ArcGIS and the Internet of Things

Josh Joyner

Brian Watson

SEE WHAT OTHERS CAN'T

Agenda

1. What is the IoT?
2. Decomposing an IoT solution
3. IoT deployment patterns
4. ArcGIS as an IoT platform
5. ArcGIS as an IoT platform: roadmap
6. Wrap-up

1 What is the IoT?

Internet of Things overview

What is the IoT?

The network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.

Source: Gartner February 2016

Internet of Things overview

What Things?

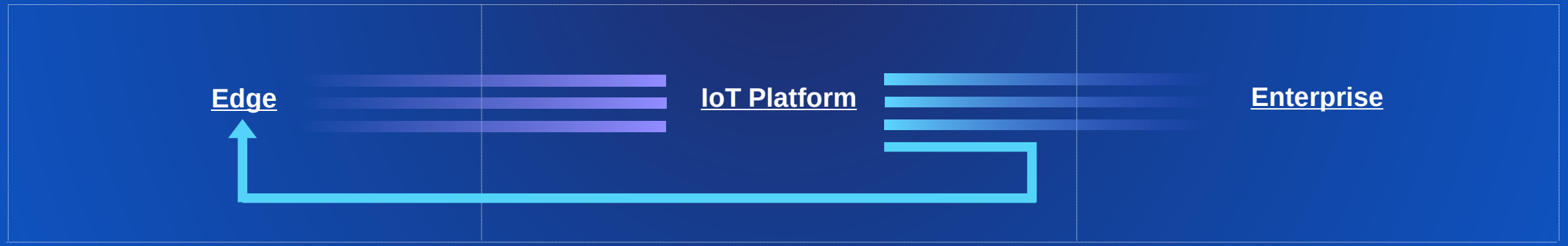
2 Decomposing an IoT solution

Blueprint

for IoT solutions

- **The Internet of Things (IoT) is an integrated solution that senses & collects data from devices at the edge, analyzes that data and takes action to accomplish the business goals of an enterprise.**

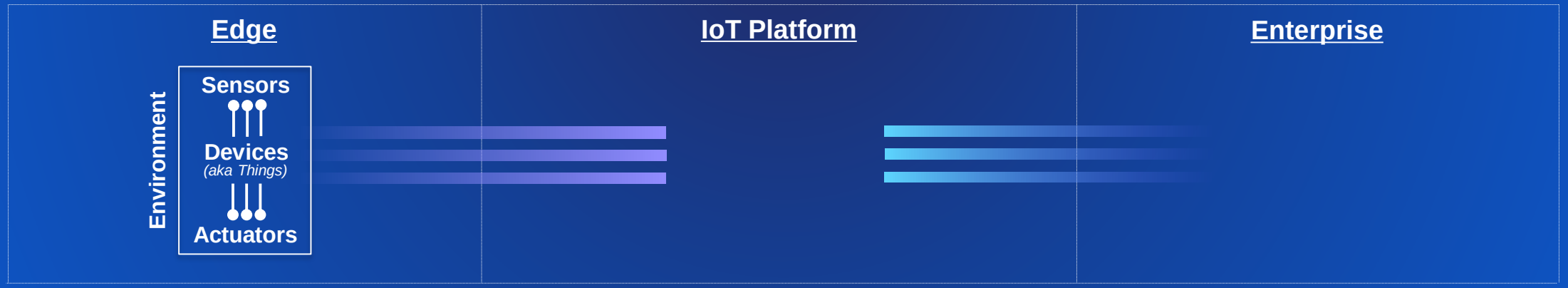
- **An IoT solution consists of the following layers:**
  - **Edge: Embedded technology at the "edge" that senses, acquires & disseminates data.**
  - **IoT platform: Accepts, ingests, stores, analyzes and shares intelligence gleaned from the data.**
  - **Enterprise: Applications & processes that act upon the intelligence as a result of analytic results.**



Edge of an IoT solution

environment, sensors, devices & actuators

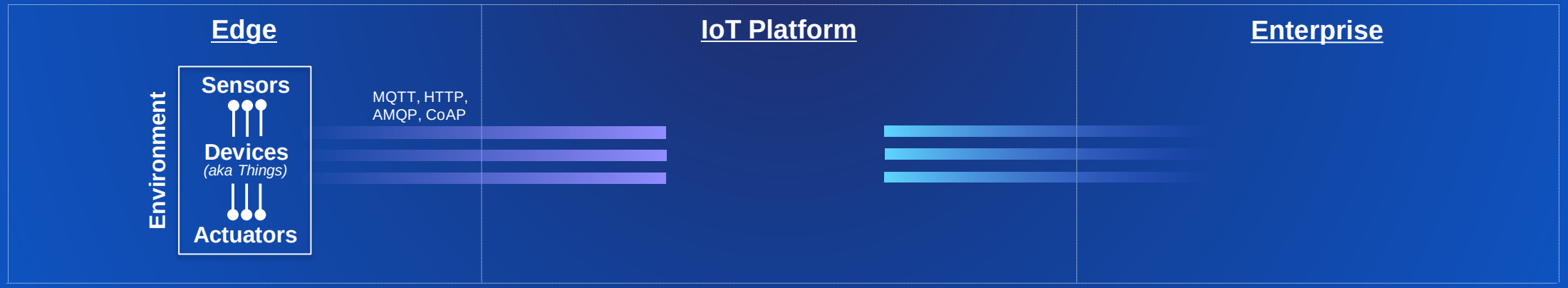
- **The Edge consists of:**
  - **Environment:** The "real world" that generates real-time observations which are sampled by sensors and converted to information by devices.
  - **Sensors:** Samples & collects data from the environment, typically 1,000 times per second to ensure sampling accuracy.
  - **Devices (aka Things):** Applies basic analytics to sensor data to reduce it to a more limited & valuable dataset for transmission. Typically devices emit data on set intervals (once per second), when certain events occur, or when polled.
  - **Actuators:** Receive commands to adjust the behavior of devices in our environment.



Edge of an IoT solution

edge to IoT platform communication protocols

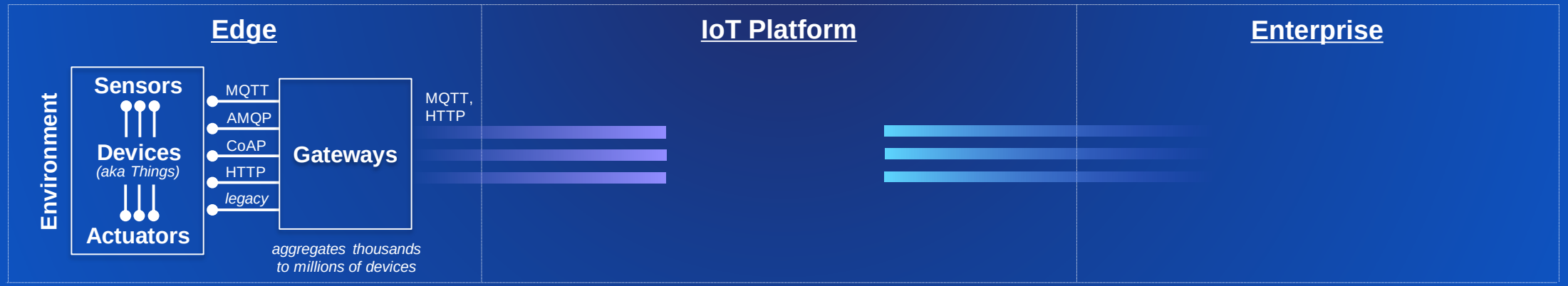
- **Edge communication to an IoT platform typically uses one of the following protocols:**
  - **MQTT:** Message Queuing Telemetry Transport
  - **HTTP:** Hyper Text Transfer Protocol, pushed or polled
  - **AMQP:** Advanced Message Queuing Protocol
  - **CoAP:** Constrained Application Protocol



