Large Scale Field Data Collection and Open Source GIS

Matt von Wahlde
Mobile Data Collection and GIS

- What’s Covered
  - System for collecting transit system accessibility data
  - Overview of Project
  - Special Problems for project
  - Data management Challenges
  - Open Source GIS technology
Massachusetts Bay Transportation Authority
Plan for Accessible Transit Infrastructure
Over 7000 bus stops
250 subway, commuter rail, and light rail stations
Needed to determine barriers to accessibility for people with a wide range of disabilities
Mixture of old and new stations
- Platform
- Elevators
- Doors
- Restrooms
- ...
Challenges for project

- Significant need for GIS
- Minimal Training for users
- Many facility element types
- Planning survey for efficient use of field personnel
- Tracking of field personnel
- Field Survey
- Design
- Challenging Location problems
- GIS part of the solution
### Special Requirements

- Wanted open, flexible, non-proprietary system that could be used in the future
- Crew Management and planning
- Complex data validation and data entry rules
- Look ups into ADA and Accessibility guidelines
- Full off line mode with real time syncing
- Role based data entry behaviors
- Duplicate survey detection
- Custom Built In Quality Control Mode

<table>
<thead>
<tr>
<th>Source Name</th>
<th>Element Type</th>
<th>Section Reference</th>
<th>Link</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>206.2.2</td>
<td>link</td>
<td>At least one accessible route shall connect accessible buildings, accessible facilities, accessible elements, and accessible spaces that are on the same site.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>206.2.3</td>
<td>link</td>
<td>At least one accessible route shall connect each story and mezzanine in multi-story buildings and facilities.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>207</td>
<td>link</td>
<td>Accessible Means of Egress</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>208.3.1</td>
<td>link</td>
<td>Parking spaces complying with 502 that serve a particular building or facility shall be located on the shortest accessible route from parking to an entrance complying with 206.4. Where parking serves more than one accessible entrance, parking spaces complying with 502 shall be dispersed and located on the shortest accessible route to the accessible entrances in parking facilities that do not serve a particular building or facility, parking spaces complying with 502 shall be located on the shortest accessible route to an accessible pedestrian entrance of the parking facility.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>209.2.1</td>
<td>link</td>
<td>Passenger loading zones, except those required to comply with 209.2.2 and 209.2.3, shall provide at least one passenger loading zone complying with 503 in every continuous 100 linear feet (30 m) of loading zone space, or fraction thereof.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>216.6</td>
<td></td>
<td>Where not all entrances comply with 404, entrances complying with 404 shall be identified by the International Symbol of Accessibility complying with 703.7.2.1. Directional signs complying with 703.5 that indicate the location of the nearest entrance complying with 404 shall be provided at entrances that do not comply with 404.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>216.8</td>
<td>link</td>
<td>Where existing toilet rooms or bathing rooms do not comply with 603, directional signs indicating the location of the nearest toilet room or bathing room complying with 603 within the facility shall be provided. Signs shall comply with 703.5 and shall include the International Symbol of Accessibility complying with 703.7.2.1. Where existing toilet rooms or bathing rooms do not comply with 603, the toilet rooms or bathing rooms complying with 603 shall be identified by the International Symbol of Accessibility complying with 703.7.2.1. Where clustered single user toilet rooms or bathing facilities are permitted to use exceptions to 213.2, toilet rooms or bathing facilities complying with 603 shall be identified by the International Symbol of Accessibility complying with 703.7.2.1 unless all toilet rooms and bathing facilities comply with 603.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Door</td>
<td>302.1</td>
<td>link</td>
<td>Floor and ground surfaces shall be stable, firm, and slip resistant and shall comply with 302.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Ramp</td>
<td>302.3</td>
<td>link</td>
<td>Openings in floor or ground surfaces shall not allow passage of a sphere more than 1/2 inch (13 mm) diameter except as allowed in 407.4.3, 409.4.3, 410.4, 810.5.3, and 810.10. Elongated openings shall be placed so that the long dimension is perpendicular to the dominant direction of travel.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Ramp</td>
<td>303.2</td>
<td>link</td>
<td>Changes in level of 1/4 inch (6.4 mm) high maximum shall be permitted to be vertical.</td>
</tr>
<tr>
<td>2010 ADA Standards for Accessible Design</td>
<td>Ramp</td>
<td>305.3</td>
<td>link</td>
<td>The clear floor or ground space shall be 30 inches (760 mm) minimum by 48 inches (1220 mm) minimum.</td>
</tr>
</tbody>
</table>
Location Challenges

- Need to manage large number of crews
- Don’t know where all bus stops are
- Train stations are complex and have complex interior spaces
- Lack of accurate floor plans
Location Challenges

- GIS Not Appropriate for Inside/underground spaces
- Need to be cost effective
- GPS not accurate enough
Hybrid Data Model

Because not all elements could be located geographically, a hierarchical data model was used to record complex objects and relationships.

