

Factors Affecting the Suitability and Usefulness of an Enterprise Centerline Dataset within Metro Nashville Paving Operations

Donald Reid
Nashville-Davidson County Metropolitan Government
Nashville TN
donald.reid@nashville.gov

Jeff Deason
Collier Engineering Inc.
Brentwood TN
jeff.deason@collierengineering.com

Abstract

The enterprise geodatabase in use within the Metropolitan Government of Nashville – Davidson County contains a street centerline feature class that manages information for more than 37,000 segments. In addition to roadway segments that are maintained by Metro Nashville, this dataset includes items for alleys and ramps, for some commercial and private driveways, and for some segments that are maintained by the State or other local governments. The centerline data is used by GIS users and GIS-centric systems for a variety of purposes across Metro Nashville, including transportation planning, emergency response, management of paved surfaced, and routing for trash and recycling pick-up. This presentation focuses on the lessons learned throughout the evolution of Metro Nashville’s centerline data as pertains specifically to the Public Works department.

Our presenters will discuss factors that affect the quality and accuracy of street centerline data – from the initial planning of a data acquisition project to the maintenance of an existing enterprise centerline geodatabase, and the effects that data accuracy and maintenance efforts can have on downstream processes and business operations within the realm of Public Works and the management of assets within the right-of-way.

Introduction: The Enterprise Use of Roadway Centerline Data Presents A Variety of Benefits and Challenges

Roadway Centerline (CL) data access for GIS use in the government of Metro Nashville – Davidson County has come a long way, and is continually improved through coordinated efforts in multiple departments. This presentation discusses:

- observations on the access to and many uses of CL data in the Public Works Department,
- the suitability of —and challenges to— the networked use of the dynamic enterprise CL geodatabase resource and the desktop use of static “snapshots” when necessary,
- opportunities and challenges provided by the use of CL data “snapshots” on the desktop for various departmental efforts that can ultimately enhance the usefulness of the enterprise CL geodatabase.

Enterprise Access to Metro Nashville Roadway Centerline Data

Stewardship and use of the enterprise CL data resource in the Metropolitan Government of Nashville & Davidson County is distributed among several departments for multiple uses. Distributed access to the live CL data is provided through ESRI ArcSDE from the Metro Nashville Planning Department. Good communication between departments results in workable access agreements and fosters continual improvement to the usefulness and accuracy of the street data.

This “live” centerline data is the most accurate CL data available to Metro Nashville staff, and it is very useful — but its use comes with a price. Users who access the enterprise geodatabase must do so through networked database connections, which means their data access is at the mercy of

- auto-expiring network and database logins/passwords
- the stability and performance of the RDBMS
- the stability and performance of all network connections between the RDBMS and the user’s computer
- a “closed” dataset; while *view* access is readily available, the ability to *edit* the enterprise CL data is generally limited to the Metro Nashville E-911 Coordinator.

Another option for access to roadway data is the use of the public Metro Nashville Planning web site. This resource does not provide anywhere near the level of detail provided through the enterprise CL dataset, but it is ideal for many view-only uses.

Still, localized use of GIS within the various departments sometimes requires a standalone CL dataset on the local desktop. This can be accomplished through the use of shapefiles or personal geodatabase feature classes extracted from the enterprise CL dataset. The “up” side of this is the absence of the possible chokepoints listed previously, but the “down” side is also sizeable:

- the “snapshot” dataset is no longer current – if the roadway GIS data changes for the enterprise, the local dataset will not be updated with the changes.
- likewise, any data revision to the data in the “snapshot” (updated trash pick-up route numbers, for example) will not be reflected back to the enterprise dataset unless staff in various departments initiate and actively manage the process
- processes are in place to refresh and continually update the enterprise CL dataset; however, it is possible for users of “snapshot” data to perform so many modifications and become so accustomed to working in a standalone manner that they would be reluctant to manage the work involved in refreshing their snapshot.

CL Data: Product of Multiple Sources & Processes

The enterprise CL dataset in use at Metro Nashville – Davidson County is currently distributed as part of an ESRI ArcSDE geodatabase deployment using an Oracle RDBMS. Its linework and attributes have evolved as an amalgam of different sources.

Some of the linework has been:

- Digitized from old Mylar/paper parcel maps
- Derived from plans provided by developers
- Hand-digitized from orthophotography or from ROW polygons
- Imported from CAD data

Some of the attributes have been:

- Bulk-loaded from other systems or projects as needed/available
- Hand-edited by consultants and staff in multiple departments
- Structurally re-defined as part of a recent RDBMS migration

Recently, the entire enterprise CL dataset recently migrated from a DB2 database to an Oracle system. During this migration, each of the roughly 37,000 segments received a new TRANSPORTEDGEID value —the key ID that uniquely identifies a segment in a variety of downstream applications. Thankfully, careful cooperation between Metro departments resulted in relatively uninterrupted service for these applications during and after the RDBMS migration and the resulting shift in ID nomenclature.