Edge of an IoT solution

gateways

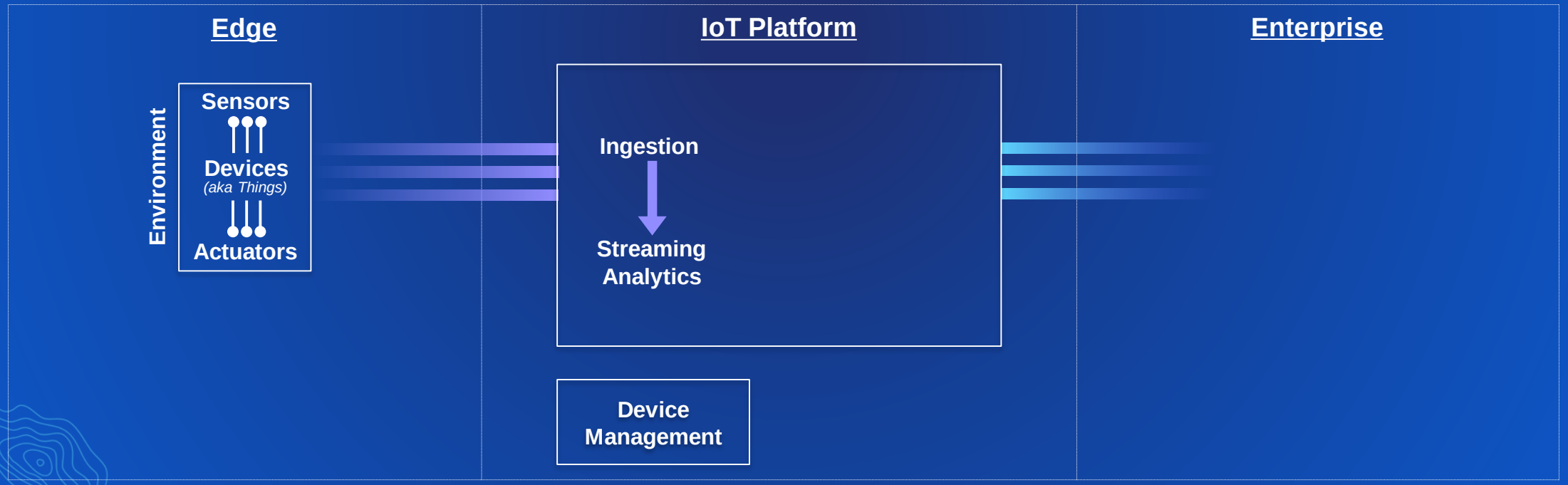
- **Optionally, the Edge may consist of one or more:**
  - **Gateways (aka Aggregation Points):** Accepts multiple protocols & data models from disparate devices & translates that data into the IoT Platform's protocol, API & data model. Serves as a primary interconnection to the IoT Platform.
- **Gateway communication to an IoT platform typically uses one of the following protocols:**
  - **MQTT:** Message Queuing Telemetry Transport
  - **HTTP:** Hyper Text Transfer Protocol, pushed or polled



IoT platform

device management & ingestion

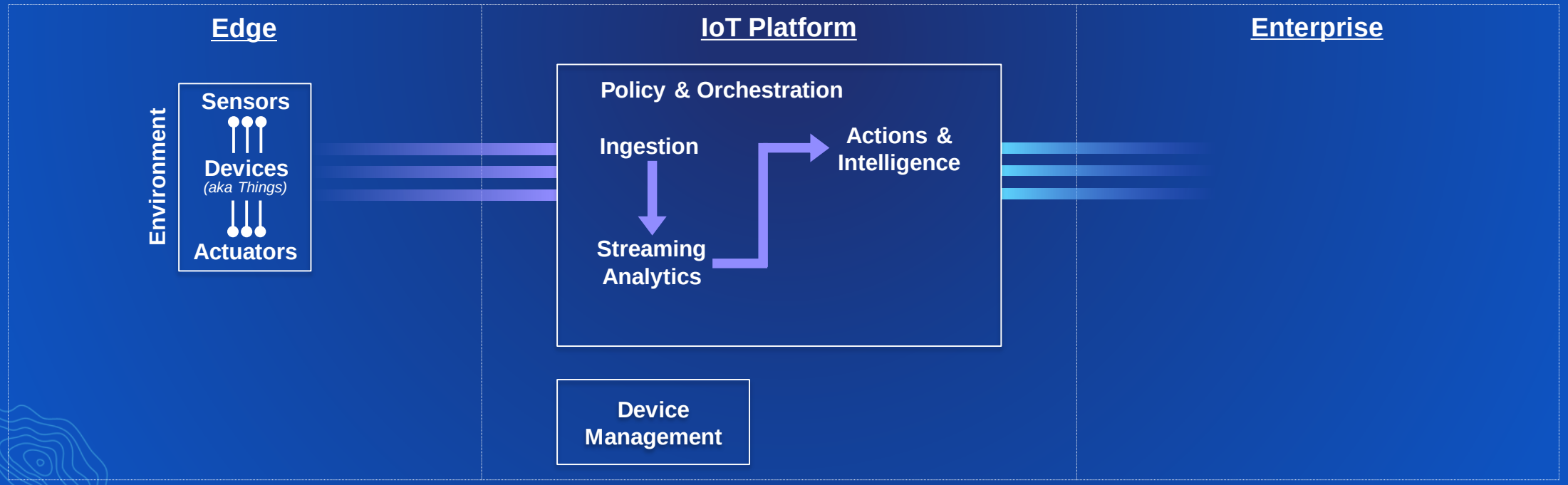
- **An IoT platform consists of:**
  - **Device Management:** Authenticates & establishes secure communications with the Edge devices and/or gateways to ensure incoming data can be trusted. Also, is responsible for keeping devices up to data and provisioning software updates as appropriate.
  - **Ingestion:** Accepts data from the Edge and prepares it to be consumed by one or more Streaming Analytics.



IoT platform

streaming analytics, policy, orchestration, actions & intelligence

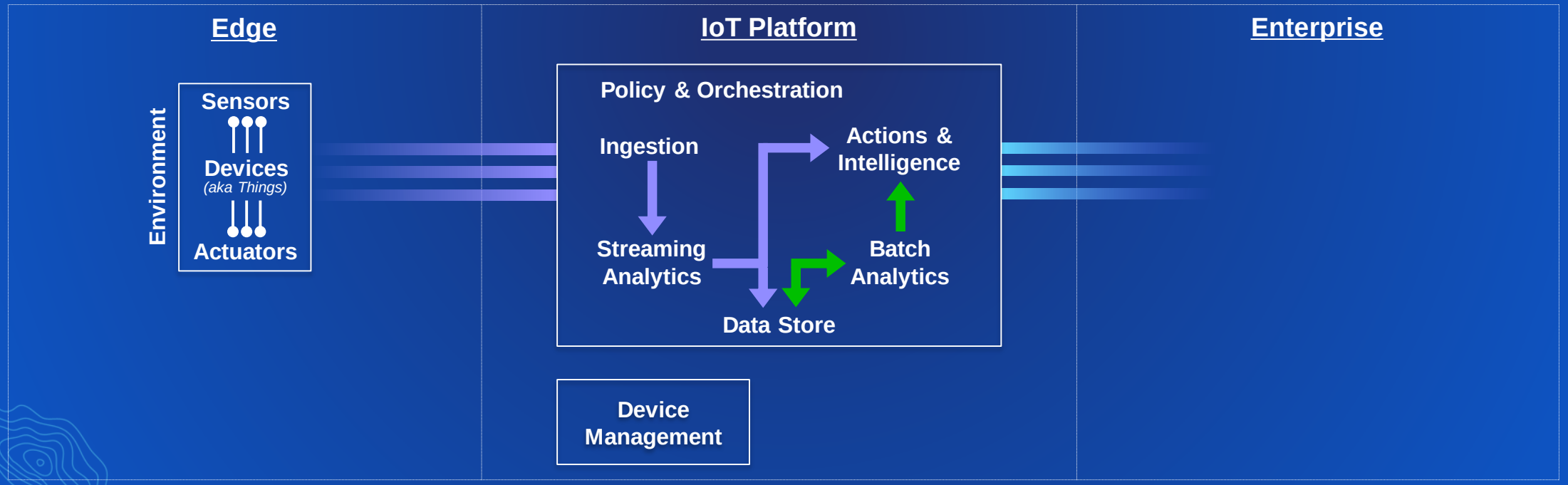
- **An IoT platform consists of:**
  - **Streaming Analytics:** consumes a continuous stream of data from the Ingestion layer using Orchestration & a Policy (aka Business Rule) to make decisions about what to do: trigger immediate actions and/or store the data in a Data Store for Visualization and subsequent Analytics.
  - **Actions & Intelligence:** takes action via secure access to Actuate Edge Devices and/or Enterprise applications.



