



# Esri Roads and Highways: Integrating and Developing LRS Business Systems

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Technical Workshop

# 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

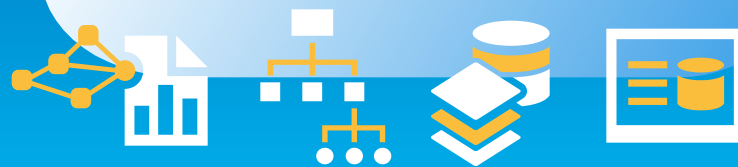
*Provides COTS solution for roadway inventory*



- § Web event editing
- § Quality checks
- § Information model

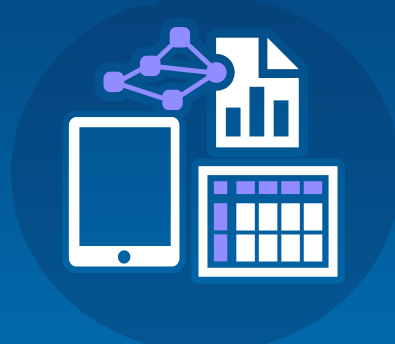


GIS-enabled LRS platform



# Esri Roads and Highways

*Also provides COTS solution for HPMS*



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



GIS-enabled LRS platform



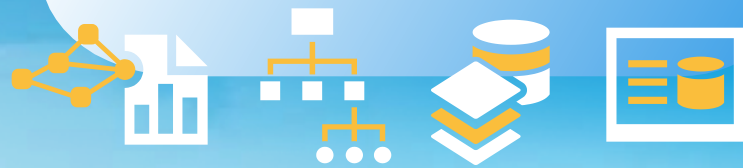
# Esri Roads and Highways

*Data interoperability and LRS platform for the enterprise*



- § Planning
- § Safety Analysis
- § Executive Dashboards
- § Field Data Collection
- § Asset Management
- § Straight Line Diagrams

...and more...

