ArcGIS GeoEvent Server: Applying Real-Time Analytics

Ken Gorton
RJ Sunderman
Agenda

1. Performing Analysis in Real-Time
2. Use Case 1: Identifying Conditions
3. Use Case 2: Finding Patterns in Data
4. Use Case 3: Tracking & Rendezvous Detection
5. Summary & Resources
Performing Analysis in Real Time
ArcGIS Enterprise

*with real-time capabilities*

Apps

Desktop

APIs

ArcGIS Enterprise with real-time capabilities

- Ingestion
- Actuation

ArcGIS GeoEvent Server

- Spatiotemporal big data store
- Analytics
- Storage

Visualization

Live & historic aggregates & features

Live features stream services
Applying real-time analytics

**GeoEvent Services**

- **A GeoEvent Service** configures the flow of GeoEvents
  - The **Filtering** and **GeoEvent Processing** steps performed
  - The input(s) data comes from and the output(s) to which results are sent
Applying real-time analytics

processors and filters

- Perform continuous analytics on GeoEvents as they are received using processors and filters.

You can create your own processors.
Fleet Asset Tracking Pseudo Service

real-time analytics design
Processors

- Some work only on geometry
- Some work on geometry and/or attributes
- Some respond to spatial and/or attribute conditions and generate new messages
- Processors typically transform the event record being processed in some way
Filters

- Allow event records to pass only if a conditional expression evaluates *TRUE*
- The expression can use attributes or geometries you have established as geofences
Filters

- You can use Boolean logic (AND, OR, NOT) to combine expressions

![Diagram showing a flowchart with 'Poll Features', 'If Disjoint AND Count is not zero...', and 'Update Polygons']
Spatial Operators

*geofence selection vs. spatial operator scope*

- Don’t confuse “ANY” and “ALL” with the regular expression pattern used to select a set of geofences

GEOMETRY INTERSECTS ALL \.*\/*

GEOMETRY DISJOINT ANY \.*\/*
Spatial Operators

overlapping geofences

- Intersects Any geofence
- Intersects All geofences
# Spatial Operators

<table>
<thead>
<tr>
<th>inside</th>
<th>outside</th>
</tr>
</thead>
<tbody>
<tr>
<td>enter</td>
<td>exit</td>
</tr>
<tr>
<td>intersect</td>
<td>disjoint</td>
</tr>
<tr>
<td>touches</td>
<td>contains</td>
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<tr>
<td>crosses</td>
<td>equals</td>
</tr>
<tr>
<td>overlaps</td>
<td>within</td>
</tr>
</tbody>
</table>
GeoFences

*feature service synchronization*

- **Import from a feature service**
  - Reads once (good for static geofences)

- **Synchronize with a feature service**
  - Periodically refreshes to update geofences

**GeoFences**

- Category (e.g. “RestrictedZone”)
  - SecurityPavilion
  - LoadingDock
  - ObservationHanger
GeoFences

*feature service synchronization*

- Synchronize with a stream service
  - Allows geofences to become dynamic
- Requires active management and purging of geofences as they expire
Dynamic GeoFences

33.322336
-117.416323
Dynamic GeoFences

33.322125, -117.398225
Use Case 1: Identifying Conditions
Identifying Conditions (demo)
Identifying conditions with real-time data

real-time analytics design
Identifying conditions with real-time data

real-time analytics design
Field Mapper processor

- Use a **Field Mapper** when you need to:
  - Change the schema or structure of an event record
  - Translate from one GeoEvent Definition to another
  - Specify how attribute values map from an inbound to an outbound event record
Field Mapper processor

