Nedge

TECHNOLOGY
WHITE PAPER

Which EUD for VDI

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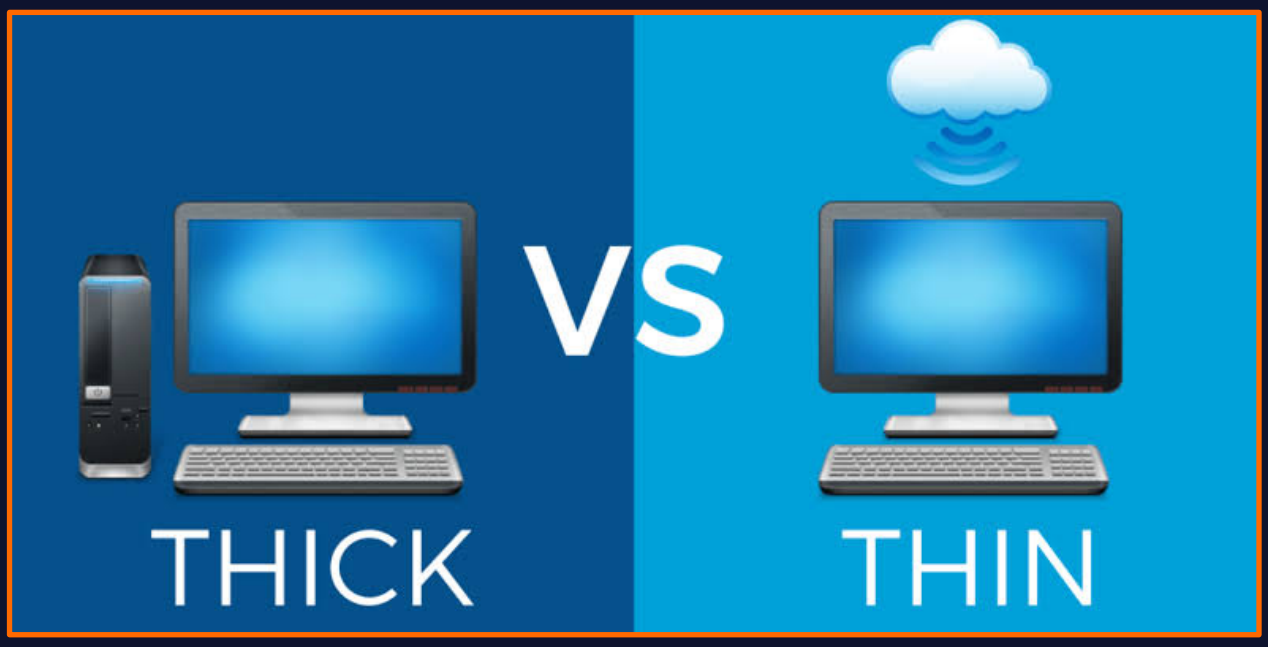


TABLE OF CONTENTS

1. Desktop Options for VDI – Approaches to Getting “Thinner”

Most of us, when joining a new company in the past, would be provisioned a traditional desktop, or rather a “thick client” device. A thick client, also known as a fat client, represents a variant of client-server architecture characterized by a networked computer system wherein the majority of resources are locally installed, as opposed to being distributed across a network.

Typically, devices like PCs function as thick clients, housing their own hard drives, software applications, and other essential local resources. This architecture consolidates most, if not all, vital components within the thick client itself.

The preference for thick clients among network users is nearly unanimous due to their high degree of customizability, providing users with greater control over installed programs and system configurations. Workplaces commonly deploy thick clients to empower employees to work offline, as these devices eliminate the necessity for continuous server communication. The robust local resource set-up of thick clients contributes to their popularity in offering a versatile and user-centric computing experience.

However, is a thick client device really the best option for CIOs and their IT admins – from both a cost, maintenance, security standpoint? The answer is typically “no”. So, what’s the alternative if a business wants to get “thinner” with their device management?

1.1. How to Select an End User Device (EUD) for Your VDI Environment

When navigating the realm of Virtual Desktop Infrastructure (VDI), IT administrators are confronted with a myriad of decisions. Whether it's deciphering the distinctions among various VDI software options, understanding remote display protocols, or navigating the complex landscape of licenses, the choices can be overwhelming. In this paper, we unravel some of the most perplexing challenges faced by VDI IT admins to provide clarity and guide you through the decision-making process.

One critical aspect of deploying VDI is determining the hardware that will support your virtual desktops. The options for hosting virtual desktops are diverse, ranging from thin clients and zero clients to tablets and mobile devices. Each choice comes with its own set of benefits, challenges, and cost implications.

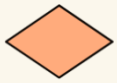
In a VDI deployment, effective communication hinges on the interaction between an endpoint hardware piece, or client device, and a back-end server. This server is typically housed remotely, often within an organization's data center. The client initiates a request to the server, and this exchange is facilitated over a network connection, typically leveraging the internet.

In the VDI model, the virtual desktop operating system resides on the server, while the end user engages with their virtual desktop interface locally on their EUD. The communication between

the client and the server is orchestrated through a remote display protocol, transmitting requests from the client to the server and rendering information back on the user's virtual desktop. The ultimate objective within this client-server architecture is to provide the end user with an experience akin to interacting with a locally hosted desktop on their client device.

1.2. Key Differences Between Thick Clients, Thin Clients and Zero Clients





End User Device	Thick Client	Thin Client	Zero Client
Requirements	Requires local software	Needs network connection to central server	Requires no configuration & minimal software
Management	More complicated	Centralized	Simplified
Cost	$600 > $1000	$200 > $600	< $200
Security	Traditional measures required	Hard drives & media ports are vulnerable	Highly secure with no attach surfaces

1.2.1. Refining the Distinction Between Thin Clients and Zero Clients in Desktop Virtualization:

Thin clients and their lightweight counterparts streamline operations by establishing a network connection to a central server, delegating comprehensive computing tasks and minimizing local hardware processing. Taking this efficiency a step further, zero clients eliminate the necessity for any local software, representing the pinnacle of simplicity in the VDI hardware landscape. In contrast, thick clients, synonymous with traditional PCs, autonomously manage all server functionalities directly on the desktop.

