Real-Time and Big Data GIS
The Road Ahead

Sarah Ambrose

Suzanne Foss

Josh Joyner

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Agenda:

1. GeoEvent Server: Current Status
2. GeoEvent Server: Roadmap
3. GeoAnalytics Server
4. Embracing the Internet of Things
5. ArcGIS Analytics for IoT

1 GeoEvent Server Current Status

ArcGIS Enterprise

with real-time capabilities

ingestion

actuation

Apps

Desktop

APIs

live features
stream services

live & historic
aggregates & features

visualization

ArcGIS
Enterprise

ArcGIS GeoEvent
Server

analytics

spatiotemporal
big data store

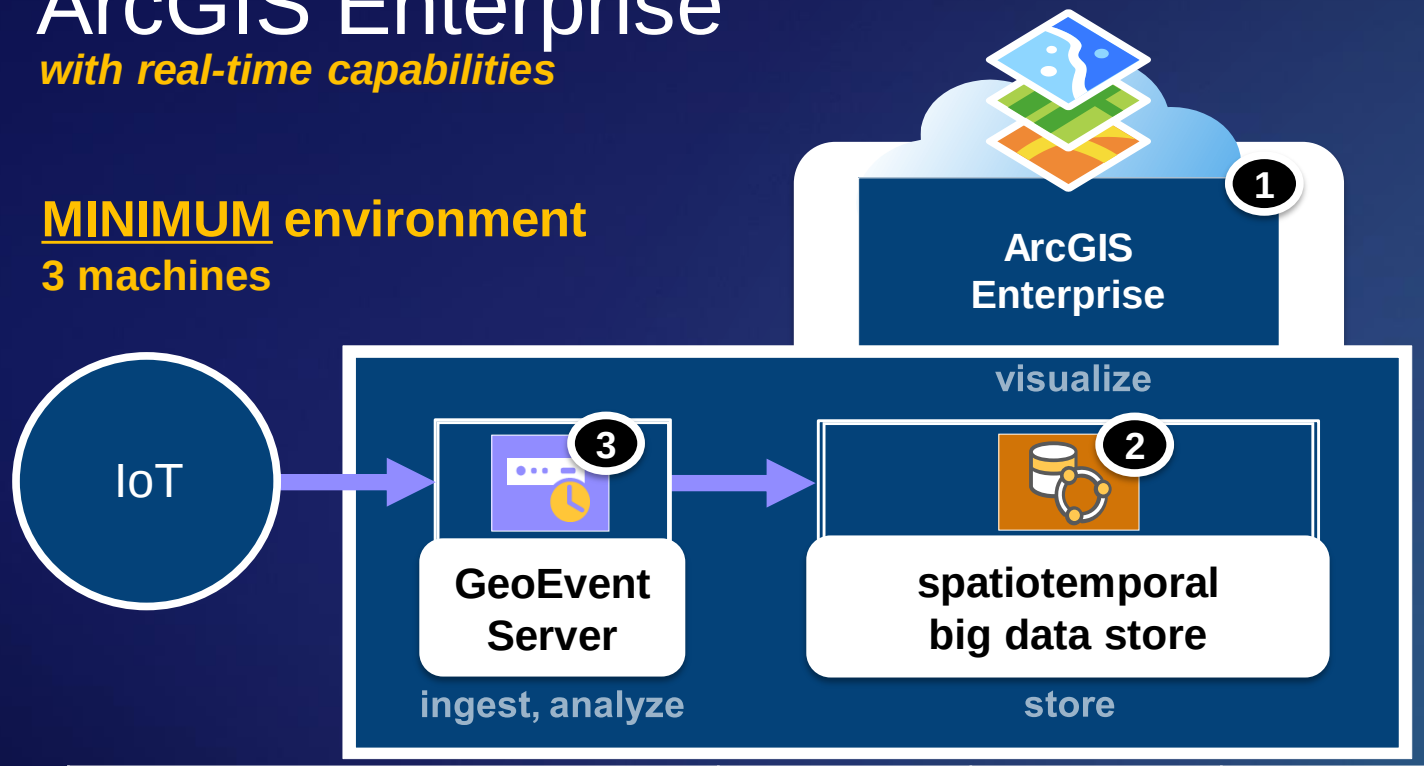
storage

ArcGIS Enterprise

with real-time capabilities

MINIMUM environment

3 machines



ArcGIS GeoEvent Server	10.2	10.3	10.4	10.5	10.6
Velocity throughput *measured in events per second (e/s)*	*up to* 500 *e/s*	*up to* 2,000 *e/s*	*up to* 3,000 *e/s*	*up to* 4,000 *e/s*	*up to* 6,000 *e/s*

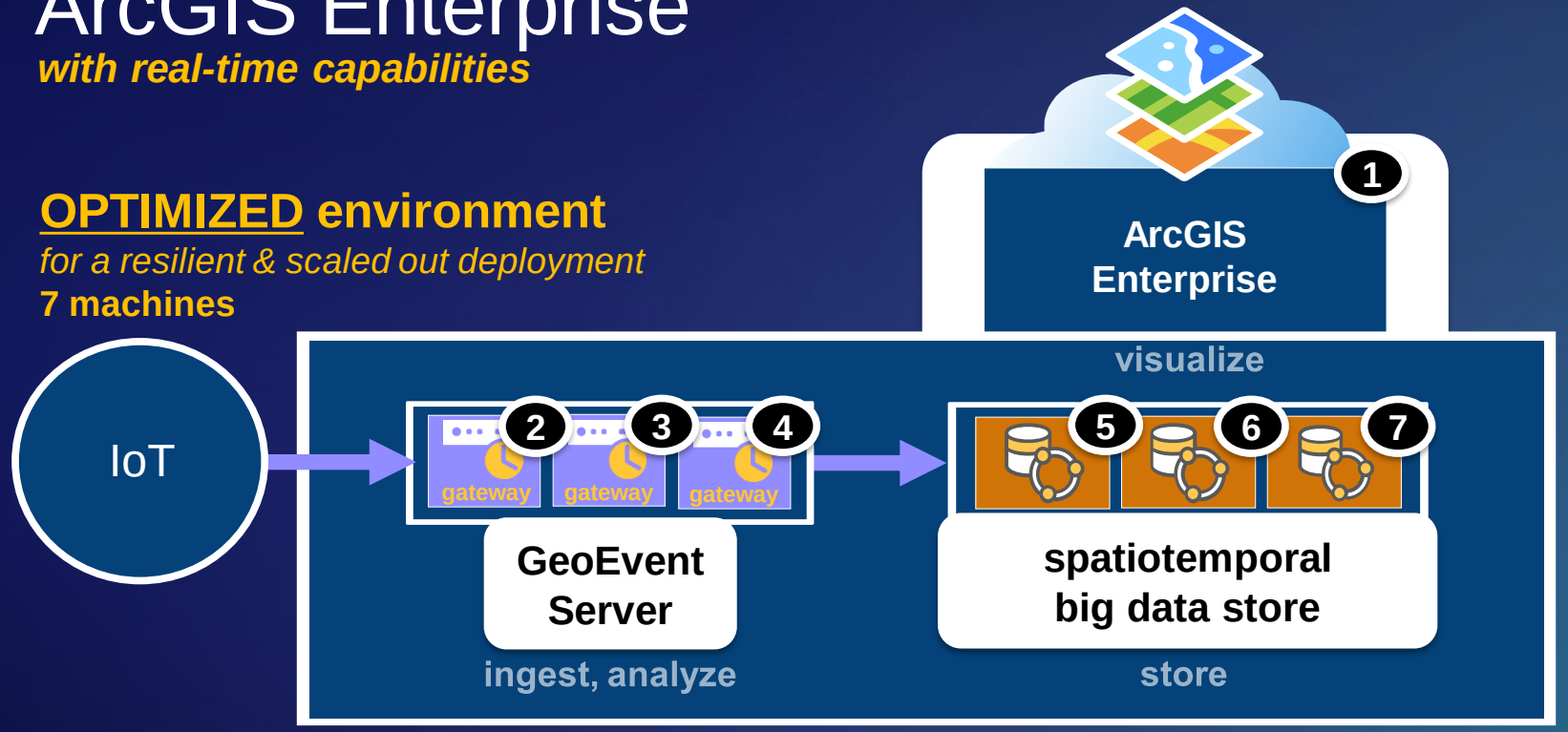
ArcGIS Enterprise

with real-time capabilities

OPTIMIZED environment

for a resilient & scaled out deployment

7 machines



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Resiliency & Scalability *via multi-machine site*	no	no	no	no	yes

GeoEvent Server

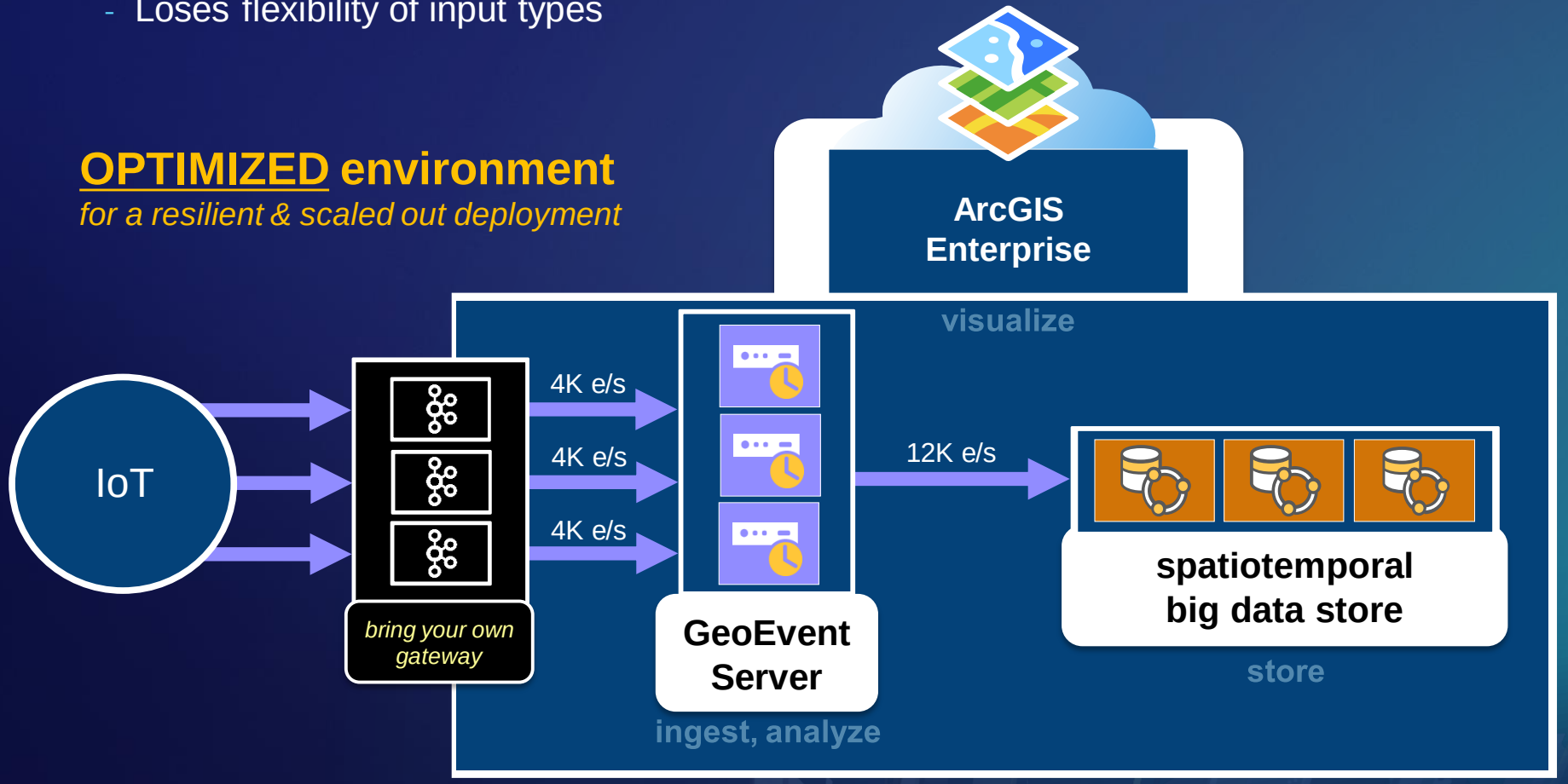
resiliency, scalability & performance

10.5

- ArcGIS 10.5
  - Resiliency (high availability) & scalability is only possible if users “bring their own gateway”
    - Barrier to entry is HIGH & typically requires a professional services engagement for success
  - Loses flexibility of input types

