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GIS and Emerging Technology (GIS is IT)

MTASC Spring Meeting
3/21/2024
Columbia, SC

Jim Tochterman, VP - Research & Development



GIS and Emerging Technology

Evolution and Expansion

- Becoming even more IT-centric (SysOps, DataOps, DevOps)
- New cloud products and capabilities (Site Scan for ArcGIS, ArcGIS Places Service)
- Open Source / Cross Platform (Leaflet, OpenLayers, MapLibre, .NET MAUI)
- Data Science (Pandas, Spark, Parquet, Apache Arrow)
- 3D / Digital Twin / VR-XR / Metaverse (Unity, Unreal Engine)
- Deep Learning / AI / LLM
- GIS Professionals / IT Professionals / Developers





GIS and Emerging Technology

ArcGIS

A Comprehensive Spatial Analytics System

Raster Analytics & Modeling, Visual Modeling, Modeling & Scripting, Spatial Statistics, Big Data Analytics, Network Analysis & Geocoding, Graph Analytics, Knowledge Graph, Analysis (Vector, Raster & Graph), Analysis in Map Viewer, Suitability Model Evaluation, Point Cloud Classification, Python Environment Upgrades, ModelBuilder: Iterate Time Slices, GeoAnalytics Engine, Neighborhood Explorer, Causal Inference, Density-Based Clustering with Time, 3D Inverse Distance Weighting.

Thousands of Tools . . . Empowering Analysts & Data Scientists



GIS and Emerging Technology

ArcGIS is a Well-Architected IT System

Available as Software, SaaS, PaaS

WELL-ARCHITECTED SYSTEM PILLARS: Integration, Security, Performance & Scalability, Reliability, Automation, Observability, Infrastructure (Cloud and on-premises - compute, storage, network...).

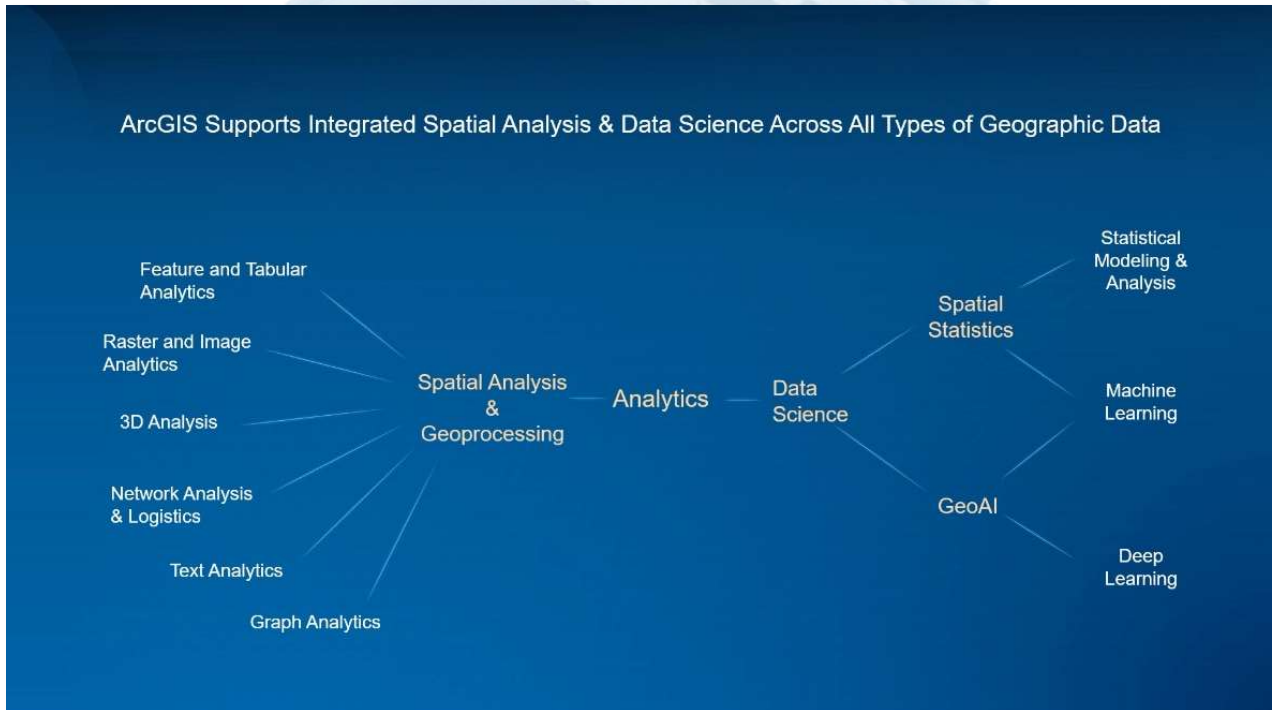
APPs & APIs
SERVICES
PORTAL
DATA
MAPPING & VISUALIZATION
ANALYSIS
INFORMATION MODELS
DATA STORES
FEEDS
DATA Persistence



GIS and Emerging Technology



GIS and Emerging Technology





GIS and Emerging Technology

Evolution and Expansion also means other changes...

- Product rebranding: ArcGIS Maps SDK [Insert Product...]
 - ArcGIS Maps SDK for JavaScript (formerly ArcGIS API for JavaScript)
 - ArcGIS Maps SDK for .NET (formerly ArcGIS API for .NET)
 - ArcGIS Maps SDK for Java (formerly ArcGIS API for Java)
 - ArcGIS Maps SDK for Swift (new)
 - ArcGIS Maps SDK for Kotlin (new)
 - ArcGIS Maps SDK for Qt (formerly ArcGIS API for Qt)
- Retirement: ArcGIS API for JavaScript 3.x
 - July 2024, no more bug fixes, enhancements, no tech support
 - Existing apps will continue to run
 - Custom web apps should be migrated /rewritten



GIS and Emerging Technology

Evolution and Expansion also means other changes...