An interesting avenue within this spectrum is the option for organizations to repurpose aging PCs, transforming them into a refined version reminiscent of thin clients. This strategic flexibility affords a diverse range of choices, allowing organizations to tailor their VDI hardware to precise operational needs and strike a balance between efficiency and resource optimization.

1.3. The Use of Thick/Fat Clients in Desktop Virtualization

While incorporating thick clients into desktop virtualization is feasible, it's a choice often met with less enthusiasm by organizations. The principal drawback stems from the inability to significantly reduce overall hardware requirements and the reliance on extensive local software.
Opting for traditional PCs to link with virtual desktops undermines several key advantages associated with VDI, such as curbing power consumption, enabling centralized management, and enhancing overall security.

In essence, a thick client operates as a fully equipped PC running thin client software, contributing to its elevated cost in comparison to specialized thin client devices. Moreover, the inclusion of hard drives and media ports in thick clients renders them less secure than their sleeker thin counterparts.

Noteworthy is the fact that thin clients, despite occasional hardware issues that may necessitate entire device replacement, generally demand less maintenance than their bulkier counterparts. Grasping these nuanced distinctions empowers organizations to make well-informed decisions aligned with their specific requirements and priorities. In general, there is a much higher CapEx and OpEx total cost of ownership for thick clients.

1.4. The Use of Thin/Lean Clients in Desktop Virtualization

Thin client hardware plays a pivotal role in VDI, where virtual desktops reside in the data center, and the thin client functions as a streamlined terminal connecting to the back-end server. The simplicity and efficiency of thin clients make them an appealing choice, facilitating easy installation, streamlining application access, fortifying security, and enabling administrators to repurpose older PCs, thereby reducing overall hardware requirements.

Designed to be compact and straightforward, thin clients tend to become more expensive as advanced features are incorporated. Therefore, when selecting thin client devices, careful consideration of specific needs is crucial. Assessing requirements for features like 3-D capabilities, video conferencing, and multi-monitor support is essential. Additionally, evaluating the remote display protocol and the back-end server's display processing capacity ensures optimal performance.

Apart from cost-effectiveness and simplicity, centralized management is a key attribute of ideal thin client solutions. Automation of user profile policies to groups of thin clients with similar configurations enhances efficiency, especially when compared to individual manual management. The goal is to have VDI hardware that is user-friendly enough for non-expert IT staff or those operating from remote branch offices to deploy seamlessly.

Several reputable vendors, including HP, Dell, 10Zig, IGEL, NComputing, and others, offer thin and zero client options, providing a diverse range of choices to suit various organizational needs in the realm of VDI.

1.5. The Use of Zero/Ultrathin Clients in Desktop Virtualization

Zero clients are emerging as the epitome of sleek, cost-effective solutions, surpassing even the efficiency of thin clients. These client devices embody simplicity by requiring no configuration and storing no data locally.

The advantages of zero clients in VDI hardware are noteworthy. Firstly, they often boast a lower price point (CapEx) compared to thick and thin clients, contributing to cost-effectiveness. Furthermore, their reduced power consumption aligns with contemporary sustainability ("green") goals.

However, there are nuances to consider. Despite being marketed as requiring no management or maintenance, this isn't universally accurate. Some zero client products necessitate software or memory, and other resources for optimal functionality.

Additionally, zero clients are typically proprietary and aligned with only one remote display protocol, potentially leading to vendor lock-in. For organizations seeking greater flexibility and access to native desktop components, this can pose a limitation, prompting careful consideration of the trade-offs associated with the sleek simplicity of zero clients in the VDI landscape.

1.6. The Benefits of Thin and Zero Clients

Thin client deployment offers superior cost-effectiveness compared to regular PCs. Centralizing operations at the server-side results in reduced IT support and licensing expenses.

1.6.1. Better centralized security

Thin clients contribute to improved security by limiting operations at the server level. These devices can only run authorized software from the server, and data cannot be copied or stored outside the server. The architecture simplifies monitoring as all endpoints connect to the same central server. If users inadvertently download malware, a shared firewall protects all thin clients connected to the server, blocking potential threats. Additionally, attempts to save corrupted data on the thin client itself are thwarted, forcing users to store it on the protected server. This safeguards against injecting malicious code into the server, ensuring the security of all thin client users.

1.6.2. Greater cost-effectiveness

Deploying thin clients is more resource-efficient compared to regular computers. Thin clients perform fewer tasks than standard PCs, requiring fewer resources such as high-end graphics

cards, expensive hard drives, and extensive memory. Each of these components incurs significant costs. Thin client manufacturers can pass on these savings to consume.

1.6.3. Streamlined resource management

Thin clients streamline management processes by enabling upgrades, security policies, and other tasks to be executed centrally from the data center rather than the endpoint. This approach offers several advantages:

A. **Centralized Efficiency:** Managing upgrades and security policies from the data center reduces downtime, enhancing the overall efficiency of IT operations.

B. **Productivity Gains:** With a single IT team member handling day-to-day tasks like updating security software on a central server, multiple users can be served simultaneously. This eliminates the need for IT staff to visit individual workstations for installation or troubleshooting.

C. **Minimized Downtime:** Centralized management minimizes disruptions, ensuring that users experience less downtime related to updates, security enhancements, or troubleshooting.

D. **Consistent Security:** Centralized security policies can be consistently applied to all thin clients, reducing the risk of vulnerabilities. IT administrators can enforce security measures from a central location, ensuring a uniform and secure computing environment.

