Development of the Data Content Standard for Transportation: Retrospective and Future Prospects.

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Abstract: The Data Content Standard for Transportation is one of the early efforts to realize the objectives of the Geospatial One Stop initiative. The goal of the standard is to advance the cause of data interoperability by facilitating the exchange of transportation data. This paper provides an overview of the development of the standard, an introduction to the standard, and a discussion of the technical and organizational factors affecting implementation.

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1. Process overview

1.1 Background: origins of the standard.

The transportation standard has been developed as part of the Geospatial One Stop (GOS), one of 24 initiatives sponsored by the federal Office of Management and Budget (OMB) to jump-start the development of the National Spatial Data Infrastructure (NSDI). Transportation is one of the seven Framework layers of the NSDI and consequently was part of this first phase of standards development. Although the standard has been developed for submission as an American National Standards Institute (ANSI) standard, the Federal Geographic Data Committee (FGDC) is the sponsoring agency and will retain ownership of the development process until the standard is submitted. Because the collection and maintenance of transportation data is central to the mission of the Bureau of Transportation Statistics (BTS), the FGDC turned responsibility over to the BTS to execute development.

1.2 Development Process

The process used for transportation standards development consists of six phases:

1. Model review – Review existing models and standards to determine the state of the art in transportation modeling.
2. Modeling Advisory Teams (MATs) – Organize teams of subject matter experts from local, state, tribal, and Federal government agencies, as well as the private sector, database modeling experts, and support personnel.
3. Hold MAT meetings – Review existing models, determine the scope of the GOS standard, direct the modeling effort, and supply subject matter expertise.
4. Draft the modal standards – Draft the standards following ANSI style guidelines, submit to the MAT for review, incorporate comments, and submit for public review, incorporate comments.
5. Harmonize the standards – Reconcile redundancies, discrepancies,

commonalities of features and definitions between standards. Working with the modeling subteam, determine which terms and definitions apply to more than one transportation mode.

6. Submit the base transportation standard to ANSI – Submit to ANSI for review and approval.

The model review established a baseline, or starting point for the MAT to begin building a new transportation model. The MAT builds the model by balancing business requirements against the existing models and other national, international, and industry standards. In addition to the MAT meetings, email lists supplement the discussion and facilitate the transfer of draft documents. The finished draft standard and model is brought together with contractor support and distributed to the MAT and public reviewers for comment. The final base transportation standard will be submitted to ANSI in September 2003.

1.3 Business requirements

The primary purpose of the standard is to facilitate the exchange of transportation data, specifically transportation data with explicit geospatial content. The standard is not geometry driven, but because the focus of the standard is geospatial, the standard accommodates the transfer of geometry. The goal of the MATs was to balance the need to keep a geospatial focus with the desire for wide adoption by transportation agencies. Because many transportation agencies do not have geospatial transportation data, geometry is considered an optional attribute for transfer. The standard remains independent of business functions because it does not dictate database content, nor does it dictate how transportation operations should occur.

1.4 Scope of the standard

The transportation standard is currently 5 individual standards. In July 2003, representatives from all 5 modeling advisory teams (MATs) will come together to develop the first draft of the harmonized, base transportation standard. In their current version, the standards accommodate the following 5 modes of transportation:

- Roads
- Rail
- Air
- Transit
- Inland Waterways

The standard is extensible, so other modes of transportation, such as pedestrian and bicycle could be added in time.

The transportation standard builds on numerous previous standardizations including existing ISO standards, ANSI standards, FGDC standards, International Civil Aviation Organization (ICAO), Radio Technical Committee for Aeronautics (RTCA), FAR (Federal Aviation Regulations) / Aeronautical Information Manual (AIM) (air), National Transportation Communications for ITS Protocol (NTCIP) (transit). The advantage of building on existing standards is that the processes of generating consensus around particular terms and practices do not have to be repeated. Also, by utilizing existing standards industry does not have to retool or re-engineer their business processes in order comply with the standard.

1.5 Stakeholders

While the Federal government has sponsored the transportation standard, the standard has been developed with substantial state, local, and tribal government input, as well as participation by private industry. Therefore, all agencies that produce or use transportation data are seen as stakeholders. A list of representative agencies is listed in Appendix A. Because Federal agencies will be required to adopt and implement the standard, they have a large stake in the adoption of the standard. However, states, tribes, localities and private industry also have a widespread interest in the adoption of having a nationwide standard with Federal backing.

2. Technical aspects

2.1 Organizational principles

One of the central objectives of the standard is to develop useful semantic definitions for transportation features. These definitions are transportation terms with whose definitions are agreed upon by the transportation community, as represented by the MATs. The community acts to develop common definitions that can be employed by organizations regardless of their specific business applications. The significance of the transportation standard is that it embodies an organizational principle that provides a means for many disparate transportation agencies and other organizations to independently to achieve a common goal.

2.2 Overview of the models

At this writing, the five individual, modal standards have yet to be harmonized into a single, unified transportation standard. While there are overlaps and redundancies that will be reconciled during the harmonization process, each mode

retains aspects peculiar to the specific mode of transportation.