IoT platform

data store & batch analytics

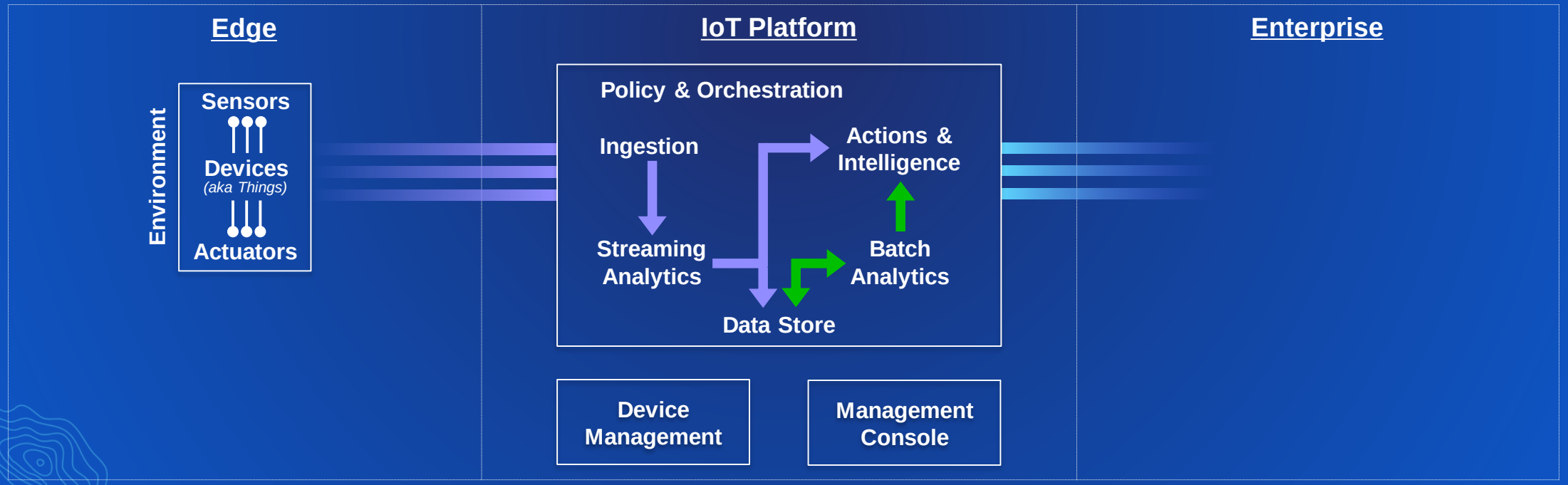
- **An IoT platform consists of:**
  - **Data Store:** provides storage for data that has been Orchestrated for storage. Prepares stored data for efficient visualization, interactive queries & Batch Analytics.
  - **Batch Analytics:** performs descriptive, prescriptive and/or predictive analysis on data, processes resulting events & applies policies to determine actions. Typically, can be ad-hoc or scheduled on a recurring basis.



IoT platform

management console, policy & orchestration

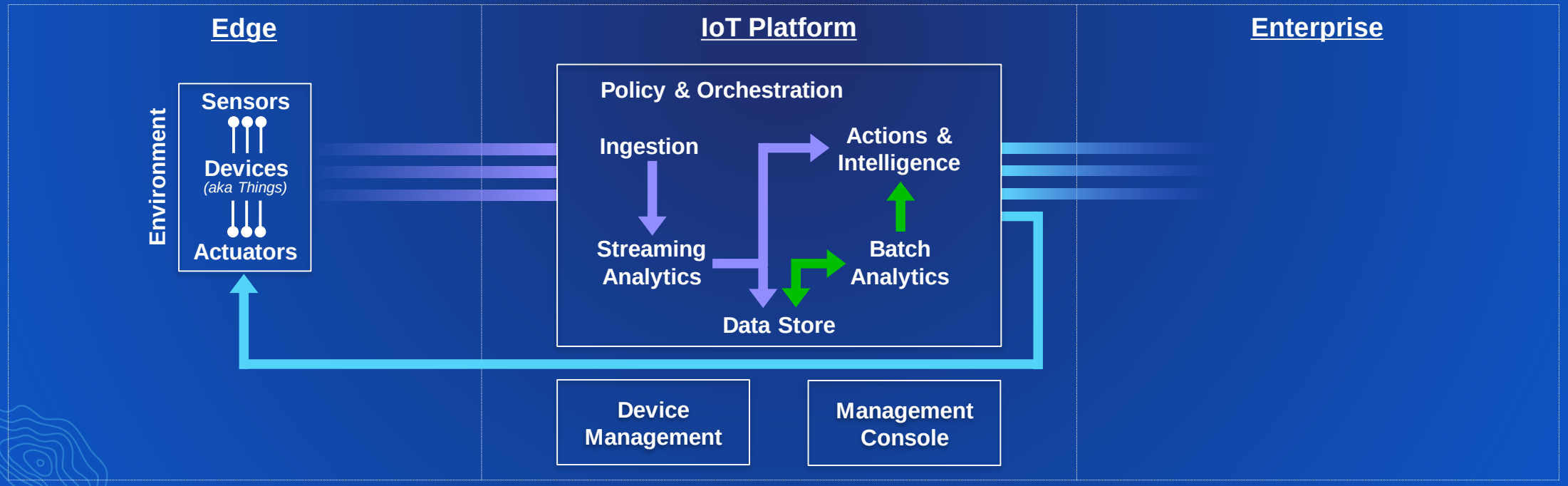
- **An IoT platform consists of:**
  - **Management Console:** Handles a range of management tasks for the IoT platform such as managing the flow of data, creating Policies, setting event thresholds & managing Data Stores.
  - **Policy (aka Business Rule):** Processes resulting data from Analytics & compares thresholds/triggers configured by data scientists to determine a course of action for the orchestration engine to execute.
  - **Orchestration:** Coordinates steps necessary to execute an action.



IoT platform

actuating devices

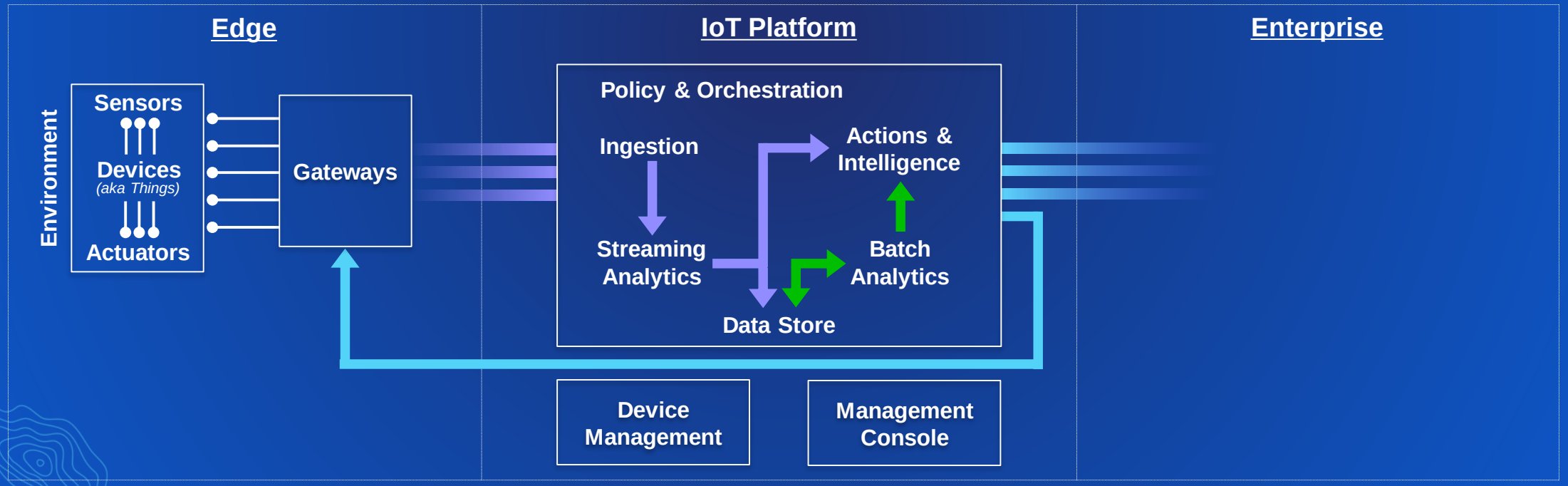
- An IoT platform consists of:
  - **Actuation Action:** A special type of action that sends a command to a device to alter the behavior of it's environment.



IoT platform

actuating devices with a gateway

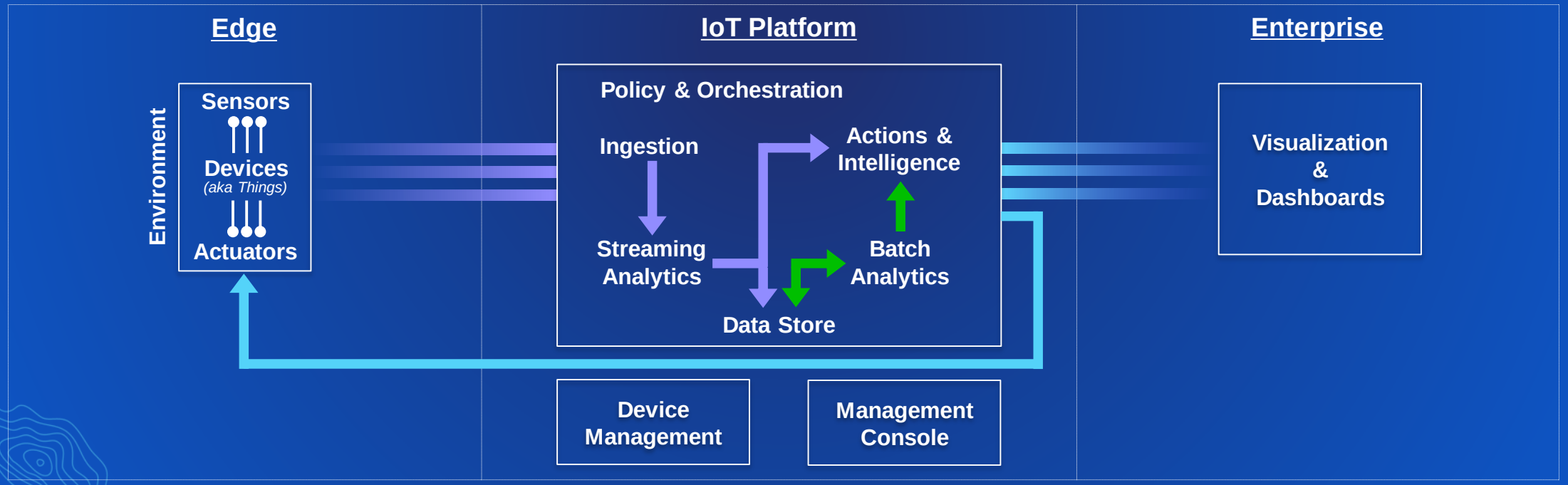
- An IoT platform consists of:
  - **Actuation Action:** A special type of action that sends a command to a device to alter the behavior of it's environment. When a gateway is present it is responsible for mediating the actuation command to the appropriate device.



