A close-up of a logo

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**TEMASEK POLYTECHNIC**

**SCHOOL OF INFORMATICS & IT**

**DIPLOMA IN INFOCOMM AND DIGITAL MEDIA**

**ICT SYSTEMS, SERVICES & SUPPORT**

**VIRTUAL DESKTOP TECHNOLOGY (VRDT) CIML015**

**AY 2024/25 OCTOBER SEMESTER**

**PROJECT**

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| --- |
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**Project Report – 30%**

**Requirement: At least 20 page or above.**

**Introduction** – Background, Aim and Purpose of this Proposal

**Intro and Background:**

You are employed in the IT division of Macro Soft, a software training school with six locations around Southeast Asia. According to estimates, their current environment is:  
  
25 employees in management and administration;   
20 IT support staff, 35 instructors;   
800 student developers.   
  
Currently, Ubuntu OS or Windows 10 are given to teachers and students, and they run the following apps:

1) The Libre Office Suite   
2) The Chrome Web Browser   
3) Zoom   
4) The Sublime Text IDE

**Problem statement:**

The employees go around the Southeast Asian branches on a regular basis. Online or in-person, the classes can be dynamic and ad hoc. The IT support team must be able to quickly set up the training environment. When their notebooks or apps malfunctioned, teachers and students frequently lamented the poor response times and lack of technical help. Teachers suffer unnecessary stress as a result, and pupils have a poor educational experience.

**Tasks assigned by Manager:**

To address the notebook or program failure issue, your manager is considering offering a virtual desktop with the required apps pre-installed as a temporary substitute. You are expected to draft and deliver a proposal on this solution to your management.

**Design -** With reference to the above scenario, report on the Virtual Desktop solution for

a. Compute, storage and network requirement.

b. Costing.

c. Pros and Cons.

**Introduction**

**Virtual Desktop Infrastructure (VDI)**

Virtual Desktop Infrastructure (VDI) is a technology that enables the creation and management of virtual desktops hosted on centralized servers. VDI removes the requirement for users to run an operating system and applications locally on a physical device by enabling them to access a virtualized desktop environment from nearly any device with an internet connection.

On a virtual desktop infrastructure (VDI) setup, desktop operating systems—typically Windows or Linux—run on virtual machines (VMs) on a centralized server. Users can engage with these desktops remotely and take advantage of all the functionality of a standard desktop computer by using a web browser or client application.

A picture to show Virtual Desktop Infrastructure (VDI) being used:

A computer screen with icons

AI-generated content may be incorrect.

# **Virtual Desktop components**

The infrastructure used to provide and administer virtual desktops for users is known as a virtual desktop infrastructure, as the name suggests. In general, VDI is made up of four major parts:

**Hypervisor** - The virtualization layer that enables the operation of numerous virtual machines (VMs) on a single physical server is provided by the hypervisor, which forms the basis of virtual desktop infrastructure (VDI). It controls how each virtual desktop instance is allotted computer resources like CPU, memory, and storage.

**Virtual machines** - Every virtual desktop operates as a separate virtual machine (VM) with its own operating system, apps, and user information. As previously stated, many virtual machines (VMs) can operate on a single server, and they are easily transportable across servers, data centres, and cloud settings.

**Connection broker** - The connection broker authenticates users, connects them to the relevant virtual desktop, and controls their session by serving as a middleman between users and their virtual desktops.

**User Devices** - Users can choose from a wide variety of devices for work, including desktops, laptops, thin clients, and even mobile devices, because the desktop environment and its apps operate on a central server rather than depending on endpoint computing resources.

A diagram of a connection between a virtual machine and a computer

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# **Benefits of Implementing a VDI Environment:**

The widespread adoption of virtual desktop infrastructure is easy to understand, given its wide range of benefits for users, IT, and the organization.

**Anywhere, any-device productivity** – Users can use any connected device, from any place, to access their whole work environment. This flexibility allows the company to lower hardware expenses with bring-your-own-device (BYOD), increase employee happiness with remote work policies, and more readily accommodate mobile executives and salespeople.

