Real-Time & Big Data GIS:
Leveraging the spatiotemporal big data store

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Agenda

1. Overview
2. Real-time data ingestion using GeoEvent Server
3. Storage, visualization & replay
4. Big data analytics using GeoAnalytics Server

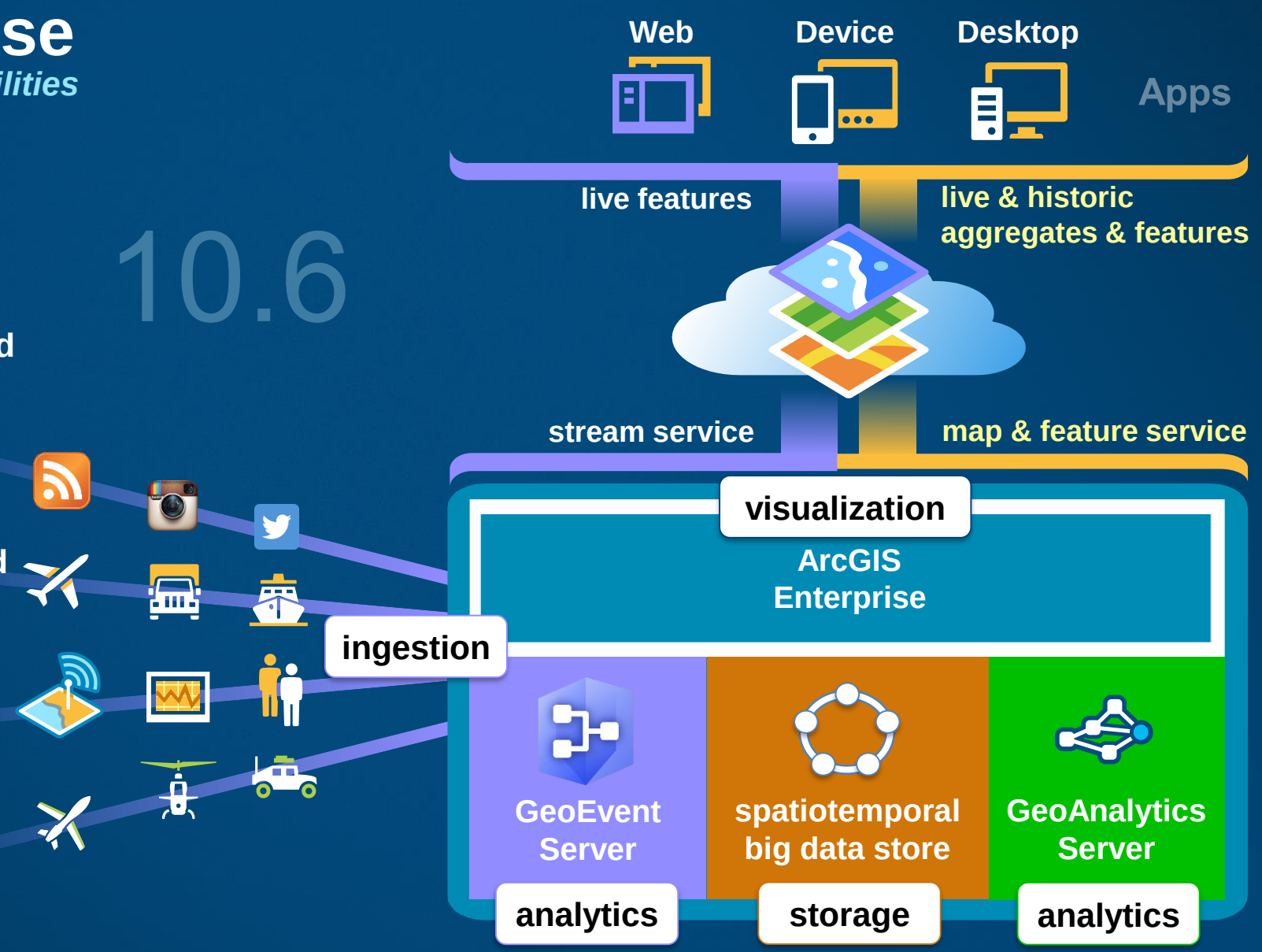
1 Overview

ArcGIS Enterprise

with real-time & big data capabilities

- Ingest high velocity real-time data into ArcGIS
- Perform continuous analytics on events as they are received
- Store observations in a spatiotemporal big data store
- Run batch analytics on stored observations
- Visualize high velocity & volume data:
  - as an aggregation
  - or as discrete features
- Notify about patterns of interest

10.6

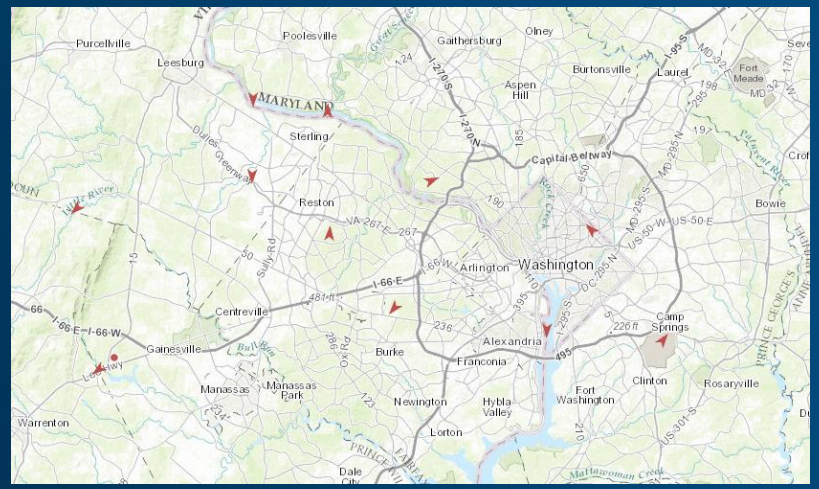


Observation data

types of observation data

moving

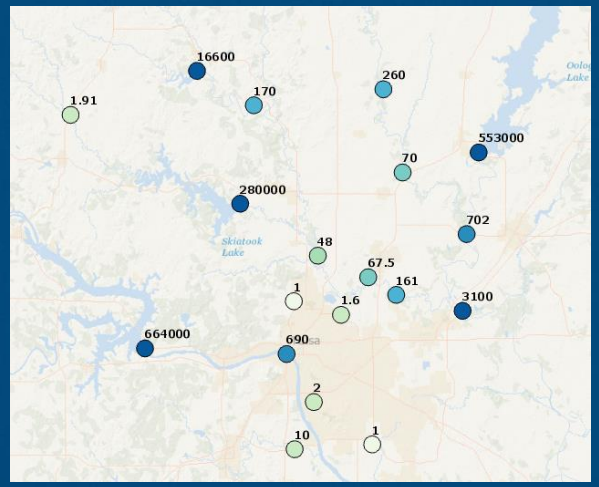
something that moves



- planes
- vehicles
- animals
- satellites
- storms

stationary

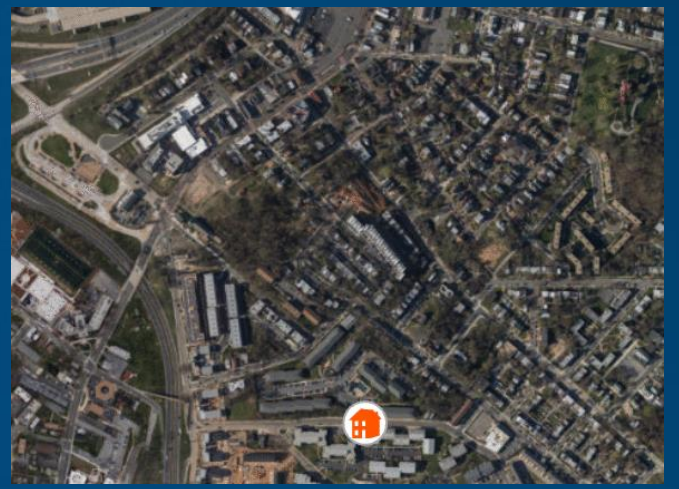
stands still but attributes change



- water gauges
- weather stations
- traffic sensors
- air quality

discrete

something that "just happens"



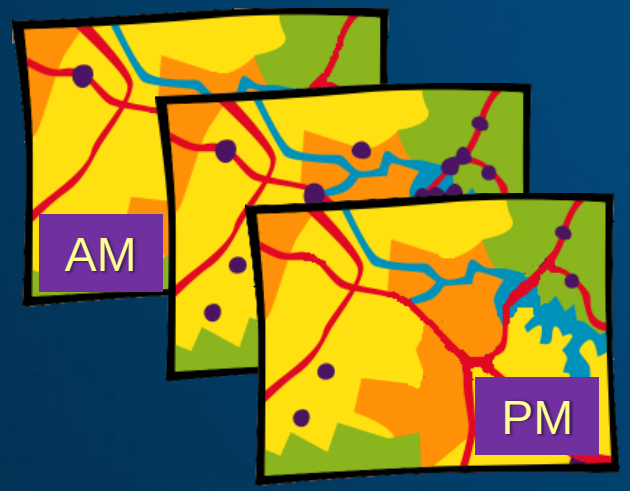
- crimes
- lightning
- accidents

Observation

defined

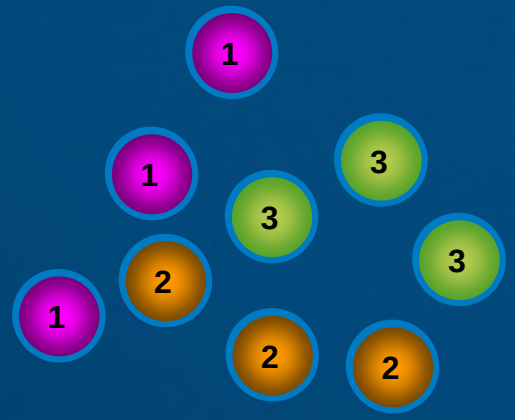
- An observation is a recording of a feature's attribute values and location at a specific moment in time
  - Observations are immutable, they happen and are typically not edited
  - Observations can be replayed over space & time
  - Moving observations are identifiable by a unique attribute, known as a track id

space & time



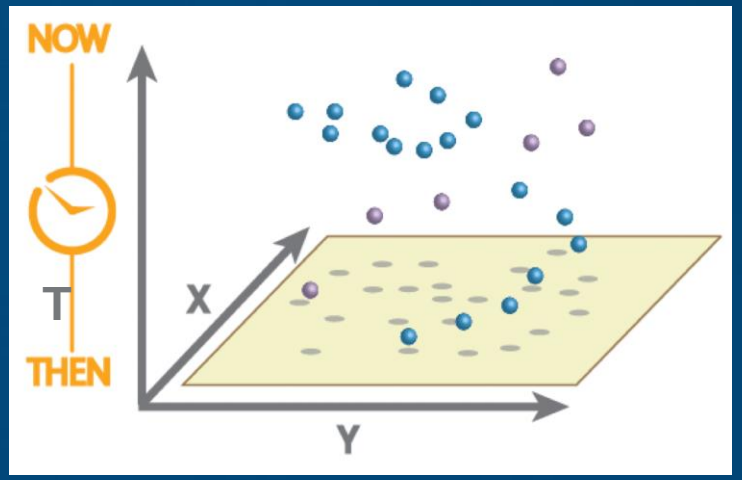
Observations can be shown at a specific time

tracks



Moving observations can be identified by a unique attribute

tracks of moving observations can be reconstructed

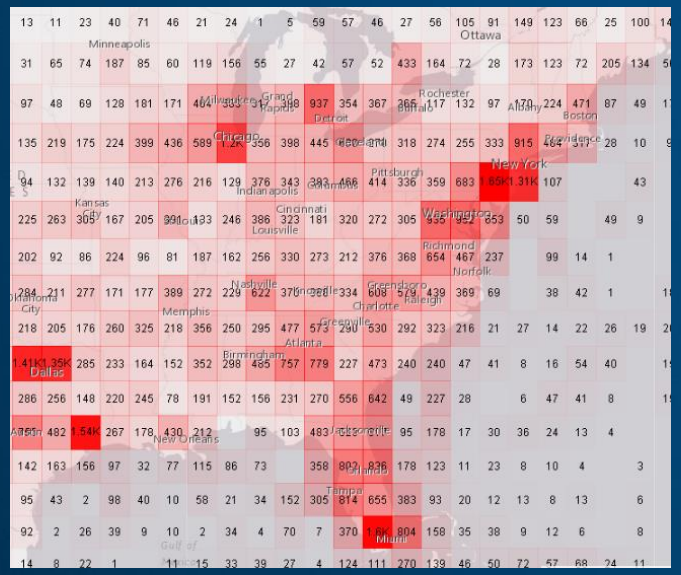


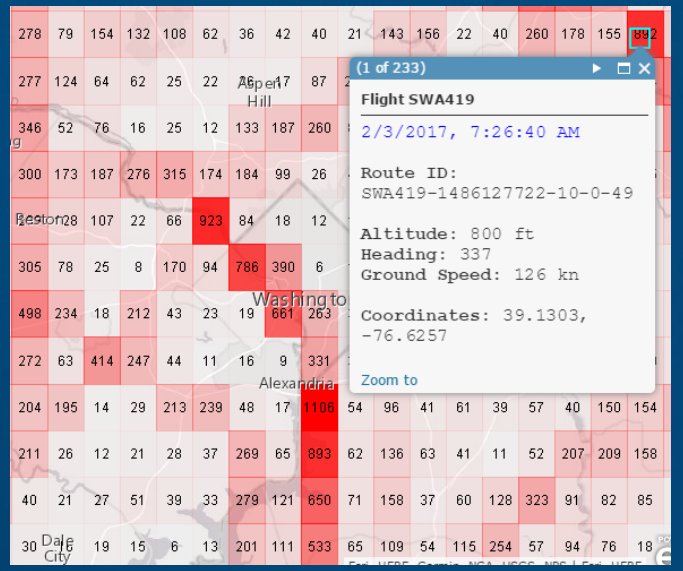
Moving observation illustration for two tracks over space (X, Y) and time (T)

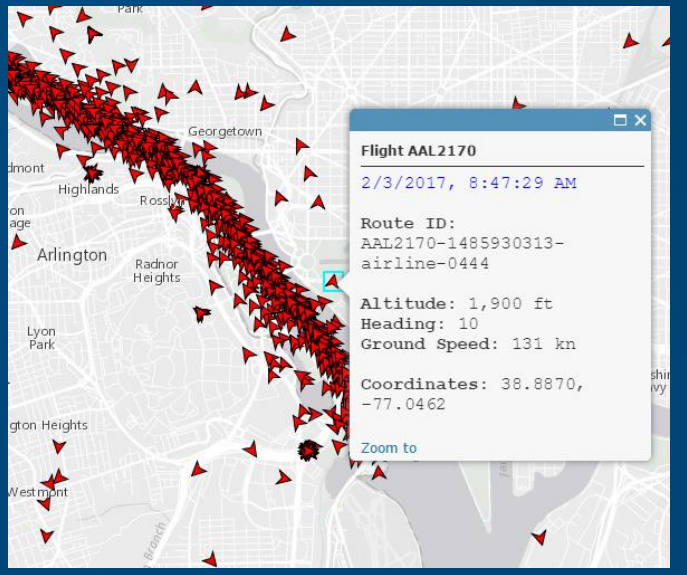
Visualization

of observation data

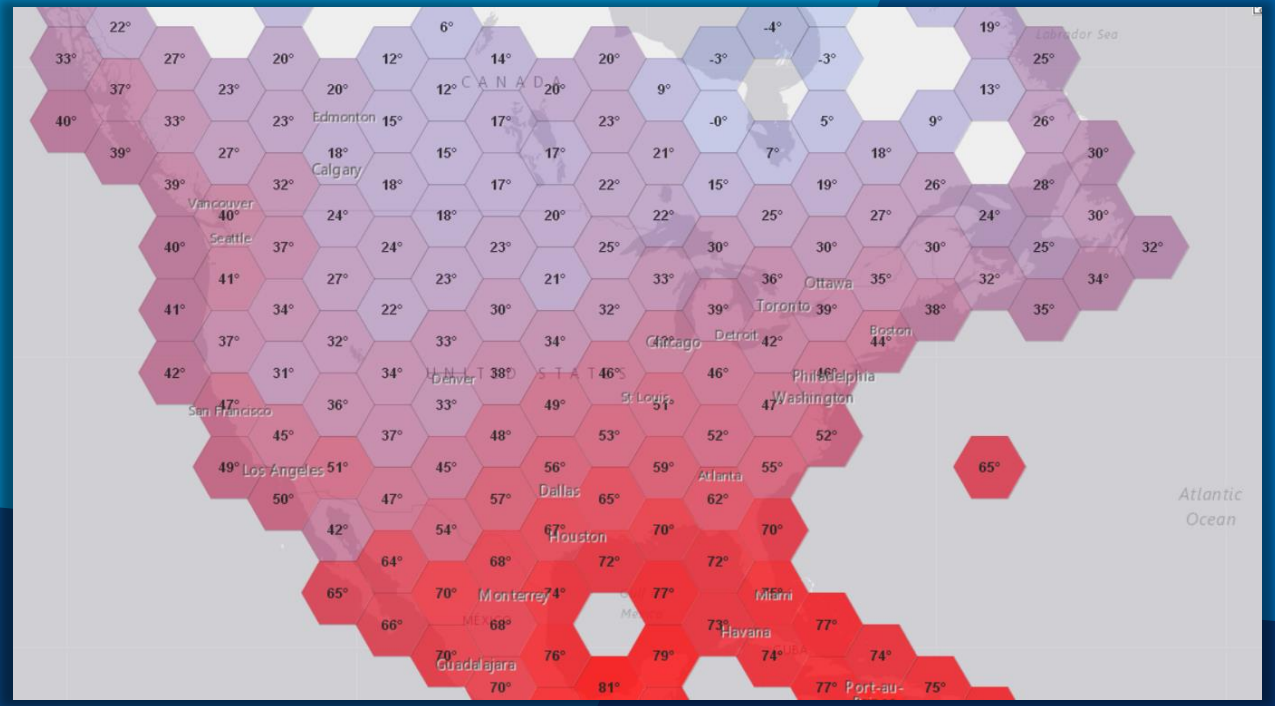
- Map & Feature services that use data in the spatiotemporal big data store enable you to:
  - Visualize on-the-fly aggregations of data
  - Perform exploratory queries over any combination of space, time, and attributes
  - Switch visualization from aggregation to raw features
  - Inspect feature-level attributes while in aggregation *or* raw feature view
  - Replay (via time slider) historic observations in aggregation *or* raw feature view