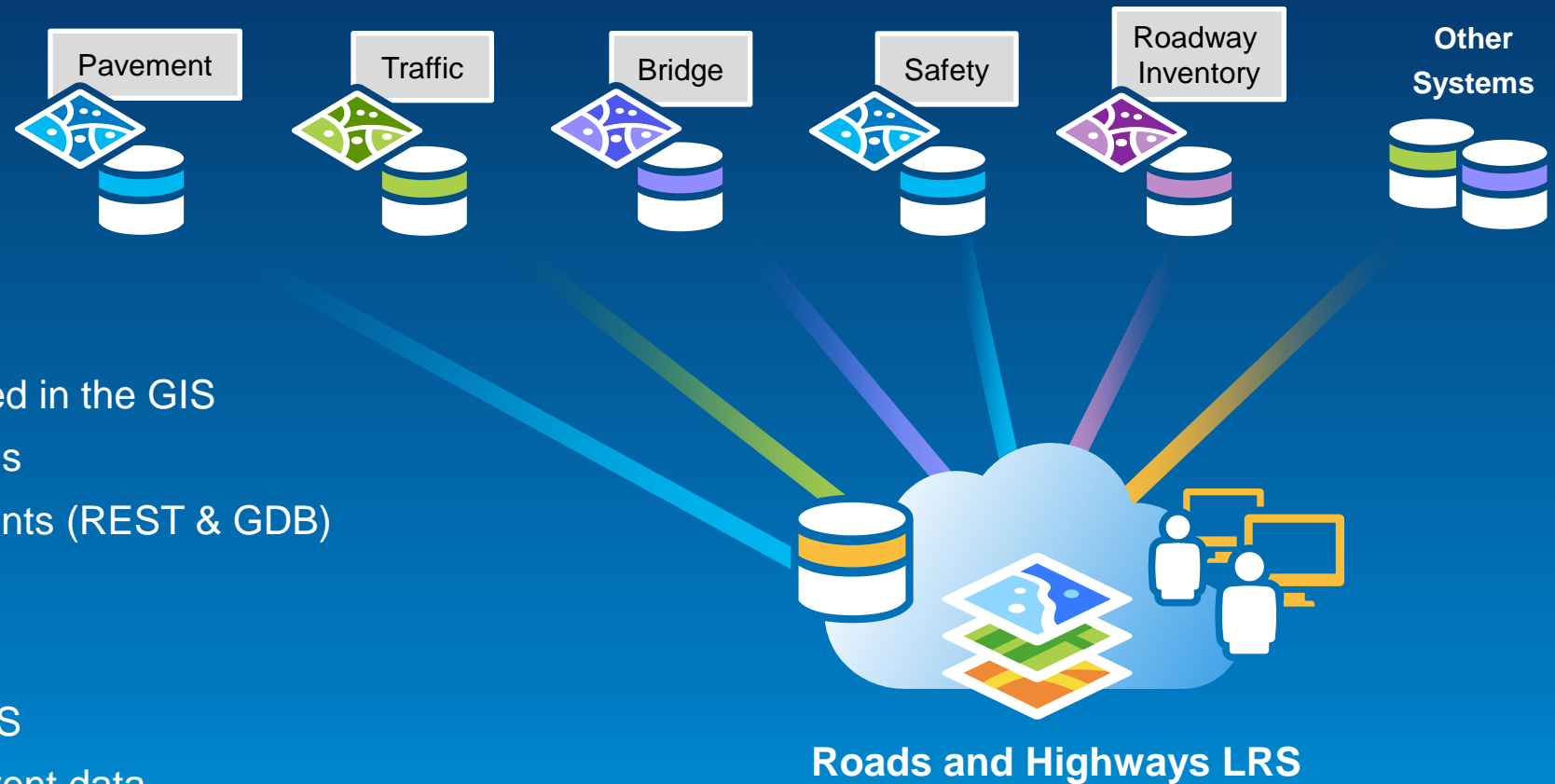




# LRS Integration Platform



# 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

## Event registration

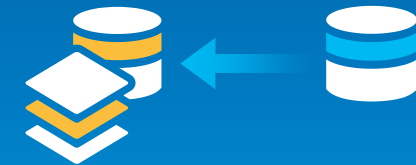
- Event data can be registered with the LRS in two ways
- **Internal:** event feature classes
  - Local to the LRS geodatabase
  - Measures and shapes updated directly by Roads and Highways



# Event Measure Updates

## Event registration

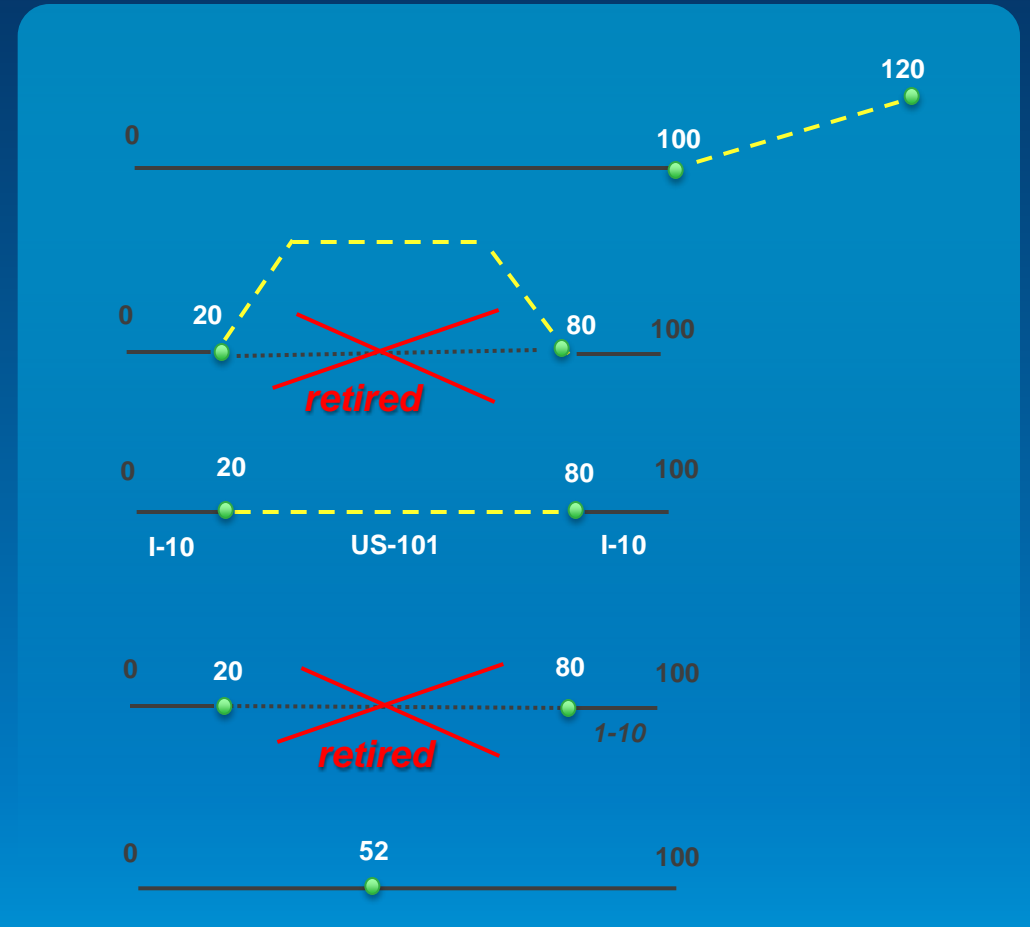
- Event data can be registered with the LRS in two ways
- **Internal:** event feature classes
  - Local to the LRS geodatabase
  - Measures and shapes updated directly by Roads and Highways
- **External:** event tables
  - Located in a different database than the LRS
  - Accessed by ArcGIS through a 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

