MTA LINEAR REFERENCING DATA MODEL
MTA

- New York City Transit
  - Department of Subway
  - BUS
  - Paratransit
  - Staten Island Railway
- Long Island Rail Road
- Metro-North Railroad
- Bridges and Tunnels
- Capital Construction
# MTA Totals at a Glance*

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 operating budget</td>
<td>$13 billion</td>
</tr>
<tr>
<td>Annual ridership</td>
<td>2,658,000,000</td>
</tr>
<tr>
<td>Average weekday ridership</td>
<td>8,600,000</td>
</tr>
<tr>
<td>Rail and subway lines, and bus routes</td>
<td>357</td>
</tr>
<tr>
<td>Rail and subway cars</td>
<td>8,863</td>
</tr>
<tr>
<td>Buses</td>
<td>5,725</td>
</tr>
<tr>
<td>Track miles</td>
<td>2,080</td>
</tr>
<tr>
<td>Bus route miles</td>
<td>2,952</td>
</tr>
<tr>
<td>Rail and subway stations</td>
<td>736</td>
</tr>
<tr>
<td>Employees</td>
<td>73,575</td>
</tr>
</tbody>
</table>

GIS at MTA

- System Analysis
- Ridership Analysis
- Project Analysis
- Population Forecasts
- Data Communication
- Transparency
Integrating Organizations and People

Breaking Down the Barriers

MNR
ESRI

LIRR
ESRI

B&T
ESRI

NYCT
Geomedia
ESRI

MTAHQ
ESRI
Maptitude

MTA
EGP

NYCT

MTA
HQ

MNR

B&T

LIRR

8/6/18

...Sharing Resources
Consolidation

- Software redundancies
- Infrastructure redundancies
- Mobility
- Reliance on consultants
- Large project implementation
- Integration
- Emergency & Disaster preparedness
- Geospatial governance and policies
- Legacy systems
- Security enhancements
- Real-time data tracking

...Drive business value
MTA Geospatial Platform enables every employee to easily discover, use, make and share maps from any device, anywhere, anytime.
Enterprise Geospatial Platform

Increased Business Processes and Outcomes

Outcomes
- Organization
  - Improved efficacy
- Business
  - Increased efficiency
- Customer/Users
  - Easier accessibility

Support
- Geo-data providers partners
- Governance Segment Architecture Portfolio Management

Offerings
- Shared data, services applications and infrastructure
- Policies, standards and guidelines

Streamlined Access to Resources
MTA EGP Program – Work Streams

**Strategic Guidance**
- Geospatial Platform Program
- Business Information Flow
- Governance
- Implementation and Training

**Technical Framework**
- Architecture
- Security, Access Control and DRBC

**Data Management**
- R&H Linear Data Model
- Data Capture and Validation
- Tracking, Sensor, Big Data and Data Integration

**Products, Services and Applications**
- Geospatial platform products, tools and services
- Visualization and Analysis
- Reporting and Business Intelligence
GIS and EAM

- System of record for geographic location referencing
- System of record for Linear Asset Management
- Evolve Location referencing to depend on GPS and GIS to greatly improve accuracy
- Whole life asset management
- Planning & design, procurement & inventory, installation, maintenance & work management, decommissioning & disposal
- EAM manages asset information including asset attributes & specifications, work management, cost, etc.

EAM and GIS are linked by a common “GIS” ID that represents the geolocation NOT the asset
Relationship between GIS and EAM

Asset GeoLocation Management
- Geospatial location
- Geographic visualization
- Spatial hierarchy
- Spatial query
- Spatial analytics
- Spatial cost tracking
- Discrete and linear assets

GIS Data
- ASSET LOCATION REGISTRY
  - Location attributes
  - Linear reference

Stores the assets that reside at a geographic location
Stores the geographic locations at which assets reside

