



Microsoft Azure Virtual Desktop on Azure Local 23H2 on Lenovo MX455V3 Premier Solution RA

Last update: 23 January 2025

Version 1.0 – Final Draft

Simplified deployment and management

Enhanced security and compliance

Flexible and scalable

Affordable and cost-effective

Emanuel Andreescu



1 Table of Contents

2	Introduction.....	1
2.1	AVD at the Edge: Bridging the Gap Between Cloud and On-premises.....	1
2.2	The Power of Edge AVD: Why It Matters.....	2
2.3	Lenovo MX455 V3 PR : Engineered for the Edge.....	3
3	Business problem and business value.....	4
3.1	Business problem.....	4
3.2	Business value.....	4
4	Architecture Design.....	5
4.1	Logical Architecture Diagram.....	5
4.1.1	Key Solution Components and Interactions.....	6
4.2	Requirements.....	7
4.3	Component Details.....	8
4.3.1	Azure Local Instance on Lenovo ThinkAgile MX455V3 Edge Premier Solution.....	8
4.3.2	Hardware.....	8
4.3.3	Software.....	9
4.3.4	Management Components.....	9
4.3.5	AVD Session Hosts.....	10
5	Deployment and Configuration.....	12
5.1	Edge-Specific Considerations.....	12
5.1.1	Limited Bandwidth and Intermittent Connectivity.....	12
5.1.2	Simplified Management for Remote IT.....	13
5.1.3	Physical Security and Environmental Factors.....	13
6	Conclusion.....	14
6.1	Summary of Benefits.....	14
6.2	Edge AVD Use Cases.....	14
6.3	Future Considerations.....	15
	Resources.....	16

2 Introduction

This document describes the reference architecture for Azure Virtual Desktop which is a cloud-based desktop and application virtualization service that runs on Microsoft Azure. It provides users with access to virtual desktops and applications from anywhere, on any device. Azure Virtual Desktop is a flexible and scalable solution that can be used to meet the needs of a wide range of organizations, from small businesses to large enterprises.

Azure Virtual Desktop can be deployed in the cloud or on-premises. On-premises deployments can be used to meet data locality requirements or to improve performance for users with poor connectivity to the Azure public cloud. Azure Local is a hyperconverged infrastructure (HCI) solution that can be used to deploy and manage Azure Virtual Desktop on-premises.

2.1 AVD at the Edge: Bridging the Gap Between Cloud and On-premises.

The modern workplace is no longer confined to traditional office walls. Businesses are increasingly distributed, with employees operating from remote offices, branch locations, manufacturing floors, retail stores, and even in the field. This shift demands secure and high-performance virtual desktop solutions that can deliver consistent experiences wherever work happens. Azure Virtual Desktop (AVD) steps up to this challenge, extending the power of cloud-based desktops to the edge, where data and users reside.

- **Remote Offices/Branch Locations:** Employees in satellite offices seamlessly accessing critical business applications and data with the same performance as their headquarters counterparts. No more relying on slow VPN connections or cumbersome file transfers.
- **Manufacturing/Industrial Sites:** Workers on the factory floor using ruggedized tablets to access real-time production data, schematics, and collaboration tools, directly from the AVD environment hosted on-site.
- **Retail/Customer-Facing Environments:** Interactive kiosks in shopping malls running engaging product demonstrations and personalized experiences, powered by AVD and managed centrally.
- **Healthcare:** Doctors accessing patient records and medical imaging applications on mobile devices within a hospital campus, ensuring efficient and secure access to critical information.

