# CCT College Dublin

## Assessment Cover Page

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| **Module Title:** | Computing Architectures |
| **Assessment Title:** | Integrated CA2: Virtual Windows Active Directory |
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| **Assessment Due Date:** | 28/04/2024 |
| **Date of Submission:** | 27/04/2024 |

**Declaration**

By submitting this assessment, I confirm that I have read the CCT policy on Academic Misconduct and understand the implications of submitting work that is not my own or does not appropriately reference material taken from a third party or other source. I declare it to be my own work and that all material from third parties has been appropriately referenced. I further confirm that this work has not previously been submitted for assessment by myself or someone else in CCT College Dublin or any other higher education institution.

**Summary**

The project aims to establish a virtualized network infrastructure composed by two virtual machines: a Domain Controller Server and a Web server. Through a series of systematic steps, the network infrastructure is set up to facilitate efficient communication, centralized management, and reliable service hosting.

Important Actions:

Installation of Virtual Machine: Two virtual machines are constructed, each operating Windows Server 2019 or Server 2022, using virtualization software. Operating systems for servers can be hosted in isolated settings thanks to these virtual machines.

Server Renaming: To provide consistent identification across the network, the Domain Controller Server and Web server are renamed using Windows Server Manager and Windows PowerShell, respectively.

Static IP Address Assignment: In order to guarantee reliable network connectivity, static IP addresses are assigned to each server. IP addresses, default gateways, and DNS server addresses must all be specified in accordance with the guidelines provided during configuration.

Testing for Connectivity: The PING command is used to confirm that there is network connectivity between the two servers. This test verifies correct configuration and makes sure packets can move over the network.

Domain Controller Configuration: The DNS service is installed concurrently with the Domain Controller Server's transformation into a Domain Controller. Within an Active Directory domain, this permits centralized management of user accounts, security settings, and network resources.

Creation of an Active Directory Domain: "Domain-789.abc" is created as an Active Directory domain, offering a structure for grouping network resources and facilitating centralized services for authorization and authentication.

Web Server Domain Joining: This allows for centralized user authentication and access control by integrating the Web server into the "Domain-789.abc" domain. Interaction with domain resources and services is smooth after joining the domain.

## Installation of Virtual Machine

Using virtualization software, two virtual machines are created to facilitate the construction of a robust network infrastructure. The first virtual machine is designated to function as the Domain Controller Server, responsible for managing user accounts, security policies, and network resources within an Active Directory domain. This server plays a pivotal role in centralizing authentication and authorization services, fostering streamlined network management. For this VM, either Windows Server 2019 (Desktop - GUI) or Server 2022 (Standard or Datacentre - Desktop Experience) is selected, offering a comprehensive suite of features tailored for domain controller operations. The second virtual machine is configured to operate as the Web server, tasked with hosting and serving

web applications and content to clients accessing the network. Similar to the Domain Controller Server, this VM is also equipped with either Windows Server 2019 or Server 2022, ensuring compatibility and interoperability within the network environment. Both virtual machines are pivotal components of the network infrastructure, working synergistically to deliver reliable services and support seamless communication across the network.