OPTIMIZED environment

for a resilient & scaled out deployment



GeoEvent Server

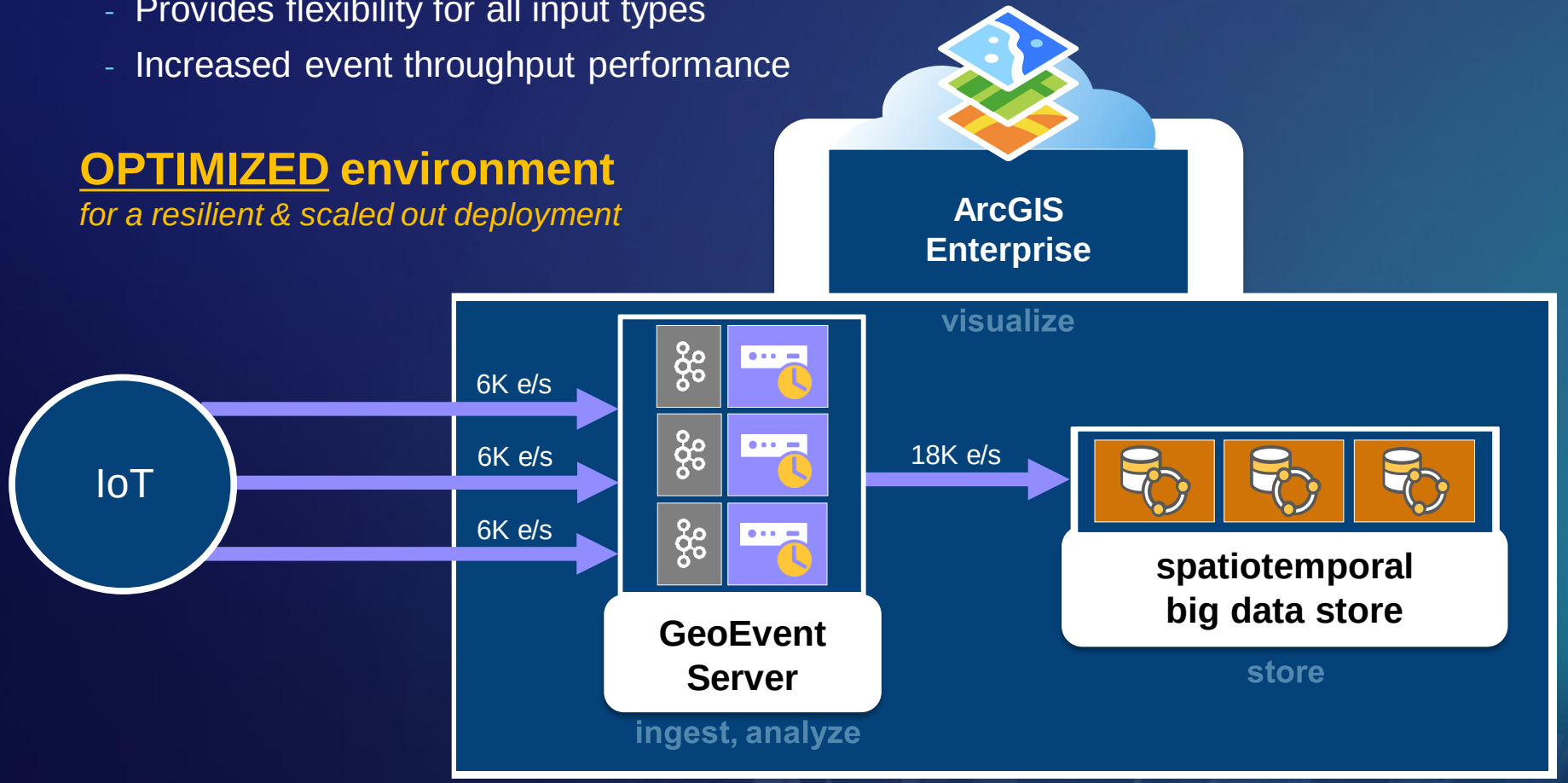
resiliency, scalability & performance

10.6

- ArcGIS 10.6
  - Provides users with a resilient & scalable Real-Time GIS deployment OUT-OF-THE-BOX
    - Introduces a gateway process that is automatically configured as part of GeoEvent Server installation
  - Provides flexibility for all input types
  - Increased event throughput performance

OPTIMIZED environment

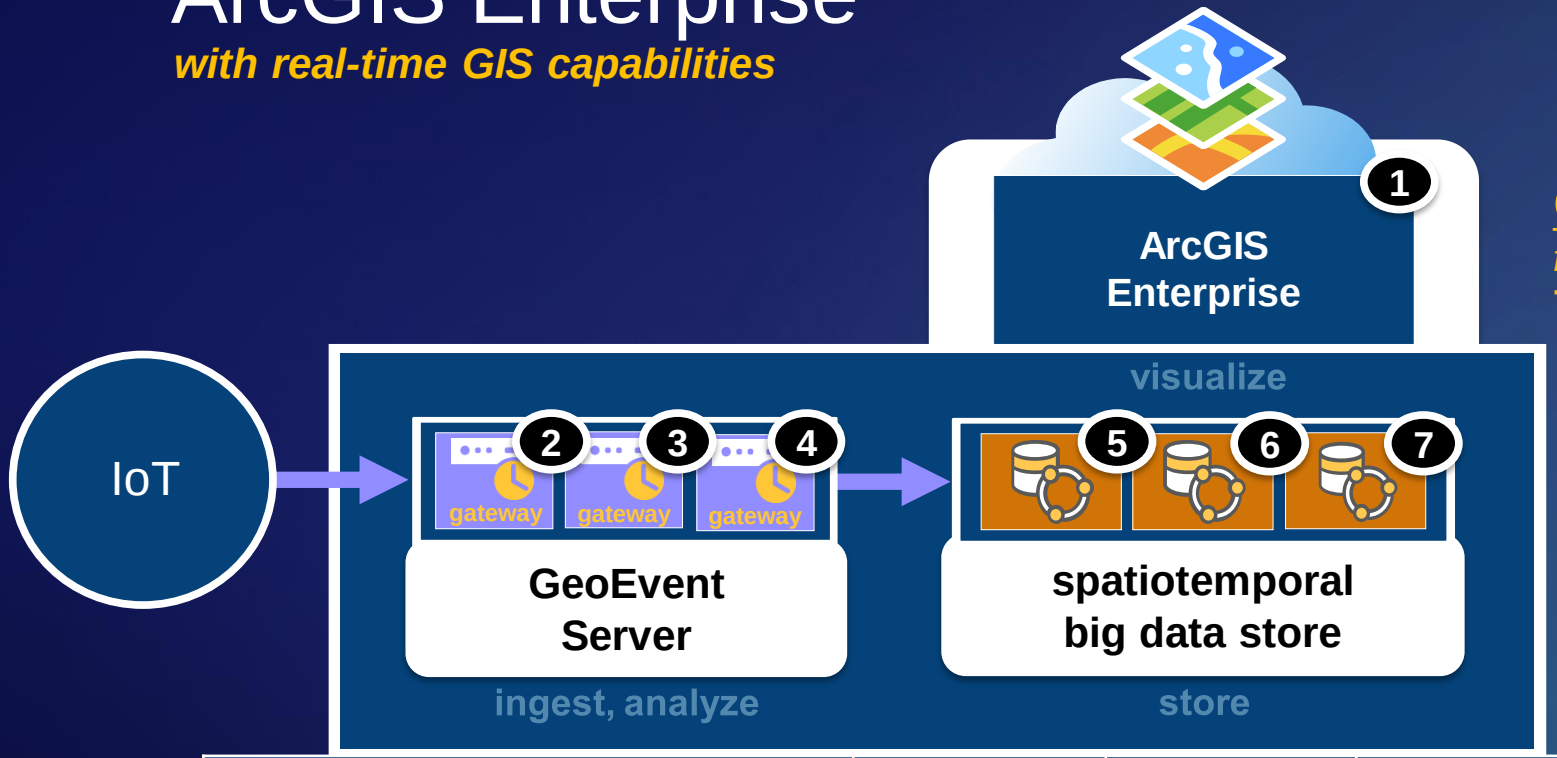
for a resilient & scaled out deployment



ArcGIS Enterprise

with real-time GIS capabilities

10.6



OPTIMIZED environment

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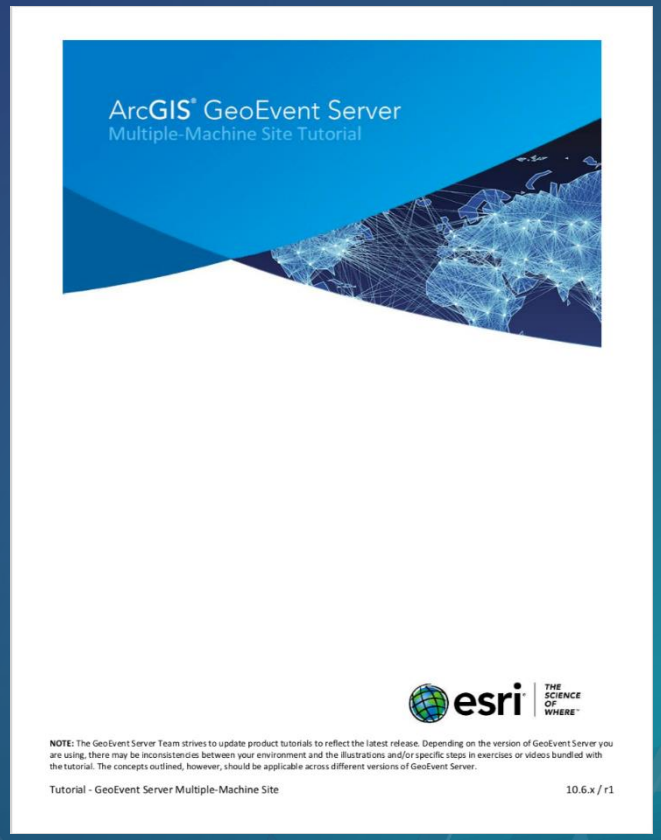
Resiliency & Scalability *via multi-machine site*	no	no	no	no	yes *up to 5 practically, so can scale to up to* 30,000 *e/s*

GeoEvent Server

best practices tutorial for multi-machine site deployment

10.6

- Available Now: http://links.esri.com/geoevent-multiplemachine



2 GeoEvent Server Roadmap

GeoEvent Server

10.6.1 key improvements

10.6.1

- Significant Performance improvements over 10.5.x and 10.6
  - Configurable multi-threaded writing to the spatiotemporal big data store
  - Single machine peak throughput velocity up to 10,000 events per seconds (e/s)
- Multi-machine deployments for improved resiliency with linear scalability
  - Up to 5 machines practically supporting up to 50,000 e/s
- Integrated Public Key Infrastructure (PKI) Authentication (Defense / Intel)
- Improved User Interface for Processor configuration
- ArcGIS Monitor Support
- Stream Layer Support in Pro 2.2 (New render support for published Web Maps)

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GeoEvent Server

10.7

10.7 major epics

- New Input and Output connectors coming with Support for Native Cloud Storage Types
  - Watch an **Amazon S3 bucket** for New Delimited Text / **Parquet** Files
  - Watch an **Azure Blob** for New Delimited Text / **Parquet** Files
  - Write to a Delimited Text / **Parquet** File in an **Amazon S3 bucket**
  - Write to a Delimited Text / **Parquet** File in an **Azure Blob**
- Automatic Configuration Backup to Azure Blob / Amazon S3 bucket
- Configurable Message level resiliency for select inputs and outputs
- User Interface Improvements
  - Support for multi-machine control and statistics
  - Embedded help in Service Designer
- Additional Monitoring Support

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Spatiotemporal big data store

10.7

10.7 major epics

- Enhance data retention policy with ability to automatically export prior to purge
- Enhance GeoEvent Manager and REST API with ability:
  - to export data on demand: including Delimited Text or Parquet to S3/Azure Blob
  - to import data on demand: including Delimited Text or Parquet from S3/Azure Blob
- Z Value Support for Polyline, Polygon, and Multi-Point Geometries
- Additional Symbology Support in ArcGIS Enterprise / Online JavaScript Web Maps
- Other incremental enhancements based on user feedback

3 GeoAnalytics Server

ArcGIS GeoAnalytics Server

*Tools for processing **large vector and tabular data** with both spatial (location) and temporal (time) components using **distributed analytics and storage***