E. **Remote Troubleshooting:** Troubleshooting can be conducted remotely, allowing IT staff to address issues promptly without physically visiting individual workstations. This results in quicker issue resolution and improved overall system reliability.

1.6.4. Effortless scalability on demand

Thin client architecture not only provides the benefits of streamlined management but also facilitates seamless resource scaling through the deployment of virtual desktops. Beyond the inherent advantages of thin client setups, virtual desktop environments introduce the flexibility for users to bring their own devices (BYOD). Key features of this architecture include:

A. **Effortless Resource Scaling:** Thin client architecture enables easy scalability of resources by deploying virtual desktops. This scalability ensures that organizations can adapt their computing infrastructure to accommodate changing workloads and user requirements without significant complexity.

B. **BYOD Flexibility:** Virtual desktop environments in thin client setups empower users to bring their own devices. This flexibility allows employees to use their preferred devices, contributing to increased satisfaction and productivity. Additionally, it supports a diverse range of devices, including laptops, tablets, and other endpoints.

C. **Shared Server Infrastructure:** The servers initially utilized for thin clients can serve as a comprehensive virtual desktop base. This shared infrastructure approach is particularly beneficial for seasonal or casual workers who can effortlessly connect to the centralized servers, access virtual desktops, and efficiently complete their tasks.

D. **Cost-Efficient Resource Utilization:** Leveraging the same servers for both thin clients and virtual desktops optimizes resource utilization, contributing to cost efficiency. This shared infrastructure model minimizes the need for separate hardware for thin clients and virtual desktops, resulting in economic advantages for organizations.

E. **Streamlined Management Across Devices:** Centralized management extends to a variety of devices in a virtual desktop environment. This unified management approach simplifies administrative tasks, ensuring consistent policies, updates, and security measures across the diverse range of devices supported in a BYOD environment.

In summary, the centralized management capabilities of thin clients contribute to a more efficient, secure, and responsive computing environment, benefiting both IT teams and end users. The combination of thin client architecture and virtual desktop environments creates a versatile and scalable computing infrastructure, supporting BYOD initiatives and optimizing resource utilization for enhanced organizational efficiency.

2. What is a Thick Client (*Fat Client*) Device?

2.1. A Thick Client (Sometimes Referred to as a Fat Client) is a Form of Client-Server Architecture.

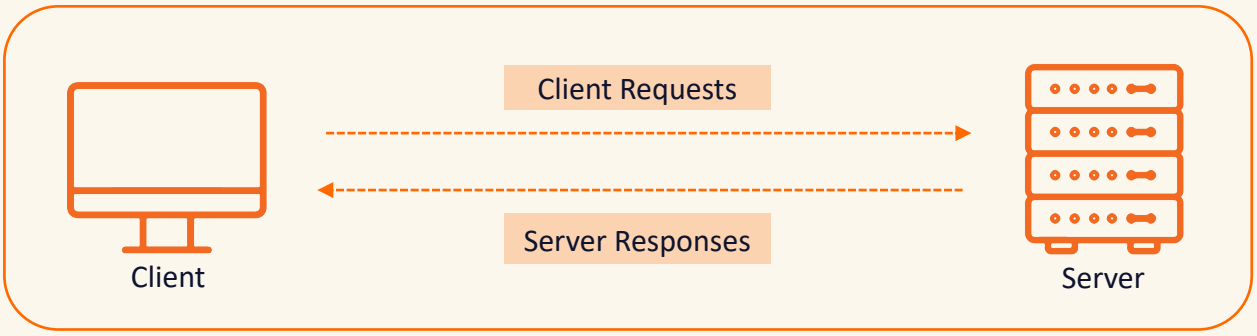
The client-server dynamic represents a fundamental relationship in computing, where one program, the client, solicits services or resources from another program, the server. Initially coined to distinguish distributed computing by personal computers from the monolithic, centralized model employed by mainframes, the client-server model has evolved significantly.

In contemporary computing, transactions where the server fulfills client requests have become ubiquitous. This model stands as a cornerstone in network computing, with clients establishing connections to servers over local or wide-area networks, including the internet.

Upon the completion of the server's task in meeting the client's request, the connection is terminated. Given that multiple client programs share the services of a common server program, a specialized server, often referred to as a daemon, may activate to await incoming client requests.

In the nascent days of the internet, network traffic predominantly followed a north-south pattern. This entailed data traversing between remote clients seeking web content and centralized data center servers providing said content. However, the landscape has transformed with the maturation of virtualization and cloud computing. In the present scenario, network traffic is more inclined to flow server-to-server, characterized by the east-west traffic pattern.

This shift underscores the evolving intricacies and efficiencies in modern computing architectures.



A thick client system is characterized by the concentration of most resources locally, as opposed to being dispersed across a network. Devices like PCs exemplify thick clients, boasting their own hard drives, software applications, and a comprehensive set of local resources encapsulated within the device.

The appeal of thick clients lies in their high degree of customization and the user's substantial control over installed programs and specific system configurations. Often favored by network

users, thick clients offer the advantage of offline functionality, making them particularly suitable for workplaces where employees require autonomy in their tasks. Notably, continuous server communication is unnecessary with thick clients.

Although thick clients establish a connection to a server over a network, this connection need not be maintained continuously. The temporary link serves the purpose of downloading programs, data, and updates to the operating system. Importantly, thick clients operate without consuming significant server computing resources. With most resources available locally, they function independently, excelling in environments where the primary server has limited storage and computing capacity or experiences high network speeds. This independence is especially advantageous in work-from-home setups, underscoring the adaptability and efficiency of thick client configurations.

Similarly, a system that combines locally installed components and software with the utilization of distributed network resources is often referred to as a rich client.

