

Sensor Data Streams in ArcGIS

Geospatial Sensing 2020

31.08.2020



Introduction





EAT
SLEEP
MAP



UC
2020
LIVE FROM ESRI

GIS Is Organizing the World's Geographic Knowledge

Transforming How
We See the World



Creating Building Blocks for Shared Understanding

Geospatial Infrastructure

Is the Modern GIS Implementation Pattern

Supporting Individuals . . .
. . . and Organizations of All Sizes

Engaging
Everyone



GIS at Scale . . .

Interconnecting Distributed
Geospatial Services

Leveraging Services-Based
Architecture and GIS Portals

Interconnecting Everything . . .

Geospatial Infrastructure Is Transforming Organizations

Integrating and Leveraging Many Technologies



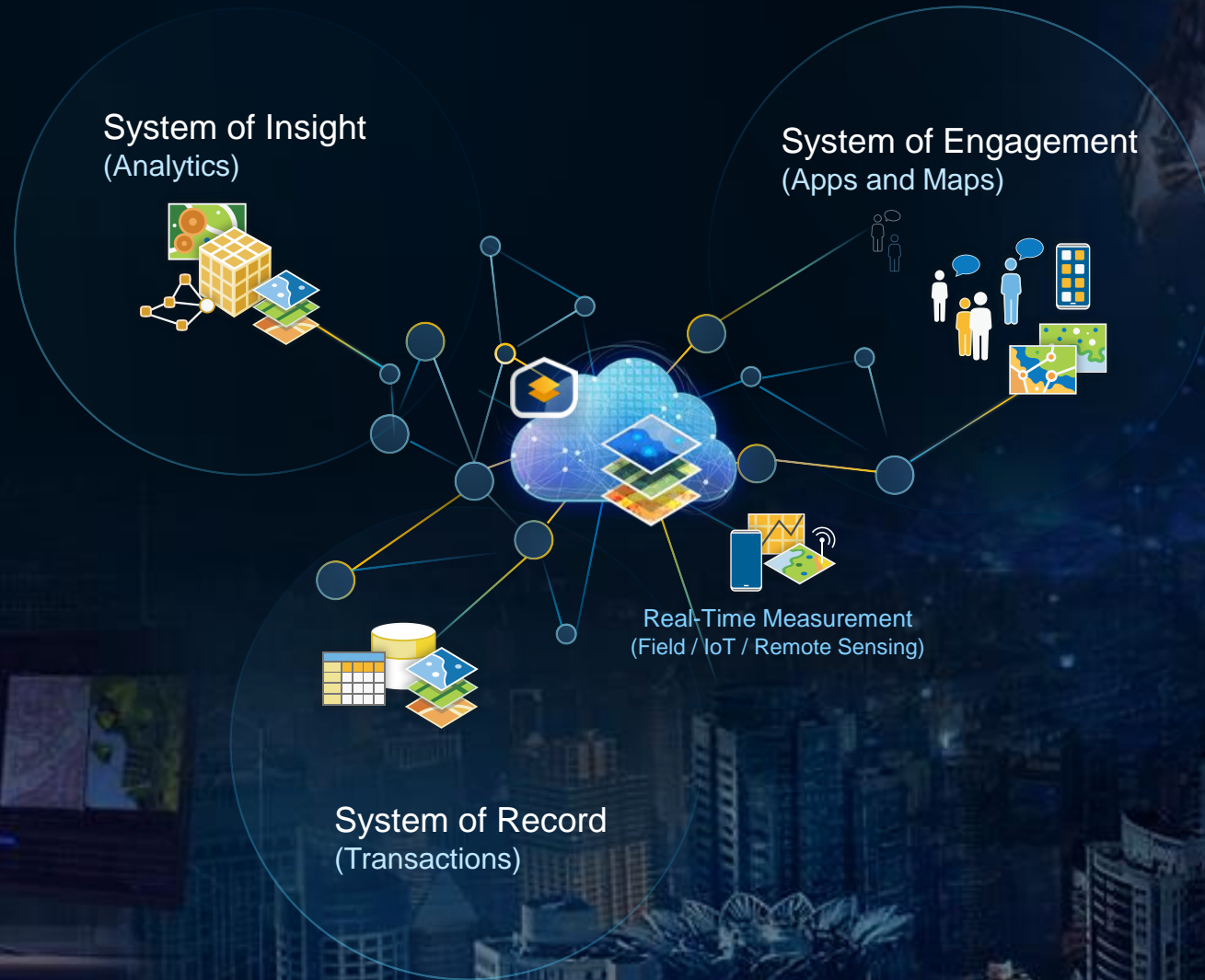
Geospatial Infrastructure Is Emerging Rapidly

Providing a Rich Network of Distributed Content and Capabilities



ArcGIS

Supports Three Fundamental Systems





ArcGIS and the IoT

Internet of Things overview

What Things?



What Things?



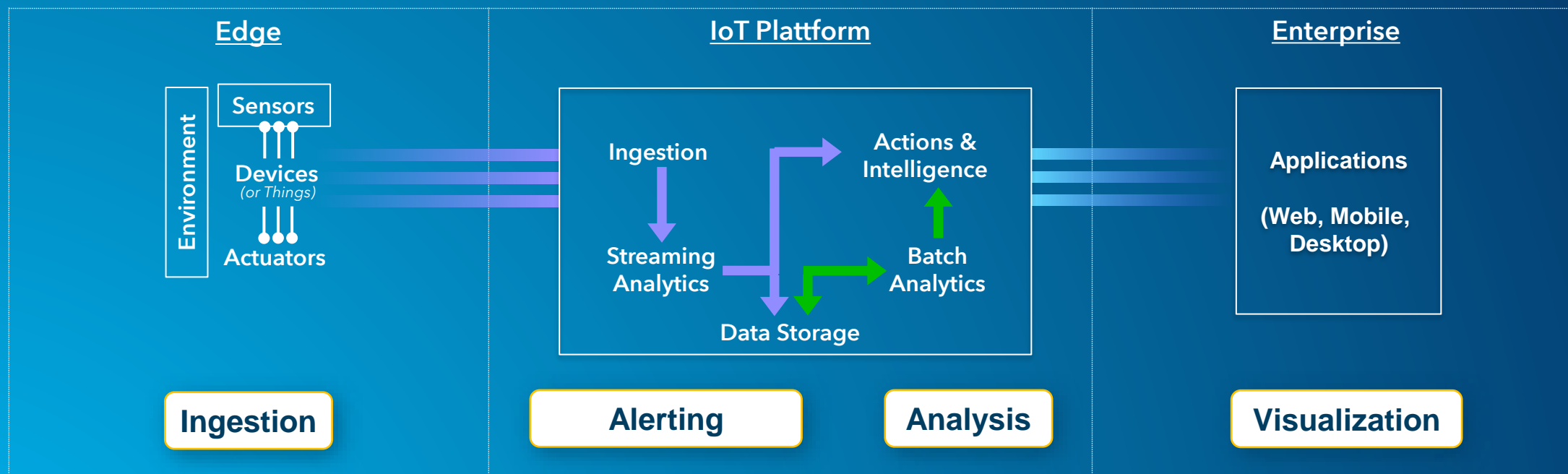
Internet of Things overview

What Things?



