Real-Time GIS: Applying Real-Time Analytics

Mark Bramer
Esri Professional Services
mbramer@esri.com
Real-Time GIS
Integration and exploitation of streaming data

• Integrates real-time streaming data into ArcGIS

• Performs continuous processing and real-time analytics

• Sends updates and alerts to those who need it where they need it
Receiving Real-Time Data

Easily integrate real-time streaming data into ArcGIS using an Input Connector

You can create your own connectors.

GeoEvent Extension

GeoEvent Services

Inputs

Outputs

Out of the Box

- Poll an ArcGIS Server for Features
- Poll an external website for JSON
- Poll an external website for XML
- Receive Features on a REST endpoint
- Receive JSON on a REST endpoint
- Receive JSON on a WebSocket
- Receive RSS
- Receive Text from a TCP Socket
- Receive Text from a UDP Socket
- Receive XML on a REST endpoint
- Subscribe to a WebSocket for JSON
- Watch a Folder for New CSV files
- Watch a Folder for New JSON files

Esri Gallery

- ActiveMQ
- CAP
- GeoMessage
- Instagram
- Kafka
- NMEA
- RabbitMQ
- Sierra Wireless (RAP)
- Trimble (TAIP)
- Twitter
- VMF

Partner Gallery

- CompassCom
- exactEarth
- FAA (ASDI)
- GNIP
- Harris
- NetworkFleet
- OSIsoft
- Valarm
- Zonar

* indicates the connection is not live.
How do I update and alert those who need it where they need it?

Easily disseminate notifications, alerts, and updates using an Output Connector.

You can create your own connectors.

Out of the Box
- Add or Update a feature
- Publish Text to a UDP Socket
- Push GeoJSON or JSON to an external Website
- Push GeoJSON or JSON to an external WebSocket
- Push Text to an external TCP Socket
- Send a Text Message
- Send an Email
- Send an Instant Message
- Send Features to a Stream Service
- Write to a CSV, GeoJSON, or JSON File

Esri Gallery
- ActiveMQ
- Cursor-on-Target
- Hadoop
- Kafka
- MongoDB
- MQTT
- RabbitMQ
- Twitter
Applying real-time analytics

GeoEvent Processing

- You can perform continuous analytics on GeoEvents as they are received using a processor.

You can create your own processors.

<table>
<thead>
<tr>
<th>GeoEvent Extension</th>
<th>GeoEvent Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>Outputs</td>
</tr>
</tbody>
</table>

GeoEvent Services

- GeoEvent Services
- Out of the Box
  - Field Calculator
  - Field Enricher
  - Field Mapper
  - Field Reducer
  - GeoTagger
  - IncidentDetector
  - Track Gap Detector

New at ArcGIS 10.4

- Buffer Creator
- Convex Hull Creator
- Difference Creator
- Envelope Creator
- Intersector
- Projector
- Simplifier
- Symmetric Difference
- Union Creator

Esri Gallery

- Add XYZ
- Bearing
- Convex Hull Creator
- Ellipse
- ETA Calculator
- Field Group
- GeoNames Lookup
- Motion Calculator
- Range Fan
- Reverse Geocoder
- Service Area Creator
- Symbol Lookup
- Track Idle Detector
- Unit Conversion
- Visibility
- Volume Control
- Query Report
Applying real-time analytics

Perform real-time analytics by defining a GeoEvent Service

- A GeoEvent Service configures the flow of GeoEvents,
  - The Filtering and GeoEvent Processing steps to perform,
  - what input(s) to apply them to,
  - and what output(s) to send the results to.
GeoEvent Processing

*Calculate new fields on a GeoEvent*

- A **Field Calculator** processor uses an expression to:
  - calculate a new field or update an existing field.
  - Expressions can be mathematical expressions, string operations, or regular expressions.

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>V10987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
</tr>
<tr>
<td>BatteryLevel</td>
<td>Low</td>
</tr>
<tr>
<td>Distance</td>
<td>105.6</td>
</tr>
<tr>
<td>Speed</td>
<td>1.2</td>
</tr>
<tr>
<td>Course</td>
<td>186.4</td>
</tr>
<tr>
<td>geometry</td>
<td>-117.123…, 36.064…</td>
</tr>
</tbody>
</table>

Convert from Feet to Miles

**Expression:**

\[
\text{Distance} / 5280
\]
GeoEvent Processing

*Enrich a GeoEvent with new fields*

- **A Field Enricher processor**
  - Uses a field on the incoming GeoEvent to join with another data source and retrieve fields.
  - After the Field Enricher retrieves the required data from a data source, it enriches the GeoEvent with new fields derived from the source.

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>NoContact</th>
<th>NoEntry</th>
</tr>
</thead>
<tbody>
<tr>
<td>K90123</td>
<td></td>
<td>Temecula gangland</td>
</tr>
<tr>
<td>V10987</td>
<td>F65432</td>
<td>Pass Christian School</td>
</tr>
</tbody>
</table>

---

**SuspectID** | **V10987**
---|---
**Date** | 1405176845553
**BatteryLevel** | Low
**Distance** | 105.6
**Speed** | 1.2
**Course** | 186.4
**geometry** | -117.123..., 36.064...

