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ORBIT: The Oregon Road base Information Team Draft Summary Report II

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Introduction

Data sharing among organizations has the potential to 1) decrease long-term costs of obtaining and maintaining data and 2) to facilitate data consistency and accuracy. Consistency includes both completeness and currency, while accuracy includes positional and relative accuracy of transportation features and their attributes, i.e. any data element related to roads or other transportation infrastructure.

ORBIT, the Oregon Road Base Information Team, is an ongoing effort to create an accessible and comprehensive GIS transportation base for use by public and private agencies with shared stewardship through stakeholder partnerships and standards. ORBIT is occurring concurrently with an effort at the national level to develop an NSDI Framework Transportation Identification Standard to enhance the development and implementation of principles and procedures for sharing of transportation data.

The ORBITS approach collects or divides roadway features and identifies them with a unique code. In the context of a case study of Canby, OR. decision rules for breaking or collecting roadway sections were developed. Assigning codes to roadway features is the next step in the project. The Canby, OR. area is located on edge of Portland Metro area. It was selected because it provides a model mixture of state, county and local roads with which to test data sharing among overlapping jurisdictions

The ORBITS project is a practical and applied case study that attempts to address problems with the existing “integrated data model” used in many road databases. This model, the basis of TIGER and Arc, integrates the cartography, the network link and the attributes of the link into a single linear spatial object, which causes difficult conflation problems in sharing data.

The ORBITS approach (1998) adopted the Transportation Feature aspect of Dueker-Butler GIS-T data model without ID’s, but segmentation rules and authority
As discussed above, there is currently underway an effort to develop, at the federal level, the FGDC NSDI Framework Transportation identification Standard. This study tests that proposed standard in comparison to the prior ORBITs (Wuest, Dueker, Bosworth, 1998) approach.

<u>NSDI and Dueker-Butler GIS-T Data Model</u>

Bruce Westcott has described the NSDI project: “The proposed NSDI standard is intended to use terminology and concepts which are entirely consistent with the GIS-T work, the ITS work, and other transportation conceptual models. NSDI is concerned with data exchange between digital map bases developed at different scales, and having different attributes. The standard must enable a user to reference the same “chunk” of road (or other linear transportation feature) in multiple databases; the transportation segment must be stable over time, independent of cartographic or topological representation. *The most important "deliverable" of NSDI is a* ***permanent, unique identifier*** " (Westcott, 1999).

The basic components of the NSDI Framework are Framework Road Segments (FTSeg) and Framework Road Segment Reference Points (FTRP). "FTSeg should be created to represent those segments of roads about which attributes (including cartographic shape) are to be shared among organizations…Road data authorities should coordinate the development of a road data base with all relevant stakeholders, particularly with respect to which roads should be included in a local implemetation. The decision of which roads to include should reflect a reasonable compromise between an economical number of FTRP and FTSeg, and common network application needs of the stakeholders"(NSDI Draft #2, 1999).

The assigning of the permanent, unique identifier must be viewed as a potentially daunting task, and one that is best approached as a "machine-aided" task. Manual coding of IDs will be a time-consuming, tedious task that may limit or deter relevant stakeholders from participating in the data-sharing standard. Fir this reason, machine aided assignment using GIS scripts should be considered the optimal and most prudent method.

The NSDI Framework Transportation Identification Standard imposes only one constraint with respect to how a physical road is partitioned into FTSeg: segments must not span state borders. However, the ORBITS project follows several segmentation principles that will be described in detail below.

Data sharing will be occurring for roads that cross jurisdictions, such as county boundaries or the Portland Metro boundary. A Transportation feature (TF) will not cross county boundaries, but will be segmented at this point. Similarly, the 1998 ORBITs report called for segmenting Transportation Features at:

Dynamic segmenting can be used to subdivide (segment) the resultant TBS to correspond with the extent of other attributes or linear events on the feature.