Demo



Visualizing observation data

Map & feature services using data from the spatiotemporal big data store

2

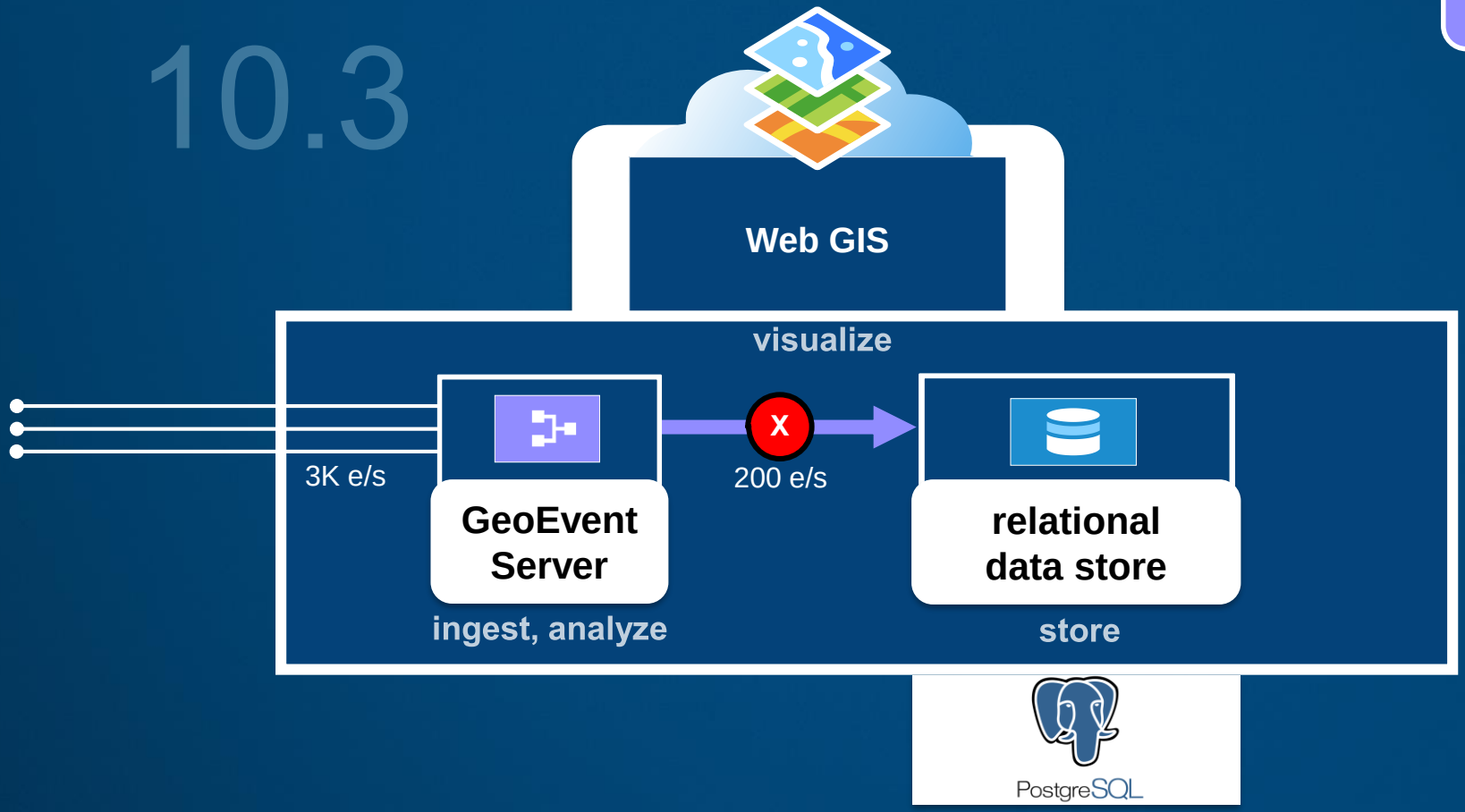
Real-Time data ingestion

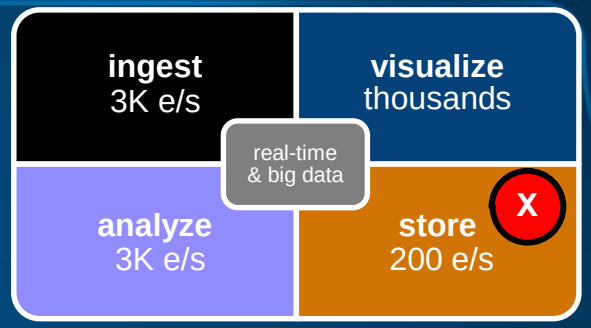
using GeoEvent Server

Web GIS

with real-time capabilities

10.3

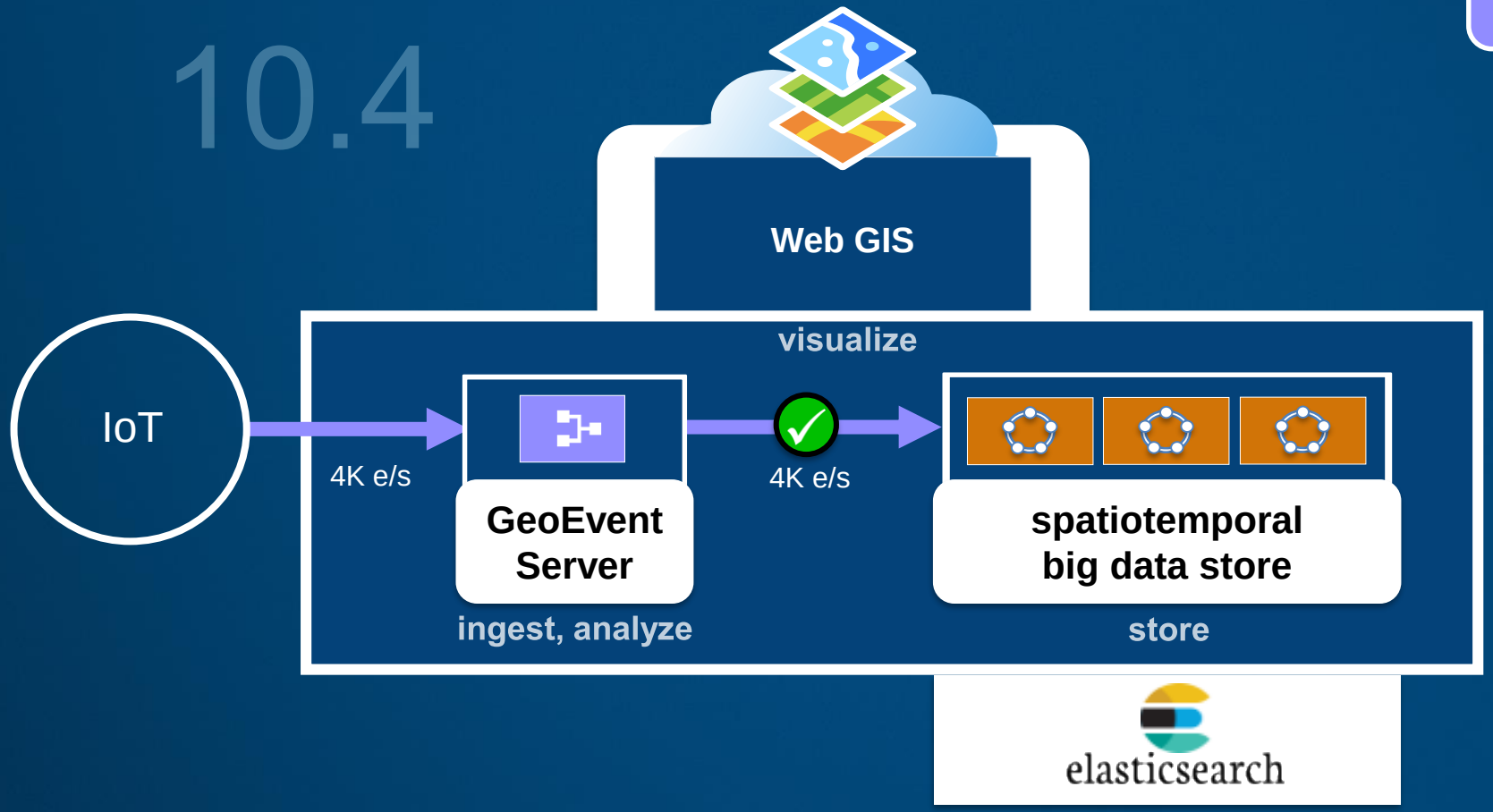


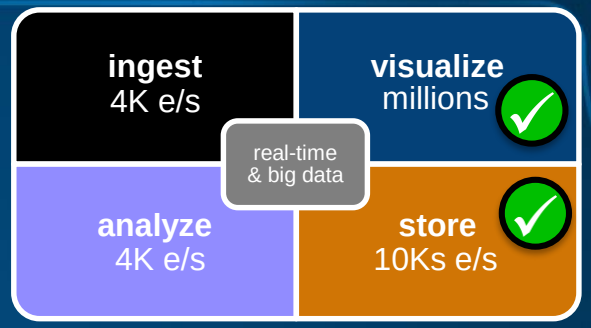


Web GIS

with real-time capabilities

10.4

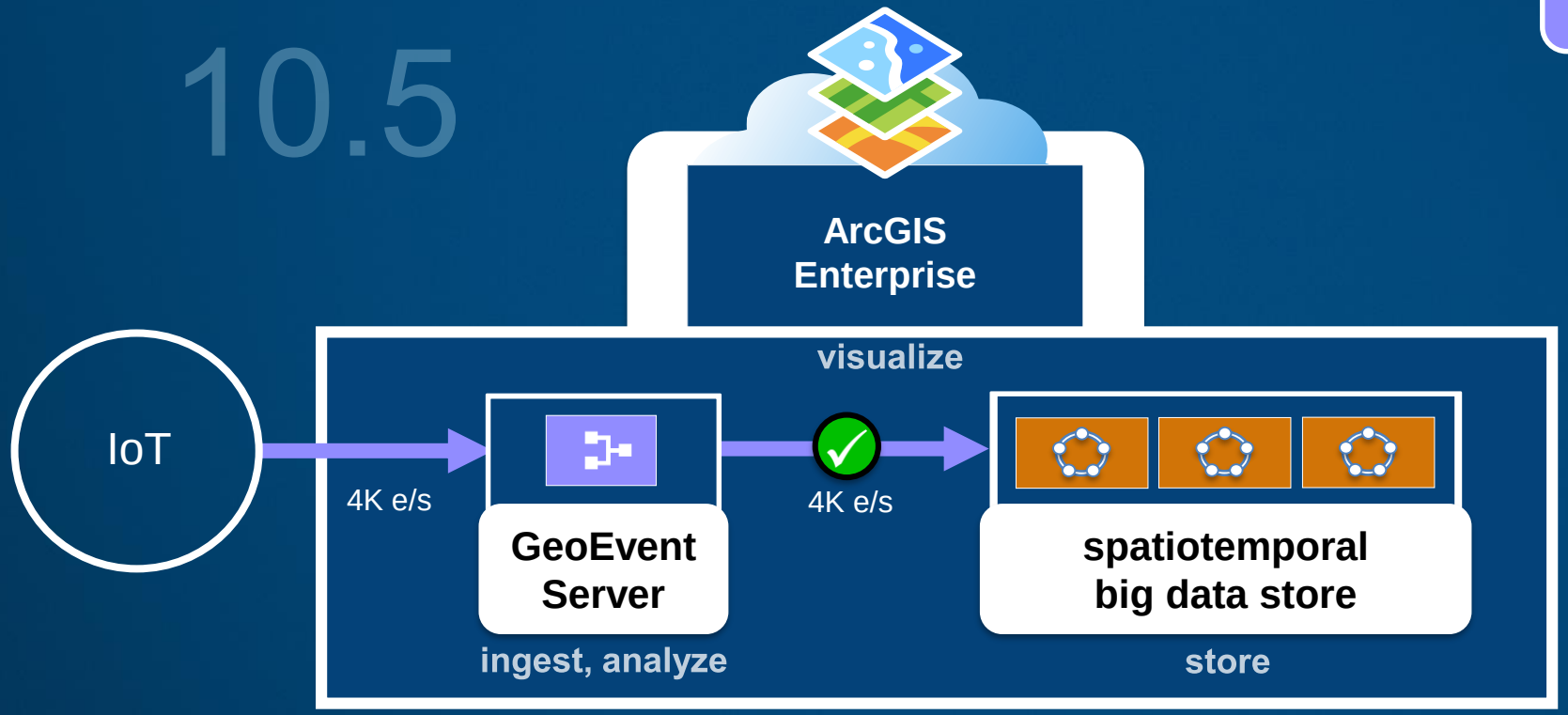


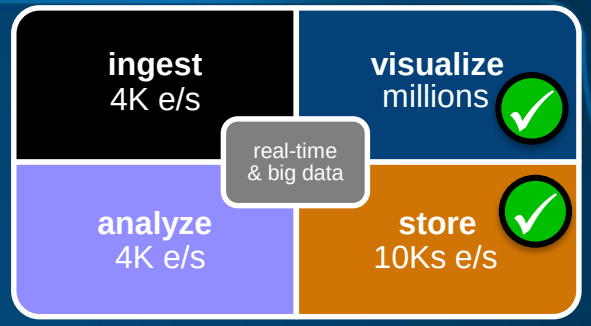


ArcGIS Enterprise

with real-time capabilities

10.5

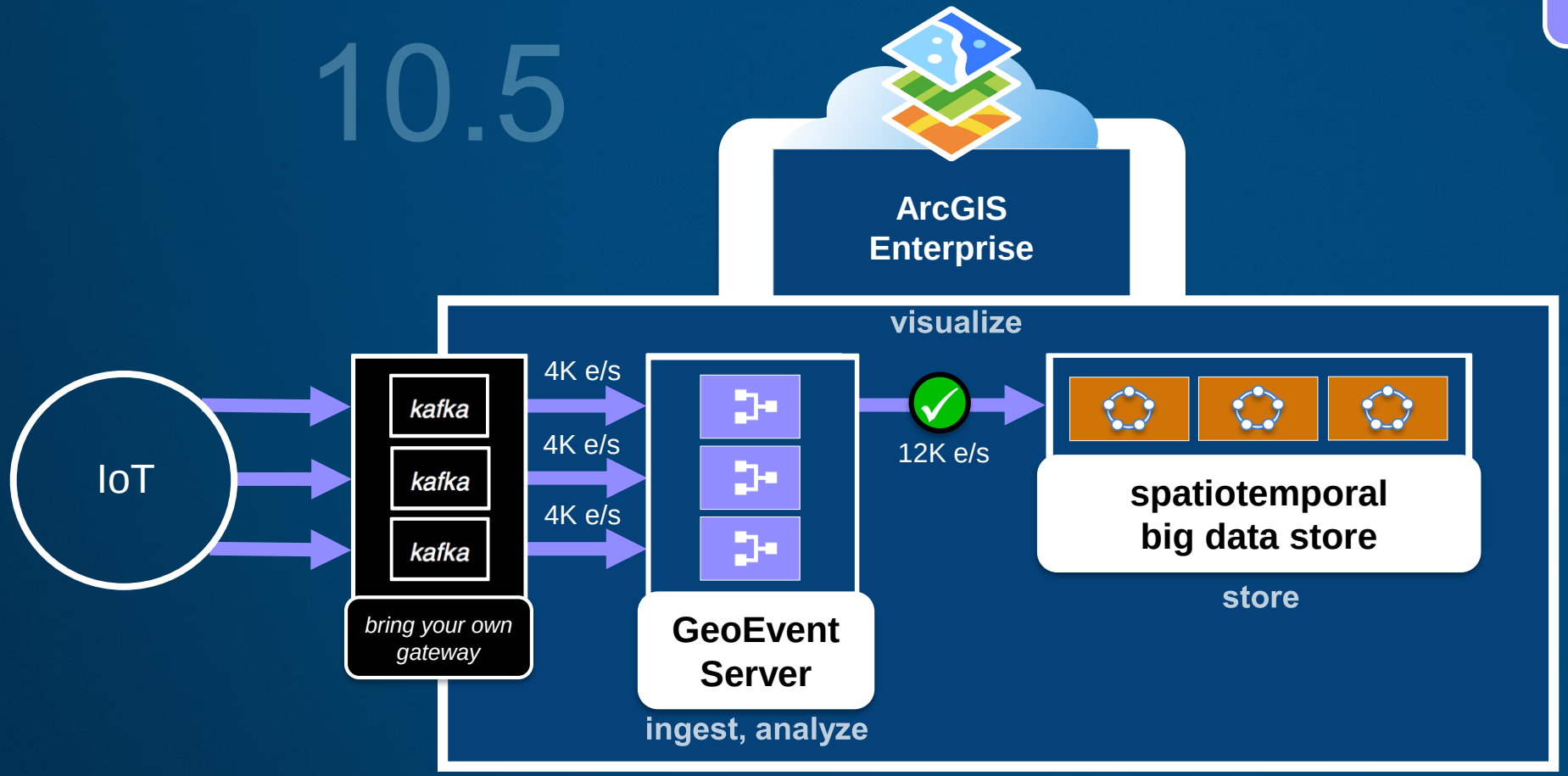




ArcGIS Enterprise

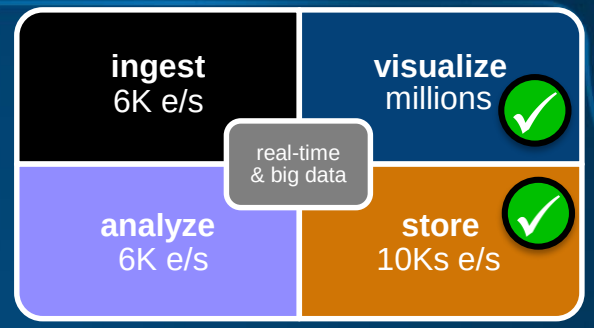
with real-time capabilities

10.5

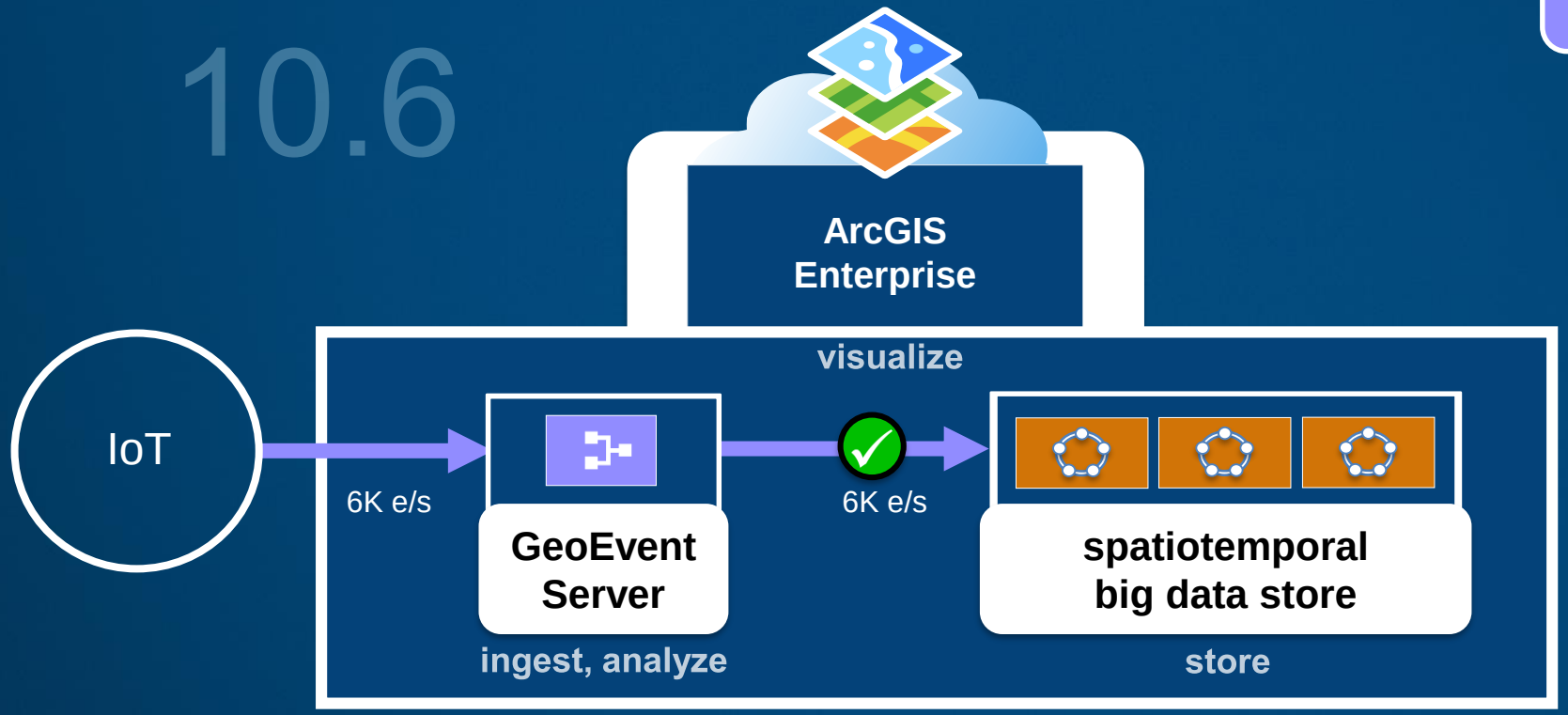


ArcGIS Enterprise