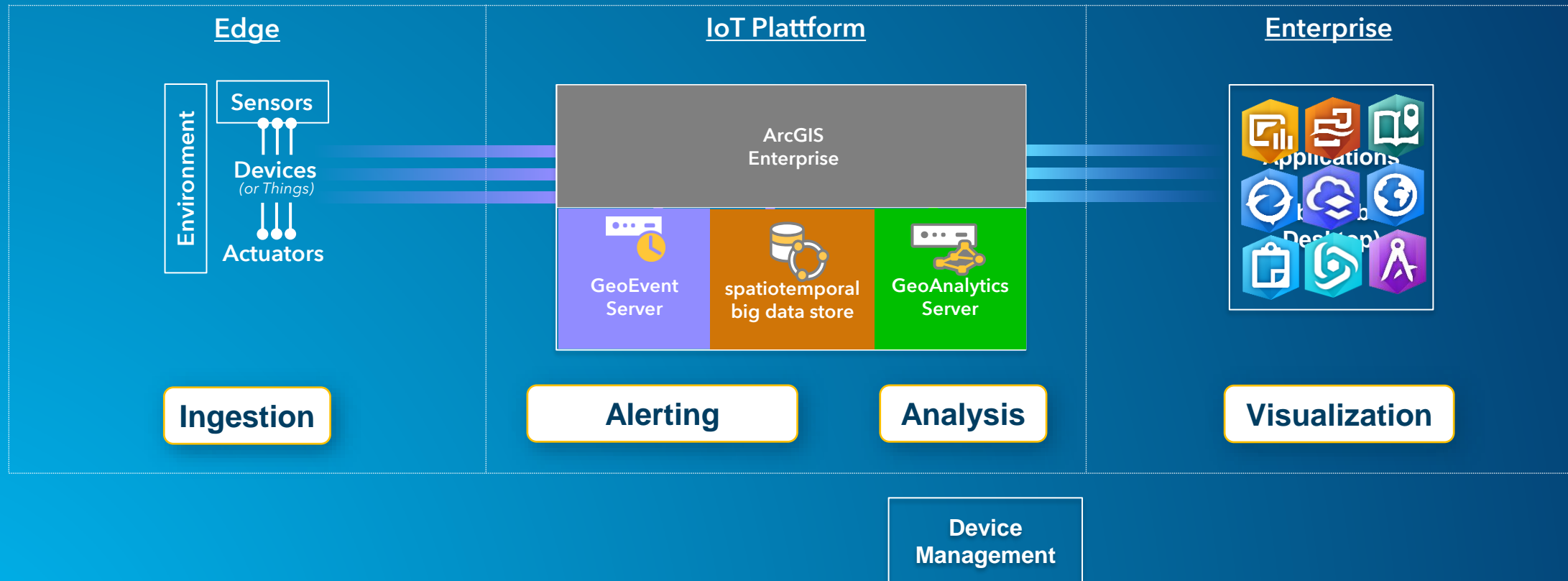
Decomposing an IoT Platform

Generic Blueprint of an IoT solution



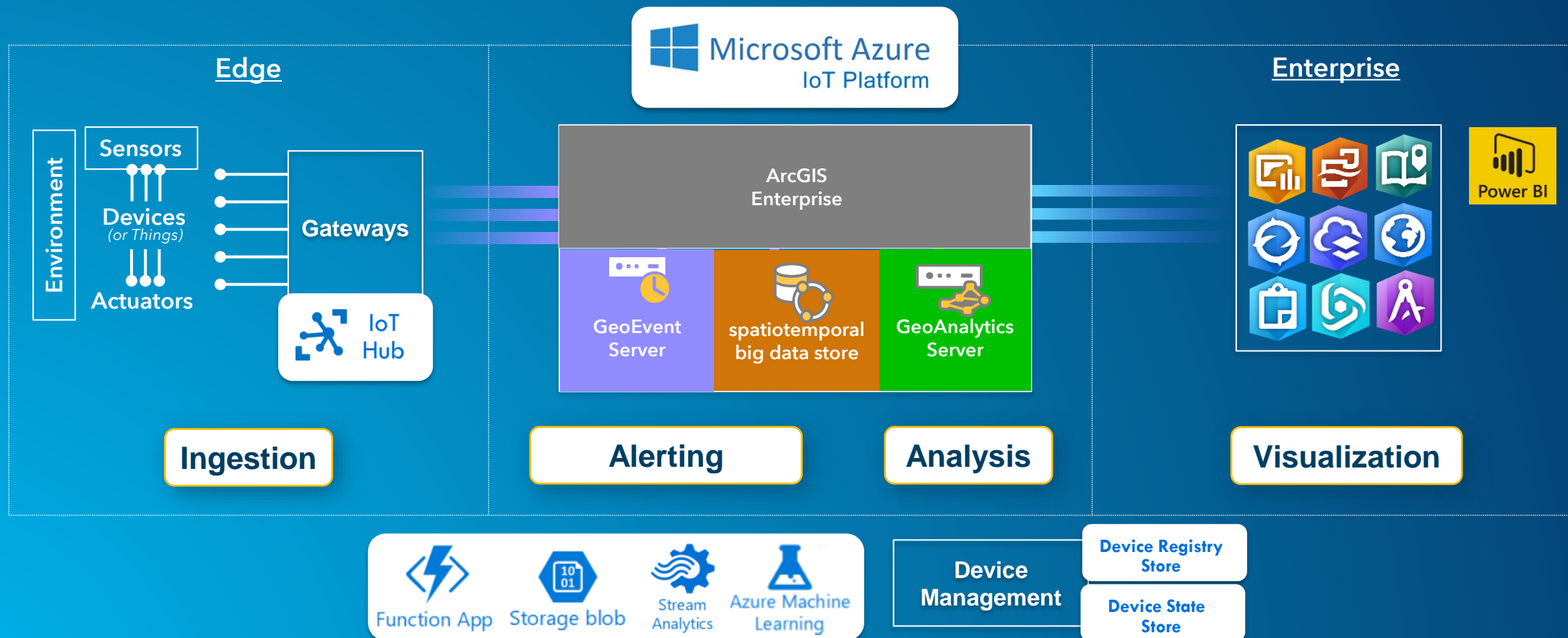
ArcGIS as an IoT Platform

enabling geospatial insights with your IoT solution



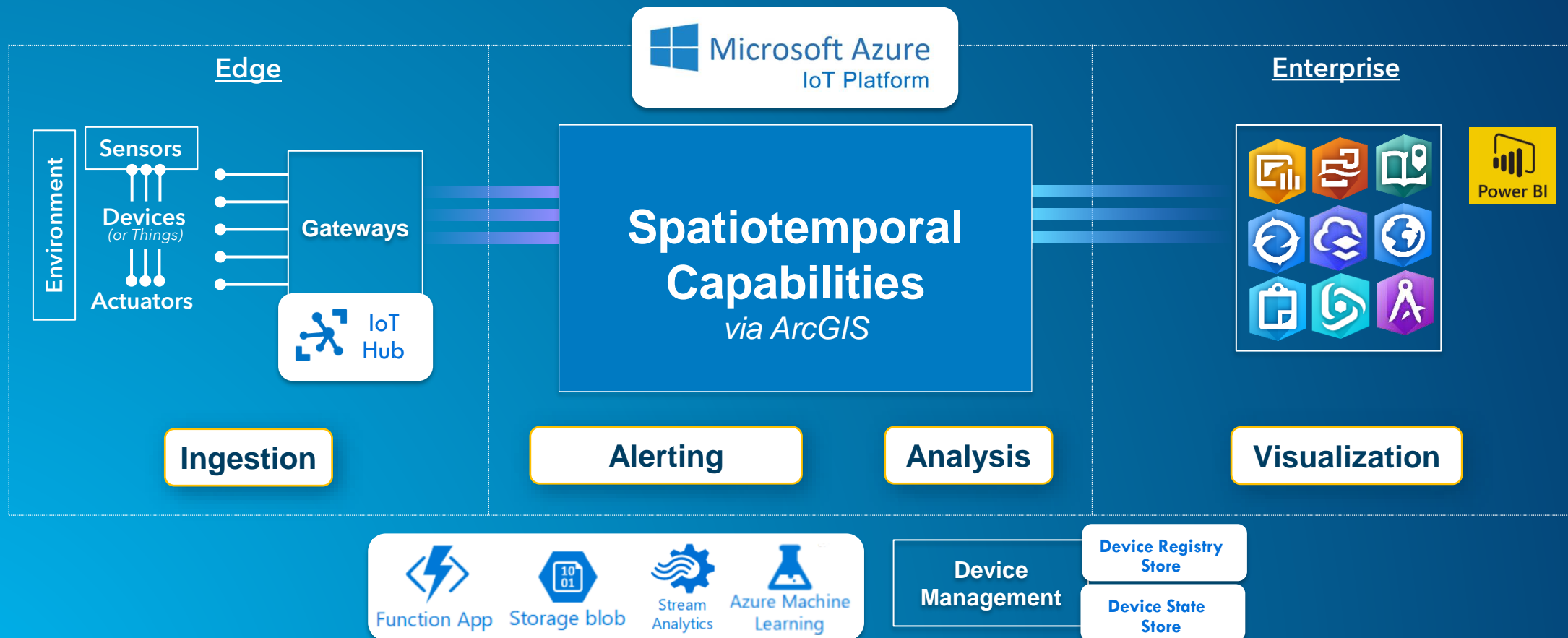
Complementing an IoT platform with ArcGIS

enabling geospatial insights with your IoT solution



Complementing an IoT platform with ArcGIS

enabling geospatial insights with your IoT solution

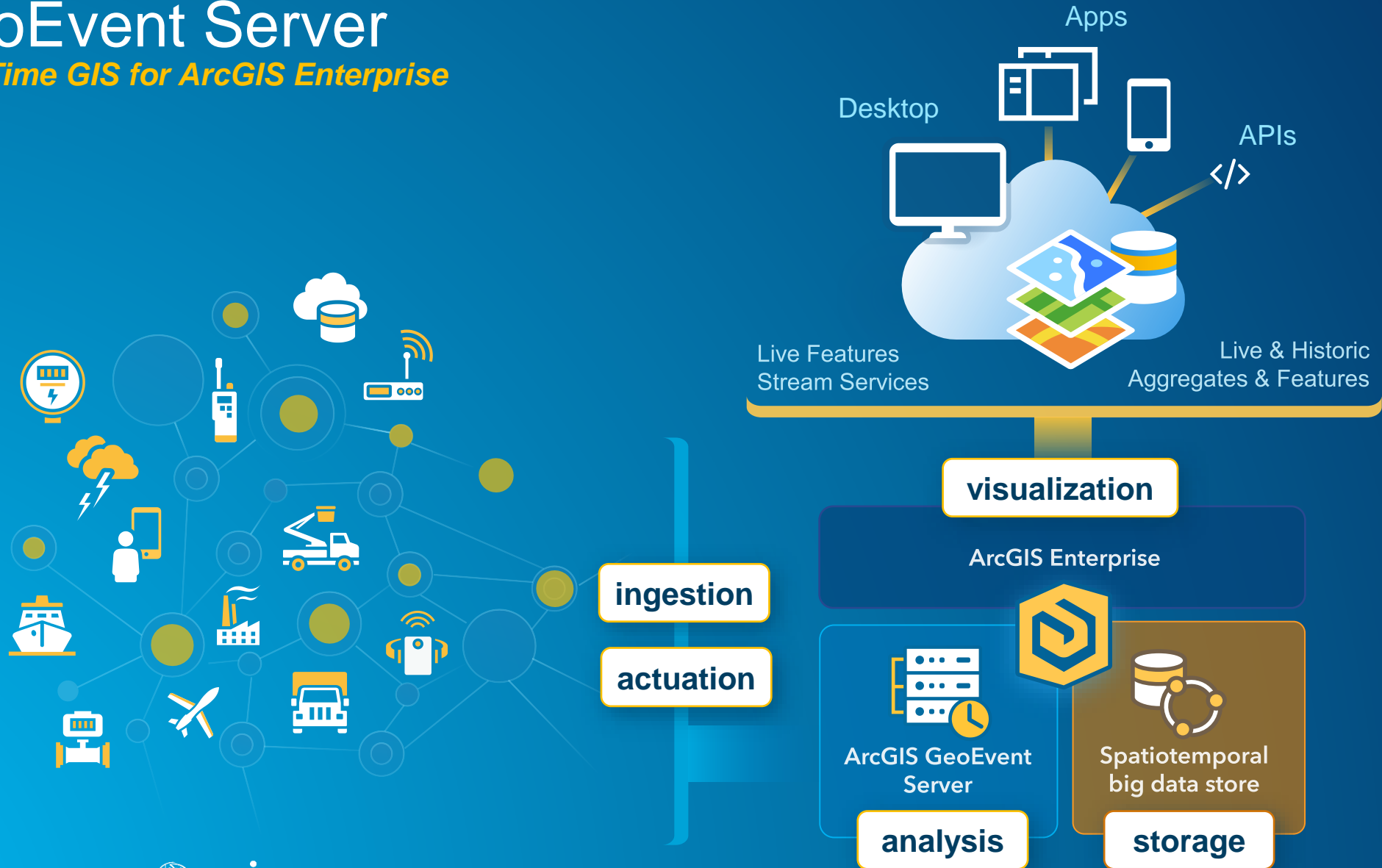




ArcGIS GeoEvent Server

GeoEvent Server

Real-Time GIS for ArcGIS Enterprise



GeoEvent Server

Ingestion



Out of the Box

- Poll an ArcGIS Server for Features
- Poll an external website for GeoJSON, JSON, or XML
- Receive Features, GeoJSON, JSON, or XML on a REST endpoint
- Receive GeoJSON or JSON on a WebSocket
- Receive RSS
- Receive Text from a TCP or UDP Socket
- Subscribe to an external WebSocket for GeoJSON or JSON
- Watch a Folder for new CSV, GeoJSON, or JSON Files
- Subscribe to a Kafka Topic for JSON, GeoJSON, Text

Input Connectors

ingestion



Esri Gallery

- Azure IoT
- Amazon IoT
- ActiveMQ
- RabbitMQ
- GTFS
- NMEA 0183
- Kafka
- KML
- MQTT
- Instagram
- Twitter
- ...

Partner Gallery













- CompassLDE
- enviroCar
- exactEarth AIS
- FAA (ASDI)
- Networkfleet
- OSIssoft
- Valarm
- Waze
- ...

GeoEvent Server

Dissemination



Out of the Box

-  Add or Update a Feature
-  Add or Update a Feature to a SBDS
-  Send Features to a Stream Service
-  Push data to an external TCP Socket
-  Push data to a UDP Socket
-  Push data to an external Website
-  Push data to an external WebSocket
-  Send an Instant Message
-  Send a Text Message
-  Send an Email
-  Write to a CSV, GeoJSON, or JSON File
-  Write data to a Kafka Topic










Output Connectors

actuation


ArcGIS GeoEvent
Server

Esri Gallery



-  Amazon IoT
-  Azure IoT
-  ActiveMQ
-  RabbitMQ
-  Hadoop
-  Kafka
-  MongoDB
-  MQTT
-  Twitter

You can create your own connectors using the GeoEvent SDK.