<u>Transportation Data Sharing Principles</u>

The following principles from the Dueker-Butler data model guide the project:

-Transportation Features are bounded by jurisdiction, not intersection;

-Attributes of Transportation Features are represented as linear or point events
These two principles enable longer TFs than is the case in link-based networks, and reduces the number of TFs that must be maintained to represent the system. Additional network detail or attributes can be added by linearly referenced event tables and analyzed and visualized using dynamic segmentation.

Two key subsidiary principles for assignment of identifiers that were used for the ORBITs case study are:

- Segment major arterial facilities at county boundaries or major intersections if consistency with traffic assignment networks is desired.
- Collect minor road facilities by street name to minimize the number of unique identifiers.

Orbits and NSDI framework

Oregon Road Base Information Team Subcommittee (ORBITS) in 1998 (in the absence of the NSDI standard) sought to integrate transportation cartography from various sources by means of common segmentation criteria and common attributes.

NSDI Framework Road ID standard focuses on assigned IDs to roads in a coordinate-free form. The basic principles, or issues, are as follows:

- Establishing FTSeg
  -"Physical" vs. "Logical"
  - Complex Intersections
- Establishing framework Road Segment Reference Points (FTRP)
  -"Physical" vs. "Logical"
  -"FTRP should be placed at wherever a road crosses a jurisdictional boundary between two road data authorities."
  - Simple road intersections

ORBITS Case Study

The ORBITS approach collects or divides roadway features and identifies them with a unique code. In the context of the Canby case study, decision rules for breaking or collecting roadway sections were developed. Procedures for bulk assignment of higher level codes to sequenced numbered roadway features is the next step in the project.
The Canby, OR. area is located on edge of Portland Metro area. It was selected because it provides a model mixture of state, county and local roads with which to test data sharing among overlapping jurisdictions. The area is not cluttered with too many local roads.

Orbits Decision Rules

Development of Decision Rules

The ORBITS approach collects or divides roadway features and identifies them with a unique code. In the context of the Canby case study, decision rules for breaking or collecting roadway sections were developed. The fundamental basis for these decision rules are the Dueker-Butler data model principles:
-Segment major arterial facilities at county boundaries or major intersections if consistency with assignment networks is desired.
- Collect minor road facilities by street name to minimize the number of unique identifiers.

Procedures for bulk assignment of higher level codes should be straightforward using scripts or other simple manual GIS procedures. This bulk assignment will be crucial in the acceptance of the common TF identifiers, as coding would otherwise be time and resource consuming.

Decision rules for assignment of TF identifiers

Arterial road identifiers in metropolitan counties are a concatenation of State and county FIPS codes and a concatenation of I and j traffic assignment network node numbers. Diag. 1 below illustrates the straightforward use of this rule, using the traffic assignment network. The assignment network is displayed over the enhanced TIGER network to facilitate the collection and segmentation choices.

Figure 1 basic arterial concatenation

Much of Clackamas and the Canby study area can be described as rural in nature, with a corresponding rural road network. One characteristic of a rural road network is the much lower road and intersection density. It is also highly unlikely to be a traffic assignment network such as that found in the Portland area. For these reasons, for the rural parts of the study area would normally be assigned an arterial roads code that is the concatenation of the Oregon and Clackamas County FIPS codes and Oregon or Clackamas DOT road ID. Many of these rural roads, however, were within the boundaries of Portland Metro, which desired a finer segmentation.

Local Roads: The decision rule for assigning codes to local roads is to collect connected TIGER lines that have the same name and assign them sequence numbers within the concatenated state and county FIPS codes. This is demonstrated in a straight-forward manner in the diagram below. An arterial street, with the same name throughout, has been concatenated using this name. In this case, since the route runs solely through a residential development, there were no i,j traffic assignment network node numbers.