2.2 The Power of Edge AVD: Why It Matters

Deploying AVD at the edge is more than just a technical choice; it's a strategic enabler for businesses seeking agility, efficiency, and enhanced user experiences. Here's why it matters:

- **Unleash Performance with Reduced Latency:** Applications feel snappy and responsive when the computing power is closer to the user. Edge AVD minimizes the distance data travels, leading to significant improvements in latency, especially noticeable for graphics-intensive applications, 3D modelling, video editing, and real-time collaboration tools. This translates to increased productivity and a smoother user experience.
- **Optimize Bandwidth, Minimize Costs:** WAN links can be expensive and congested. Edge AVD reduces the need to constantly transfer large amounts of data over these connections. By processing data locally, you optimize bandwidth consumption, lower costs, and improve application performance, especially in locations with limited or expensive internet access.
- **Embrace Resilience with Offline Availability:** Internet outages happen. But with AVD on Azure Local Instance at the edge, work doesn't have to stop. The local infrastructure can continue to operate, providing access to critical applications and data, ensuring business continuity, and maximizing employee productivity even in offline scenarios.
- **Maintain Control with Data Sovereignty:** Data privacy and compliance are paramount. Edge AVD allows organizations to keep sensitive data within specific geographical boundaries or on-premises, complying with data residency regulations and reducing the risks associated with data transfers.

2.3 Lenovo MX455 V3 PR : Engineered for the Edge

The Lenovo ThinkAgile MX455 V3 Edge Premier Solution isn't just another server; it's a comprehensive platform meticulously engineered to excel in edge AVD deployments. It combines the ruggedness and reliability of Lenovo's ThinkEdge servers with the seamless integration and management capabilities of a fully validated Azure Local solution.



Figure 1: ThinkAgile MX455 V3 Edge Premier Solution

Validated and Certified: The ThinkAgile MX455 V3 undergoes rigorous testing and validation by both Lenovo and Microsoft, ensuring compatibility and reliability for your AVD deployment. This translates to reduced risk, faster time-to-value, and a smoother overall experience.

Simplified Deployment and Management: This solution streamlines the deployment of Azure Local instance, providing a pre-integrated and pre-configured platform that's ready to go. With Azure Arc integration, you can easily manage your edge servers from the Azure portal, simplifying updates, monitoring, and policy enforcement. Lenovo XClarity Controller further enhances management capabilities with centralized control, automated updates, and proactive platform alerts.

Performance Optimized for Edge: The ThinkAgile MX455 V3 Edge is designed to deliver consistent performance for demanding edge workloads. It supports powerful AMD EPYC processors, high-speed memory, and NVMe drives, ensuring a responsive and smooth experience for your AVD users. The inclusion of GPU support further enhances performance for graphics-intensive applications and AI workloads.

Resilience and Availability: Downtime is not an option at the edge. This solution incorporates features like redundant power supplies, hot-swappable drives, and advanced memory RAS features to maximize uptime and ensure business continuity. Built-in resiliency with Azure Local protects against drive, server, or component failures, providing continuous availability for your critical AVD environment.

Security Enhanced for the Edge: Security is paramount, especially in distributed edge environments. The ThinkAgile MX455 V3 Edge includes a range of security features, including TPM 2.0, Secure Boot, and optional chassis intrusion detection, to safeguard your AVD deployment. Lenovo's ThinkShield security suite provides additional protection with features like Secure Memory Encryption and remote attestation.

Designed for Demanding Environments: The compact and rugged design of the ThinkAgile MX455 V3 Edge Premier Solution allows it to be deployed virtually anywhere. It can withstand high temperatures, dust, and vibration, making it suitable for harsh edge locations. Its flexible mounting options (wall-mount, floor-stand, rack-mount) provide further deployment versatility.

3 Business problem and business value

This section dives deeper into the specific challenges faced by organizations with distributed workforces and how AVD on Azure Local with Lenovo ThinkAgile MX455 V3 Edge Premier Solution delivers tangible value.