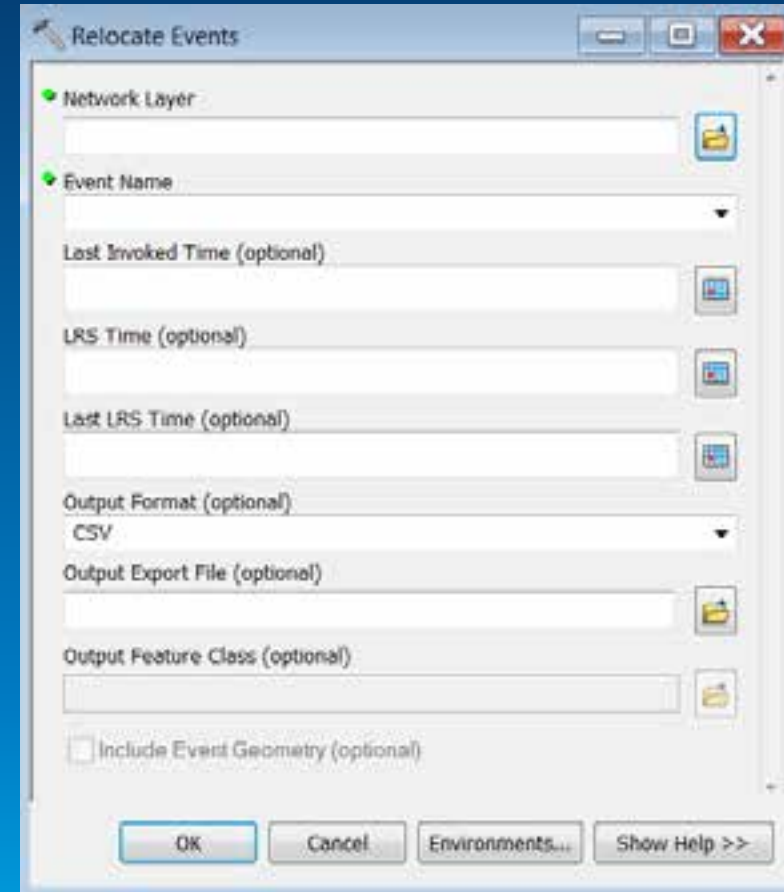
## Geoprocessing service

- 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

Route ID	Old From Measure	Old To Measure	New From Measure	New To Measure	...
SR85	0	2.5	6	8.5	
SR85	2.5	2.9	8.5	8.9	
US101	52.1	52.5	52.1	52.4	
US101	52.5	53.0	52.4	52.8	
US101	53.0	53.2	52.8	53.0	