Figure 2: Local road string

<u>Problem Situations</u>

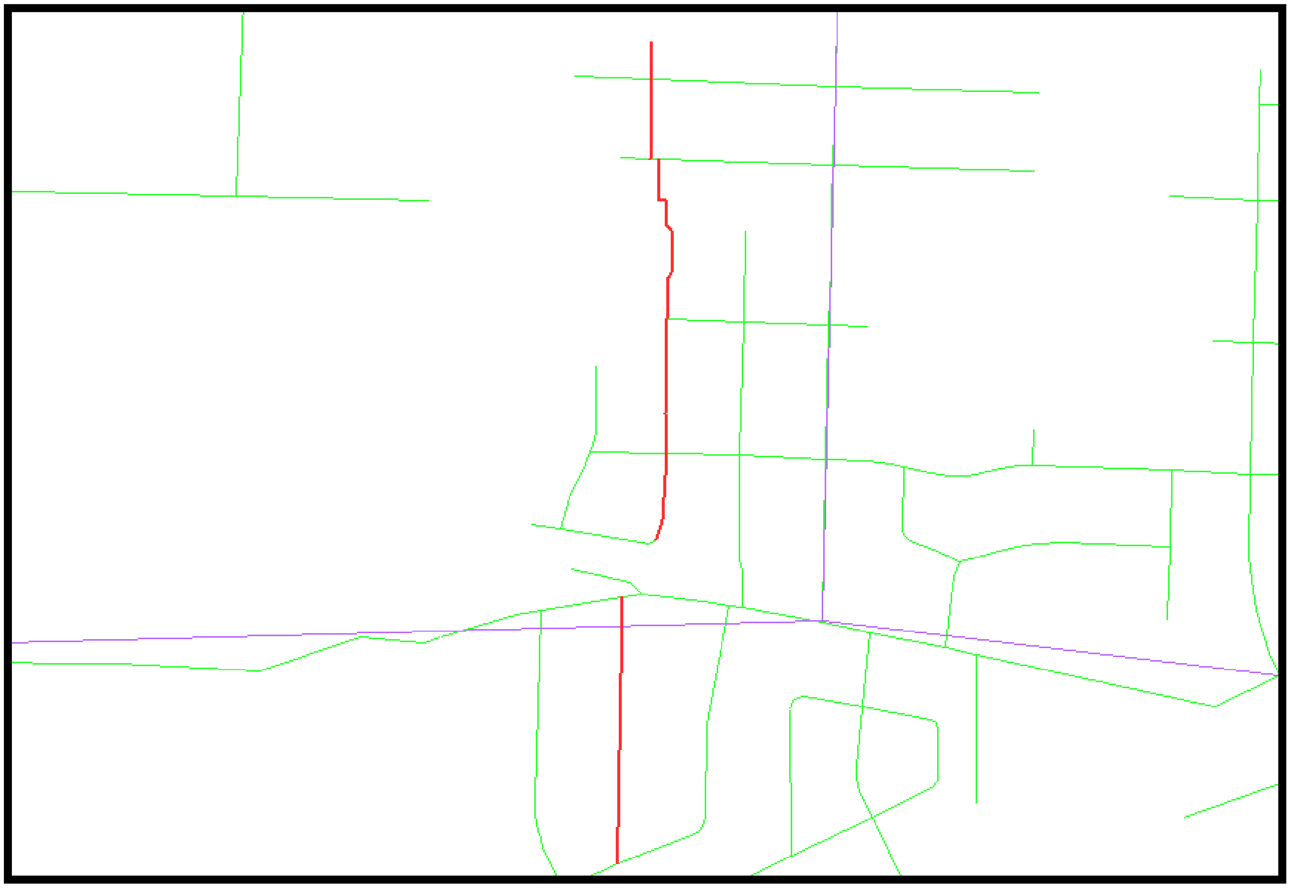
Decision rules are needed in more complex situations involving ambiguity. Following the earlier, straightforward rule for local streets will not work when a major state highway route follows local streets in urbanized areas. This situation is illustrated in the diagram below. A state route enters Canby, and follows a local street, Grant, dashed. In this situation, the TF is a more important part of the state route. The decision is clearly to treat the local street now as an part of an arterial. The nodes from the traffic assignment network are used.