**Consistent user experience** – VDI lowers training needs and enables employees to operate seamlessly across offices and devices by offering a consistent desktop and experience across devices and locations.

**Better performance for resource-intensive applications** – Researchers, data analysts, engineers, and designers depend on demanding apps that might strain their endpoints' processing power. By using virtual desktop infrastructure (VDI), IT can execute these workloads more effectively on strong centralized servers rather than purchasing a fleet of expensive workstations.

**Centralized management** – The time required for software updates, security patches, and user support can be significantly decreased by IT managing, updating, and troubleshooting each virtual desktop in the company from a single location. Cost and downtime are reduced when operational efficiency rises.

**Streamlined provisioning** – IT can quickly set up a new virtual machine (VM) that new personnel can use on any device, whether it's company-owned or personal. With non-persistent VDI desktops, IT can swiftly and effectively outfit contact centers, retail establishments, and other task-based or seasonal workplaces.

**Cost efficiency** – VDI desktops can run on machines that are obsolete or underpowered. VDI can reduce desktop environments' total cost of ownership by prolonging the life of endpoints. The savings are increased via centralized maintenance and lower energy use.

**Scalability** – Increasing the number of employees? Run a couple additional virtual machines. Expanding your workforce or adjusting to seasonal swings has never been easier thanks to cloud resources that are accessible on demand to run centralized desktop workloads. With a few clicks, you may deprovision and clean virtual machines to scale back down.

**Security and compliance** – Since all data is kept on the host of the virtual machine, it is not susceptible to client loss or theft. Because centralization gives you more control over data access, storage, and transfer, it also makes it easier to comply with laws like GDPR, HIPAA, and PCI DSS.

**Continuous business and disaster recovery** – All information is kept on the host of the virtual machine (VM), making it impervious to client loss or theft. Better control over data access, storage, and transfer is another benefit of centralization, which makes it easier to comply with laws like GDPR, HIPAA, and PCI DSS.

**Green IT** – With longer device lifespans that reduce e-waste and energy-efficient centralized computing resources, VDI helps achieve sustainability goals.

**Common Use of VDI**

VDI is commonly used in industries such as healthcare, finance, education, and remote work environments where secure, scalable, and consistent desktop experiences are essential.

# **Product selection**

Depending on the requirements of the company, selecting Azure Virtual Desktop (AVD) over alternative cloud-based virtual desktop infrastructure (VDI) options, can be a calculated move.

A diagram of a cloud computing system

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**1. Deep Integration with Microsoft Ecosystem**

* Microsoft Teams and 365 Optimisation: AVD offers improved user experience and performance for Microsoft Teams and Microsoft 365 apps.
* Azure AD & Active Directory: Identity and access management is seamlessly integrated with Azure AD and on-premises Active Directory.
* Windows 10/11 Multi-Session: Only available on Azure, this feature lowers expenses by enabling numerous users to share a single Windows 10/11 virtual machine.

**2. Cost Efficiency**

* Per-user licensing: You might not need to pay more for AVD access if you already have Windows or Microsoft 365 licenses.
* Auto-scaling: Azure allows virtual machines to be scaled up or down in response to demand, which lowers expenses during off-peak hours.

**3. Security & Compliance**

* Built-in security: Azure comes with cutting-edge security features including data encryption, Conditional Access, and Microsoft Defender for Endpoint.
* Compliance certifications: For regulated industries, Azure's compliance with numerous international compliance standards, like as ISO, HIPAA, and GDPR, is essential.

**4. Global Reach & Reliability**

* Extensive global presence: With one of the biggest data centre footprints in the world, Azure guarantees high availability and minimal latency.
* Disaster recovery & backup: Business continuity is improved by integrated solutions like Azure Backup and Site Recovery.

**5. Management & Monitoring Tools**

* Azure Monitor & Log Analytics: Integrated diagnostic, alerting, and performance monitoring tools.
* Intune & Endpoint Manager: Unified endpoint administration for virtual and physical devices.

**6. Flexible Deployment Options**

* Hybrid support: Cloud-based on-premises environments can be readily extended.
* Custom images & scaling: Custom virtual machine images and adaptable scaling options are supported.