Now, let's delve into the benefits and nuances of thick clients:

A. Working Offline:
- Thick clients excel in providing the capacity to work offline. Equipped with necessary hardware and software, they can operate independently, reducing the reliance on a constant connection to a central server.

B. Server Connection:
- Unlike some other configurations, thick clients don't necessitate continuous connections to central servers. After an initial data exchange, ongoing server connections are typically unnecessary.

C. Fewer Server Requirements:
- Thick clients lighten the load on central servers by handling a significant portion of application processing locally. This can lead to cost savings as less high-performing server infrastructure is required.

D. Server Capacity:
- The use of thick clients often translates to increased server capacity. With reduced demands on the server for individual clients, a single server can effectively serve more clients.

E. More Flexibility:
- Operating from local resources, including the operating system, user interface, and storage, thick clients offer heightened flexibility. They can function from various locations, requiring only intermittent connections to central servers for data downloads.

F. Existing Infrastructure:

- Leveraging already potent local PCs within an organization facilitates the implementation of thick clients seamlessly, often without significant upgrades.

G. Storage:

- Thick clients allow for local storage of files and applications, enabling anytime access without the need for a continuous network connection.

H. Computer Performance:

- Resource-intensive applications perform well on thick clients as individual computers contribute their resources, mitigating the need for centralized allocation by a server.

Understanding these advantages positions thick clients as versatile solutions, especially in environments where offline functionality, cost efficiency, and flexible operation are key considerations.

2.2. Thick Clients are Not Free of Downsides

While thick clients offer a range of advantages, several considerations and challenges merit attention:

A. Security:

- With data stored locally on the thick client, individuals bear increased responsibility for computer security. This demands heightened vigilance to safeguard sensitive information.

B. Data Storage:

- Local data storage introduces the need for robust backup strategies. Ensuring regular backups becomes imperative to prevent permanent data loss in the event of unforeseen issues.

C. Investment into Each Client:

- The hardware and software requirements of thick clients involve higher initial costs. Additionally, ongoing expenses for maintenance and updates contribute to the total investment per client.

D. Maintenance:

- Maintenance tasks, including security updates and fixes for hardware and software issues, become an integral part of managing thick clients. Regular maintenance is essential to uphold performance and security standards.

E. Network Traffic:

- The decentralized nature of thick clients can contribute to increased network traffic. Each client needs to fetch data through the network for local processing, potentially leading to higher data transfer demands.

F. New Applications:
- Introducing new applications may involve uploading and configuring them on individual workstations. This decentralized process contrasts with centralized systems where applications can be deployed more uniformly.

Navigating these considerations requires a balanced approach, weighing the benefits of offline functionality, increased flexibility, and reduced server load against the potential challenges associated with individual client management, security, and data maintenance. Organizations must carefully evaluate their specific needs and priorities to make informed decisions regarding the adoption of thick clients in their computing infrastructure.

2.3. Examples of Thick Clients

A prime illustration of a thick client is a computer designated for company employees. Typically, most employees share similar requirements for client applications and files. In the context of a thick client, this computer comes pre-loaded with the essential business applications.

The comprehensive hardware and software configuration within the computer means that employees only need to establish a connection to the company's server for updates or to retrieve necessary data. Once this data is downloaded, the employee no longer requires a continuous network connection. This aspect proves particularly advantageous for remote work scenarios, freeing employees from the obligation of staying connected throughout the entire workday.

In instances where an employee needs to work from home, the thick client setup eliminates the need for constant connectivity. Even in the event of an internet outage, the employee can seamlessly continue their work since all required files are stored on the computer's hard drive, provided the applications do not demand a constant internet connection. This autonomy enhances productivity and flexibility, underscoring the practicality of thick clients in supporting diverse work environments.

2.4. Thick Clients vs. Thin clients

Thin clients represent an alternative network architecture, functioning as the antithesis of their thick client counterparts. A thin client is a cost-effective network computer that leans heavily on a server for its computational functions, deliberately restricting computing capabilities to essential applications.

In contrast to thick clients, thin clients offer distinct advantages, being more easily manageable, better shielded against security risks, and boasting lower maintenance and licensing costs. The most prominent disparity lies in their reliance on a network connection for computing tasks, as

they minimize local processing on the hardware itself. This stands in sharp contrast to thick clients, which can execute a significant portion of processing for client/server applications without the need for a constant network connection.

Thin clients shine in their streamlined approach, relying on the server for processing power, which enhances manageability and mitigates potential security vulnerabilities. While both thin and thick clients adhere to server-specified operations, thin clients may experience more downtime. This nuanced comparison underscores the trade-offs between these two network architectures, offering organizations the flexibility to choose the most fitting solution based on their specific priorities and operational requirements.

2.5. History of Thick Clients

Initially, thick clients were not widely adopted, particularly during the early surge in personal computer usage. This period witnessed the popularity of thin-client architectures due to the economic considerations associated with providing a broad user base with pricier and bulkier CRT terminals and PCs.

However, the landscape evolved over time. The resurgence of thick clients became noticeable as their advantages gained prominence. Thick clients proved to be more responsive, offering enhanced performance without the reliance on a constant server connection. This shift in preference was driven by the increasing demand for improved user experiences and efficiency.
In contemporary computing, thick clients have become significantly more prevalent, serving diverse functions in various environments.

Nevertheless, thin clients still maintain their relevance, finding utility in specific use cases and scenarios. The coexistence of both architectures reflects the nuanced considerations organizations make, balancing factors such as performance, connectivity, and cost-effectiveness in aligning with their evolving operational needs.

3. What is a Thin Client (*Lean Client*) Device?

A thin client, also known as a lean client, embodies a virtual desktop computing paradigm wherein computational tasks are executed using resources housed on a central server rather than the local resources of an individual computer.

Typically, these are cost-effective computing devices intricately reliant on a server for their computational load. Additionally, the term extends to describe software applications employing the client-server model, where the server shoulders all processing responsibilities.