In this example, it is also unclear at first over how to assign the i, j nodes, since the network crosses a street grid diagonally. In this case, the TF is created after the state route is traced out from the local TIGER streets.

<u>Local Name with discontinuity</u>

Another potential problem arises with the situation illustrated below (diag.). In this case, a local street experiences two types, or degrees of discontinuity. First, there is a slight jog in the road where it intersects another local road. Since this does not represent a major break , and network continuity is actually maintained, the local street rule would still hold, and the line segments that make up this street are concatenated into a string that forms then becomes the unique TF.

Further along, however, this same "street' string experiences a major discontinuity. The "street" continues with the same name below the intersecting arterial, but here there is an actual network discontinuity that cannot be overcome. Here we have decided not to continue the original name-based string. Instead, a separate TF is created with the remaining line segments forming a string and TF.

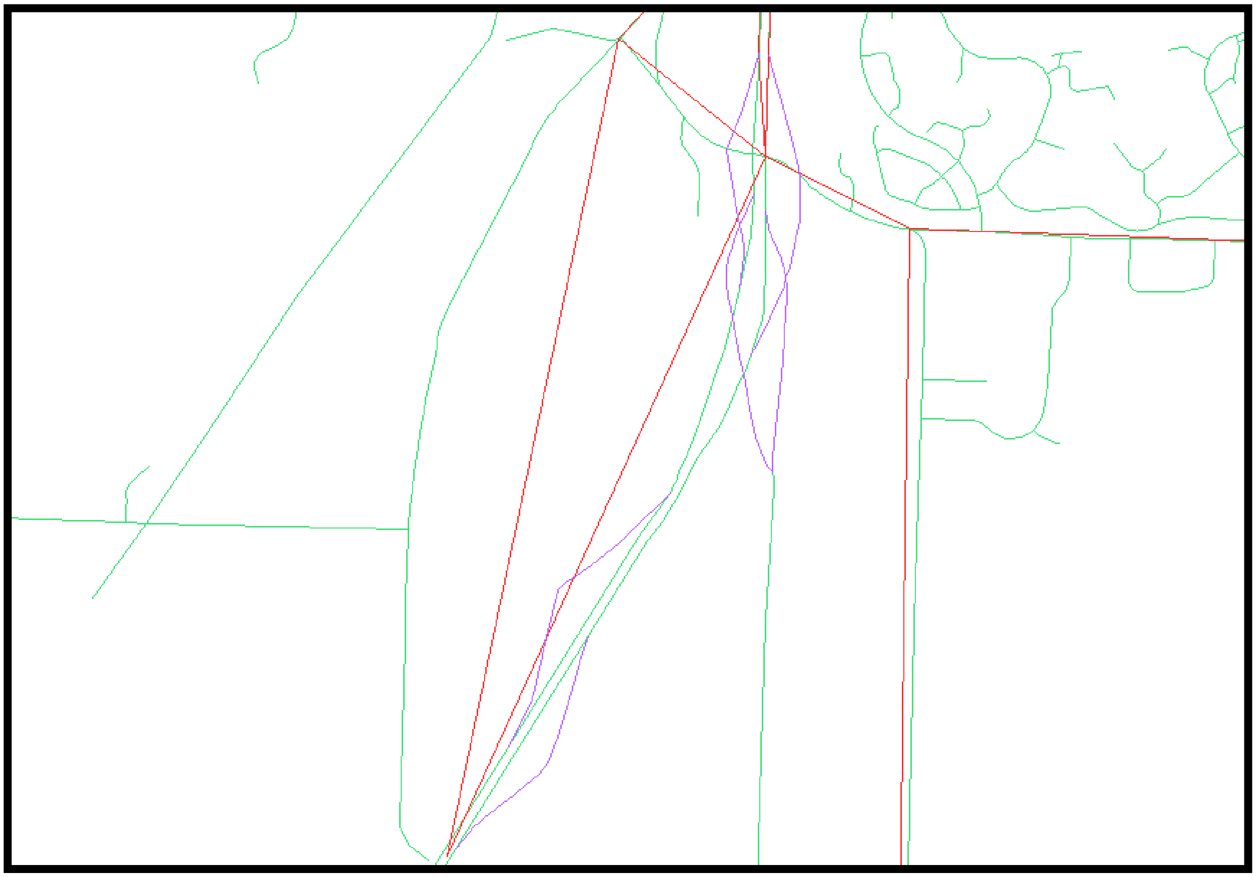


Some judgement must therefore be made when applying the basic decision rules. In this case, when there are minor interruptions the same code is assigned; for larger interruptions, the separate IDs are assigned.

State Road segmented by traffic assignment network. This decision can be made by comparing ODOT and Clackamas road database networks and overlaying them with the TIGER and EMME/2. In this case, the ODOT road segmentation (from ODOT database) is actually *finer* than is necessary, occurring in between major intersections. Here we use the EMME/2 network to *collect*, rather than segment, the OR 99 links.

The comparison of ODOT/County networks requires some additional analysis for more concrete and uniform decision rules to be constructed.

Highway Ramps: Transition between State/County Road
Highway ramps pose perhaps the greatest challenge in any and all GIS-T models due to the inherent ambiguity involved with (non)planar topology. In this case, the highway ramps do not intersect any arterials, but become in fact the arterials



Conclusion

The ORBITS Canby study is an attempt to address the challenges inherent in attempting to share GIS-T data between government agencies. The study attempts to build upon the establishment of the Dueker-Butler model for Transportation Features and their identifiers. Concurrent with this effort has been the NCHRP project that seeks to build a GIS-T data model based on a national consensus, and the NSDI framework identification standard process.