Enterprise

visualization & dashboards

- **The Enterprise layer of an IoT consists of:**
  - **Visualization:** enables data scientists to spot key trends and patterns using exploratory visual analysis techniques that have the ability to interactively query the data. Once trends are recognized policies can be created to automatically detect the pattern and automatically trigger desired action(s).
  - **Dashboards:** Dashboards can be configured to enable the monitoring of an IoT solution's environment and the behavior of it's Devices/Things.

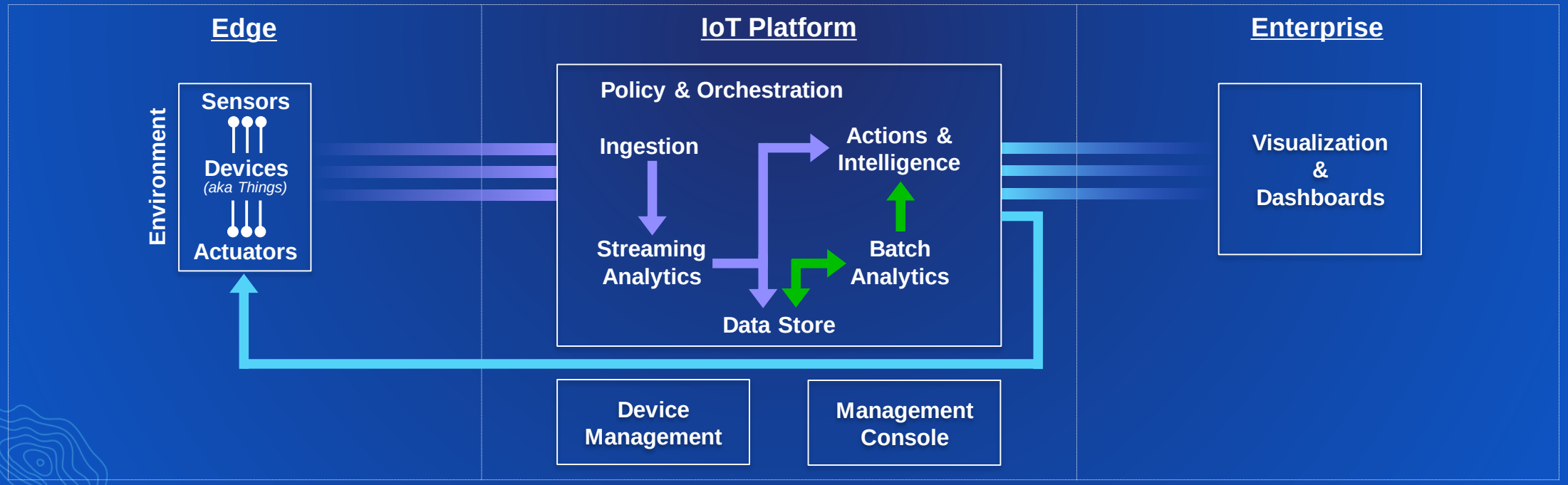


3 IoT deployment patterns

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

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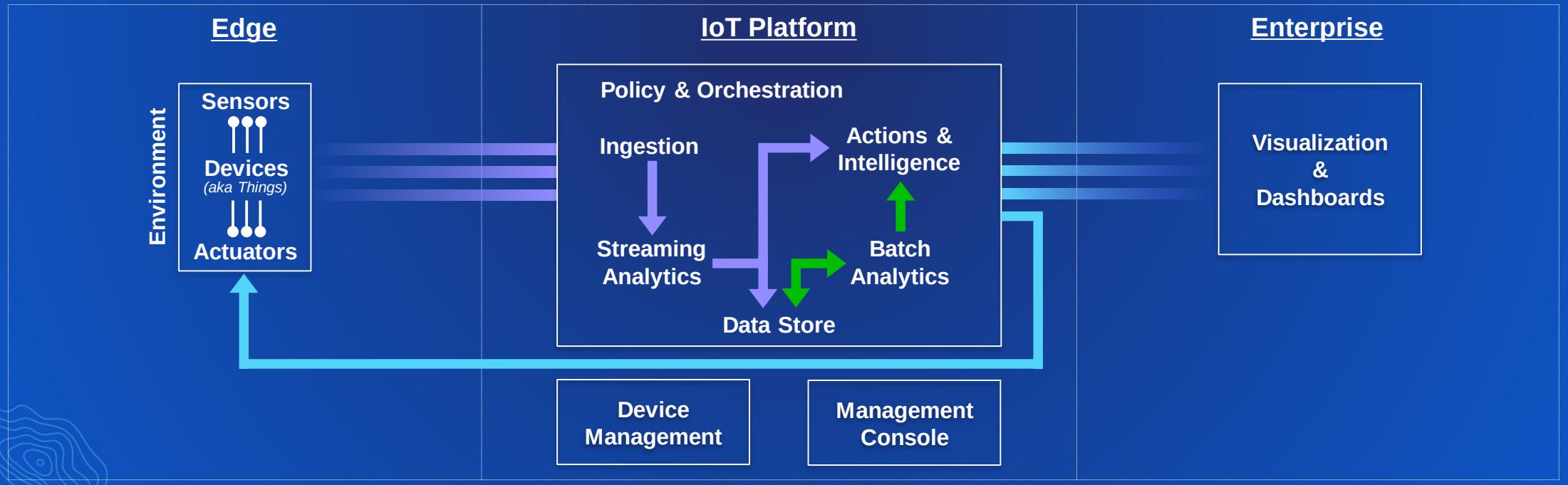

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- **An ArcGIS based IoT Platform & Enterprise consists of the following capabilities:**
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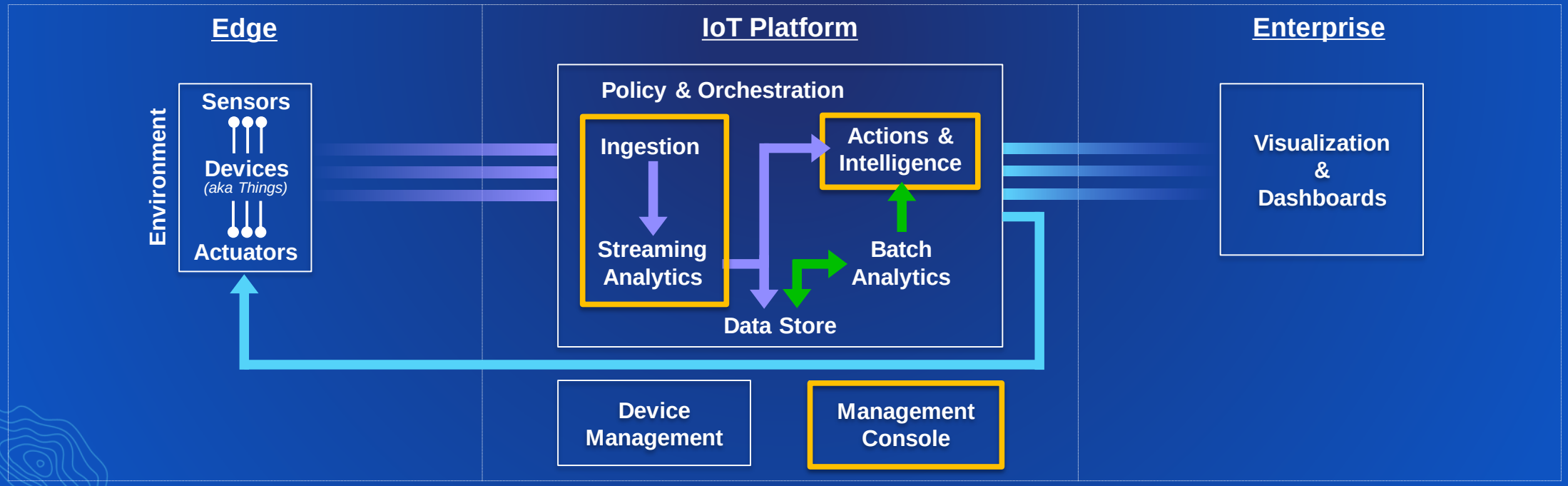
  - **Visualization**
  - **Dashboards**