Thin clients find widespread utility in diverse environments such as businesses, where employees and IT personnel, as well as public spaces like libraries or government offices, leverage their attributes of heightened security, scalability, and manageability.

The operational mechanism of thin clients involves connectivity to a server-based computing environment. The server stores critical data, including applications and memory, essentially hosting the desktop environment. Managed server-side, thin clients integrate seamlessly with a Virtual Desktop Infrastructure (VDI). These lean devices rely on a continuous network connection to a central server for comprehensive computing, with minimal processing performed locally.

The nomenclature stems from the conventional understanding that smaller computers in networks often function as clients rather than servers. The overarching objective is to confine the capabilities of thin clients to essential applications, a strategy that preserves their "thin" profile in terms of the client applications they include. Thin clients encompass a spectrum of devices, ranging from traditional PCs and Chromebooks to mobile devices, reflecting their adaptability across various computing platforms.

3.1. Use Cases for Thin Clients

Thin clients find widespread application among employees across various industries, serving multiple purposes such as replacing traditional computers and facilitating access to virtual desktops or virtualized applications. The cost-effectiveness of thin clients becomes evident when compared to locally processing computers. Their efficiency lies in the fact that individual thin clients need not be as cutting-edge or powerful, given that the bulk of processing occurs server-side.

In remote environments, thin clients offer an additional layer of convenience, reducing the need for frequent PC troubleshooting. With the majority of data downloaded from a server, thin clients boast fewer components, minimizing potential points of failure. This feature not only simplifies maintenance but also aligns with security considerations, making thin clients an attractive choice for organizations prioritizing endpoint device security.

However, it's crucial to acknowledge that thin clients may not be universally suitable. Optimal performance requires a robust and stable network connection, making them more suited for environments with reliable connectivity. Additionally, thin clients may encounter challenges with resource-intensive applications, particularly when multiple users access the network simultaneously. Therefore, organizations leveraging less resource-intensive applications and possessing a robust back-end infrastructure are better suited for the advantages that thin clients offer. Understanding the nuanced scenarios where thin clients shine ensures that organizations can make informed choices aligning with their specific operational needs.

3.2. Examples of Thin Clients in Workplaces

Consider a government office where a set of endpoint devices exemplifies the concept of thin clients. In such a scenario, numerous individuals utilize the same machine, accessing office data and applications through a central server rather than locally. This centralized approach enhances security, as sensitive information remains within the confines of the server.

Moreover, the server-side processing of computationally intensive tasks allows the endpoint device to be cost-effective and somewhat aged, without compromising performance. Resource-demanding applications, challenging for older computers, can be offloaded to the server, ensuring quick and efficient performance. Proprietary protocols like Microsoft Windows Terminal Service may further be employed for remote desktops and applications.

Similarly, in a library setting, employing a cluster of thin clients connected to a central server serves to streamline operations. This setup facilitates the simultaneous use of multiple devices, all easily manageable from a centralized point. The thin client architecture proves beneficial in environments where flexibility, security, and efficient management of resources are paramount, showcasing its adaptability across diverse professional settings.

3.3. Thin Client Architecture

Employing a cloud computing-based architecture involves offloading the processing burden from individual clients to a server situated in a data center. In this paradigm, client hardware and software remain lightweight, designed to utilize the server for essential applications. This approach minimizes the need for intricate client-side setups or administrations, fostering simplicity and ease of use. Centralizing user assets and data recovery tasks enhances visibility and scalability.

The lightweight design of the client side ensures that the central server shoulders a significant portion of the processing load. As the majority of data resides in the central server, security efforts predominantly concentrate on fortifying this central hub. This centralized security model enhances the overall robustness of the system.

Furthermore, critical IT assets are also centralized, optimizing resource utilization and allocation. The central server efficiently manages resources such as memory and processor cores,

streamlining operations and contributing to the scalability of the architecture. This cloud-centric approach not only improves efficiency but also ensures a more secure, manageable, and resource-efficient computing environment.

3.4. How Do Thin Clients Work?

Thin clients exhibit versatility by functioning within various architectures, including shared terminal services, desktop virtualization, or a browser-based approach. In a shared terminal service, multiple clients share a server-based operating system and applications.

Desktop virtualization, on the other hand, involves creating virtual machines for each desktop, partitioned from a central server. Although the operating system and applications are not shared resources, they are stored centrally, and the server allocates resources to the respective clients.

In a browser-based approach, thin clients differ from the traditional model as functions execute within a web browser on the client side. Data processing occurs locally on the thin client, emphasizing retrieval of software and data held on a network.

Despite these diverse approaches, the overarching objective remains consistent — to maintain client hardware and software as lightweight as possible. Typically equipped with low-energy processors, minimal RAM, and storage space, thin client hardware prioritizes connectivity over raw computing power. These devices require a minimum processing power to initiate and connect to a central server, where users interact with them as if they were conventional computing devices.

Thin client software is streamlined, encompassing an operating system and connectivity software for server access. An ideal setup involves the thin client automatically receiving an IP address upon startup and connecting to the server seamlessly using a designated protocol or software. This user-friendly approach facilitates efficient server access and resource utilization.

For seamless operation, the central server must be sophisticated enough to handle concurrent sessions from multiple thin clients, preventing outages and bottlenecks. Consistent connectivity between the server and each thin client is crucial for uninterrupted workflow and user satisfaction. This emphasis on robust server capabilities ensures the reliability and performance of the entire thin client infrastructure.

3.5. Advantages of thin clients

A. Enhanced Security:

- Thin clients are inherently less vulnerable to malware attacks, as critical data and applications are centrally managed on the server, reducing the attack surface and minimizing security risks.

B. Extended Lifecycles:

- Enjoying longer lifecycles compared to traditional PCs, thin clients require less frequent hardware upgrades. This longevity contributes to cost savings and sustainability.