Regardless of the actual final form of the feature ID, the ORBIT project takes us one step further in demonstrating the potential for implementation of an integrated solution based on an agreed upon ID standard.

The ORBIT Canby study has succeeded in developing and testing initial decision rules for defining and assigning unique Transportation Feature IDs to road segments. The next step will test machine-aided coding of IDs for each segments.

Future Challenges and Directions

Based on the experience of two case studies OBRITS needs to examine again its objectives and approaches. In addition to experience gained from case studies, there have been developments nationally and regionally that require reassessment.

First, there are several contextual institutional developments. The reorganization of the Oregon State Service Center for GIS implies a reduced interest or reassignment of interest responsibility to ODOT in building a statewide streets and roads layer for interagency use in Oregon state government. In Contrast there is a growing federal interest in building a roads layer for use in the activities of the Interorganizational Resource Information Coordinating Council (IRICC). Thus we may see a more active involvement in ORBITS of the U.S. Forest Service, BLM and EPA. Also the work of the FGDC in development of the NSDI Framework Transportation Identification Standard may lead to guidelines and mandates relating to maintenance of the USGS streets and roads layer and the U.S. DOT Intelligent Transportation Systems (ITS) digital road databases. These institutional changes underscore the need to redefine the objectives for ORBIT, to sharpen the focus for products, and to make choices among alternative approaches.

Second, is the need to examine in more detail the alternative approaches to sharing transportation data. This involves careful examination of centralized versus decentralized development and management of the digital road database. We have been pursuing a decentralized approach that requires common segmentation rules and common codes for owner, maintainer and road type to facilitate the exchange of data, but no one has been assigned or stepped forward to actually build a single road layer from all the participant pieces. A more active lead agency is needed to foster standards for exchange and to actually build an integrated roads layer for all or part of the state.

A more centralized approach might reduce the role of exchange standards, but would increase the role of the lead agency to actually project road vector files from various sources onto imagery, to improve or verify spatial accuracy, and then attribute the vectors consistently. It is recommended that ORBIT assess its current position and options for future direction. With retrenchment at the Oregon SSC for GIS , who will provide leadership for sharing GIS transportation data?