



AN ESRI
TECHNICAL PAPER

July 2025

Virtualization of ArcGIS Pro

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Virtualization of ArcGIS Pro

Executive Summary

ArcGIS® Pro is a powerful desktop GIS application that leverages 64-bit processing, multi-threading, and GPU acceleration to support data management, simple to advanced spatial analysis, and rich 2D, 3D visualization. As demand for high-performance computing grows, organizations are turning to virtualization to deliver ArcGIS Pro in secure, scalable, and flexible environments.

This technical paper is for IT professionals, system designers, and GIS administrators. It gives practical advice on virtualizing ArcGIS Pro using cloud platforms, GPU technologies, and deployment frameworks. It covers Desktop-as-a-Service, NVIDIA vGPU, Microsoft Azure Virtual Desktop, Windows 365 GPU-enabled Cloud PCs, and Amazon EC2/AppStream. Readers will gain insight into VM sizing, GPU profiles, hardware selection, and deployment best practices to ensure performance and user satisfaction across a variety of environments.

Building on Esri's 2020 virtualization technical paper, this updated edition includes expanded insights on Windows 365 GPU-enabled Cloud PCs, Azure Virtual Desktop, and modern NVIDIA RTX/Ada-generation GPUs. It draws from real-world implementations across industries such as utilities, transportation, and government.

Introduction

Virtualizing ArcGIS Pro offers significant advantages in terms of manageability, scalability, and remote accessibility. Thanks to advances in cloud computing, GPU virtualization, and automation, organizations can now deliver ArcGIS Pro in environments that meet or exceed the performance of traditional desktop workstations.

This guide describes recommended practices and deployment strategies for virtualizing ArcGIS Pro successfully, highlighting recent developments in:

- GPU-accelerated virtual desktop environments
- Cloud-based delivery platforms from Microsoft Azure, Amazon Web Services (AWS), and Google Cloud Platform (GCP).
- VM profile and resource sizing for different types of users
- Hardware and GPU recommendations based on Esri testing
- Integration with enterprise IT policies and security frameworks

The goal is to provide a clear path for successful deployment of ArcGIS Pro across both on-premises and cloud-based infrastructures, supporting a wide variety of GIS workflows and user roles.

Deployment Options Overview

ArcGIS Pro can be used in many different virtualization environments. These include traditional on-premises virtual desktop infrastructure (VDI), cloud-based desktops, and hybrid models that combine the benefits of both. Each platform offers distinct trade-offs in terms of cost, control, scalability, and administrative complexity. Selection should be guided by organizational goals, user performance expectations, compliance requirements, and operational maturity.

Esri supports a wide ecosystem of virtualization platforms—VMware ESXi/Horizon, Citrix, Microsoft Hyper-V, and cloud solutions—that align with varied agency needs and infrastructure strategies. Whether migrating legacy desktops or scaling for a distributed workforce, deployments must balance technical limitations with long-term GIS objectives. For example, VMware ESXi combined with NVIDIA vGPU offers nearly native DirectX/OpenGL performance via mediated pass-through, while GPU pass-through enables dedicated resources for intensive 3D and CUDA workloads. Real-world benchmarks—validated using Esri’s Performance Assessment Tool show that both shared vGPU and pass-through models deliver fluid map navigation, rendering, and spatial analysis. On-premises VMware Horizon deployments use PCoIP or Blast Extreme to stream these GPU-accelerated VMs with minimal latency. By choosing the right combination of hypervisor, GPU configuration, remote display protocol, and sizing profile, GIS teams can modernize their infrastructure effectively ensuring performance, scalability, and alignment with strategic GIS goals.

VDI Environments

Traditional VDI environments hosted in data centers remain a popular choice for organizations with existing investments in virtualization platforms such as VMware vSphere or Citrix Virtual Apps and Desktops. These solutions allow centralized management of desktops and applications, integration with internal security frameworks, and flexible allocation of compute resources.

When deploying ArcGIS Pro in on-premises VDI, a GPU is required to support rendering and processing. NVIDIA vGPU software should be used with compatible hardware (e.g., NVIDIA L4, L40/L40S, A10)

ArcGIS Pro should not use virtualization that uses sessions, like Citrix Virtual Apps (formerly XenApp). This is because ArcGIS Pro needs a dedicated GPU for each virtual desktop session. Citrix Virtual Apps or XenApp is not recommended for applications that use many threads, like ArcGIS Pro. This is because it has a shared-session architecture that can cause resource contention, unpredictable performance, and limited isolation. This makes it not suitable for CPU or GPU-intensive workloads.

A dedicated or virtual GPU is essential for delivering an optimal ArcGIS Pro experience in virtualized environments. Rendering performance, application responsiveness, and 3D capabilities are directly influenced by GPU availability and configuration.