- ArcGIS Enterprise server role released at 10.5
- Run analysis in Pro, Portal, or the ArcGIS Python API
- Distributes analysis over multiple machines for faster processing time
- Supports reading directly from common data sources
  - File shares, HDFS, Hive, Amazon S3, Azure Data Lake
- Most tools support spatiotemporal analysis

ArcGIS 10.7

Themes

- Enable users to run distributed machine learning analytics
- Support developers and data scientists that want to author python-based tools
- New GIS tools and enhancements to existing tools and user experiences
- Support for additional output data stores

ArcGIS 10.7

Machine learning and Python

- Expand ML capabilities
  - Find point clusters (HDBSCAN)
  - Geographically weighted regression (GWR)
  - Forest-based classification and regression, ordinary least squares (OLS)

- Integration between GeoAnalytics and PySpark (python)
  - Enable WebGIS datasets to work with Spark libraries (e.g., SparkML)
  - Expose spatiotemporal capabilities through python

ArcGIS 10.7

Developer API and Python integration

- Use the Python Script tool to run user defined Python on the GA Server within the PySpark framework
  - A user can submit a script that will run across the cluster

- Enable Hosted Notebooks to run on a GeoAnalytics Server
  - PySpark will be integrated to support execution across the cluster

ArcGIS 10.7

New tools and enhancements

- Implement new GIS functionality
  - Clip, Merge, Dissolve

- Continued work on interfaces and tool enhancements

ArcGIS 10.7

Writing to big data file shares

- Users will have the ability to write the output of analysis to a big data file share
  - E.g., CSVs in HDFS, Parquet in S3, Azure Data Lake, Azure Blob Store

4 Embracing the Internet of Things (IoT)

ArcGIS & the IoT

enabling geospatial insights with your IoT

Environment

noise co2 nitrates
gases temperature humidity
atmospheric pressure radiation
pesticides electromagnetic feedback
rain gauges water level gauges
water quality air quality

Weather

warnings earthquakes
precipitation icy conditions

Airports

flight status queues
plane location runway status

Public Safety

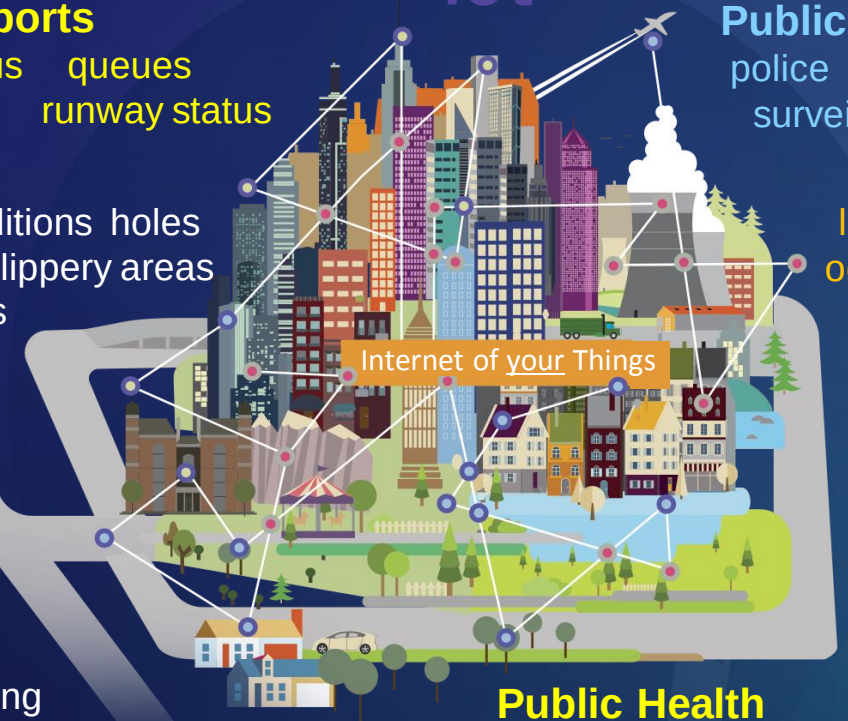
police fire
surveillance

Connected Cars

autonomous driving traffic conditions holes
parking meters road conditions slippery areas
network improvements

Buildings

lighting hvac
occupancy counts



figure_</>
Apps
Desktop
APIs
ArcGIS Enterprise

with real-time & big data capabilities

Transit

buses taxis rail
trains crowds

Energy Usage

electricity gas smart meters

City Workers

sanitation snow plows

People

health monitoring
social activity

Public Health

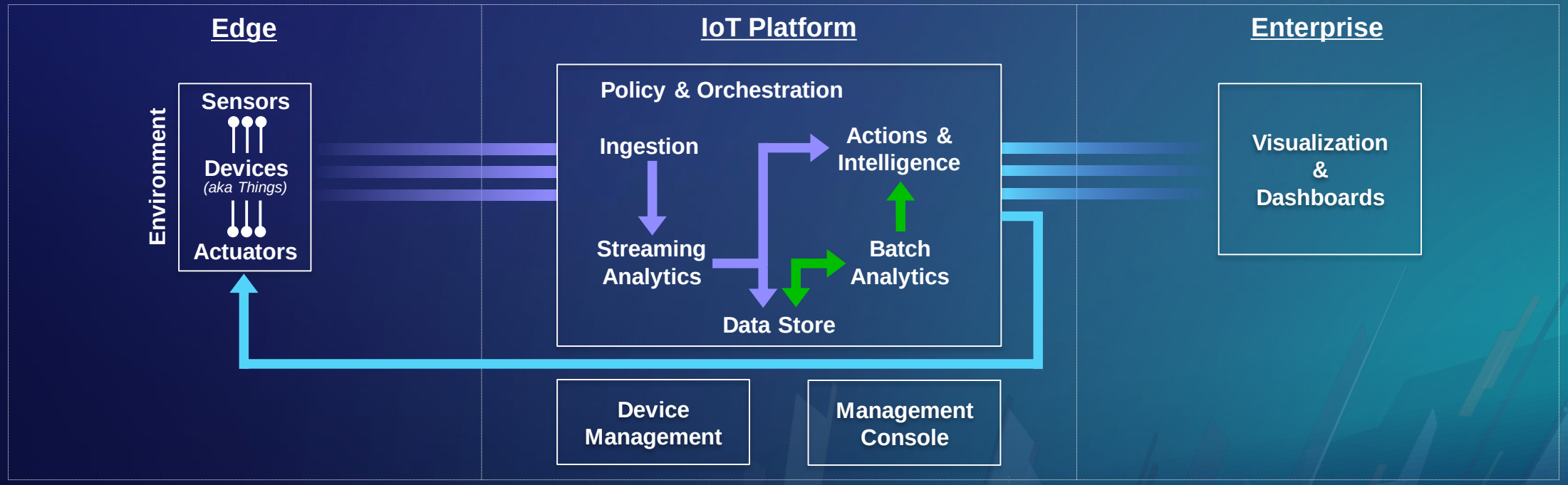
hospitals ambulances

Telecommunications

cell phone signals dropped calls

Blueprint
for IoT solutions

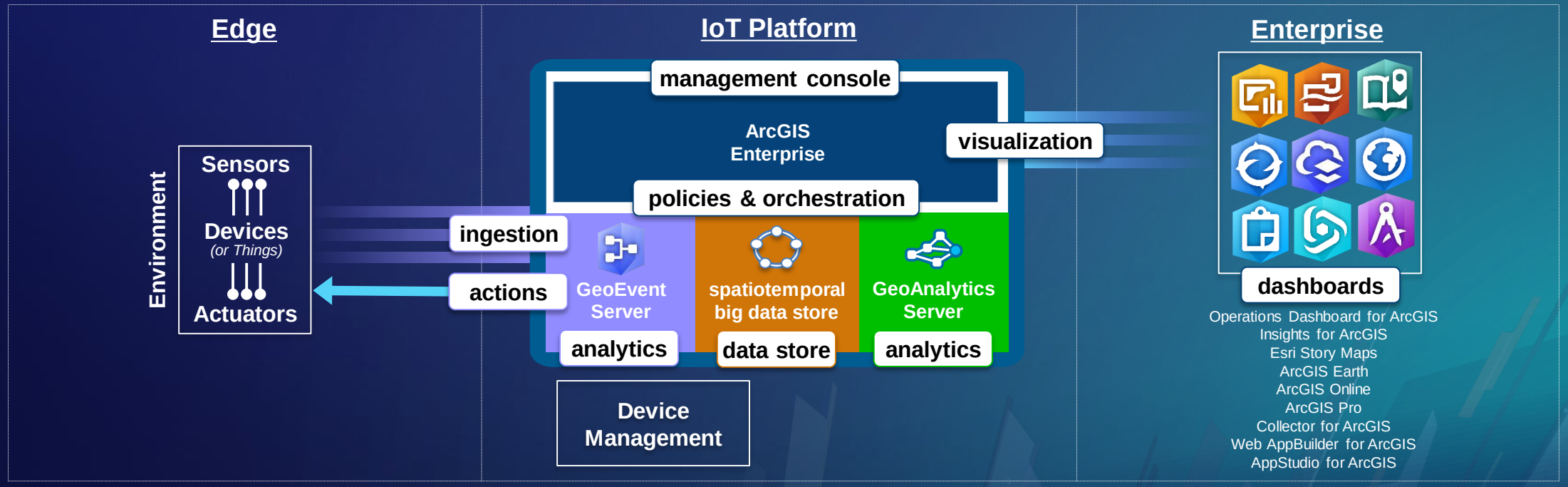
- An IoT Platform & Enterprise consists of the following capabilities:
  - Ingestion
  - Streaming Analytics & Policies
  - Actions (including Actuation)
  - Data Store
  - Device Management
  - Batch Analytics
  - Management Console
  - Visualization
  - Dashboards



ArcGIS as an IoT Platform

enabling geospatial insights with your IoT solution

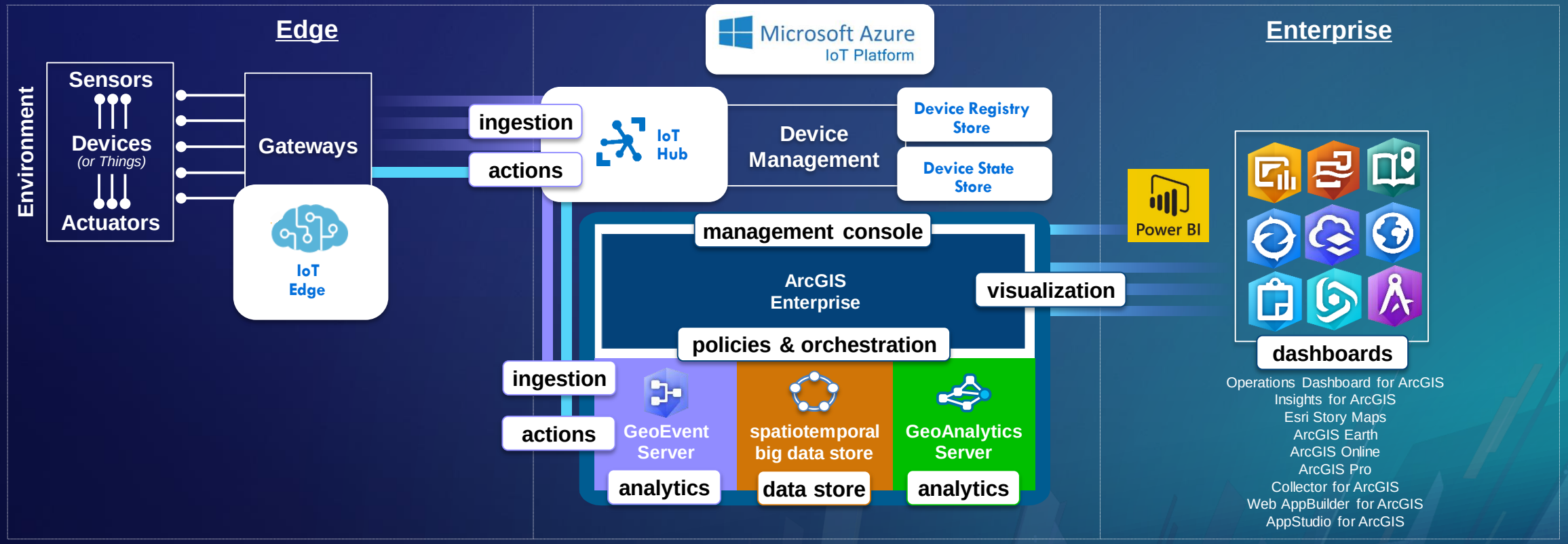
- An ArcGIS based IoT Platform & Enterprise consists of the following capabilities:
  - Ingestion: GeoEvent server input connectors
  - Streaming Analytics & Policies: GeoEvent Services
  - Actions (including Actuation): GeoEvent output connectors
  - Data Store: spatiotemporal big data store
  - Device Management: *for those requiring this functionality another IoT platform can be complemented with ArcGIS.*
  - Batch Analytics: GeoAnalytics Server
  - Management Console: Portal & GeoEvent Manager
  - Visualization: Map & Feature Services
  - Dashboards: Operations Dashboard, Insights, Story Maps



