ArcGIS GeoEvent Extension for Server: Best Practices

Gary Sheppard
Solution Engineer
Esri
gsheppard@esri.com

C. Adam Mollenkopf
Product Lead
Esri
amollenkopf@esri.com
@amollenkopf
Live Data: Ubiquitous, Plenteous

- **Internet of Things (excluding PCs, phones, and tablets)**
  - 2009: 0.9 billion devices
  - 2020: 26 billion devices
  - *Source: Gartner*

- **Total amount of digital data created**
  - 2010: 1.2 zettabytes
  - 2013: 4 zettabytes
  - 2020: 35 zettabytes
  - *(Zettabyte = 1 billion terabytes)*
  - *Sources: IDC, VSAT Voice*
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
“I built my own system to handle live data. It was easy and it’s awesome.”

No one ever
Benefits of GeoEvent Extension

- We’ve built what’s hard about live data handling
- You build what’s specific to you (the easy part!)
- We’ll fully support you
- Let us show you some best practices...
Agenda

• Getting started
• Basic configuration
• Filtering and processing
• Real-time in web maps
• Security
• Performance
• High availability and scalability
Getting Started
How to Get GeoEvent Extension

• Now (getting started):
  - Check to see if your organization already has it
  - Or subscribe to Esri Developer Network (EDN)

• Later (when you deploy):
  - Purchase it if you don’t have it yet
  - It’s an extension to ArcGIS for Server
Installation and Configuration
**Installation and Configuration**

![Screen Shot of ArcGIS GeoEvent Manager](attachment:image.png)

### GeoEvent Definitions

<table>
<thead>
<tr>
<th>Name</th>
<th>Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>aerodrome</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>AerodromeStatus</td>
<td>airportname, deploc, adminstatus, immigrationstatus, atstatus, elid...</td>
</tr>
<tr>
<td>AirAssets</td>
<td>datetimesubmitted, scene, wing, deploc, actype, model, primmission...</td>
</tr>
<tr>
<td>AirOperationsMerge</td>
<td>airportname, deploc, adminstatus, immigrationstatus, atstatus, elid...</td>
</tr>
<tr>
<td>AirTracks</td>
<td>msnno, packaged, primmissiontype, secondarymissiontype, deploc, a...</td>
</tr>
<tr>
<td>airtracksspecified1</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>airtracksspecified2</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>airtracksspecified3</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>airtracksspecified4</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>airtracksspecified5</td>
<td>slc_type, action, _id, control_points, uniquedesignation, Message...</td>
</tr>
<tr>
<td>AirTracksGeofences</td>
<td>msnno, packaged, msncommander, primmissiontype, secondarymission...</td>
</tr>
</tbody>
</table>
Best Practices for Getting Started

- GeoEvent tutorials on ArcGIS.com
Better Together

- GeoEvent Extension
- Operations Dashboard
Live Data

Demo:
- GeoEvent Manager
- Operations Dashboard
Basic Configuration
GeoEvent Definitions

- Schema for GeoEvents
- Reusable
- Create by hand or import from feature service
Best Practices for GeoEvent Definitions

- Import from feature service
  - Avoid creating by hand
- Treat as a contract
  - Don’t edit unless you absolutely must
Receiving Real-Time Data

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

GeoEvent Extension

GeoEvent Services

Inputs

Outputs

You can create your own connectors.

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
- CoT
- Cursor-on-Target
- GeoMessage
- Instagram
- Kafka
- NMEA
- RabbitMQ
- Sierra Wireless (RAP)
- Trimble (TAIP)
- Twitter
- VMF

Partner Gallery

- CompassCom
- CompassCom
- exactEarth
- FAA (ASDI)
- Geofeedia
- GNIP
- Harris
- NetworkFleet
- OSIsoft
- Valarm
- Zonar
- Zonar
Receiving Real-Time Data

*Input Connector = Transport + Adapter*

**GeoEvent Extension**
- GeoEvent Services
- Inputs
- Outputs

**Connectors**
- Receive JSON on a WebSocket
- Receive XML on a REST endpoint

**Transports**
- ActiveMQ
- Kafka
- RabbitMQ
- Twitter
- Feature Service
- File
- HTTP
- HTTP+BasicAuth
- HTTP+OAuth
- TCP
- UDP
- WebSocket

**Adapters**
- JSON
- JSON (Feature)
- RSS
- Text
- XML

**Transport**
- WebSocket
- HTTP

**Adapter**
- JSON
- XML

**Esri Gallery**
- CAP
- Cursor-on-Target
- GeoMessage
- Instagram
- NMEA
- Sierra Wireless (RAP)
- Trimble (TAIP)
- Twitter
- VMF

*Receive JSON on a WebSocket*

*Receive XML on a REST endpoint*
You can create your own connectors.