3.1 Business problem

Organizations with employees operating from remote offices, branch locations, retail stores, or manufacturing sites often encounter significant hurdles in providing reliable and efficient virtual desktop infrastructure (VDI):

- **Inconsistent User Experience:** Employees at the edge frequently experience performance limitations, latency issues, and restricted access to resources due to inadequate local IT infrastructure. This can lead to frustration, reduced productivity, and an inability to perform tasks effectively.
- **Bandwidth Constraints and Costs:** WAN links connecting edge locations to central data centers are often expensive and have limited bandwidth. Transmitting large amounts of data can strain these connections, leading to performance bottlenecks, increased costs, and a poor user experience.
- **Limited IT Resources at the Edge:** Edge locations typically have limited or no dedicated IT staff. This makes it challenging to manage and maintain complex IT infrastructure, troubleshoot issues, apply updates, and ensure security, potentially leading to downtime and security vulnerabilities.

3.2 Business value

Deploying AVD on Azure Local Instance with Lenovo ThinkAgile MX455 V3 Edge Premier Solution provides a compelling solution to these challenges, delivering significant business value:

- **Enhanced User Experience and Productivity:** By bringing virtual desktops closer to the users at the edge, this solution provides a responsive and seamless experience, with improved application performance and reduced latency. This leads to increased employee satisfaction, enhanced productivity, and the ability to leverage demanding applications even in remote locations.
- **Reduced Bandwidth Consumption and Costs:** Processing virtual desktop workloads locally minimizes data transfer over WAN links, optimizing bandwidth usage and potentially leading to significant cost savings. This is particularly beneficial in areas with limited or expensive internet connectivity.
- **Simplified IT Management:** The integrated and pre-validated solution simplifies deployment and management, reducing the burden on IT staff. Centralized management through Azure Arc and Lenovo XClarity Controller enables efficient monitoring, patching, and policy enforcement, even with limited IT resources at the edge.

By addressing these critical business problems, AVD on Azure Local Instance with Lenovo ThinkAgile MX455 V3 Edge Premier Solution empowers organizations to effectively support their distributed workforce, enabling productivity, agility, and innovation.

4 Architecture Design

This section delves into the architectural design of our edge AVD solution. We'll explore how the combination of Azure Local Instance and Lenovo ThinkAgile MX455 V3 Edge Premier Solution servers creates a powerful and secure platform for delivering high-performing virtual desktops to users at the edge.

We'll highlight the advantages of this architecture and outline best practices to ensure optimal performance, security, and manageability in edge environments.

4.1 Logical Architecture Diagram

The diagram in this section provides a visual roadmap of your edge AVD environment. It shows how Azure Virtual Desktop (AVD), running on the robust foundation of Azure Local and Lenovo ThinkAgile MX455 V3 Edge Premier Solution servers, delivers a powerful and flexible solution for providing virtual desktops to your users wherever they are.

This architecture empowers your workforce with secure access to their applications and data from any device, anywhere, while providing centralized management and control through Azure.