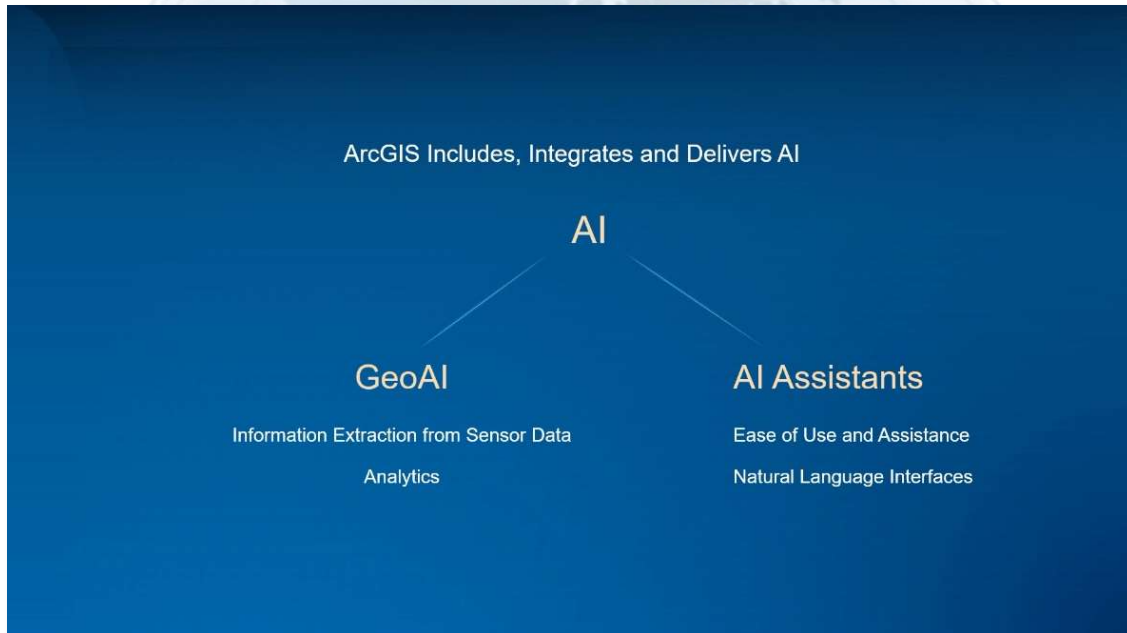
- Web AppBuilder (Developer Edition) retires July 2024
- Web AppBuilder (ArcGIS Online) retires in Q4 of 2025
- Web AppBuilder (ArcGIS Enterprise) is deprecated
 - Will continue to be a part of Enterprise until the first half of 2025, at which point it will be retired and no longer released in new versions of Enterprise
 - Existing versions of Enterprise will continue to be supported in accordance with the ArcGIS Enterprise Product Lifecycle.
- ArcGIS Desktop – Mature Support as of March 2024, Retires March 2026





GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)

GeoAI Tools & Models for Feature Extraction & Analysis

New & Improved

- 16 New Pretrained Models
- New Model Types
- Foundation Models (SAM, Prithvi)
- AI-Assisted Labeling
- AutoML / AutoDL
- Point Cloud Feature Detection
- Fairness & Multimodal Input in ML

Coming

- Model Explainability
- Visualize & Compare Model Metrics
- Text Prompts for Labelling
- New Models (SuperRes)
- LLM Support for Text Analysis

Imagery & Remote Sensing

- Point Cloud Classification
- Object Classification
- Road Extraction
- Crop Classification

Text

- Text Classification
- Text Transformation
- Entity Extraction

Feature & Tabular Data

- Time-Series Forecasting
- Classification
- Regression
- Prediction
- Causal Inference

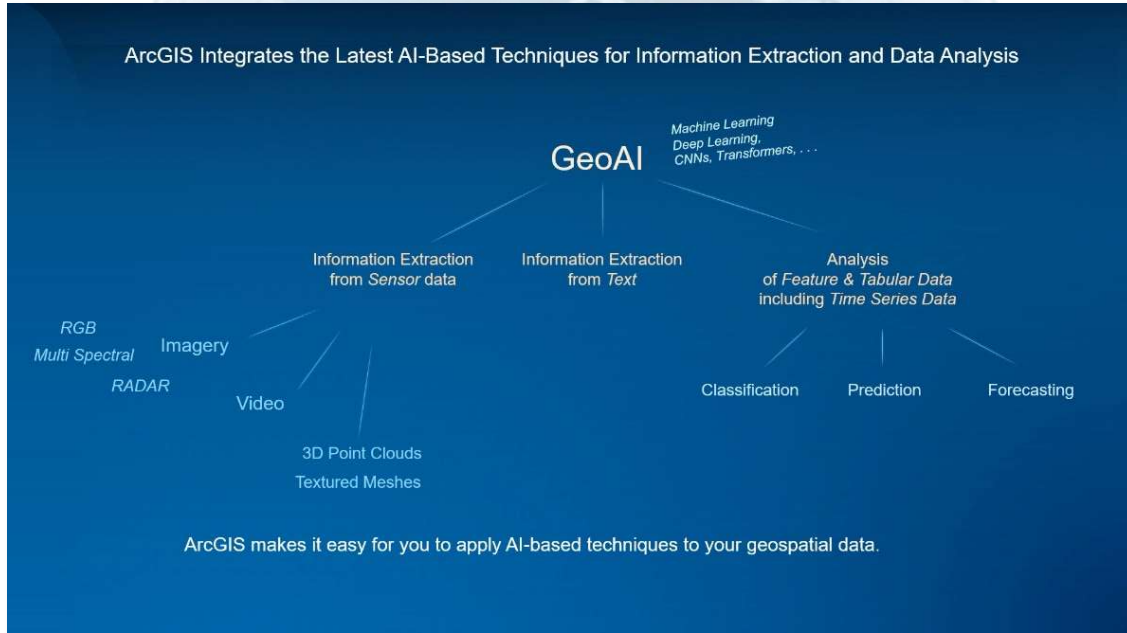
Leveraging Open Science Libraries

... Automating, Processing & Accelerating Data Analytics



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)

AI Assistants

ArcGIS integrates AI to assist you in the doing of your work

- Enabling easier access to geographic information
- Making our products easier to use via Natural Language Interfaces

- Improving the *effectiveness* of our integrated help
- Helping our users find *the right* layers and tools
- Helping our users create *effective* maps, surveys, . . .
- Helping our users perform the *desired* analyses
- Helping our users generate *useful* Arcade scripts and Python code
- . . .