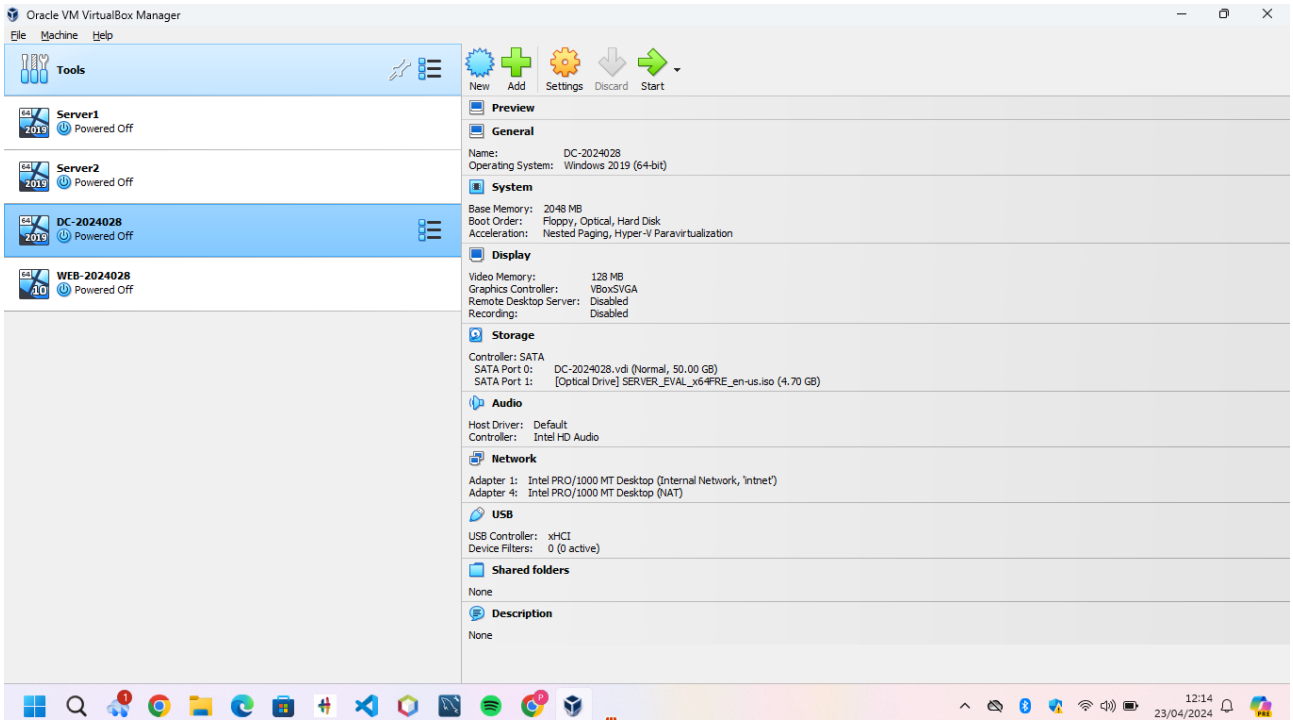


*Image 1: First Virtual machine named DC-2024028*

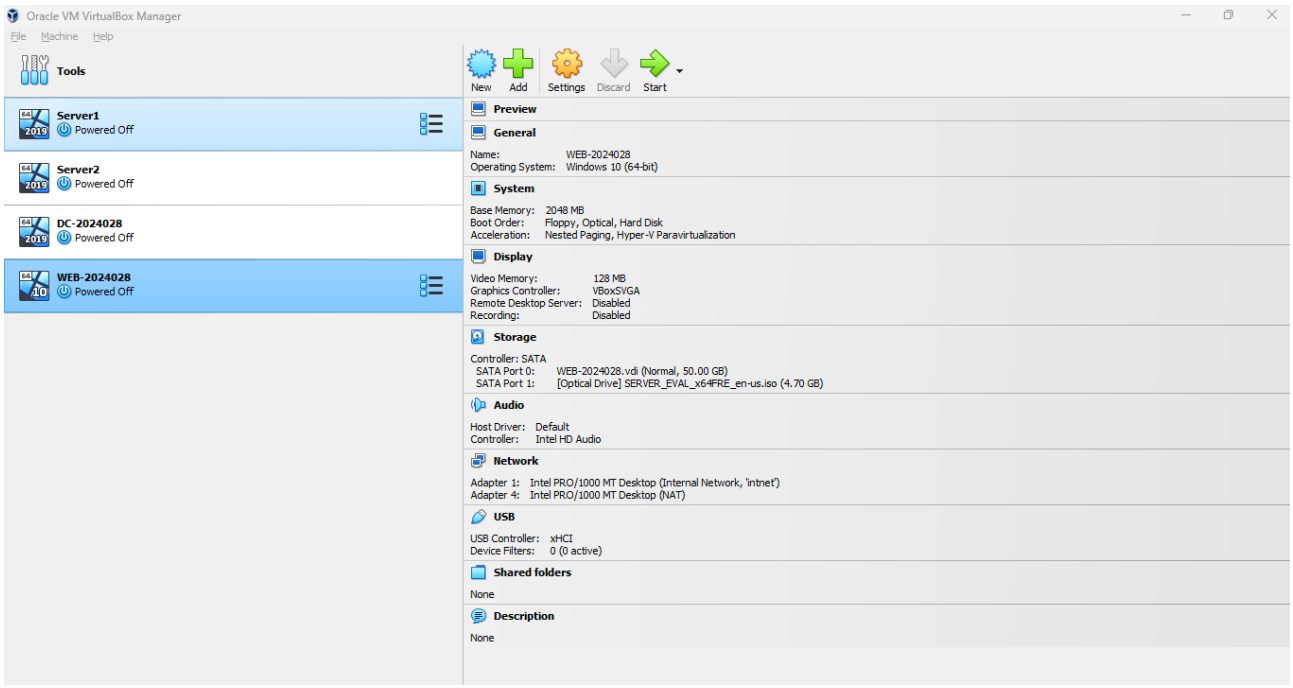


*Image 2: Second Virtual machine named WEB-2024028*

The Domain Controller Server and Web server are renamed throughout the network infrastructure configuration process to facilitate management and distinct identification in the network. The

Domain Controller Server can be renamed using Windows Server Manager, which also provides an intuitive management interface. This utility gives the server a name that follows a conventional naming convention, improving its network visibility and accessibility. On the other hand, Windows PowerShell, a potent scripting tool with effective automation features, is used to rename the Web server. The server is precisely renamed by running particular instructions, following the predetermined naming policy to maintain consistency across network assets. By creating a unified and well-organized network environment, these renaming practices help administrators efficiently manage and keep an eye on network resources.