with real-time capabilities

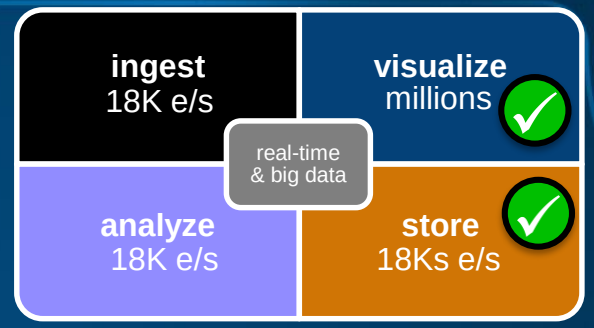


10.6

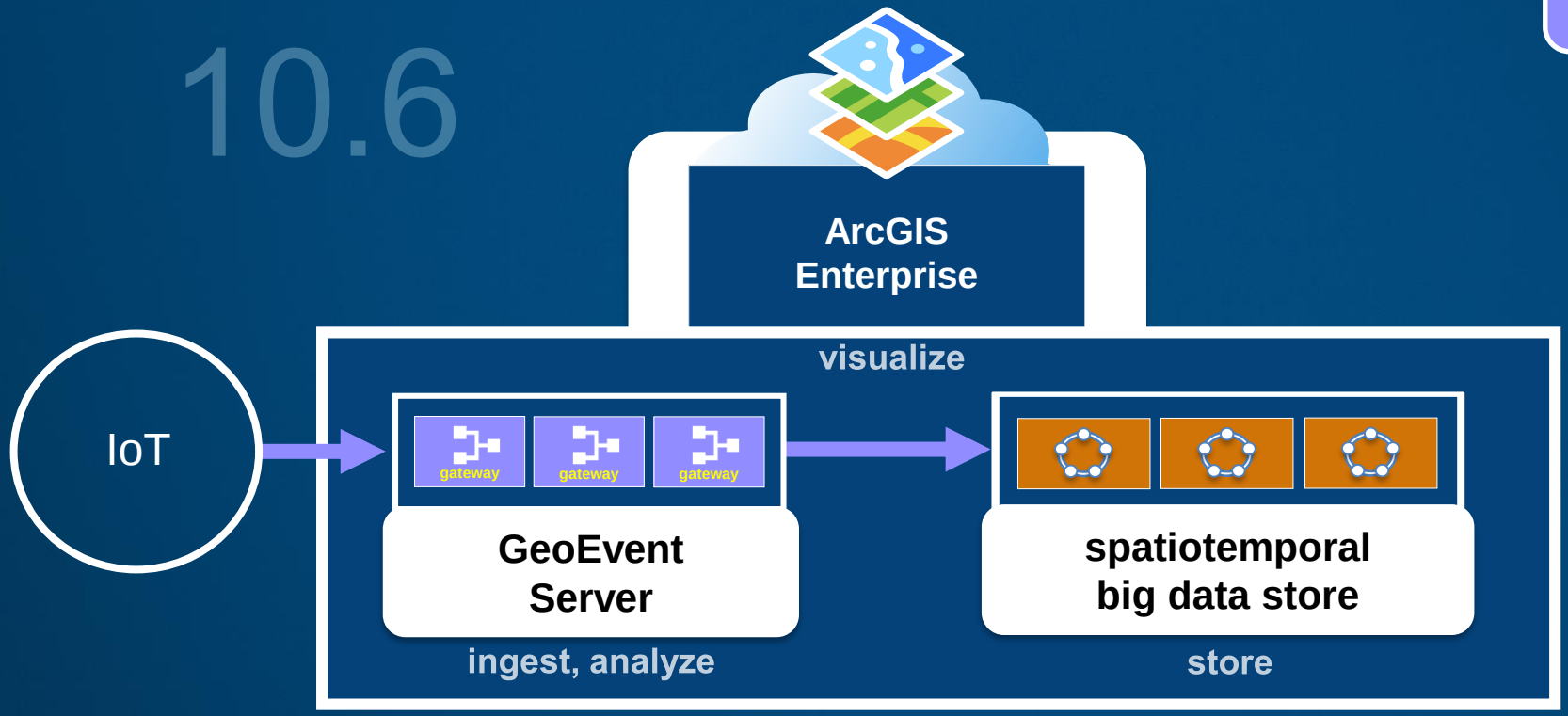


ArcGIS Enterprise

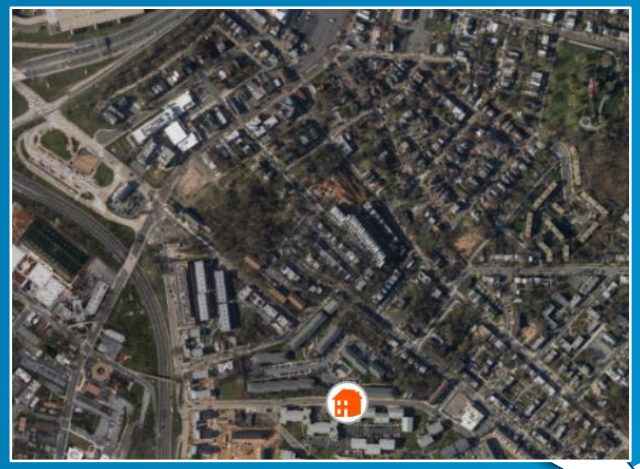
with real-time capabilities



10.6

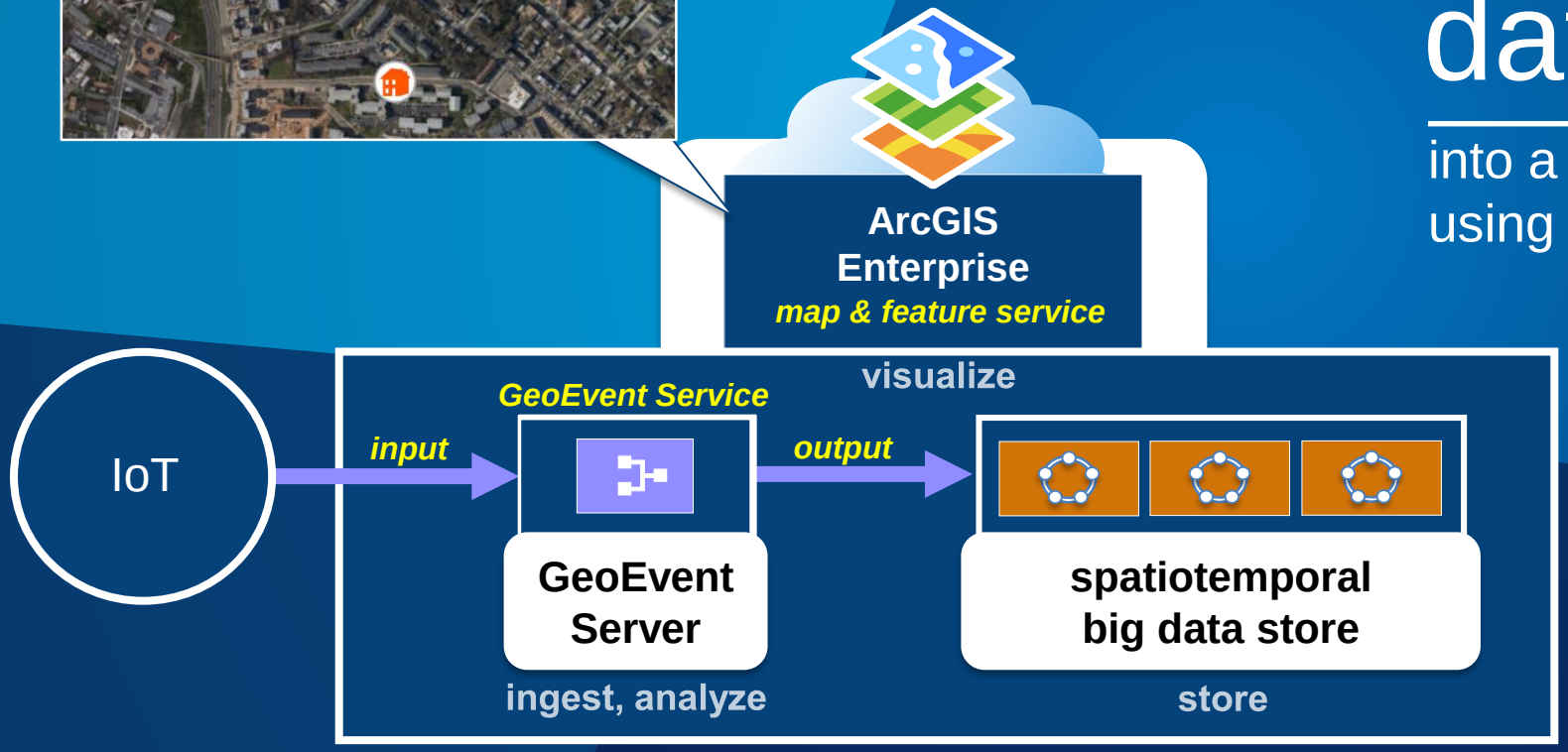


Demo



Real-Time data ingestion

into a spatiotemporal big data store using GeoEvent Server



3

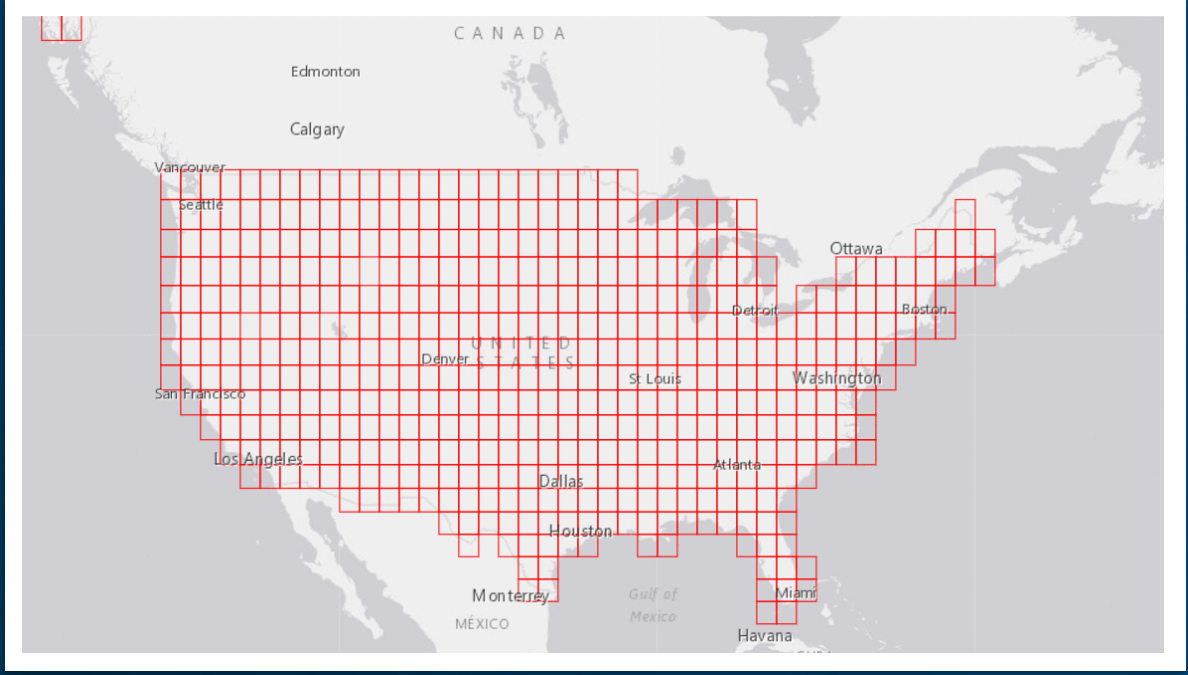
Storage, visualization

& replay

Spatiotemporal big data store

geohash spatial indexing to support on-the-fly aggregation

- As data is written to a dataset in the spatiotemporal big data store
  - A spatial index for geohash aggregation is continuously updated



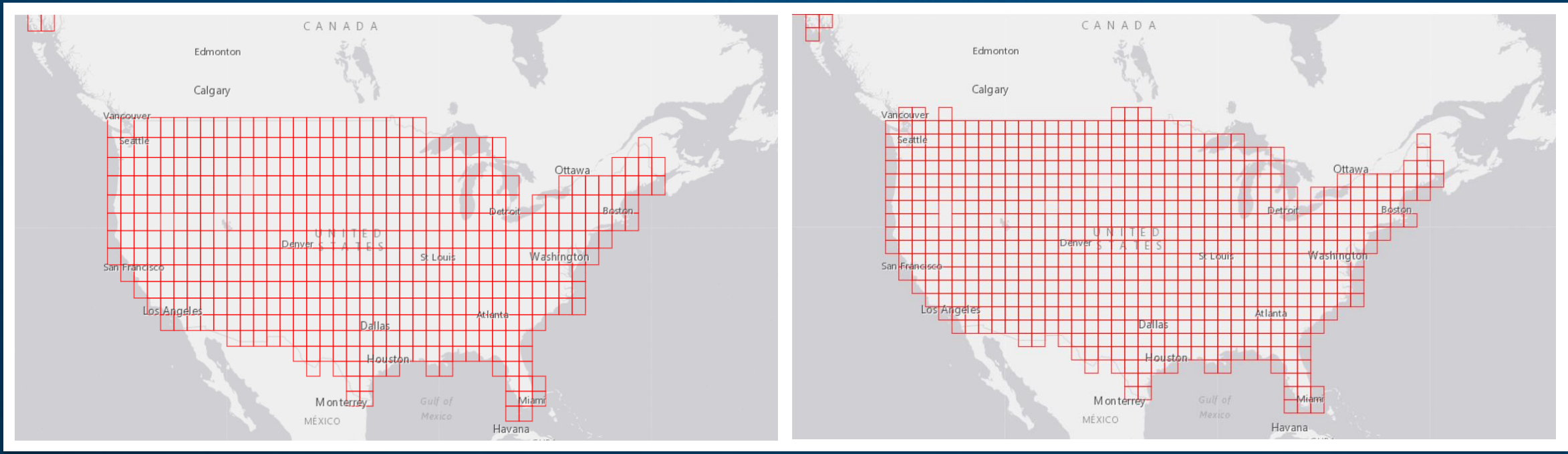
geohash aggregation (based on a geohash index)