Asset Life Cycle Management
- Material stock/inventory
- Installation
- PM
- Repair
- Decommission
- Replace
- Asset hierarchy
- Cost tracking
- Discrete and linear assets

Asset Management Data
- ASSET REGISTRY
  - Attributes
  - Specifications
  - Condition

Geographic Information System
Asset Management Information System

Geographic Information System
Stores the geographic locations at which assets reside

Asset Management Information System
Stores the assets that reside at a geographic location
Location Lifecycle and Asset Lifecycle
GIS Integration – Other Systems

Operations 204/ Movement Bureau

Safety Exceptions -
Infor work request, work order

Infor EAM 11.3.2
Assets Registry
- GIS/Non-GIS assets
- Non-GIS – Assets that reside within LGU
- Work management

Infor HTML

Point Assets

Infor TM Mobile App

Optram

Safety Exceptions – service impact

W0 completion/status
Work request, work order

TCB2 nonconformities, defects,
Capital replacement, planned maintenance
Linear Network, LMU asset locations,
Nonconformities, defects from field

ESRI GIS (incl. R&H)
Geo-location Registry
- Lowest Geographic Unit (LGU)
- LRS

Sync attribute including Org data

Sperry & GPR shapefiles

ESRI Collector

TC-82 GPR Sperry
Why Linear Referencing?

- Critical for MTA operations
- Varying asset infrastructure – above ground, underground, tunnels, bridges, etc
- EAM Linear requirements
- Emergency Preparedness: real time web services for FDNY, NYPD, etc.
Benefits

- Coordinated, all agency approach to develop a linear data model that fits the MTA’s needs
- Improved Business
- Support the MAP-21 requirements
- Support data driven decision making and better analytical capabilities
- Integration with other systems
- Standardization
- Data Governance
- Qualitative benefits
Challenges

- No comprehensive rail data model
- Business information remains in silo and maintained in different referencing systems (Mile Post, Stationing, Chaining etc)
- Challenging or expensive integration between different systems
- Latency in propagation of updates to the system
MTA Linear Use Cases (very incomplete list)

1. Non-zero starting point (Segments which start at either a positive number or a negative number)
2. Miles which are not a mile (Short and long miles)
3. Gaps (Gaps in the numbering sequence)
4. Jumps (Jumps in the numbering sequence)
5. Tracks which join or separate (Track 1 becomes track 2, which then becomes track 1 again)
6. Lines which become another line (Harlem becoming the New Haven)
7. Reversals (numbering sequence reverses on itself)
8. Positive sequence in both directions around a zero point – Brooklyn Bridge which is a zero location and both directions head out as positives.
9. Chaining
10. Stationing
11. Mile Marker Positions
12. Changes to the physical location of a mile marker/s
13. Transposing Track (High side to low side of a curve)
14. Re-using Track (Moving to a branch line, or less used line)
15. Multiple Mile markers of the same value (Mile markers increase to 71, then go back to 68 and increase again – on same line)
16. Must accommodate ladders
17. Must accommodate any asset as a starting point
18. Must be able to create a physical route, but that physical route cannot be identified in the asset list of Infor
Criteria of Linear (very incomplete list)

1. Beginning (non-zero) measurement/stationing
2. Ending measurement/stationing
3. Stationing in feet is the fundamental measurement unit?
4. Allow base measurement relative to/from a non-”asset” reference line
5. Direction of increasing stationing (may/might be implied by ending being smaller than beginning)
6. Some way to have the segment related to other segments and reference points
7. Accommodate complex relationships like ladders, yards, interlockings, etc.
8. Allow for GAPS/Jumps in stationing
9. Short/Long milepost calculations
10. Allow for multiple mileposts with the same value.
11. Allow for measurements relative to other reference points and linear segments (signals, platforms, etc.)
12. Allow for conversion between measurement systems (stationing to/from mileposts, feet from signal to absolute stationing, etc.) – “Universal Translator”
13. Additional attribution like division, line, track, etc.
QUESTIONS ?