<table>
<thead>
<tr>
<th>TrackID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
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<tr>
<td>Sensor</td>
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<tr>
<td>BatteryLevel</td>
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<tr>
<td>Latitude</td>
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<td>DurationMin</td>
<td>1.03</td>
</tr>
<tr>
<td>SpeedMPH</td>
<td>0.62</td>
</tr>
<tr>
<td>CourseDeg</td>
<td>250.0</td>
</tr>
<tr>
<td>Geometry</td>
<td>-117.123..., 36.064...</td>
</tr>
<tr>
<td>Category</td>
<td>AnkleBraceletGPS</td>
</tr>
</tbody>
</table>
Identifying conditions with real-time data

real-time analytics design
Field Enricher processor

- Use a Field Enricher when you need to:
  - Enrich an event record with new attribute values from a secondary source

An attribute join is used to retrieve values from the secondary table. The processor retrieves specified data values and then enriches an event record by either appending new fields or writing the data to new fields.
Field Enricher processor

<table>
<thead>
<tr>
<th>TrackID</th>
<th>V10987</th>
<th>NoContact</th>
<th>NoEntry</th>
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<tr>
<td>BatteryLevel</td>
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<tr>
<td>Distance</td>
<td>105.6</td>
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<tr>
<td>Speed</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course</td>
<td>186.4</td>
<td>F65432</td>
<td>Pass Christian School</td>
</tr>
<tr>
<td>geometry</td>
<td>-117.123…, 36.064…</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>BatteryLevel</th>
<th>Distance</th>
<th>Speed</th>
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</tr>
</tbody>
</table>
Identifying conditions with real-time data

real-time analytics design
Buffer Creator processor

- Use a **Buffer Creator** when you need to:
  - Construct a polygon around an event’s point, polyline, or polygon geometry
  - Enrich an event record by adding a new geometry field
  - Replace an event record’s geometry with a derivative
Identifying conditions with real-time data

real-time analytics design
Intersector processor

- Use an **Intersector** processor when you need to:
  - Generate a geometry representing the intersection between a event record’s geometry and a set of specified geofences

Geometry processors can either enrich an event record by adding a new geometry field or replace an event record’s geometry with a derivative geometry.
Intersector processor

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<thead>
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<th>S90909</th>
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</thead>
<tbody>
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<tr>
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<tr>
<td>geometry</td>
<td>rings: [[-114.3175, 33.6703],[-114.3175, 33.6703]...]</td>
</tr>
</tbody>
</table>

- Event
- Intersector
- Enriched Event

<table>
<thead>
<tr>
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<th>S90909</th>
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<tbody>
<tr>
<td>Date</td>
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<tr>
<td>intersection</td>
<td>rings: [[-116.3175, 33.6703],[-116.3175, 33.6703]...]</td>
</tr>
</tbody>
</table>
Use Case 2: Finding Patterns in Data
Finding Patterns in Data (demo)
Finding patterns in real-time data

real-time analytics design
Finding patterns in real-time data

real-time analytics design
GeoTagger processor

- Use a GeoTagger when you need to:
  - Enrich an event record with the name of a geofence with which the event has a spatial relationship

The processor uses a spatial expression to identify related geometries. The “name” or unique identifier of the related geofences is appended to the event record. A GeoTagger is essentially a spatial join.
GeoTagger processor

<table>
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</table>

Temecula gangland

IsInside Temecula gangland
Finding patterns in real-time data

real-time analytics design

CrimeIDs 19382, 21472, 39820, …
Finding patterns in real-time data

real-time analytics design
Field Calculator processor

- Use a **Field Calculator** when you need to:
  - Calculate new values using data from a received event record
  - An expression is evaluated and used to calculate the new values
  - Results can be written to a new field or used to update an existing attribute

Expressions can be mathematical, string operations, or function invocations which use regular expressions.
Field Calculator processor

<table>
<thead>
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<th>TrackID</th>
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<tbody>
<tr>
<td>Date</td>
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<td>186.4</td>
</tr>
<tr>
<td>geometry</td>
<td>-117.123…, 36.064…</td>
</tr>
</tbody>
</table>