Complementing an IoT platform with ArcGIS

enabling geospatial insights with your IoT solution

- The Edge of an IoT broadcasts into an IoT platform such as: *Azure IoT, Amazon IoT, Cisco IoT, IBM Bluemix, ...*
- The IoT platform integrates with ArcGIS to expand it's capabilities with spatiotemporal analytics, visualization & dashboards



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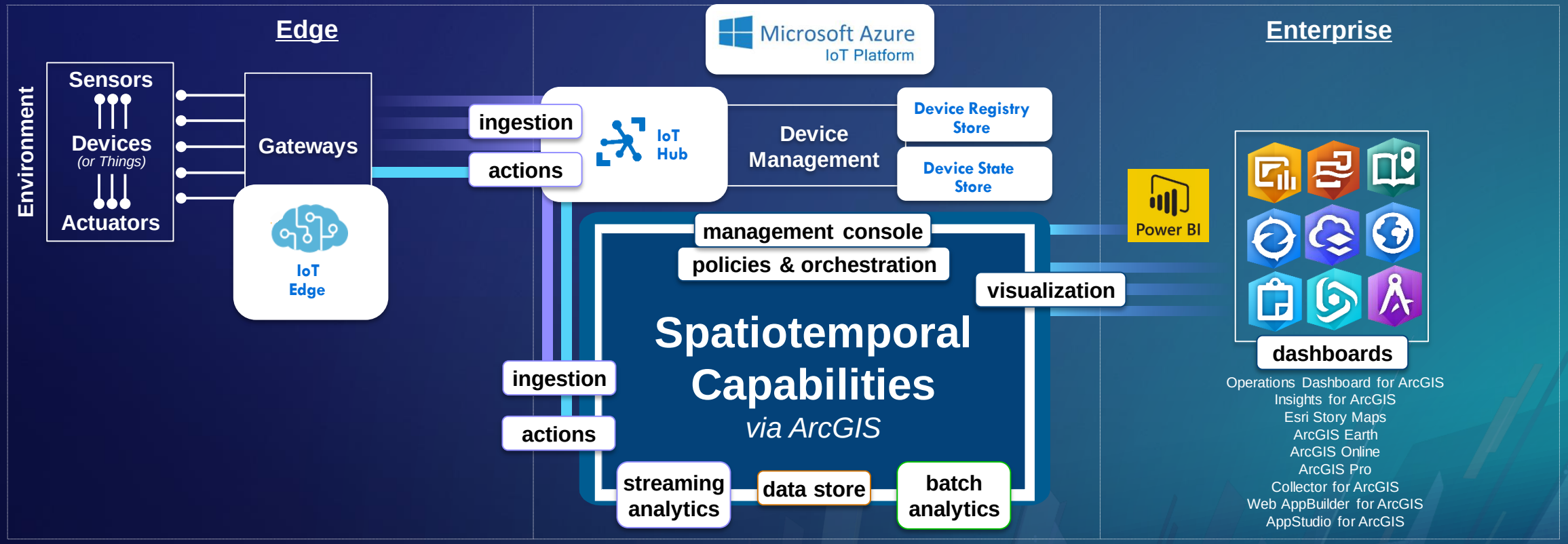
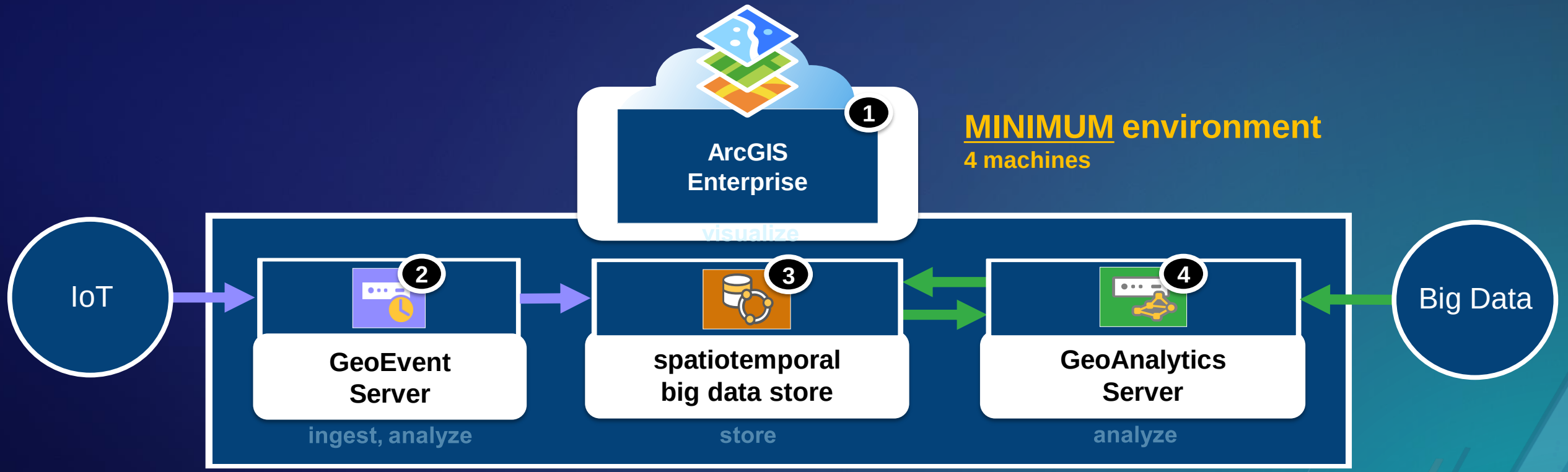


ArcGIS Enterprise

with real-time & big data GIS capabilities



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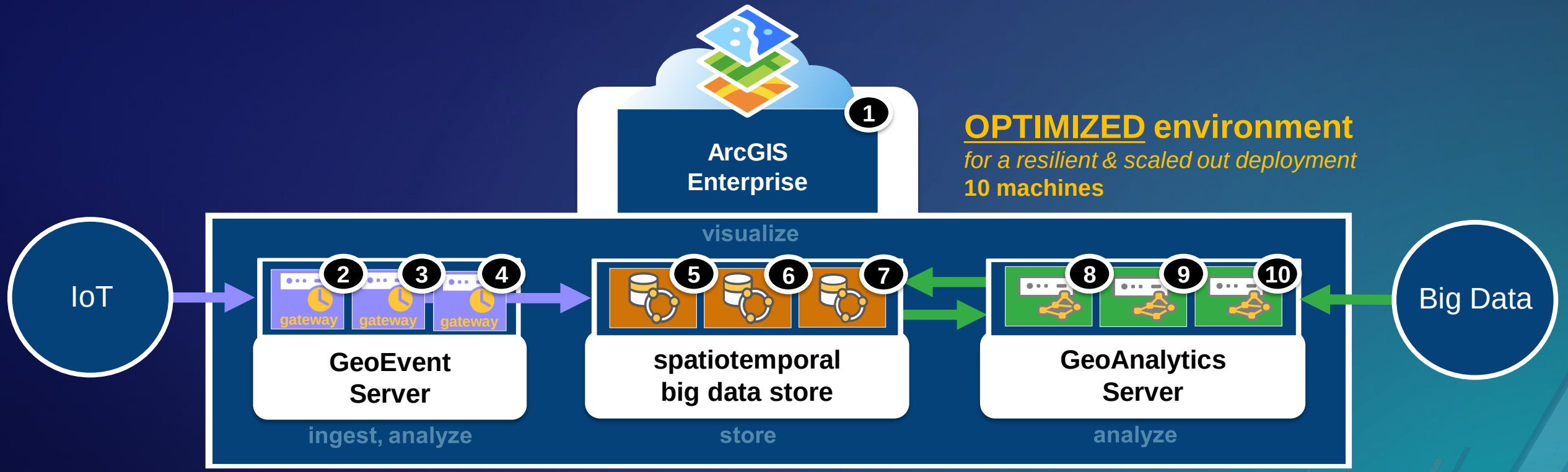