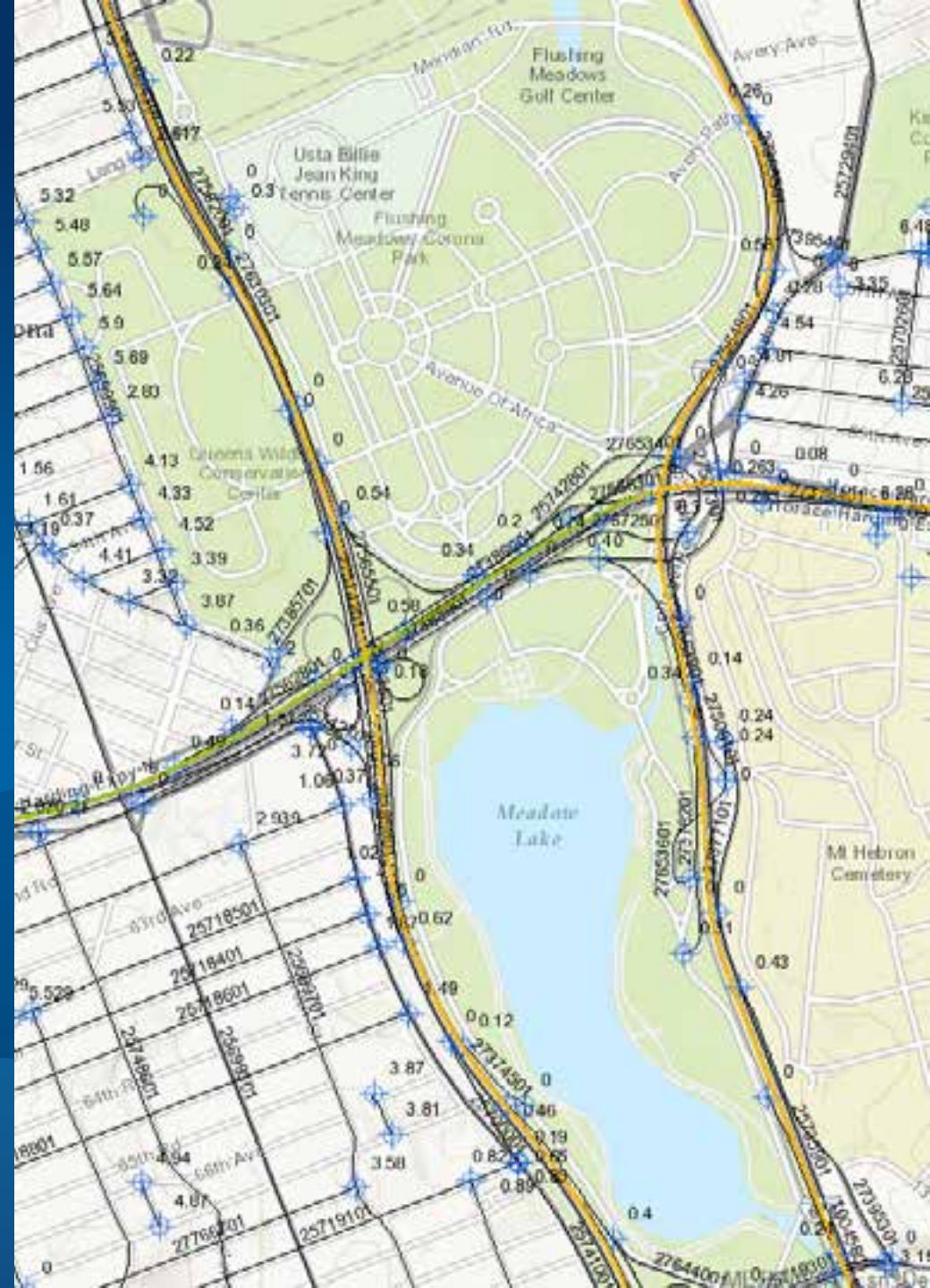
Route extension

Route realignment

Demo

# 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

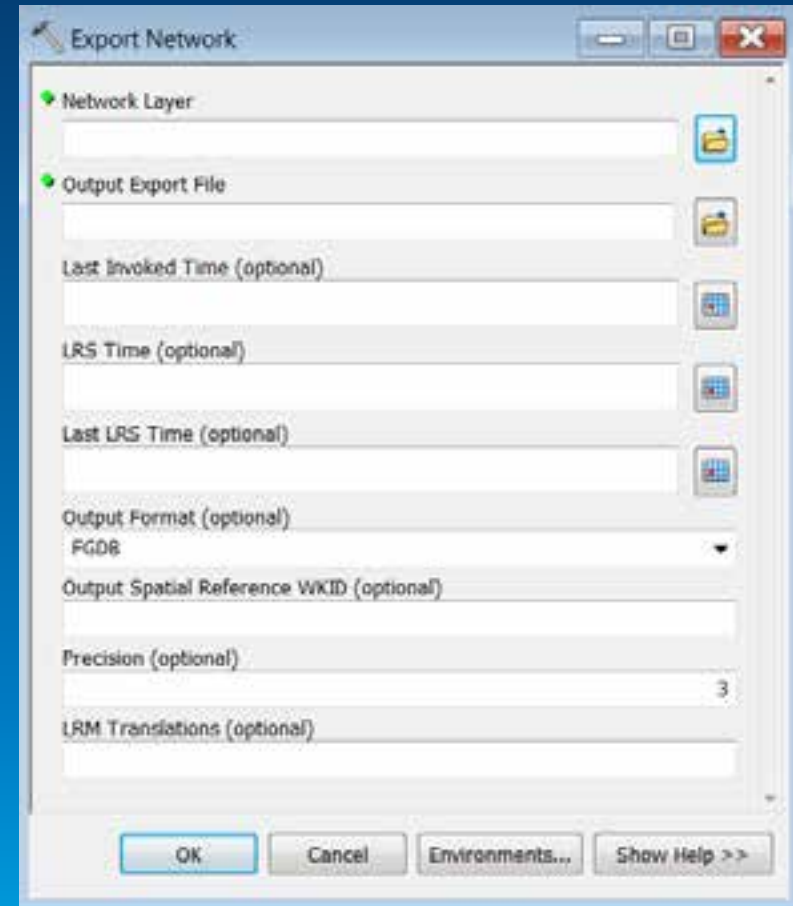
## Geoprocessing service

- 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



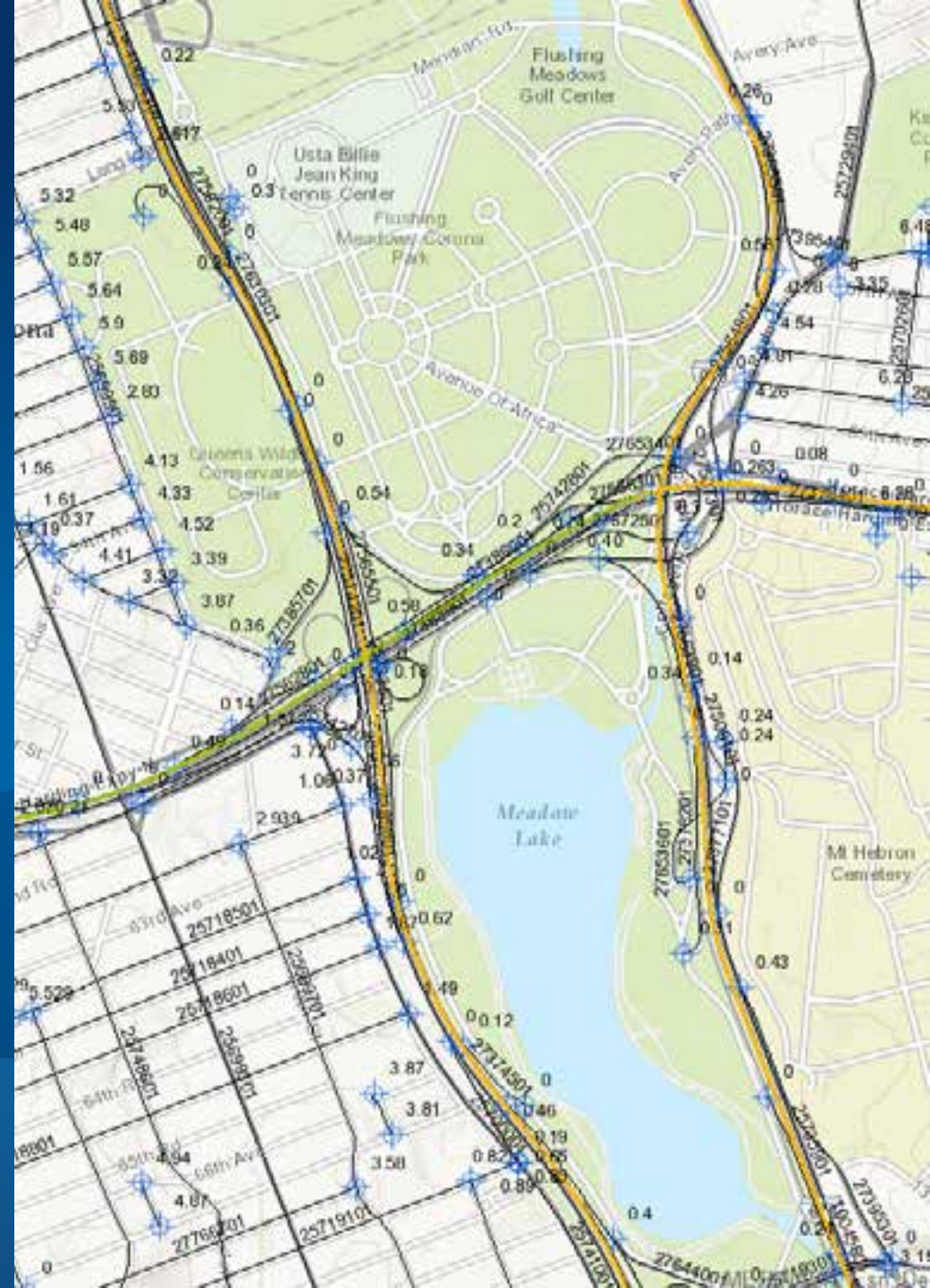
# Export Network Output

- **Routes feature class**
- **Gaps table**
- **Concurrencies table**
- **LRM translations table**

Demo

# Export Network

Geoprocessing service



# Mapping and Query

Integration Pattern



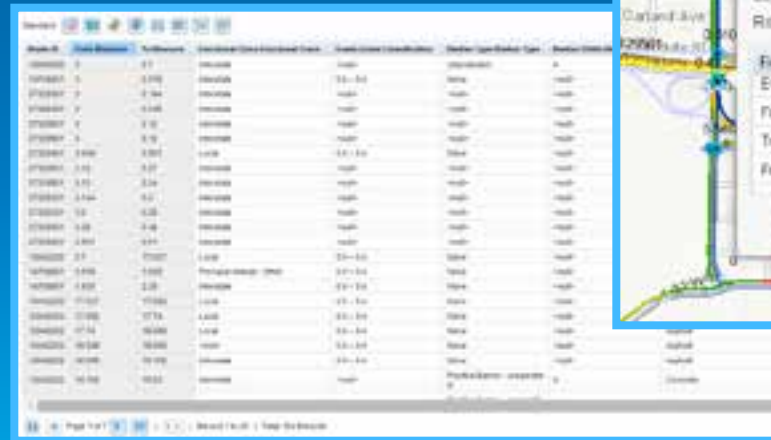


# Mapping and Query

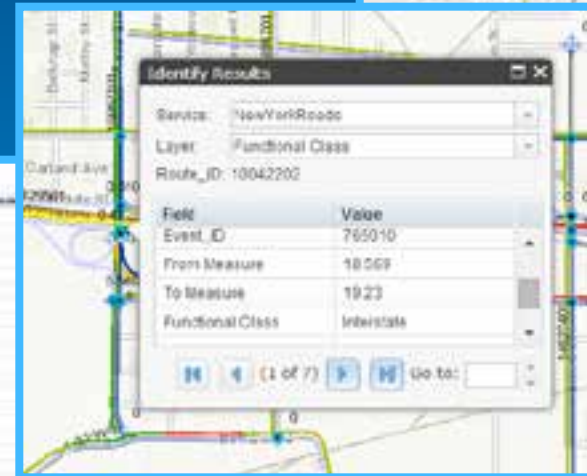
- **LRS routes and events are stored in the LRS geodatabase**
- **Managed and edited by Roads and Highways**
  
- **External system needs visualization and query capabilities**
- **On-demand requests for LRS information**

# 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



Route_ID	Length	Functional Class	Speed Limit	Direction	...
10042200	1.1	Interstate	65-80	North	...
10042201	1.2	Interstate	65-80	North	...
10042202	1.3	Interstate	65-80	North	...
10042203	1.4	Interstate	65-80	North	...
10042204	1.5	Interstate	65-80	North	...
10042205	1.6	Interstate	65-80	North	...
10042206	1.7	Interstate	65-80	North	...
10042207	1.8	Interstate	65-80	North	...
10042208	1.9	Interstate	65-80	North	...
10042209	2.0	Interstate	65-80	North	...



