

# A view from the cloud



**Leveraging cloud solutions  
for improved performance and extreme savings**

**State:** Wisconsin

**Agency:** Wisconsin Department of Transportation

**Award Category:** Emerging and Innovative Technologies

**Project Title:** A View from the Cloud

**Project dates:** September 2022 to September 2023

**Contact:**



**Adam M. Feidt**

*GIS Unit Supervisor*

(608) 266-8882

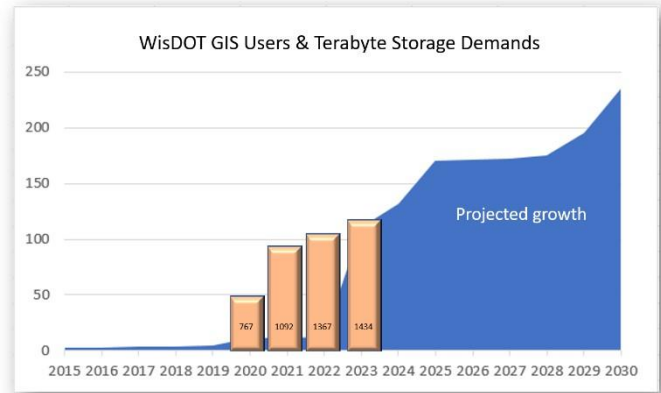
[Adam.Feidt@dot.wi.gov](mailto:Adam.Feidt@dot.wi.gov)

## EXECUTIVE SUMMARY

The Wisconsin Department of Transportation (WisDOT) was one of the first DOTs to implement Geographic Information Systems (GIS) when the technology was in its infancy. The agency had accumulated four decades' worth of imagery data, an estimated 100 plus terabytes of data, stored on devices across the agency. Data and images were brought in from outside agencies or consultants using physical hard drives, then copied, shared, and stored on many different appliances across the agency.

These archaic methods created a plethora of problems, including logistics, increased storage costs, delayed manual distribution, and sharing of non-standard information. Overall, there was an inconsistent performance, which could compromise effective decision-making for staff and the public.

WisDOT's large and growing number of GIS and AutoCAD users needed improved access to accurate data. WisDOT recognized that this irregular model would not be sustainable to support the future growth of the datasets. It became clear a new method for storing and distributing this high-impact data was necessary.



The solution was to store the large format data in Amazon Web Services (AWS) and distribute the data from a single source via web services by leveraging Esri's ArcGIS Image Dedicated software-as-a-service (SaaS) solution.

WisDOT is now able to centralize all imagery data, including the expanding demand for LiDAR data, into a single storage container and distribute the data at high speeds to all users without having to replicate the data across appliances. WisDOT leveraged cloud solutions for large format aerial imagery and has improved collaboration, made it more efficient and accurate to consume, and reduced storage costs up to 90%.

## IDEA

WisDOT's Amazon Web Services (AWS) Storage and ArcGIS Image Dedicated Project implemented a cutting-edge solution by leveraging advanced technology to improve how staff at the agency consume and share high-resolution imagery for many business processes. Past workflows isolated images and data on individual servers, often duplicating the same data and slowing the process. All of this created a problem of disparate datasets and rising costs for storage.

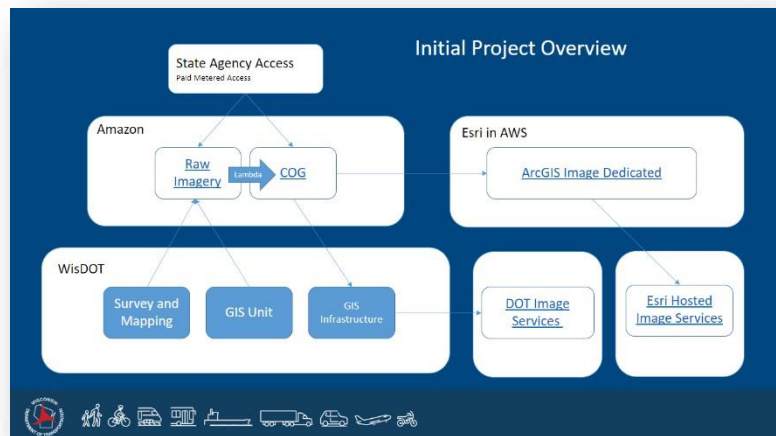
WisDOT's business demands, technological advances, and participation in data sharing programs, such as the Wisconsin Regional Orthoimagery Consortium (WROC) program that will build and

acquire digital and orthoimagery and elevation data through LiDAR every five years throughout Wisconsin, clearly indicated that the data storage problem would get worse.

