



DOT&PF Image Server Deployment

FINAL REPORT



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13. ABSTRACT (Maximum 200 words) <i>This report summarizes the results of the DOT&PF Image Server deployment research project, focusing on the implementation and usage of ArcGIS Image Dedicated in a Microsoft Azure cloud environment. The project aimed to enhance the ability of DOT&PF to manage and analyze extensive imagery data, critical for operational needs. The research grant facilitated the testing of ArcGIS Image Dedicated, revealing significant benefits in applying raster analytics and streaming capabilities to cloud-stored imagery. Positioning dedicated servers next to Azure storage, effectively reduces egress costs and improves scalability. The use of Image Dedicated has enabled DOT&PF to convert imagery into tiled and dynamic image services, supporting on-the-fly analysis and dynamic mosaicking. Image Dedicated is equipped with a Virtual Machine including raster functions, tools, and APIs for image analysis in ArcGIS and facilitates the distribution of both 2D and 3D image products to DOT&PF, enhancing operational efficiency and data accessibility. Despite these advantages, there were several challenges such as the need for extensive initial setup and expertise, and potential long-term costs due to reliance on cloud infrastructure. While ArcGIS Image Dedicated offers a robust platform for image data management and analysis, it also requires careful consideration of image management, ongoing expenses, and data governance.</i>				
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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<u>LENGTH</u>				
in	inches	25.4	mm	
ft	feet	0.3048	m	
yd	yards	0.914	m	
mi	Miles (statute)	1.61	km	
<u>AREA</u>				
in ²	square inches	645.2	millimeters squared	cm ²
ft ²	square feet	0.0929	meters squared	m ²
yd ²	square yards	0.836	meters squared	m ²
mi ²	square miles	2.59	kilometers squared	km ²
ac	acres	0.4046	hectares	ha
<u>MASS (weight)</u>				
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg
<u>VOLUME</u>				
fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	liters
ft ³	cubic feet	0.0283	meters cubed	m ³
yd ³	cubic yards	0.765	meters cubed	m ³
Note: Volumes greater than 1000 L shall be shown in m ³				
<u>TEMPERATURE (exact)</u>				
°F	Fahrenheit temperature	5/9 (°F-32)	Celsius temperature	°C
<u>ILLUMINATION</u>				
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m ²	cd/cm ²
<u>FORCE and PRESSURE or STRESS</u>				
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa
These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements				

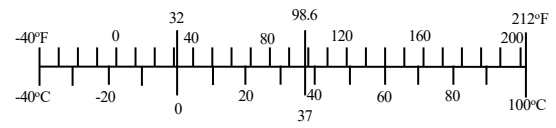
Symbol	When You Know	Multiply By	To Find	Symbol
<u>LENGTH</u>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi
<u>AREA</u>				
mm ²	millimeters squared	0.0016	square inches	in ²
m ²	meters squared	10.764	square feet	ft ²
km ²	kilometers squared	0.39	square miles	mi ²
ha	hectares (10,000 m ²)	2.471	acres	ac
<u>MASS (weight)</u>				
g	grams	0.0353		oz
kg	kilograms	2.205		lb
mg	megagrams (1000 kg)	1.103	short tons	T
<u>VOLUME</u>				
mL	milliliters	0.034	fluid ounces (US)	fl oz
liters	liters	0.264	Gallons (liq)	gal
m ³	meters cubed	35.315	cubic feet	ft ³
m ³	meters cubed	1.308	cubic yards	yd ³
<u>TEMPERATURE (exact)</u>				
°C	Celsius temperature	9/5 °C+32	Fahrenheit temperature	°F
<u>ILLUMINATION</u>				
lx	lux	0.0929	foot-candles	fc
cd/cm ²	candela/m ²	0.2919	foot-lamberts	fl
<u>FORCE and PRESSURE or STRESS</u>				
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi
				