Identify Results

Service: NewYorkRoads  
Layer: Functional Class  
Route\_ID: 10042202

Field	Value
Event_ID	765010
From Measure	18069
To Measure	1923
Functional Class	Interstate

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# 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

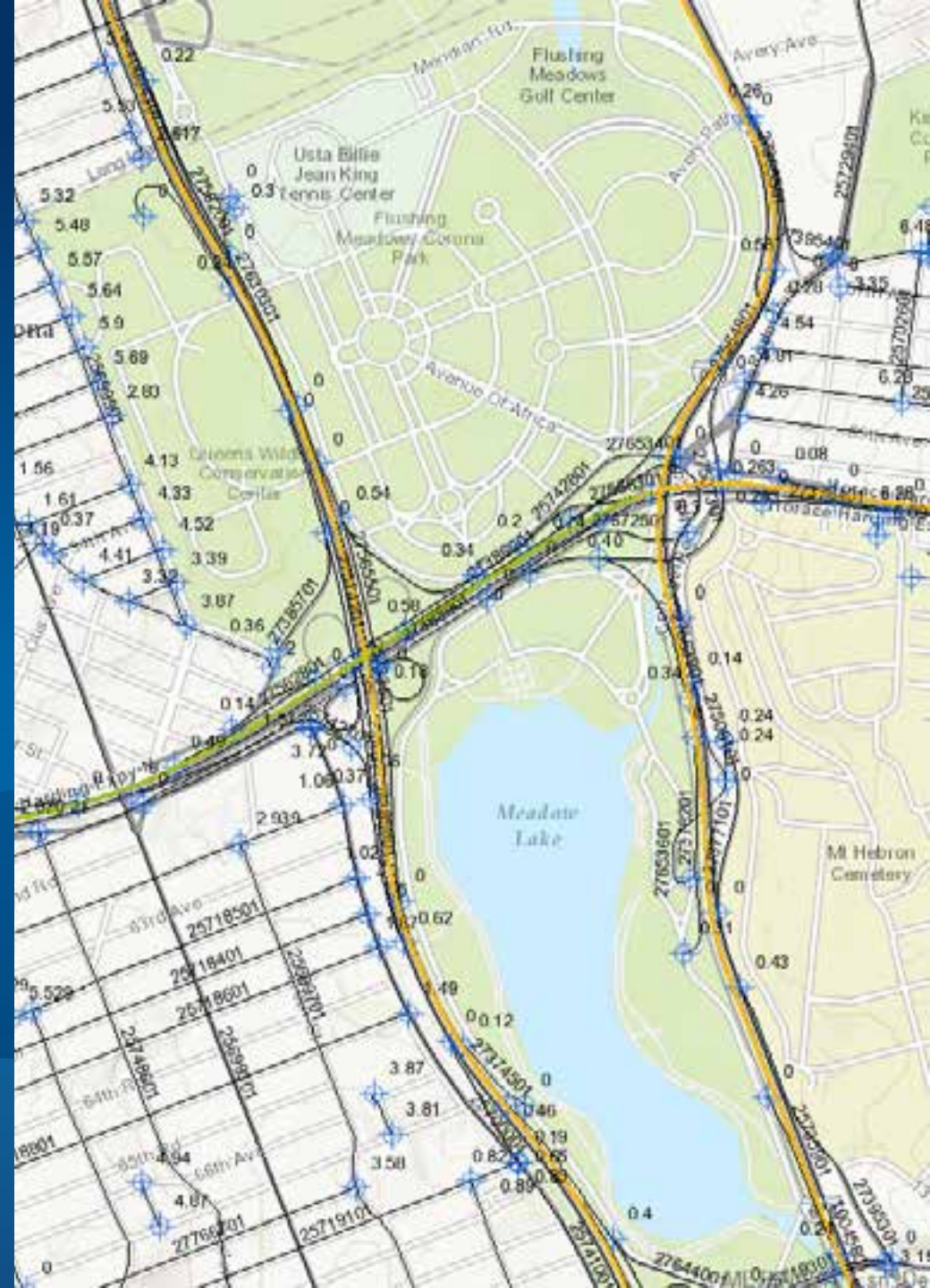
- REST and SOAP web services provided by ArcGIS for Server