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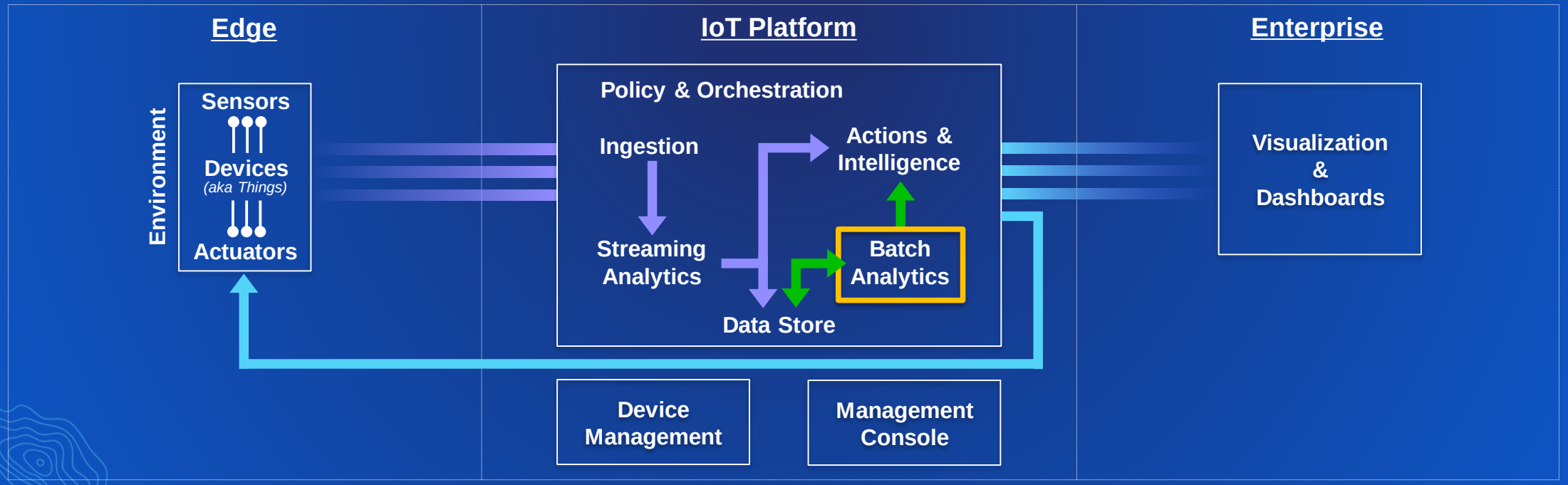

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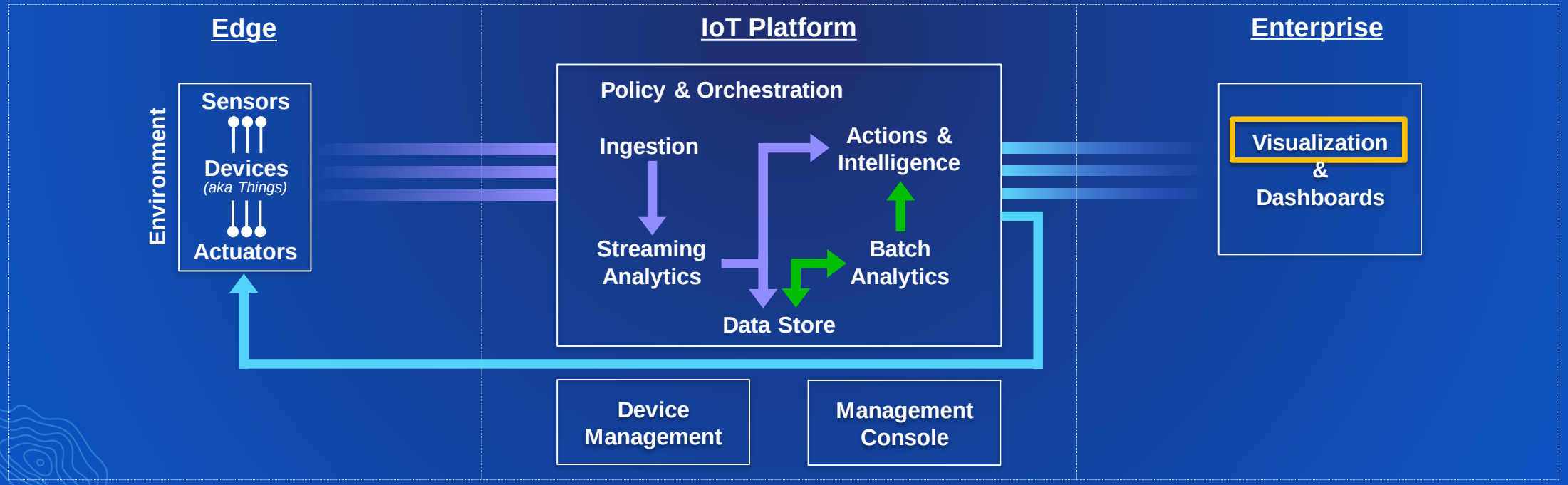
  - **Visualization** – Map, Feature, & Stream Services
  - **Dashboards**



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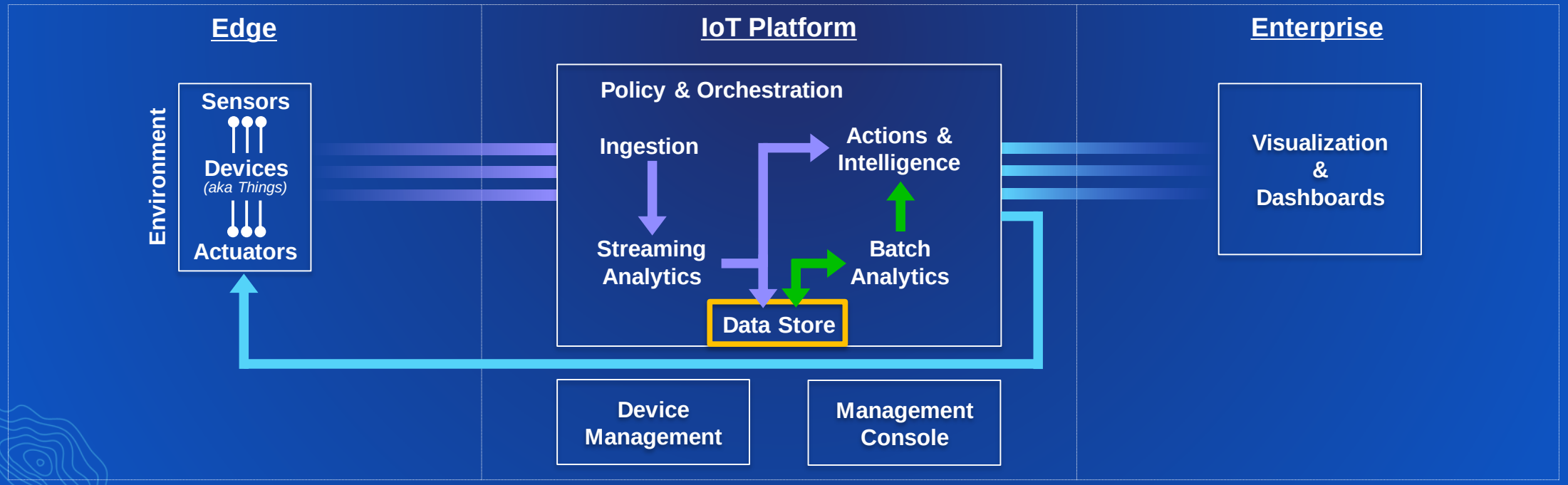

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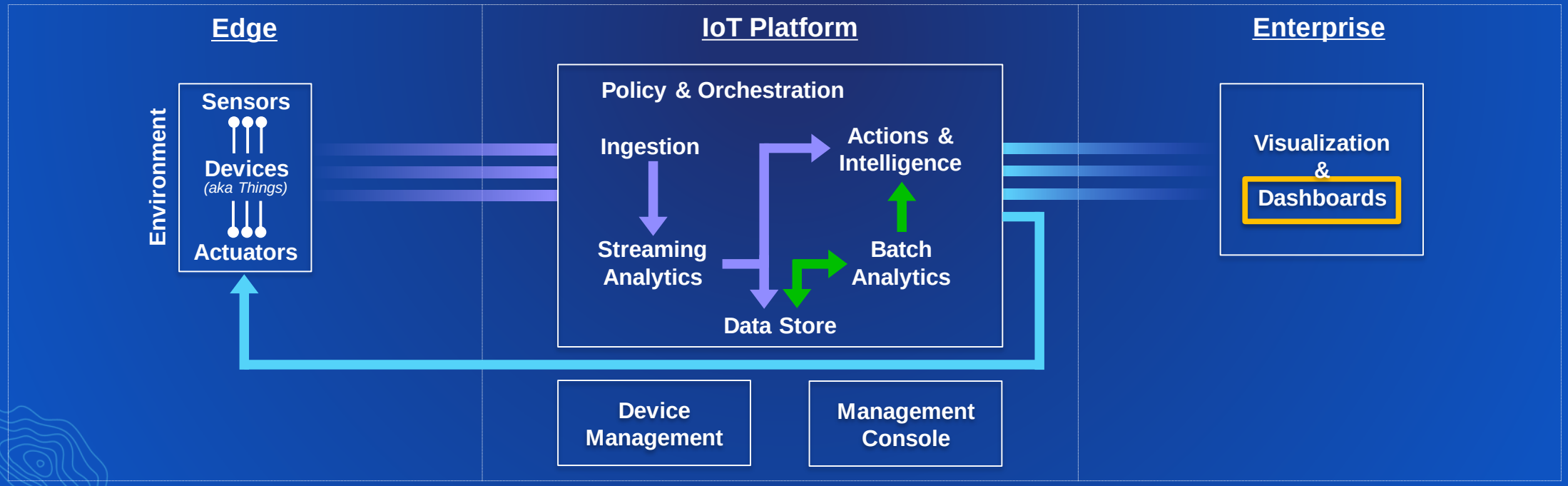