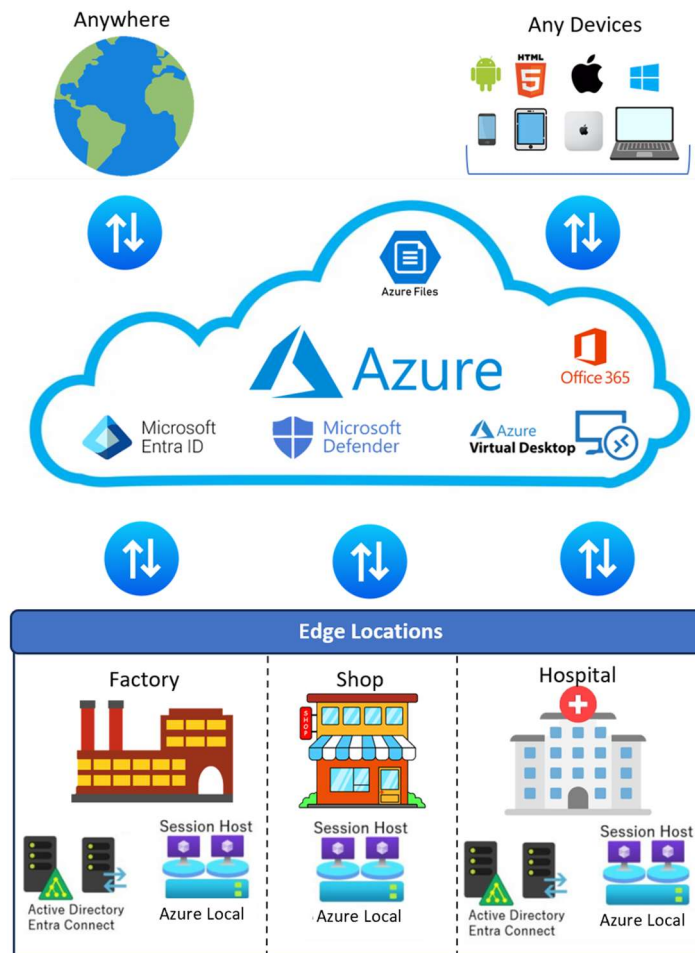


Figure 2: Edge locations with Azure Local Instance for AVD

4.1.1 Key Solution Components and Interactions

This section breaks down the essential elements of our edge solution and how they work together to deliver a powerful and versatile platform for both virtual desktops and containerized applications.

At the Edge: Bringing IT Closer to the Action

We begin by recognizing the importance of the edge location itself – a hospital, a retail store, a factory floor, or any environment where users and data reside. By placing the core IT infrastructure at the edge, we minimize latency, optimize bandwidth, and enable a more responsive and efficient experience.

Virtual Desktops: AVD Session Hosts

These virtual machines, running on the Azure Local cluster, are the workhorses of our AVD environment. Each session host acts like a separate computer, providing a familiar Windows 10/11 Enterprise multi-session desktop experience to users.

Identity and Access: Active Directory

To ensure secure access to resources, we integrate with Active Directory. This could be a local domain controller within the cluster or a connection to a central Active Directory in Azure or the on-premises data center.

Network Connections: Bridging the Edge and the Cloud

Our edge solution requires two primary network connections:

- **To Azure:** A secure link to Azure, established through a site-to-site VPN, ExpressRoute, or Azure Arc-enabled servers, enables centralized management, monitoring, and updates for AVD.
- **To Users and Devices:** Users connect to their virtual desktops and applications from their laptops, tablets, or thin clients over the internet or the local network.

Management Tools: Your Edge Orchestration Platform

We leverage a suite of tools to manage and monitor our edge solution:

- **Azure Portal:** The Azure portal serves as our central command center, allowing us to manage the Azure Local Instance AVD session hosts, and the AKS cluster from a single, unified interface.
- **Lenovo XClarity Controller:** This provides direct access to the hardware, enabling us to monitor the health of the Lenovo servers, apply firmware updates, and receive proactive alerts about potential issues.

This architecture effectively combines the power of virtual desktops and containerized applications at the edge, providing a versatile and efficient solution for modern workloads.

4.2 Requirements

To ensure optimal performance for your Azure Virtual Desktop environment, begin with these baseline requirements for your on-premises infrastructure, remembering that a minimal setup will utilize approximately 24-30GB of RAM. We recommend 1TB storage capacity in your Azure Local storage pool used to store virtual machines. However, again, this will be determined by your workload requirements.

- Active Directory domain, you need a domain account that can join computers to your domain.
For
- Microsoft Entra Domain Services, you would need to be a member of the AAD DC Admin group.
- User Account Requirements. Users must have accounts in the Microsoft Entra ID system. For Azure
- Virtual Desktop on Azure Local deployments using AD DS - Configure Microsoft Entra Connect for user identity synchronization between AD DS and Microsoft Entra ID.
- External internet connectivity for both the Azure Local nodes, and the Azure Virtual Desktop components.
- Azure subscription for Azure Virtual Desktop Session Host Pool with the appropriate permissions.
- Network Validation for AVD Links - <https://docs.microsoft.com/en-us/azure/virtual-desktop/safe-url-list>.
- Ensure your account is granted the built-in RBAC roles at the resource group or subscription