Spatiotemporal big data store

10.5

geohash & square spatial indexing to support on-the-fly aggregation

- As data is written to a dataset in the spatiotemporal big data store
  - A spatial index for geohash aggregation is continuously updated
  - A spatial index for square aggregation is continuously updated



geohash aggregation (based on a geohash index)

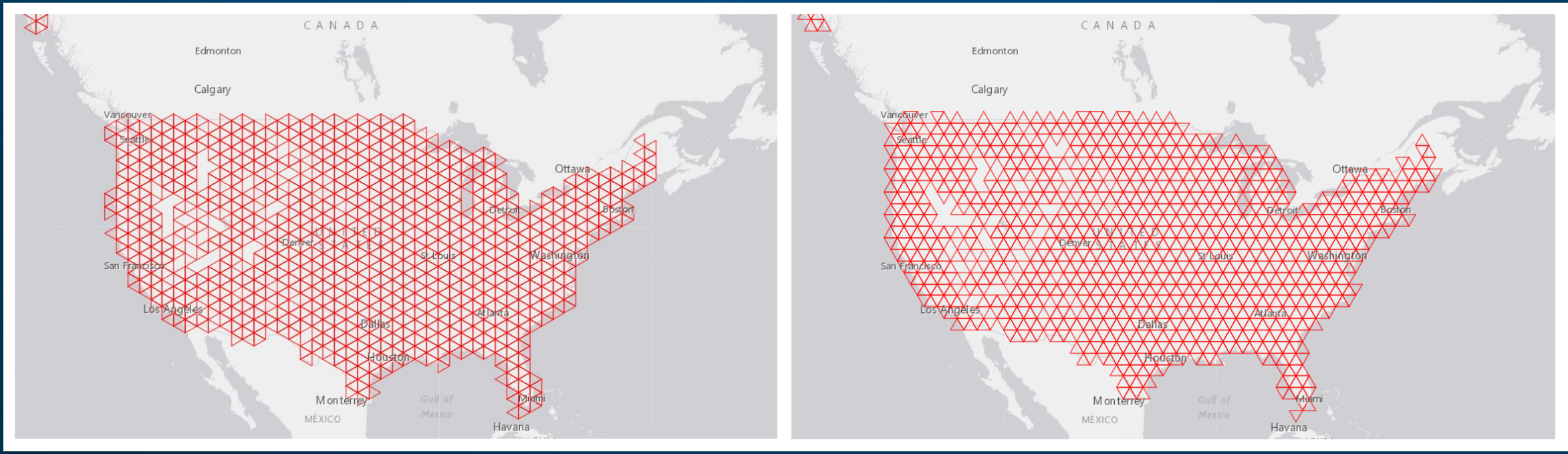
square aggregation (based on a square index)

Spatiotemporal big data store

triangle spatial indexing to support on-the-fly aggregation

10.5

- As data is written to a dataset in the spatiotemporal big data store
  - A spatial index for ‘pointy triangle’ aggregation is continuously updated
  - A spatial index for ‘flat triangle’ aggregation is continuously updated



pointy triangle aggregation (based on a pointy triangle index)

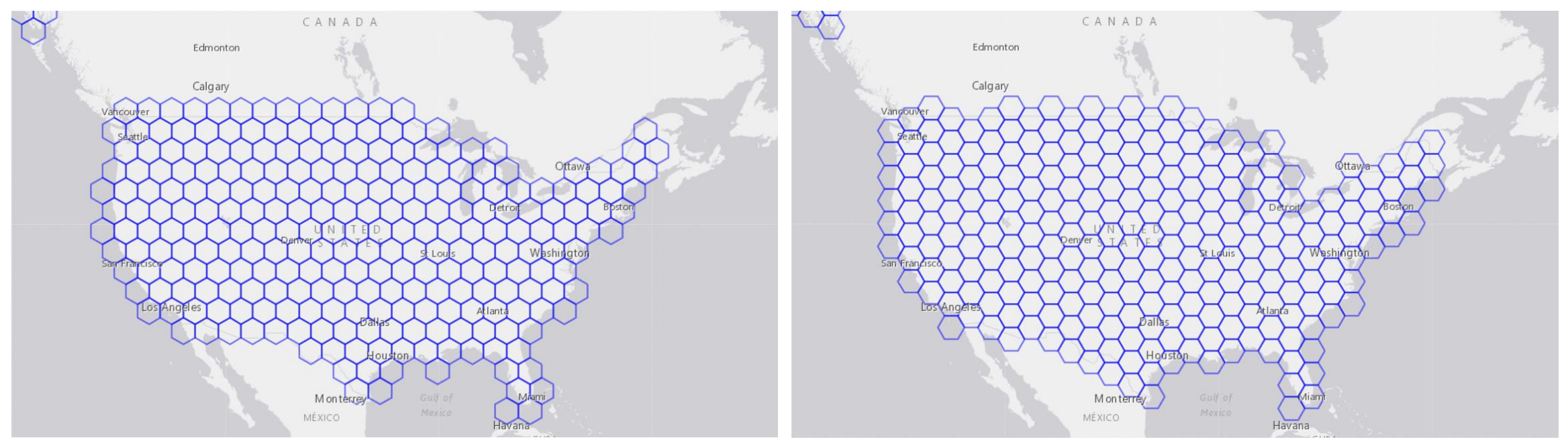
flat triangle aggregation (based on a flat triangle index)

Spatiotemporal big data store

10.5

hexagon (same as triangle) spatial indexing to support on-the-fly aggregation

- As data is written to a dataset in the spatiotemporal big data store
  - A spatial index for ‘pointy hexagon’ (pointy triangle) aggregation is continuously updated
  - A spatial index for ‘flat hexagon’ (flat triangle) aggregation is continuously updated



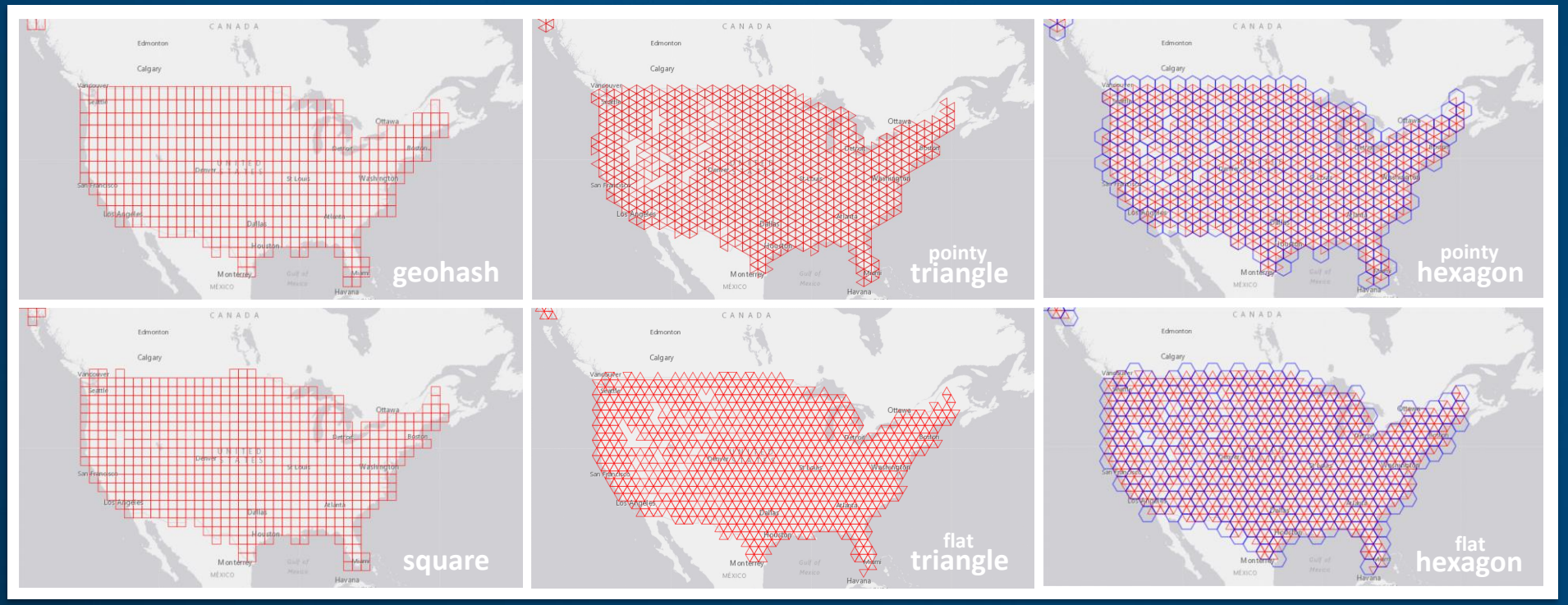
pointy hexagon aggregation (based on a pointy triangle index)

flat hexagon aggregation (based on a flat triangle index)

Spatiotemporal big data store

spatial indexing to support on-the-fly aggregation

- As data is written to a dataset in the spatiotemporal big data store
  - Up to four types of spatial indices are supported: geohash, square, pointy & flat hexagon/triangle
  - This is in addition to a temporal index on the time field
  - And an inverted index on each of the attribute fields

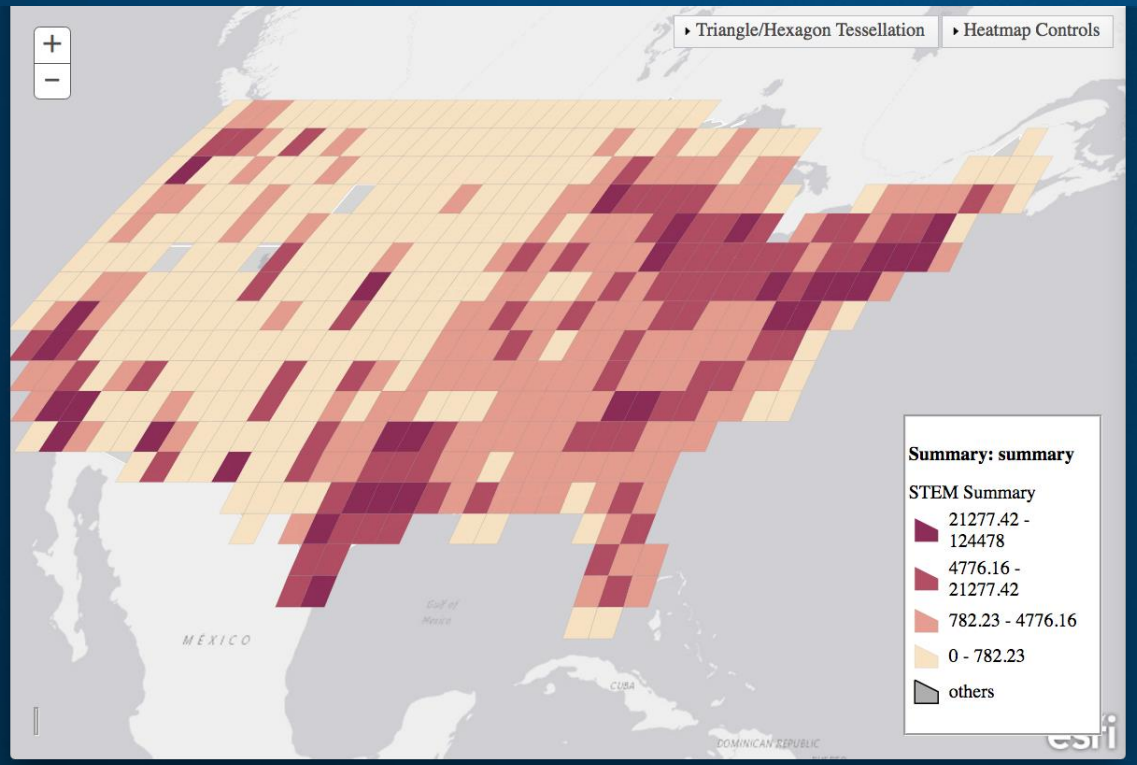


Visualization

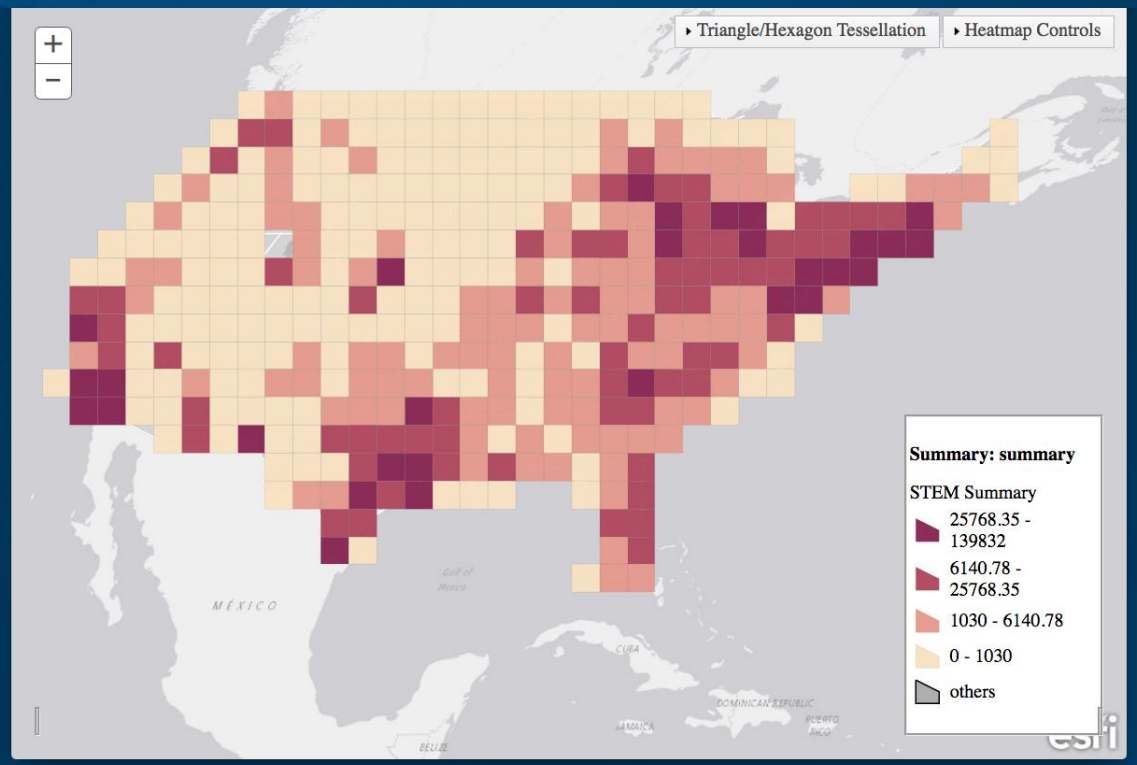
map or feature services: spatial projection

10.5

- Some of the spatial indices support projections
  - The geohash spatial index only supports WGS 1984; however you can project on-the-fly
  - Square, pointy & flat hexagon/triangle spatial indices are defined with a spatial reference



geohash aggregation in world mollweide projection (wkid = 54009)



square aggregation in world mollweide projection (wkid = 54009)

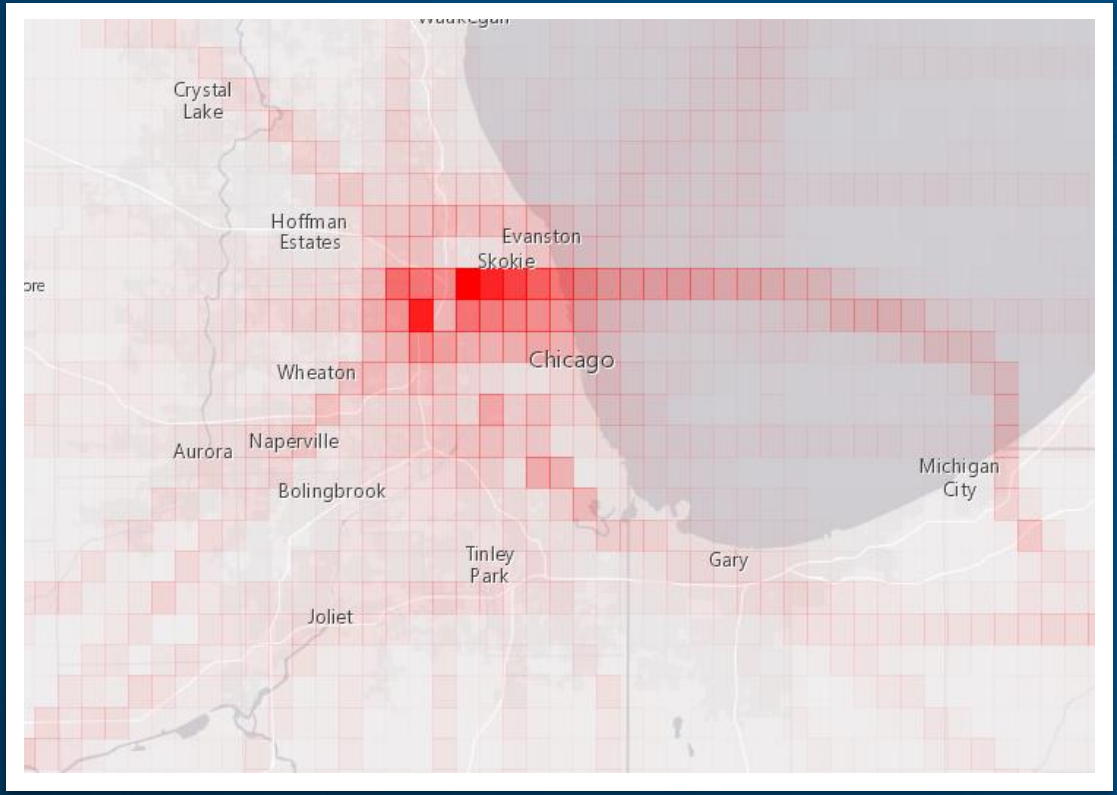
Visualization

10.5

map or feature services: geohash aggregation response

- Map & feature services can query a dataset in the spatiotemporal big data store with results aggregated on-the-fly.