---

**SuspectID** | **V10987**
---|---
**Date** | 1405176845553
**BatteryLevel** | Low
**Distance** | 105.6
**Speed** | 1.2
**Course** | 186.4
**geometry** | -117.123..., 36.064...

---

**NoContact** | **F65432**
---|---
**NoEntry** | Pass Christian School
**GeoEvent Processing**

*Enrich the geometry of a GeoEvent*

- **A Buffer Creator processor**
  - applies a geometric buffer to a geometry field on the incoming GeoEvent
  - and either:
    - enriches the GeoEvent with a new geometry field representing the buffered result
    - or replaces the geometry of the incoming GeoEvent with the new buffer
GeoEvent Processing

*Adjust the format of a GeoEvent*

- **A Field Mapper** processor
  - Translates from one GeoEvent Definition to another
  - Specifying how fields map across the GeoEvent Definitions

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
</tr>
<tr>
<td>Sensor</td>
<td>2</td>
</tr>
<tr>
<td>BatteryLevel</td>
<td>Medium</td>
</tr>
<tr>
<td>Latitude</td>
<td>36.064</td>
</tr>
<tr>
<td>Longitude</td>
<td>-117.123</td>
</tr>
<tr>
<td>Distance</td>
<td>0.01</td>
</tr>
<tr>
<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>

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
</tr>
<tr>
<td>Geometry</td>
<td>-117.123…, 36.064…</td>
</tr>
<tr>
<td>Category</td>
<td>AnkleBraceletGPS</td>
</tr>
</tbody>
</table>
Tracking Parolees and Buffering Location
Field Calculator, Field Enricher, Buffer Creator, Field Mapper
Applying real-time analytics
Perform real-time analytics by defining a GeoEvent Service
Applying real-time analytics

*Perform real-time analytics by defining a GeoEvent Service*
Applying real-time analytics
Perform real-time analytics by defining a GeoEvent Service
Applying real-time analytics

Perform real-time analytics by defining a GeoEvent Service
Video Demo

Tracking Parolees and Buffering Location

Field Calculator, Field Enricher, Buffer Creator, Field Mapper
Parolee Geofencing
Geofences, Geotagging, Incident Detection and Reverse Geocoding
GeoEvent filtering

Geofencing

- Spatial operators at 10.2:
  - inside
  - outside
  - enter
  - exit

- Spatial operators at 10.3 & 10.4:
  - intersect
  - disjoint
  - touches
  - contains
  - crosses
  - equals
  - overlaps
  - within
GeoEvent filtering

Geofencing scope

- Geofencing scope: Any or All
- Any geofence
- All geofences
GeoEvent filtering

Geofencing

- Import geofences from a feature service – reads once
- Synchronize geofences with a feature service – refreshes periodically

**Feature Service**
/AnkleBracelet/NoEntryAreas

**Geofences**

- NoEntryAreas/
- Pass Christian School
- Temecula Gangland
- USA-Mexico Border

**Event**

GEOMETRY Inside
ANY NoEntryAreas/*.^

**Filtered Event**

**Import**

**Synchronize**

**Feature Service**
/AnkleBracelet/NoEntryAreas
GeoEvent filtering

Geofencing
- Synchronize geofences with a stream service – updates continuously
Applying real-time analytics

Perform continuous analytics on GeoEvents as they are received using processors

You can create your own processors.

GeoEvent Services

Inputs

Outputs

GeoEvent Extension

Out of the Box

- Field Calculator
- Field Enricher
- Field Mapper
- Field Reducer
- GeoTagger
- IncidentDetector
- Track Gap Detector

- Buffer Creator
- Convex Hull Creator
- Difference Creator
- Envelope Creator
- Intersector
- Projector
- Simplifier
- Symmetric Difference
- Union Creator

- Add XYZ
- Bearing
- Bearing
- Ellipse
- ETA Calculator
- Field Group
- GeoNames Lookup
- Motion Calculator
- Range Fan
- Reverse Geocoder
- Service Area Creator
- Symbol Lookup
- Track Idle Detector
- Unit Conversion
- Visibility
- Volume Control
- Query Report
GeoEvent processing

*Enrich a GeoEvent with geographic context*

- A **GeoTagger** processor
  - uses a spatial expression to tag the event with related geometries.