Involves understanding the user's written or spoken intent and creating the appropriate results that they can then further refine as needed

Generative AI & LLMs



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)

Machine Learning Tools in ArcGIS

Classification

- Pixel & Object Based
- Image Segmentation
- Maximum Likelihood
- Random Trees
- Support Vector Machine



Clustering

- Spatially Constrained Multivariate Clustering
- Multivariate Clustering
- Density-based Clustering
- Hot Spot Analysis
- Cluster and Outlier Analysis
- Space Time Pattern Mining



Prediction

- Empirical Bayesian Kriging
- Areal Interpolation
- EBK Regression Prediction
- Ordinary Least Squares Regression and Exploratory Regression
- Geographically Weighted Regression







GIS and Emerging Technology


AI: GeoAI & AI Assistants (LLM/ML/DL)

So... what is deep learning?


Artificial Intelligence



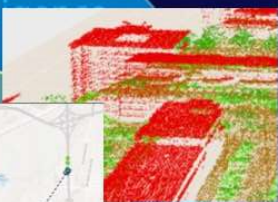
Text



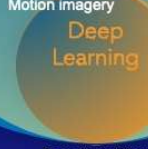
Motion imagery



Optical imagery



Point clouds



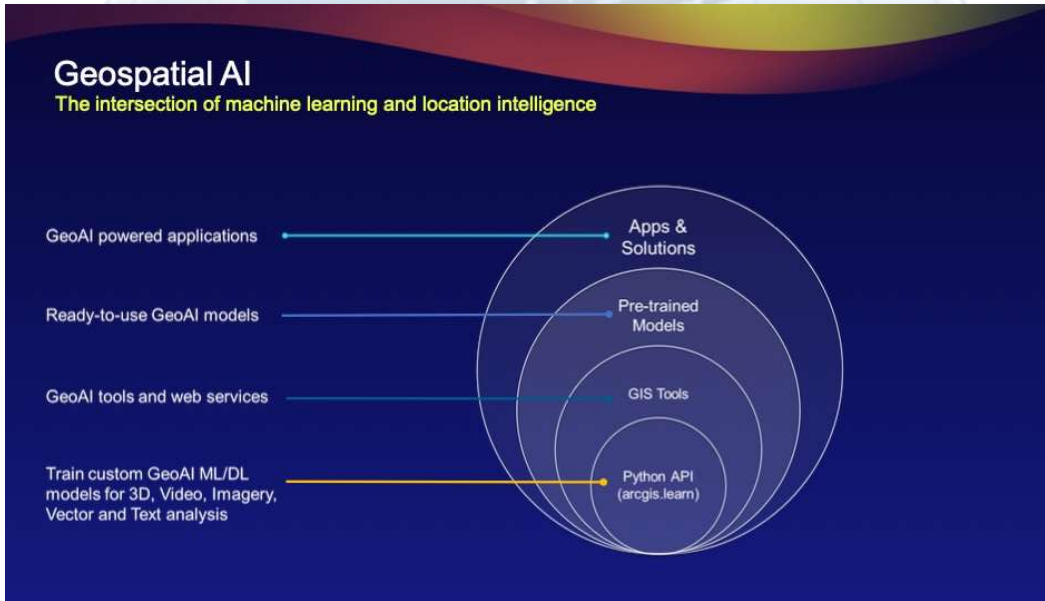
Deep Learning

Deep Neural Networks to find complex patterns especially in unstructured data



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)

Why is deep learning important?
Rising need for automation

- More sensors
- Large volumes of imagery and raw data
- Velocity of data
- Automation
- Accuracy

Defacto Solution

- Artificial Intelligence, Machine learning, Deep learning



GIS and Emerging Technology

AI: GeoAI & AI Assistants (LLM/ML/DL)



GIS and Emerging Technology

Digital Twin / VR / XR / Metaverse

ArcGIS Maps SDK for Game Engines (Unity / Unreal)
 ArcGIS CityEngine





GIS and Emerging Technology

Digital Twin / VR / XR / Metaverse

CityEngine export and ArcGIS Maps SDKs for Game Engines
 Example: project "Urban in VR"



Elevation, basemap, existing buildings
streamed via Maps SDK for Unreal



BIM model, streets, trees
imported into Unreal



GIS and Emerging Technology

Digital Twin / VR / XR / Metaverse

How can we get a CityEngine scene into a game engine?
 There is a whole workflow involved

1. Model CityEngine scene
2. Export from CityEngine
3. Import into game engine
4. Modify / replace assets in game engine
5. Complete the game / experience / scene

CityEngine → Export/Import →

Unreal Engine

Unity

...