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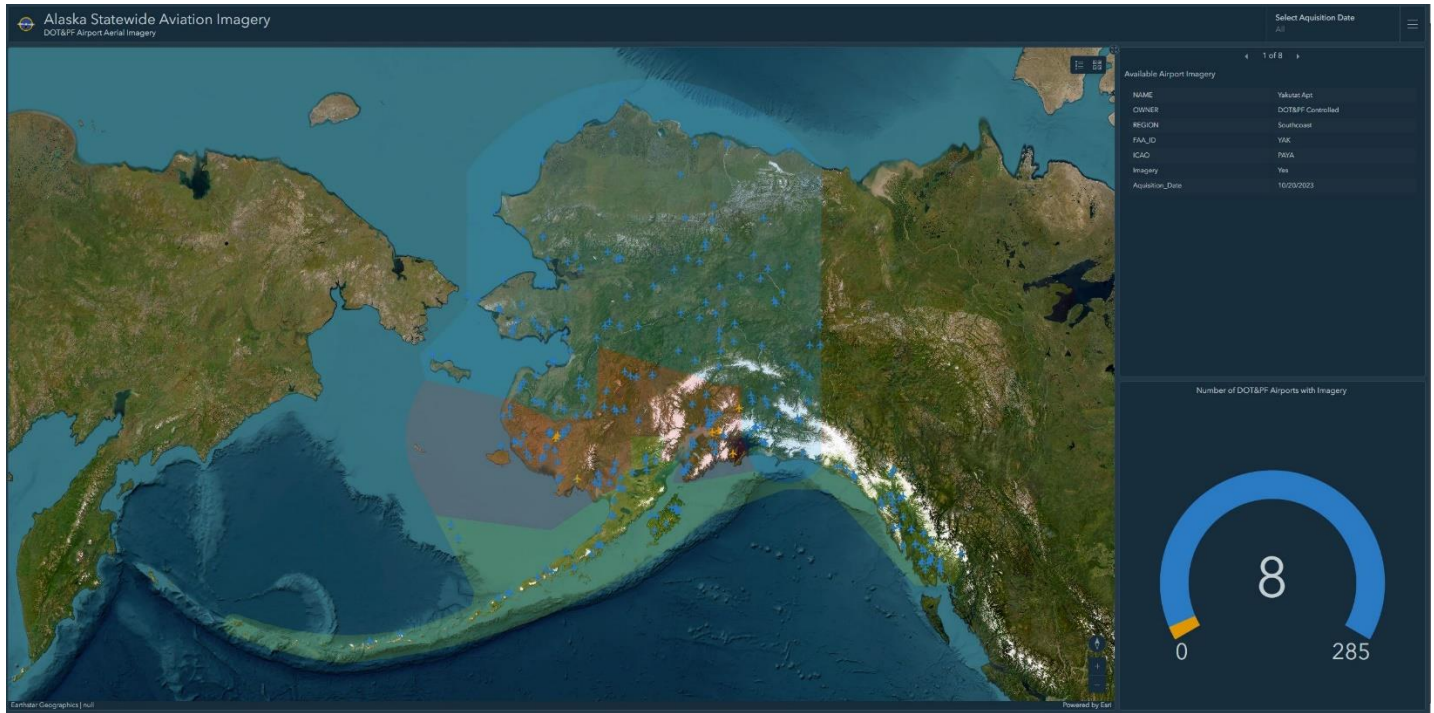