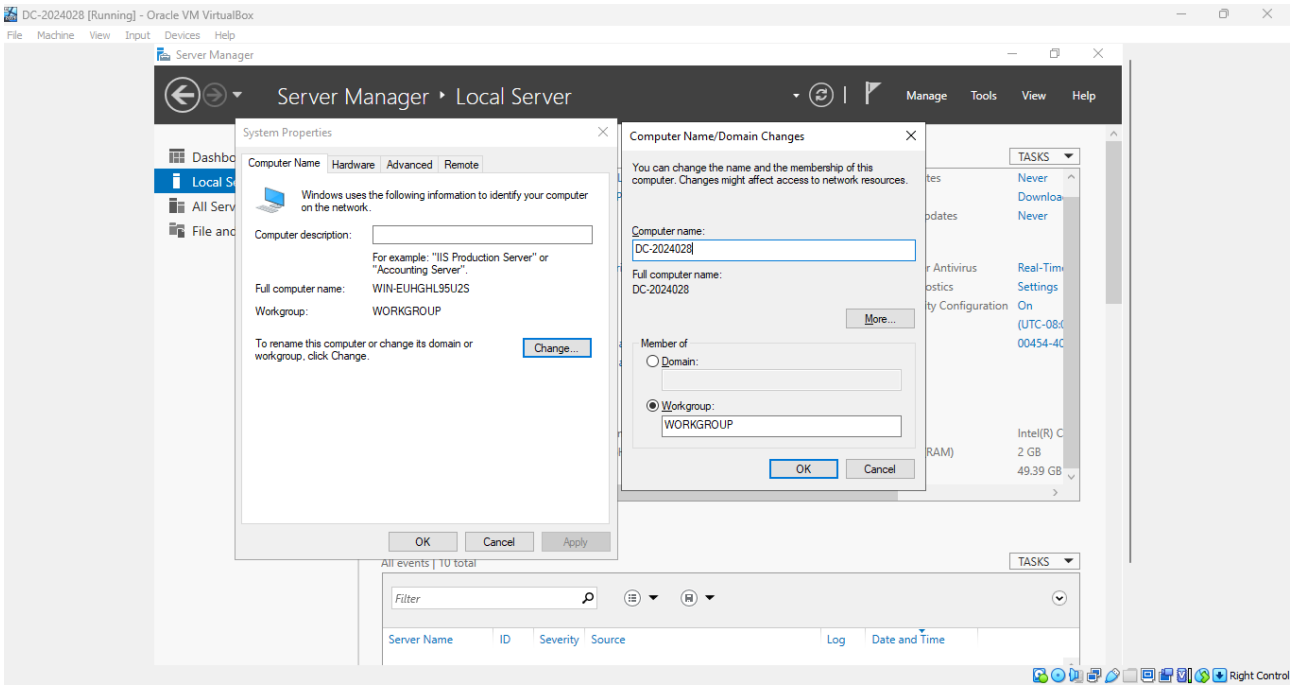


*Image3: Renaming the server of the first VM to DC-2024028*

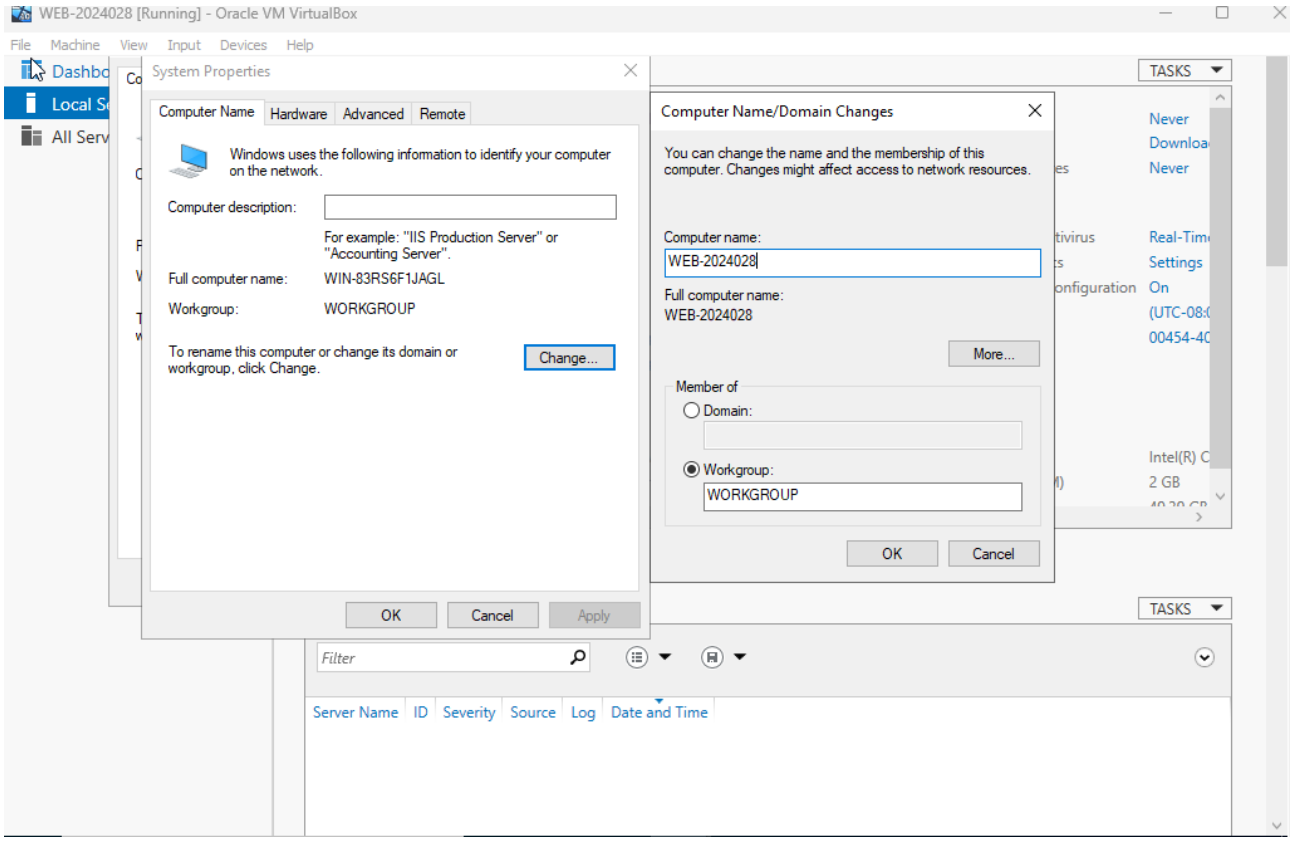


*Image 4: Renaming the second VM to WEB-2024028*

Static IP addresses are assigned to the Web server and the Domain Controller Server to ensure reliable network connectivity within the virtualized environment. As a result, any server will always have a fixed network address, eliminating any possible disruptions from dynamic IP allocation. As part of the configuration procedure, IP addresses, default gateways, and DNS server addresses must be specified in line with the guidelines. Administrators can ensure dependable connection between network devices and enable smooth data transfer and network resource access by assigning static IP addresses. Additionally, setting DNS server addresses permits effective name resolution across the network, and setting default gateways guarantees appropriate network traffic routing. These meticulous configuration procedures help create a durable and stable network infrastructure, which is necessary to enable vital corporate processes and services.