Godot Engine

Twinmotion

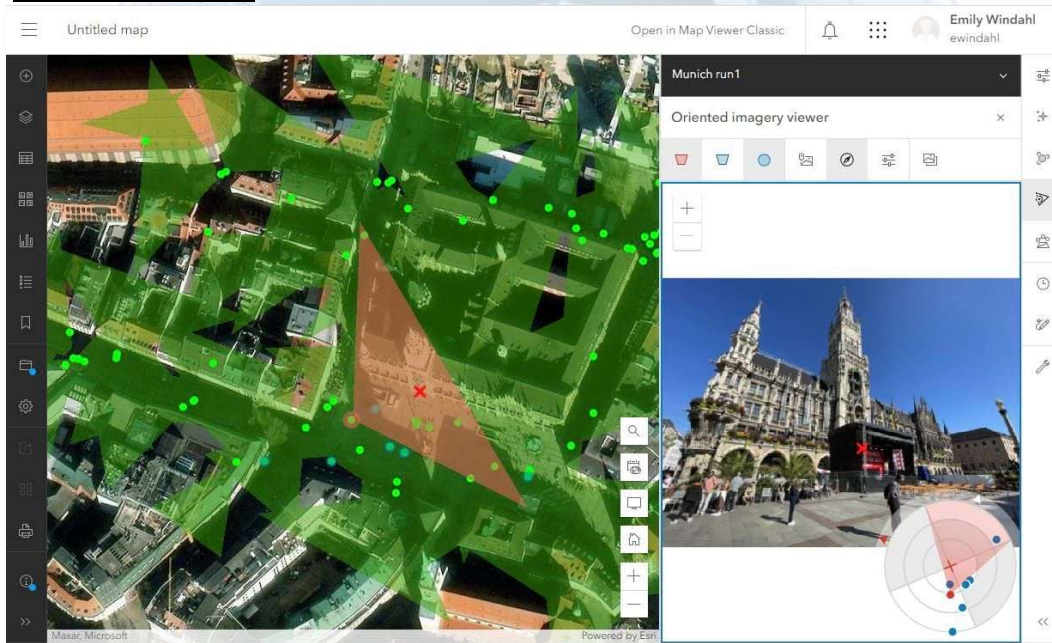
Omniverse

...



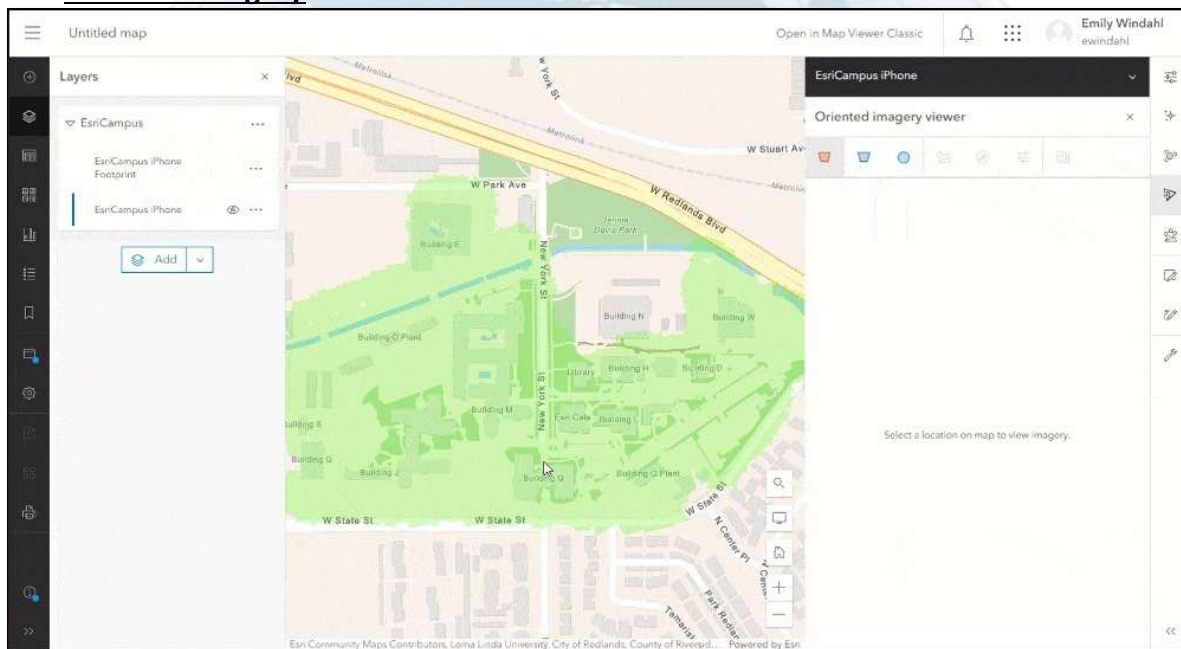
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Oriented Imagery



GIS and Emerging Technology

Oriented Imagery





GIS and Emerging Technology

Orchestration and Automation

Automating ArcGIS within Your Enterprise

ArcGIS API for Python

ArcPy

Infrastructure Automation

DevOps Automation

Hosted Notebooks (Webhooks, Scheduling)

Workflow Automation

ArcGIS Pro

ArcGIS Enterprise

ArcGIS Online



GIS and Emerging Technology

Orchestration and Automation

- Orchestration of tools, processes, and resources
- Automate administrative workflows and analyses





GIS and Emerging Technology

Orchestration and Automation

Where can you script and automate?

Here, There, and Everywhere!