Considering this dataset’s long history, the large number of segments (37,000+), and cooperative approach to QC and upgrades, it is a very accurate representation of the roadway network for ongoing programs and projects within the service areas of the Metropolitan Government of Nashville & Davidson County.

Segmentation breaks (nodes) at

- Intersections with other streets
- Bridges
- Satellite City boundaries
- County boundaries

Primary CL Data Attributes

Naming

- PREFIX_DIR (N, S, E, W)
- NAME
- SUFFIX_TYPE (DR, AVE, BLVD, PIKE, etc.)
- SUFFIX_DIR (N, S, E, W)
- FULL_NAME (combine previous 4 fields)
- ALT_NAME
- FORMER_NAME

Connectivity

- FROM_STREET (intersecting street at segment's lowest address point)
- TO_STREET (intersecting street at segment's highest address point)
- NAVIGABLE (related to OFFICIAL_STATUS and LEGISLATION)

Addressing

- LEFT_FROM (lowest address value possible on the left side of this segment)
- LEFT_TO (highest address value possible on the left side of this segment)
- RIGHT_FROM (lowest address value possible on the right side of this segment)
- RIGHT_TO (highest address value possible on the right side of this segment)

Accepted Status

- Accepted: Adopted and maintained by Metro Nashville – Davidson County
- Accepted: “State Aid” segments are maintained by Metro Nashville with State funding
- Not Accepted: State or Other Government / “Satellite Cities”
- Not Accepted: Private Roads/Drives
- Not Accepted: Under Development

Legislative Acts

- Acceptance Date
- Abandonment Date
- Naming Changes

Other Fields Available

- Many other (UNETRANS) fields available.
- Some are populated and maintained.
- Some have been partially populated for studies or short-term projects, but not maintained.
- Others are there for future use, but have never been populated due to minimized need.

Enterprise CL data is available as a geodatabase feature class served from Planning's SDE.

- Useful as reference data for map production, desktop asset location, typical analysis, etc.
- Connecting to the enterprise CL dataset adds a layer of complexity (not to mention software licensing and IT overhead costs) that may be beyond the need or technical capacity of the more casual GIS user. These people can rely on a simpler ArcIMS web site that hosts the same data if view-only access is sufficient.
- However, some specific applications require access to a standalone “snapshot” of the CL dataset. Some require shapefiles specifically, while others require geodatabases only.

CL Data is the Basis for Several Processes within Public Works

Customer Service Department: ArcGIS & Cityworks

Public Works staff geocode incoming service request calls in real time.

The accurate geocoding of incoming Service Request (SR) incidents is a critical point in the workflows for Asset Management and for Customer Service. ArcGIS & Cityworks provide useful geocoding tools – as well as work-arounds to “manually” geocode addresses that fail automatic geocoding. Instead of live access to the enterprise CL geodatabase, Customer Service reps receive a monthly snapshot of the street data along with an updated address locator.

In addition to the direct benefit provided from geocoded SRs, users in Customer Service can influence the continual improvement of the CL dataset by communicating to E-911 the locations of SR calls that fail automatic geocoding. Such locations can indicate the need to correct errors in the address range along a specific CL segment, etc.

Customer service reps can immediately close some service requests through simple geocoding.

- When is trash-pickup day for my street?
- When will my street be paved?
- When will the alley behind my house be cleaned?

Other SRs are assigned by type and priority to inspectors, who benefit from the CL data and geocoded SR data.

- Immediate map-based identification of active service requests by type and status.
- Visual “clustering” of active inspection workload to assist in simple route planning.
- Pattern recognition & reporting over time.

Streets & Roads Department

Inspectors benefit from geocoded ROW maintenance SRs mapped by work sector, easy identification of “hot spots” and planned ROW activity, etc.

Geocoded SRs and street CL data are also used in the production of maps and reports developed to enhance communication with Finance, Metro Council, other departments, and public citizens via 311 or Nashville.gov web site.

- Snow Route Maps
- ROW Maintenance Schedules
- Closure Notifications

Waste Management Department

Waste Management is performing trash and recycling routing using RouteSmart for ArcGIS. The workload includes mass routing for 5 contracted trash haulers and 1 recycling hauler. A CL data “snapshot” (personal geodatabase) must be used instead of using the enterprise CL geodatabase. As with Cityworks in Customer Service, Routesmart provides geocoding tools – and communication with E-911 ensures that the enterprise CL datasource benefits from the correction of segment data when trash/recycling customer addresses fail to automatically geocode.

Geocoded SRs and street CL data are also used in the production of maps and reports developed to enhance communication with Finance, Metro Council, other departments, and public citizens via 311 or Nashville.gov web site.

- Trash Pick-up Route Maps
- Recycling Route Pick-up Maps
- Customer Add/Drop Data to Contracted Haulers

Paving Operations Department

The Pavement Resurfacing & Rejuvenation program at Metro Nashville Public Works includes several projects that make use of CL data “snapshots” instead of a live connection to the enterprise CL geodatabase resource. Some data elements from these projects would be of benefit to the enterprise users, though, so careful process management is required to ensure that the appropriate aspects of locally-altered segment data gets reflected back to the enterprise geodatabase.