Demo

# 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**

## Recommended Pattern

- **Easy to implement**

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- Sample code available

- **Loosely coupled**

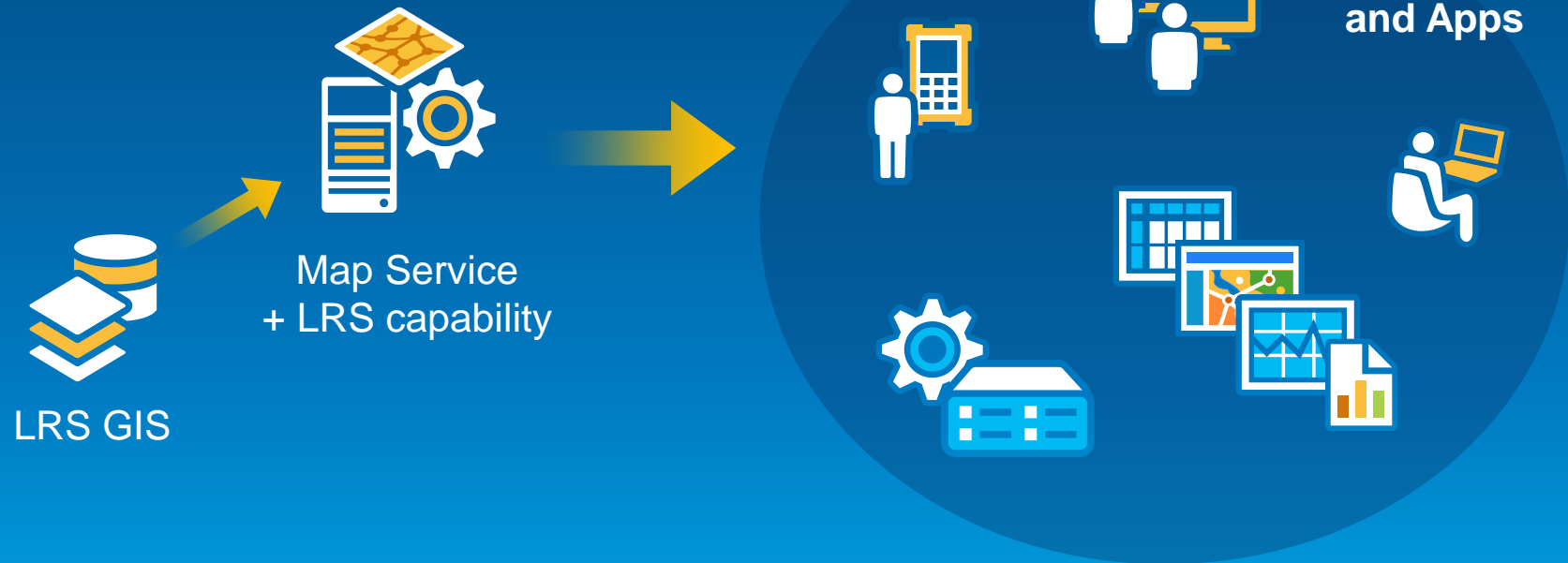
- No Esri libraries required for client to invoke
- No direct client access to database required, just HTTP

## Recommended Pattern

- **Easy to implement**
  - Coarse grained REST services
  - Invokers abstracted from complexities of database schema
  - Sample code available
- **Loosely coupled**
  - No Esri libraries required for client to invoke
  - No direct client access to database required, just HTTP
- **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

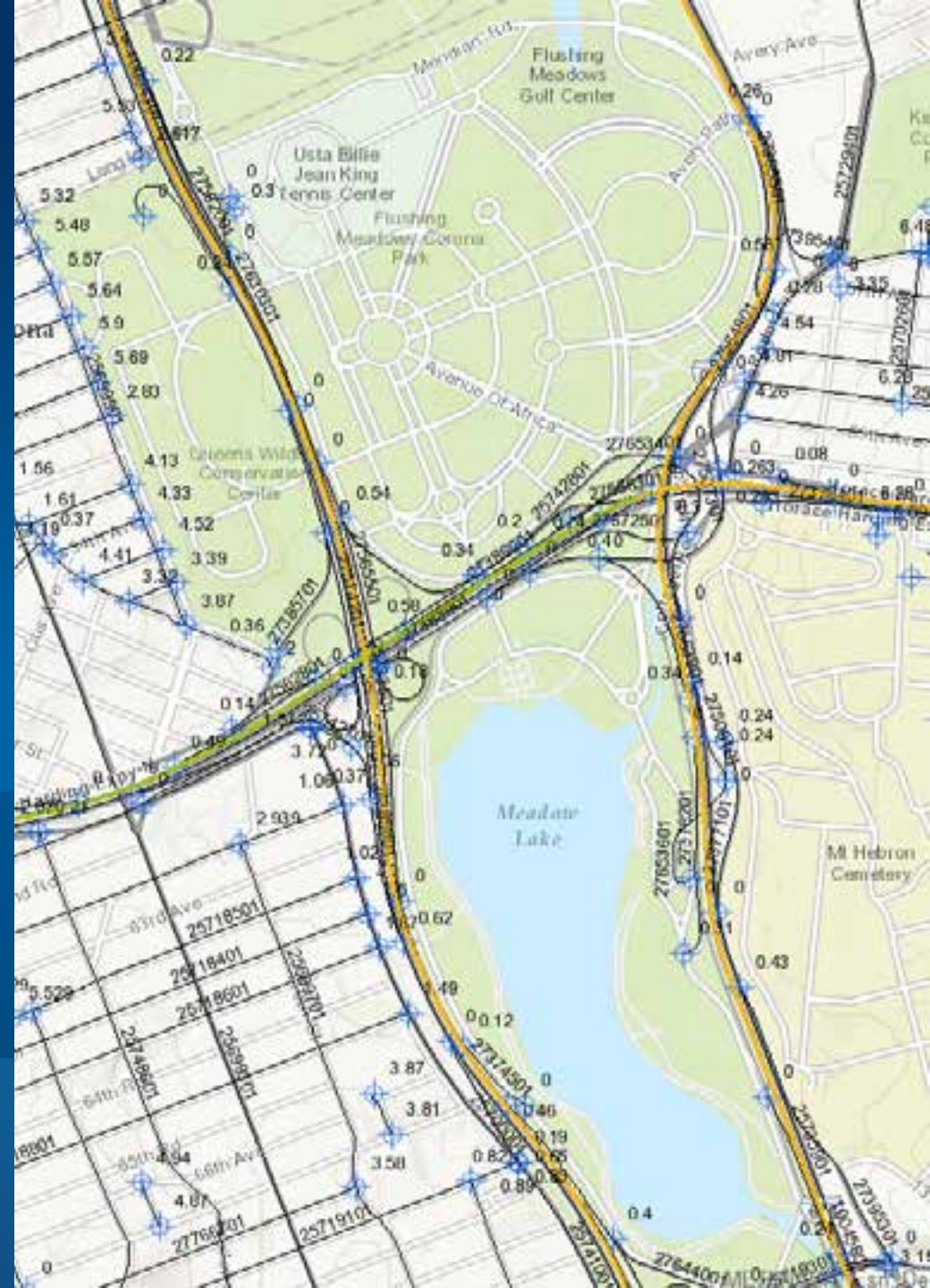
- REST web services provided by Roads and Highways for Server