GPU Requirements

Esri recommends NVIDIA RTX-class GPUs with vGPU software for virtualized ArcGIS Pro deployments. Supported models include the following: NVIDIA L4, L40/L40S, A10, A40, A2, and T4.

For vGPU configurations, **Q-series profiles** (e.g., 1Q, 2Q, 4Q, 8Q, 16Q) are recommended. These profiles guarantee a fixed frame buffer per VM and support features critical to ArcGIS Pro, such as OpenGL and DirectX acceleration.

Avoid using B-series profiles (intended for lightweight business applications) or non-virtualization-capable GPUs in production environments. Additionally, it is recommended to use NVIDIA RTX Workstation licenses.

Recommended Server Specifications for ArcGIS Pro Virtualization

- CPU: 3.0 GHz or higher
- High-speed RAM (sized based on user profiles in the following section)
- Fast networking connections of 10 GbE or higher recommended
- Optimized storage such as NVMe SSDs or fast RAID configurations
- NVIDIA GPU designed for virtualization with vGPU support

To enable fully GPU acceleration for CUDA-based geoprocessing tools within ArcGIS Pro, an **NVIDIA vWS (Virtual Workstation)** license is also recommended. This license unlocks access to CUDA capabilities on the vGPU, allowing ArcGIS Pro to utilize the GPU for tasks like spatial analysis, raster processing, and 3D rendering at optimal performance.

Example Server Configuration (2024): *Dell PowerEdge R760 Rack Server (or comparable)*

- Two (2) Intel® Xeon® Gold 6458Q, 3.1 GHz, 32C/64T
- Two (2) NVIDIA L40S GPUs
- 1024 GB RAM (16 x 64 GB RDIMMs)
- PERC H755 RAID Controller
- iDRAC9 Enterprise 16G
- Two Broadcom 57416 Dual-Port 10GbE Base-T Network Cards
- Dual Hot-Plug, Redundant 1400W Mixed Mode Power Supplies

Additional CPU Options

Ensure the selected processor meets your organization's core density and clock speed requirements

- Intel® Xeon® Gold 6548N (2.8 GHz)
- Intel® Xeon® Gold 6542Y (2.9 GHz)
- Intel® Xeon® Platinum 8462Y (2.8 GHz)
- Intel® Xeon® Platinum 8562Y (2.8 GHz)
- Intel® Xeon® Performance 6527P (3.0 GHz)

VM Sizing Guidelines

Virtual machine sizing should reflect user workload complexity. Below are general guidelines based on common user profiles:

- **Light User** – *View-only access to 2D maps, simple navigation, and queries.*
 - **vCPU:** Minimum 4 vCPU
 - **Memory:** Minimum 6 GB RAM
 - **vGPU Profile:** 1Q – 2Q
- **Medium User** – *2D/3D editing, moderate geoprocessing, and map layout creation.*
 - **vCPU:** Minimum 8 vCPU
 - **Memory:** Minimum 8 GB RAM
 - **vGPU Profile:** 2Q or greater
- **Heavy User** – *Advanced 2D/3D visualization, symbology, labeling, and spatial analysis.*
 - **vCPU:** Minimum 12 vCPU
 - **Memory:** Minimum 16 GB RAM
 - **vGPU Profile:** 4Q or greater

***Tip:** Consider allocating slightly more resources than the baseline to accommodate performance spikes or background services.*

Additional Recommendations

- Adjust configurations based on user concurrency, workload variability, and performance targets.
- Monitor real-time resource utilization and historical trends to optimize VM sizes.
- Use GPU monitoring tools (e.g., NVIDIA-SMI, GPUProfiler) to ensure the vGPU frame buffer is not saturated under load.

Public Cloud Environments

Public cloud environments offer on-demand scalability and simplified infrastructure management. Organizations are increasingly turning to Desktop-as-a-Service (DaaS) models to meet the needs of a distributed and mobile workforce. Two key platforms supported by Esri are Microsoft Windows 365 Cloud PCs and Azure Virtual Desktop.

Windows 365 GPU-enabled Cloud PCs

Windows 365 provides a persistent desktop experience hosted in the Microsoft cloud, with recent support for GPU-enabled instances powered by NVIDIA hardware. These virtual desktops deliver the performance needed for ArcGIS Pro while offering a simplified deployment model that integrates directly with Microsoft Endpoint Manager.

Azure Virtual Desktop

Azure Virtual Desktop (AVD) delivers scalable, multi-session GPU-accelerated desktop environments optimized for ArcGIS Pro. With GPU-enabled NV-series or NC-series VMs, AVD supports a range of workloads—from basic viewing to advanced 3D analysis. The ArcGIS AVD Accelerator simplifies deployment by providing templates, scripts, and best practices. It's ideal for enterprises using Azure Active Directory and Microsoft's security tools.