The road standard accommodates the roads, a means for segmenting the roads in logical pieces, support for topology or connectedness, and flow, as well as the 'furniture' of the roadscape (i.e. signage, traffic controls, bridges, tunnels, etc.).

The rail standard is very similar to roads in that there is a means for representing the rails in segments, as well as support for topological relations, and a means to relate appurtenances such as signage, lighting, and maintenance facilities to the rails.

The air model differs from the other models in that it is oriented toward exchange of information about the airport facility. During development of the air standard, substantial effort was made to coordinate with an FAA-sponsored group developing a similar standard for Airport Layout Plans called *eALP*. There is substantial overlap between these two standards. Airspace, while recognized as a necessary and important part of the air standard, was not taken up during this round of the development process because the MAT felt it would unnecessarily complicate the standard and has been adequately dealt with by other standards for the time being.

Transit also differs from the other models in that it is concerned not so much with the underlying infrastructure but instead with exchanging data about transit operations. It does provide for links to the underlying transportation network, but generally speaking, the transit standard has a strong operations-orientation. The transit standard contains information about scheduling and routing, mobile assets, and amenities such as parking and bus shelters.

3. Adoption of the standard

As with any standard, it is anticipated that certain benefits accrue to agencies and individuals that adopt the standard. These benefits fall loosely into several categories: organizational, financial, social, and internal business processes.

Organizational

- Improve the exchange of spatial transportation data – Improvements in the ability to exchange spatial data may be a factor in improving interagency communication. For example, if many localities have the means to transfer transportation data to a state agency, it could prove to be one factor that contributes to better communications between the agencies, as well as

providing for a common base of information.

- Consistent semantic version of transportation terms – Adoption of the standard implies agreement with how the transportation features are defined in the standard. Agencies can map proprietary terms to the terms in the standard to affect a data exchange without disrupting their established practices.

Financial

- Decrease the acquisition of redundant spatial data – If agencies can obtain suitable data from other agencies, they need not spend resource to acquire it on their own.
- Community developed and free of charge – This standard has been developed by a wide variety of transportation professionals and placed in the public domain for public and private use.
- Non-proprietary to any hardware or software platform – The standard does not rely on, nor is it written for any specific hardware or software platform. On the contrary, it is developed for the broadest possible application, regardless of where the data reside, or the type of system on which they reside.
- Makes the costs sharable for data acquisition – If the business needs for several agencies overlap sufficiently, acquiring data to a standard specification allows them to share the cost of acquiring data.

Social

- Community of interest – One belief, which is yet untested, is that the practices of adopting a standard and sharing data will lead to a gradual improvement in the quality of base transportation data as the best data is implemented in more applications. Thus, it is anticipated that as the standard is adopted by more and more agencies, a community of interest will evolve where stakeholders will realize the benefits regardless of platform, hardware, or applications.
- Community of interest – Another basic tenet of this transportation standard is that anyone with an interest can participate in standards development process and join the community of interest. Adopting the standard will be necessary for agencies to participate in initiatives such as the Geospatial One Stop or the NSDI.

Internal Business Processes

- Greater accessibility to spatial data – It is thought that by easing the data exchange process, agencies will have access to more data sets that meet their business needs.
- Greater exchange of data is predicated on partnerships. Partnerships can be formed to share the cost of acquiring data. If costs can be shared, then the price for producing more accurate data goes down.

These anticipated benefits are based on the results of earlier implementations of standards. In time, this list should be compared with actual results to determine the true benefits to transportation agencies of adopting the standard.

4. Lessons learned in the development of this standard

The lessons learned in the development of this standard fall in to two broad categories: technical and organizational.

Technical learning – The current transportation standard is for the most part, an abstract standard. The road standard has been tested through the transportation pilot, but the rail, transit, inland water, and air standards remain untested. During the road pilot several changes were made to the model that were unforeseen in the abstract development process. Because of the overall schedule, these changes will make it in to the final harmonized standard. However, for the remaining modes, testing will have to occur after the abstract standard is submitted for approval. Building ample time into the schedule for adequate testing should be a part of the standards development process.

Organizational learning – The transportation development process focused the attention of many subject matter experts on the subject of data exchange. By doing so, a community of interest has been established around transportation data, but also around a Framework layer of the NSDI. The BTS is at the center of this community, reflecting their role as the technical and administrative champion for the standard.

5. Issues

- Equivalencies – During the development of the transportation standard, the problem arose of how to distinguish between representations in disparate databases of the same real world transportation feature. Databases created at different times using different source materials will have different positional accuracies and attribution to represent the same feature. There may be many compelling business needs to distinguish each representation but also retain the

knowledge that each represents the same transportation feature. Equivalency is the term given to the process of equating road segments from disparate databases. The problem is not limited to transportation and so the issue was elevated to a larger group for resolution.