- ModelBuilder
- Pro Python Window
- ArcGIS Notebooks (Pro, Online, Enterprise)
- Jupyter Notebooks
- Python IDEs (PyCharm, Spyder, PyDev, Sublime Text, Visual Studio, etc.)
- ArcGIS Scheduled Notebooks (Online, Enterprise)
- ArcGIS Notebook Web Tools



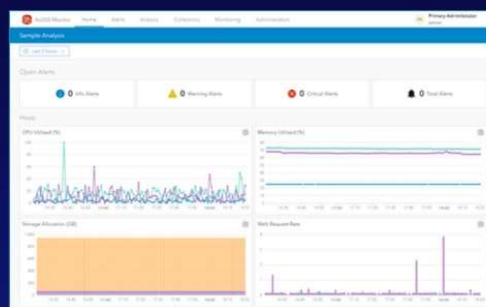
GIS and Emerging Technology

Systems Management: ArcGIS Monitor

- Monitoring and reporting: health, performance, and usage

ArcGIS Monitor

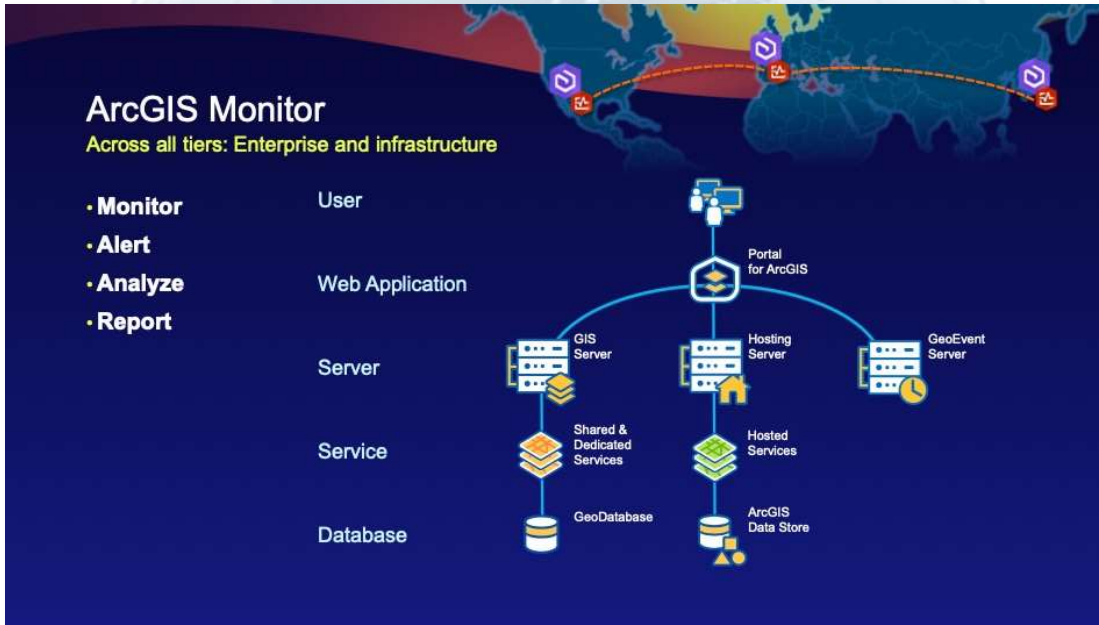
- Tailored for holistic monitoring of
 - ArcGIS solutions
 - Underlying infrastructure
- Provides effective alerting and reporting
- Driven by field experience
- For administrators and managers
- Enables focus on implementation and growth





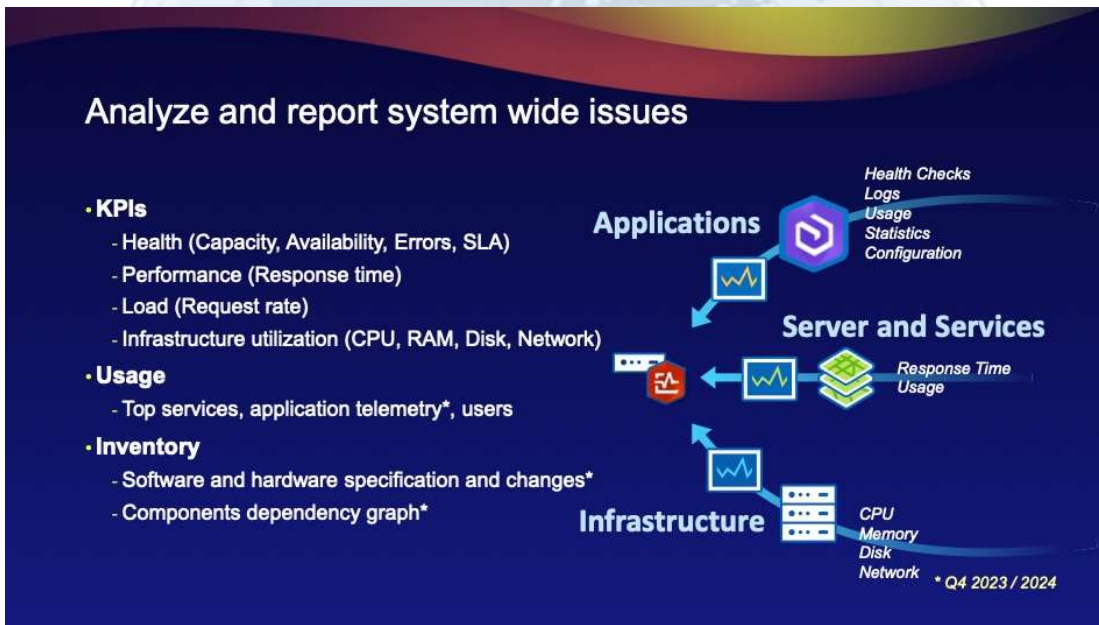
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Systems Management: ArcGIS Monitor



GIS and Emerging Technology

Systems Management: ArcGIS Monitor





GIS and Emerging Technology

ArcGIS API for Python

- Inventory and backup of ArcGIS Online content
- Automate administrative workflows and analyses

Why Python?