Figure 1. Alaska Statewide Aviation Imagery Dashboard

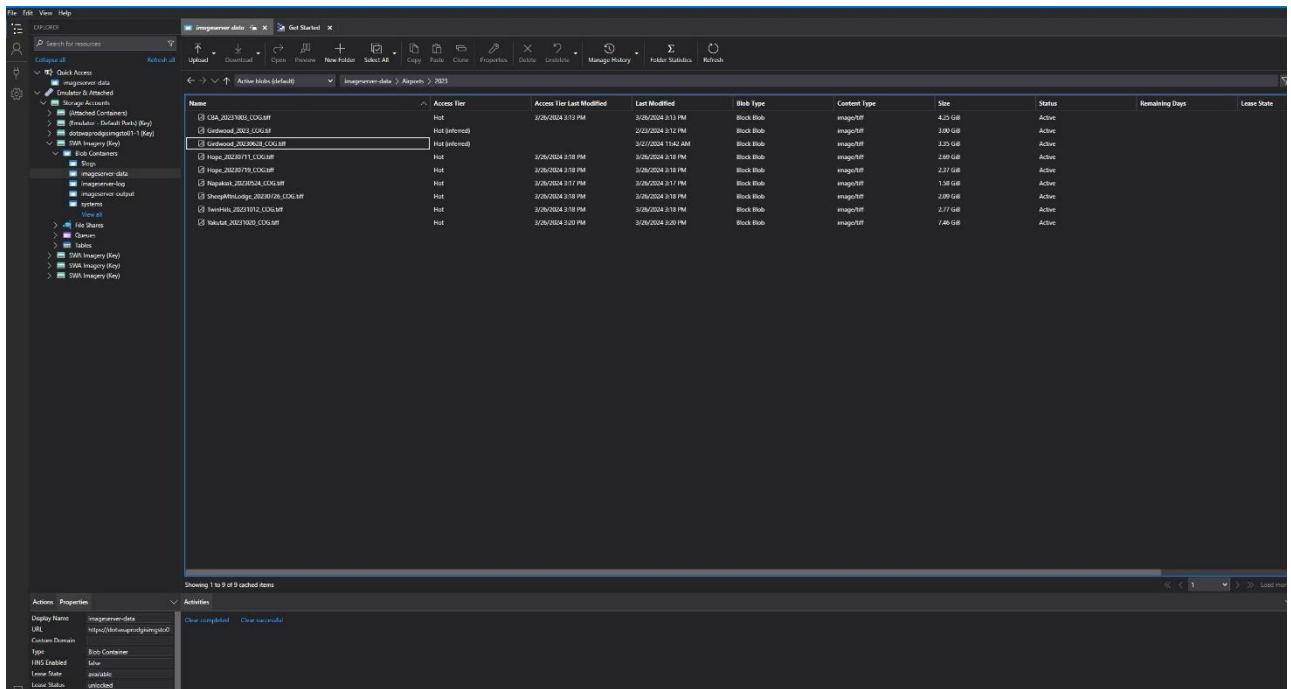


Figure 2. Microsoft Azure Storage Explorer – application to view/upload/download files to the Azure blob storage bucket.

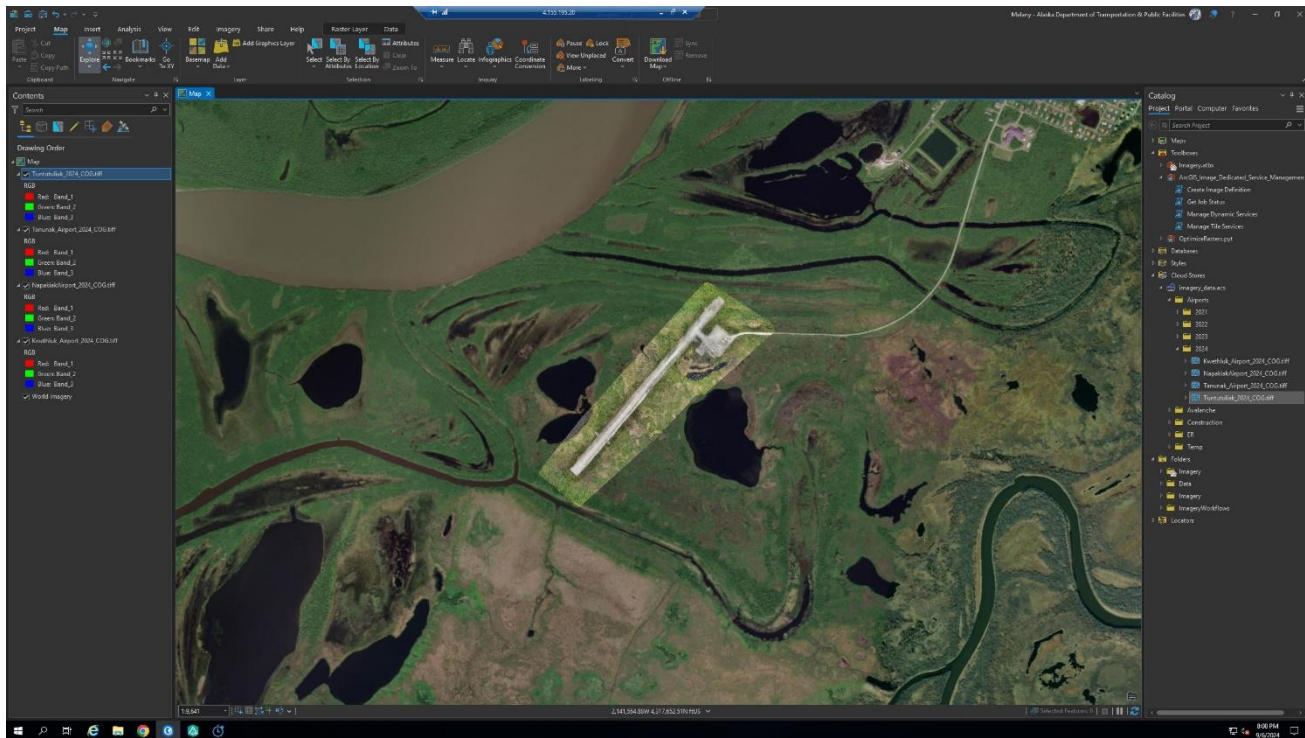


Figure 3. ArcGIS Pro virtual machine in ArcGIS Image Dedicated (Esri managed server) environment. Taking airport drone imagery and creating a mosaic dataset to publish as a Dynamic Image Service in Image Server. This image service is configured into the dashboard in Figure 1.