Support the ability to do complex queries of “things containing” such as “show me all the platforms that have call boxes on the inbound side”
System Architecture

USER Tier
- Browser/HTML Interface
- Mobile Data Tool
- QGIS Interface

APPLICATION Tier
- .NET Core
- Entity Framework Core

DATA Tier
- REST Document Services
- REST Data Services
- REST Sync Services
- Elastic Block Storage
- GeoServer
- PostGIS LRS
- PostgresSQL
Choosing Technologies

- Wanted a platform that was flexible and could be extended in the future
- Chose Open Source Software
- Longevity of Technology
- Wanted Open GIS Platform
- Complexity of data and ease of query
Custom Application Server

- Implemented in .NET Core
- Open Source
- Code repository: https://github.com/dotnet/core
- Runs on Windows, Linux

- Contains Workflow and business logic
- Syncing Engine
- Scoring engine
Microsoft Entity Framework and PostgreSQL

Object Relational Model for databases
Open source GIS

- Geoserver
  - http://geoserver.org/
- PostGIS
  - /www.postgresql.org
- Open Layers
  - https://openlayers.org/
- QGIS
Used Microsoft Xamarin To Create Mobile App

- Creates Native Android (or iOS) App
- Faster
- Access to lower level mobile function
- Cross platform mobile development environment
- Uses standard C# programming language
- Can compile on Android, iPhone, or Windows mobile platform
- Develop in Visual Studio

Big advantage
Planning Tool
Multi Crew scheduling and Planning

- Up to 20 field crews simultaneously in the field
- System Constraints to prevent duplicate surveys
- Custom Quality Control checks
Mobile Data Collection App
Mobile GIS Interface

- Wanted Custom User interface tailored to Client needs
- System Constraints to prevent duplicate surveys
- Detected nearby bus stops so no survey duplicates
Browser Based Management Interface
Survey Monitoring Feature

- Data available Realtime
- Monitor progress of data as it was recorded
- Custom Quality Control checks
Geoserver Report Generation
Content Management Functions

Table of Contents

Introduction

1.1 PATI Overview

Through the Plan for Accessible Transit Infrastructure (PATI), the MTA envisions and plans for a fully accessible system. PATI began with the survey of over 7,500 bus stops and 178 rail stations in order to inventory and catalogue all significant barriers to access. Parallel to that effort, the MTA, in conjunction with an external committee of disability stakeholders, is working to develop a process for setting priorities that can be replicated over time. For example, this may include prioritizing removal of barriers where ROD pickup/drop-offs often take place or where other State of Good Repair (SGR) work is needed. This prioritization methodology will then be applied to the inventory of barriers to produce recommendations for their removal.

Ultimately, PATI will yield a plan and recommendations for achieving a fully accessible MTA system.

PATI will enable Department of System Wide Accessibility, together with Capital Delivery, Engineering & Maintenance and other departments, to work with the disability community to remove barriers in a proactive rather than reactive manner. This report represents one of 768 station reports prepared for the PATI project.

1.2 Survey Methodology

The MTA engaged a consultant team (“Team”) to develop a tablet-based data collection tool and website interface (“web tool”) to plan and oversee data collection, collect field data and take photographs, compile and analyze results, and report findings. The Department of System Wide Accessibility provided the consultant with approximately 200 questions to assess all key public-facing sections of a station, including horizontal and vertical circulation on adjacent streets, crossings, sidewalks, parking facilities, drop-off areas, business entrances, station buildings, platforms, and track crossings.

The Team organized the survey hierarchy into sections and elements. Sections represent a method to organize the entire station property into specific zones. Elements represent those features found within sections and can be present in more than one section. Table 1 lists surveyed sections.

Table 1 – Survey Sections

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station Exterior</td>
</tr>
<tr>
<td>Parking Area</td>
</tr>
<tr>
<td>Busway</td>
</tr>
<tr>
<td>Drop OFF</td>
</tr>
<tr>
<td>Entrance</td>
</tr>
<tr>
<td>Station Interior</td>
</tr>
<tr>
<td>Vertical Circulation</td>
</tr>
<tr>
<td>Station Access</td>
</tr>
</tbody>
</table>
Element and Station Scoring

Edit Rules

What is the narrowest width of the walkway? (0 - 120)

- When answered less than 36.00 assign a score of 25
- When answered between 36.00 and 60.00 assign a score of 50
- When answered between 60.00 and 84.00 assign a score of 75
- When answered greater than 84.00 assign a score of 100
- When answered equal to 50.00 assign a score of 50
- When answered equal to 36.00 assign a score of 25
- When answered equal to 84.00 assign a score of 100

When skipped assign a score of

Add
Save changes
Close
Reporting

- Needed to be easy to use
- Complexity of deeply hierarchical data
- Hard to flatten out
- Export to presentation quality Word document
Geoserver Integration

- Geoserver is free
- Scales extremely well
- Easy to set up
- Very flexible and open
- Support cached vector tiles
- Extremely fast performance
- Good security
QGIS integration
QGIS Integration
Next Steps

- Remediation and Prioritization
- Browser Based 3D visualization linked to database
- Visualize paths of travel
- Cesium JS
- Babylon JS
Wrap Up

- Design the system with the end in mind
- Clearly define EXACT reporting requirements
- Consider End Users
- Support Open GIS projects!

Thank-you!
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