GeoEvent Server

Processors and Filters



Out of the Box

Buffer Creator	Geotagger	Add XYZ
Convex Hull Creator	Incident Detector	Event Volume Control
Difference Creator	Intersector	Range Fan
Envelope Creator	Projector	Bearing
Field Calculator	Simplifier	Feature To Point
Field Enricher	Symmetric Difference	Event Joiner
Field Mapper	Track Gap Detector	
Field Reducer	Union Creator	

Processors & Filters

Esri Gallery

HTTP Handler	Event Counter
Field Splitter	Reverse Geocoder
Ellipse	Service Area Creator
Spatial Query	Symbol Lookup
Extent Enricher	Track Idle Detector
Field Grouper	Unit Converter
GeoNames Lookup	Visibility
Motion Calculator	Update Only



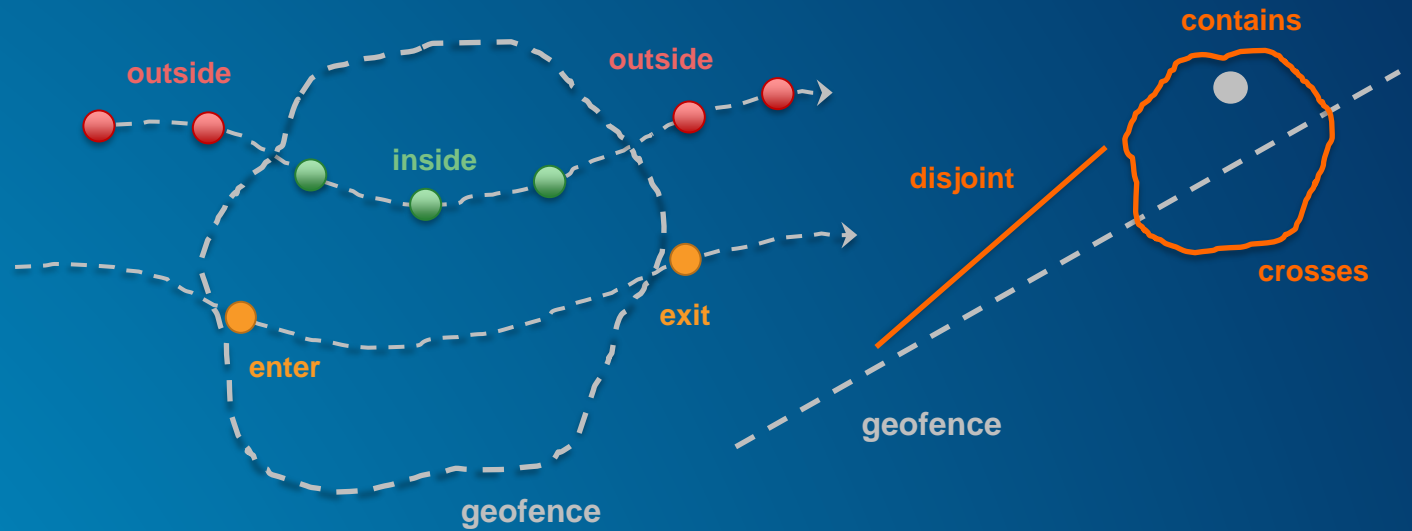
analysis

You can create your own processors using the GeoEvent SDK.



GeoEvent Server

GeoFences



GeoFences & Spatial Operators



ArcGIS GeoEvent
Server

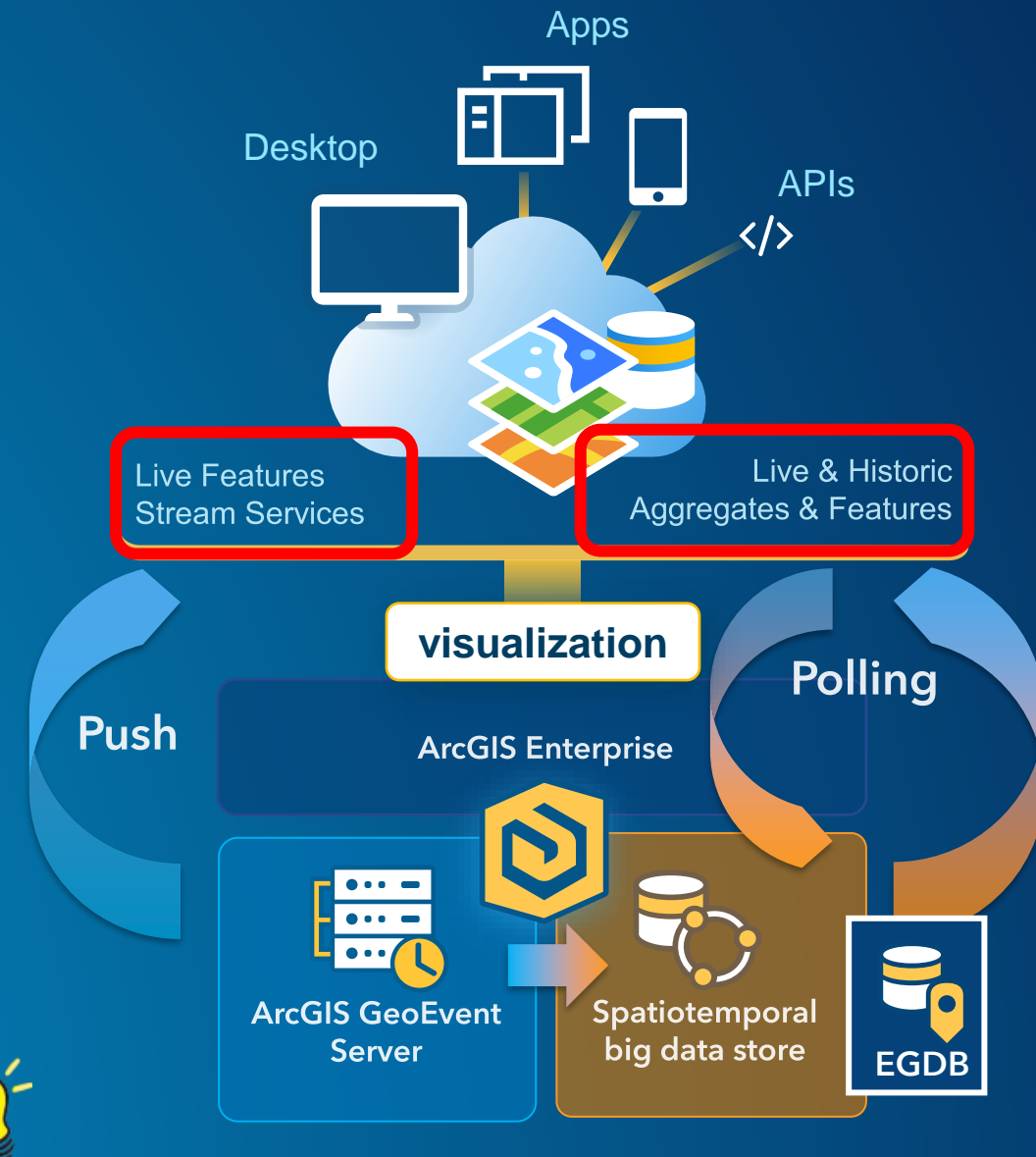
analysis

inside	outside
enter	exit
intersect	disjoint
touches	contains
crosses	equals
overlaps	within

GeoEvent Server

Visualizing Real-Time data

- **Map & Features layers in apps periodically poll to visualize most current observations**
 - backed by an enterprise geodatabase (EGDB) or a spatiotemporal big data store (BDS)
 - history can be retrieved & queried for playback and analysis
- **Stream layers in apps subscribe to stream services to immediately visualize observations**
 - does not require storage, low latency, no playback



Integrating Sensor Data Streams

ArcGIS GeoEvent Server Demo

The screenshot displays the ArcGIS GeoEvent Manager web application. The top navigation bar includes 'Monitor', 'Inputs', 'GeoEvent Services', and 'Outputs'. The 'Monitor' tab is active, showing a table for the 'ISS' service. The table has columns for Status, In/Out, Count, Rate (over last 5 mins), Edit Rate, Max Rate, Time Since Last, View Graph, and Action. The 'Status' column shows 'STARTED'. Below the table, there is a 'Layout' section with a 'New Elements' list (Input, Output, Filter, Processor) and a 'Inputs' list (Busradar-Hünster-ws-in, ISS-poll-in, MS-Busradar-tcp-5566-in, MS-EnviroCar-tcp-5567-in). The 'Outputs' list includes ISS-Stream-out, MS-Bus-ws-json-out, MS-Busradar-ws-json-out, MS-EnviroCar-ws-json-out, and tcp-text-out. The 'Site Settings' section includes GeoEvent Definitions, GeoFences, Data Stores, and Spatiotemporal Big Data Stores. The main workspace shows a workflow diagram with three components: 'ISS-poll-in' (green), 'DateTime (Field Calculator)' (yellow), and 'ISS-Stream-out' (blue). A blue arrow connects 'ISS-poll-in' to 'DateTime', and a black arrow connects 'DateTime' to 'ISS-Stream-out'. Below the diagram, a 'Disable' dialog box is open for the 'ISS-poll-in TO DateTime' connection, showing a JSON configuration for the 'ISS-position' field.

Status	In/Out	Count	Rate (over last 5 mins)	Edit Rate	Max Rate	Time Since Last	View Graph	Action
STARTED	In Out	18.335 18.335	0 /sec 0 /sec		0 /sec 0 /sec	00:00:00 00:00:00		

```
{
  "GEO_name": "iss-position",
  "name": "iss",
  "id": "25544",
  "latitude": "19.854047468778",
  "longitude": "68.542249325666",
  "altitude": "423.02024109691",
  "velocity": "27570.528971878",
  "visibility": "daylight",
  "footprint": "4522.7972842578",
  "timestamp": "Mon Jan 19 08:48:19 CET 1970",
  "daynum": "2458912.723125",
  "solar_lat": "-6.2542163121898",
  "solar_lon": "102.59352644350",
  "units": "kilometers",
  "geometry": "[[\"X\":19.854047468778,\"Y\":68.542249325666,\"Z\":423.02024109691,\"spatialReference\":{\"wkid\":\"4326\"}]]"
}
```

Events Sampled: 3/10

GeoEvent Server

Automatization & Extensibility

- **Java Software Development Kit (SDK)**
 - Included with GeoEvent installation
 - Including tutorials and samples
- **Admin REST API**
 - Swagger UI / documentation

ArcGIS GeoEvent Server: Real-Time Mapping and Analytics

Created by ArcGIS GeoEvent Server Product Team

adapters		Show/Hide	List Operations	Expand Operations
GET	/adapters			Gets all adapters
GET	/adapters/inbound			Gets all inbound adapters
GET	/adapters/outbound			Gets all outbound adapters
POST	/adapters/reset			Resets all of the adapters

connector		Show/Hide	List Operations	Expand Operations
DELETE	/connector/{name}			Deletes a connector by name
GET	/connector/{name}			Gets a connector by name

connectors		Show/Hide	List Operations	Expand Operations
GET	/connectors			Gets all connectors
POST	/connectors			Adds a new connector

ArcGIS® GeoEvent Server Developer Guide

```
SampleInboundAdapter.java
1 package sample.adapter;
2
3 import java.nio.BufferUnderflowException;
4
5 public class SampleInboundAdapter extends InboundAdapterBase
6 {
7     /**
8      * Initialize the i18n Bundle Logger
9      * See {@link BundleLogger} for more info.
10     */
11     private static final BundleLogger LOGGER = BundleLoggerFactory.getLogger(SampleInboundAdapter.class);
12
13     public SampleInboundAdapter(AdapterDefinition definition) throws ComponentException
14     {
15         super(definition);
16     }
17
18     @Override
19     public GeoEvent adapt(ByteBuffer buffer, String channelId)
20     {
21         buffer.mark();
22         try
23         {
24             // This is how you get a single byte of data.
25             // byte singleByte = buffer.get();
26
27             // This is how you would get a byte array
28             byte[] data = new byte[10];
29             buffer.get(data);
30
31             // Create an instance of the GeoEvent
32             // we started up.
33             GeoEvent msg;
34             try
35             {
36                 msg = geoEventCreator.create(msg);
37                 LOGGER.info("CREATED_MSG");
38             }
39             catch (MessagingException e)
40             {
39                 return null;
40             }
41
42             // Populate the message with data
43             int i = 0;
44             msg.setField(i++, 1);
45             double x = 1.0;
46             double y = 1.0;
47             int wkid = 4326;
48             msg.setField(i++, new MapGeometry(x, y, wkid));
49             LOGGER.info("POPULATED_FIELD");
50             return msg;
51         }
52         catch (BufferUnderflowException e)
53         {
54             return null;
55         }
56     }
57 }
```

Maven™



Features Business Explore Marketplace Pricing Search GitHub Sign in Sign up

REPOSITORIES 29 Language: All Sort: Best match

Esri / twitter-for-geoevent ★ 15
ArcGIS GeoEvent Server sample Twitter connectors for sending and receiving tweets.
geoevent twitter java connector arcgis arcgis-geoevent-server transport adapter
● Java Updated on Apr 22

Esri / mongodb-for-geoevent ★ 9
ArcGIS GeoEvent Server sample MongoDB Connector for storing GeoEvents.
java geoevent arcgis mongodb connector transport arcgis-geoevent-server
● Java Updated on Apr 17