**Azure Virtual desktop**

A typical architectural setup for Azure Virtual Desktop is illustrated in the following diagram:

Design diagram: **Public Cloud**

A screenshot of a computer

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# **Description Product & design Core components**

1. **Dataflow**

The diagram's dataflow elements are described here:

* The on-premises network of a customer houses the application endpoints. Microsoft Entra Connect connects the customer's Active Directory Domain Services (AD DS) with Microsoft Entra ID, while Azure ExpressRoute expands the on-premises network into Azure.
* Web access, gateway, broker, diagnostics, and extensibility elements like REST APIs are managed by the Azure Virtual Desktop control plane.
* The customer oversees Azure subscriptions, virtual networks, Azure Files or Azure NetApp Files, Azure Virtual Desktop host pools and workspaces, and AD DS and Microsoft Entra ID.
* The customer links two Azure subscriptions in a hub-spoke design using virtual network peering to boost capacity.

1. **Components**

Windows Server Remote Desktop Services (RDS) and Azure Virtual Desktop share a similar architecture. Enterprise clients are in charge of their own desktop host virtual machines (VMs), data, and clients, even though Microsoft oversees the brokering and infrastructure components.

1. Components that Microsoft Manage

As part of Azure, Microsoft oversees the following Azure Virtual Desktop services:

* **Web Access**: With Azure Virtual Desktop's Web Access service, you can access distant apps and virtual desktops from any location on any device using an HTML5-compatible web browser, just like you would with a local PC. With Microsoft Entra ID, multifactor authentication can be used to safeguard web access.
* **Gateway**: From any internet-connected device that can run an Azure Virtual Desktop client, remote users can access Azure Virtual Desktop desktops and apps through the Remote Connection Gateway service. After the client establishes a connection with a gateway, the gateway arranges for a connection to be made from a virtual machine back to the gateway.
* **Connection Broker**: User connections to remote apps and virtual desktops are managed by the Connection Broker service. Load balancing and session reconnection are offered by Connection Broker.
* **Diagnostics**: Every user or administrator action on the Azure Virtual Desktop deployment is flagged as successful or unsuccessful by Remote Desktop Diagnostics, an event-based aggregator. To find malfunctioning parts, administrators can query the event aggregation.
* **Extensibility components**: Several extensibility components are included in Azure Virtual Desktop. Using Windows PowerShell or the offered REST APIs, which also allow third-party tools to be used, you can administer Azure Virtual Desktop.

1. Components that we manage

We manage the following components of Azure Virtual Desktop solutions:

* **Azure Virtual Network**: Azure Virtual Network enables secret communication between Azure resources, including virtual machines (VMs), and the internet. Depending on organizational policy, you can specify network topology to access virtual desktops and virtual apps from the intranet or internet by connecting Azure Virtual Desktop host pools to an Active Directory domain. A virtual private network (VPN) can be used to link an Azure Virtual Desktop instance to an on-premises network, or Azure ExpressRoute can be used to extend the on-premises network into Azure via a private connection.
* **Microsoft Entra ID**: Microsoft Entra ID is used by Azure Virtual Desktop to manage identification and access. Microsoft Entra integration helps preserve app compatibility in domain-joined virtual machines (VMs) by implementing Microsoft Entra security technologies including conditional access, multifactor authentication, and Intelligent Security Graph.
  + **Active Directory Domain Services (Optional)**: Azure Virtual Desktop virtual machines can be deployed using Microsoft Entra-joined virtual machines or domain-joined to an AD DS service.
  + To link users between the two services, an AD DS domain needs to be in sync with Microsoft Entra ID. AD DS can be linked to Microsoft Entra ID via Microsoft Entra Connect.
  + When using Microsoft Entra join, review the supported configurations to ensure your scenario is supported.
* **Azure Virtual Desktop session hosts**: Users connect to session hosts, which are virtual machines, for their desktops and apps. You may make photos using your apps and customizations, and it supports a few Windows versions. VM sizes are customizable, including those with GPU support. An Azure Virtual Desktop host agent is installed on each session host, registering the virtual machine as a tenant or workspace of Azure Virtual Desktop. App groups are groupings of desktop sessions or remote programs that you can access, and each host pool may have one or more of these.
* **Azure Virtual Desktop workspace**: For managing and publishing host pool resources, the Azure Virtual Desktop workspace or tenant is a management construct.