C. Energy Efficiency:
- Thin clients operate with lower power consumption, promoting energy efficiency. Reduced power requirements translate to cost savings and a smaller environmental footprint.

D. Cost-Effectiveness:
- Thin clients are generally more affordable to purchase and deploy than traditional PCs. This cost advantage extends across hardware, software, and maintenance, making them an economical choice for organizations.

E. Centralized Manageability:
- The centralized nature of thin clients enhances manageability. Administrators can efficiently control and update applications, security protocols, and configurations from a central server, simplifying overall maintenance.

F. Scalability:
- Thin client architectures offer enhanced scalability, accommodating the growth of user numbers or applications with ease. This scalability ensures that the infrastructure can evolve in tandem with organizational needs.

Incorporating thin clients into an IT environment provides a range of tangible benefits, from heightened security and cost-effectiveness to improved sustainability and centralized manageability. These advantages make thin clients a compelling choice for organizations seeking efficient and streamlined computing solutions.

3.6. Drawbacks of Thin Clients

A. Dependency on Network Connectivity:
- Thin clients are heavily reliant on a consistent network connection. Any disruptions in connectivity can impede user productivity and access to essential resources, making them less suitable for environments with unreliable or intermittent network access.

B. Network Speed Limitations:
- Networks, especially external ones, typically operate at slower speeds compared to the internal components of individual computers. This discrepancy can result in delays and slower performance for thin clients, particularly when handling data-intensive tasks.

C. Bandwidth Bottlenecks:

- Bandwidth constraints can emerge as a critical bottleneck for thin clients. In scenarios where multiple users are simultaneously accessing the network, competition for bandwidth may lead to reduced performance and responsiveness.

D. Server Sizing Challenges:

- Properly sizing servers becomes crucial for the effective functioning of thin clients. Servers must be adequately configured to deliver the requisite amount of resources to each client, ensuring optimal performance. Inaccurate sizing can lead to performance degradation and user dissatisfaction.

While thin clients offer various advantages, these downsides underscore the importance of evaluating the specific needs and infrastructure of an organization. In environments with robust and reliable network connectivity, where server sizing is meticulously addressed, thin clients can deliver substantial benefits. However, in situations where network dependencies and potential bottlenecks are significant concerns, alternative computing solutions may be more suitable.

3.7. Thin Clients vs. Thick Clients

Thin clients and thick clients represent distinct computing models, with thick clients resembling desktop PCs capable of executing server functionalities independently. Thick clients store most, if not all, resources locally, utilizing their own hard drives, software applications, and other components.

In contrast, thin clients are economical network computers heavily reliant on a server for computational tasks, deliberately restricting computing capabilities to essential applications. The core advantage of thin clients lies in their enhanced manageability, heightened security protection, and reduced maintenance and licensing costs compared to thick clients.

The key disparity lies in their operational approach: thin clients depend on a network connection for computing, minimizing local processing, while thick clients, self-sufficient in processing power, don't necessitate a constant network connection. This distinction underscores the trade-offs between centralized management and local autonomy in the client-server paradigm.

For even more streamlined functionality, an extremely thin client is termed a "zero client." These devices, often compact boxes, connect peripherals like a keyboard, mouse, monitor, and Ethernet to a remote server hosting the client's operating system and applications. Zero clients, prevalent in virtual desktop infrastructure environments, epitomize minimalism by offloading the majority of processing tasks to the server, accessible either wirelessly or through a cable connection.

3.8. History of Thin Clients

While thin clients may appear as a contemporary innovation, their roots extend back to an era predating the actual coining of the term. The inception of thin clients can be traced to multi-user

systems that accessed a mainframe through computer terminals. Initially designed for command-line interfaces, these systems evolved to embrace graphical user interfaces over time.

A pivotal moment occurred in 1984 when Unix extended its support to devices running display server software, namely graphical X terminals. This marked a crucial step towards the graphical evolution of thin client systems. The term "thin client" itself was coined in 1993 by Tim Negris, then Vice President of Server Marketing at Oracle. The intention behind this terminology was to distinguish server-oriented software, such as Oracle's, from the desktop-focused products of Microsoft.

The landscape saw further changes in 1995 when Windows NT began supporting multi-user operating systems with the release of Windows NT 3.51. This development contributed to the expanding relevance of thin clients in diverse computing environments.

Moving into the 2010s, thin clients underwent a significant shift, extending their reach beyond traditional PCs to include mobile devices like Windows or Linux-based tablets. This evolution highlights the adaptability of thin clients across various platforms, aligning with the changing dynamics of computing in the modern era.

4. What is a Zero Client (*Locked Down*) Device?


Zero Client

A zero client, or ultrathin client, operates within a server-based computing model, devoid of local storage on the end user's computing device. This stands in contrast to a thin client, which preserves the operating system and device-specific configuration settings in flash memory.

Essentially, zero clients are minimalistic computers relying on a server to manage functions that a traditional PC (thick client) would handle with its own hardware and software. Primarily employed in virtual desktop infrastructure (VDI) setups, zero clients excel in remote work scenarios or distributed work environments.

Zero client devices are a type of computer hardware designed to provide a minimalistic and streamlined computing experience. Zero clients are distinct from traditional personal computers (PCs) and other thin client solutions in that they have very limited local processing capabilities and rely heavily on remote servers or virtual desktop infrastructure (VDI) for computing tasks. Here are the key characteristics and features of zero client devices:

A. **Minimal Local Processing**: Zero clients are designed to have minimal or zero local processing power. They typically lack a traditional CPU (Central Processing Unit), hard drive, or extensive RAM. Instead, they rely on remote servers or VDI infrastructure to handle processing tasks.