Esri / instagram-for-geoevent ★ 7
ArcGIS GeoEvent Server sample Instagram connector for receiving Instagram feeds.
geoevent arcgis-geoevent-server arcgis java instagram connector adapter transport
● Java Updated on Apr 17

Esri / kafka-for-geoevent ★ 6
ArcGIS GeoEvent Server sample Kafka connectors for connecting to Apache Kafka message servers.
geoevent arcgis-geoevent-server arcgis kafka java connector transport server
● Java Updated on Jul 11

arcgis-geoevent-server
Suggest edits
Related topics See more topics
geoevent connector jar-files

Resources

Self-Paced Training and Resources

- **ArcGIS GeoEvent Server resources**

- <http://enterprise.arcgis.com/en/geoevent>
 - Updated documentation
 - Quick Start Guide (PDF)
 - Installation Guides
 - System Requirements
 - Tutorials

- **GeoEvent Gallery**

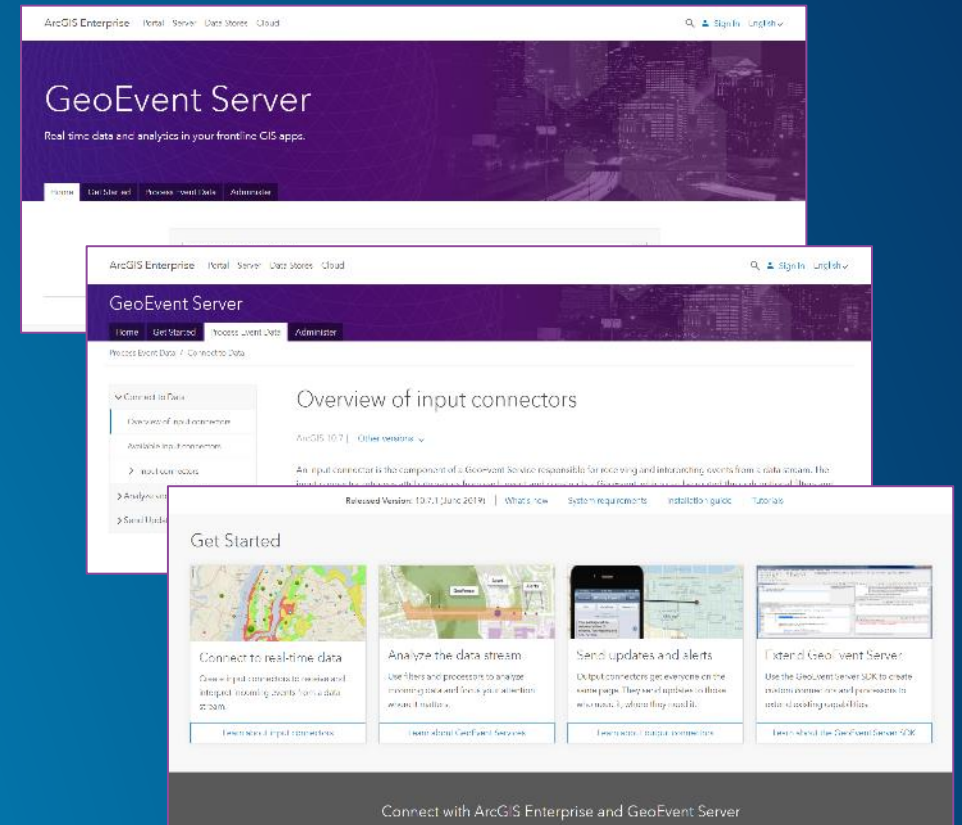
- <https://links.esri.com/geoevent-gallery>

- **Blogs and discussion forum**

- <http://links.esri.com/geoevent-forum>

- **Video recordings of technical workshops**

- <http://www.esri.com/videos>



ArcGIS Enterprise

with *Real-time capabilities*

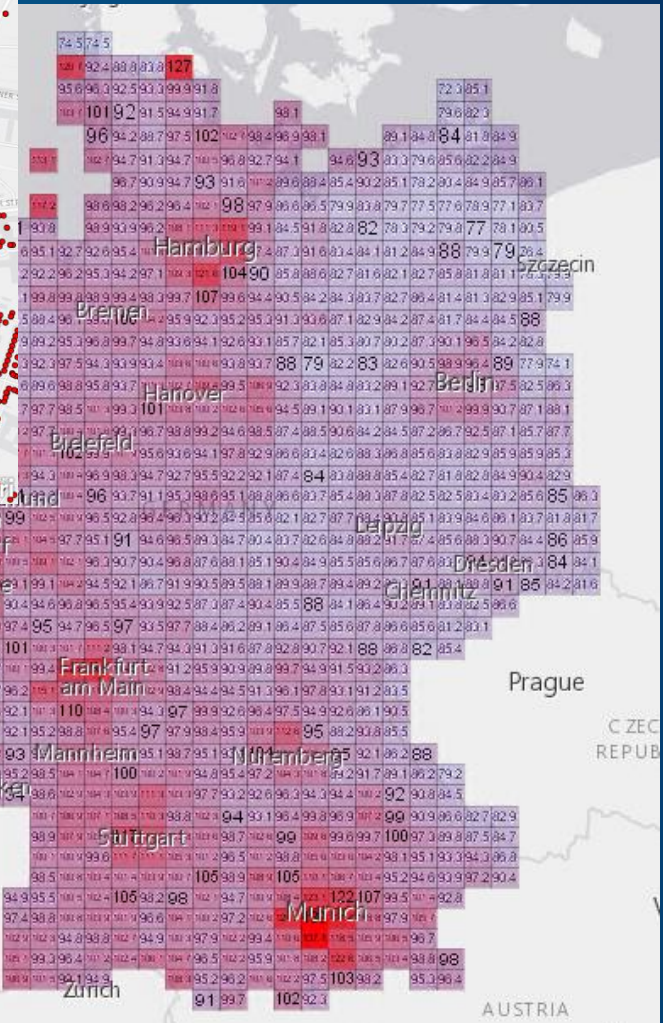
10.8



Spatiotemporal Big Data Store

Optimized for large data volumes

- **Non-relational database**
 - Better performance
- **Distributed database**
 - Replicated data storage
- **Spatial, temporal & attribute indices**
 - Performant queries
- **On-the-fly aggregation**
 - Threshold to switch between aggregated and individual feature view

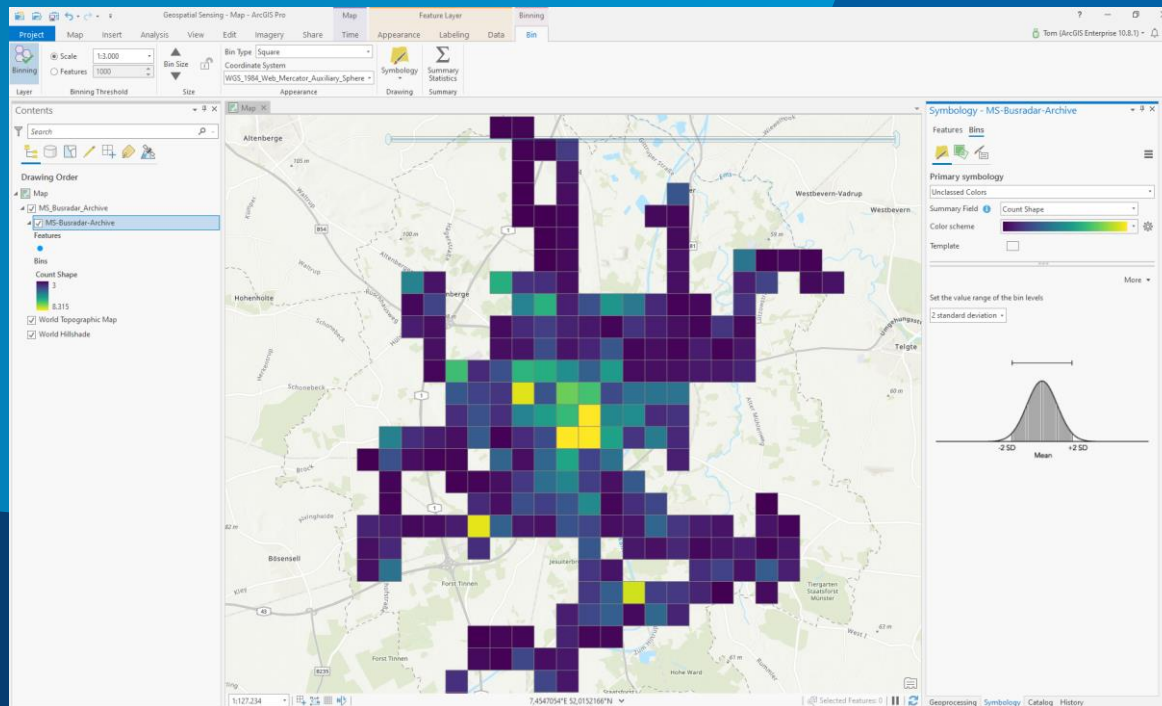


Spatiotemporal
big data store

Speicherung



elasticsearch.



SBDS MapService in ArcGIS Pro

Spatiotemporal Big Data Store Demo

ArcGIS Enterprise

with Real-time & Big Data capabilities

10.8



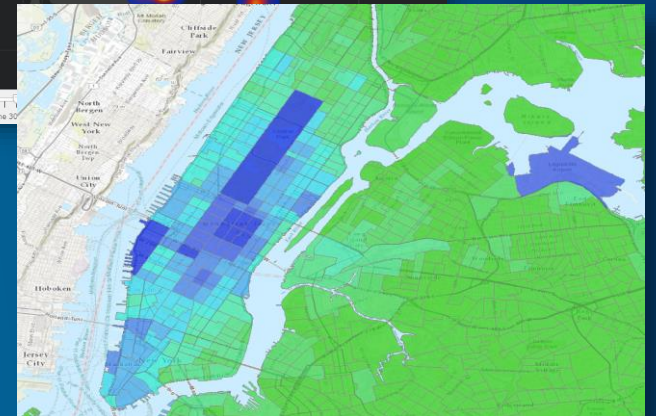
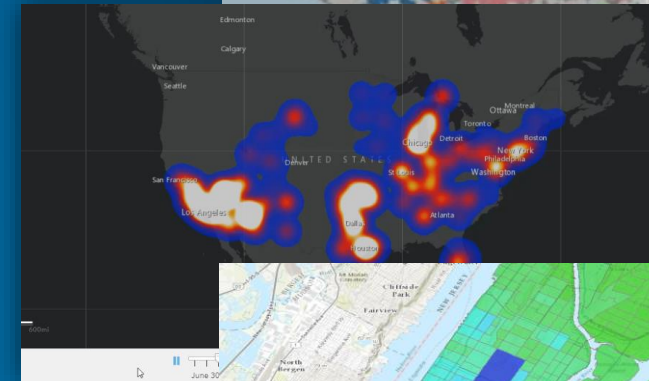


ArcGIS GeoAnalytics

What is GeoAnalytics?