map service



geohash aggregation response

feature service
lodType=geohash&lod=2


```
{
    "features": [{
        "attributes": {
            "objectid": 1,
            "Geohash": "dp",
            "Count": 216747
        },
        "geometry": {
            "rings": [
                [
                    [-90.0, 39.375],
                    [-90.0, 45.0],
                    [-78.75, 45.0],
                    [-78.75, 39.375],
                    [-90.0, 39.375]
                ]
            ],
            "spatialReference": {
                "wkid": 4326
            }
        }
    }, {
```


geohash aggregation response

feature service
lodType=geohash&lod=2
&returnGeometry=false


```
{
    "features": [{
        "attributes": {
            "objectid": 1,
            "Geohash": "dp",
            "Count": 217499
        }
    }, {
        "attributes": {
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            "Geohash": "dn",
            "Count": 216878
        }
    }, {
        "attributes": {
            "objectid": 3,
            "Geohash": "dr",
            "Count": 193689
        }
    }, {
```


geohash aggregation response

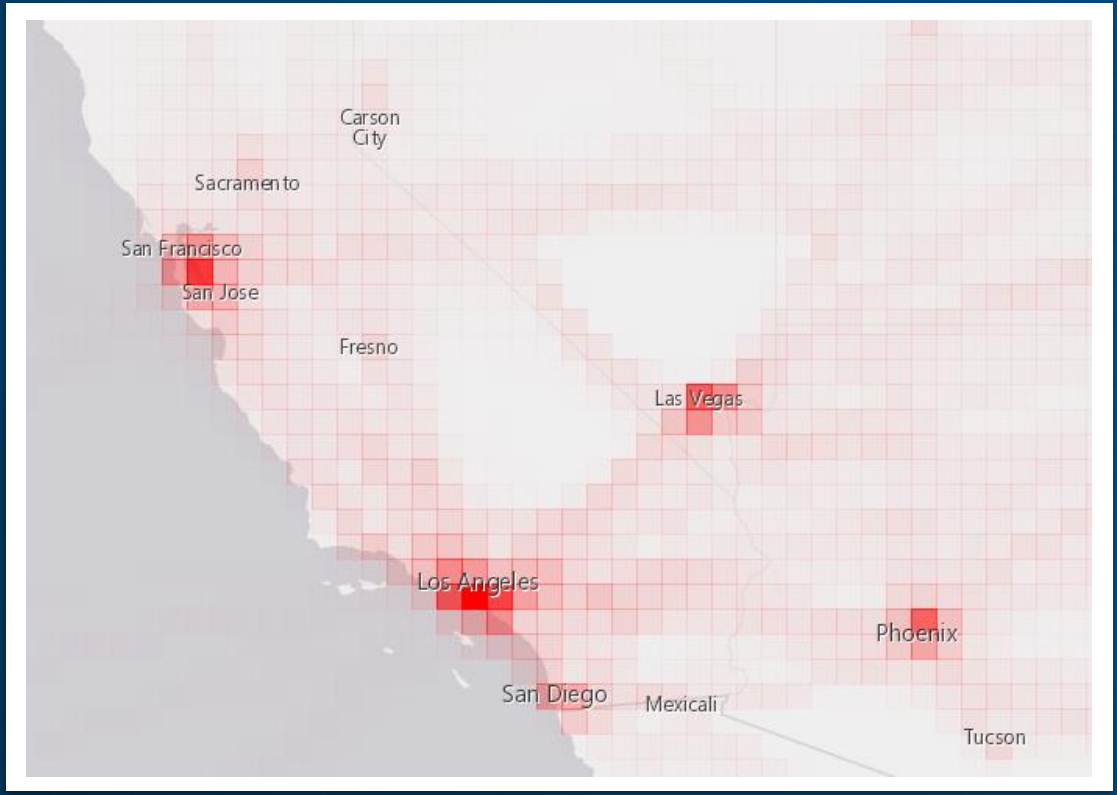
Visualization

map or feature services: square aggregation response

10.5

- Map & feature services can query a dataset in the spatiotemporal big data store with results aggregated on-the-fly.

map service



square aggregation response

feature service
lodType=square&lod=2


```
{
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                ]
            ],
            "spatialReference": {
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            }
        }
    }, {
```


square aggregation response

Visualization

map or feature services: discover which aggregations are enabled

10.5

/arcgis/rest/services/safegraph/MapServer/0?f=json


```
lodInfos: [
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      hasClusterGeometry: false,
      lodType: "geohash",
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      },
    - levels: {
        min: 1,
        max: 12
      },
    - lodSchema: [
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        0.010986328125,
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        0.00004291534423828125,
        0.00001072883605957031 2,
        0.00000134110450744628 9,
        3.352761268615722 7e-7
      ]
  },
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    - levels: {
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        max: 20
      },
    - lodSchema: [
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        10018850,
        5009425,
        2504712.5,
        1252356.25,
        626178.125,
        313089.0625,
        156544.53125,
        78272.265625,
        39136.1328125,
        19568.06640625,
        9784.033203125,
        4892.0166015625,
        2446.00830078125,
        1223.004150390625,
        611.5020751953125,
        305.75103759765625,
        152.87551879882812,
        76.43775939941406,
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      ]
  },
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        626178.125,
        313089.0625,
        156544.53125,
        78272.265625,
        39136.1328125,
        19568.06640625,
        9784.033203125,
        4892.0166015625,
        2446.00830078125,
        1223.004150390625,
        611.5020751953125,
        305.75103759765625,
        152.87551879882812,
        76.43775939941406,
        38.21887969970703
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        611.5020751953125,
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        152.87551879882812,
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      hasClusterGeometry: false,
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        76.43775939941406,
        38.21887969970703
      ]
  },
  {
      supportsDynamicAggregations: true,
      hasClusterGeometry: false,
      lodType: "square",
    - lodSR: {
        wkid: 102100,
        latestWkid: 3857
      },
    - levels: {
        min: 1,
        max: 20
      },
    - lodSchema: [
        20037700,
        10018850,
        5009425,
        2504712.5,
        1252356.25,
        626178.125,
        313089.0625,
        156544.53125,
        78272.265625,
        39136.1328125,
        19568.06640625,
        9784.033203125,
        4892.0166015625,
        2446.00830078125,
        1223.004150390625,
        611.5020751953125,
        305.75103759765625,
        152.87551879882812,
        76.43775939941406,
        38.21887969970703
      ]
  }
```
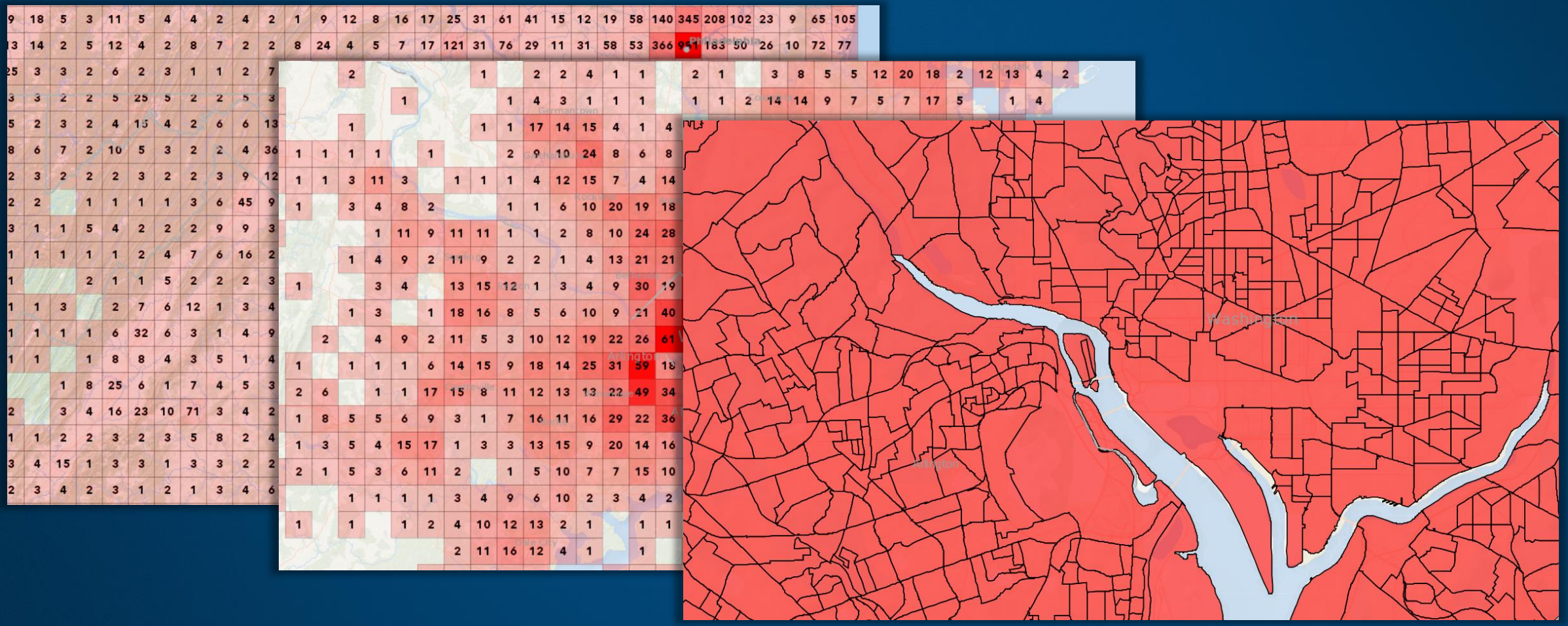

Visualization

map services: on-the-fly aggregation of polyline and polygon features

10.6



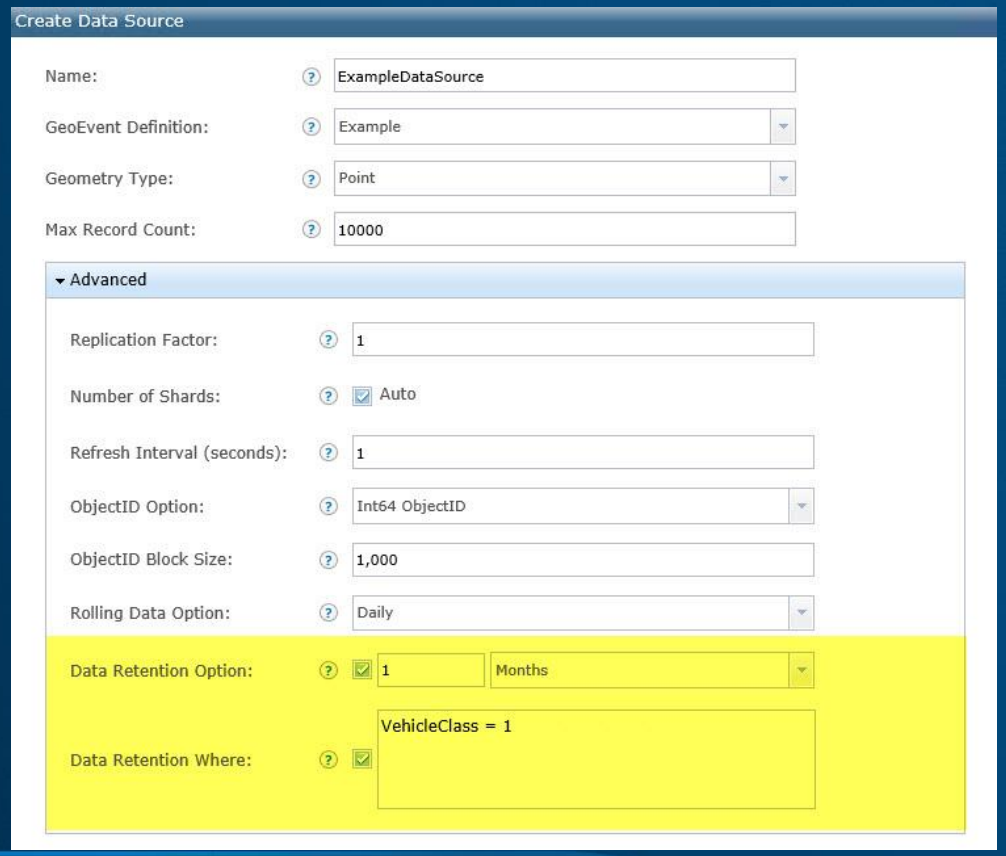
aggregation using centroid of polyline & polylgon features

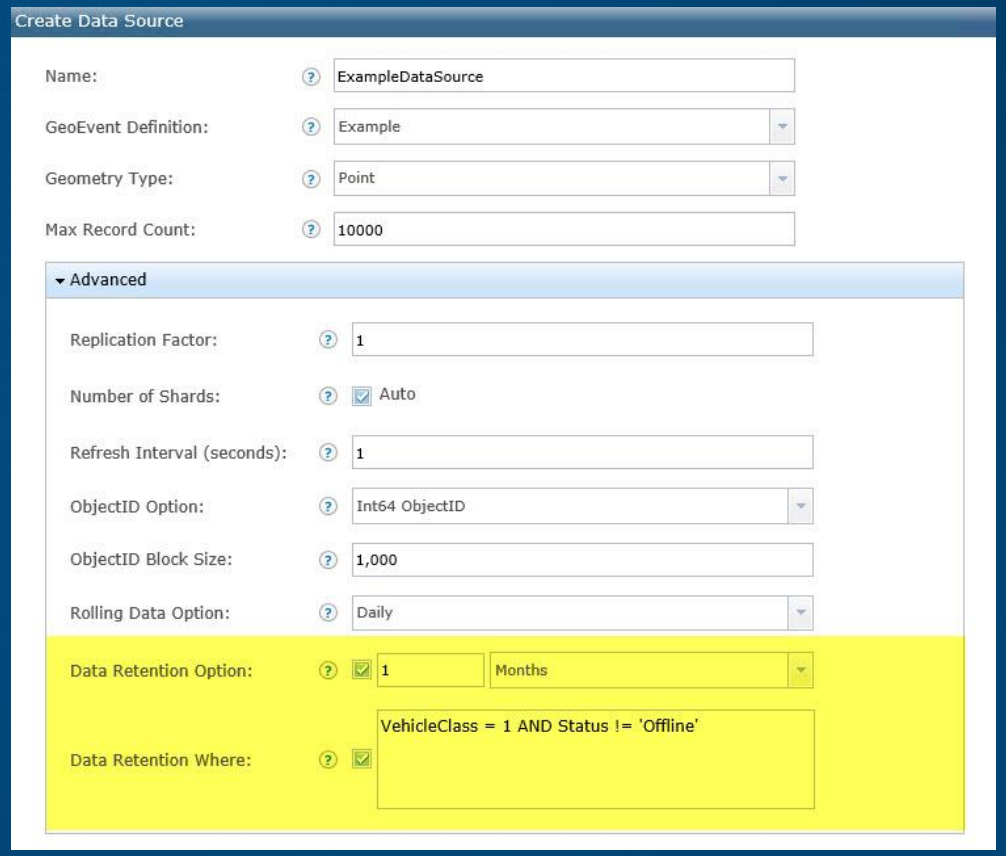
Storage

expanded spatiotemporal big data store capabilities

10.6

- Enhanced data retention control:
  - Allows users to define both a maximum feature age and create exemptions for features based on a WHERE clause.



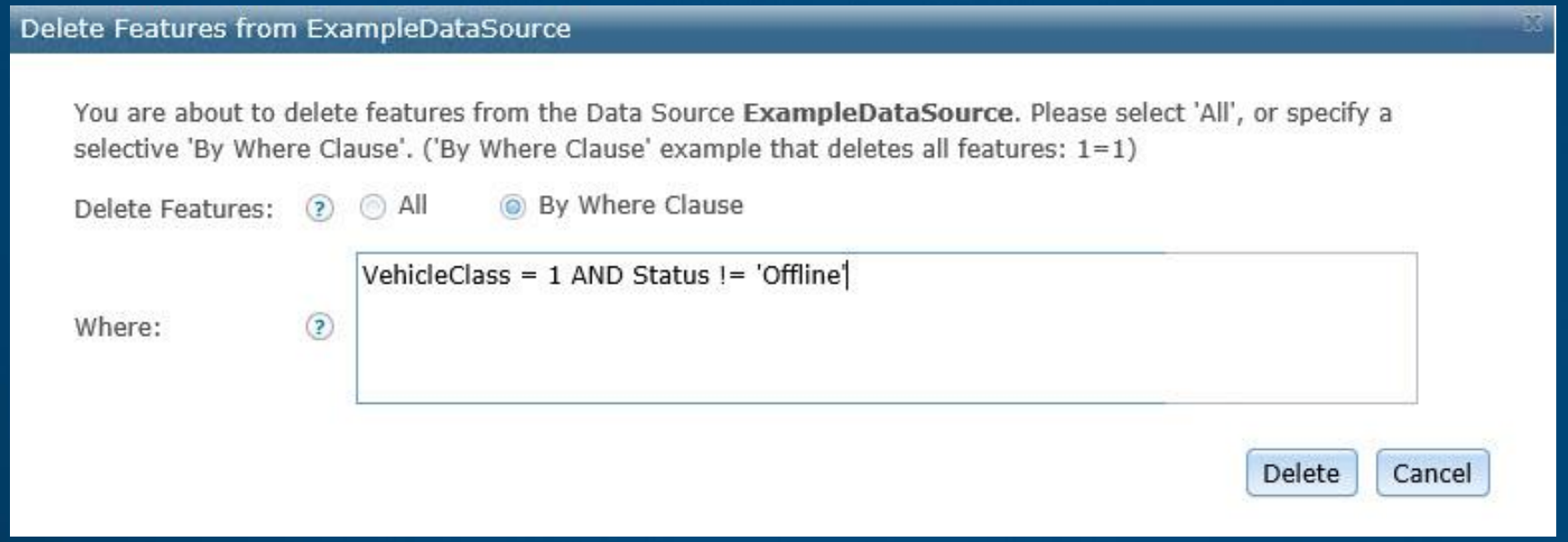


Storage

expanded spatiotemporal big data store capabilities

10.6

- Enhanced manual deletion of features.