B. **Remote Desktop Protocol (RDP)**: Zero clients often use remote desktop protocols such as Microsoft's Remote Desktop Protocol (RDP) or other similar protocols to connect to virtual desktops hosted on servers. This means that the actual computing and application execution occur on the server, not on the zero client itself.

C. **Low Energy Consumption**: Because they lack powerful processors and internal storage, zero clients are energy-efficient devices. They consume much less power compared to traditional PCs, making them suitable for environments where energy efficiency is a concern.

D. **Centralized Management**: Zero clients are typically easier to manage centrally. IT administrators can configure and update the software, settings, and security policies for multiple zero clients from a central location, reducing the need for on-site maintenance.

E. **Cost Savings**: Zero clients are often less expensive to purchase and maintain than traditional PCs. This is because they have fewer components and longer lifespans, as they are less prone to hardware failures.

F. **Securit**y: Zero clients can enhance security because data remains centralized on servers rather than being stored locally. Security measures can be implemented and enforced at

the server level, reducing the risk of data breaches or unauthorized access from local devices.

G. **Thin Client Protocol Support**: While RDP is a common protocol for zero clients, they may also support other thin client protocols, such as Citrix HDX, VMware Horizon, or Teradici PCoIP, depending on the manufacturer and model.

H. **Use Cases**: Zero clients are commonly used in business environments, education, healthcare, and industries where centralized management, security, and cost-efficiency are critical. They are ideal for scenarios where users primarily require access to virtualized desktops and applications.

I. **Display and Peripherals**: Zero clients typically have ports for connecting to displays, keyboards, mice, and other peripherals. They act as a bridge between the user and the remote computing resources.

In summary, zero client devices are hardware endpoints that provide access to virtualized desktops and applications hosted on remote servers. They are designed for specific use cases where centralized management, energy efficiency, and cost savings are priorities, and they rely on remote servers to handle computing tasks and data processing.

4.1. How Do Zero Clients Work?

Zero clients function primarily as input/output (I/O) redirection units. User inputs like mouse clicks and keystrokes are transmitted to a remote server, which responds by sending data to be displayed on a connected monitor. The term "zero client" reflects the minimal processing occurring on the client side, as almost all processing takes place on the server side.

These clients operate without an operating system, relying on firmware for connectivity to a remote device. An onboard processor utilizes a single protocol—typically PC over IP (PCoIP)—to communicate with the server. While firmware can be adapted to support different protocols like Microsoft RDP or Citrix HDX, optimization typically focuses on one protocol at a time.

Zero clients lack local storage, ensuring no data is stored on the device. Instead, applications are provisioned and managed on a server in a remote data center, then delivered to the zero-client device using its designated protocol.

4.2. Zero Client Hardware Specifications

A standard zero client product typically comprises a compact box connecting a keyboard, mouse, monitor, and Ethernet to a remote server. The server hosts the client's operating system (OS) and software applications, enabling wireless or cable-based access.

Zero clients typically feature a compact physical design with a small form factor, usually not exceeding a foot in height, around two inches in width, and weighing approximately two pounds. Equipped with a basic firmware-installed processor, these devices come with various ports such as HDMI, DVI, DisplayPort, USB, and Ethernet, alongside a dedicated power supply port.

In addition to essential ports, zero clients commonly include audio ports and offer support for wireless connectivity and Video Electronics Standards Association (VESA) mounting. Certain models also facilitate the use of multiple monitors.

4.3. How are Zero Clients Different from Thin Clients?

Zero clients and thin clients serve as high-performing endpoints connecting to remote devices and overseeing centralized computing infrastructures.

Zero clients, being more lightweight, lack an operating system, while thin clients typically have a minimal operating system.

Zero clients are optimized for a single connection type from one connection broker (e.g., Microsoft, VMware, or Citrix) and its specific connection protocol. In contrast, thin client devices are optimized for multiple connection types.

In essence, zero clients perform no client-side computing, while thin clients engage in minimal client-side computing. This renders zero clients more reliant on network connections compared to thin clients.

4.4. Benefits and Drawbacks of Zero Client Devices

The benefits of zero clients are compelling:

- Power consumption can be as low as one-fiftieth of thick client requirements.
- Devices are considerably more affordable than PCs or thin clients.
- An efficient and secure method for delivering applications to end users.
- No client-side software means vulnerability to malware is minimized.
- Administration is typically straightforward.
- In a virtual desktop environment, administrators can reduce physical PCs or blades, running multiple virtual PCs on server-class hardware.
- Increased hardware efficiency contributes to an enhanced user experience.

However, there are some drawbacks to consider:

- Limited graphics rendering capability.
- Performance is contingent on network connections as they heavily rely on remote servers for almost all processing.
- Many zero clients are optimized for a specific vendor or connection broker, potentially leading to vendor lock-in.

4.5. Zero Client Products in the Market Today

Zero client vendors such as Digi International, VIA Labs, and Dell Wyse offer a variety of products. Some examples include:

- 10ZiG 4648q Series
- Dell Wyse 5030
- LG Box CBV42-BP

These products may vary in price, I/O features, and the specific protocol connection for which they are optimized.

Zero clients are commonly employed in VDI setups, enabling users to efficiently virtualize their desktops on laptops, tablets, and mobile devices.

4.6. Using Zero Clients for VDI

Zero clients find widespread use in VDI setups due to their distinct advantages. They offer a conventional desktop experience without the added complexities of maintenance, configuration, and moving parts on the user's endpoint device.

The absence of onboard storage and operating systems minimizes opportunities for hackers to access sensitive information, reducing the risk of exposure to viruses.

Zero clients boast quick boot-up times and require minimal maintenance, typically limited to straightforward firmware updates when needed.

Moreover, IT administrators can remotely deploy and configure zero clients at scale, leveraging centralized computing infrastructure. This eliminates the need for physical proximity to the device during management tasks.