GeoAnalytics *parallelizes computing* to quickly analyze large amounts of *vector and tabular data*

A collection of analysis tools to identify *patterns, relationships, anomalies* and *incidents* in large amounts of data across space and time



ArcGIS Enterprise

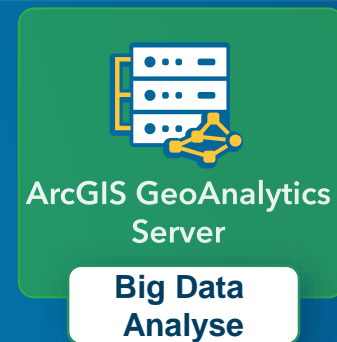
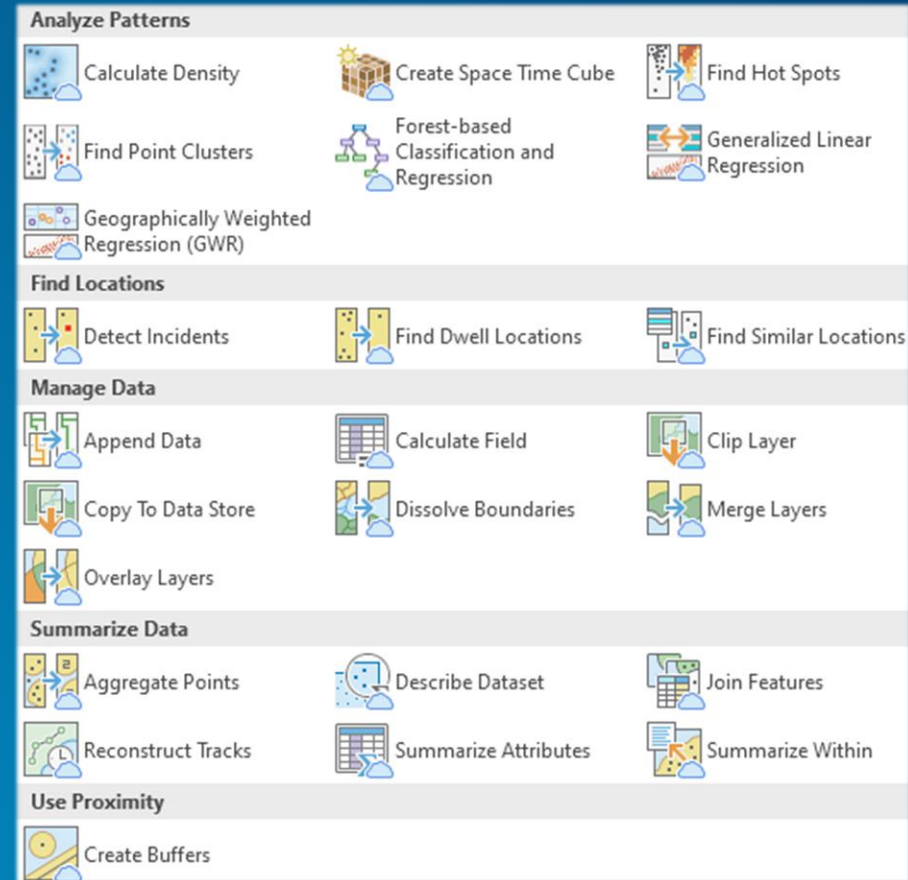
with Real-time & Big Data capabilities



GeoAnalytics Server

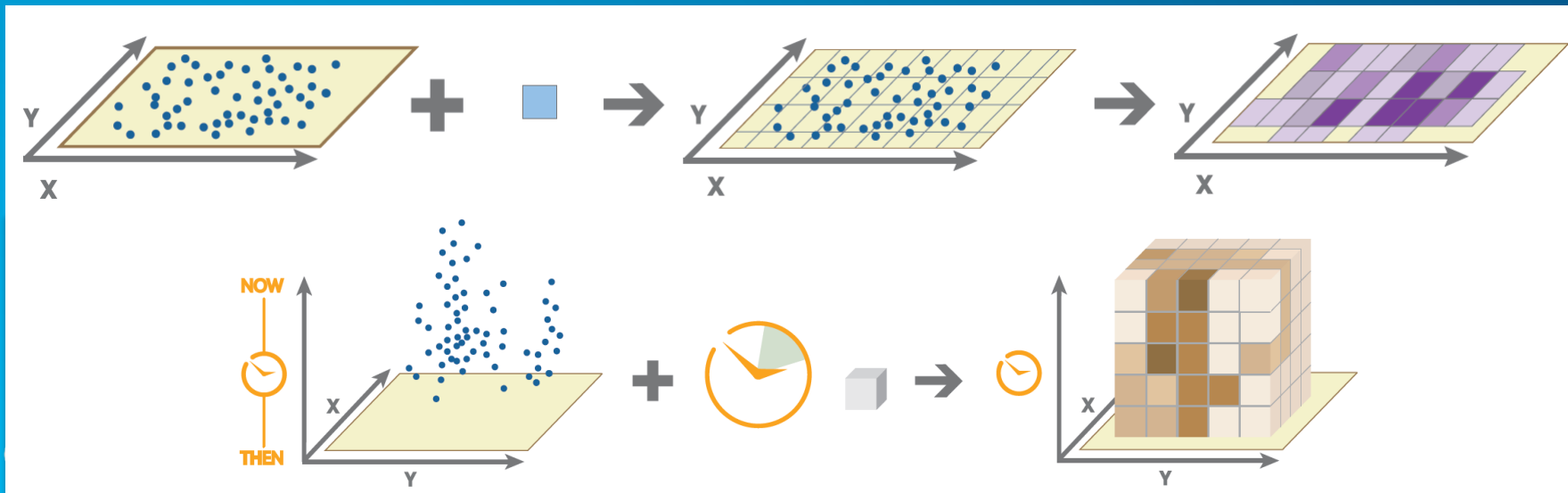
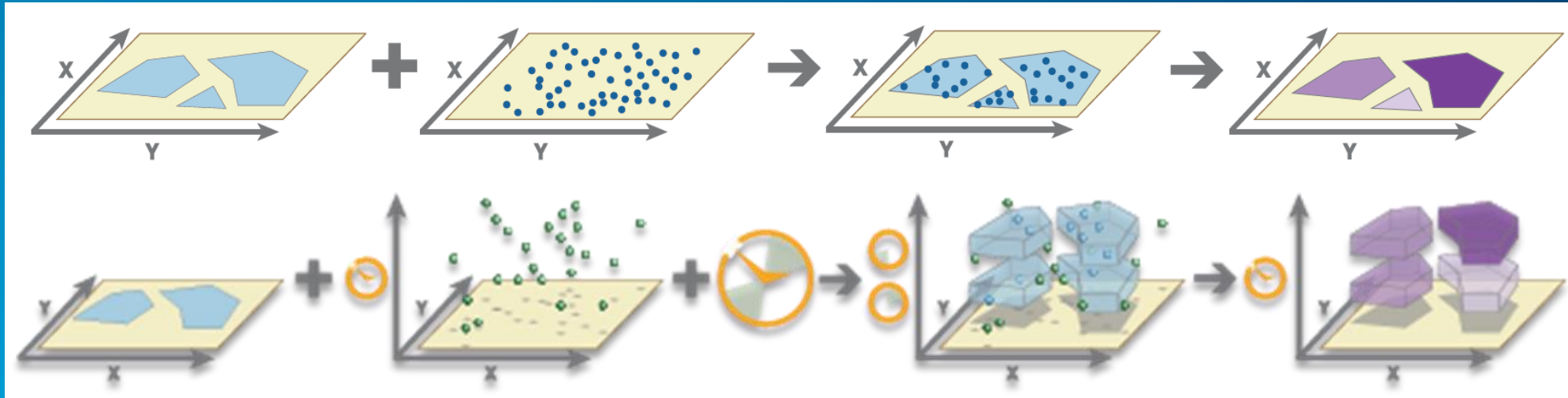
Overview

- **Spatiotemporal Analysis**
 - Tools work in both dimensions
 - Summarize data & analyze patterns



Punkte aggregieren

GeoAnalytics Analyse Funktionalität

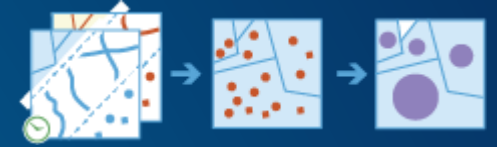


Einfache,
statistische
Berechnungen
(Anzahl, Min, Max,
Durchschnitt).

Aggregation in
zeitlicher Dimension.

Feature verbinden

GeoAnalytics Analyse Funktionalität

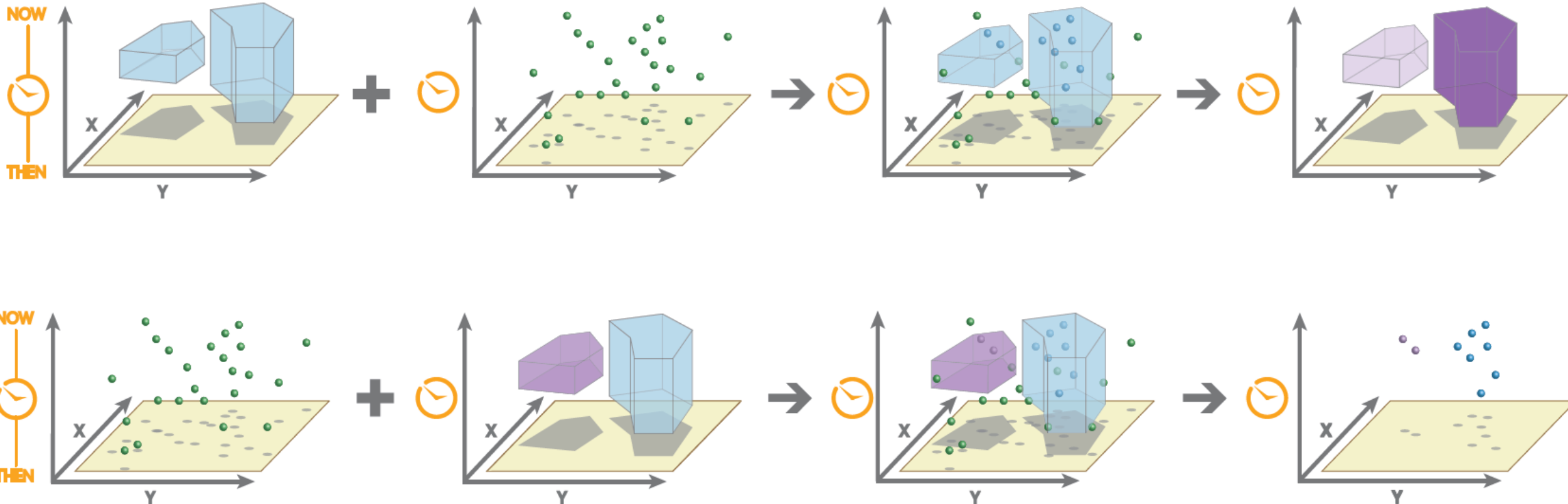


Target Features

Join Features

Zwischenergebnis

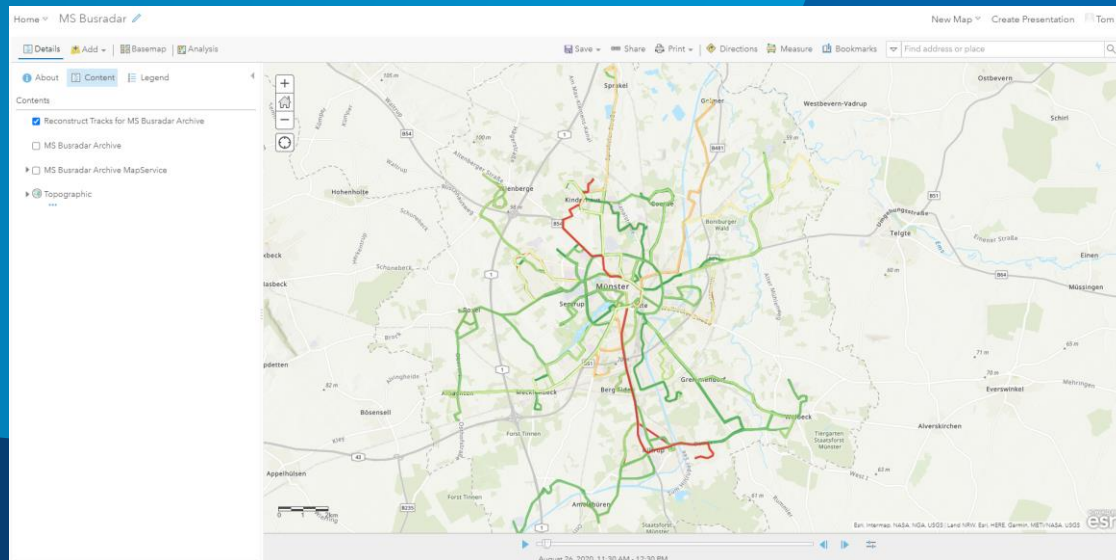
Endergebnis



Verbindet Features von zwei Layern miteinander auf Basis von räumlichen, zeitlichen und attributiven Zusammenhängen.