Out of the Box
- Add a feature
- Publish Text to a UDP Socket
- Push JSON to an External Website
- Push 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
- Update a Feature
- Write to a CSV File
- Write to a JSON File

Esri Gallery
- ActiveMQ
- Hadoop
- Kafka
- MongoDB
- RabbitMQ
- Twitter

Partner
- CESIUM
Sending Real-Time Data

Output Connector = Adapter + Transport

GeoEvent Extension

GeoEvent Services

Inputs

Outputs

Connectors

- Send an Email
- Send Features to a Stream Service

Adapter

MessageFormatter

Transport

SMTP

Generators

Connectors

GeoEvent Services

Inputs

Outputs

Adapters

- Cache
- JSON
- JSON (Feature)
- Message Formatter
- RSS
- Text
- WebSocket

Partners

CESIUM

Transports

Feature Service

SMTP

File

Stream Service

HTTP

TCP

HTTP+BasicAuth

UDP

HTTP+OAuth

WebSocket

SMS

XMPP

Transport

File

SMTP

HTTP+BasicAuth

HTTP+OAuth

SMS

WebSocket

XMPP

Partners

ActiveMQ

Hadoop

Kafka

MongoDB

RabbitMQ

Twitter
Best Practices for Adapters and Transports

- Use included adapters and transports if possible
- Use GeoEvent SDK if necessary to build your own (Java)
  - If you do, try to make them generic
Best Practices for Connectors

- “Incoming Data Contains GeoEvent Definition”: careful! (Demo)
- Use included connectors when possible
- Configure new connectors if needed (no code)
  - Make them generic if possible
- Remember:
  - Connector = Adapter + Transport
- Try solutions-geoevent-java repository
Filtering and Processing
Filtering GeoEvents

- Attribute filters
- Spatial filters (GeoFences)
- GeoEvent property filters (e.g. $DEFINITION_NAME and $RECEIVED_TIME)
Applying real-time analytics

*GeoEvent Processing*

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

**GeoEvent Extension**

**GeoEvent Services**

**Inputs**

**Outputs**

**You can create your own processors.**

**Out of the Box**

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

**New at ArcGIS 10.3**

- 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
Best practice for processing GeoEvents

- Use Field Reducer to avoid writing null values with Field Mapper
Real-Time in Web Maps
Real-Time GIS

10.2
Real-Time GIS

10.3

ArcGIS Server
GeoEvent Extension
Stream Service
Stream Layer
Web
Device
Desktop
Apps
Access
Services
Getting Real-Time data into Web Apps

Two patterns

- **Feature layers** pull from feature services
  - Web apps poll to get periodic updates
  - Must be backed by an enterprise geodatabase (EGDB)

- **Stream layers** subscribe to stream services
  - Web apps subscribe to immediately receive data
  - Low latency and high throughput

---

ArcGIS Server
GeoEvent Extension

Map Services
Feature Services
Stream Services

EGDB

Polling (Pull)

Feature Layer
Stream Layer

Your Applications

Update a Feature
Add a Feature
Send Features to a Stream Service
Real-Time in Web Maps
Stream Services
Real-Time GIS

Stream Layer support coming later in 2015

Stream Service

GeoEvent Extension

ArcGIS Server
Security
Security @ 10.3
Integrated security with ArcGIS for Server and Portal for ArcGIS

- **GeoEvent Manager**
  - Uses the same credentials as ArcGIS for Server or Portal for ArcGIS
  - Recognizes Server/Portal roles – Administrators and Publishers