Users can always connect to the same session host by employing personal desktop solutions, often known as persistent desktops. Typically, users can save files in the desktop environment and customize their desktop experience to suit their tastes.

Personal desktop solutions:

* Allow users to save files in the desktop environment and personalize their desktop environment, including installed apps.
* Permit users to be assigned specialized resources, which can be useful for certain use cases in development or production.

Depending on the load-balancing mechanism, pooled desktop solutions, also known as non-persistent desktops, allocate users to the session host that is accessible at any given time. Users typically lack administrator access and have limited control over the desktop environment because they don't constantly connect to the same session host.

# **Comparing of changes after implementing Azure Virtual Desktop to the cloud**

**User Experience**

* Consistent Desktop Environment: From any device, anyplace, users can enjoy a familiar Windows 10/11 experience.
* Enhanced Performance: Enhanced accessibility to Teams and Microsoft 365 apps, particularly with GPU support and multimedia redirection.
* Remote Access: Safe, easy access to company resources while on the go or at home.

**Security Enhancements**

* Centralized Data: By keeping data in Azure, endpoint device data breach risk is decreased.
* Conditional Access & MFA: Azure AD features provide improved identity protection.
* Endpoint Security: Connectivity with Intune for device compliance and Microsoft Defender for Endpoint.

**Cost Management**

* Reduced Hardware Costs: High-end user devices are not as necessary.
* Optimized Licensing: Make use of your current Microsoft 365 licenses.
* Auto-scaling: With dynamic session host scaling, only pay for what you utilize.

**IT Operations**

* Simplified Management: Centralized management with Endpoint Manager, Intune, and Azure Portal.
* Faster Provisioning: Give consumers access to desktops and apps in a matter of minutes.
* Automation: When deploying infrastructure as code, use PowerShell or Azure DevOps.

**Business Agility**

* Scalability: Easily scale up or down in response to seasonal demand or labor numbers.
* Business Continuity: Alternatives for high availability and catastrophe recovery built in.
* Global Reach: Use Azure's global data centres to place desktops close to users.

# **Capacity sizing and Costings**

**Key Assumptions**

* Users: 880 total (800 students, 80 staff)
* Storage: 16 TB for students + 4 TB for staff = 20 TB total
* Operating Systems: Mix of Windows and Ubuntu
* Usage Pattern: Likely 24 hours/day, 7 days/week = 730 hrs per month

**1. Virtual Machine (VM) Costs**

* 800 Students: Use Azure Virtual Desktops, pooled, with scaling plan (cost-effective)
  + B2als v2 VM (2 vCPU, 4 GB RAM)
  + 720 Usage hours / month, multi-session
* 80 Staff: Use dedicated Windows or Ubuntu VMs
  + B2as v2 VM (2 vCPU, 8 GB RAM)
  + 720 Usage hours / month

**2. Storage Costs**

* Standard Storage Disks:
  + 800 students x 20GB = 16TB
  + 80staff x 50GB = 4TB
  + Total = 16TB + 4TB = 20TB

**3. Networking & Bandwidth**

* 5GB outbound data transfer from Southeast Asia to East Asia.
* Outbound data transfer: First 5 GB/month free, then approx. $0.087/GB

### **Estimated Monthly Cost Summary**

| **Component** | **Quantity/Usage** | **Estimated monthly Cost (USD)** |
| --- | --- | --- |
| Student VMs | 800 x B2als v2 | $10K |
| Staff VMs | 80 x B2as v2 | $4.5K |

Task workload is for students = 800

Knowledge workload is for Staff = 80

Storage calculation:

800 students x 20GB = 16TB

80staff x 50GB = 4TB

Total storage = 20TB

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**Total cost for project:**

For 80 staff, cost: USD $4.5k x 12months = $54K per year

For 800 students, cost: USD $10K x 12 months = $120K per year

**Pros and Cons:**

**Pros of Azure Virtual Desktop**

**1. Scalability**

* **Elastic Resource Allocation**: Depending on user demand, virtual machines (VMs) can be scaled up or down. For instance, you can expand student capacity during exam times and then reduce it afterwards.
* **Auto-scaling**: Azure allows for dynamic cost and performance optimization with auto-scaling algorithms.