OPTIMIZED environment

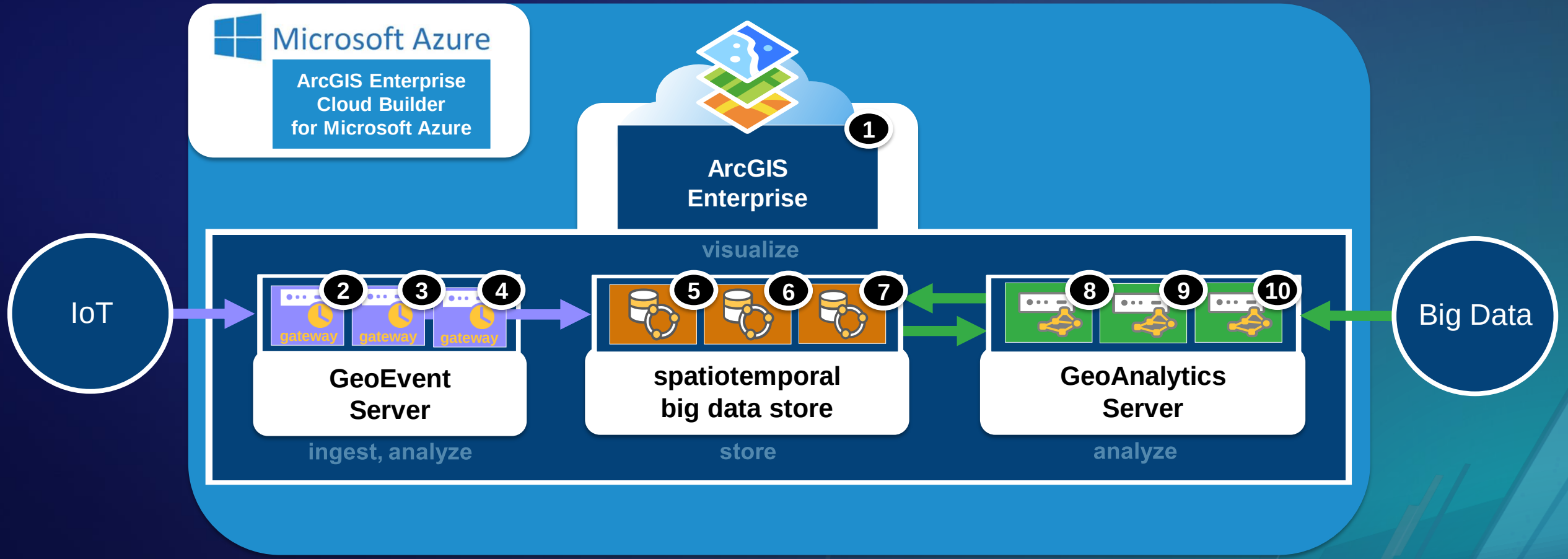
for a resilient & scaled out deployment

10 machines

ArcGIS Enterprise

with real-time & big data GIS capabilities on Microsoft Azure

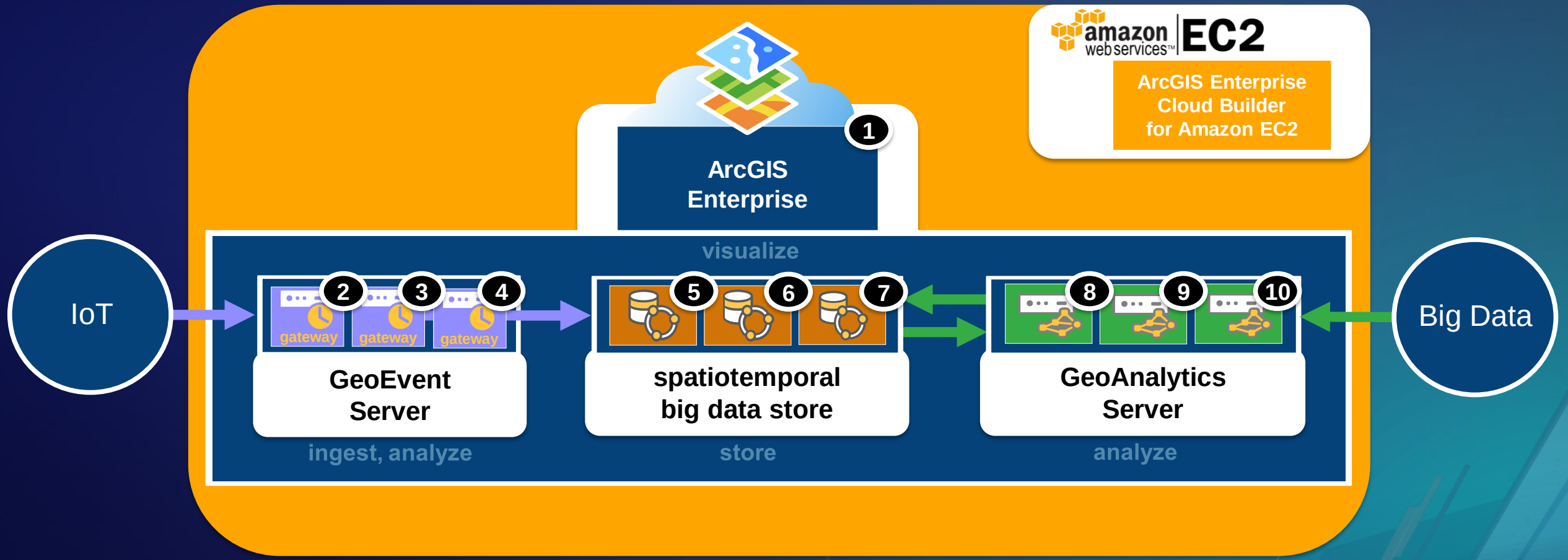
10.6.1



ArcGIS Enterprise

with real-time & big data GIS capabilities on Amazon EC2

10.6.1



5 ArcGIS Analytics for IoT

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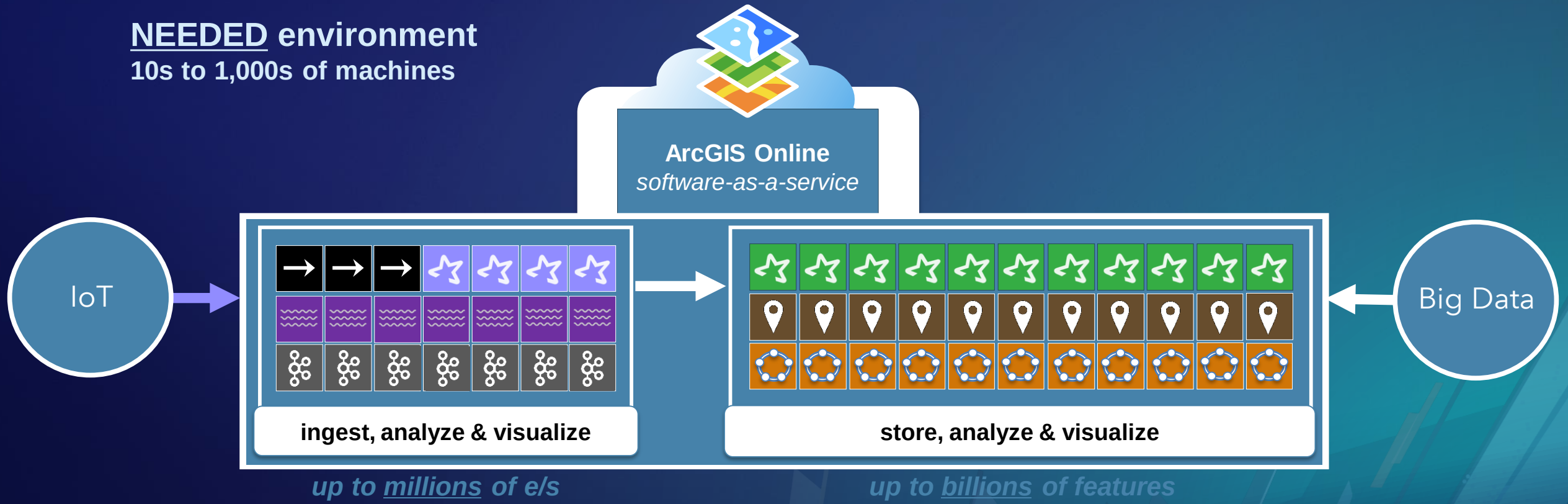
ArcGIS Analytics for IoT

Real-time and big data GIS as a service

- A new class of customer is demanding real-time & big data analytic capabilities as a service
- A new class of customer is demanding MASSIVE real-time & big data analytic capabilities

NEEDED environment
10s to 1,000s of machines



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project Trinity

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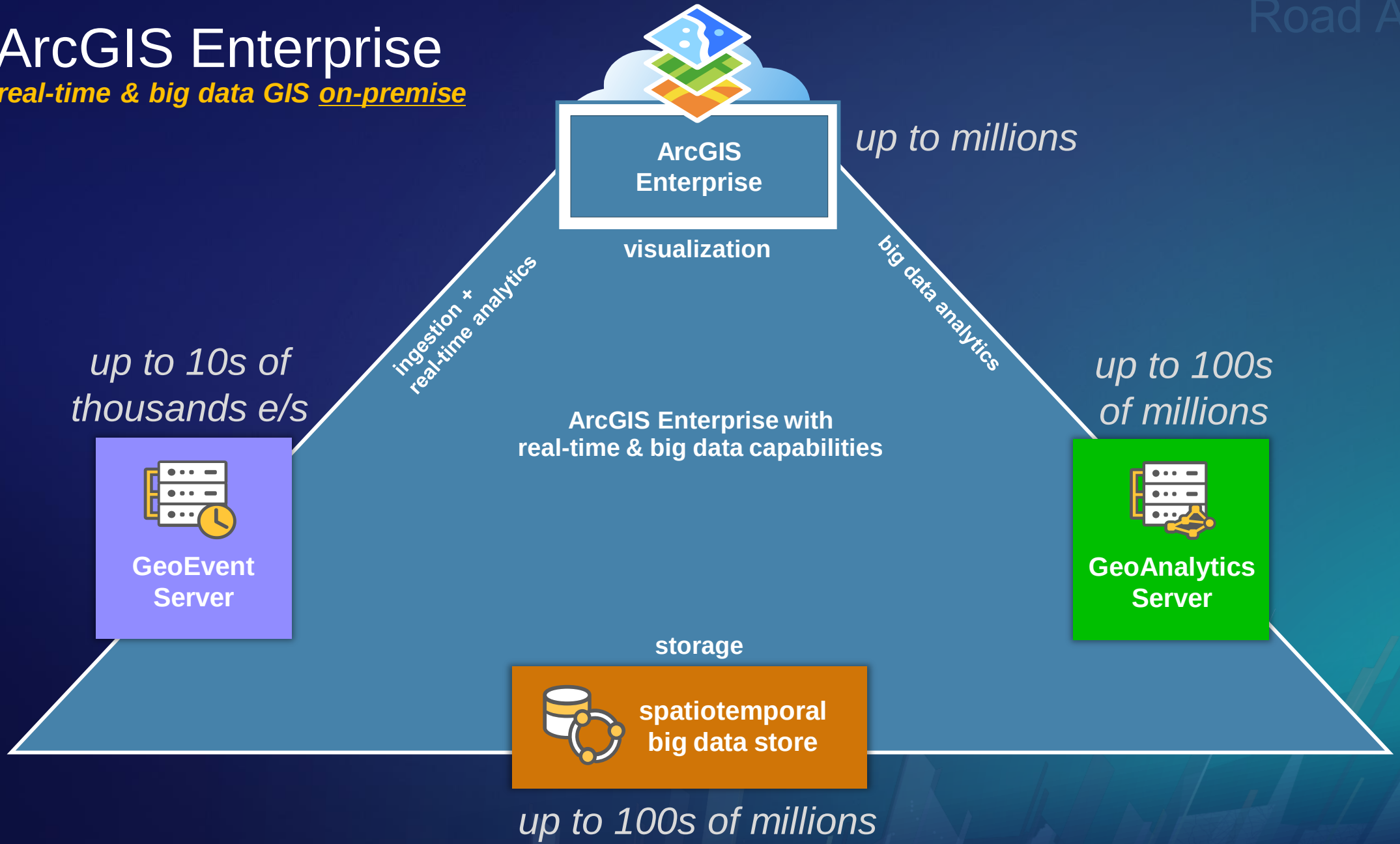
ArcGIS Enterprise

real-time & big data GIS on-premise



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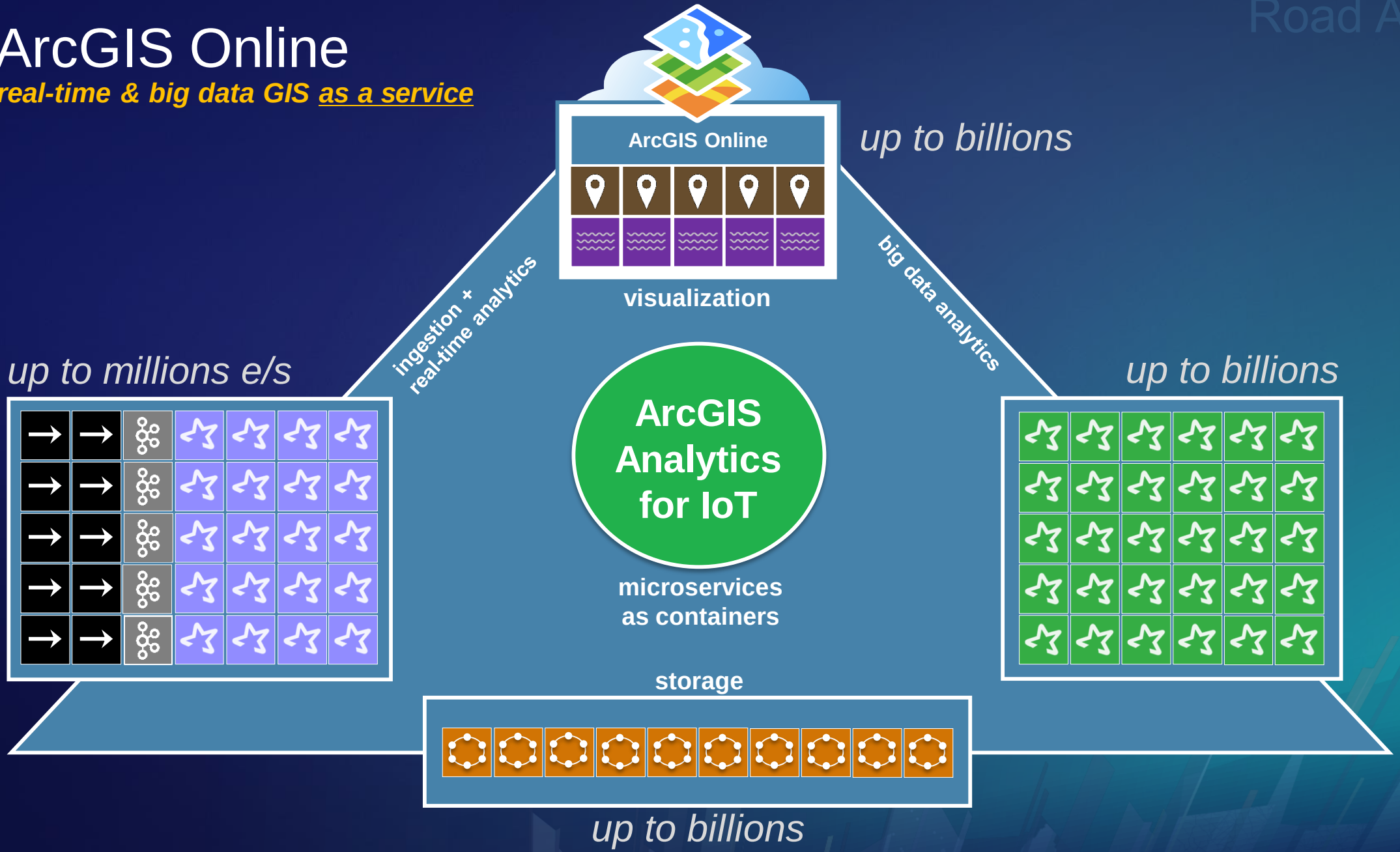
ArcGIS Online

