Building a Highly Structured Geo Delivery System for E-911 CAD

ABSTRACT OF THE PROGRAM

The Montgomery County, Maryland, Department of Technology Services (DTS), Geographic Information Systems (GIS) team (DTS-GIS) uses the ESRI ArcGIS software platform to build, quality control (QC), distribute and deploy GIS data. GIS data uses points, lines and polygons to represent places in much the same way as a map does, but it also holds relevant information about these places. ESRI's GIS platform allows the County to do a large part of our data processes for the E-911 system. Our data consists of a multitude of different *Feature Classes* (datasets). Examples of the type of data that it uses include points (location of fire stations, stores, schools, buildings, etc.), lines (street centerlines, rivers, water lines, etc.) and polygons (beats, jurisdictions, municipalities, etc.). Needed data for each feature classes that were required was gathered into a project window called an *.mxd*. We also develop *Look_Up_Tables* (related files) that are used to QC and/or fill various database fields.

Public Safety data is like a tapestry. It is woven from all the diverse data interacting with all the diverse data. Data cannot be developed or QC'ed in a vacuum. A change in one *Feature Class* can affect one or more other *Feature Classes*. Any or all of them can change on a daily basis. This presents unique challenges and opportunities. Our objective was to bring our public safety data into the 21st century and deliver the highest quality data to our newest E911 system by enacting processes that eliminate or at least minimize the possibilities of human errors.

THE PROBLEM OR NEED FOR THE PROGRAM

The County's previous E911 systems employed flat files derived from the centerlines; they were used to validate addresses for responding, and to assign polygon (responding unit) data for Public Safety dispatch. Geographic data was used for display purposes only. The day-to-day QC's performed were done by the analysts on individual data sets. Only the final pre-delivery QC was conducted on the combined Public Safety data layers and took a full three days to complete.

The County's new E911 CAD system (the Premier One CAD, or P1 CAD) uses data in a completely different way. Geographic data is now used interactively to provide live routing, mapping, and polygon (i.e. responding unit) assignments. Polygons hold data such as Beat, Jurisdiction, Zip Code, etc. and to provide the correct data these polygons need to be coincident (within the parameters set by the system) with the centerlines. This new E-911 CAD system requires much more robust data sets, and thereby require much more extensive development and QC processes. We now have many different analysts working simultaneously on the creation and maintenance of their assigned feature classes (i.e. GIS data layers). Due to the interrelatedness of the data, they all need to have eyes on the latest data developed by their teammates.

Based on the requirements of the new E-911, the County's Senior GIS analysts developed an inventory of what the Public Safety E-911 project required and the steps needed to upgrade and enhance our existing data.

New Data Requirements - The new E-911 system requires much more robust data sets, and those require much more intense development and QC. The new system also holds regional data which extends to the boundaries of surrounding Counties. Our in-County data sets have far more breadth and depth than the bordering Counties do; but we must ensure that the out-of-county data is present, QC'd, geographically correct, and matched to our schema.
The primary data sets that are required include:

- Police polygon- data includes Beat, Sector, P_Area, Tow area,
- Fire polygon - data includes Beat, Sector, F_area, Fire Marshall
- Zipcode polygon - holds the Zipcode and the corresponding Mail City
- Jurisdiction polygon - holds the Public Safety Response Jurisdiction
- Cities - hold municipalities and the first due areas outside our county boundaries
- Out of County data requires centerlines, jurisdictions, first due areas, and zipcodes
- Centerline data is unique in that it is the basis for all other *Feature Classes* and the requirements are much more stringent. Because they are used for both dispatch and routing, they must provide live, accurate, least time travel from unit location to incident location. This necessitates Centerline data holding addresses, speed limits, segment length, travel direction, directional values, turn and road restrictions, elevations, cross streets, dual centerlines and access data, and all the above polygon data as well. It must model real world street and highway use to be successful.

Centerlines and polygons interact in both geographically and data-wise fashion. P1 CAD uses the centerline addresses X ,Y coordinates with five foot offset from the centerlines to access polygons which provide important data to E-911. This means the polygons must be coincident with the centerlines and their common data must match. Moving from a flat file data delivery to one which uses data in this live and interactive fashion was a huge undertaking. The development of QC scripts and models allowed us to progress in this endeavor in an accelerated pace

DESCRIPTION OF THE PROGRAM

There are three basic steps required to provide data to Public Safety and ensure that we meet our goal of delivering the highest quality data for the new E911 system. These three steps are: (1) Develop the data; (2) QC the data; and, (3) Deliver the data. The new procedures are very similar for each *Feature Class* whether they are points, lines or polygons. Work is distributed across multiple analysts, each being assigned one *Feature Class to "*own.*"* That person creates, updates, and modifies their own data. Occasionally, they also may need to share some editing responsibilities with an analyst from their own or a different agency.

The centerline QC procedures use models and scripts for their daily QC. Centerlines hold forty-two (42) data fields and each one needs to be correct. Meeting this requirement involved the development of eighty scripts, models or routing procedures. As an example, the FirstQC60Script checks that data fields are filled correctly and that there are no discrepancies between the data. (It looks at things like speed limit vs. road class, parity issues, and others) There are still a few processes that require 'human hands touching, or human eyes seeing the data' (like route testing) but the pre and post portions of those data points have been automated. An example of this is the routing QC procedure that was built. It provides needed pre-routing data set up, allows multiple people to test routing at the same time, and delivers reports.