Emergency Response

Wrangell landslide with time slider



Mendenhall River flood imagery

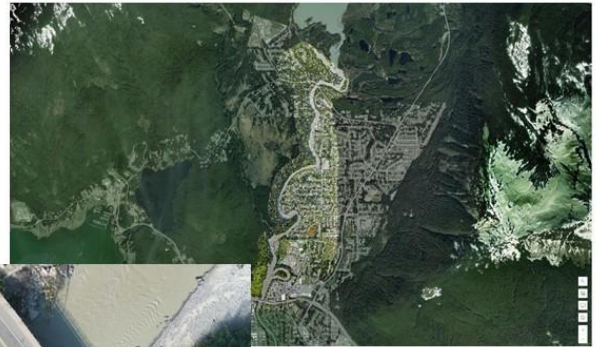


Image Services
Rest Endpoints



Figure 4. Using Image Services for Emergency Response provides internal DOT&PF access to the imagery as a Dynamic Image Service which can be used for both analysis and visualization. These services can also be shared publicly.

Acknowledgements

The research reported in this document was conducted as part of the DOT&PF Image Server deployment project, which was led by Melany Wilson, GIS Analyst at Alaska Department of Transportation and Public Facilities (DOT&PF) and Ryan Marlow, UAS Coordinator at the Alaska DOT&PF. The project was conducted with significant contributions from Garry Remsberg, GIS Analyst at Alaska DOT&PF, David Oliver, GIS Analyst at Alaska DOT&PF, Jeremy Arnold, Systems Administrator at Alaska DOT&PF, and Adam Rolfe, Systems Administrator at Alaska DOT&PF. At the time of the research, these individuals played key roles in deploying and evaluating ArcGIS Image Dedicated within a Microsoft Azure cloud environment. The contributions of all mentioned individuals were instrumental in achieving the research objectives, and their expertise was essential in overcoming the project's challenges and leveraging cloud-based imagery solutions.

Executive Summary

The DOT&PF Image Server deployment research project was undertaken to advance the management and analysis of extensive imagery data crucial for operational efficiency. The project centered on deploying ArcGIS Image Dedicated for processing and publishing imagery and raster analysis tool. We used the Microsoft Azure cloud environment for data storage, as well as Site Scan for ArcGIS for imagery processing, creation of data products and cloud data storage. The goal was to optimize the handling of large-scale imagery.

Key findings reveal that ArcGIS Image Dedicated significantly enhances DOT&PF's capability to manage and analyze imagery. The solution leverages cloud-based raster analytics and streaming, which improves both scalability and cost-efficiency. By positioning dedicated servers adjacent to Azure storage, the project successfully reduced egress costs and enabled the seamless conversion of imagery into tiled and dynamic image services. This innovation supports on-the-fly analysis and dynamic mosaicking, providing DOT&PF with robust 2D and 3D image products that boost operational efficiency and data accessibility.

However, the implementation came with challenges. The project required a considerable initial setup and specialized expertise. Additionally, long-term costs associated with cloud infrastructure necessitate careful planning and ongoing management. Despite these hurdles, the deployment of ArcGIS Image Dedicated represents a significant step forward in leveraging cloud technology for advanced image data management and analysis.

In summary, while ArcGIS Image Dedicated offers substantial benefits in image management and analytics, DOT&PF must consider the associated setup complexities and potential long-term expenses to maximize the value of this advanced platform.

CHAPTER 1 - INTRODUCTION AND RESEARCH APPROACH

Problem Statement and Research Objective

The Alaska Department of Transportation & Public Facilities (DOT&PF) encountered a significant issue in managing extensive imagery data that is critical for various engineering projects. The department heavily relies on imagery for activities ranging from public service to infrastructure projects. The available base maps were often outdated and did not meet the required resolution. Moreover, millions of dollars' worth of recent and historic project imagery were inaccessible, stored in cardboard boxes across the state without a proper system for viewing or sharing. The objective of this research was to explore the deployment of ArcGIS Image Server and its potential to solve these data management issues, particularly for imagery storage, analysis, and distribution in cloud-based environments.