WisDOT's Bureau of Information Technology Services (BITS) GIS Unit recognized that the current method of data sharing and storage needed to change and took the lead on this project. Its purpose was to improve the ease of distribution of this type of data and reduce storage costs for the agency. And it needed to easily integrate into current platforms.

WisDOT's internal ArcGIS Enterprise platform supports more than 1,500 GIS and AutoCAD users and our ArcGIS Online supports approximately 350 users, plus the distribution of GIS maps and applications to the public.

With these innovative GIS platforms in mind, WisDOT's GIS Unit identified a solution for better imagery storage and distribution. WisDOT looked to combine cloud and web services as the ideal solutions for this new system. This solution officially went live in September of 2023 and has gained recognition from state practitioners and industry leaders in GIS.



All state DOTs use extremely large data files for imagery and LiDAR as a base for their many GIS maps and applications. The WisDOT GIS Unit created a model that is both sustainable and reproducible for all state agencies. WisDOT appears to be the first to leverage these technologies to consume and share imagery with its staff, other agencies, consultants, and even the public. It has opened the doors for strategic sharing practices. WisDOT's model, including a standard of best practices and leveraging SaaS for distribution, has created a successful example of reduced costs and improved performance.

## IMPLEMENTATION

WisDOT's GIS capabilities go back four decades. Discussions to formulate a better plan to store all imagery sources at WisDOT began in 2017.

In 2019, WisDOT, alongside the Department of Administration's (DOA) Division of Enterprise Technology (DET), defined security protocols and architecture solutions centered around cloud services, such as AWS. With these in place, key decision-makers were more comfortable with the security and deployment patterns in a cloud environment. Then, from 2021 to 2022, WisDOT worked very closely with AWS and DET to set the groundwork for deploying solutions using various

AWS services. By September 2022, a formal project was developed to move forward with AWS S3 for storage and Esri web services for distribution.

Extensive work was done to ensure the move to AWS S3 storage and Esri’s ArcGIS Image Dedicated SaaS solution for delivery was optimal. After various models of cloud and on-premises infrastructure and storage were determined, the GIS Unit performed over 100 hours of load-testing on three main architectural plans. First, on-premises infrastructure and storage were tested, then a hybrid approach of AWS S3 storage and on-premises servers, and finally the optimal solution of all cloud-based services using AWS S3 and ArcGIS Image Dedicated was tested.

Both cost and performance were determined in all three architecture plans. The plan with all-cloud solutions was able to replicate the performance of local storage and infrastructure.

The cost differences, however, were significant. As the project developed, the WisDOT team learned that cloud-based storage was about 90% cheaper than on-premises storage. To store on-premises, the 100TB of data mentioned above would cost the GIS Unit \$260,000/year. To store that same volume of imagery in AWS and utilize ArcGIS Image Dedicated would cost \$20,000-25,000/year.

In addition, optimized business workflows would realize even more savings. With this kind of deployment, agencies can share data directly in the cloud without having to transport physical hard drives from location to location. The ability to distribute imagery from AWS through web services has a ripple effect on costs everywhere.

The GIS Unit worked with business areas such as Survey and Mapping, Environmental, and Construction Methods Development to understand how they integrate imagery into business area’s workflows to ensure the new solution would fit. For some business areas, ArcGIS Image Dedicated services were integrated directly into AutoCAD design software to ensure the adoption of the new technology. In other areas, services were integrated seamlessly without interruption. The changeover was seamless. In most cases, users didn’t even realize the source and service changed.

Once the technical implementation was completed, WisDOT’s GIS Unit wanted to ensure that the process improvement benefits were maximized.