Single-Session VM Sizing Recommendations

For users requiring dedicated resources, single-session VMs provide optimal performance isolation.

Workload Type	Recommended VM Sizes
Light (2D viewing, basic navigation)	NV4as_v4, NV8as_v4
Medium (2D/3D editing, moderate analysis)	NV16as_v4, NC4as_T4_v3, NC8as_T4_v3
Heavy (Advanced 3D visualization, GPU-intensive tools)	NC16as_T4_v3, NV12ads_A10_v5, NV18ads_A10_v5

Multi-Session VM Sizing Recommendations

Multi-session VMs support concurrent users, ideal for shared environments or cost optimization.

Workload Type	Recommended VM Sizes	Max Users per VM
Light	NV18ads_A10_v5, NC16as_T4_v3, NV32as_v4	Up to 6 users
Medium	NV18ads_A10_v5, NC8as_T4_v3	Up to 4 users
Heavy	NV18ads_A10_v5, NC16as_T4_v3	Up to 3 users

AVD supports geographic scalability with GPU acceleration and integrates with Azure services like FSLogix, Azure Files, and NetApp Files for enterprise-grade profile and data management. The choice between cloud platforms typically depends on administrative preferences, security requirements, and IT strategy—AVD being a strong fit for large-scale, multi-session GIS deployments.

Azure Local with ArcGIS Pro

Azure Local (formerly Azure Stack Hub) allows organizations to deploy ArcGIS Pro in on-premises or hybrid environments while maintaining consistency with Azure cloud services. This approach is ideal for scenarios requiring data sovereignty, low-latency processing, or disconnected operations where public cloud access is limited or restricted.

With Azure, Local, IT teams can leverage the same VM configurations, GPU-enabled instances, and security frameworks used in Azure public regions, while keeping sensitive geospatial data on-premises. ArcGIS Pro workloads running on Azure Local can work with local storage, fast networking, and enterprise identity solutions. This gives

government, defense, utilities, or other regulated industries the ability to deploy ArcGIS Pro in a way that fits their needs.

AWS EC2 GPU-Enabled Instances

Amazon EC2 offers flexible compute instances with GPU acceleration, enabling high-performance virtual desktops tailored for ArcGIS Pro. EC2 instances like the G4dn, G5 families give the GPU resources needed to support advanced spatial workflows like 3D rendering, geoprocessing, and real-time visualization. These instances can be provisioned as part of a persistent desktop image or integrated into a dynamic autoscaling group for elasticity. EC2's broad instance catalog allows organizations to fine-tune cost and performance based on workload requirements and geographic deployment preferences.

ArcGIS Pro deployments on EC2 are usually managed using Amazon WorkSpaces or custom remote desktop solutions. They work well with enterprise identity providers through the AWS Directory Service. EC2 is ideal for agencies requiring granular control over infrastructure, OS-level customization, and integration with a broader AWS cloud ecosystem, including S3 for storage and FSx for user profile management.

Amazon AppStream 2.0

Amazon AppStream 2.0 is a fully managed Desktop-as-a-Service (DaaS) solution that streams ArcGIS Pro to end users via HTML5 browsers, eliminating the need for local installation or persistent virtual desktops. It supports GPU-backed instance types like Graphics G4dn and GraphicsPro G5, which provide the necessary rendering power for demanding ArcGIS Pro workflows. AppStream allows for fine grained control of user access, application entitlements, and cost optimization through usage-based scaling.

Esri supports AppStream 2.0 as a deployment option for organizations seeking a streamlined, browser-based experience with minimal administrative overhead. With native support for federated identity, encrypted streaming, and cloud-native file access via Amazon S3, AppStream 2.0 is well-suited for distributed GIS teams, education environments, and contractors requiring temporary or on-demand access to ArcGIS Pro.

Google Cloud Platform (GCP)

Deploying ArcGIS Pro on GCP by using GPU-enabled VMs ensures a responsive experience comparable to a local workstation. GCP's Compute Engine offers a variety of NVIDIA GPUs, including T4. By selecting a GPU-backed VM and combining it with sufficient vCPUs, RAM, and SSD storage, you can virtualize ArcGIS Pro with either GPU pass-through or a vGPU setup, enabling smooth map panning, 3D rendering, and the ability to run CUDA-accelerated spatial analyses and deep learning models. For display, GCP supports remote access via Windows RDP, NVIDIA's RTX Virtual Workstations, NICE DCV, or HTML5 clients through Terra PCoIP-like protocols, helping you stream the graphics output with minimal latency even over remote connections. This setup makes GCP a robust choice for GIS professionals requiring on-demand, high-performance virtual environments for ArcGIS Pro workflows.