- Scientific computing
- Package management
- Interface consistency
- Platform agnostic

python
conda
TensorFlow
matplotlib
scikit-learn
jupyter

Domain experts could accomplish tasks
No matter the computing environment
No matter the skill level



GIS and Emerging Technology

ArcGIS API for Python

- Move / Clone Content

Staging **Production**

Desktop Apps APIs </>

Desktop Apps APIs </>



GIS and Emerging Technology

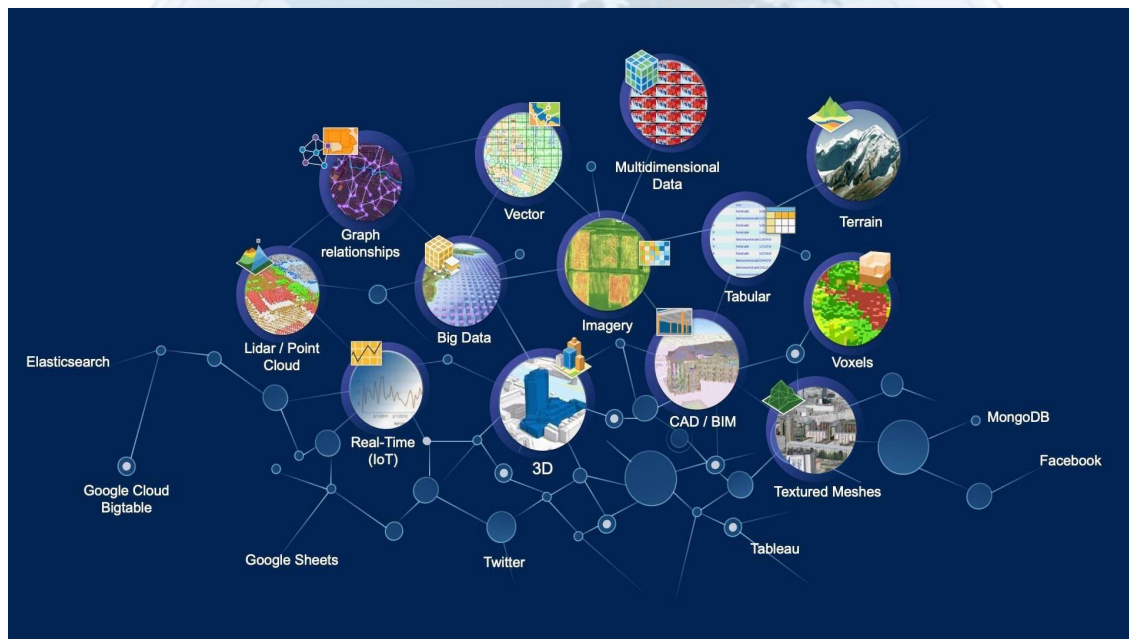
Extending ArcGIS Enterprise with Custom Data Feeds

- New at 11.1
- Developer Technology
 - Developer creates a provider using Enterprise SDK
 - Administrator registers provider with ArcGIS Server
 - Administrator creates feature service using provider
- Write in JavaScript
- Runs in ArcGIS Server
- Expose data as an input for read-only feature services



GIS and Emerging Technology

Extending ArcGIS Enterprise with Custom Data Feeds





GIS and Emerging Technology

Extending ArcGIS Enterprise with Custom Data Feeds



GIS and Emerging Technology

Workflows: Webhooks

Receivers

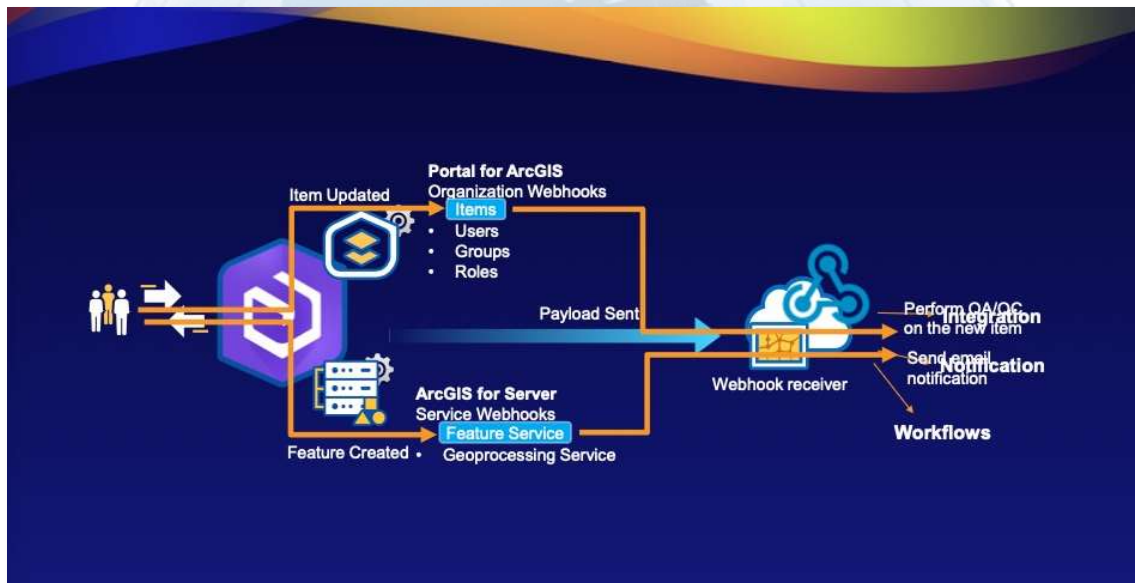
- Two flavors:
 - Commercial (web service)
 - Power Automate, Make, Zapier, Tray.IO, IFTTT, etc
 - Custom (develop your own)
 - JS, Java, Python, .NET
 - <https://github.com/Esri/webhooks-samples/>
- Payloads sent over HTTP to an actively listening service that accepts a JSON payload





GIS and Emerging Technology

Workflows: Webhooks



GIS and Emerging Technology

Workflows: Webhooks

Organization Webhooks : New 11.1

- **Administrative Privilege: Organization Webhooks**
 - Custom roles allow the delegation of webhook workflows
 - Previously restricted to members assigned to the built-in Administrator role
- Home App Experience – Creating and Managing
- Org Webhooks /w Notebooks
 - UI identifies if Notebook Server is available
 - If 1 (or more) Notebooks exist, select notebook
 - Trigger will execute the notebook

