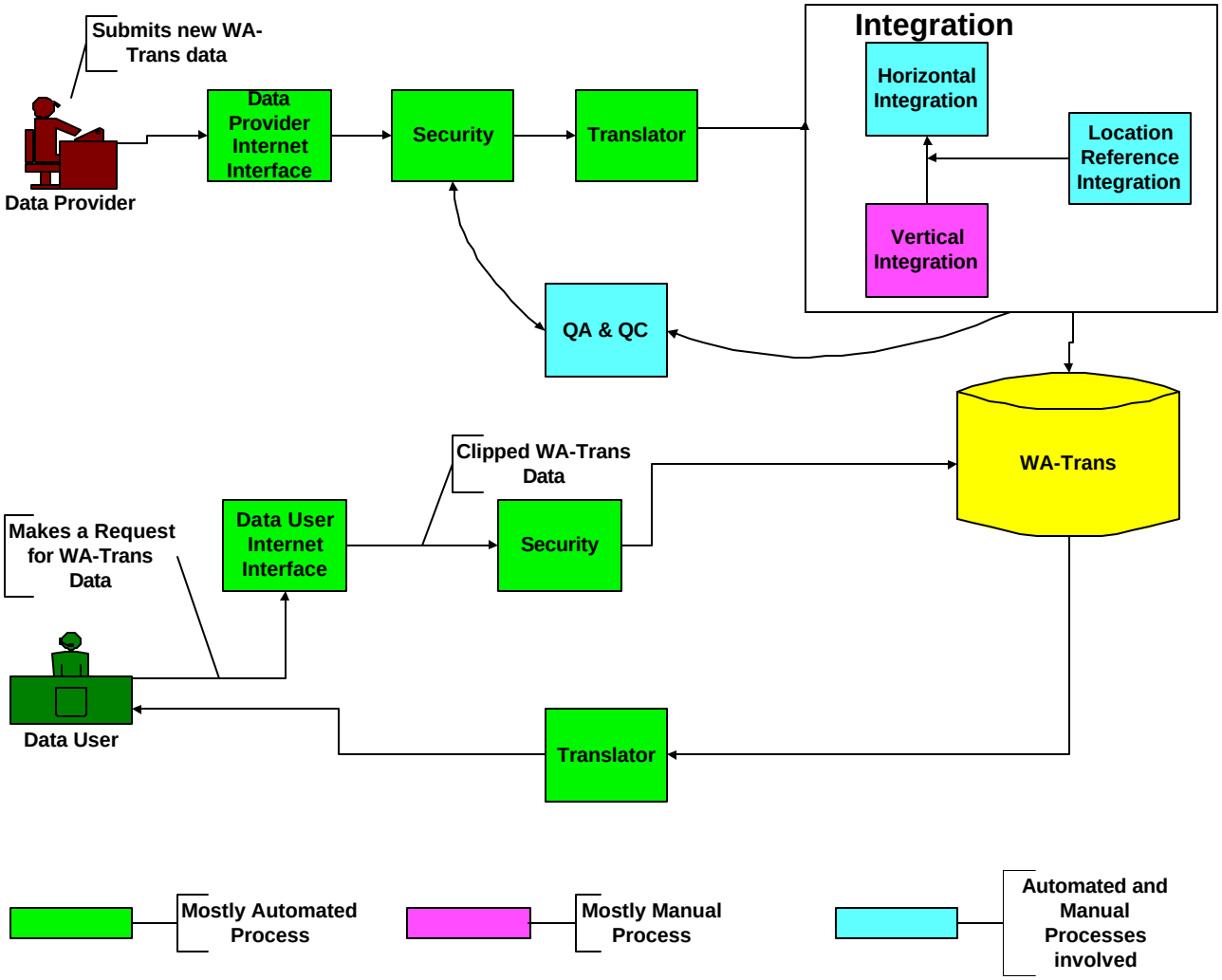
When building GIS for transportation infrastructure, a major business need is to be able to locate things along the infrastructure network. This is achieved through location referencing. In Washington State, multiple forms of location referencing are frequently used:

- WSDOT and counties use a form of route/milepost for location referencing,
- Counties and cities use addresses,
- Cities also use distance from intersection
- All use GPS for various purposes.

In order to accurately place things and relate things across location referencing systems it is critical that these systems be integrated between various data providers in transportation framework. This will facilitate geocoding across the state and locating things by a variety of methods, meeting a variety of business needs. Geocoding is the process of using location to retrieve, analyze or map

different things based on location. It uses addresses, x, y and other location referencing to place these items. One transportation business need that is supported by geocoding is asset management. Software tools that support location reference integration will be critical when bringing outside data of any sort into any GIS system and then trying to use that data to locate features along a transportation network.

Although local location referencing will be provided with data, it will not include location referencing that is consistent between data providers and across boundaries. In order to have one location referencing system for the whole state it must be applied to the data during integration.



The Need for a Consortium

The current development effort on these types of tools through September 2005 is funded by a small federal grant using in kind resources for testing. However in order to complete the full suite of tools in a time frame which allows for development and reasonable cost maintenance of any GIS transportation framework a consortium of supporting members is needed to provide consistent, continuing funds and interaction for a period of three to four years. A major, additional benefit of membership is implementation opportunities for tools and identification of future tools needs.

Consortium Benchmarks

The GISDC is to be action oriented with the primary focus being the development and implementation of tools that facilitate sharing and integration of geo-spatial transportation data and testing of those tools with a variety of data formats and sources from a variety of geographic locations. It is important that complete documentation of all tools be provided including through conferences and refereed publications. Thus, papers will be developed as appropriate and submitted to organizations such as the Transportation Research Board (TRB), GIS-T and URISA for review, presentation, and publication. Presumably, the Consortium members will co-author these papers.

Consortium Management

The pooled fund lead states are Washington and Oregon with the funding for the Consortium arranged through WSDOT. The Consortium members will each designate one member to form an Advisory Team (AT). The team will guide the work of the GISDC.

Following establishment of the GISDC a workshop will be held for members to:

- Gain knowledge of existing tools and determine what can be bought and customized and what must be developed from scratch.
- Establish minimum requirements for each tool to be developed.
- Recommend the preferred way of communicating between the GISDC member and the research team.
- The management board will decide on if and when future workshops will be held and who should attend. Day to day operations will be guided via interactions with the lead states of the Consortium.

Current Commitments and Estimated Funding Requirements

Category	Year 1	Year 2	Year 3	Year 4
Current Commitments:				
Washington State DOT	$30k	$30k	$30k	
Oregon DOT	$35k	$30k	$30k	
Additional Funding:				
State DOT (7 to participate in AT - $30k per year)		$210k	$210k	$210k
State DOT (3 not participating in AT- $10k per year)		$30k	$30k	$30k
Private Industry	TBD	TBD	TBD	TBD
Totals	$65k	$300k	$300k	$240k

Verbal commitments have been made for year 1 funding. Washington State DOT, as the pooled fund lead, with the support of Oregon DOT plan to solicit support of 6 to 10 additional State agencies to support the effort. Year 2 through 4 budgets represent estimated requirement to complete these tools. Additional contributions would accelerate product development and possibly expand the scope. It is anticipated that the total funding for the project would not exceed $900 thousand total over three to four years.

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