One such element is the **Last-paved Date** attribute. Last-paved Date is a field that is accessed by the enterprise Permitting system to trigger additional fees for applicants who apply for permits to perform pavement cuts on recently resurfaced roadways.

Additionally, the activities of these projects sometimes uncover CL data errors (network connectivity, addressing, TO/FROM naming, accepted status, etc.), which are then forwarded to the E-911 Coordinator for review/approval. Such incremental improvement is another way in which the use of data snapshots —usually strongly advised against if enterprise data access is available— has proven *beneficial* to the enterprise as a whole.

Pavement Management Programs Use CL Data “Snapshots”

Pavement Management workflow and maintenance decisions are supported by

- Physical inspections
- Customer Service requests and other forms of public input
- Photo log & custom ArcGIS Roadway Viewer
- Cartegraph: PavementView for ArcGIS

Annual Roadway Data Collection in Support of Paving Operations

- Photo and roadway distress image collection, with approx ½ county collected annually
- 4 photos shot every 20’ (image views: front, front-right, rear-left, rear-down)
- Laser distress analysis to help gauge roughness and raveling
- Process develops segment-level overall condition index (OCI)
- OCI values, threshold trigger values, and annual program funding levels influence CarteGraph PavementView to make suggestions toward decisions on scheduling treatment (resurfacing vs rejuvenation vs crack seal vs *wait*, etc.)
- TRANSPORTEDGEID is the Primary Key for all of these activities; it is the ID that identifies a segment uniquely. However, when Planning/E-911 splits an existing segment, it results in a new TRANSPORTEDGEID value for each of the resulting “children.” “Parent” segment (and ID) is retired and copied to an archival layer.
- This means special care must be taken to ensure appropriate data transfer occurs in the event that segmentation (and therefore, segment IDs) within the enterprise CL data source change (due to splits, etc.) in an area while Paving-related GIS/IT projects are working with a snapshot of the same area.

- Geocoded SRs and street CL data are also used in the production of maps and reports developed to enhance communication with Finance, Metro Council, other departments, and public citizens via 311 or Nashville.gov web site.
 - Weekly/Monthly ROW Work Coordination
 - Long Term Pavement Preservation Program

Continuing CL Data Acquisition/Management Challenges & Likely Solutions

- Inventory lines do not maintain a 1:1 relationship with the number of actual travel lanes. Some divided roadways are represented by a single line segment, while others have one segment to represent each division of the roadway.
- No real way to accurately estimate roadway lengths, widths, surface area, etc. Currently conducting a pilot project that uses high-resolution (6" pixels) 3D aerial imagery to measure the surface area of pavement on any road segment and reflect that measurement back to the existing CL data. The use Metro Nashville's 6" data (flown by Kucera on contract with Metro Planning, and using StereoGIS software by SimWright) should result in roadway geometry measurements that are accurate enough to prevent the need to send inspectors out with measuring wheels to estimate construction quantities.
- As mentioned previously, sometimes roadways are split between data collection "seasons"; proper QC must be employed to ensure a segment's condition survey data, photographs, etc., associated with the parent are inherited by or reflected onto the children appropriately. This process will likely benefit from the geodatabase replication functionality provided by recent releases of ESRI ArcGIS software.
- Centerline addressing is based on the activities of the E-911 coordinator. Some of the segments have address ranges that include only the *actual* addresses that were in use on that segments at the time of its last update (LEFT_FROM = 1228; LEFT_TO = 1292), while others have ranges that include *all possible potential* addresses for that segment (LEFT_FROM = 1200; LEFT_TO = 1298). This is less of an issue for Paving, but it does affect the geocoding efforts of efforts afoot in Customer Service and Waste Management.
- In addition to the *actual vs potential* address issue described previously, corner lots present other addressing challenges. Nashville addresses are influenced by the USPS, Metro Nashville, and the persistence of the affected residents. For example, some residents on corner lots have a mailing address that is really a different house number on the intersecting street from the legal book of record just because they want their mailbox by the driveway instead of the front walk.
- Because much of the original CL linework was generated to match the Metro cadastral basemap instead of the ground evidence, there are a few areas of the CL dataset where segment linework is out of alignment with the orthophotography.
- Some of the digitized linework is of varying quality, dependent on accuracy, skills, and GIS work habits of employees who digitized or imported the linework.

Conclusion

- Metro Nashville – Davidson County provides several means for its staff and consultants and citizens to access roadway centerline data.
- Real-time street CL data is available as a geodatabase feature class served through ESRI ArcSDE, but can be overkill for some projects and not enough for others.
- Web-based viewing of the street network map is available from Nashville.gov, but some internal projects require direct access to analyze and edit a standalone snapshot of the CL dataset.
- If not managed carefully, data snapshots can introduce data forking, which is a bad idea; however, managed carefully, the use of snapshots can ultimately add value to the enterprise CL dataset.