Convert from Feet to Miles
Expression:
\[
\text{Distance} / 5280
\]
Finding patterns in real-time data

real-time analytics design
Finding patterns in real-time data

real-time analytics design
Use Case 3: Entity Tracking and Rendezvous Detection
Entity Tracking and Rendezvous Detection (demo)
Entity Tracking & Rendezvous Detection

real-time analytics design

- Detect Gap in Track (Track Gap Detector)
- Track Gap (Incident Detector)
- Reverse Geocode (Reverse Geocoder Processor)
- Workforce tracking, tcp-5565
- FieldCrew-stream
- Detect Rendezvous (Rendezvous Detector)
- started or ended
- rendezvous-stream
- trackgap-stream
- email-text-out
Entity Tracking & Rendezvous Detection

real-time analytics design
Track Gap Detector

- Use a Track Gap Detector when you need to:
  - Detect the absence of event record reporting
  - Alert or notify someone that expected data was not received
Track Gap Detector

- **TrackID**: V10987
- **Date**: 1405176845553
- **Geometry**: -116.93..., 33.93...

- **TrackID**: V10987
- **Date**: 1405176855553
- **Geometry**: -116.93..., 33.93...

- **trackId**: V10987
- **gap**: True
- **lastReceived**: 1405176855553
- **geometry**: -117.123..., 36.064...

- **TrackID**: V10987
- **Date**: 1405176915553
- **Geometry**: -116.93..., 33.93...

- **TrackID**: V10987
- **Date**: 1405176925553
- **Geometry**: -116.93..., 33.93...

- **TrackID**: V10987
- **Date**: 1405176935553
- **Geometry**: -116.93..., 33.93...

- **TrackID**: V10987
- **Date**: 1405176945553
- **Geometry**: -117.123..., 36.064...
Entity Tracking & Rendezvous Detection

real-time analytics design
Incident Detector

- Use an Incident Detector when you need to:
  - Detect that a condition has occurred and monitor its duration

Uses a filter expression to specify an opening and (optional) closing condition.
Maintains state for the duration of the incident, closing the incident when a specific closing condition is observed.
Incidents may also close (expire) when no further events are received for the TRACK_ID associated with the incident.
<table>
<thead>
<tr>
<th>TrackID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176935553</td>
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<tr>
<td>BatteryLevel</td>
<td>Medium</td>
</tr>
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<td>Distance</td>
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<tr>
<td>DurationMin</td>
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<tr>
<td>SpeedMPH</td>
<td>0.62</td>
</tr>
<tr>
<td>Geometry</td>
<td>-117.123..., 36.064...</td>
</tr>
</tbody>
</table>

**Type:** Ongoing

**Status:** Cumulative

**Alert Type:** Warning

**Open Condition:** (INSIDE(AnkleBraceletGPS/Temecula Gangland) AND (TrackID = J7890))

**Close Condition:** Ended at 7/12/14 10:54 AM and lasted for 40 seconds

**Definition Name:** incident

**Definition Owner:** com.esri.ges.processor/Incident Detector/10.3.0

**Track ID:** J7890

**Geometry:** Temecula Gangland

**Note:**

```
3bbb61211eb6, J7890)) AND (TrackID = J7890))

```

---

**Incident Detector**

A diagram showing the process of an incident detector with nodes for TrackID, Date, BatteryLevel, Distance, DurationMin, SpeedMPH, and Geometry, connected by arrows indicating the timeline and status of the incident.
Entity Tracking & Rendezvous Detection

real-time analytics design
Reverse Geocoder processor

- A Reverse Geocoder is an example of a custom processor
  - Enriches an event record with the street address nearest the event’s location

Uses a point geometry from a received event to enrich the event record with new attribute field(s) representing a matched address.
### Reverse Geocoder processor

<table>
<thead>
<tr>
<th>TrackID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
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<td>Geometry</td>
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</table>