Analysis with GeoAnalytics

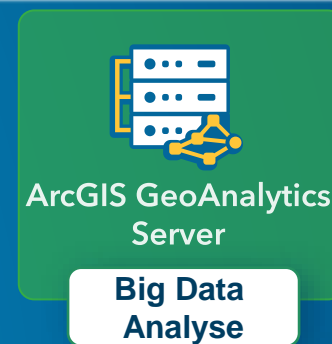
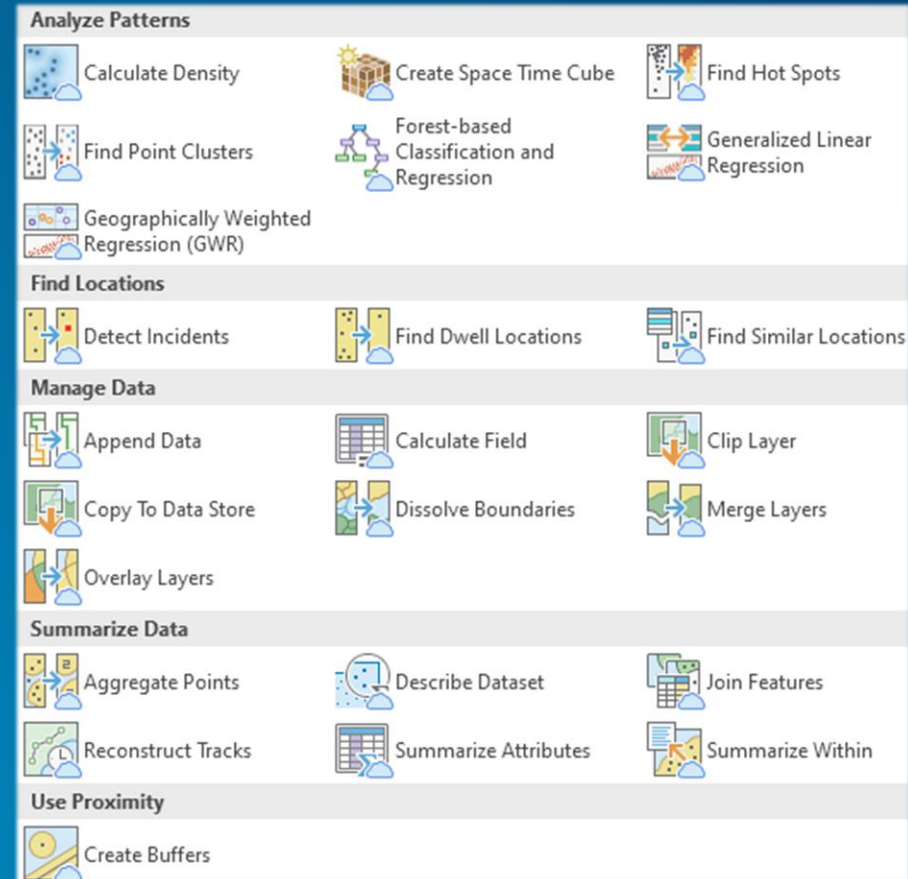
GeoAnalytics Server Demo



GeoAnalytics Server

Overview

- **Spatiotemporal Analysis**
 - Tools work in both dimensions
 - Summarize data & analyze patterns
- **Scale across multiple machines**
 - Framework for parallel processing
- **Connection to external data sources**
 - Analysis of existing enterprise data

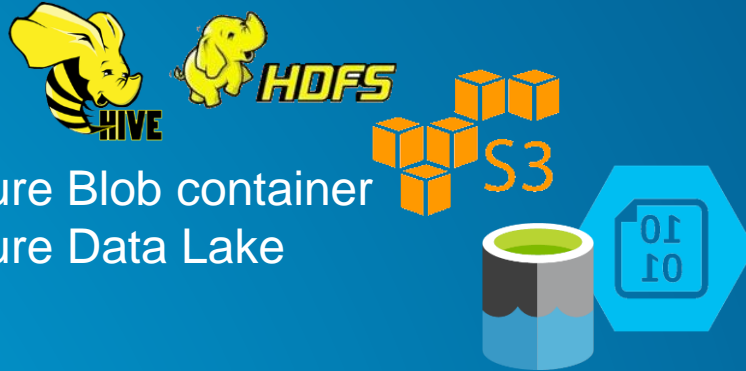


Data Integration

Big Data File Shares

Input: Big Data File Share (Referenced Datasource)

- Read from:
 - File shares
 - HDFS – Hadoop Distributed File System
 - Hive
 - Cloud Storage
 - AWS S3
 - Microsoft Azure Blob container
 - Microsoft Azure Data Lake
- Supported Formats:
 - Delimited files (.csv, .tsv, .txt)
 - Shapefiles
 - Parquet files
 - ORC files



Output:

Hosted Feature Layer
(SBDS)



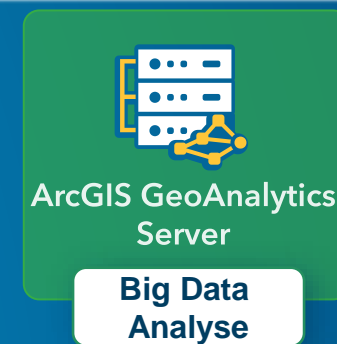
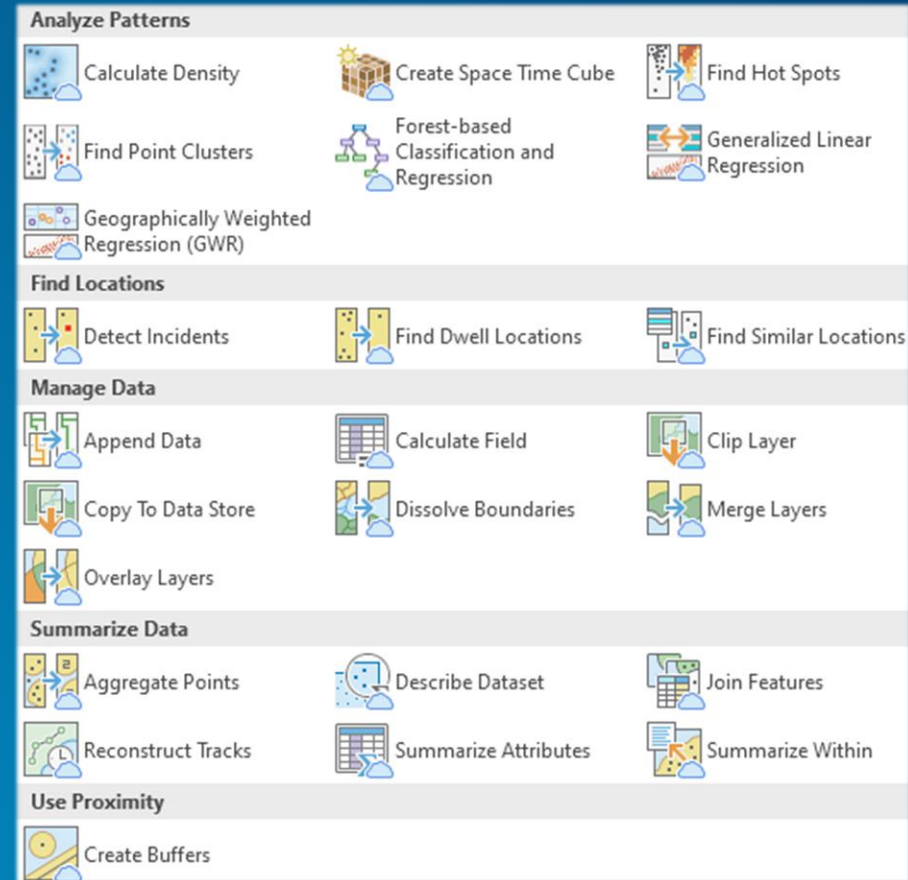
Big Data File Share
(Referenced Datasource)



GeoAnalytics Server

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- **Spatiotemporal Analysis**
 - Tools work in both dimensions
 - Summarize data & analyze patterns
- **Scale across multiple machines**
 - Framework for parallel processing
- **Connection to external data sources**
 - Analysis of existing enterprise data
- **Run a Python script in the Spark framework**
 - Use of PySpark and Mllib
 - Pipeline analysis workflows



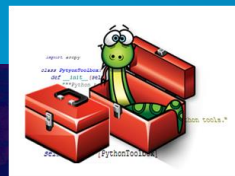
ArcGIS Notebooks

Integration of Jupyter Notebooks in ArcGIS



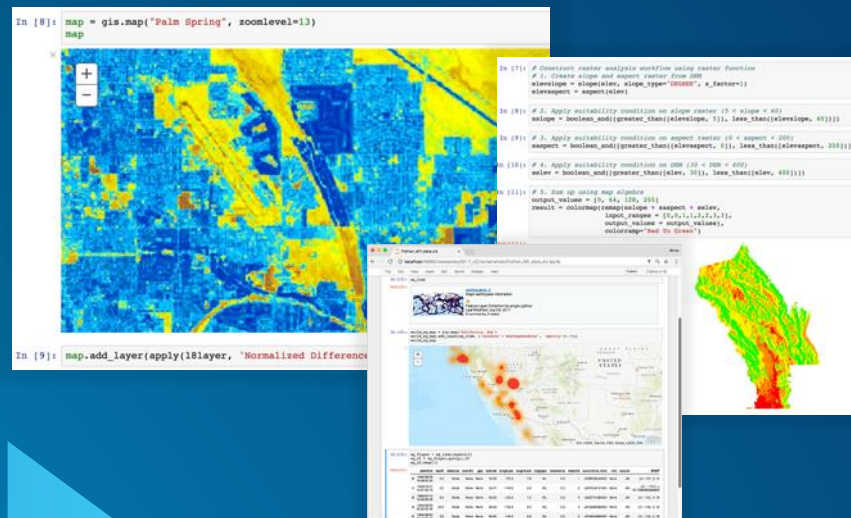
ArcGIS

- ArcGIS API for Python
- ArcPy



ArcGIS API for Python

A powerful Python library for spatial analysis, mapping, and GIS.