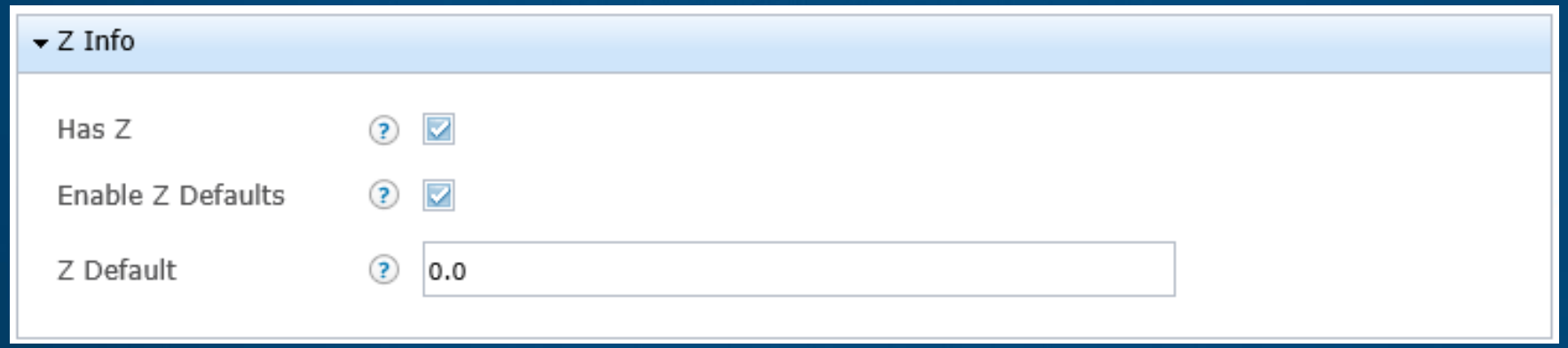


Storage

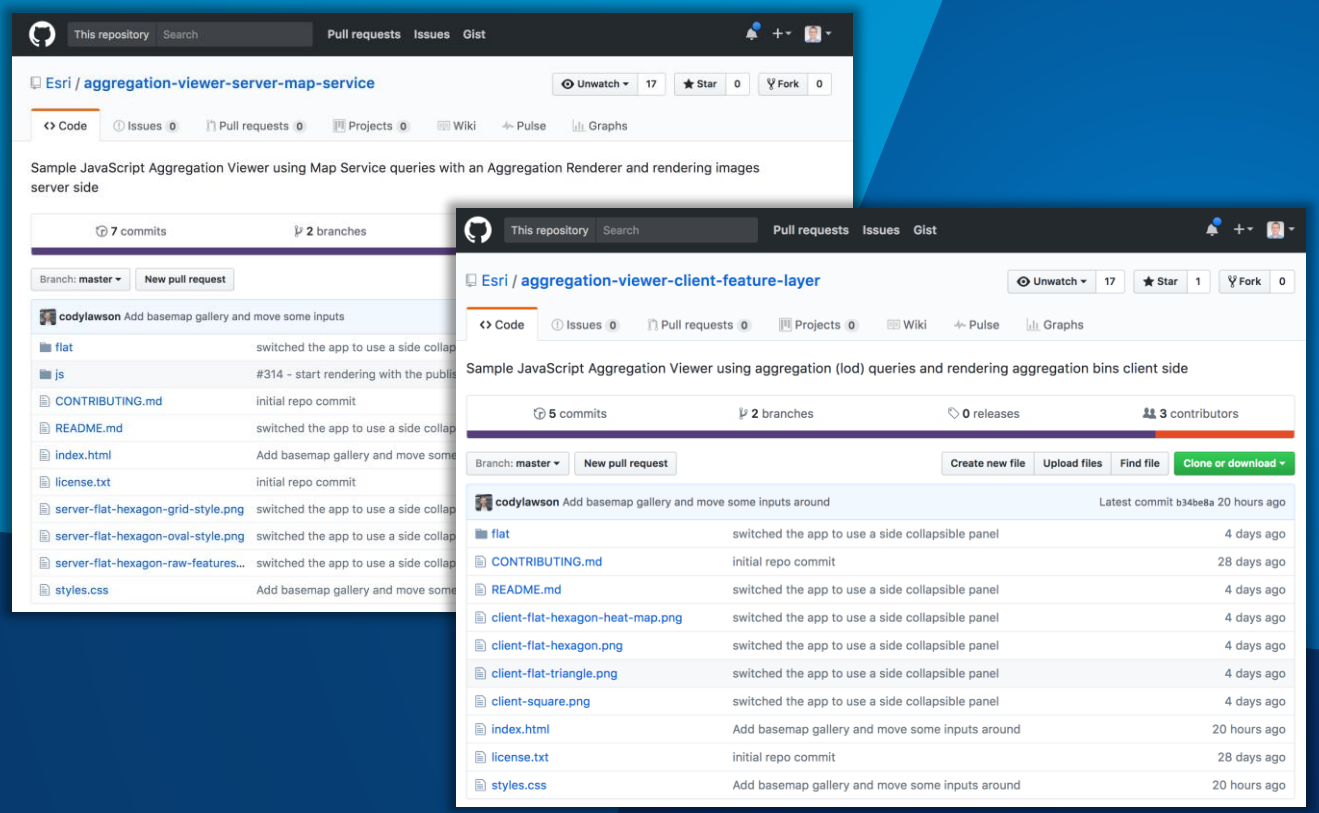
expanded spatiotemporal big data store capabilities

10.6

- Z-value support for point geometries:
  - Enabled during dataset creation
  - Allows 3D rendering of discrete features



Demo



Storage, visualization & replay

geohash, square & hexagon aggregation

4

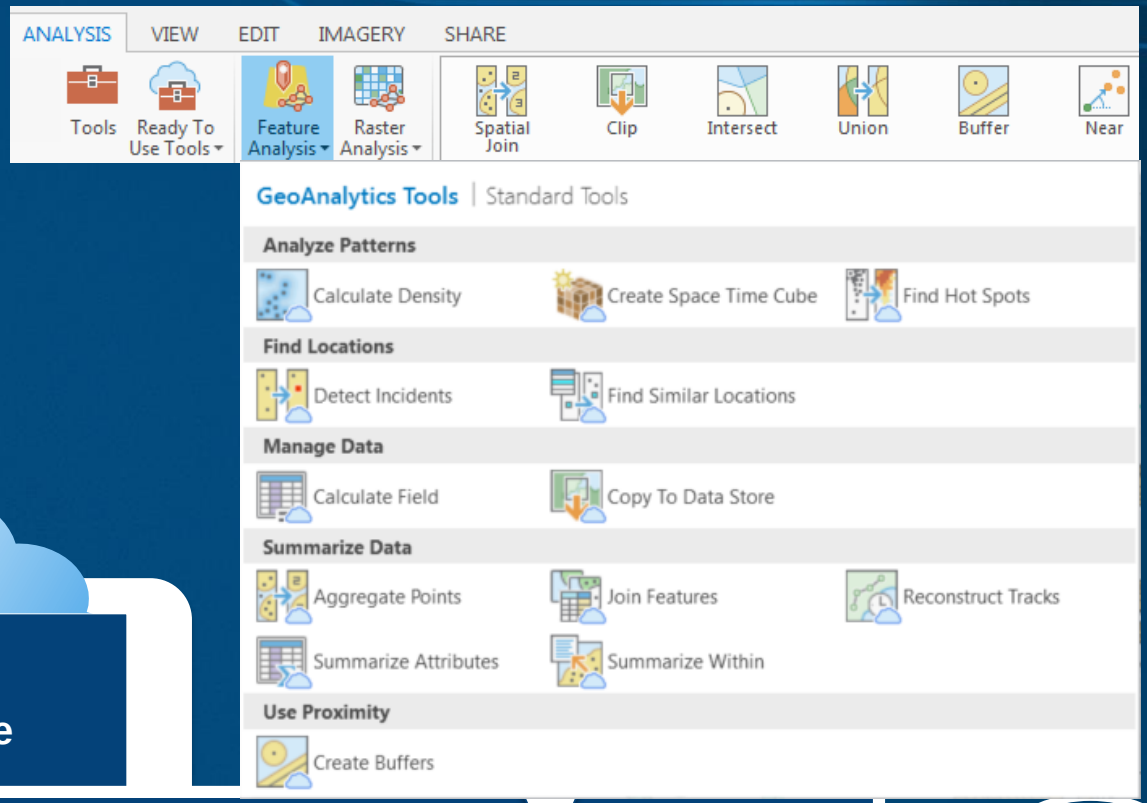
Big data analysis

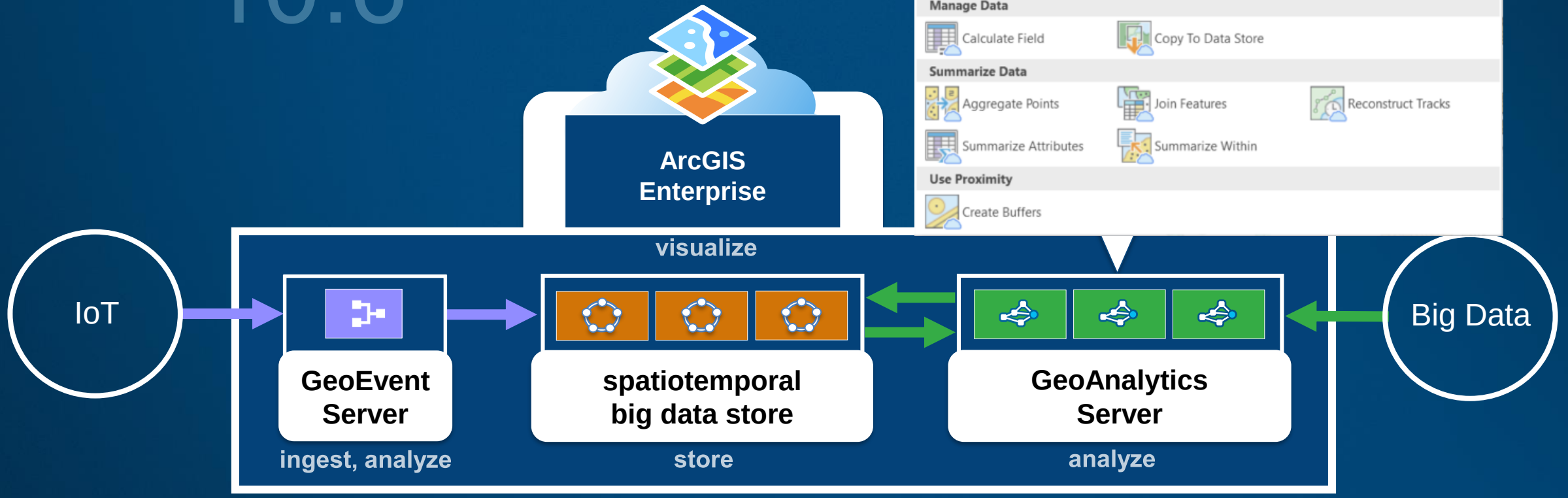
using GeoAnalytics Server

Big data analysis

using GeoAnalytics Server

10.6





Batch analysis

GeoAnalytics Server: analytic capabilities

10.6

"I want to…"

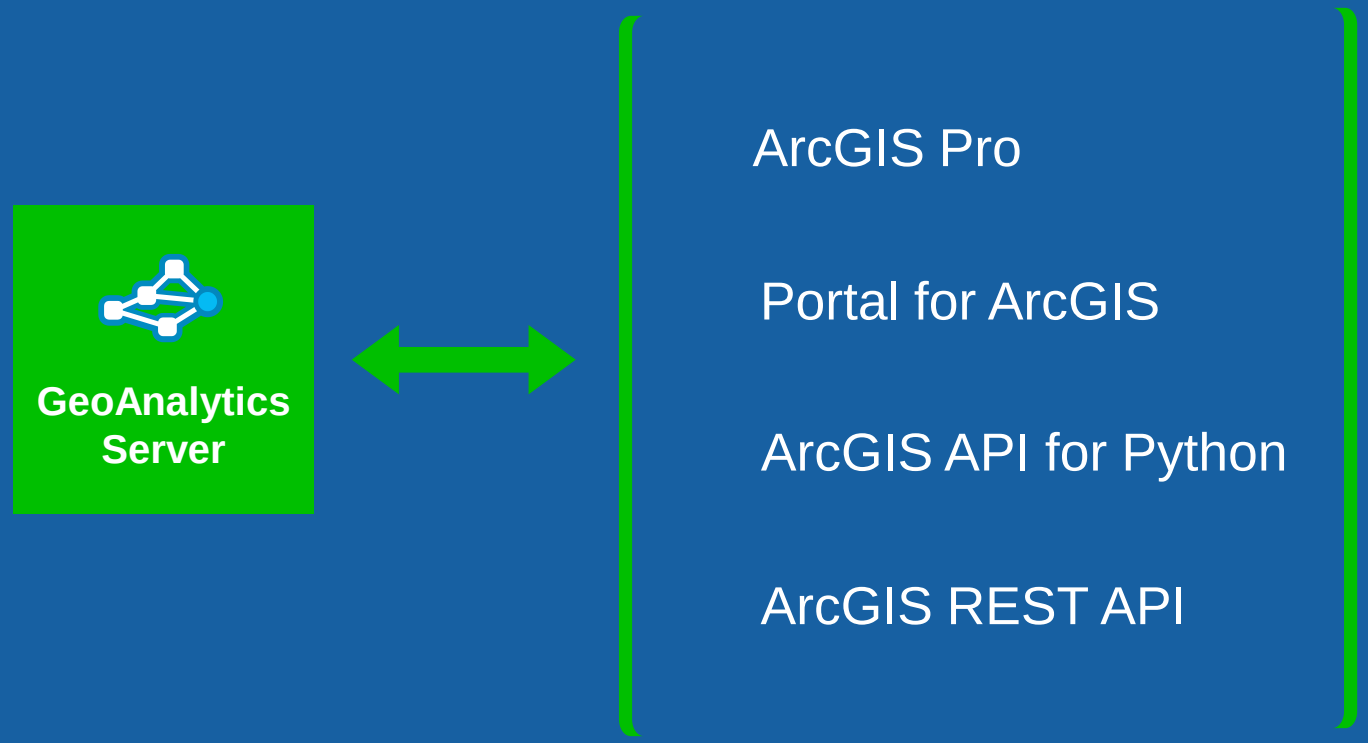
- *Summarize Data* → Join Features, Aggregate Points, Summarize Within, Summarize Attributes, Reconstruct Tracks
- *Use Proximity* → Create Buffers
- *Find Locations* → Detect Incidents, Find Similar Locations, Geocode Locations
- *Analyze Patterns* → Calculate Density, Find Hot Spots, Create Space Time Cube
- *Manage Data* → Calculate Field, Copy To Data Store

Batch analysis

GeoAnalytics Server: analytic capabilities

10.6

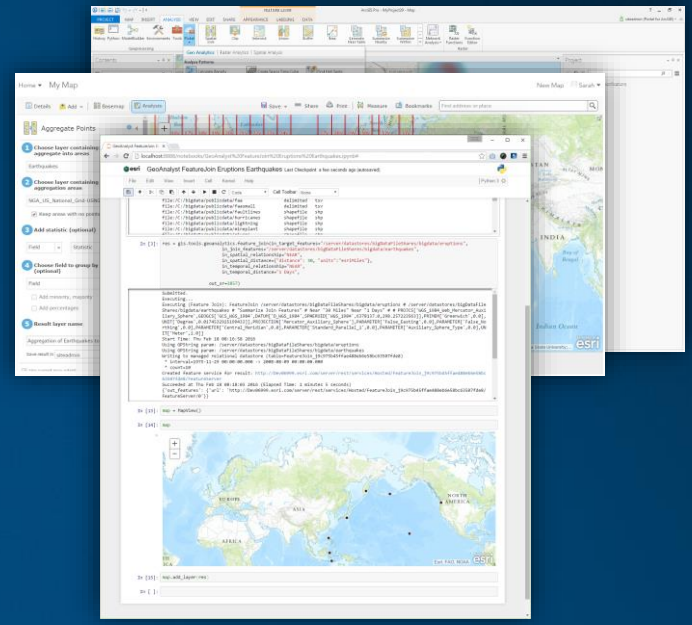
"Where can I perform analysis?"