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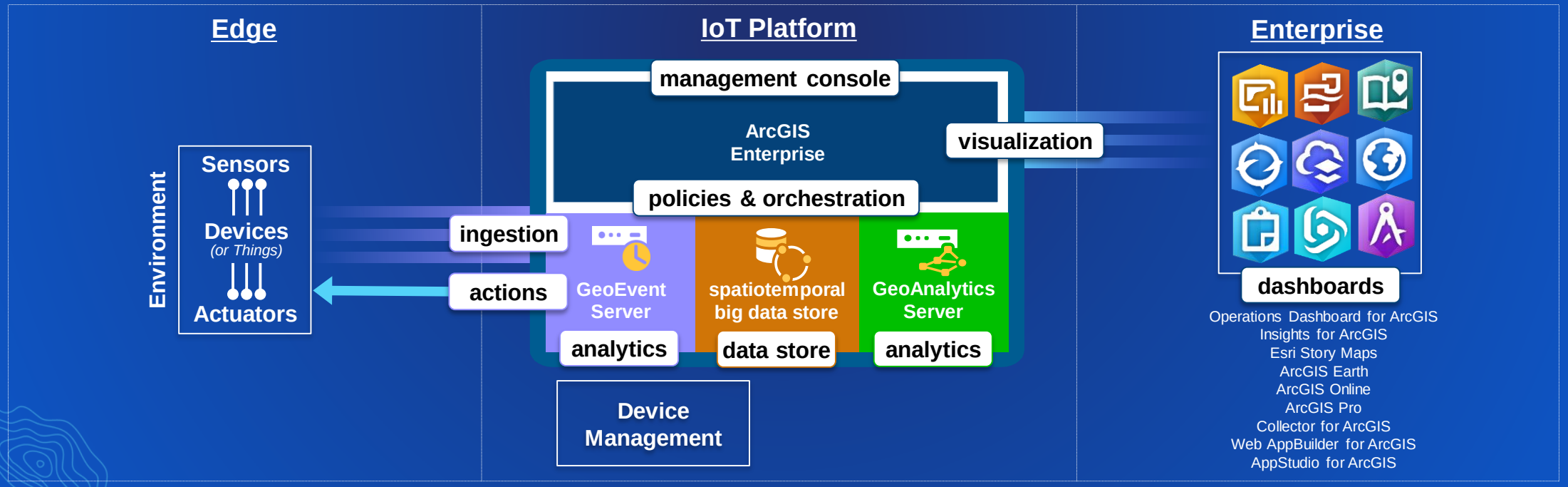

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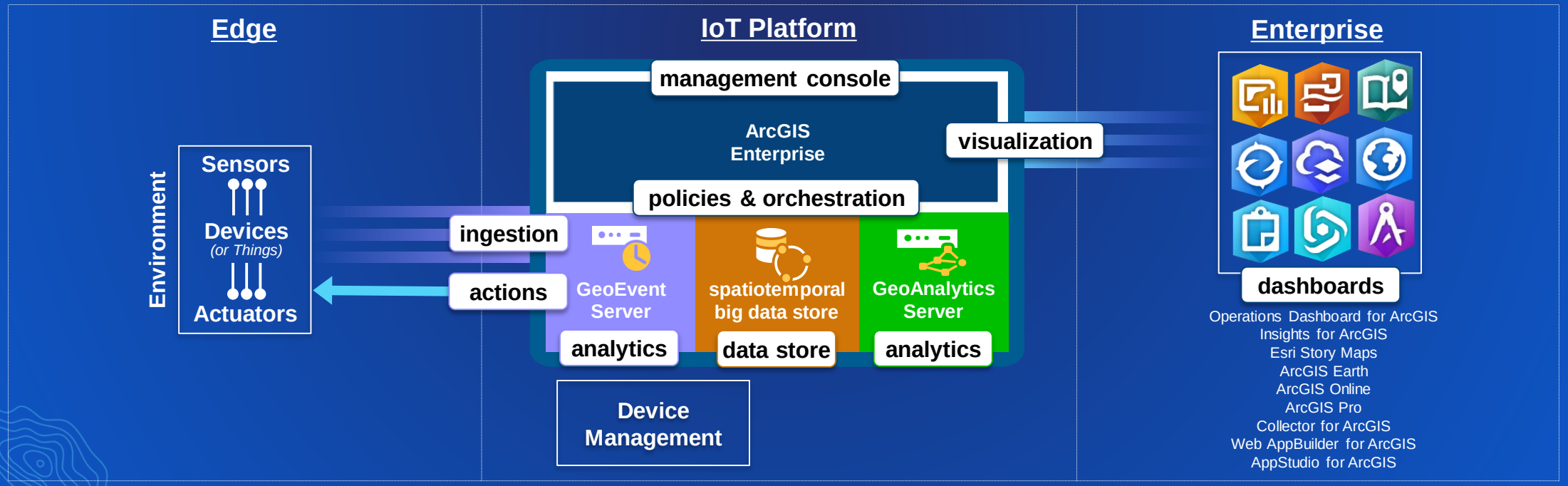
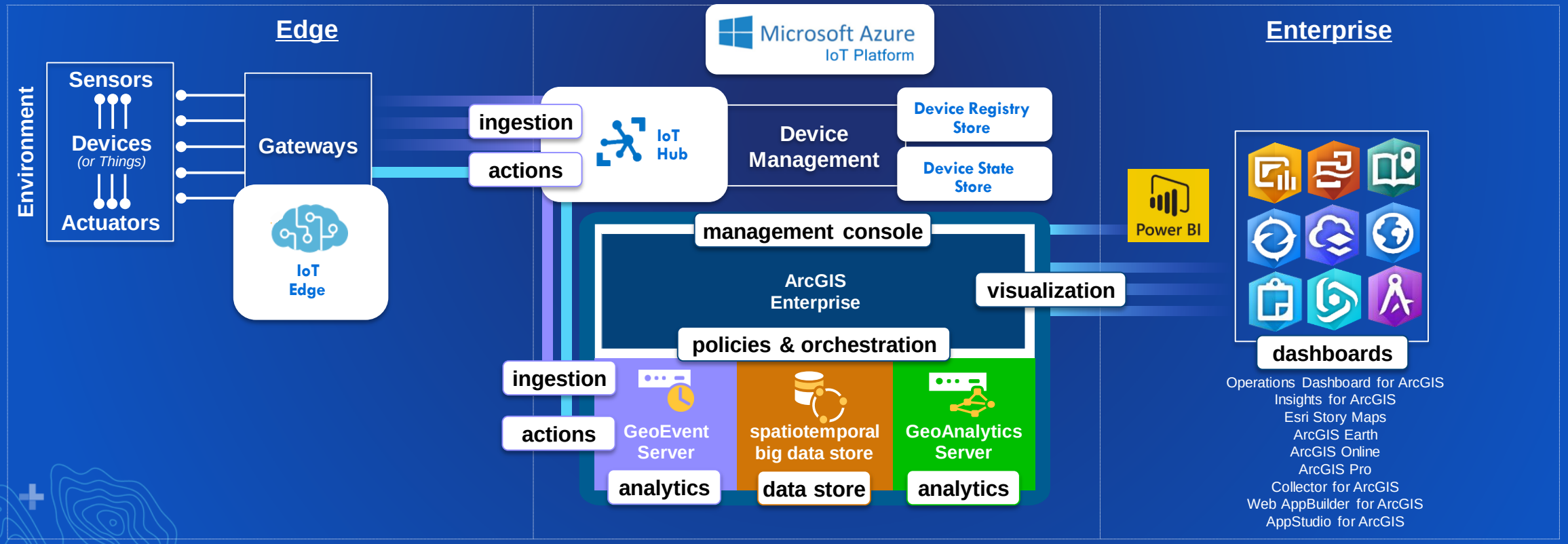
  - **Device Management** *for those requiring this functionality another IoT platform can be complemented with ArcGIS.*



