LRS Enabled Parallel Field Data Collection

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“Data, I think, is one of the most powerful mechanisms for telling stories. I take a huge pile of data and I try to get it to tell stories.”

– Steven Levitt, Co-author of Freakonomics

“Data is a precious thing and will last longer than the systems themselves.”

- Sir Tim Berners-Lee, Director of World Wide Web Consortium

“I think you can have a ridiculously enormous and complex data set, but if you have the right tools and methodology then it’s not a problem.”

– Aaron Koblin, Creator of the Data Arts Team at Google
What is LRS Enabled Parallel Field Data Collection?

Utilize the Geospatial LRS of Record

• Ability to load LRS geometry and location information for asset and attribute referencing
• Snap attribution and/or assets to appropriate route
• Ensures continuity in data collection and location referencing

Collection/Verification/Modification of Multiple Assets Concurrently

• Singular Asset/Attribute collection requires time consuming repeat reviews
• Planning data historically covers a wide variety roadway characteristics (e.g. lane configuration, feature crossings, intersection locations)
• Need for possible expansion of collectable data elements to fit MIRE data model

Integrated Visual Display of Data Elements & Attributes

• Real time visual interaction with collected/modified assets and attribution
• Simplified heads up, asset-based, visual display
• Elements of material and skeuomorphic design to allow for easier collector visual recognition
Roadway Information System (RIS) User Interface

HPMS Collection Tablet User Interface

Road Inventory Tablet User Interface

Roadway Inventory System

Select a Route Number: 055
Inventory Month/Year: 11/2011
Log Direction: N

Town Name: Greenwich
Route Name: (I 95 - GOV JOHN D LODGE TPKE)

Current Pavement: 4 101 00000 361 00000 101 1 112 11/11

Current Milepoint:

NOTES MILES 4

DESCRIPTION
SB END ACCEL LAN 0 63
4 101 00000 361 00000 101 1 112 11/11
0 63 20 SB ACC FR DELAVAN AVE 002
4 101 00000 361 00000 101 1 112 11/11

Selected Tiepoint Information:

Description: AVE (002)

Angle: 0
Route #: 055
Town #: 056
Road #: 

HOV/Ramp #: 
Road Class: M
Log Direction: N
One Way Direction: 

Exit Number: 
Suffix: 
Tie point type code: 

Clear
In this one screen/view there is LRS located information on pavement cross sectional configuration, line striping, intersecting road and geometry, projects, and signal assets.

RIS Collection Methodology – Multiple Assets
Coordinates were an attribute of the mileage
Strictly point based, all post processed relational
MAVRIC – What is (was) it?

Mobile Asset Verification and Roadway Inventory Collection (MAVRIC) Application
MAVRIC – Functional Requirements

Core Requirements

• Standalone application that works in disconnected environment
• Ability to load data from updated LRS management system
• Utilize GPS receivers to match collector location to the road network
• Support “parallel data collection” efforts – display & modify multiple assets/attributes concurrently
• Support roadway segment creation and attribution by utilizing a GPS trace feature
• Ability to QA/QC data before integration back to LRS management system of record

Field Data Collector Functional Requirements

- **Purpose:**
  - To collect and maintain roadway inventory information along an established linear referencing system (LRS) and with geospatial attributes.

- **Description:**
  - A stand-alone application that can run on a laptop or mobile device in the field.
  - Road sections and associated asset information will be checked out of the EXOR database, loaded into the data collection application, and brought into the field to collect, verify, and update.
  - The application will use a GPS sensor to match the location of the data collector on the road network. The user will see a graphical representation of the roadway characteristics and asset inventory, and be able to modify them interactively based on their observations.
  - The application will support parallel data collection activities. It will have the ability to display & modify the roadway network itself, along with roadway characteristics and multiple pieces of asset information/attributes in a seamless and simultaneous manner.
  - The application will support roadway location creation based upon a GPS trace feature. It will have the ability to create a new road & new location in the field and assign attributes/characteristics/assets along the newly established linear feature, as well as tie it back to the existing road network.
  - All field collected/modified data will have the ability to be validated upon return to DOT and checked back into the EXOR database.

- **Testing:**
  - CT DOT will be involved in a beta testing phase.