- Identifiers – Another problem that surfaced during development of this standard is the unique identification of transportation features. A permanent and unique identifier must be assigned to each transportation feature to support the development of the NSDI enabling the relationships between those feature elements and associated data. Most organizations have been free to develop their own identification system or have adopted a state or regional scheme to support their initial needs. These schemes, while satisfying internal business needs, do not transfer well across multiple organizations. In regard to the NSDI, unique identification becomes critical to reliably connecting data to geographic locations.

§ Other modes of transportation - Many nations recognize the need for including pedestrian and bicycle transportation in their models. Whether the transportation standard eventually accommodates these modes will depend on compelling national interests in being able to exchange transportation data for areas outside the North American continent. Another factor will be the technical imperative of having a complete transportation model to support fully intermodal transportation modeling.

§ Role of participants regarding the maintenance of the standard - It is anticipated that once the transportation standard is submitted, it will become the property of ANSI. ANSI may however, wish to recognize BTS as the agent for maintaining the standard. BTS may want to retain the communities of interest established during development of the current standard for the purpose of enhancing and maintaining the standard on an ongoing basis.

§ Implementations of the transportation standard - It is anticipated that software vendors will develop their own implementations of the standard and it is highly likely (if not certain) that each implementation will be slightly different. Which implementation is favored is likely to be decided by a combination of market forces and the various community interests and agencies that adopt and favor one implementation.

6. Final thoughts

The costs of adopting the transportation standard are not documented. For those

agencies that adopt this standard, an implementation specification will need to be developed as well as supporting applications. The transportation standard steers clear of dictating internal business processes, such as how data should be stored and used. But users will be faced with a choice between having to store their data in a format that mimics the exchange standard or having to devote resources to translating between their operational systems and export data sets.

One of the biggest obstacles to overcome is providing incentives for agencies to adopt. As with so many standards, the benefits seem to accrue to not to those who adopt the standard, but to external users, who typically do not bear the costs of acquisition and maintenance. Early adopters, in particular, feel this most acutely. And, as pointed out earlier, the benefits can be anticipated, but not necessarily predicted with absolute certainty. Anecdotal evidence suggests that adoption of standards needs to align closely with other actions to improve internal business processes such as enhancing customer service, adopting best practices for information handling, and increasing data interoperability.

The transportation standard will continue to evolve over the next few years as the information technology matures and reaches a more stable state. If early adopters can demonstrate successful implementations, a compelling case can be made for other agencies to adopt, particularly if adoption makes sense from a social, organizational, and business sense.

Appendix A.

The following agencies were represented on the Modeling Advisory Teams (MATs):

Road mode: Organizations Represented

Bentley Systems
Booz Allen Hamilton
CALROADS
Environmental Systems Research Institute
Federal Highway Administration
Galdos Systems, Inc
Harvard Design and Mapping
Image Matters, LLC
Indus Corporation
Intergraph

Lockheed Martin
Marasco Newton Group
Mason County, Washington State
Natural Resources Canada
North Dakota State University
Ohio State University
Open GIS Consortium
Orange County, Florida
Oregon Geospatial Data Clearinghouse
State of Utah
Roads Decisions
U.S. Army Corps of Engineers
U.S. Army Corps of Engineers, CADD / GIS
U.S. Bureau of Transportation Statistics
U.S. Census Bureau
U.S. Geological Survey
University of Wisconsin, Milwaukee
Washington State Department of Transportation

Air Mode: Organizations Represented

Booz Allen Hamilton
Bureau of Transportation Statistics
Calibre
Carter-Burgess
Columbus Airport Authority
Dulles International
Environmental Systems Research Institute
Federal Aviation Administration
Grafton Technologies
Hartsfield Atlanta International Airport
Image Matters, LLC
Lockheed Martin
SAR
McCarran Airport
National Imagery and Mapping Agency
Northrop Grumman Corp
Ohio State University
Open GIS Consortium
Space Imaging
Tulsa (TUL)

U.S. Army Corps of Engineers, CADD/GIS

Rail Mode: Organizations Represented

AMTRAK
Association of American Railroads
Bentley Systems
Booz Allen Hamilton
Burlington Northern Santa Fe Railway
Canadian National
Canadian Pacific Railroad
CSX Real Properties
ENSCO
Environmental Systems Research Institute
Illinois Commerce Commission
Image Matters, LLC
Kansas City Southern Railway
Lockheed Martin
Long Island Railroad
Operations Respond Emergency Information System
Parsons Brinckerhoff
SRA International
Union Pacific
U.S. Bureau of Transportation Statistics
U.S. Federal Railroad Administration
U.S. Geological Survey

Transit Mode: Organizations Represented

Booz Allen Hamilton
Dallas Area Rapid Transit
Fairfax County, Virginia, USA
Federal Geographic Data Committee
GIS/Trans
Hickling, Lewis, Brod Decision Economics
Image Matters, LLC
King County Metro Transit
LYNX Planning Department
Open GIS Consortium
Orange County, Florida, USA
Orange County Transportation Authority
Regional Transportation Authority

SRA International
Systems & Solutions, Inc.
Tri Met
University of Wisconsin, Madison
U.S. Federal Transit Administration
U.S. Bureau of Transportation Statistics
Washington Metropolitan Area Transit Authority

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