- **SSL**
  - GeoEvent utilizes SSL certificates that have been registered for ArcGIS for Server / Portal for ArcGIS
Performance
Throughput Performance @ 10.3

Two times more throughput than 10.2.2

As captured on primary benchmarking machine using ArcGIS 10.3
Geofencing Performance @ 10.3
US States benchmark – 51 geofences with 1,617 vertices on average (78 min / 21,970 max)
Geofencing Performance @ 10.3
US Congressional Districts benchmark – 436 geofences with 512 vertices on average (24 min / 7,285 max)
Geofencing Performance @ 10.3

US Counties benchmark = 3,143 geofences with 166 vertices on average (9 min / 838 max)
Geofencing Performance @ 10.3

US States benchmark

<table>
<thead>
<tr>
<th>Operator</th>
<th>10.3 events per second</th>
<th>10.2.2 events per second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disjoint Any</td>
<td>2,499</td>
<td></td>
</tr>
<tr>
<td>Inside Any</td>
<td>2,488</td>
<td>150</td>
</tr>
<tr>
<td>Intersect Any</td>
<td>2,486</td>
<td></td>
</tr>
<tr>
<td>Within Any</td>
<td>2,482</td>
<td></td>
</tr>
<tr>
<td>Touches Any</td>
<td>2,248</td>
<td></td>
</tr>
<tr>
<td>Outside Any</td>
<td>2,245</td>
<td></td>
</tr>
</tbody>
</table>

Throughput = Processed # Events per Second

Velocity = # of produced events per second

US States
51 Geofences
1,617 vertices on average (78 min and 21,970 max)

16 times faster than 10.2.2

As captured on primary benchmarking machine using ArcGIS 10.3
Geofencing Performance @ 10.3
US Congressional Districts benchmark

<table>
<thead>
<tr>
<th>Operator</th>
<th>10.3 events per second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disjoint Any</td>
<td>2,249</td>
</tr>
<tr>
<td>Outside Any</td>
<td>2,248</td>
</tr>
<tr>
<td>Intersect Any</td>
<td>2,248</td>
</tr>
<tr>
<td>Touches Any</td>
<td>2,244</td>
</tr>
<tr>
<td>Within Any</td>
<td>2,244</td>
</tr>
<tr>
<td>Inside Any</td>
<td>2,244</td>
</tr>
</tbody>
</table>

US Congressional Districts
436 Geofences
512 vertices on average (24 min and 7,285 max)

As captured on primary benchmarking machine using ArcGIS 10.3
note: this scenario was not benchmarked at 10.2.2
Geofencing Performance @ 10.3

US Counties benchmark

<table>
<thead>
<tr>
<th>Operator</th>
<th>10.3 events per second</th>
<th>10.2.2 events per second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disjoint Any</td>
<td>1,997</td>
<td>1,996</td>
</tr>
<tr>
<td>Intersect Any</td>
<td>1,996</td>
<td>1,996</td>
</tr>
<tr>
<td>Outside Any</td>
<td>1,992</td>
<td>1,992</td>
</tr>
<tr>
<td>Touches Any</td>
<td>1,747</td>
<td>1,747</td>
</tr>
<tr>
<td>Inside Any</td>
<td>1,742</td>
<td>1,742</td>
</tr>
<tr>
<td>Within Any</td>
<td>1,740</td>
<td>1,740</td>
</tr>
</tbody>
</table>

As captured on primary benchmarking machine using ArcGIS 10.3
Performance
Primary factors to consider

• Operating environment
  - Virtual Machines – beware! resources need to be shared in an effective way, like EC2.
  - Bare-Metal machines – have dedicated resources which are much more deterministic.

• Network
  - Speed (Mbps) – the faster the better.

• RAM
  - size (GB) – minimum of 8GB is required at 10.3.
  - type (DDR2, DDR3) – minimum of DDR3 is recommended.
  - clock speed (MHz) – the faster the better.
  - transfer rate (Mbps) – the faster the better.