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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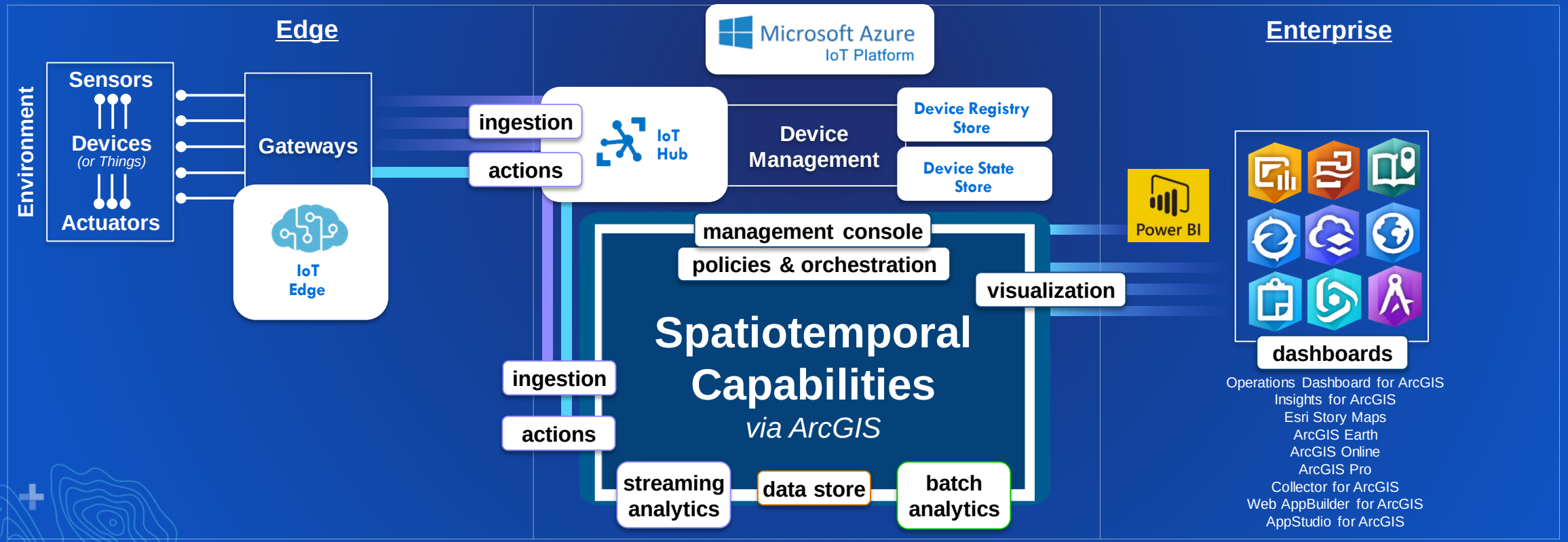