4.3 Component Details

4.3.1 Azure Local Instance on Lenovo ThinkAgile MX455V3 Edge Premier Solution

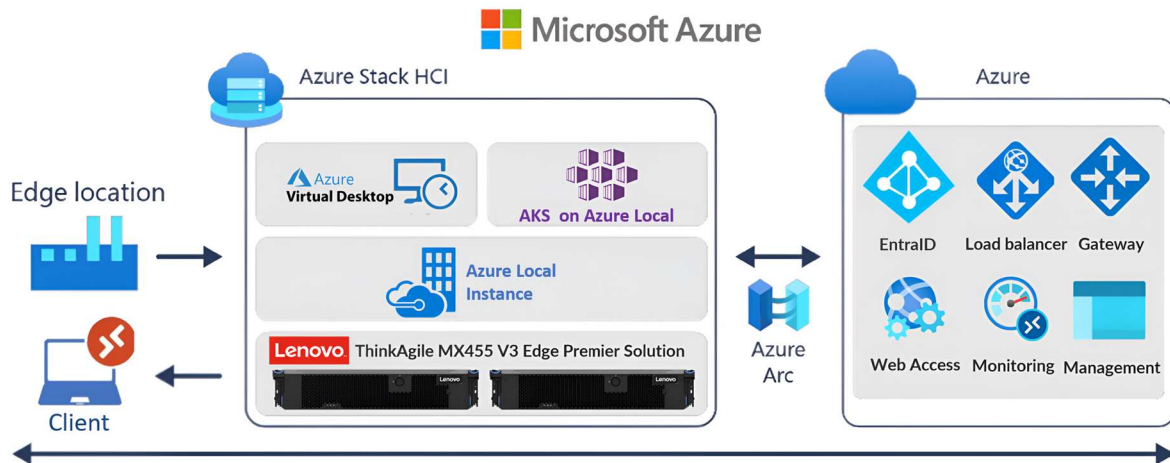


Figure 3: high level architecture of AVD on Azure Local on Lenovo MX455V3 PR

The Azure Local Instance, built on Lenovo ThinkAgile MX455 V3 servers, forms the foundation of the edge AVD environment.

4.3.2 Hardware

- **Servers:** The cluster consists of at least two Lenovo ThinkAgile MX455 V3 Edge Premier Solution servers to ensure high availability.
- **Processors:** Each server is equipped with a powerful AMD EPYC processor, providing ample processing power for multiple concurrent AVD sessions.
- **Memory:** The servers are configured with a generous amount of high-speed DDR5 memory, ensuring smooth performance for AVD workloads.
- **Storage:**
 - **Type:** High-performance NVMe drives are used for primary storage, providing low latency and high throughput for optimal AVD performance.
 - **Configuration:** RAID configuration (mirroring or parity) used to protect against drive failures and ensure data integrity.
- **Networking:**
 - **Adapters:** Each server has multiple network adapters, typically 25GbE(10GbE supported) or faster, to handle the network traffic.
 - **Switches:** A network switch with sufficient bandwidth and features (VLAN support, QoS) connects the servers and provides connectivity to the external network

4.3.3 Software

- **Azure Local OS:** The cluster runs the latest version of the Azure Local operating system, providing a robust and secure platform for virtualization and software-defined storage.
 - **Virtualization:** Microsoft's Hyper-V hypervisor is used for creating and managing the virtual machines that host the AVD session hosts.
 - **Storage:** Storage Spaces Direct, a software-defined storage technology built into Azure Local, pools the storage capacity of the servers drives and provides features like data deduplication and compression to optimize storage efficiency.
 - **Networking:** Software-defined networking (SDN) capabilities within Azure Local enable network virtualization and management, providing flexibility and control over network traffic.