real-time & big data GIS as a service



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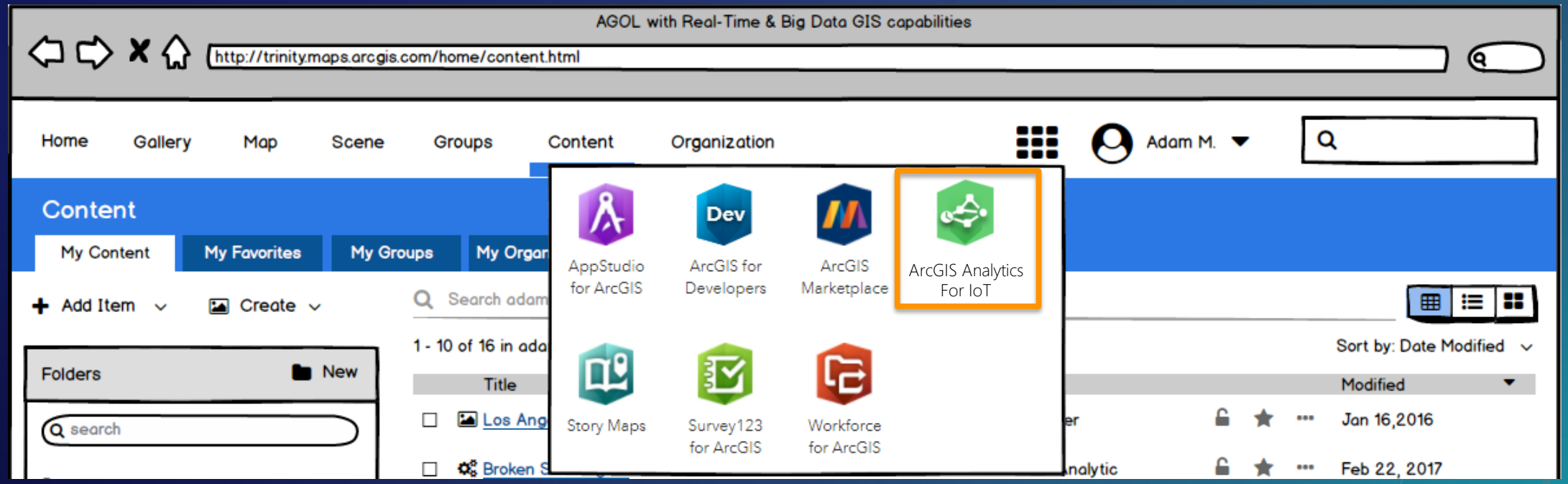
ArcGIS Online

with real-time & big data GIS as a service

- **Launched as an application on ArcGIS Online**



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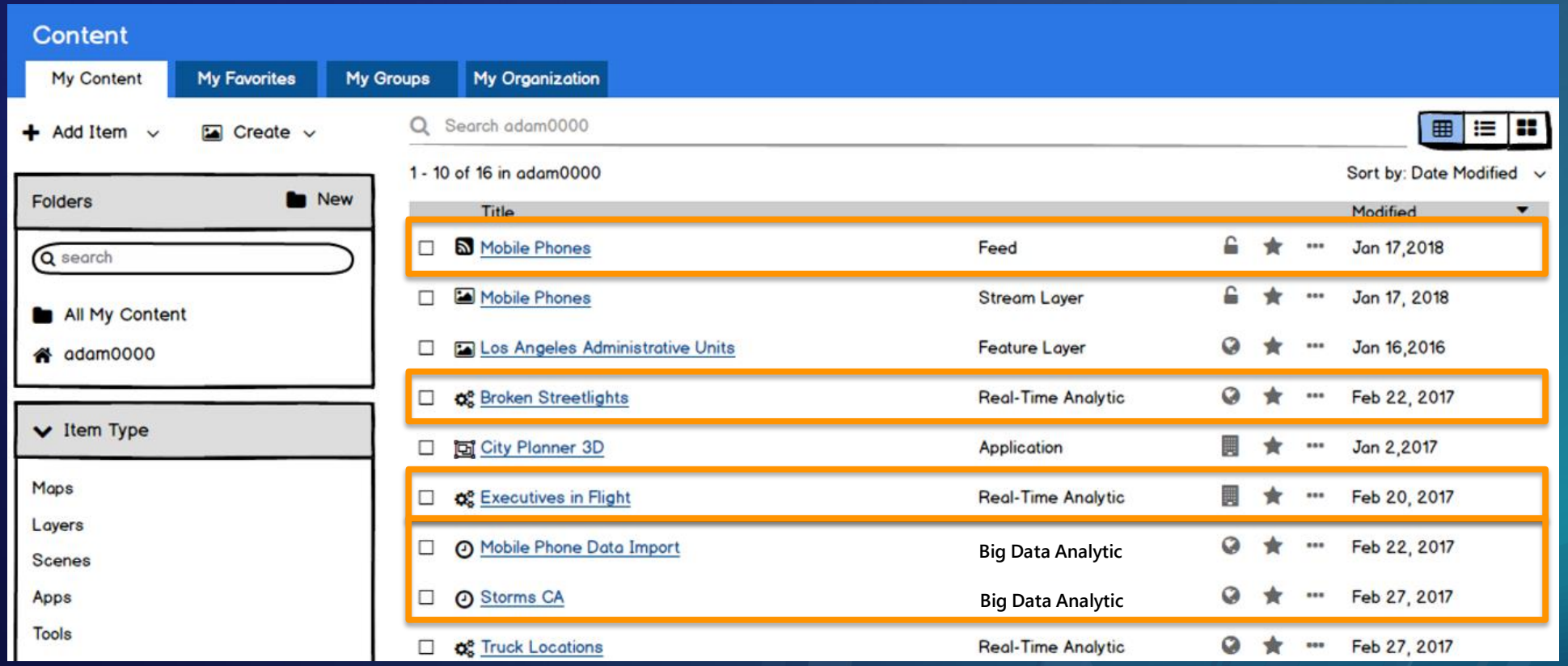
ArcGIS Online

with real-time & big data GIS as a service

- "ArcGIS for IoT" application enables authoring new ArcGIS Online items including:
  - Feed
  - Real-Time Analytic
  - Big Data Analytic



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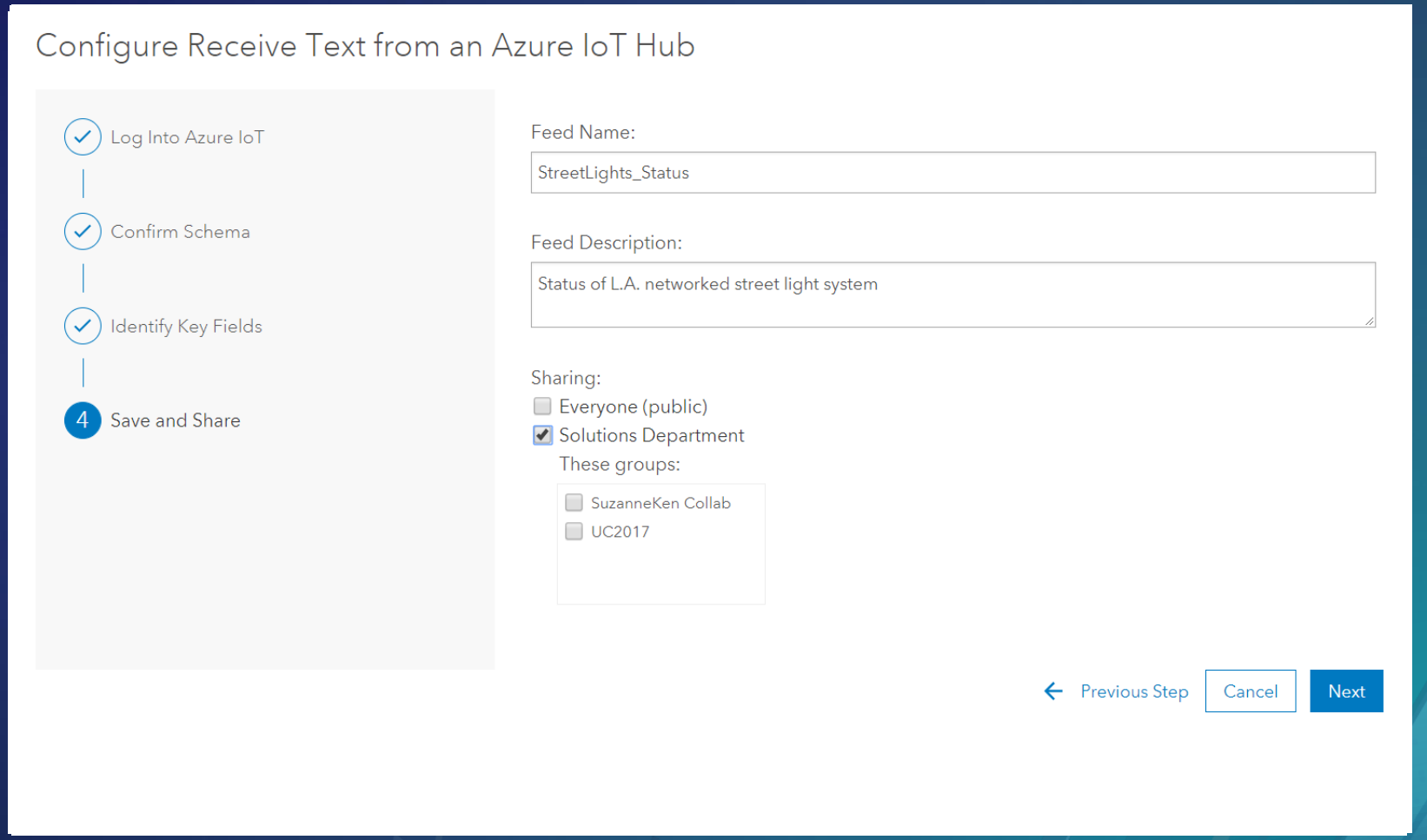
Feeds

Real-time, streaming data

- Configure & share
- Visualize directly in web maps



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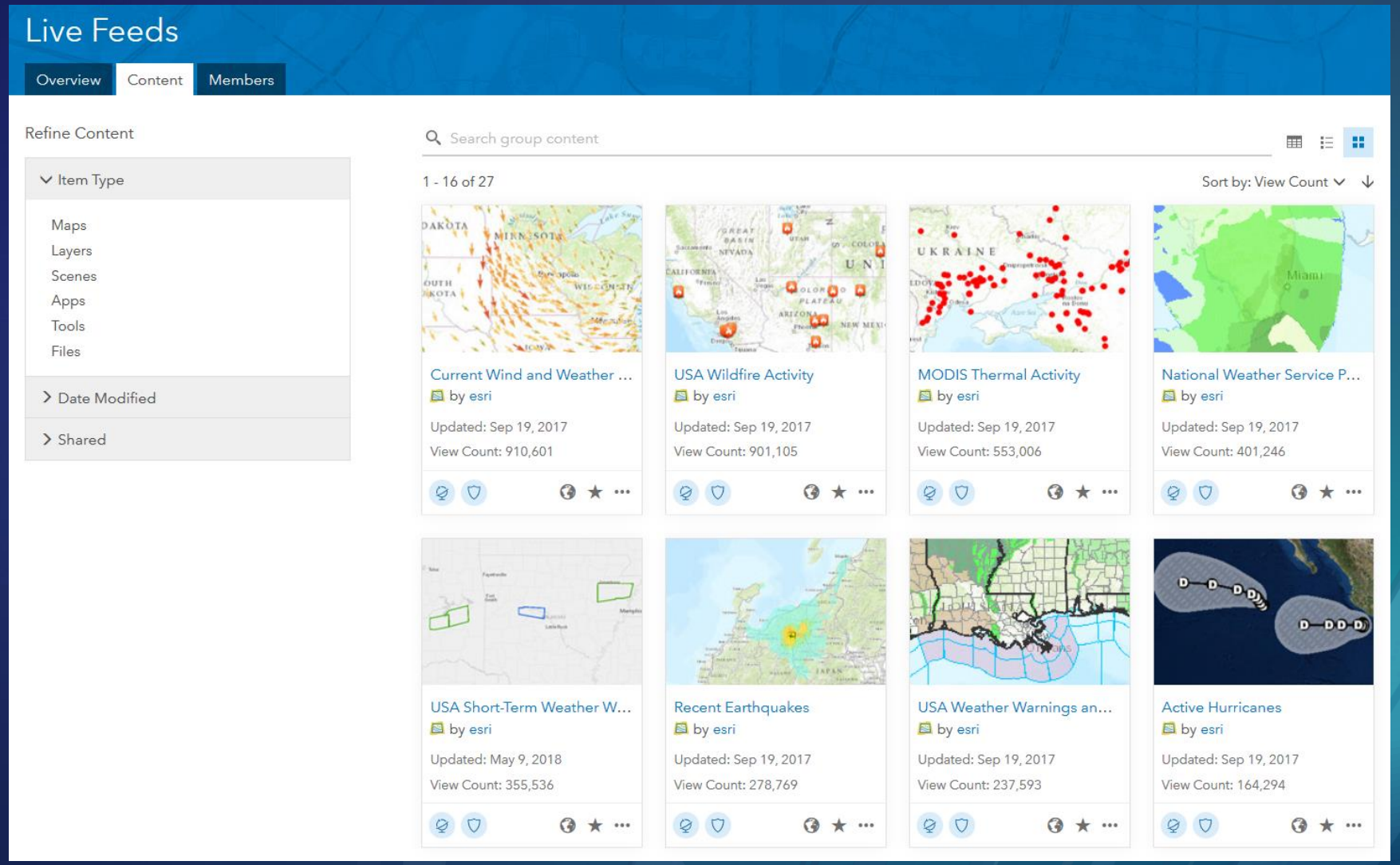
Feeds