4 ArcGIS as an IoT Platform

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

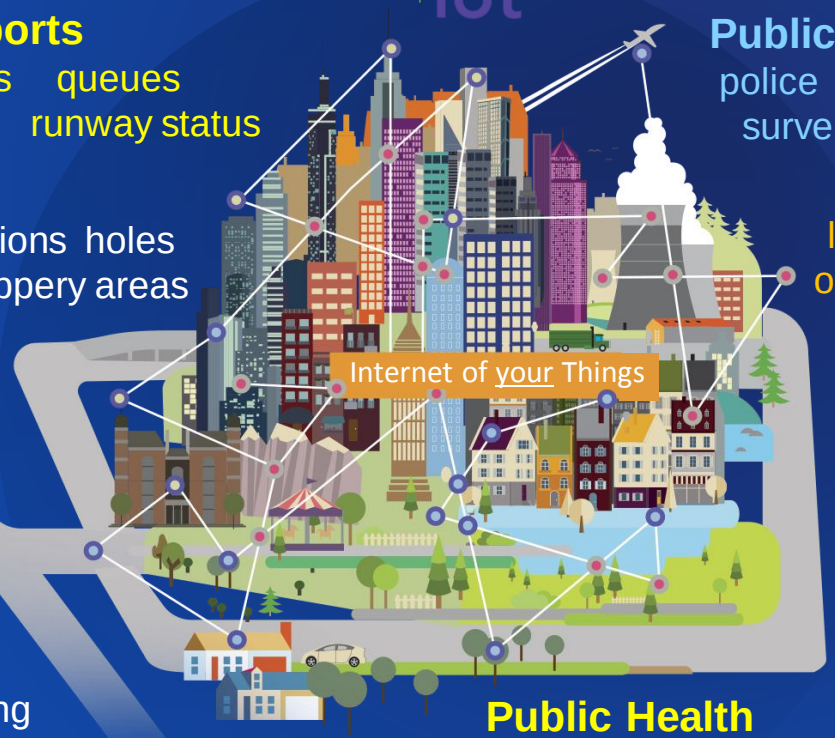
police fire
surveillance

Connected Cars

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

Buildings

lighting hvac
occupancy counts



Apps
Desktop
APIs

ArcGIS Enterprise

with real-time & big data capabilities

ingest, store, analyze, visualize

Transit

buses taxis rail
trains crowds

Energy Usage

electricity gas smart meters

City Workers

sanitation snow plows

People

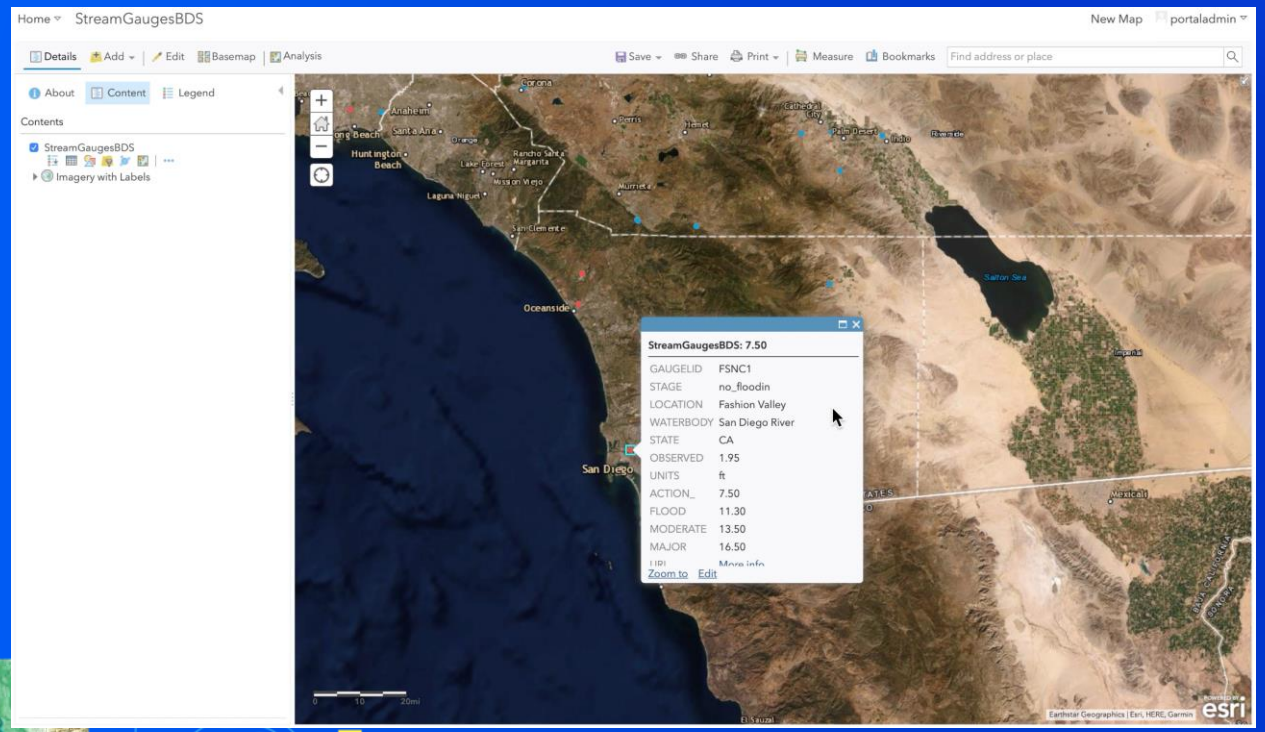
health monitoring
social activity

Public Health

hospitals ambulances

Telecommunications

cell phone signals dropped calls



Spatiotemporal Capabilities

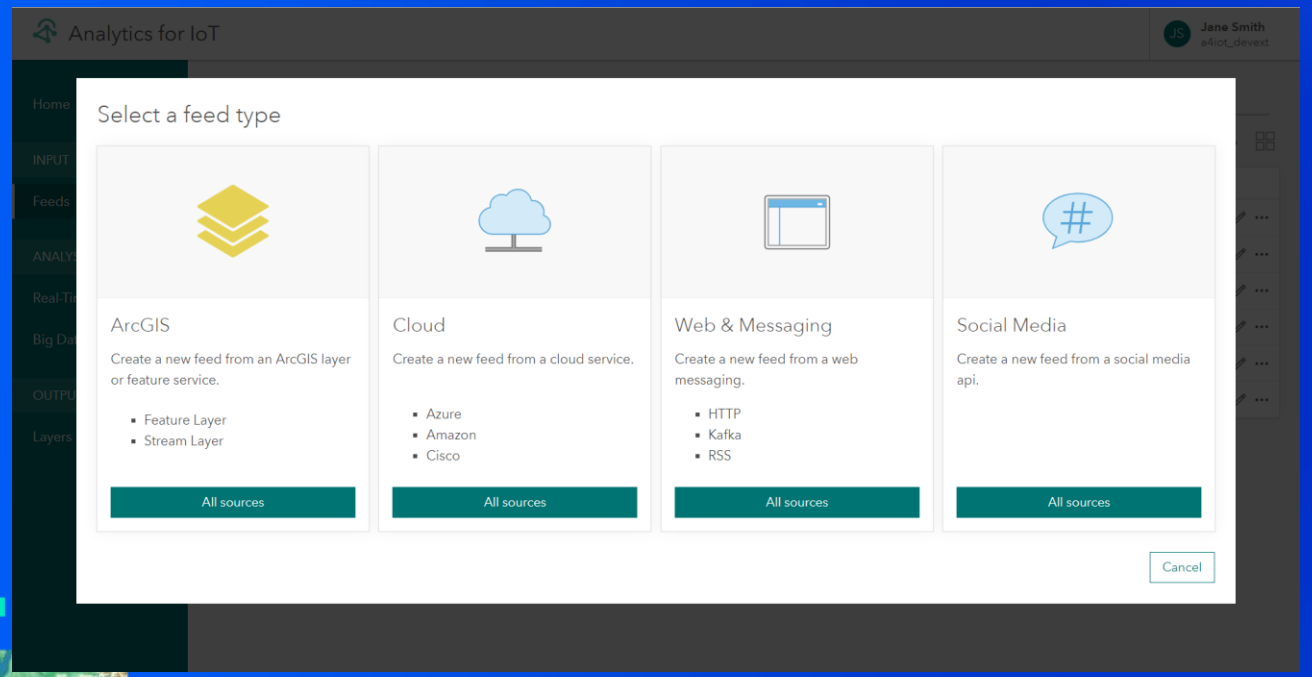
Demo

5 ArcGIS as an IoT Platform roadmap

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



Analytics for IoT

Demo

6 Wrap-up

ArcGIS & the Internet of Things

Additional Resources

Esri User Conference 2018 pre-conference seminar on 'Integrating IoT & ArcGIS':

https://github.com/Esri/integrating-iot-arcgis

Integrating IoT & ArcGIS

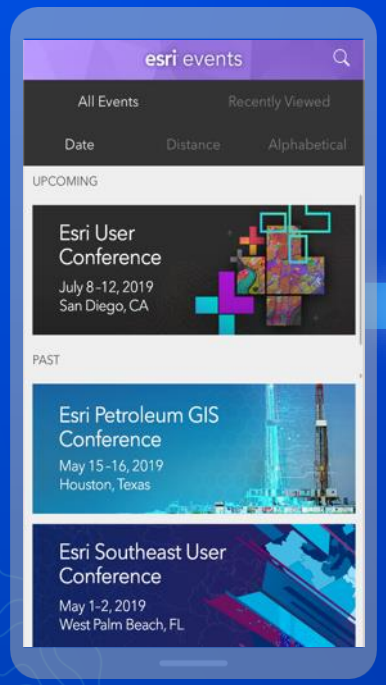
- Agenda [slides, video]
- What is the IoT? [slides, video]
- Decomposing an IoT Solution [slides, video]
- ArcGIS as an IoT Platform [slides, video]
  - visualization of moving observations (map service) [video]
  - visualization of stationary observations (map service) [video]
  - visualization of discrete observations (map service) [video]
  - visualization of observations (feature service) [video]
- Deployment patterns [slides, video]
  - Edge to ArcGIS as an IoT Platform demonstation [video]
  - Complementing an IoT platform with ArcGIS demonstration [video]
- Spatiotemporal analytic capabilities [slides, video]
  - Real-Time spatiotemporal analytics demonstration [video]
  - Actuation demonstration [video]
  - Big Data spatiotemporal analytics demonstration [video]
- Handling IoT scale requirements [slides, video]
  - Ingestion, streaming analytics, storage & visualization at scale demonstration [video]
  - Batch analytics at scale demonstration [video]

Real-Time and Big Data Technical Workshops

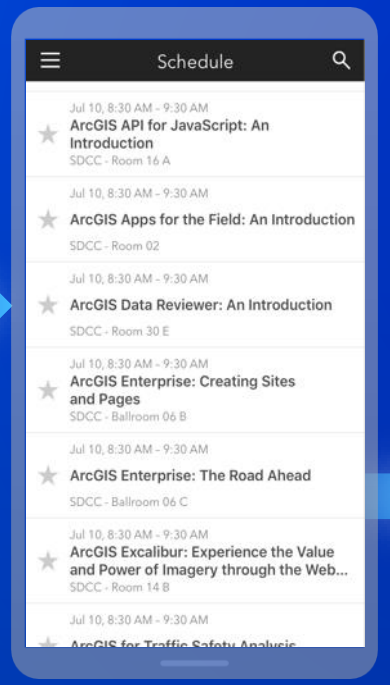
- **Tuesday**
  - 8:30 - 9:30 ArcGIS GeoEvent Server: An Introduction
  - 10:00 - 11:00 ArcGIS GeoEvent Server: Applying Real-Time Analytics
  - 2:30 - 3:30 ArcGIS and the Internet of Things (IoT)
- **Wednesday**
  - 8:30 - 9:30 ArcGIS GeoEvent Server: Visualizing Real-Time Data
  - 10:00 - 11:00 Real-Time & Big Data GIS: Best Practices
  - 1:00 - 2:00 ArcGIS GeoEvent Server: An Introduction — 2nd offering
  - 4:00 - 5:00 ArcGIS GeoEvent Server: Applying Real-Time Analytics — 2nd offering
  - 4:00 - 5:00 ArcGIS and the Internet of Things (IoT) — 2nd offering
- **Thursday**
  - 10:00 - 11:00 Real-Time & Big Data GIS: Best Practices — 2nd offering
  - 2:30 - 3:30 Real-Time & Big Data GIS: Road Ahead — Only Offering
  - 4:00 - 5:00 ArcGIS GeoEvent Server: Visualizing Real-Time Data — 2nd offering

Please Share Your Feedback in the App

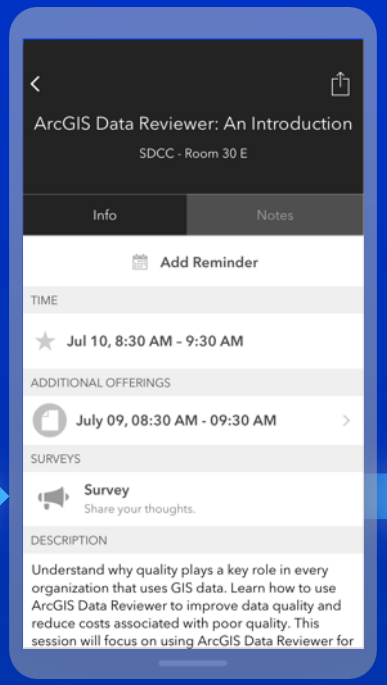
Download the Esri Events app and find your event



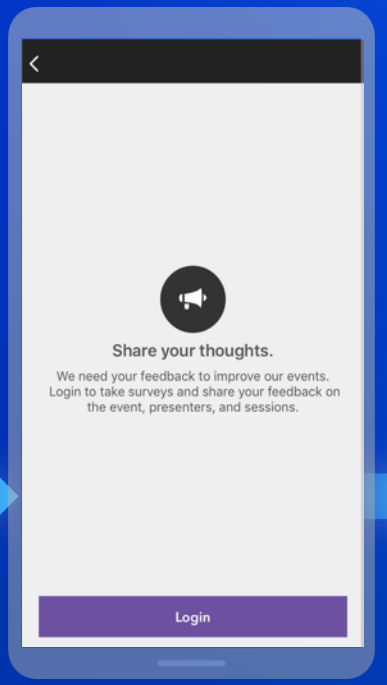
Select the session you attended



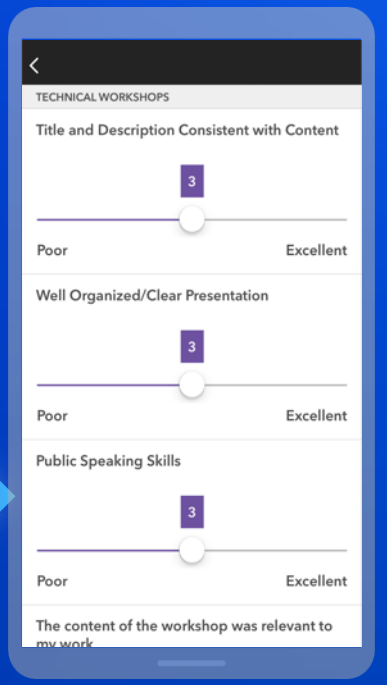
Scroll down to "Survey"



Log in to access the survey



Complete the survey and select "Submit"



Questions
Feedback

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SEE
WHAT
OTHERS
CAN'T

esri | THE SCIENCE OF WHERE