Users benefit from the flexibility of loading the virtual desktop on any endpoint, complete with personalized preferences and configurations. In case of maintenance issues with one endpoint, users can seamlessly switch to another device and experience an identical desktop environment.

5. Use Cases for Thick, Thin & Zero Clients with VDI

When deciding between thick clients, thin clients, or zero clients for VDI deployments, IT professionals should weigh the cost and management requirements.

- **Thick clients** are preferable when additional peripherals or extensive software options are necessary. They work well in scenarios where virtual desktops serve as an alternative option for users, such as during disasters or when providing loaner computers.

- **Thin clients** are ideal for scenarios requiring a robust user experience, especially when users are open to devices other than traditional PCs. They are often chosen by smaller organizations with budget constraints or a preference for simpler, easy-to-manage devices. Thin clients find specific applications in serving user groups, such as design departments needing a specific application. Common sectors using thin clients include healthcare and education, where shared devices or desktops are crucial.

- **Zero clients** excel in high-security environments due to minimal software access points. They are suitable when stringent security is paramount.

5.1. VDI Environments

Many IT organizations on campus are moving to Virtualized Desktop Infrastructure (VDI) employing thin clients. By centralizing the OS and applications an individual uses on his or her computer on a back-end server, thin clients are easier to secure and support than typical desktop computers or laptops distributed across campus. But beyond these benefits, organizations replacing desktop computers with thin clients dramatically reduce power consumption and carbon emissions related to the production, packaging, shipment, use and disposal of traditional desktop computers.

5.2. Public Environments

Thin / Zero clients are helpful in public environments (government offices, healthcare facilities, airlines, libraries) where many people use the same device and need to reduce the risk of data left over from previous sessions.

Anywhere there are security concerns usually benefits from some thin client setup. The data is kept on the backend, and the client only renders what the user is allowed to see, and tampering with the client usually results in a corrupted client rather than data theft.

5.3. Low Workloads

Thin / Zero clients are great for workloads where the actual work is not CPU-intensive and requires only as much client feedback as the web browser provides. Many of these thin clients are likely web browsers, as they give the toolset to handle most of the necessary user interaction.

5.4. Heavy Computational Demand

A common approach to repurposing old computer hardware is to turn it into a thin client system. Applications that do not work correctly on the PC can be accessed from the server via a thin client connection, providing the required functionality without multiple and constant hardware updates.

5.5. Traditional desktops (PCs) are Power Gogs

A typical PC consumes between 30 and 45 KWh per month. With power management features enabled groups on campus have been able to reduce the per PC energy consumption to an average of 25 kWh/month.

A Virtual Desktop Infrastructure including thin clients provides a similar user experience but consumes only a fraction of the energy required to run individual desktops. Factoring in the server infrastructure required for a typical thin client installation, these types of implementations consume between 8 and 14 Watts of electricity.

Assuming 10,000 thin clients, this equates to 800 MWh to 1,400 MWh of power per year ($68,600 to $120,048/year). This results in a 66% to 73% reduction in overall power consumption or $188,650 to $240,096 in savings per year. Only 564 to 988 metric tons of carbon is released into the atmosphere during a typical year of running 10,000 thin clients. **That means transitioning 10,000 PCs to thin clients could free up enough electricity to power 80 to 102 homes for a year.**

5.6. Manufacturing and Shipping add to the PC's Carbon Footprint

The reduction in mass of thin clients means far fewer materials are being mined, processed, and assembled for a thin client. Smaller mass also means less packaging. Infosys reports that packing materials for a thin client average between 2.2 and 4.4 lbs. vs. 11 to 22 lbs. for a typical PC. As a result, less energy is spent producing not only the device, but the packaging, and the lighter weight of the device and packaging materials results in substantially less fuel being consumed during the transportation phases of the device's lifecycle.

5.7. Thin / Zero Clients Last Longer

With few, if any moving parts, thin clients tend to remain viable for a considerably longer period of time than typical PCs. The typical operational lifecycle of a PC is 3 to 4 years, while a thin client can remain reliable for 6 to 8 years. This means that not only is the device consuming less energy

over the course of its entire life, but a single thin client can be used in the same period of time that any 2 PCs would be used. This yields additional reductions in the carbon footprint of thin clients.

5.8. Traditional PCs Fill Up Landfills and are Toxic

Last but not least, PCs contribute millions of tons of waste to landfills each year. In 2009, the last year for which statistics are available, 29 million computers were disposed of in the U.S. These computers have components that contain small amounts of heavy metals like mercury, lead, and cadmium that can leech into local water supplies. Their cases are often made from plastics that come from petroleum products.

Fortunately, almost 62% of the computers disposed of in the US in 2009 were recycled, but even that requires transport to recycling facilities where additional energy is expended to remove the harmful metals for re-use in manufacturing.

While not all thin clients are completely void of such materials, like everything else about thin clients, the amount of heavy metals contained in a thin client is significantly less and the energy spent to transport the device and safely dispose of the toxic metals contained within them is substantially less than that of a traditional PC.

5.9. Adoption Thin / Zero Clients will Grow Exponentially

As organizations plan for the future, the cost, longevity and green benefits of thin/zero client computing should be factored into the decision-making process. Dramatic reductions in power consumption along with a reduced carbon footprint throughout the entire lifecycle of these devices will yield tremendous benefits in support of stability, security and sustainability goals. Currently, adoption for cost efficient, constrained devices is quite low – around 10% of total desktop penetration.

The powerful, modern, and intuitive experience that thin clients deliver across industries sets a new standard for what customers expect from client devices. The final endpoint is always a well-connected, highly secure, and low-maintenance device, providing customers with a convenient option to deploy virtual environments.

Moreover, in the mobile era, users can leverage tablets, smartphones, or USB devices for VDI. Laptops and Tablets, with improved network speeds and screen resolutions, are suitable for presenting virtual desktops, making them fitting for highly mobile workers and executives.