Real-time, streaming data

- Configure & share
- Visualize directly in web maps
- Discover & use
  - Living Atlas
  - ArcGIS Marketplace
  - User community



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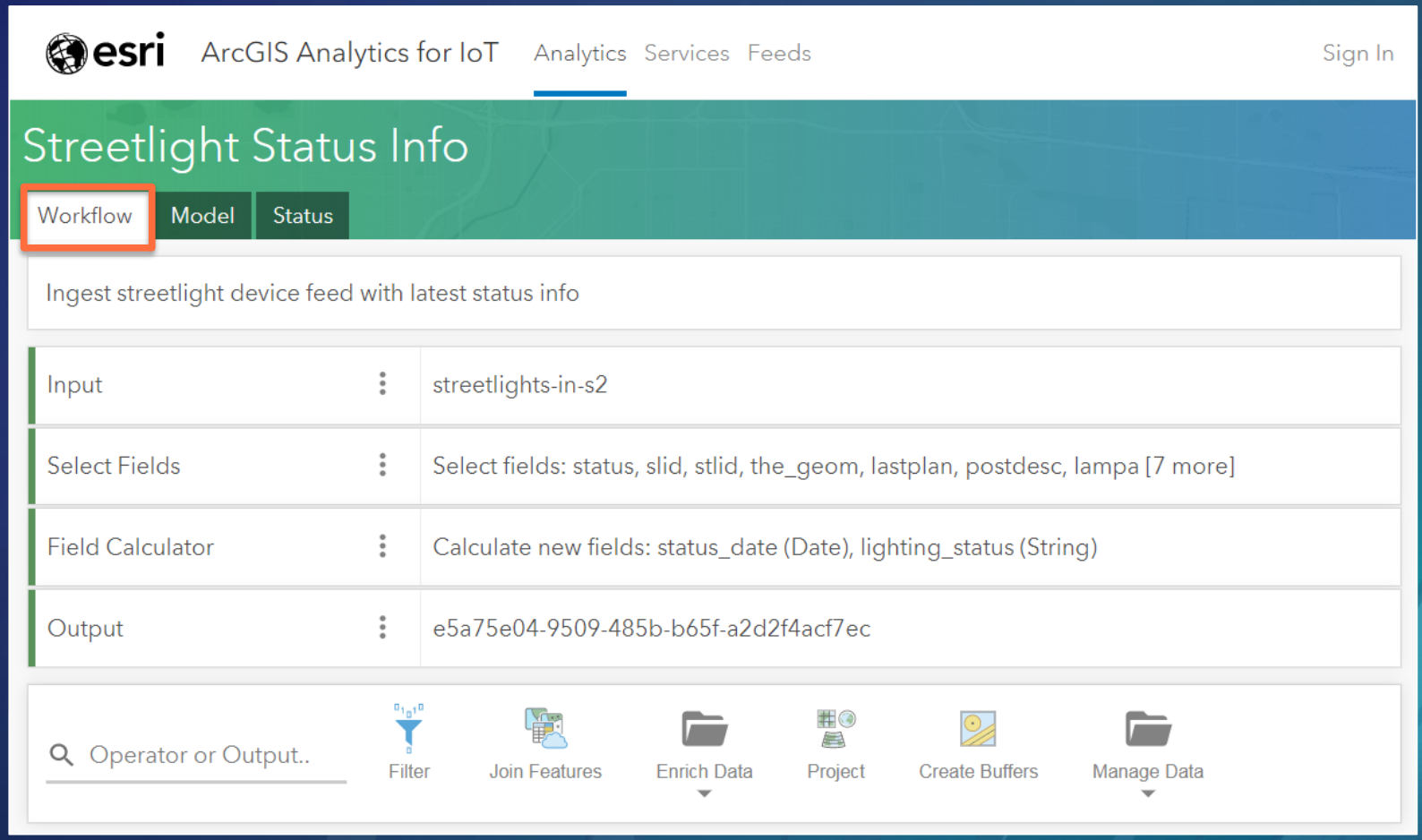
Real-Time Analytics

Continuous analysis

- Consume a Feed
- Analyze & detect patterns of interest
- Alerts & actuation
- Store to map/feature services
- Share as item



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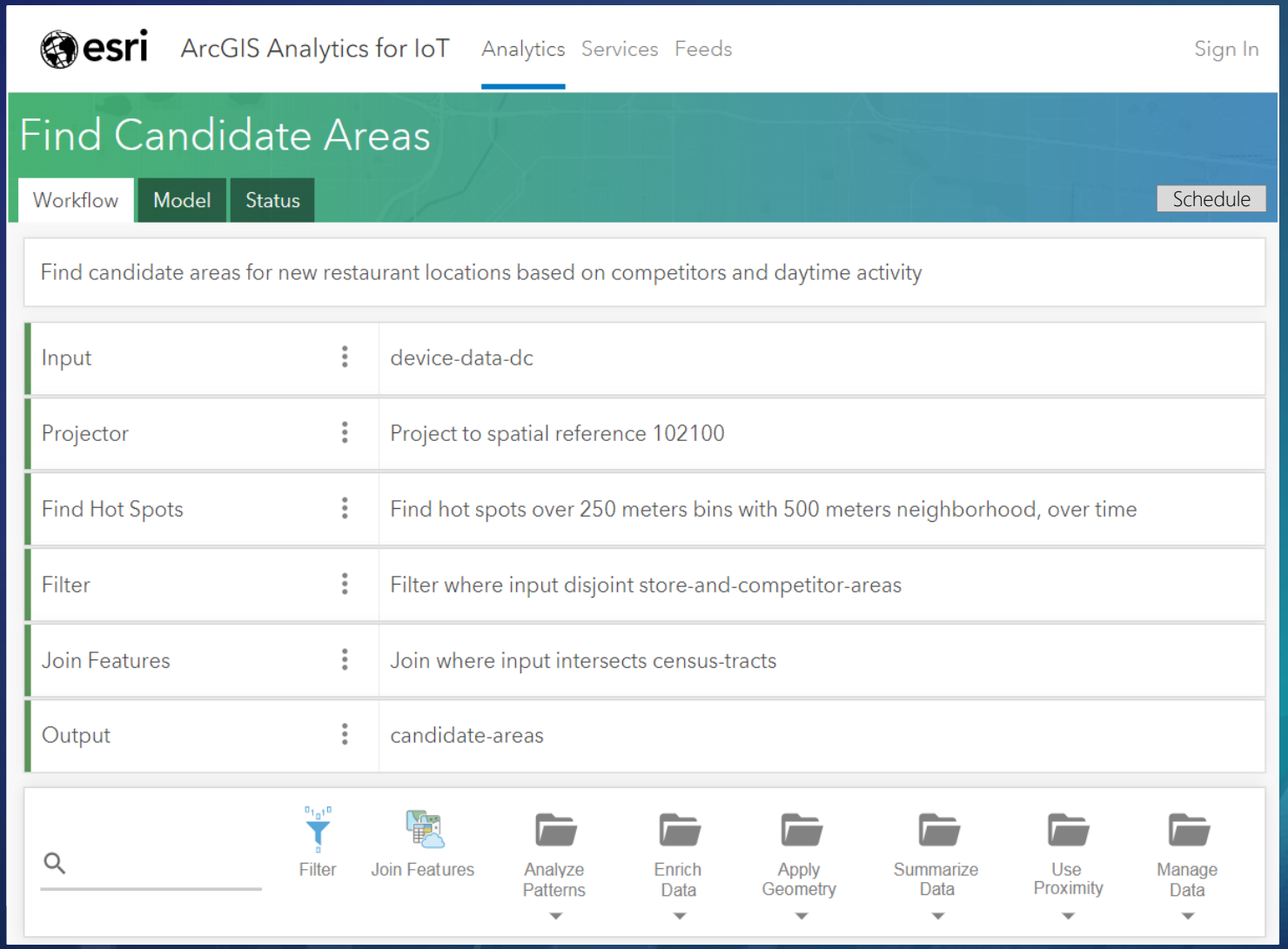
Road Ahead

Big Data Analytics

Batch analysis

- Access big data stores
- Analyze patterns
- Assess trends
- Store results
- Share as item

- Schedule analysis



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Road Ahead

ArcGIS Analytics for IoT

Spatiotemporal operators

real-time & batch analytic

batch analytic only

Summarize Data

Aggregate Points

Join Features

Reconstruct Tracks

Summarize Attributes

Summarize Nearby

Summarize Within

Analyze Patterns

Calculate Density

Calculate Journeys

Create Space Time Cube

Emerging Hot Spots

Find Hot Spots

Find Point Clusters

Use Proximity

Create Buffers

Create Service Areas

Calculate Distance

Snap to Network

Find Locations

Find Similar Locations

Detect Gaps

Detect Idle Locations

Detect Incidents

Manage Data

Calculate Fields

Dissolve Boundaries

Filter

Map Fields

Merge

Overlay Layers

Project

Select Fields

Enrich Data

Lookup Geoname

Calculate Motion Statistics

Reverse Geocode

Identify Relationships

Geographically Weighted Regression

Logistic Regression

Ordinary Least Squares

Principal Component Analysis

Forest-based Classification

Self Organizing Maps

**capabilities in italics slated for later release*

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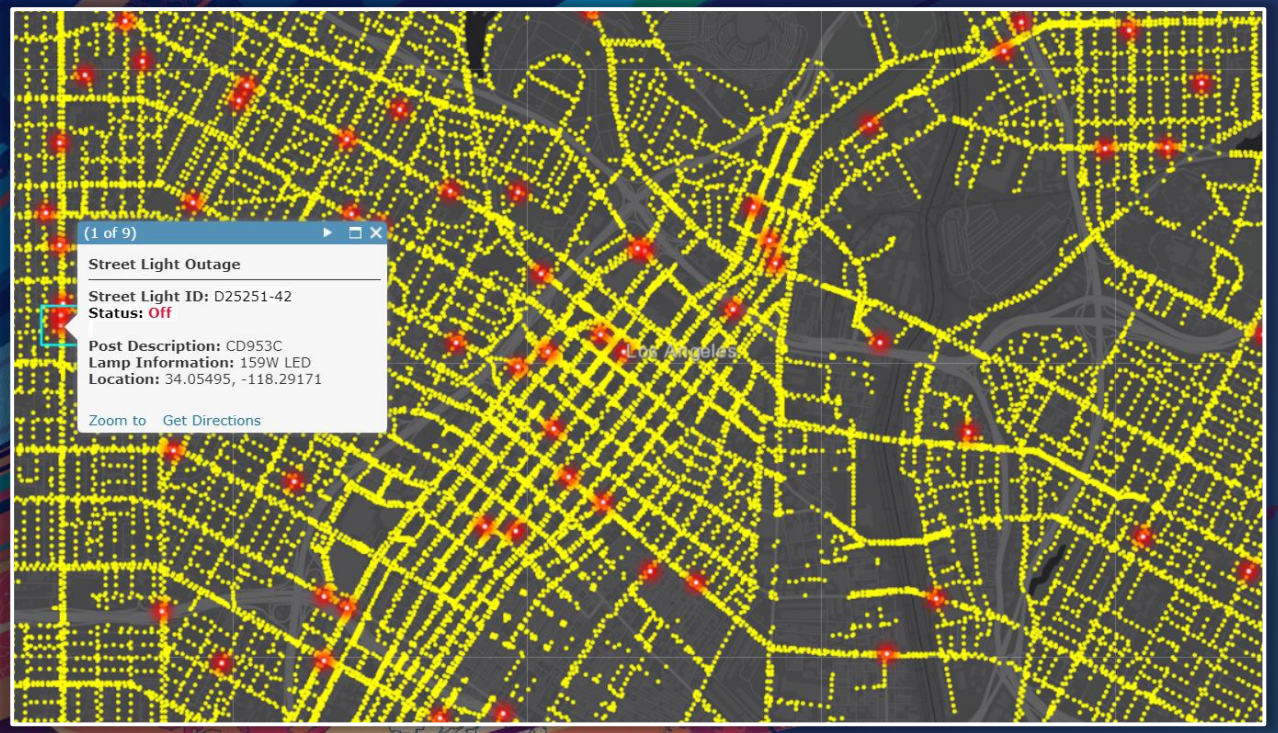