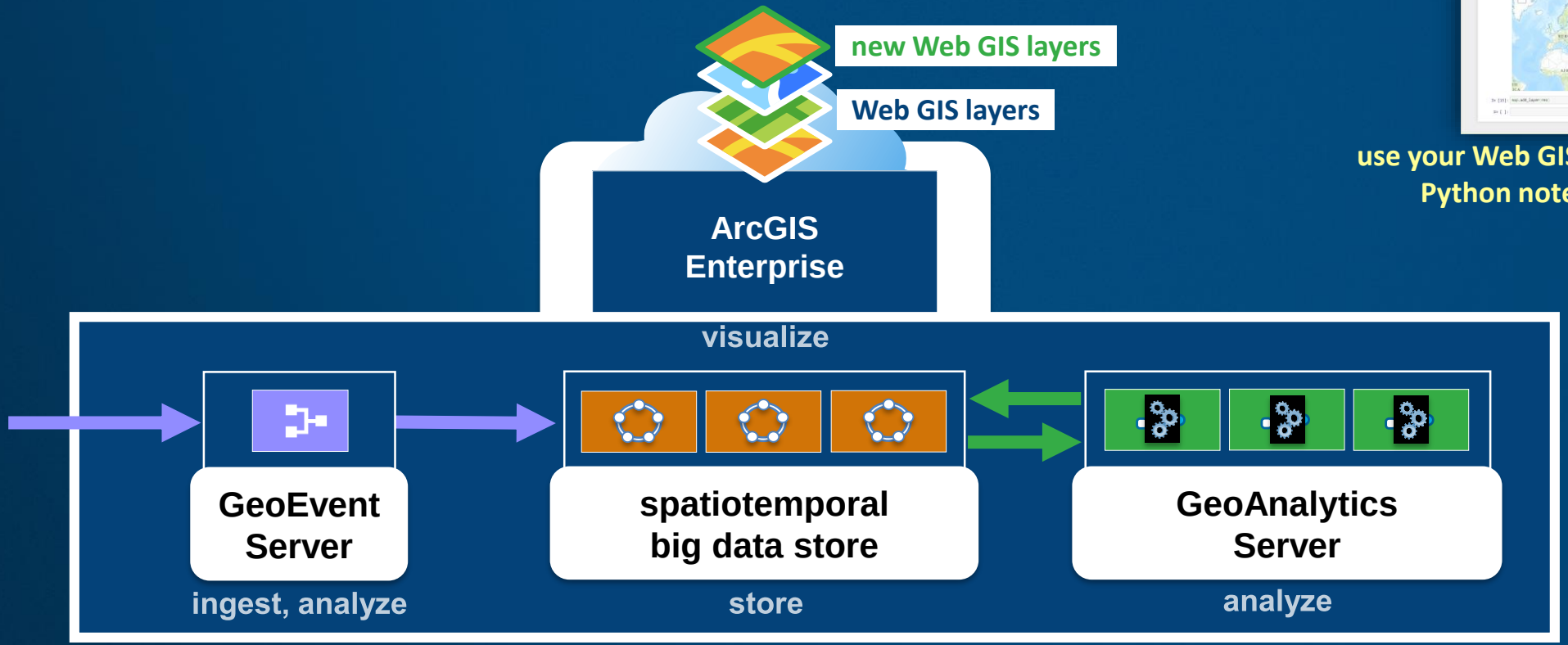
Batch analysis

GeoAnalytics Server: analytic workflow

- GeoAnalytics Server has the ability to:
  - Perform analytics against data in the spatiotemporal big data store
  - Write analytic results to the spatiotemporal big data store



use your Web GIS layers through Pro, Portal, Python notebooks or the REST API

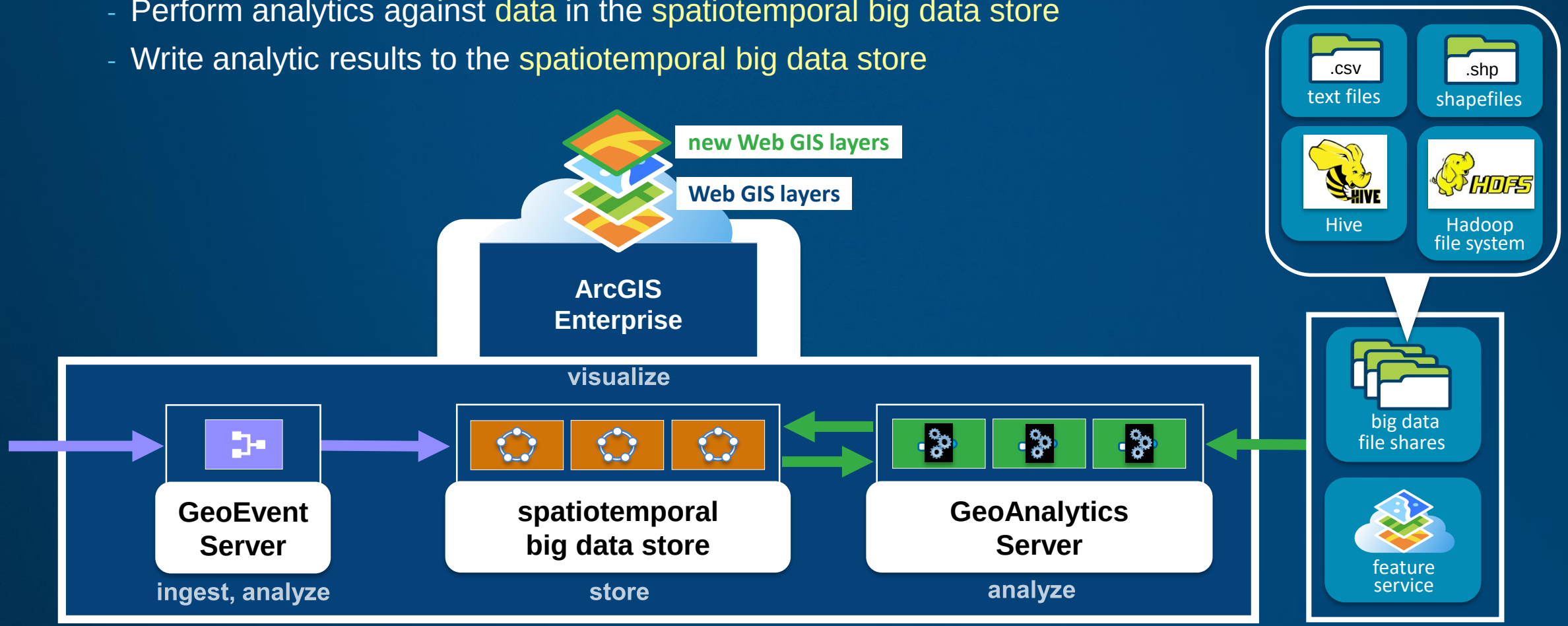


Batch analysis

GeoAnalytics Server: analytic workflow

10.6

- GeoAnalytics Server has the ability to:
  - Perform analytics against data in the spatiotemporal big data store
  - Write analytic results to the spatiotemporal big data store



Batch analysis

summarize data

10.6

- Reconstruct Tracks
  - “What is the path of each ship entering a port, based on millions of point observations of ship location?”
  - “Which planes fly within 1 mile of each other, based on millions of point observations of plane location?”

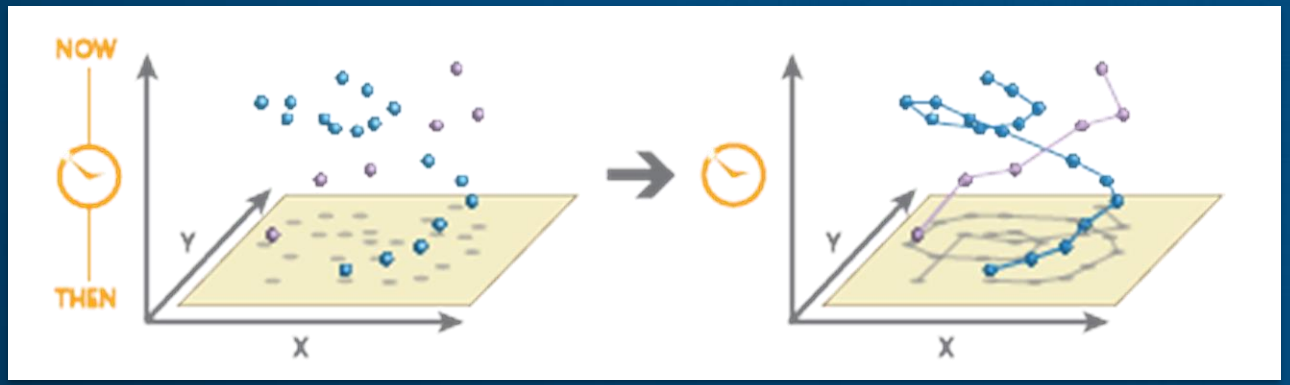
Batch analysis

summarize data

10.6

- Reconstruct Tracks

  - Input 1: Points
  - Output: Polylines or Polygons

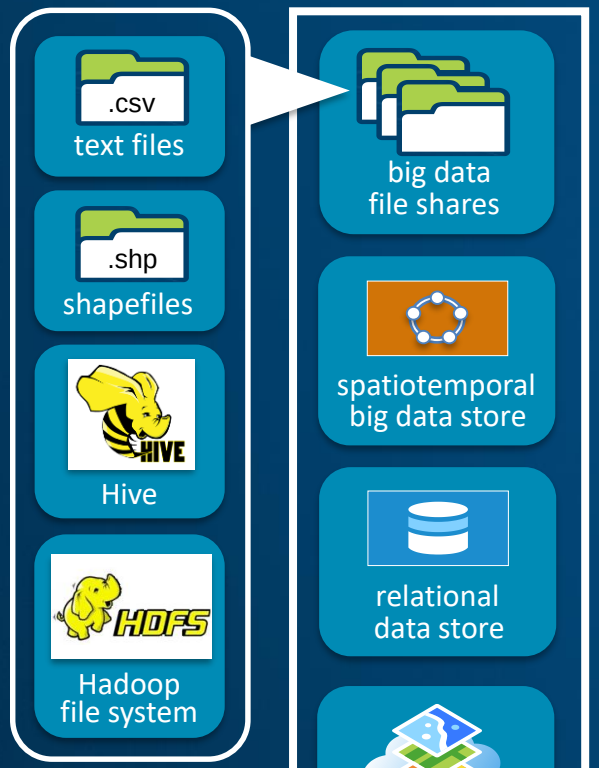


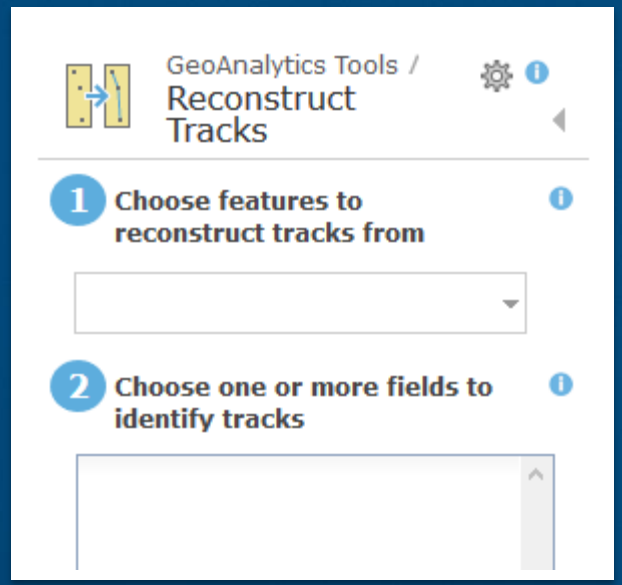
  - Creates polyline tracks from time-enabled point data, or polygon tracks by buffering input data
  - Buffers can be calculated using a field or expression

Batch analysis

summarize data: using the reconstruct tracks tool

10.6



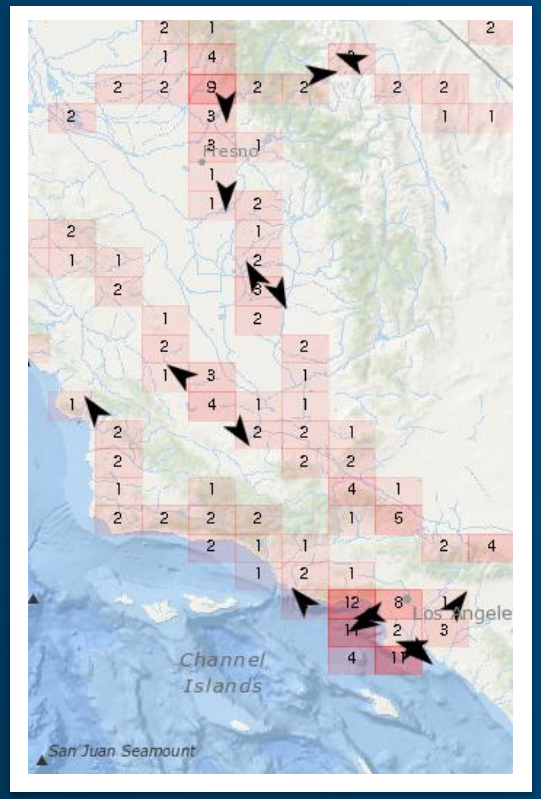


GeoAnalytics tool interface

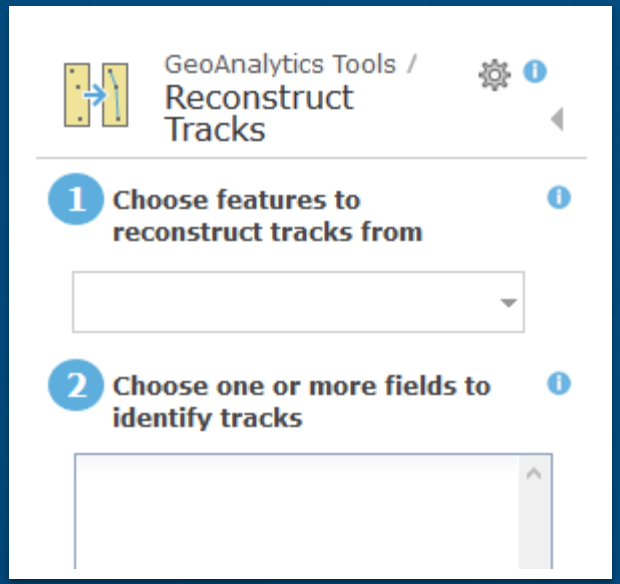
Batch analysis

summarize data: using the reconstruct tracks tool

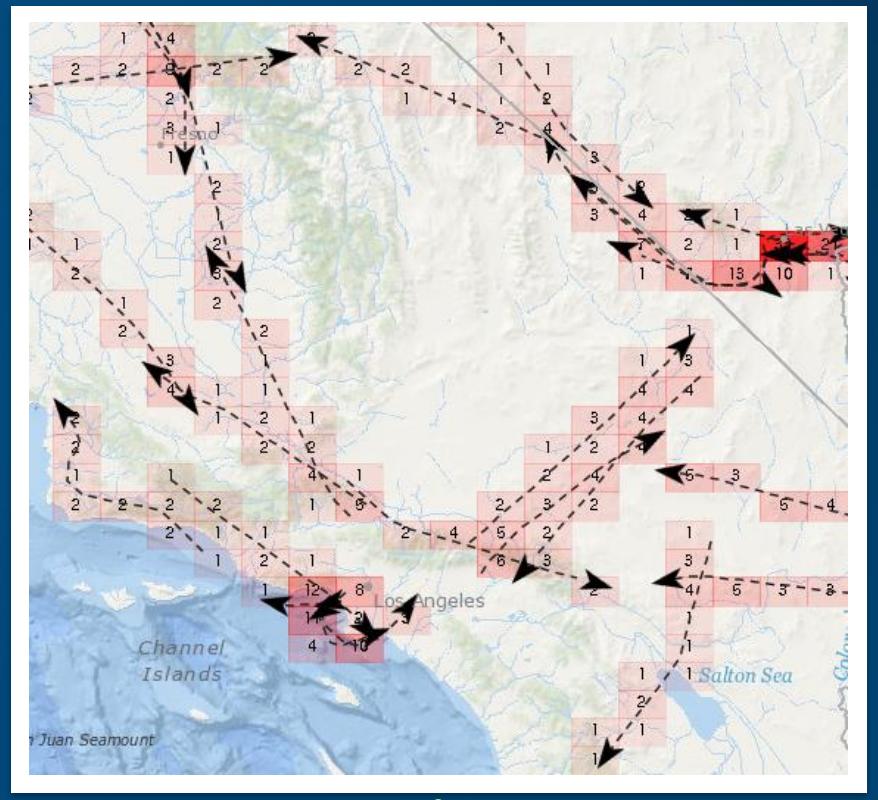
10.6



input features



GeoAnalytics tool interface



output features

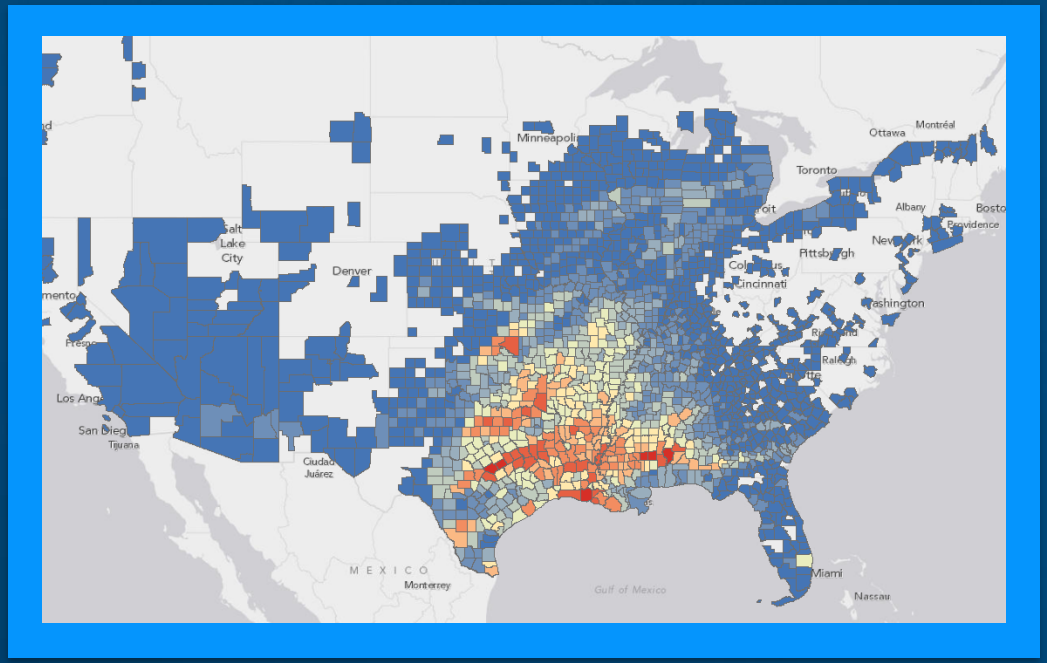
Batch analysis

summarize data

10.6

- Aggregate Points

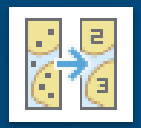
  - “How does the spatial distribution of vehicle collisions change over time?”
  - “What zip codes have the highest count of crime incidents?”
  - “Where are there the most power outages?”
  - “What does my data look like?”