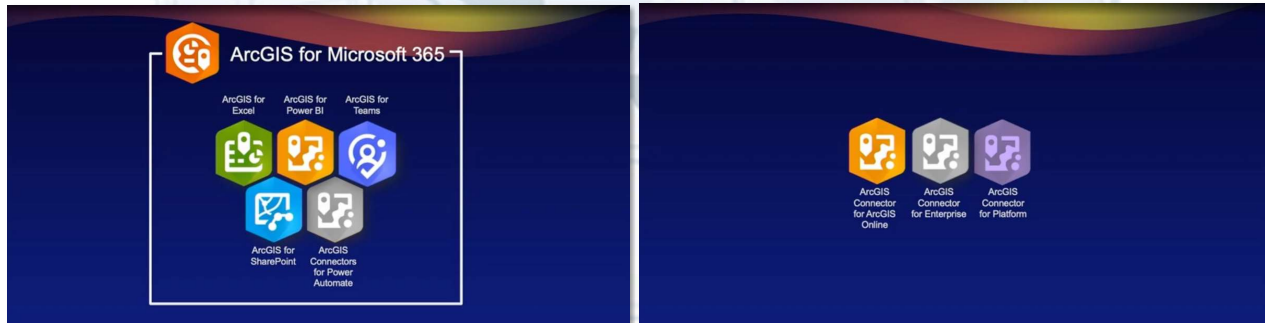
The top screenshot shows the 'Create webhook' form with fields for Name, URL, and Webhook URL. The bottom screenshot shows a notification: "Run QA via webhook trigger" with a timestamp of "10/25/2018".



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

- Access mapping and location services inside Microsoft products
- Built using no-code, drag- and-drop tools for desktop and cloud workflows



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

ArcGIS Connectors for Power Automate

Functional Groupings

- Data Management
- Geocoding & Geoenrichment
- Spatial Capabilities
- Attachment Handling

ArcGIS

ArcGIS connects your authorized workflow to location from your ArcGIS organization. Access geocoding, geoenrichment, and mapping services to add demographics and location information to your data. You can also use ArcGIS to create feature layers and batch jobs from existing feature layers in your ArcGIS organization.

See documentation >

Premium



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

Data Management

Triggers

- Feature Layer Webhooks

Actions

- Fetch Updates
- Create Feature Layer
- Get Attributes
- Record Management
 - Insert
 - Update
 - Delete



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

Geocoding & Geoenrichment

Actions

- Find Address Candidate
- Batch Geocoding
- Point-to-Point Routing
- Geoenrichment
 - Demographics
 - Business



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

Spatial Capabilities

Actions

- Get Geometry
- Get Data from Feature Layer

The screenshot shows a Power Automate flow titled 'When a record is updated in a feature layer'. The steps include: 'When a record is updated in a feature layer', 'Patch updates, changes, or additions from feature layer', 'Check records for closed', 'Update items that with closed information', and 'Update an attachment url in a table or channel'. A 'To Incident Cloud' connector is also visible.



GIS and Emerging Technology

Integration: ArcGIS and the MS Power Platform

Attachment Handling

Triggers

- Attachment Webhooks

Actions

- Search for Attachments
- Get Attachments
- By URL
- Direct
- Create Attachment
- Delete Attachment

The screenshot shows a Power Automate flow titled 'Update a record in a feature layer'. The steps include: 'Get attachment' (with fields for Layers in, Feature Layer, Object ID, and Attachment), 'Delay', 'Add attachment' (with fields for Layers in, Feature Layer, Record ID, Attachment name, and File content), and 'Increment variable'.



GIS and Emerging Technology

Development: ArcGIS Maps SDK

Web

[JavaScript Maps SDK >](#)

Game engines

[Unity Maps SDK >](#)

[Unreal Engine Maps SDK >](#)

Native

[.NET Maps SDK >](#)

[Kotlin Maps SDK >](#)

[Swift Maps SDK >](#)

[Java Maps SDK >](#)

[Qt Maps SDK >](#)



GIS and Emerging Technology

Open Source / Cross Platform

Scripting and service APIs

APIs for building mapping, spatial analysis, data management, and administration applications with ArcGIS services.

[ArcGIS API for Python >](#)

[ArcGIS REST JS >](#)

[ArcGIS REST APIs >](#)



Open source libraries

Open source and third-party libraries for building applications with ArcGIS services.

[Esri Leaflet >](#)

[MapLibre GL JS >](#)

[OpenLayers >](#)