Data polygons (emergency service areas, jurisdictions, zip codes, etc.) are based on the road centerlines but the other polygon data sets also need to be considered. If municipal boundaries change, it may affect police beats, fire beats, jurisdictions, etc. This possibility must be researched as changes made in one polygon may involve necessary changes to other polygons and/or centerlines as well. Due to their interrelatedness, all *Feature Classes* must agree with each other spatially, data-wise, or both. Because of the degree of interaction between *Feature Classes,* all GIS analysts must be able to access and view all the latest data but they also must be limited so as to have editing permission for only the data they "own."

DTS-GIS developed new and more efficient processes using models and scripts. Switching to ESRI's *Spatial Database Engine* (*SDE*)/SQL platform meant we could allow access to multiple people to view the needed data and limit editing to authorized users only. It also allows versioning so that more than one person can work on a data layer at the same time.

The data is developed and processed in an MXD on the individual analyst's computer. At the end of the day, or sooner if needed, the feature class is uploaded into the Staging SDE. This allows all users to view the newest data while working on their own. The nightly QC scripts focus primarily on centerline QC and uploading the QC'd GIS layers to the Staging SDE DB. Data QC and development work together throughout our lifecycle. We now have local and nightly processes. Our local Models were developed into tools that could be installed on each analyst's computer to perform their own QC on individual feature class. These Models can be run anytime that the analyst choses. These local tools allow the analyst to run comparisons between unique beats (old vs. new), Polygon Counts (CompareCount_NewOld), populate beat derivatives for Police Beat and Fire Beat, check that all fields are populated, perform new polygon boundary check vs old boundary, find null fields, update staging SDE DB, and conduct polygon to Centerline checks.

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THE COST OF THE PROGRAM

This program was developed over a period of three months. We deployed each piece as it was developed and tested. The development and QC processes have been live for about four months. The new Geo delivery process has been employed three times in 4 to 6 week intervals requested by Public Safety. Due to budget constraints, the project was constructed entirely in-house. It was very labor intensive. Two full time Senior employees worked on creating the automated system architecture. This included creating and maintenance of SDE DB, developing local QC tools and nightly jobs using python and ArcGIS model builder. Another three fulltime employees worked on data creation and maintenance and testing of the system as it was developed. Our group interacted with multiple agencies (ex: Police, Fire etc.) in the development of this project.

Three senior GIS analysts spent 3 months to accomplish this new Geo data preparation and delivery system. The personnel cost is about $70K. Standing up a new VM based SDE/SQL server cost about

$35K. GIS software (ArcGIS Server and Desktop) are already in the DTS-GIS portfolio and incurred no added cost.

The RESULTS/SUCCESS OF THE PROGRAM

The sophisticated QC models (built on the ESRI ArcCatalog environment) enable rigorous QC's of individual data layers (feature classes) needed for delivery to Public Safety as well as the check of linear features (street centerlines, property boundaries, hydro lines, etc.) and the polygon layers (Police PRA's and Fire Box areas). This check is vital for the proper assignment of the event (represented by the geocoded X,Y) to the public safety responding units. Whereas in the earlier CAD systems, the responding unit ID's were hard coded right at the individual centerlines, the contemporary CAD, just like many point-to-polygon association queries, relies on the correct event locations falling in the right polygons (responding units). The many QC scripts made this point to polygon (proper) association possible.

Without the need to code and maintain responding unit ID's (for PRA's, Fireboxes, etc.) on the centerlines, the task for maintaining it is smaller. With the enforcement of line/polygon topology, future realigning centerlines (due to roadway realignment) will cause the affected polygons to adjust their shapes accordingly. This represents another labor savings on maintaining the polygons.

SDE/SQL requires disciplined version controls which ensure that the correct version of Geo data is delivered to the E911 system. These Geo databases supporting the P1 CAD are then deployed. There is no more confusion of which windows folder the GIS analysts should use to fetch the data. Analysts in multiple agencies (DTS-GIS, Fire, and Police) now always access the latest GIS data for update or reference. The enhanced centerlines are being used by all data consumers. In addition, the development and QC procedures we have developed for Public Safety can be used/'tweaked' for data development, QC, and routing by many all other County agencies. This project cuts the time and manpower used for the QC procedures from more than two weeks of an analysts time, to a push of a button. Not too shabby!!

WORTHINESS OF AWARD

The new Geo data preparation and delivery system for the County's public safety E-911 CAD system represents a significant jump from the 'traditional' file based system to the modern database based system. It allows GIS analysts from multiple departments to collaborate on the many faceted Geo data provisioning. Streamlined Geo delivery eliminates the confusion of Windows folders. More frequent Geo deliveries are now possible so that the E-911 CAD has access to more current data to ensure proper protection of lives and property.

More and more Counties in the U.S. are migrating to E-911 CAD systems that require GIS maintained polygon layers having boundaries co-incident with the underlying street centerlines, property boundaries, and hydro lines. The County's effort of migrating to a database environment for strict version control and smooth Geo delivery to public safety CAD system and enforcing co-linearity of polygons with underlying linear features for proper responding unit assignment serve as a model for other Counties to mimic.

SUPPLEMENTAL MATERIALS (attached)