<table>
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<th>J7890</th>
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<tr>
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<td>Medium</td>
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<tr>
<td>SpeedMPH</td>
<td>0.01</td>
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<tr>
<td>Geometry</td>
<td>-116.97..., 33.98...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>39583 Avenida Sonrisa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neighbor</td>
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</tr>
<tr>
<td>City</td>
<td>Beaumont</td>
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<tr>
<td>Subregion</td>
<td></td>
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<tr>
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</tr>
<tr>
<td>CountryCode</td>
<td>USA</td>
</tr>
<tr>
<td>Match_addr</td>
<td>39583 Avenida Sonrisa, Beaumont, California, 92223</td>
</tr>
<tr>
<td>Loc_name</td>
<td>USA.PointAddress</td>
</tr>
</tbody>
</table>
Entity Tracking & Rendezvous Detection

real-time analytics design
Rendezvous Detector processor

• Use a **Rendezvous Detector** when you need to:
  - Identify when two or more objects come into close proximity
  - Detect when other parties join or leave an ongoing rendezvous

User-defined parameter sets the proximity threshold.

Sends geoevents for:
- New rendezvous detected
- Party joined existing rendezvous
- Party departed rendezvous
- Rendezvous ended
Rendezvous Detector processor

Minimum Proximity = 100m

Parties:
- V10987, J7890
- F65432

Status and Actions:
- Rendezvous detected
  - Action: started 1405176845553
  - Duration: 0
  - Geometry: rings
- Joined: F65432 1405176845553 10
  - Geometry: rings
- Departed: F65432 1405176845553 20
  - Geometry: rings
- Departed: V10987 1405176845553 30
  - Geometry: rings
- Departed: J7890 1405176845553 30
  - Geometry: rings
5 Summary & Resources
Summary

**GeoEvent Server – real-time analytics for your ArcGIS Enterprise**

- ArcGIS is a dynamic platform that enables continuous analytics and real-time visualization for better understanding of our world
- The ArcGIS GeoEvent Server allows you to:
  - know what is happening, as it happens
  - react and make smarter decisions faster
  - be notified when interesting events occur
Summary

self-paced training and resources

- Step-by-Step Tutorials, free to download
  - Introduction
  - Stream services
  - Spatiotemporal Big Data Store
  - Notifications

- Blogs and discussions on the forum
  - http://links.esri.com/geoevent-forum

- Video recordings of technical workshops
  - http://www.esri.com/videos
<table>
<thead>
<tr>
<th>WORKSHOP</th>
<th>LOCATION</th>
<th>DAY</th>
<th>TIME FRAME</th>
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<tr>
<td>ArcGIS GeoEvent Server: An Introduction</td>
<td>SDCC - Room 03</td>
<td>Tuesday</td>
<td>8:30 am - 9:30 am</td>
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<tr>
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<td>SDCC - Room 04</td>
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<td>4:00 pm - 5:00 pm</td>
</tr>
<tr>
<td>ArcGIS and the Internet of Things (IoT)</td>
<td>SDCC - Room 04</td>
<td>Tuesday</td>
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<td></td>
<td>SDCC - Room 03</td>
<td>Wednesday</td>
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<tr>
<td>ArcGIS GeoEvent Server: Applying Real-Time Analytics</td>
<td>SDCC - Room 31</td>
<td>Tuesday</td>
<td>2:30 pm - 3:30 pm</td>
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<td></td>
<td>SDCC - Room 15 B</td>
<td>Wednesday</td>
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<td>SDCC - Room 05 B</td>
<td>Wednesday</td>
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<td>Big Data Store</td>
<td>SDCC - Room 14 B</td>
<td>Thursday</td>
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<tr>
<td>Real-Time &amp; Big Data GIS: Road Ahead</td>
<td>SDCC - Room 05 B</td>
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<td></td>
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<td>SDCC - Room 33 C</td>
<td>Thursday</td>
<td>2:30 pm - 3:30 pm</td>
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</tbody>
</table>

Please Attend Our Other **Sessions**!
Please Take Our Survey on the App

Download the Esri Events app and find your event

Select the session you attended

Scroll down to find the feedback section

Complete answers and select “Submit”
Help us improve the Real-Time & Big Data GIS Capabilities

http://esriurl.com/RealTimeSurvey
Questions / Feedback?

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