Deployment Best Practices

Implementing ArcGIS Pro in a virtualized environment requires a multidisciplinary approach that accounts for user workflows, IT operations, security, and budget constraints. Successful deployments typically follow a phased methodology: beginning with assessment, then design, pilot testing, rollout, and ongoing optimization.

To ensure high availability and user satisfaction:

- Conduct user profiling to identify workload types, geographic locations, session durations, and compute needs. These insights support more accurate VM and vGPU profile selection.
- Ensure IT teams define clear SLAs for ArcGIS Pro, especially in mission-critical areas like emergency response or infrastructure planning. Performance audits, feedback loops, and escalation paths help maintain service quality.
- Share knowledge between GIS professionals and IT staff. Hosting webinars, maintaining a knowledge base, and working with Esri support can reduce time to maturity for virtual deployments.

Successful ArcGIS Pro virtualization depends on careful planning, testing, and continuous performance monitoring. Key focus areas include image configuration, GPU allocation, profile management, and network setup.

Image and Application Configuration

- Use updated base images with the latest ArcGIS Pro and patches
- Pre-install Python packages, toolboxes, and add-ins
- Apply Esri's recommended registry and display settings
- Disable unnecessary Windows features and background services

GPU Optimization

- Assign dedicated vGPU profiles for performance consistency
- Avoid GPU over-subscription
- Monitor usage with NVIDIA-SMI, GPUProfiler, or third-party tools

User Profiles and Data Management

- Use solutions like FSLogix for roaming profiles
- Redirect home directories and temp files to high-IOPS network storage
- Leverage cloud sync tools (e.g., OneDrive, ArcGIS Online) for shared access

Network and Access Considerations

- Locate desktops in cloud regions closest to users
- Secure sessions with conditional access, MFA, and compliance policies

Regularly review usage trends and user feedback to guide optimization. Start with a pilot involving representative users before full-scale deployment.

Monitoring and Performance Tuning

Effective monitoring and performance tuning are essential for maintaining service and maximizing infrastructure ROI. Virtualized environments add complexity across hypervisors, GPUs, storage, and networks—each impacting user experience. To this, organizations need a proactive observability strategy with real-time metrics, predictive alerts, and continuous feedback.

Organizations can do the following:

- Use tools like Azure Monitor to enhance native options such as Windows Performance Monitor and NVIDIA-SMI, offering insights across users, departments, and time zones. These support benchmarking, capacity planning, and issue resolution.
- Ensure in cloud deployments, autoscaling policies align compute resources with usage patterns, e.g., ramping up on Monday mornings and scaling down during off-hours—while cost tracking aids in budget forecasting.
- Track KPIs such as user satisfaction, logon times, and incident response should be tracked. In-session surveys and telemetry help refine performance goals.

Performance tuning is ongoing. Treat the virtual desktop environment as a dynamic system—constantly monitored, adjusted, and aligned to user needs. This ensures a consistent, high-quality experience in virtualized ArcGIS Pro environments.

User Feedback and Support

Incorporating end user feedback into the monitoring process ensures that performance improvements align with the actual user experience. Support channels should collect qualitative input on session quality, rendering fidelity, and perceived responsiveness, and IT teams should investigate any recurring pain points.

Future Considerations

As virtualization technologies continue to evolve, GIS professionals and IT departments should remain informed of emerging trends that could impact the deployment of ArcGIS Pro. Organizations that proactively evaluate and pilot these advancements will be better positioned to scale capabilities, reduce costs, and support increasingly sophisticated GIS workflows. The following developments are expected to influence future strategies:

Cloud-Native and Containerized GIS Workloads

While ArcGIS Pro is currently supported only on Windows-based desktops, Esri and its partners are exploring containerized deployment options to improve portability and provisioning speed. A key limitation is the lack of full GUI support in containers, particularly for applications requiring GPU acceleration and interactive 3D rendering. Current pilot efforts focus on enabling container-based workflows using Windows containers with remote display protocols or non-GUI tasks like automated geoprocessing. As these technologies evolve, they may offer new deployment options for specific GIS use cases.

Conclusion

Virtualizing ArcGIS Pro empowers organizations to deliver scalable, secure GIS capabilities to distributed teams. With modern GPUs and cloud platforms, IT can meet the demands of complex spatial workflows while ensuring consistent performance. Furthermore, virtualization also adds strategic value—accelerating user onboarding, enabling AI, and 3D workflows, and supporting agile infrastructure scaling. It enhances collaboration, responsiveness, and business continuity.

By following the guidance in this technical paper—on platform choice, hardware, deployment, and tuning—organizations can ensure long-term success. And regularly reassessing user requirements and emerging tools ensures that virtualized environments remain future-ready.

For more information, visit
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