Scope of Study

The research focused on deploying ArcGIS Image Dedicated with Microsoft Azure cloud data storage to address the DOT&PF's imagery management needs. It aimed to implement a scalable solution that could handle massive raster datasets, provide efficient analysis, and allow the department to utilize imagery effectively across its operations. The project covered the integration of Image Server with existing ArcGIS Enterprise platforms and tested various deployment options, including cloud hosting and virtual desktop configurations.

Research Approach

This study leveraged ArcGIS Image Dedicated to creating a scalable cloud-based system for imagery storage and analysis. The deployment aimed to enhance the department's ability to manage large datasets while providing real-time raster analytics capabilities. Azure cloud was selected for its ability to reduce egress costs, improve scalability, and streamline the distribution of 2D and 3D image products.

Methodology

The research methodology included configuring ArcGIS Image Server both on-premises and in the cloud. Testing was performed on various environments, including Azure and virtual desktops, to compare performance. The research also focused on assessing the system's ability to serve imagery as tiles and Web Map Services (WMS) to meet different user needs, including compatibility with AutoCAD. Workshops were held to gather feedback and refine the implementation.

CHAPTER 2 – FINDINGS

State-of-the-Art Summary

The deployment of ArcGIS Image Dedicated revealed numerous benefits for DOT&PF, particularly in the ability to manage, analyze, and serve large volumes of imagery. The Image Server supported both tiled and dynamic image services, facilitating on-the-fly analysis and dynamic mosaicking of imagery. This capability was essential for the department's use of raster data in projects, allowing it to process and distribute imagery from satellites, aircraft, and drones.

Key Findings

1. **Improved Scalability and Cost Management:** By positioning the dedicated image servers next to Azure storage, the department was able to reduce egress costs while improving the scalability of the system. Azure's infrastructure allowed for efficient storage and management of massive datasets, which was crucial for DOT&PF's needs.
2. **Enhanced Raster Analytics:** The integration of virtual machines and raster function tools enabled DOT&PF to perform complex image analyses. This included deep learning applications, hydrologic analyses, and temporal analysis of multidimensional data. The system also allowed for rapid processing of imagery to create orthoimage mosaics and digital terrain models.
3. **Challenges:** Despite the benefits, the deployment faced challenges, including the need for substantial initial setup and expertise. Additionally, long-term costs associated with cloud infrastructure were identified as a concern.

CHAPTER 3 - INTERPRETATION, APPRAISAL, AND APPLICATIONS

General Recommendations

The findings suggest that ArcGIS Image Server is a viable solution for managing DOT&PF's imagery data. It significantly improves the department's ability to store, analyze, and distribute massive datasets efficiently. The recommendation is to continue utilizing the cloud-based system for long-term data management and expand the use of raster analytics to enhance operational efficiency.

The deployment has several practical applications for DOT&PF, including:

- **Enhanced Project Planning:** By using high-resolution, real-time imagery, the department can make more informed decisions on infrastructure projects, leading to better planning and execution.
- **Data Sharing and Collaboration:** The ability to serve data through image tiles and WMS formats allows for better collaboration with other state agencies and contractors, ensuring that everyone has access to up-to-date, accurate data.
- **Cost Savings:** By transitioning to a cloud-based infrastructure, DOT&PF can reduce long-term storage costs and gain flexibility in data access. Automated data lifecycle policies further contribute to cost efficiency.

Limitations

While the system provides robust capabilities, it is dependent on continued cloud infrastructure investment, which may present a financial burden in the long term. There is also a learning curve associated with the system's initial setup and ongoing maintenance.

CHAPTER 4 - CONCLUSIONS AND SUGGESTED RESEARCH

Conclusions

The deployment of ArcGIS Image Server using the Microsoft Azure cloud environment represents a significant advancement in DOT&PF's ability to manage and analyze vast amounts of imagery data. The system has successfully addressed key challenges related to data accessibility, scalability, and cost management. By integrating powerful raster analytics and supporting both 2D and 3D imagery, DOT&PF has improved its operational efficiency and decision-making capabilities.

Suggested Research

Future research should focus on optimizing the long-term costs of cloud infrastructure and exploring alternative hosting environments that may provide additional benefits. Further investigation is also needed into advanced applications of deep learning and artificial intelligence for automated image analysis. Continued user feedback and performance testing will be essential to refine the system and ensure that it meets evolving project demands.

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