4.3.4 Management Components

Azure Portal: The Azure portal becomes your central command center for the edge. By installing the Azure Arc agent on the servers, you can manage your entire Azure Local instance directly from the familiar Azure portal interface. This gives you a single pane of glass to monitor the health of your cluster, apply updates, and enforce policies, all without needing to be physically present at the edge location.

Lenovo XClarity Controller: Think of XClarity Controller as your direct line to the hardware. It's an out-of-band management solution, meaning it operates independently of the server's operating system. This allows you to monitor the health of the servers, even if they're offline. You can also use XClarity to perform tasks like:

- Viewing system health and status
- Applying firmware updates
- Configuring hardware settings
- Receiving proactive alerts about potential issues

XClarity Controller provides essential insights into the hardware layer of your edge AVD solution, ensuring smooth and reliable operation.

4.3.5 AVD Session Hosts

This section details the key components that make up our robust and versatile edge computing solution, where Azure Virtual Desktop (AVD) and Azure Kubernetes Service (AKS) run side-by-side on Azure Local.

AVD Session Hosts: Delivering Virtual Desktops

These are the virtual machines (VMs) that provide the familiar Windows desktop experience to your users at the edge. They run on the Azure Azure Local instance, each acting as an independent computer hosting a Windows 10/11 Enterprise multi-session operating system.

- **VM Sizing:** We carefully size the VMs based on factors like the expected number of users, the types of applications they'll be using, and the desired performance levels. This ensures a smooth and responsive experience for everyone.
- **Operating System:** Each VM runs Windows 10/11 Enterprise multi-session, an operating system specifically optimized for AVD environments. This allows multiple users to share the same VM, maximizing resource utilization and reducing costs.
- **Image Management:**
 - We create a "golden image" containing the operating system, essential applications, and security configurations. This image serves as a template for deploying new session hosts, ensuring consistency and simplifying management.
 - Alternatively, we can select a standard image from the Azure Marketplace, which can be easily downloaded and deployed from the Azure portal.
- **Application Deployment:**
 - We deploy applications to the session hosts using appropriate methods, such as FSLogix for profile management and application masking, and MSIX app attach for efficient application delivery.
 - We optimize application performance for the edge environment by leveraging techniques like local caching and application virtualization.

AKS Cluster: Container Orchestration at the Edge

Alongside AVD, we can deploy an AKS cluster on the same Azure Local infrastructure. This allows us to run containerized applications at the edge, providing:

- **Flexibility:** Deploy and manage a wide variety of applications in a portable and consistent manner.
- **Scalability:** Easily scale applications up or down based on demand.
- **Efficiency:** Optimize resource utilization by running multiple containers on the same infrastructure.
-

Integrating AVD and AKS: A Powerful Combination

Azure Kubernetes Service (AKS) is a managed Kubernetes service that simplifies the deployment, management, and scaling of containerized applications. In the context of Azure Local, AKS can be used to orchestrate and manage the underlying infrastructure components of your Azure Virtual Desktop environment, providing increased flexibility and scalability.

By combining AVD and AKS on Azure Local, we create a powerful and versatile edge computing platform that can support a wide range of workloads. This integrated approach provides:

- **Centralized Management:** Manage both AVD and AKS from the Azure portal, simplifying administration and monitoring.
- **Enhanced Resource Utilization:** Maximize the use of your hardware resources by running both virtual desktops and containerized applications on the same infrastructure.
- **Increased Flexibility:** Support a diverse set of applications and use cases, from traditional desktop applications to modern cloud-native applications.

This converged edge platform empowers your organization to deliver a modern and efficient workspace to users at the edge, while providing the flexibility and scalability needed to support future growth and innovation.

Identity and Access Management

Secure and efficient user authentication and authorization are essential.

- **Azure AD Integration:**
 - We integrate with Azure Active Directory to allow users to authenticate using their Azure AD credentials. This enables single sign-on (SSO) and multi-factor authentication for enhanced security.
 - We use role-based access control (RBAC) to manage user permissions within AVD, ensuring that users only have access to the resources they need.