The Wisconsin GIS community was engaged through a series of presentations at local conferences and consultants were also incorporated in the transfer of imagery between storage buckets directly in AWS. It was important to get the word out to the public to maximize the investment. In the end, AWS and ArcGIS Image Dedicated gave us the optimized solution to get more people involved in the use of imagery.

Testing architectural plans revealed the all-cloud solution.

Plan	Transaction Response Time	Transactions/Sec	Request Response Time	Requests/Sec	Passed Requests	Failed Requests
Local File	1.36	0.709	1.36	0.709	160	0
Local COG	1.831	0.529	1.802	0.531	152	0
Local COG with Ded	1.823	0.657	1.823	0.657	152	0
Local File	4.174	1.3	4.172	1.275	328	28
Local COG	2.891	0.845	2.891	0.845	408	0
Local COG with Ded	3.229	1.16	3.229	1.16	392	0
WRCO File	1.619	0.752	1.619	0.752	476	0
WRCO COG	2.527	0.96	2.511	0.952	428	0
WRCO COG with Ded	2.571	1.544	2.571	1.544	424	0



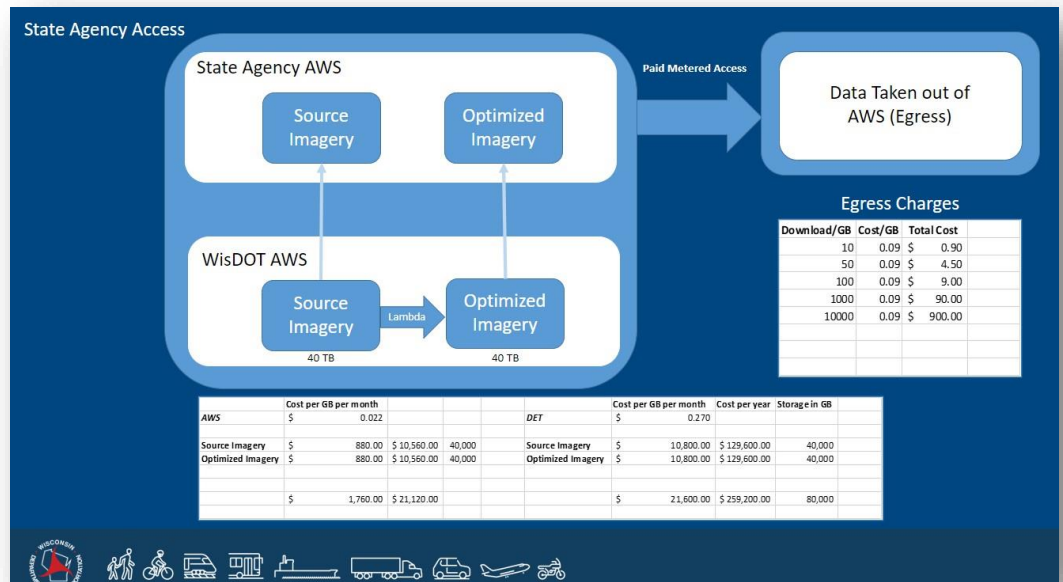
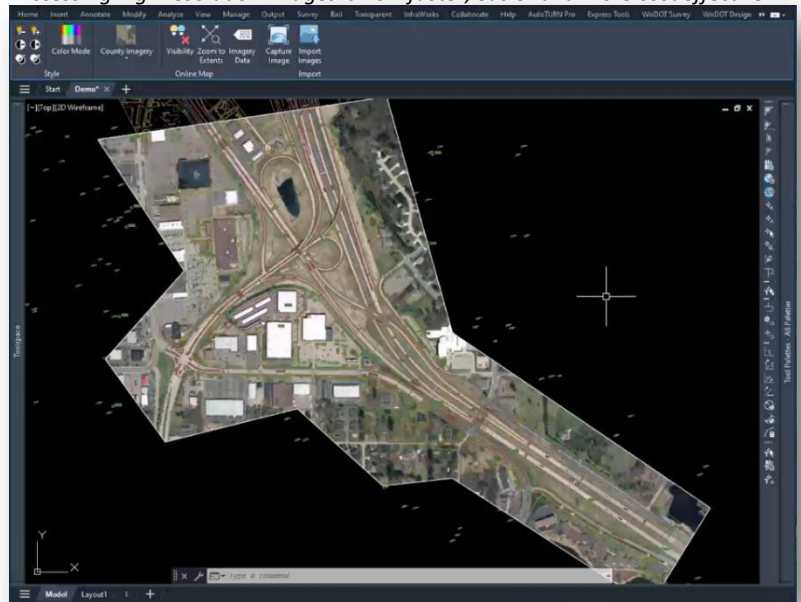
# IMPACT

