Esri Roads and Highways: Integrating and Developing LRS Business Systems

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Overview:
Esri Roads and Highways
Esri Roads and Highways

Linear Referencing for the Transportation Agency

GIS-enabled LRS platform

- LRS management
- LRS editing & maintenance
- LRS web services
- Information model
- Workflow
- Quality control
- GIS analysis
- Mapping
- Cloud collaboration
Esri Roads and Highways

Provides COTS solution for roadway inventory

Roadway Inventory

- Web event editing
- Quality checks
- Information model

GIS-enabled LRS platform
Esri Roads and Highways

Also provides COTS solution for HPMS

Roadway Inventory

HPMS Reporting

- Data product creation
- Data check & correction
- Information model

GIS-enabled LRS platform
Esri Roads and Highways

Data interoperability and LRS platform for the enterprise

- Planning
- Safety Analysis
- Executive Dashboards
- Field Data Collection
- Asset Management
- Straight Line Diagrams
...and more...

GIS-enabled LRS platform
LRS Integration Platform
Centralized LRS and Event Publication

- **Roads & Highways**
  - Centralized LRS managed in the GIS
  - Support for multiple LRMs
  - Publication of LRS & events (REST & GDB)

- **Business Units**
  - Consume GIS-based LRS
  - Manage (and expose) event data
  - Consume other business systems’ events
LRS Data and Services
Provided to external systems

- Measure updates to events
- LRS network updates
- Mapping and query of routes and events
- LRS capabilities via web services
- Workflow orchestration around data editing
Event Measure Updates

Integration Pattern
Event Measure Updates

Event registration

- Event data can be registered with the LRS in two ways
Event Measure Updates

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- **Internal**: event feature classes
  - Local to the LRS geodatabase
  - Measures and shapes updated directly by Roads and Highways
Event Measure Updates

Event registration

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- **Internal**: event feature classes
  - Local to the LRS geodatabase
  - Measures and shapes updated directly by Roads and Highways

- **External**: event tables
  - Located in a different database than the LRS
  - Accessed by ArcGIS through a read-only connection
Event Measure Updates
Triggered by LRS route editing

• **Route edit activities**
  - Extend, realign, reassign, retire, calibrate, …

• **Impacted event properties**
  - Measures
  - Effective dates
  - Shape *(if external system is spatially aware)*
Relocate Events
Geoprocessing service

- Provides measure updates based on route edits
- Geoprocessing tool published as a REST web service
- Requires development by an integrator
Relocate Events Parameters

- LRS network
- Event reference
- LRS time
- Last invoked time
- Output format: JSON, CSV, File GDB
- Include event shapes
## Relocate Events Output

<table>
<thead>
<tr>
<th>Route ID</th>
<th>Old From Measure</th>
<th>Old To Measure</th>
<th>New From Measure</th>
<th>New To Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR85</td>
<td>0</td>
<td>2.5</td>
<td>6</td>
<td>8.5</td>
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<tr>
<td>US101</td>
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<td>US101</td>
<td>52.5</td>
<td>53.0</td>
<td>52.4</td>
<td>52.8</td>
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<td>US101</td>
<td>53.0</td>
<td>53.2</td>
<td>52.8</td>
<td>53.0</td>
</tr>
</tbody>
</table>

Route extension

Route realignment
Relocate Events
Geoprocessing service
LRS Network Export
Integration Pattern
LRS Network Export

• External system must persist its own copy of the LRS
  - Required by data model or business logic
  - Maintains a different LRS schema
  - Cannot directly work with the Roads and Highways LRS
LRS Network Export

- External system must persist its own copy of the LRS
  - Required by data model or business logic
  - Maintains a different LRS schema
  - Cannot directly work with the Roads and Highways LRS

- Supported approach, but not recommended
  - Non-authoritative copy of the LRS
  - Data staleness if not updated frequently
Export Network
Geoprocessing service

- Provides LRS network updates
- Geoprocessing tool published as a REST web service
- Requires development by an integrator
Export Network Parameters

- LRS network
- LRS time
- Last invoked time
- Output format: File GDB
- LRM translations to other networks
Export Network Output

- Routes feature class
- Gaps table
- Concurrency table
- LRM translations table
Export Network
Geoprocessing service
Mapping and Query
Integration Pattern
Mapping and Query

- LRS routes and events are stored in the LRS geodatabase
- Managed and edited by Roads and Highways

- External system needs visualization and query capabilities
- On-demand requests for LRS information
Map Service

- Maps of the roadway network and characteristics
- Popup info for route and event features
- Query feature and tabular data
  - By attribute, spatial filter, or both
Map Service

- Example query from a safety analysis system

Select all Crash events
Where Accident_date after ‘2014-01-01’
And crash locations located along (Speed Limit > 35) events
Within my current map view
Map Service

- REST and SOAP web services provided by ArcGIS for Server
Mapping and Query

Map service
LRS Server Capabilities
Integration Pattern
LRS Server Capabilities

- Embed LRS business logic in...
  - Enterprise web apps: *event data management*
  - Connected mobile apps: *field data collection*
  - Back office IT systems: *roadway analysis and reporting*

- Measure-aware operations beyond basic mapping and query
- Service oriented approach across business units
Linear Referencing capability in ArcGIS for Server

- **ArcGIS for Server**
  - Mapping, Query, Geoprocessing

- **Linear Referencing server extension**
  - Event editing
  - Coordinate to measures (*includes stationing*)
  - Measure to coordinate (*includes stationing*)
  - Query attribute sets
  - Check events (*gaps, overlaps, invalid measures*)
  - Measure translation
  - Network and event metadata
Recommended Pattern

• Easy to implement
  • Coarse grained REST services
  • Invokers abstracted from complexities of database schema
  • Sample code available
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  • No Esri libraries required for client to invoke
  • No direct client access to database required, just HTTP
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• Duplication of functionality and data minimized
  • Data doesn’t need to be copied to other system databases
  • Functionality doesn’t need to be duplicated in other system apps
Linear Referencing Web Services

- REST web services provided by Roads and Highways for Server

LRS GIS → Map Service + LRS capability → Enterprise Systems and Apps
Linear Referencing
Web Services
Map service extension
Workflow
Orchestration
Integration Pattern
Workflow Orchestration

- Standardize a common workflow for everyone to follow
- Bring together disparate enterprise systems and apps
- Coordinate work among people and teams
- Ensure quality of data editing
Example workflow for route and event editing

1. Start
2. Create GDB version
3. Open ArcMap to edit routes
4. Launch Roadway Characteristics Editor (RCE)
5. Launch bridge inventory app
6. Launch RCE to check event data quality
7. Run Data Reviewer validation
8. Post data changes to Default version
9. Notify stakeholders
10. Finish
Summary of Integration Patterns

• Service-oriented approach
  - ArcGIS and LRS web services

• Client-server approach
  - Direct geodatabase access

• Hybrid approach
  - Combination to satisfy a complex workflow
Thank you...

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