• Processor
  - speed (GHz) – the faster the better.
  - # of cores – the more the better.
GeoEvent Extension
High Availability & Scalability
High Availability & Scalability

Clustering

- Clusters administered via ArcGIS Server Manager
  - Site, Cluster(s), Machines

- Machines in a cluster share configuration
  - automatic provisioning upon joining a cluster
  - including custom components

- High Availability is achievable out-of-the-box

- Scale-out by adding machines to a cluster
High Availability

*Site(s), cluster(s), and machines*
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
High Availability

Distributed configuration store
Scalability

Input transports that are automatically load balanced

- http (server)
- tcp (server)
- udp (server)
- web socket (server)

Automatically Load Balanced

Site

Cluster: default

ArcGIS Server (machine-c0)

GeoEvent

- i1
- i2
- i3

- ges1
- ges2
- ges3

Outputs

- feature service file
- http (client)
- smtp
- stream service
- tcp (client)
- udp (client)
- web socket (client)
- xmpp

Advisement
hadoop
kafka
flume
mongodb
rabbitmq
Scalability

Inputs transports that require you to bring your own load balancer
Scalability
Inputs and distributed stream processing
High Availability

Inputs and distributed stream processing
High Availability

Inputs and distributed stream processing
Scalability

Pinned inputs
Scalability
Pinned inputs and distributed stream processing
High Availability

Pinned inputs and distributed stream processing
High Availability

Pinned inputs and distributed stream processing
Scalability

*Clustering for increased throughput*

- Clusters administered via ArcGIS Server Manager
  - Site, Cluster(s), Machines
- Scale-out by adding machines to a cluster

---

**Event Throughput with Clustering**

![Graph showing increased throughput with clustering]

Throughput = Processed # Events per Second

Velocity = # of produced Events per Second

- 1 machine: 3,000
- 2 machines: 4,800
- 3 machines: 6,500

As captured on 10.3 benchmarking cluster using ArcGIS 10.3
Scalability

Scaling out Stream Services to support an increased # of concurrent users
High Availability
Stream Services concurrent user failover
High Availability

Stream Services concurrent user failover
High Availability

Stream Services concurrent user failover
Scalability

Scaling out Stream Services to support an increased # of concurrent users with a reverse proxy
High Availability
Stream Services concurrent user failover with a reverse proxy
GeoEvent Extension: Best Practices

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
Where to learn more?

Other Workshops

• **Configuring Real-Time Web Applications**
  - Mon 3:00pm-4:00pm (Hall D, Theater 3)
  - Tue 11:00am-12:00pm (Room 101)

• **ArcGIS GeoEvent Extension for Server: Best Practices**
  - Tue 1:30pm-2:30pm (Room 101)

• **ArcGIS GeoEvent Extension for Server: Applying Real-Time Analytics**
  - Tue 2:45pm-3:45pm (Room 101)

• **Web AppBuilder for ArcGIS: An Overview**
  - Mon 3:00pm-4:00pm (Room 103B)
  - Tue 5:15pm-6:15pm (Room 207B)

• **Operations Dashboard for ArcGIS: An Overview**
  - Tue 11:00am-12:00pm (Room 207B)

• **ArcGIS GeoEvent Extension for Server: Building Real-Time Web Applications**
  - Wed 1:00pm-1:45pm (Room 209A)
Where to learn more?

Resources

- To learn more, visit the ‘Get Started’ area of the GeoEvent Extension product page:
  - [http://links.esri.com/geoevent](http://links.esri.com/geoevent)
    - Introduction
    - Notifications
    - Stream Services
    - RSS, HTTP, Files
    - REST Admin API
    - Clustering

- Ask questions on the GeoEvent Forum:
  - [https://geonet.esri.com/community/gis/enterprise-gis/geoevent](https://geonet.esri.com/community/gis/enterprise-gis/geoevent)
Don’t forget to complete a session evaluation form!
Interested in diving deeper into Esri technology?

Add a day to your Fed GIS experience and register to attend the Esri DevSummit Washington DC. Stop by the registration counter to sign up.
Questions / Feedback?

To learn more:
http://links.esri.com/geoevent
https://geonet.esri.com/community/gis/enterprise-gis/geoevent

C. Adam Mollenkopf
Product Lead
Esri
amollenkopf@esri.com

Gary Sheppard
Solution Engineer
Esri, Federal Office
gsheppard@esri.com

Understanding our world.