5 Deployment and Configuration

While this guide provides a comprehensive overview, we recommend consulting our dedicated AVD Deployment Guide for a detailed, step-by-step walkthrough of the entire process.

The AVD Deployment Guide offers in-depth instructions and best practices for each stage of the deployment, ensuring a smooth and successful implementation. You can find the deployment guide [here](#)

5.1 Edge-Specific Considerations

Deploying and managing AVD in edge environments presents unique challenges that require careful consideration and planning. This section addresses those challenges and provides guidance on how to overcome them.

5.1.1 Limited Bandwidth and Intermittent Connectivity

Edge locations often have limited internet bandwidth compared to central data centers. Additionally, internet connectivity may be intermittent or unreliable due to factors like remote location or reliance on satellite or cellular connections.

- **Mitigation Strategies:**
 - **Optimize AVD Protocols:** Utilize AVD protocols like RDP Shortpath for managed networks, which establishes a direct connection between the client and the session host, bypassing the gateway and reducing latency.
 - **Implement Local Content Caching:** Use tools like BranchCache or Azure Content Delivery Network (CDN) to cache frequently accessed content (applications, updates, etc.) locally at the edge, reducing the need to download data over the WAN repeatedly.
 - **Prioritize Network Traffic:** Implement Quality of Service (QoS) policies on network devices to prioritize AVD traffic over less critical traffic, ensuring a smooth user experience even during periods of congestion.
 - **Consider Offline Availability:** For scenarios where internet connectivity is frequently disrupted, explore solutions like Azure Local's stretch cluster capability, which allows the edge cluster to continue operating even if the connection to Azure is temporarily lost.

5.1.2 Simplified Management for Remote IT

Edge locations may have limited or no dedicated IT staff, making it challenging to manage and maintain the AVD environment.

- **Mitigation Strategies:**
 - **Centralized Management with Azure Arc:** Leverage Azure Arc to manage the Azure Local Instance and AVD session hosts from a central location, eliminating the need for on-site IT personnel.
 - **Remote Monitoring and Troubleshooting:** Utilize Azure Monitor and Lenovo XClarity Controller to monitor the health and performance of the edge AVD environment remotely. These tools provide alerts, performance metrics, and remote troubleshooting capabilities.
 - **Automated Updates and Patching:** Implement automated update mechanisms for the Azure Local OS, AVD session hosts, and applications to minimize manual intervention and ensure the environment is always up to date.

5.1.3 Physical Security and Environmental Factors

Edge locations may have different physical security and environmental considerations compared to a traditional data center.

- **Mitigation Strategies:**
 - **Secure the Physical Environment:** Ensure the Lenovo ThinkAgile MX455 V3 servers are deployed in a secure location with restricted access to prevent unauthorized tampering.
 - **Environmental Monitoring:** Monitor environmental factors like temperature, humidity, and power fluctuations, which can impact the performance and reliability of the servers.
 - **Ruggedized Hardware:** Lenovo ThinkAgile MX455V3 servers are designed to withstand harsher environmental conditions, but consider additional measures like dust filters or surge protectors if necessary.
 - **Remote Management and Recovery:** Implement remote management capabilities and recovery procedures to address issues that may arise due to physical access or environmental factors.

6 Conclusion

This concluding section summarizes the key takeaways from this reference architecture, highlighting the benefits of deploying AVD on a Azure Local instance at the edge with Lenovo ThinkAgile MX455 V3 Edge Premier Solution. It also explores potential use cases and future considerations.

6.1 Summary of Benefits

By implementing this architecture, organizations can achieve significant advantages:

- **Enhanced User Experience:** Employees at the edge enjoy a responsive and seamless virtual desktop experience with improved application performance and reduced latency.
- **Optimized Bandwidth:** Local processing of virtual desktops minimizes data transfer over WAN links, optimizing bandwidth utilization and reducing costs.
- **Simplified IT Management:** The integrated and pre-validated solution simplifies deployment and management, enabling centralized control and efficient updates, even with limited IT resources at the edge.
- **Improved Business Continuity:** Azure Azure Local built-in resiliency and high availability features ensure continuous operation, while offline capabilities enable productivity even during internet disruptions.
- **Strengthened Security:** Robust security features protect sensitive data and applications at the edge, ensuring compliance with industry regulations.