**2. Security**

* **Centralized Data**: Because user data is kept in Azure rather than on local devices, there is a lower chance of data loss or theft.
* **Zero Trust Architecture**: Enforces safe access by integrating with Conditional Azure complies with international compliance requirements (such as ISO, GDPR, and HIPAA), which is essential for industries like healthcare and education.
* **Access:** Azure Active Directory (AAD), and Multi-Factor Authentication (MFA).
* **Compliance**: Azure meets global compliance standards (e.g., ISO, GDPR, HIPAA), which is crucial for sectors like education and healthcare.

**3. Cost Efficiency**

* **Multi-session Windows 10/11**: AVD lowers infrastructure costs by enabling numerous users to share a single virtual machine.
* **Pay-as-you-go**: For businesses with varying workloads, you simply pay for what you use.
* **Reserved Instances**: By committing to 1- or 3-year reserved virtual machine pricing, you can save up to 72%.

**4. Microsoft Ecosystem Integration**

* **Microsoft 365 Optimization**: A seamless user experience is ensured by AVD's optimization for Office applications and Microsoft Teams.
* **Azure Services**: Smooth interaction with services such as Defender for Endpoint, Azure Files, and Azure Monitor.

**5. Remote Access & Flexibility**

* **Device Agnostic**: Windows, macOS, iOS, Android, and web browsers can all be used to access desktops.
* **Support for Hybrid Work**: Supports remote and hybrid work patterns by providing safe access to company resources from any location.

**6. Centralized Management**

* **Unified Portal**: Using the Azure portal, manage users, virtual machines, storage, and policies.
* **Automation**: For deployment and upkeep, make use of tools like PowerShell, Azure DevOps, and ARM templates.

**Cons of Azure Virtual Desktop**

**1. Complex Initial Setup**

* **Infrastructure Planning**: Calls for meticulous preparation of storage, networking, host pools, and session hosts.
* **Identity Management**: For novice administrators, integrating with Azure AD, hybrid AD, and FSLogix profiles might be challenging.

**2. Ongoing Management Overhead**

* **Monitoring and Optimization**: Demands ongoing cost, user session, and performance monitoring.
* **Profile Management**: Although FSLogix is strong, it makes troubleshooting and storage more difficult.

**3. Cost Predictability**

* **Variable Costs**: Depending on usage, storage, bandwidth, and virtual machine uptime, costs may change.
* **Hidden Costs:** Premium storage, backup services, and networking (egress) can come with additional costs.

**4. Internet Dependency**

* **Connectivity Issues**: Fast and reliable internet connections are essential for AVD performance.
* **Latency**: Performance may lag or worsen for users in areas distant from Azure data centres.

**5. Licensing Requirements**

* **Microsoft Licensing**: Requires compatible licenses, such as RDS CALs, Windows 10/11 Enterprise, or Microsoft 365 E3/E5.
* **Third-party Tools**: Using third-party security, backup, or monitoring technologies could result in additional expenses.

# **Conclusion**

In this report, we have introduced virtual desktop infrastructure (VDI) and the different components of VDI. We have also discussed the common use of virtual desktop. We went on to discuss why we selected Azure virtual desktop to implement.

Next, we discussed the costs involved in its implementation. Finally, we listed the pros and cons of using Azure Virtual Desktop.

# References

**Azure Virtual Desktop Architecture**

<https://docs.microsoft.com/en-us/azure/architecture/example-scenario/wvd/windows-virtual-desktop>

**Azure Virtual Desktop Cost Calculator**

https://azure.microsoft.com/en-us/pricing/calculator/