Open Source

Python & Data Science





Photo by [Hitesh Choudhary](#) on [Unsplash](#)

Run a Python script in the Spark framework

GeoAnalytics Server Demo

Run a Python script in the Spark framework

ArcGIS GeoAnalytics Server

Extend Your Big Data Analysis with GeoAnalytics Server and Spark

<https://www.esri.com/arcgis-blog/products/geoanalytics-server/analytics/extend-your-big-data-analysis-with-spark/>

Detailed REST API description with examples:

<https://developers.arcgis.com/rest/services-reference/run-python-script-examples.htm>

ArcGIS Enterprise

with Real-time & Big Data capabilities



GeoAnalytics

Products

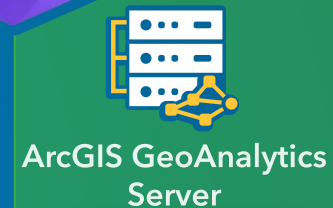
GeoAnalytics Desktop

Parallel processing across cores on
your laptop or desktop with
ArcGIS Pro



GeoAnalytics Server

Distributed processing across
multiple server cores and machines
with **ArcGIS Enterprise**



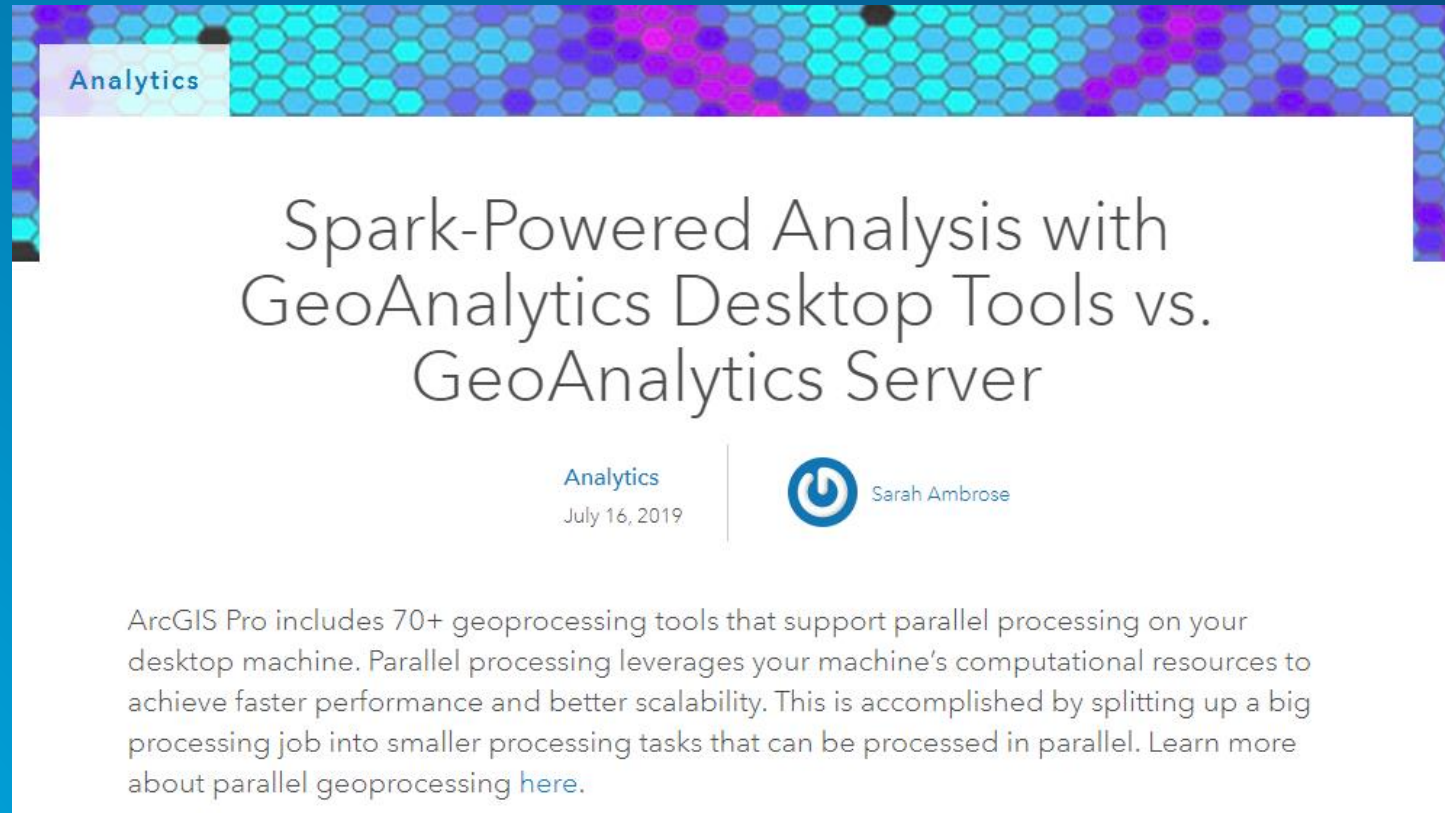
ArcGIS GeoAnalytics
Server

Big Data
Analyse



When to use Desktop or Server for GeoAnalytics?

When to use Desktop or Server for GeoAnalytics?



[Blog](#)

Considerations for GeoAnalytics Desktop Tools

Considerations for GeoAnalytics Desktop tools

GeoAnalytics Desktop tools provide a parallel processing framework for analysis on a desktop machine using Apache Spark. Through aggregation, regression, detection, and clustering, you can visualize, understand, and interact with big data. These tools work with big datasets and allow you to gain insight into your data through patterns, trends, and anomalies. The tools are integrated and run in ArcGIS Pro in the same way as other desktop geoprocessing tools.

GeoAnalytics Desktop tools are designed for large datasets; consequently, other desktop tools may be more appropriate for use with smaller datasets. GeoAnalytics Desktop tools require an initial startup time to implement the distributed processing, so they are optimal for larger datasets (hundreds of thousands or millions of records).

<https://pro.arcgis.com/en/pro-app/tool-reference/geoanalytics-desktop/considerations-for-geoanalytics-desktop-tools.htm>

ArcGIS Enterprise

with Real-time & Big Data capabilities

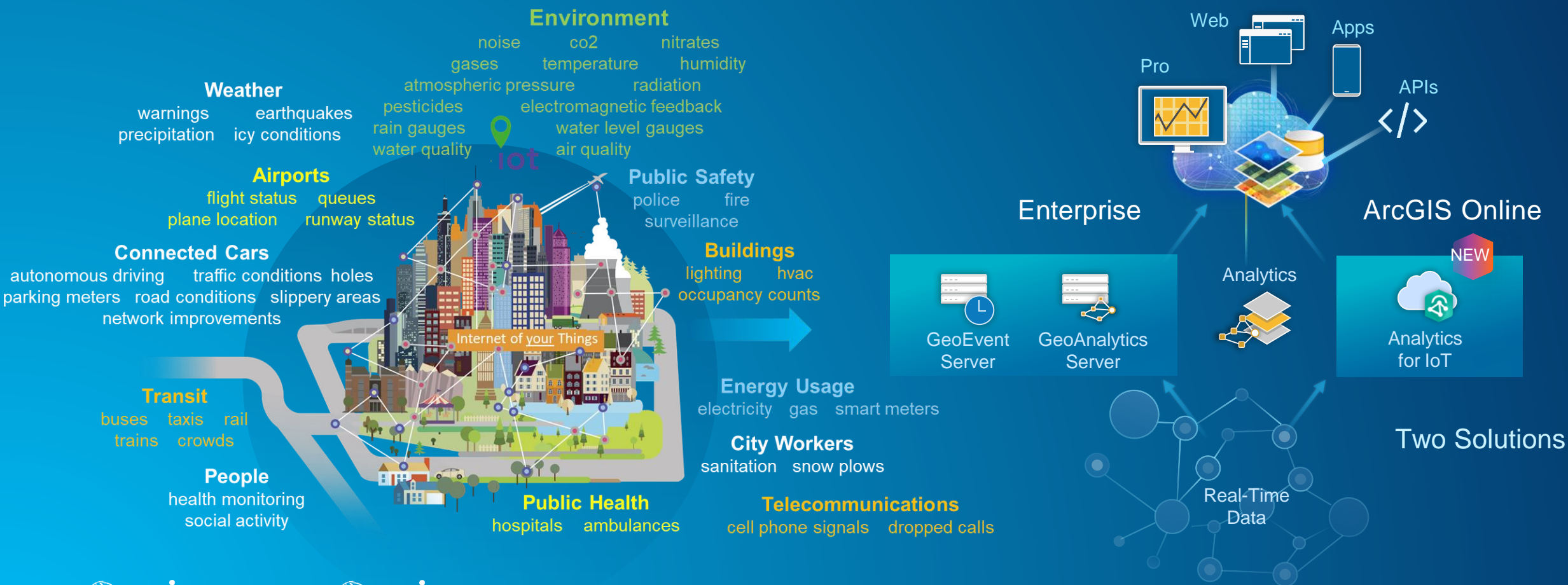




ArcGIS Analytics for IoT

ArcGIS Analytics for IoT

real-time & big data GIS capability for ArcGIS Online

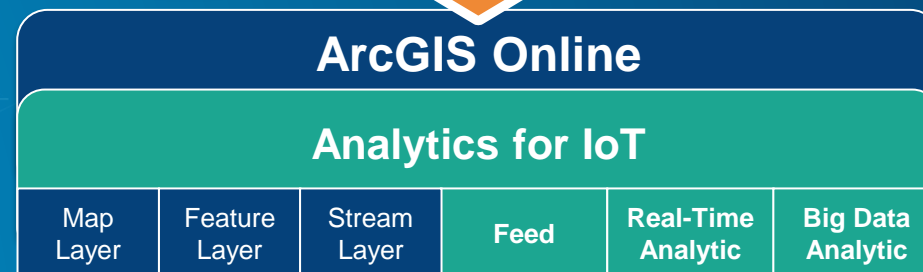
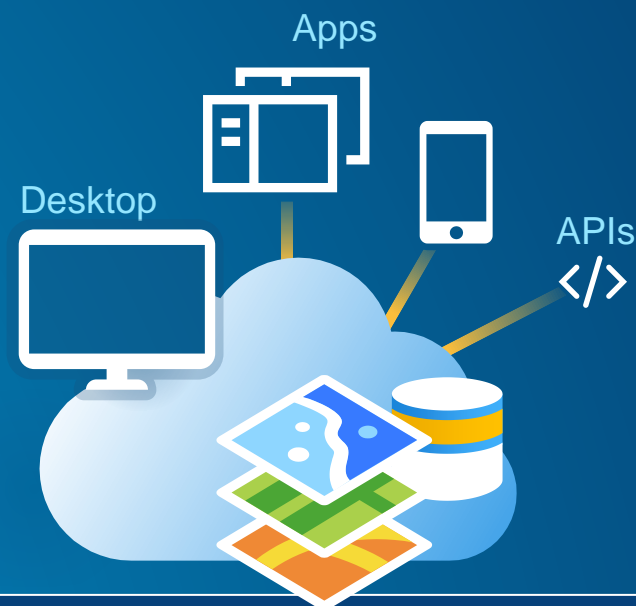


ArcGIS Analytics for IoT

real-time & big data GIS capability for ArcGIS Online



- Extract location-based intelligence from your IoT
- Rapidly visualize, replay, & analyze IoT data
- Discover & use real-time feeds
- Detect patterns over space & time



New Item Types

Feeds

Ingest and visualize real-time data streams



ship_positions_simulation Details Logs

Feed by janedoe

Simulated AIS ship positions from the Marine Cadastre Automatic Identification System