Demo

# Linear Referencing Web Services

Map service extension





# Workflow Orchestration

Integration Pattern



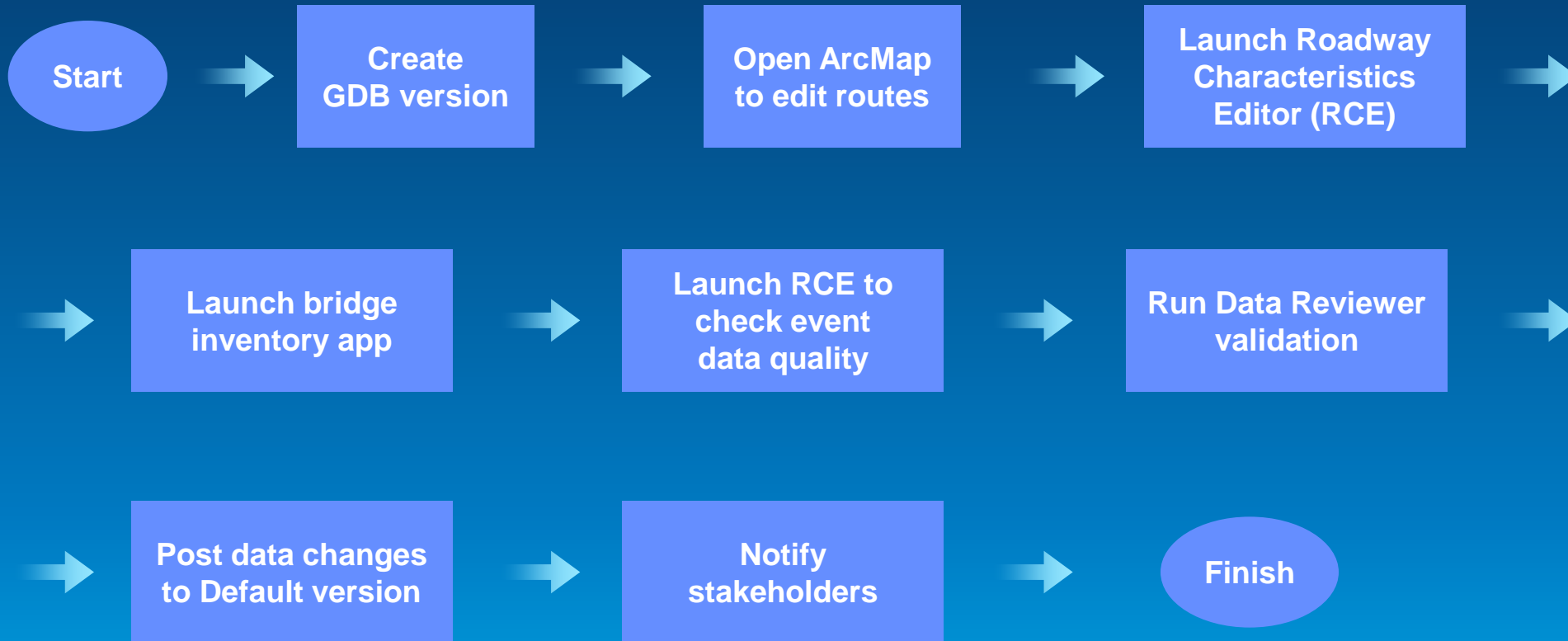


# Workflow Orchestration

- **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**

# Workflow Orchestration

Example workflow for route and event editing



# 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...**

- **Please fill out the session survey:**

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