

### 3.4.3

#### Mapping the Underground City - the NY City Transit Subway Integrated Core GIS

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The recently completed World Trade Center Area (WTC-911) Pilot for the NY City Transit (NYCT) "Integrated Core GIS" Project has provided a proof of concept for the foundation of an enterprise class GIS-LRS, which will incorporate the transportation agency's legacy engineering CADD data, depicting the rail network and Station plans, and align them in relation to a new, commensurately accurate, multi-agency NYC base map (NYCMAP). The project's foundational scope as a "core" GIS utility for interfacing spatial functionality to multiple existing and planned applications, as well as the requirement to incorporate and leverage a large repository of legacy, engineering drawing CADD files within the new City basemap has meant that the database design has had to address a number of difficult conceptual problems, uniquely inherent to one of the world's most spatially complex Subway systems. The spatial functionality of the project is primarily built around a bill-of-materials (BOM)-like, or recursive parent-child, "Asset Hierarchy," coupled to a track centerline Linear Reference System (LRS).

The data model design must synergistically support the combined query power of a relatively granular, "horizontal" LRS spatial positioning and bounding in relation to the NYC base map, with a more "vertical," drill down or roll up, recursive query mode, for small to large scale the map views and level of data detail through out the full extent and depth of the Transit network's Right-of-Way (ROW), nested infrastructure. While not currently incorporating 3D data, the foundation for such capability is being laid through incorporation of a basic "relative z" elevation index to properly structure the non-planar network topology, or relative "over/under" relationships, of major features of the Subway system, such as criss-crossing track routes and multi-level Stations. The LRS component enables, among other capabilities, user navigation and data retrieval over the Subway system by using the "underground address" routes, or track stationing offset ranges or "measures" along the ROW from known "zero point" landmarks, such as Passenger Station platforms or tunnel portals.

For the GIS-LRS WTC Pilot and the construction phase of the new City wide NYCT Integrated Core GIS Project, an Intergraph MGE GIS server, with Projection Manager (MGPM) and Segmentation Manager (MGSM) client modules, as well as an MS Access database on a standard Win 2000 LAN was specified early in the project, in order to maximize GIS tool suite compatibility with the "dgn" format of Transit's legacy CADD files, since that CADD-GIS file type is common to both Transit's Bentley Microstation CADD environment, as well as Intergraph MGE, which is built on top of Microstation. The full implementation of the first user applications in mid-2005 will be based on an Intergraph Geomedia Web interface environment, but the "core" GIS-CADD database will be migrated up to an Oracle Spatial repository, which is being designed, with help from the central NYC GIS Utility. The Oracle Spatial based GIS will be relatively non-proprietary in terms of its ability to interface with, and serve, applications created in other major GIS products, such as ESRI's ArcGIS. This target architecture will maximize the read/write warehouse interoperability with both existing, more specialized GIS power users inside Transit, and also the larger NYC GIS Utility, outside the agency, which in turn will be able to mediate Transit access to the Oracle compatible data in many other agencies, regardless of the source GIS. The final configuration will also accommodate the eventual migration of Transit's CADD development to the new Bentley CADD

Under the impetus of interagency cooperation in the aftermath of the WTC 911 attack, the NYCT "Integrated Core GIS" Project, which has started (7/2003-12/2004), will maximize the cross organizational spatial functionality of the full Citywide version, Based on an evaluation of lessons learned from the WTC Pilot, covering Stations and ROW in lower Manhattan from the Battery to Canal St, external clients, such as the NYC Office of Emergency Management (OEM), as well as in-house engineering experts, are collaborating in the development of common GIS-CADD data model and naming standards. Key concepts from this common interagency effort, which will be reviewed in this paper are:

- 1.) relationships to the data model design requirements of:
  - a.) cross referencing CADD file "Level" element symbology to GIS map "Feature" Layers,
  - b.) infrastructure "relative z", above and below ground, elevation relationships to non-planar LRS topology,
  - c.) advanced, parcel based, surface address range systems in combination with ROW LRS within GIS for cross referencing the technology specific segmentation and CADD based location indexing of the major under ground infrastructure and utility systems of various agencies, such as Subway tunnels and water main

pipe networks for flood control applications.

2.) The paper will also address the impact of these issues on the initial Transit GIS applications of capital project management, track operations diversion and outage planning, and OEM underground navigation map aids for police and fire “first responders” in Subway emergencies.

3.) the more general role of the Transit GIS-LRS, modeled as a prototype for an “underground linear city” unto itself, in pioneering a future, scaled up design of a similarly integrated LRS-BOM-like multi-agency GIS Utility system and universal Drawing Management System (DMS) for cross referencing all of the City's many underground utility systems and networks, as well as their documentation, for better capital planning, street operations and emergency management"