Created: Nov 10, 2019 Updated: Nov 10, 2019

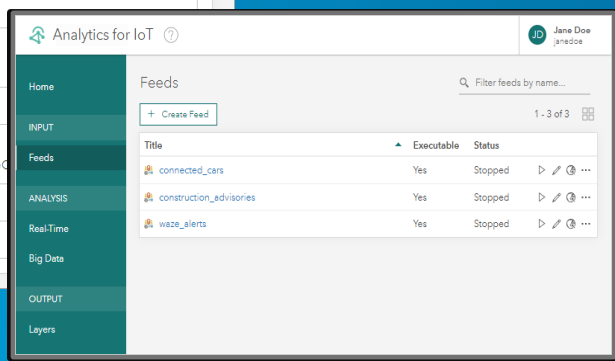
Edit Clone Delete Start

Add feed to new analytic View item details Open in map viewer

Feed Details

Type: Simulator

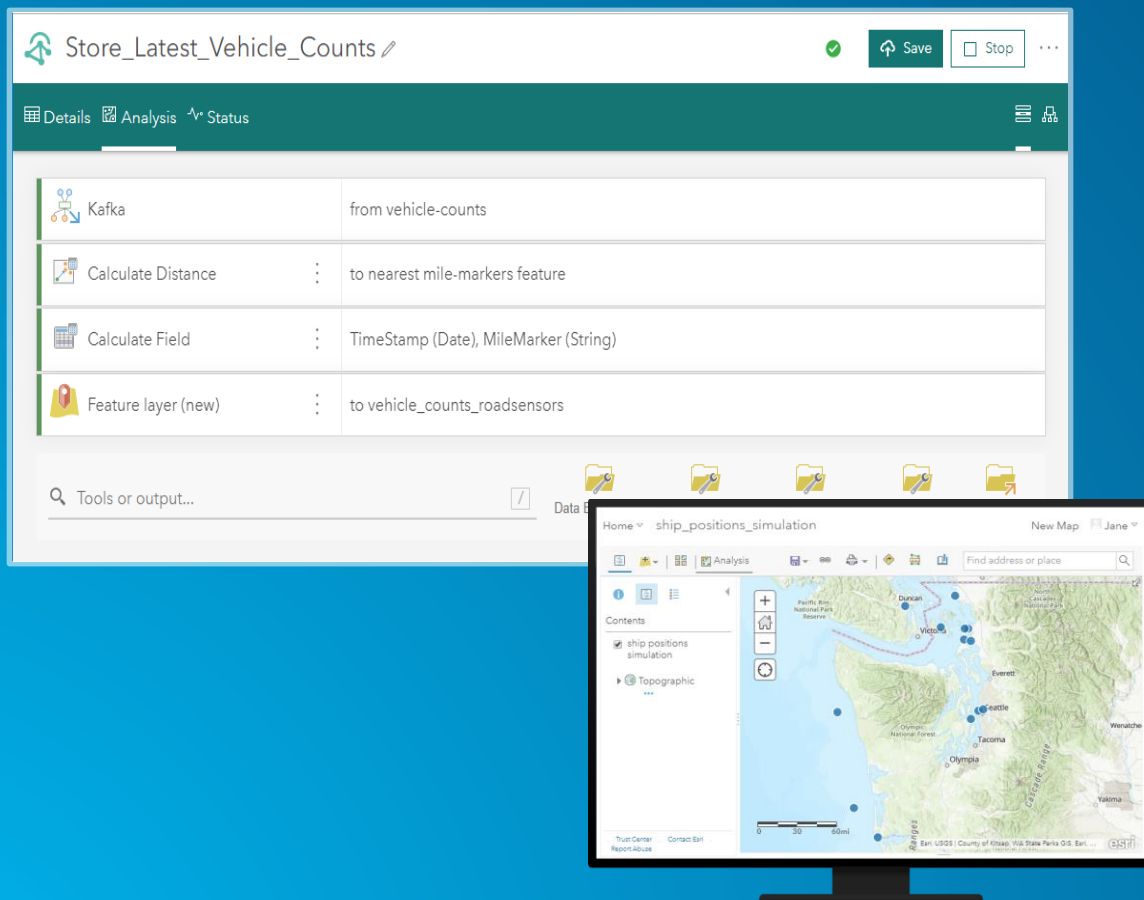
Field Separator	,
Features Per Execution	30
Repeat Simulation	true
Interval for Sending Events (milliseconds)	1000
Time Field Index	1
URL	https://s4iot-public-s3-us-west-2.amazonaws.com/simulations/AIS_MarineC...
Convert to Current Time	true
Stream Service Item ID	4ee79948ee714ca2aca7e5ed4f99e753



- Connect to data sources
 - ArcGIS (Feature & Stream Layers)
 - Cloud IoTs (Amazon, Azure, Cisco)
 - Web & Messaging (HTTP, Kafka, RSS...)
- Schema auto-discovery
- Behaves like a stream layer
- Immediate display of new data

Real-Time Analytics

Process and analyze real-time data streams



- **Input Sources**

- Feeds (one or more)
- Static data sources (enrichment, joins)

- **Analytic Tools**

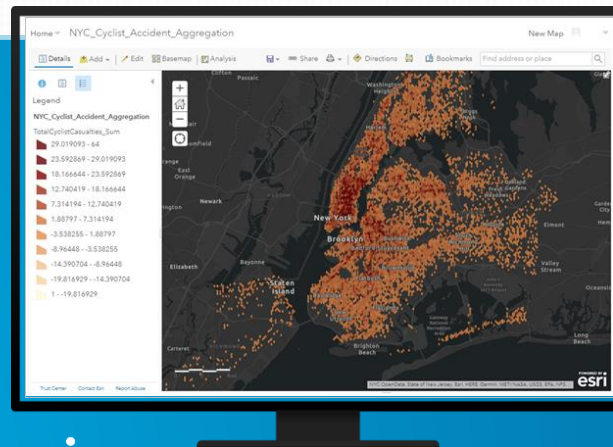
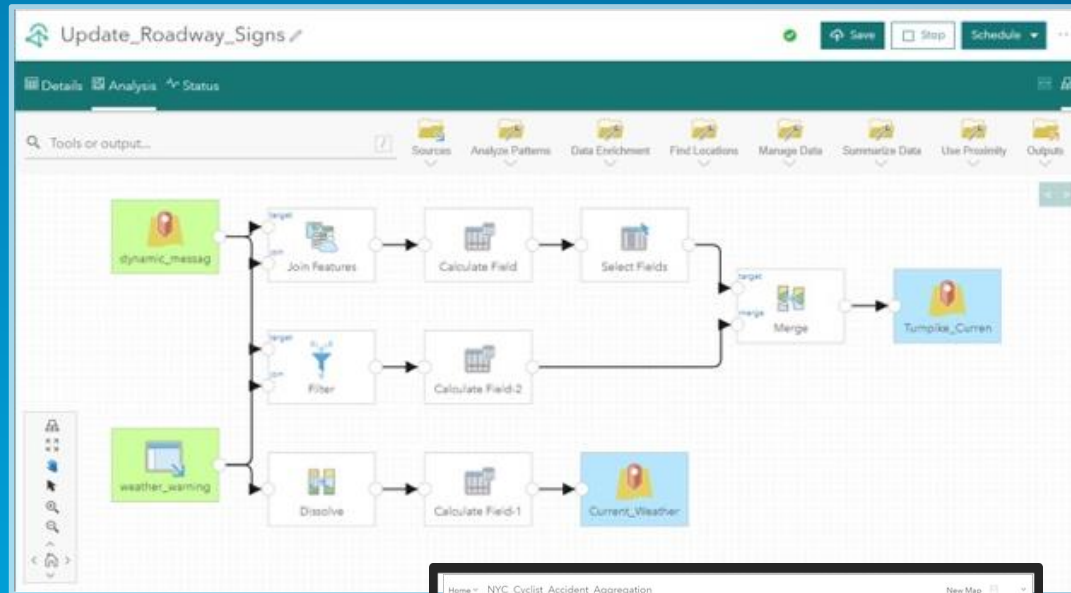
- Build a pipeline of zero to many....
- Analyze individual observations

- **Outputs**

- ArcGIS Layers (Map & Feature)
- Alerts & Notifications (Email, Actuations)

Big Data Analytics

Perform batch analysis on stored big data



- **Input Sources**

- ArcGIS (Feature Layers)
- Cloud (Amazon S3, Azure Blob)
- Web & Messaging (HTTP, RSS...)

- **Analytic Tools**

- Analyze Patterns
- Find Locations
- Manage, Summarize, Enrich Data

- **Output results to one or more destinations**



ArcGIS Analytics for IoT

Ressourcen

[Products](#)[Solutions](#)[Support & Services](#)[News](#)[About](#)[ArcGIS Analytics for IoT](#)[Overview](#)[Resources](#)[Get Started](#)

ArcGIS Analytics for IoT

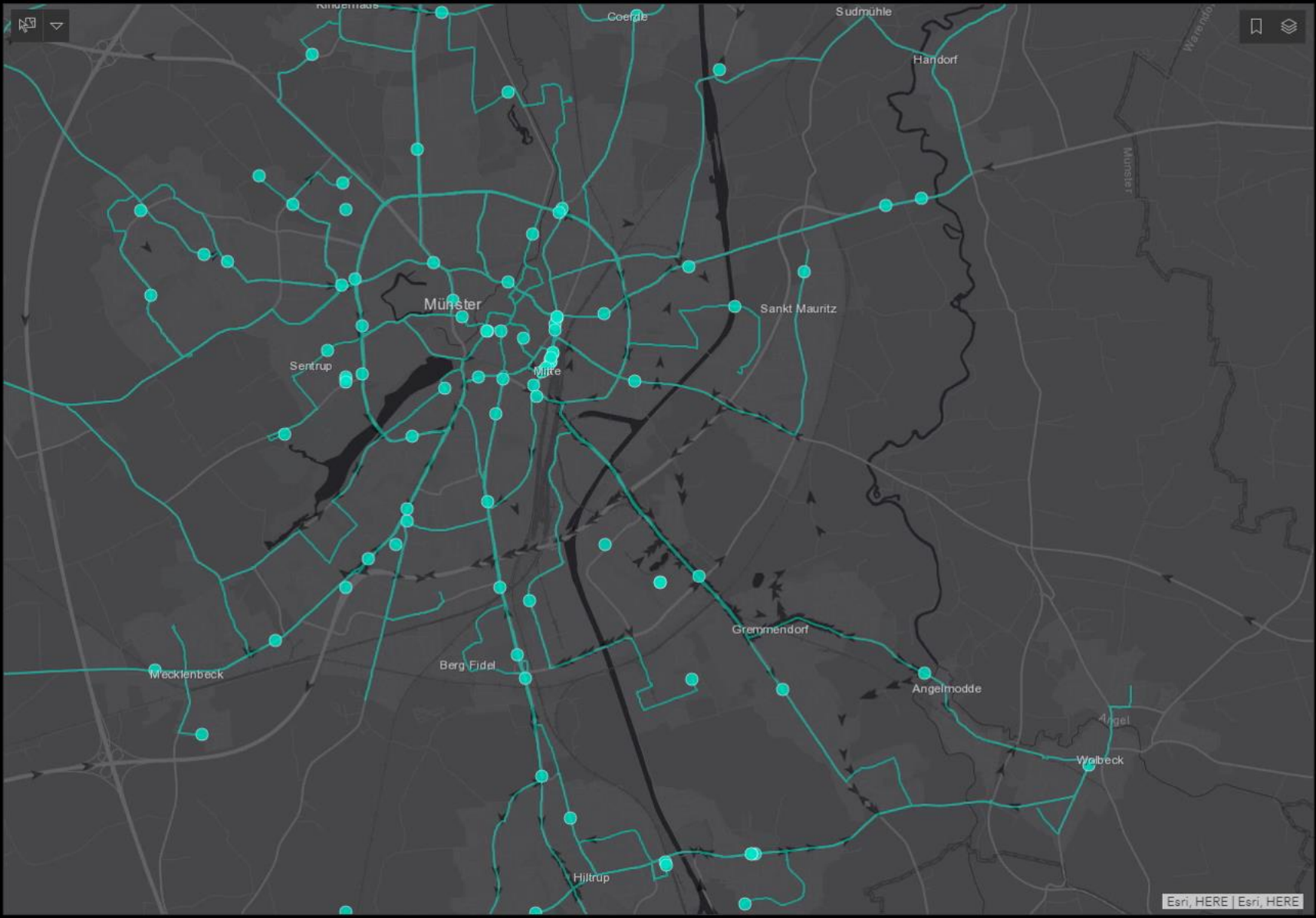
Harness the full potential of IoT




Anzahl fahrender Busse
118

- Bus: 5102 - aktuelle Verspätung: 271 Sek.
Linie: 9
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 5166 - aktuelle Verspätung: 113 Sek.
Linie: 33
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 2915 - aktuelle Verspätung: -1,067 Sek.
Linie: 10
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 5456 - aktuelle Verspätung: 90 Sek.
Linie: 2
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 2751 - aktuelle Verspätung: -43 Sek.
Linie: 12
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 1346 - aktuelle Verspätung: 185 Sek.
Linie: 8
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 1564 - aktuelle Verspätung: 134 Sek.
Linie: 14
Letztes Update: 3/5/2020, 10:41 AM
 - Bus: 2948 - aktuelle Verspätung: 304 Sek.
Linie: 5
- Last update: a few seconds ago*

Warnungen
0 



Münster Busradar Distance Warning



Münster Busradar Positionen

●


Münster Bus Routen

—


EnviroCar Positionen

▲

ArcGIS Analytics for IoT



Datenquellen:









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THE SCIENCE OF WHERE

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