- **Documentation:**
  - The application should provide an integrated online help system and user guide as well as a training manual.

- **Phase 1 Requirements:**
  - Ability to function in an offline mode in the field without an internet connection.
  - The application should have support for extensible assets and asset attribution, so as new assets are created and defined, the field data collector will be able to support it.
    - Further discussion with Transcend about how we would define the asset and its characteristics/attribute.
  - The phase 1 UI will support a straight line diagram or attribute bar representation of the road and assets in a scrolling, vertical view, similar to the photo below on the next page.
MAVRIC – System Component Diagram

Data Store
SQL Server DB

Exor
Oracle Data

SQL Server DB Translator
App Module

CSV Translator
App Module

MAVRIC Web Services (CORE)
Web Application

Upload Data

Download Data

MAVRIC Client
Mobile/Web App

Map Service
ArcGIS Server, Leaflet, Google Maps, etc.

MAVRIC Web Services
• Transportation Data Server (TDS)
• Server Side Application

Exor Translation Module
• Plug-In for TDS
• GeoJSON to CSV – SQL Server Data Warehouse

MAVRIC Client
• Web Application
• Browser/Platform Agnostic

Map Service
• User Determined
• ArcGIS Online Default – Bing, Google, Mapbox
MAVRIC – CTDOT Data Flow Diagram

AssetWise ALIM

Exor CSV File Upload
- Read data from MAVRIC DB and produce CSV file formatted for Exor load

Bentley Firewall

MAVRIC ETL

CTDOT Cloud

MAVRIC Database SQL Server

MAVRIC Loader
- Extract data from MAVRIC DB
- Transform to GeoJSON and load on mobile device (MD)
- Read updated info from MD and push back to MAVRIC DB

MAVRIC Field Data Collector
- Road Network & Assets

CSV File

TIG Extract

CSV Extract
MAVRIC – CTDOT Data Update Process

- MAVRIC ETL
- MAVRIC Loader
- MAVRIC Database
  - Exor Schema: Data populated by ETL process from Exor
  - Field Data Collection Tool (FDCT) Schema: Data uploaded from the field tool
- CSV File
- CSV Extract
- GeoJSON
- Exor Schema
- FDCT Schema
- MAVRIC Field Data Collector
  - Road Network
  - Road Assets
MAVRIC – Operational Characteristics

**Personalized Interaction**
- Sign-in – user name with password and associated credentials
- Settings & views are user based and saved for subsequent login attempts
- Asset editing permissions and data views tied to login

**Multiple Syncing Options**
- Edits can be stored locally for syncing at later time (e.g. back in the office or when connected to a secure network)
- With connected devices, edits synced at discretion of data collector – even from the field
- Only changes are synced back to database

**Fully Interactive Visualization**
- Verification of feature collection through visual recreation
- Collector receives feedback on GPS connection quality
- Guidebar assists in locating assets and features
App loads to whichever screen the user was last viewing or to the default view.

Default view could be either the map view (cached map until user initiates GPS location) or the roadway view. Setting the default could be a setting in the app.
MAVRIC – UI – Create A Map
MAVRIC – UI – Roadway Data Views
MAVRIC – UI – Data Editing

Sign
Category
Sub-Cat
Direction of Travel

Guide
- Conventional Roads
  - Conventional Roads - General
  - Conventional Roads - Route
  - Freeways and Expressways - E:
  - Freeways and Expressways - General
  - Ways and Expressways - Rest Area and Sides

Cancel OK

Cancel
Photo
Browse
MAVRIC – UI – Syncing Changes

Review & Sync

Items ready for syncing:
- Speed Limit: 65 From 1.99 To 5.14
- Guardrail: GOOD From: 2.68 To: 7.65
- Guardrail: POOR From: 7.66 To: 8.02

Envision the items ready for syncing to be featured in a grid here.
### MAVRIC – UI – Style Settings/Configuration

#### Roadway Styling Settings

<table>
<thead>
<tr>
<th>Layer Visibility</th>
<th>Stick Placement</th>
<th>Lane Placement</th>
<th>Styles</th>
<th>Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through Lane Settings:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Layer:</strong> Through Lanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Column:</strong> Number of Lanes Left</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Reverse Lane Settings: | | | | |
| **Layer:** Reverse Lanes | | | | |
| **Column:** Number of Lanes Right | | | | |