Our AWS and ArcGIS Image Dedicated solution now supports streaming imagery services across all WisDOT and the public and private sectors. The project team is distributing imagery with a resolution as high as 3 inches for all relevant county and statewide coordinate systems. All of this can take

place in a matter of seconds, allowing for more efficient workflows and tremendous cost savings. Staff can do more with imagery than ever before including streaming in high-resolution imagery, clipping project areas directly from an image service, and mosaicking images that can be stored for the life of the construction project design. This is the realized process improvement and cost savings.

Actual costs of storage have improved astronomically. What once would cost WisDOT \$21,600 per month now only costs WisDOT about \$1,760 per month. The GIS Unit has also reduced its infrastructure footprint by moving its deployment to the cloud. The reduction in servers, at about \$5,000 a year per server, not only saves infrastructure costs but reduces the number of staff hours to maintain and support those servers.

*Accessing high resolution images is now faster, easier and more cost effective.*



Business areas are realizing improved workflows for imagery, which has allowed them to spend less time processing imagery. No longer do staff need to search for their own imagery. All users are making decisions from the same dataset. It allowed for a breakdown of silos across many divisions. There is now a statewide resource with uniform resolution. Users can quickly identify and access the imagery they need.

With more GIS users to distribute imagery to, users across desktops, web platforms, and custom applications now have better options to view imagery. Since the volume of services and imagery that WisDOT can support has increased, there are no limitations in the types of imagery we can deploy. Previously, we were only able to distribute low-resolution imagery, which made it difficult for business areas to read and make decisions. Users can now access very high-resolution images from many different sources to help them compare and make better decisions.

Future projects aim to incorporate better 3D data, like LiDAR, with advanced technology to distribute via web services. As the 3D capabilities improve, WisDOT is prepared to take advantage of the growing need for 3D data.

WisDOT's cloud-based solution for delivering data and images proved faster and more efficient. Business areas can make better decisions with consistent, accurate information. WisDOT's model provides an optimal infrastructure and service plan to maximize storage costs and image performance. This is an excellent model for state agencies across the county to consider.

## Testimonials

- Esri, the global leader in geographic information system (GIS) software, featured WisDOT's solution as a case study. [Wisconsin DOT Cuts Costs and Decrease Project Delivery Time \(esri.com\)](#)
- *"The AWS/Image project enabled us to build an imagery plug-in for our roadway design software. This in turn saves staff time searching for the latest aerial imagery to use on their projects. Prior to the availability of this service, design teams would often download unnecessary amounts of imagery that was duplicated among other teams. The AWS/Image project has resulted in efficiency gains for both data storage, and end-user time to obtain imagery. In short, the AWS/Image project has made an extremely valuable data source extremely easy and fast to access for people who use the data every day."*
  - Keith Sowinski, Civil Engineer, Methods Development Unit, Wisconsin Department of Transportation
- *"As a partner in the Wisconsin Regional Orthoimagery Consortium, WisDOT takes delivery of large imagery datasets on an annual basis. In 2020, these datasets totaled 37 TB and thousands of files to provide statewide coverage. The BITS GIS team created an AWS cloud-based solution for delivery of the data. This streamlined the delivery process, moving it from multiple large USB hard drives to a direct upload from Ayres's servers to the WisDOT AWS cloud storage. The GIS team then cloud optimized the image tiles and created an image service for online streaming and viewing in CAD and GIS across many departments. This overall solution for delivery and image services streamlined the process of getting statewide leaf-off orthoimagery into the hands of those that needed it quickly and without duplication of effort. This solution has the potential to be used by other state agencies for consumption of the same WROC image services. WisDOT now has a streamlined process that is already being using for WROC 2023-25."*
  - Zachary Nienow, Manager, Aerial Mapping, Ayres Associates Inc.