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
</tr>
<tr>
<td>Sensor</td>
<td>2</td>
</tr>
<tr>
<td>BatteryLevel</td>
<td>Medium</td>
</tr>
<tr>
<td>Latitude</td>
<td>36.064</td>
</tr>
<tr>
<td>Longitude</td>
<td>-117.123</td>
</tr>
<tr>
<td>Distance</td>
<td>0.01</td>
</tr>
<tr>
<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>Category</td>
<td>AnkleBraceletGPS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176845553</td>
</tr>
<tr>
<td>Sensor</td>
<td>2</td>
</tr>
<tr>
<td>BatteryLevel</td>
<td>Medium</td>
</tr>
<tr>
<td>Latitude</td>
<td>36.064</td>
</tr>
<tr>
<td>Longitude</td>
<td>-117.123</td>
</tr>
<tr>
<td>Distance</td>
<td>0.01</td>
</tr>
<tr>
<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>

| IsInside      | Temecula gangland |
**GeoEvent processing**

*Notify about a pattern of interest*

- **An Incident Detector Processor**
  - creates an Incident upon an opening expression being met,
  - maintains state for the duration of an incident,
  - closes the incident based on a closing expression, or expiration.

---

### Table: Incident Details

<table>
<thead>
<tr>
<th>SuspectID</th>
<th>J7890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>1405176935553</td>
</tr>
<tr>
<td>BatteryLevel</td>
<td>Medium</td>
</tr>
<tr>
<td>Distance</td>
<td>0.01</td>
</tr>
<tr>
<td>DurationMin</td>
<td>1.03</td>
</tr>
<tr>
<td>SpeedMPH</td>
<td>0.62</td>
</tr>
<tr>
<td>Geometry</td>
<td>-117.123…, 36.064…</td>
</tr>
</tbody>
</table>

---

### Diagram: Incident Detector Lifecycle

- **Incident Detector**
  - **Incident Started**
  - **Incident Ended**

---

### Code Snippet

```
GEOMETRY INSIDE
AnkleBraceletGPS-Geofences/Temecula Gangland
AND SuspectID = J7890
```

---

**Note:**
- **Incident Detector**
- Notify about a pattern of interest
- An Incident Detector Processor
  - creates an Incident upon an opening expression being met,
  - maintains state for the duration of an incident,
  - closes the incident based on a closing expression, or expiration.
GeoEvent processing

*Enrich a GeoEvent with the nearest street address*

- A **Reverse Geocoder** processor
  - Uses a point geometry on the incoming GeoEvent to perform a reverse geocode
  - and enriches the GeoEvent with new field(s) representing matched address.
GeoEvent Filtering

*Enriching events to determine areas a tracked felon is not allowed to enter*

- **ABGPS-TCP5567**
  - **Inside Geofence (Incident Detector)**
    - **What did he enter (GeoTagger)**
      - **Calc NoEntry note (Field Calculator)**
        - **Not a parole violation**
          - **Map to incident (Field Mapper)**
            - **Reverse Geocode (Reverse Geocoder Processor)**
              - **Mapper (Field Mapper)**
                - **Declare parole violation (Field Calculator)**
                  - **Is NoEntry Violation**
                    - **Add Parole Restriction (Field Enricher)**
                      - **Add Parole Restrictions (Field Enricher (Feature Service))**
Video Demo

Parolee Geofencing

Geofencing, Geotagging, Reverse Geocoding
Meet up Detection and Alerting

Dynamic Geofences and Incident Detection
Parolee Meetup Detection and Geotagging

Geofencing, Incident Detection, Geotagging, Filtering, Reverse Geocoding
Failure to Report and Loitering

Track Gap Detector, Track Idle Detector, Reverse Geocoder
Applying real-time analytics
Perform continuous analytics on GeoEvents as they are received using processors

You can create your own processors.

GeoEvent Services

GeoEvent Extension

Inputs

Outputs

Out of the Box

Field Calculator
Field Enricher
Field Mapper
Field Reducer
GeoTagger
IncidentDetector
Track Gap Detector

Buffer Creator
Convex Hull Creator
Difference Creator
Envelope Creator
Intersector
Projector
Simplifier
Symmetric Difference
Union Creator

Add XYZ
Bearing
Ellipse
ETA Calculator
Field Group
GeoNames Lookup
Motion Calculator
Range Fan

Reverse Geocoder
Service Area Creator
Symbol Lookup
Track Idle Detector
Unit Conversion
Visibility
Volume Control
Query Report

Esri Gallery
GeoEvent processing

Notify about the absence of events

- A Track Gap Detector processor
  - Detects the absence of events and alerts about the situation.
GeoEvent processing

Notify about the persistence of events at the same location

- A Track Idle Detector processor
  - Detects lack of expected movement and alerts about the situation.
Applying real-time analytics
Detect when a parolee hasn’t moved from an area or position reports are no longer being received
Video Demo

Failure to Report and Loitering
Track Gap Detector, Track Idle Detector, Reverse Geocoder
Applying real-time analytics

Summary

• ArcGIS is a dynamic platform that enables continuous analytics and real-time visualization for better understanding of our world.

• The ArcGIS GeoEvent Extension for Server allows you to:
  - know what is happening, as it happens
  - react and make smarter decisions faster
  - be notified when interesting events occur

• To learn more:
  - See the tutorials: ‘ArcGIS GeoEvent Gallery’
  - http://arcg.is/13HRIFJ
Thank you!
Mark Bramer
mbramer@esri.com