#### Through Lane Settings:

<table>
<thead>
<tr>
<th>Type</th>
<th>Value Field</th>
<th>XSP</th>
<th>XSP Field</th>
<th>Location</th>
<th>Lane Order</th>
<th>Shoulder Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane</td>
<td>Lane_X_Sect</td>
<td>Yes</td>
<td>LTR1</td>
<td>Right</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>Lane_X_Sect</td>
<td>Yes</td>
<td>LTR2</td>
<td>Right</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>Lane_X_Sect</td>
<td>Yes</td>
<td>LTR3</td>
<td>Right</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>Lane_X_Sect</td>
<td>Yes</td>
<td>LTL1</td>
<td>Left</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lane</td>
<td>Lane_X_Sect</td>
<td>Yes</td>
<td>LTL2</td>
<td>Right</td>
<td>3</td>
<td></td>
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<tr>
<td>Shoulder</td>
<td>Shoulder_X_Sect</td>
<td>Yes</td>
<td>LTS1</td>
<td>Right</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

#### Reverse Lane Settings:

- Layer: Reverse Lanes
- Column: Number of Lanes Right

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[Image of tablet showing the MAVRIC UI with Style Settings/Configuration]
MAVRIC – UI – Style Settings/Configuration

**Roadway Styling Settings**

- **Layer Visibility**
- **Stick Placement**
- **Lane Placement**
- **Styles**

**Layer Fields:**

<table>
<thead>
<tr>
<th>Visible Name</th>
<th>Alias</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUTCDNAME</td>
<td>MUTCD Name</td>
</tr>
<tr>
<td>MEASURE</td>
<td>Measure</td>
</tr>
<tr>
<td>MUTCDCODE</td>
<td>MUTCD Code</td>
</tr>
<tr>
<td>ROUTE</td>
<td>Route</td>
</tr>
<tr>
<td>MUTCDCAT</td>
<td>Sign Category</td>
</tr>
<tr>
<td>BEG_MP</td>
<td>Begin Milepoint</td>
</tr>
</tbody>
</table>
## MAVRIC – CTDOT Data

### Sample Data Provided to Transcend Spatial by CTDOT

<table>
<thead>
<tr>
<th>Category</th>
<th>Type</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exits</td>
<td>Point</td>
<td>3 Attributes</td>
</tr>
<tr>
<td>Functional Class</td>
<td>Linear</td>
<td>1 Attribute</td>
</tr>
<tr>
<td>Intersection</td>
<td>Linear</td>
<td>26 Attributes</td>
</tr>
<tr>
<td>Intersection Approach</td>
<td>Linear</td>
<td>40 Attributes</td>
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<tr>
<td>Intersection Point</td>
<td>Point</td>
<td>1 Attribute</td>
</tr>
<tr>
<td>HPMS Asset</td>
<td>Linear</td>
<td>21 Attributes</td>
</tr>
<tr>
<td>Lanes</td>
<td>Linear-XSP</td>
<td>4 Attributes</td>
</tr>
<tr>
<td>Medians</td>
<td>Linear</td>
<td>2 Attributes</td>
</tr>
<tr>
<td>Road Mile Points</td>
<td>Point</td>
<td>1 Attribute</td>
</tr>
<tr>
<td>Roads</td>
<td>Linear</td>
<td>2 Attributes</td>
</tr>
<tr>
<td>Route Mile Pts</td>
<td>Point</td>
<td>1 Attribute</td>
</tr>
<tr>
<td>Routes</td>
<td>Linear</td>
<td>2 Attributes</td>
</tr>
<tr>
<td>Rumble Strips</td>
<td>Linear</td>
<td>8 Attributes</td>
</tr>
<tr>
<td>Sign Assembly</td>
<td>Point</td>
<td>15 Attributes</td>
</tr>
<tr>
<td>Sign Panel</td>
<td>Point</td>
<td>20 Attributes</td>
</tr>
<tr>
<td>Update History</td>
<td>Linear/Point</td>
<td>1 Date</td>
</tr>
</tbody>
</table>
LRS Enabled Parallel Field Data Collection

Mobile Asset Verification & Roadway Inventory Collection - MAVRIC

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Thank You