6.2 Edge AVD Use Cases

This architecture is well-suited for a variety of edge scenarios:

- **Retail Stores:** Provide employees with access to inventory systems, point-of-sale applications, and customer relationship management (CRM) tools, even in locations with limited connectivity.
- **Branch Offices:** Enable employees in remote offices to seamlessly access corporate resources and applications with the same performance as headquarters users.
- **Manufacturing Facilities:** Empower workers on the factory floor with access to real-time data, production applications, and collaboration tools on ruggedized devices.
- **Healthcare Clinics:** Provide clinicians and staff with secure access to patient records, medical imaging applications, and telehealth platforms from various locations within a healthcare facility.

6.3 Future Considerations

As edge computing continues to evolve, several factors warrant consideration for future enhancements:

- **Increased AI and Machine Learning:** Integrate AI and machine learning capabilities at the edge to enable intelligent automation, predictive analytics, and enhanced security.
- **IoT Integration:** Connect AVD with IoT devices and edge computing platforms to enable real-time data processing, analysis, and decision-making in edge environments.
- **Enhanced Offline Capabilities:** Explore further enhancements to offline availability, such as local data synchronization and collaboration tools that function seamlessly even without internet connectivity.

By staying abreast of these trends and proactively adapting the architecture, organizations can maximize the value of their edge AVD deployments and empower their distributed workforce to thrive in the ever-changing digital landscape.

Resources

[Azure ARC VM management](#)

[Azure Virtual Desktop on Azure Local](#)

[Deploy branch office and edge on Azure Stack HCI](#)

[ThinkAgile MX455 V3 Edge Premier Solution](#)

[VDI Solution with Azure Virtual Desktop on Azure Stack HCI 23H2](#)

Trademarks and special notices

© Copyright Lenovo 2024.

References in this document to Lenovo products or services do not imply that Lenovo intends to make them available in every country.

Lenovo, the Lenovo logo, ThinkCentre, ThinkVision, ThinkVantage, ThinkAgile and Rescue and Recovery are trademarks of Lenovo.

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

Intel, Intel Inside (logos), MMX, and Pentium are trademarks of Intel Corporation in the United States, other countries, or both.

Other company, product, or service names may be trademarks or service marks of others.

Information is provided "AS IS" without warranty of any kind.

All customer examples described are presented as illustrations of how those customers have used Lenovo products and the results they may have achieved. Actual environmental costs and performance characteristics may vary by customer.

Information concerning non-Lenovo products was obtained from a supplier of these products, published announcement material, or other publicly available sources and does not constitute an endorsement of such products by Lenovo. Sources for non-Lenovo list prices and performance numbers are taken from publicly available information, including vendor announcements and vendor worldwide homepages. Lenovo has not tested these products and cannot confirm the accuracy of performance, capability, or any other claims related to non-Lenovo products. Questions on the capability of non-Lenovo products should be addressed to the supplier of those products.

All statements regarding Lenovo future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only. Contact your local Lenovo office or Lenovo authorized reseller for the full text of the specific Statement of Direction.

Some information addresses anticipated future capabilities. Such information is not intended as a definitive statement of a commitment to specific levels of performance, function or delivery schedules with respect to any future products. Such commitments are only made in Lenovo product announcements. The information is presented here to communicate Lenovo's current investment and development activities as a good faith effort to help with our customers' future planning.

Performance is based on measurements and projections using standard Lenovo benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput or performance improvements equivalent to the ratios stated here.

Photographs shown are of engineering prototypes. Changes may be incorporated in production models.

Any references in this information to non-Lenovo websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this Lenovo product and use of those websites is at your own risk.