GIS and Emerging Technology

Microservices / Cloud Native

ArcGIS Enterprise on Kubernetes Cloud-Native Architecture



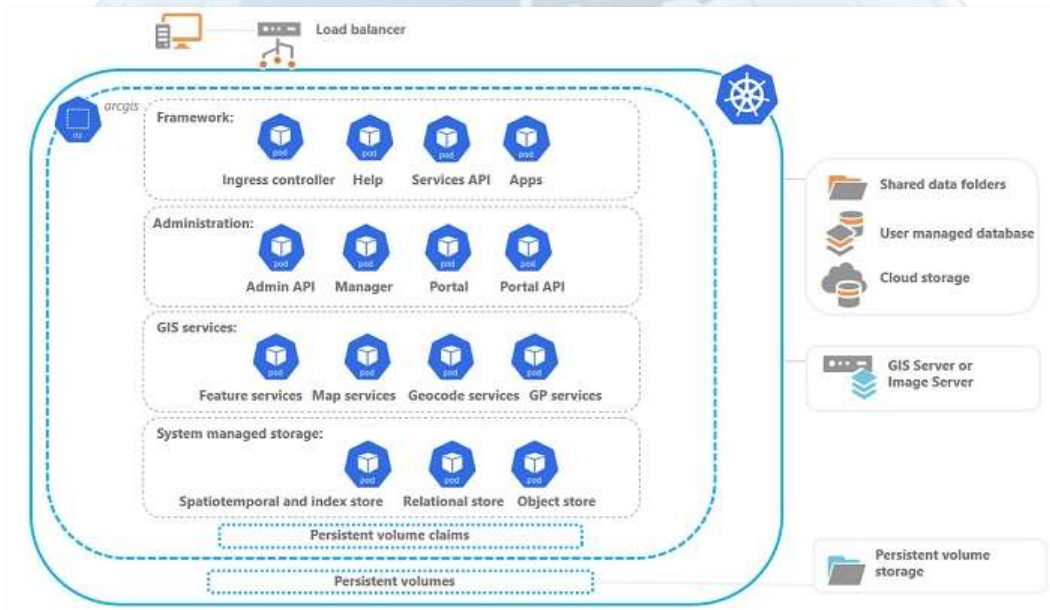
Meets
Cloud-Native Mandates

- Built for Scalability
- Easy to Deploy & Manage
- High Availability
- DevOps Integration
- Available on
 - AWS, Azure, Google, Red Hat, and Rancher



GIS and Emerging Technology

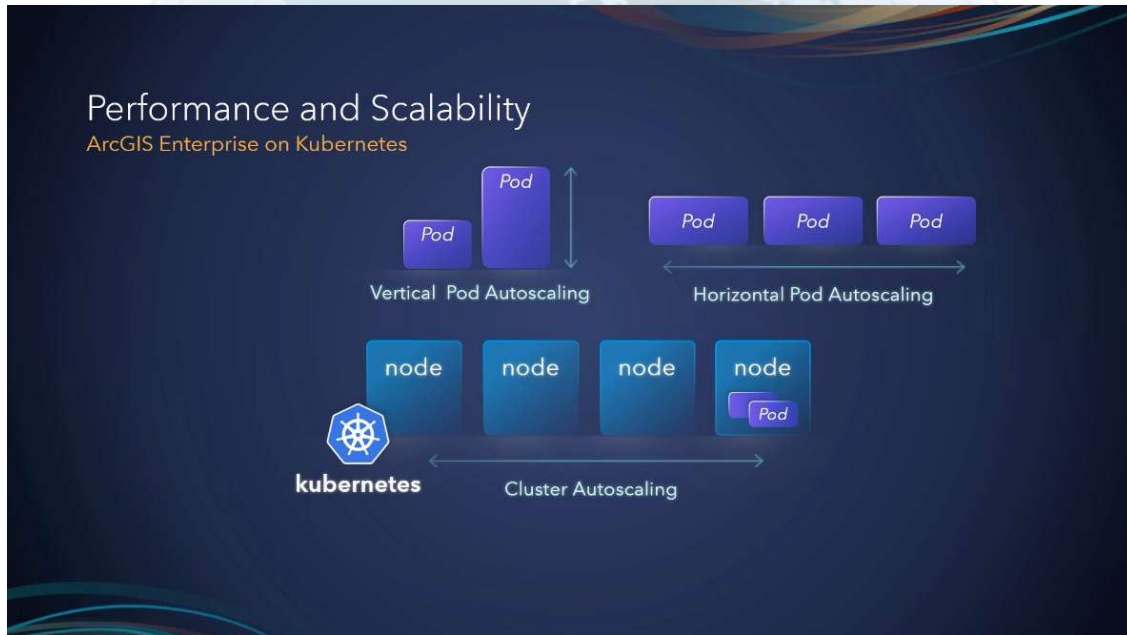
Microservices / Cloud Native





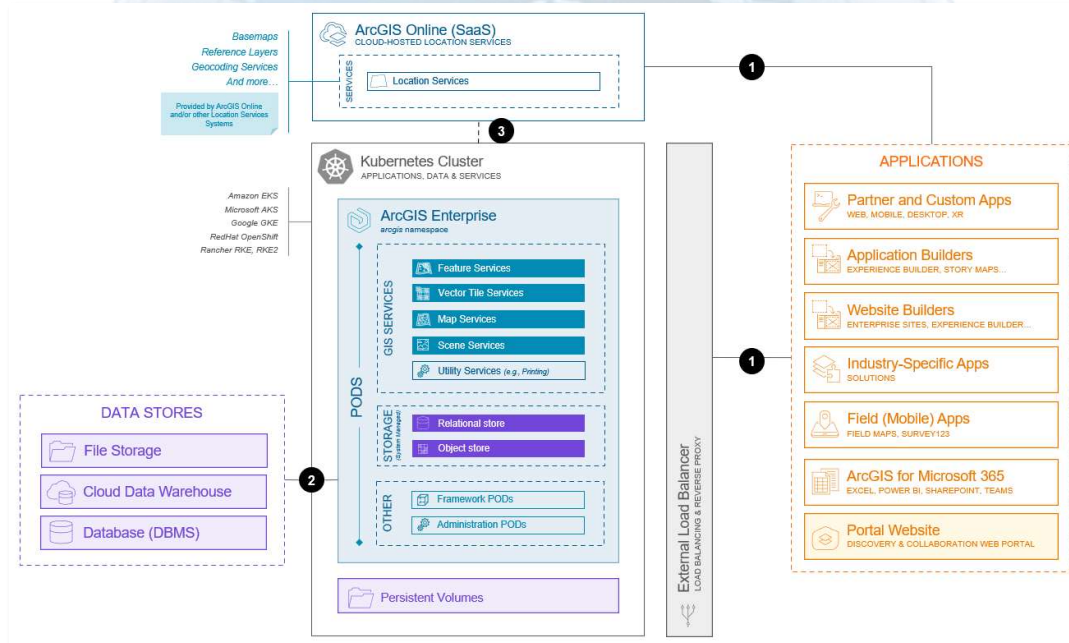
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Microservices / Cloud Native



GIS and Emerging Technology

Microservices / Cloud Native





GIS is Evolving

Are you ready?

Questions?