Street Lighting

Visualizing & analyzing street light status

Optimizing maintenance priority based on context

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Road Ahead

Real-Time Analytic

receiving and updating streetlight status

Feed	**Receive streetlight status from Azure IoT Hub**
Select Fields	**Select fields of interest (STLID, LIGHTING_STATUS, …)**
Calculate Field	**Calculate if status represents outage (…)**
Output	**Keep latest feature in streetlight_status feature service**

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Road Ahead

Big Data Analytic

finding bus stops near streetlight outages

Input	**Load streetlights where LIGHTING_STATUS = 'Off'**
Join Features	**Join streetlights to bus stops (Near Geodesic, 50 m)**
Calculate Field	**Calculate WEIGHT field (…)**
Output	**Keep latest feature in streetlight_priority feature service**

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Road Ahead

Big Data Analytic

analyzing businesses near streetlight outages

Input	**Load streetlights where LIGHTING_STATUS = 'Off'**
Join Features	**Join streetlights to businesses (Near Geodesic, 50 m)**
Calculate Field	**Calculate WEIGHT field (…)**
Output	**Keep latest feature in streetlight_priority feature service**

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Road Ahead

Big Data Analytic

analyzing human movement near streetlight outages

Input	**Load streetlights where LIGHTING_STATUS = 'Off'**
Join Features	**Join streetlights to summarized human movement data (Safegraph)**
Calculate Field	**Calculate WEIGHT field (…)**
Output	**Keep latest feature in streetlight_priority feature service**

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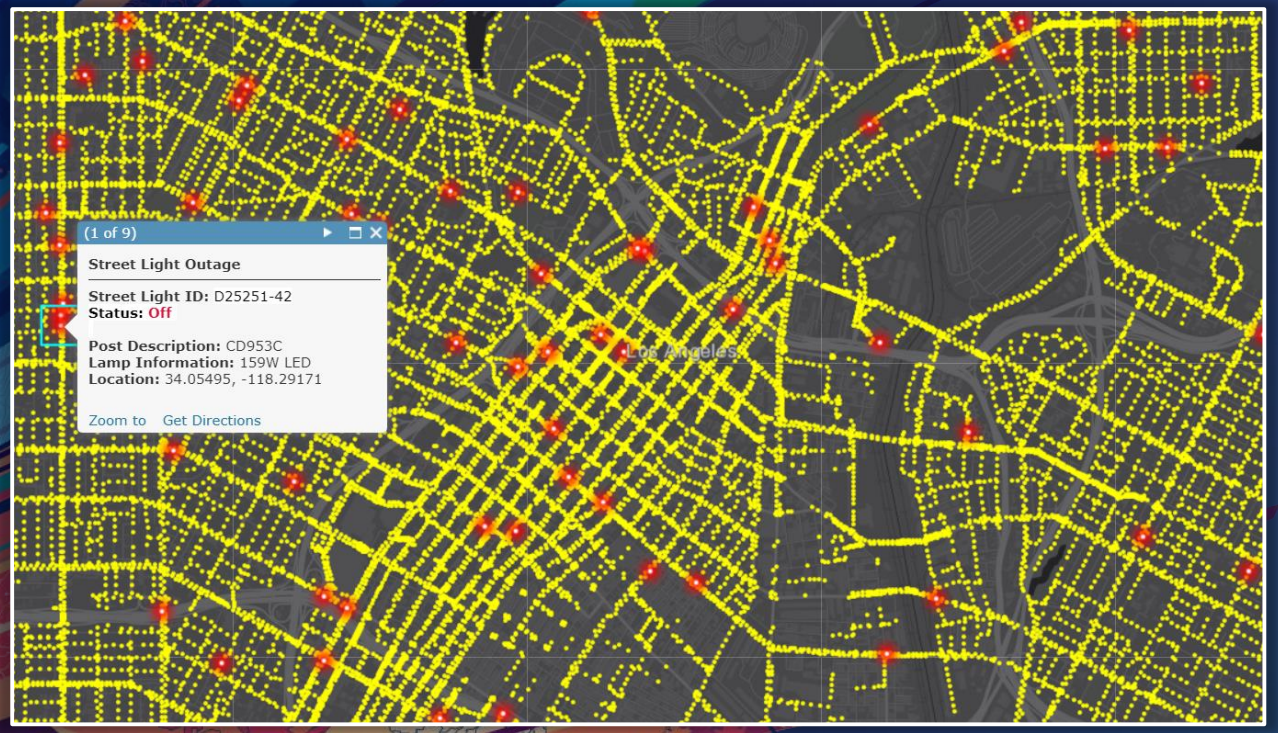

Street Lighting

Visualizing & analyzing street light status

Optimizing maintenance priority based on context

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Road Ahead

ArcGIS Analytics for IoT

summary of planned real-time & big data GIS as a service capabilities

- Feeds
  - Configure a real-time data stream & share it
  - Add a Feed to a web map and immediately visualize as live layer
  - Find & use publicly shared Feeds, *e.g. Waze, Weather, Transit, …*

- Analytics
  - Real-Time Analytics
    - Work on a Feed, perform continuous analysis
    - Alert on patterns of interest, actuate device behavior, store observations
  - Big Data Analytics
    - Work on data in ArcGIS, a big data cloud share, etc
    - Understand patterns and trends over time
    - Schedule to run on a recurring basis, *e.g. once an hour, once a day, every 5 minutes*
  - Authoring an Analytic is a simple guided user experience
  - Analytic results are shared *as Stream Services, Feature Services and/or Map Services*

Wrap Up

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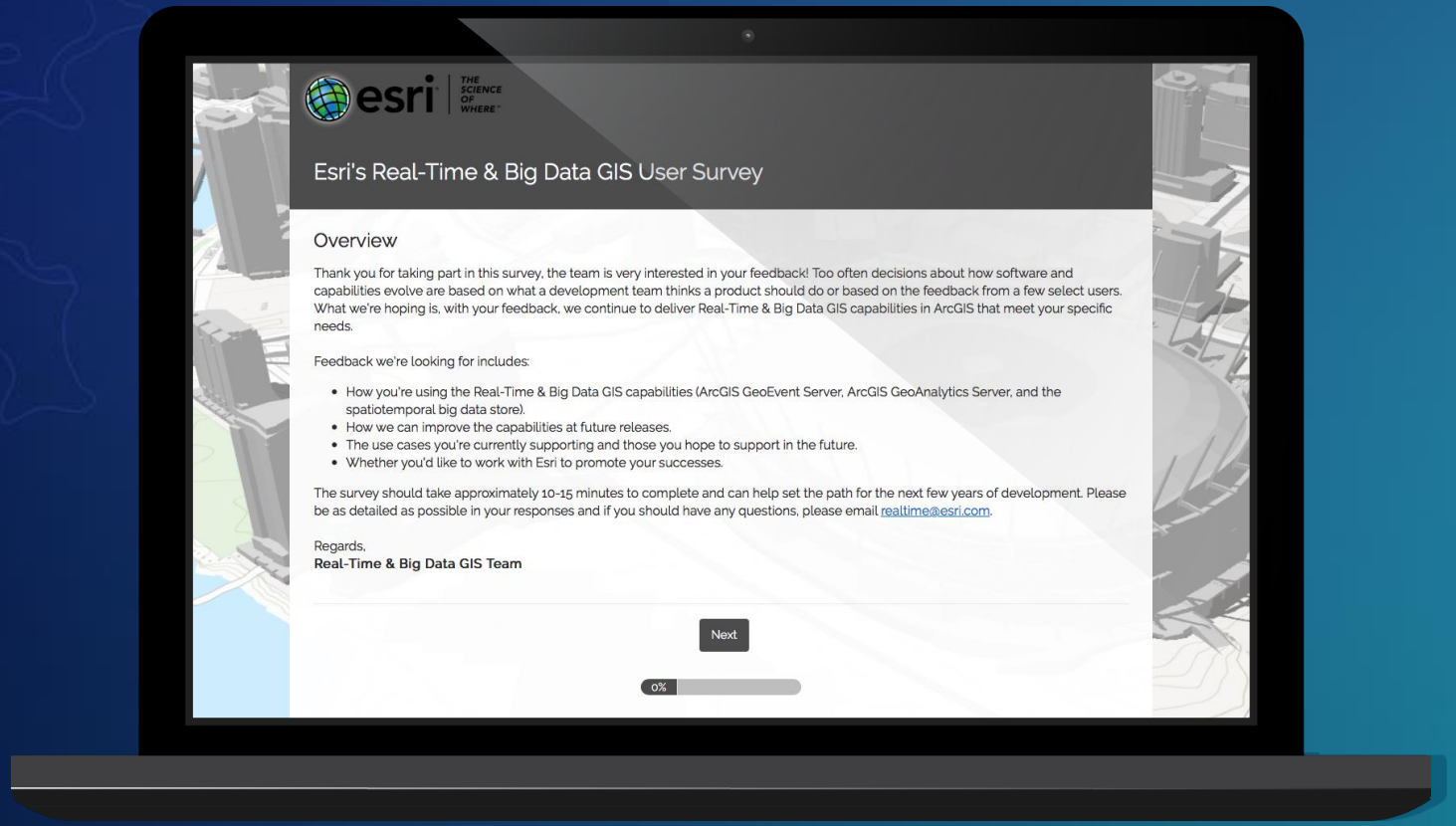
Real-Time GIS: Road Ahead

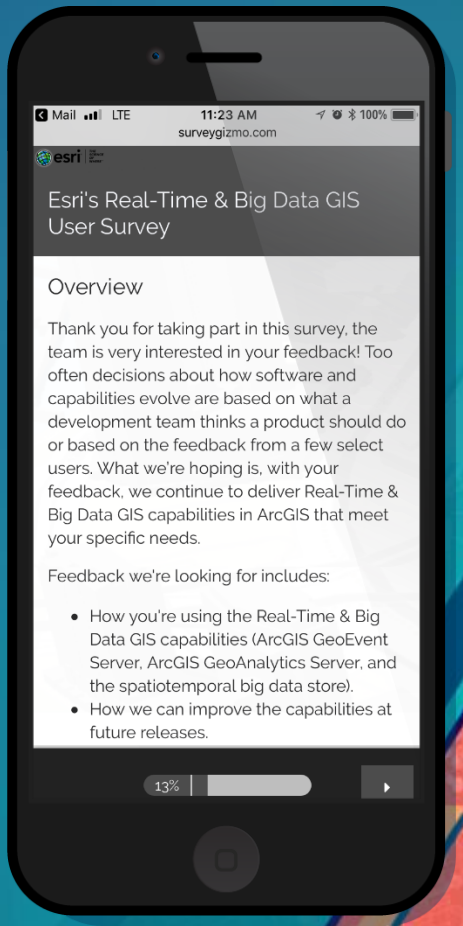
summary

- Real-Time & Big Data GIS:
  - Enables real-time data to be ingested, analyzed, stored & visualized within ArcGIS
  - At 10.6, supports reliability & scalability out-of-the-box via deployment of a multi-machine site
  - At 10.7, support for native cloud storage for input/output and backup
- You can embrace the Internet of Things:
  - Today, by deploying a reliable & scalable on-premise real-time & big data GIS
  - Today, by complementing your ArcGIS deployment with popular IoT cloud platforms
  - In the future, as a service on ArcGIS Online

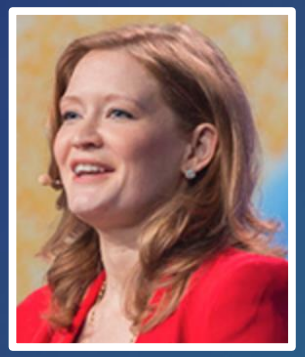
Help us improve the Real-Time & Big Data GIS Capabilities

http://esriurl.com/RealTimeSurvey





Questions / Feedback?



Suzanne Foss
ArcGIS Analytics for IoT
Product Manager
sfoss@esri.com

Josh Joyner
ArcGIS GeoEvent Server
Product Manager
jjoyner@esri.com

Sarah Ambrose
GeoAnalytics Server
Product Engineer
sambrose@esri.com

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