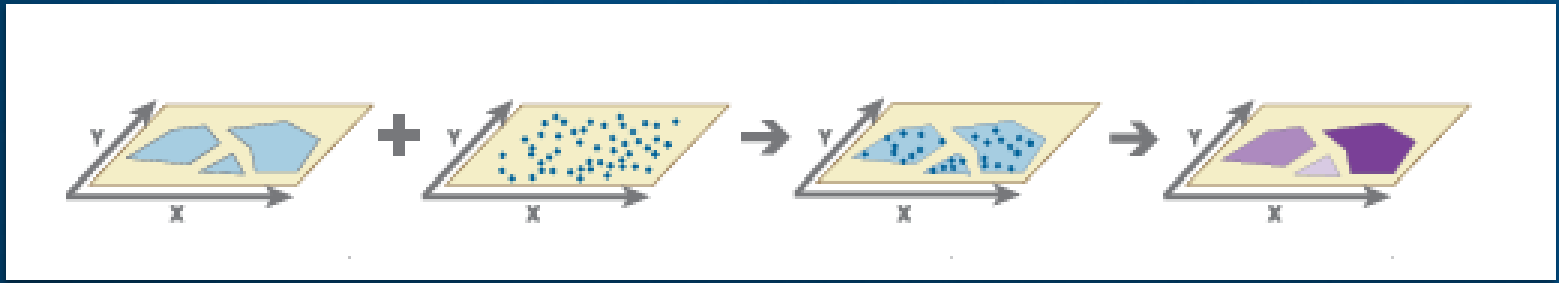
Batch analysis

summarize data

10.6

- Aggregate Points 

  - Input 1: Points, Input 2: Polygons (*or generate bins*)
  - Output: Polygons



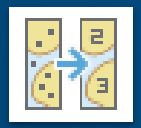
  - Aggregates point data into a either square or hexagonal grid, or user-supplied polygon features
  - Users can choose to aggregate spatially or spatiotemporally
  - A count of point features is returned for each grid cell (*bins*) or polygon, in addition to optional field statistics

Batch analysis

summarize data

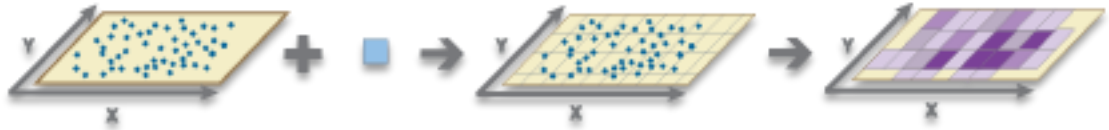
10.6

- Aggregate Points



Methods of Aggregation

Spatial, into bins:



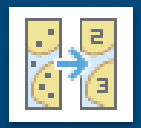
Spatial, into polygons:

Batch analysis

summarize data

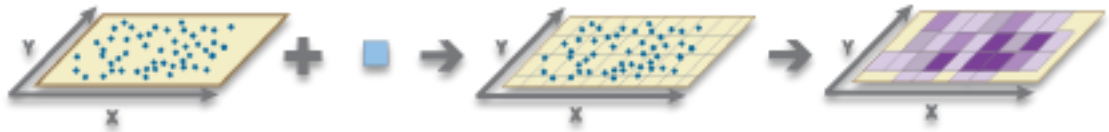
10.6

- Aggregate Points



Methods of Aggregation

Spatial, into bins:



Spatial, into polygons:

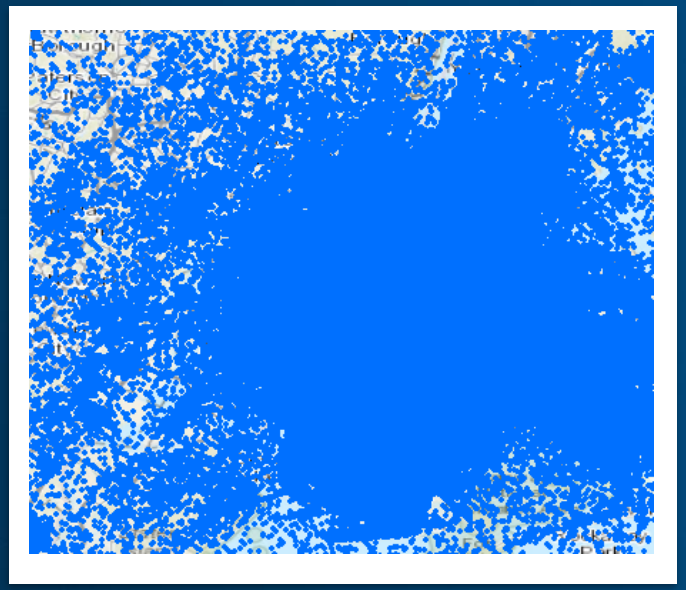
Spatiotemporal, into bins:

Spatiotemporal, into polygons:

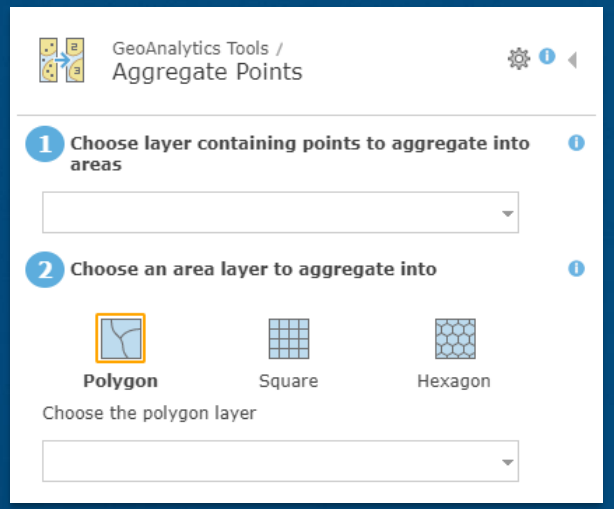
Batch analysis

summarize data: using the aggregate points tool

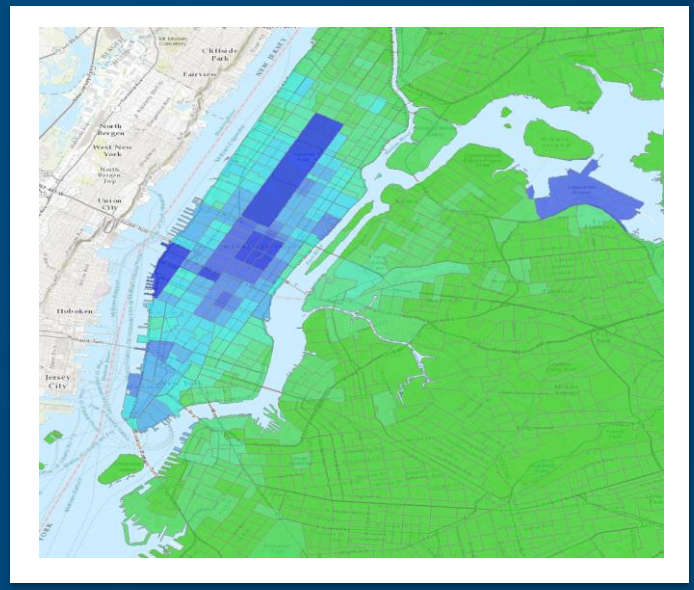
10.6



input features



GeoAnalytics tool interface



output features

Summary

spatiotemporal big data store

- The spatiotemporal big data store enables:
  - GeoEvent Server to write high velocity and high volume observation data
  - On-the-fly aggregations and raw features to be visualized using Map & Feature Services
  - GeoAnalytics Server to read and write high volume analytic results

To learn more …

spatiotemporal big data store

- See the ‘Spatiotemporal Big Data Store’ tutorial
  - **http://links.esri.com/geoevent-sbds**

- Sample JavaScript Aggregation Viewers:
  - Map Service: **https://github.com/Esri/aggregation-viewer-server-map-service**
  - Feature Service: **https://github.com/Esri/aggregation-viewer-client-feature-layer**

Please Attend Our Other **Sessions**!

• **Developing Real-Time Web Apps with the ArcGIS API for JavaScript**	Thu, 9:00-9:30 am, Demo Theater 1: Oasis 1-2
• **Real-Time GIS: Road Ahead**	Thu, 4:00-5:00 pm, Pasadena/Sierra/Ventura
• **GeoEvent Server: Creating Connectors and Processors Using the GeoEvent SDK**	Fri, 8:30-9:30 am, Mesquite B

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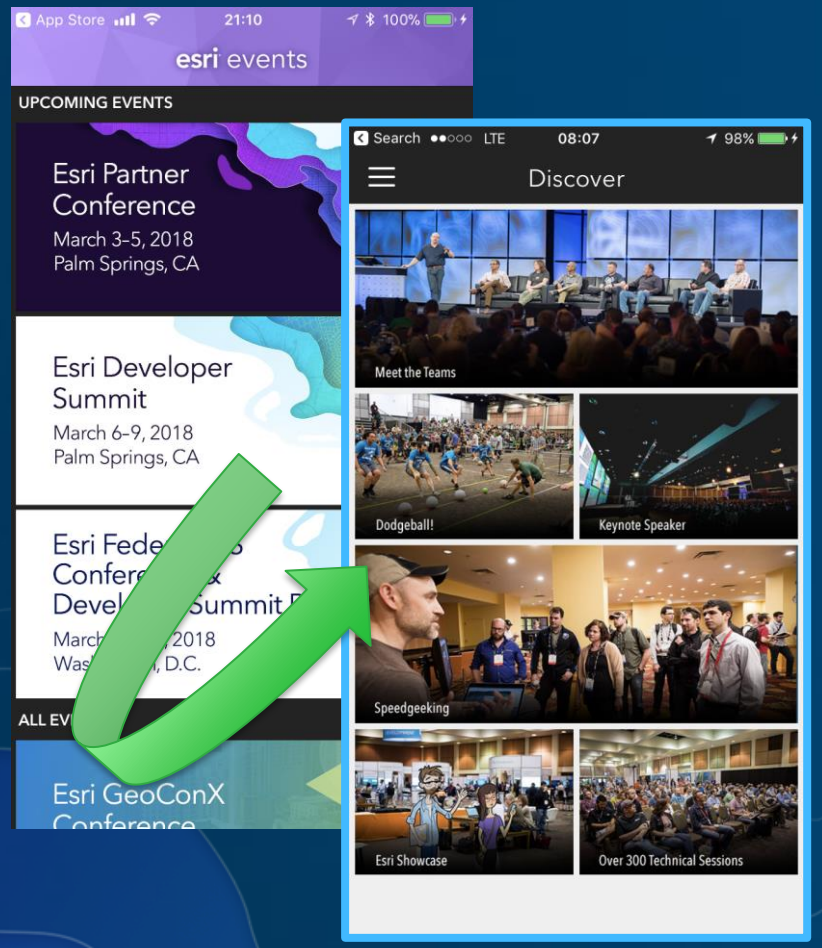
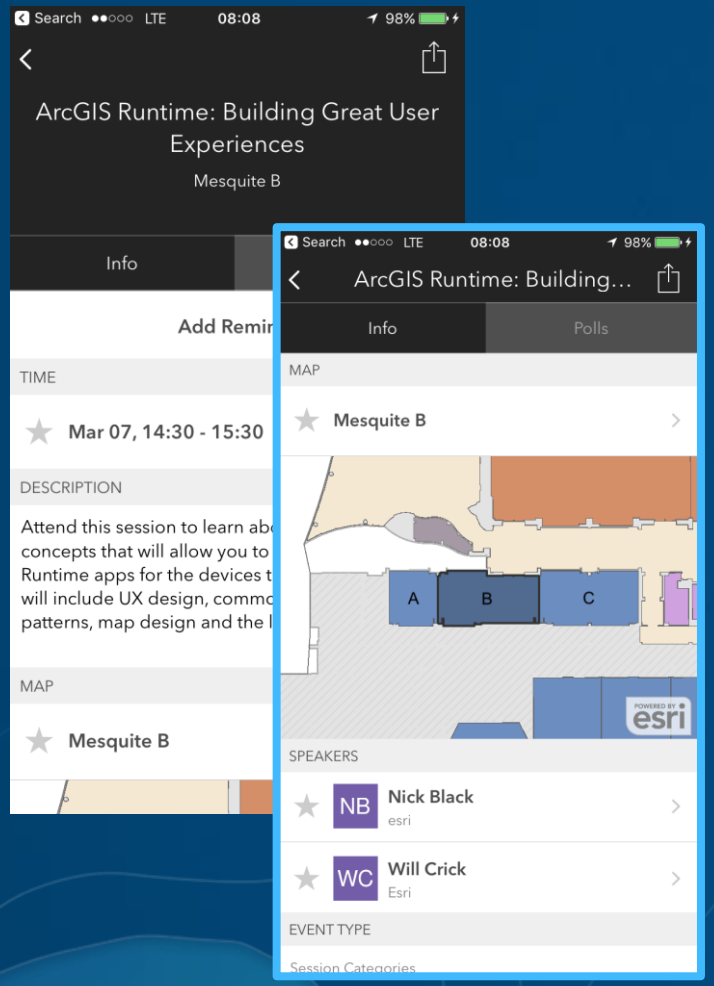
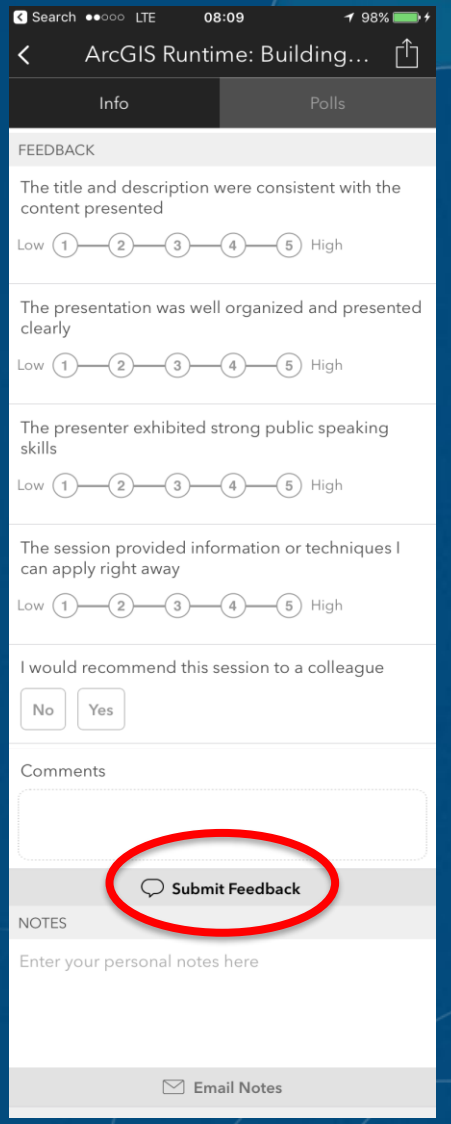


Select the session you attended



Scroll down to the "Feedback" section

Complete Answers, add a Comment, and Select "Submit"



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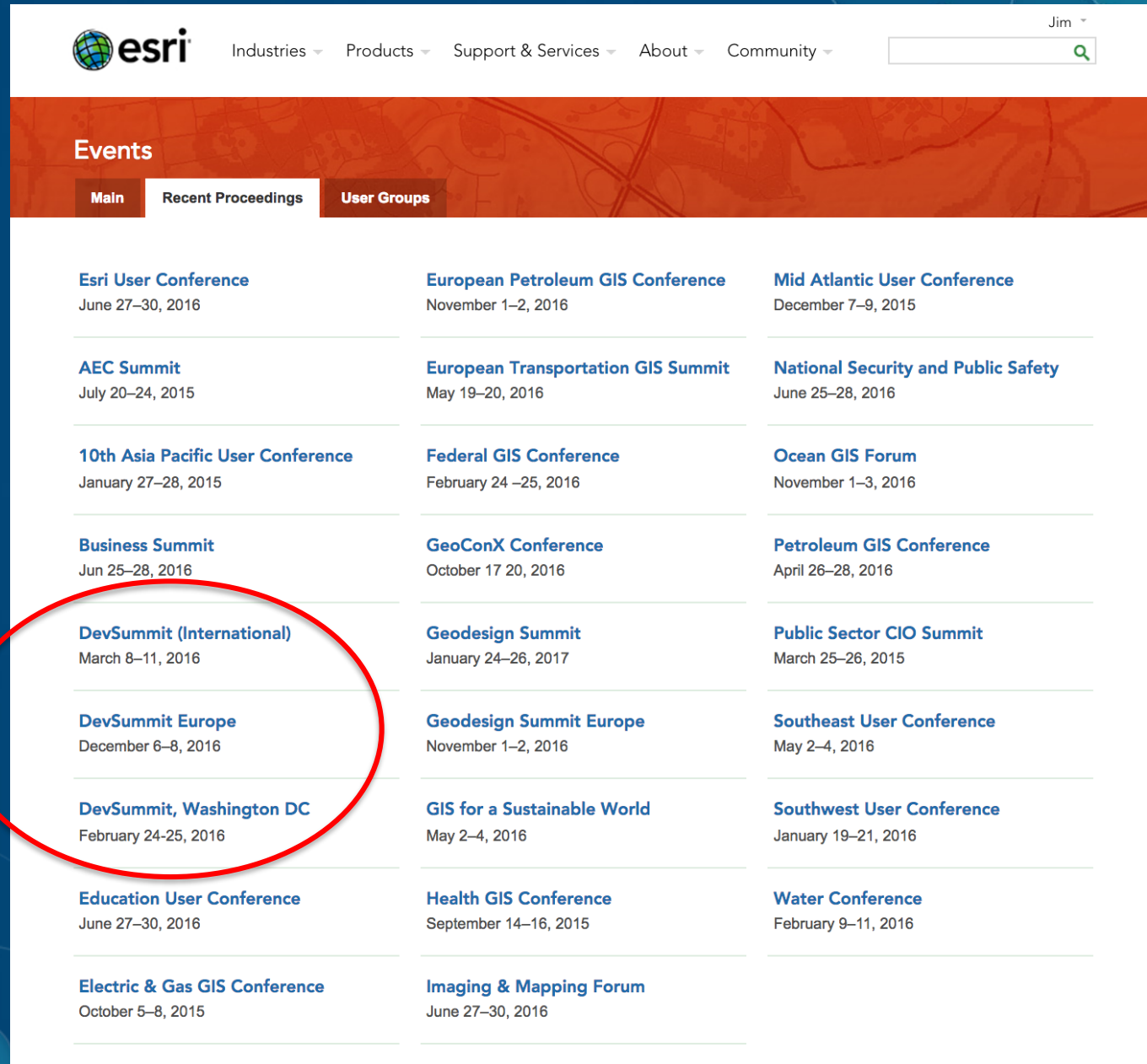

Questions / Feedback?

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rtrujillo@esri.com
@rtrujill007

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