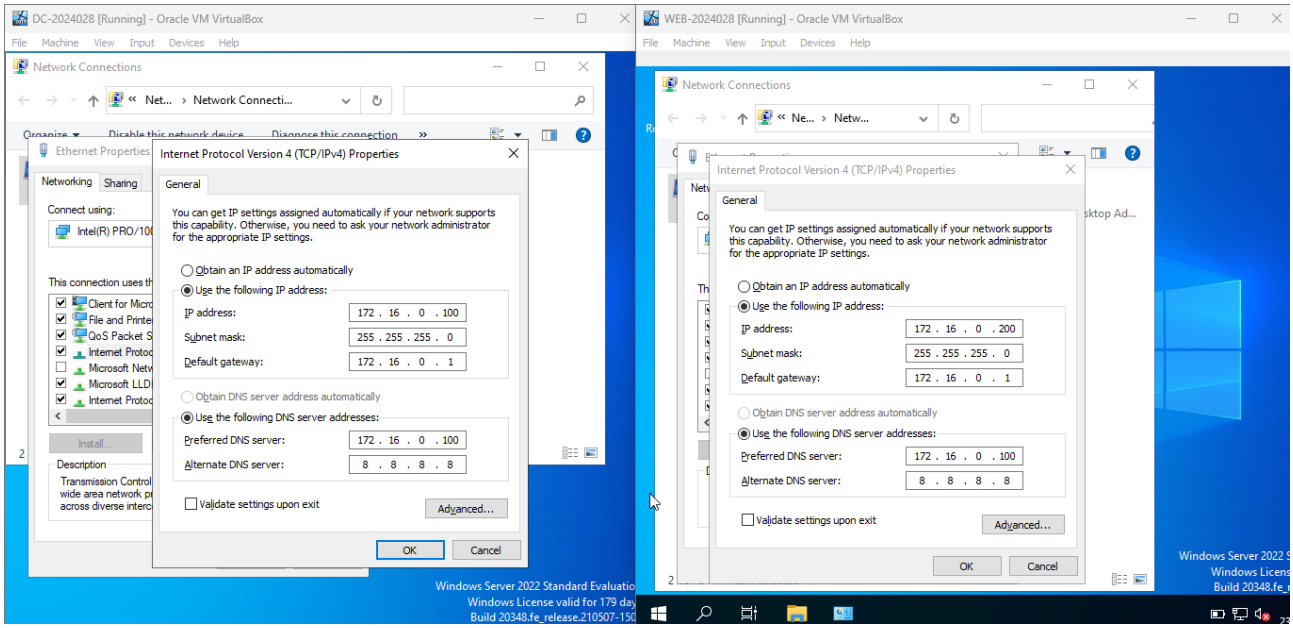


*Image 5: IP's changed for the servers.*

After assigning static IP addresses to both the Domain Controller Server and the Web server, the next crucial step is to verify network connectivity between these two servers. This validation is conducted using the PING command, a fundamental networking tool that sends ICMP (Internet Control Message Protocol) echo request packets to a specified destination IP address and waits for corresponding echo reply packets. By executing the PING command from one server to the other, administrators can confirm whether packets can successfully traverse the network, indicating proper configuration and functional connectivity. A successful PING test provides assurance that the network infrastructure is operational and capable of facilitating communication between network devices. This verification process plays a pivotal role in ensuring the reliability and efficiency of the network environment, laying the foundation for seamless data exchange and collaboration across the network.

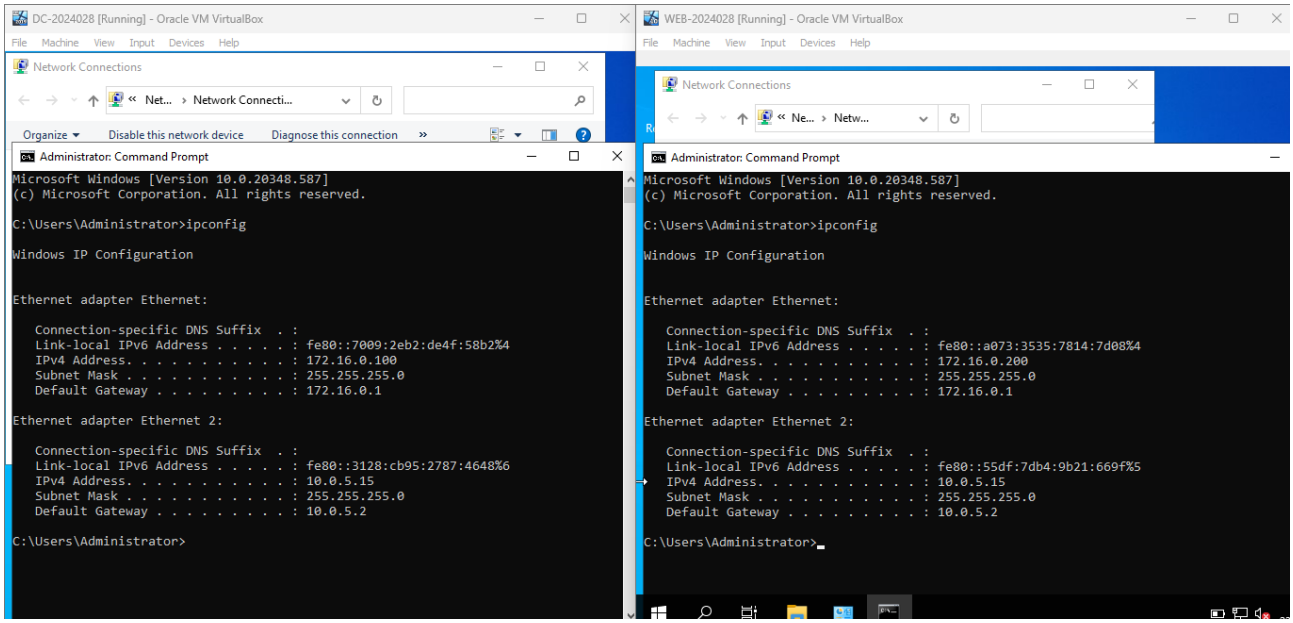


*Image 6: IP's config.*

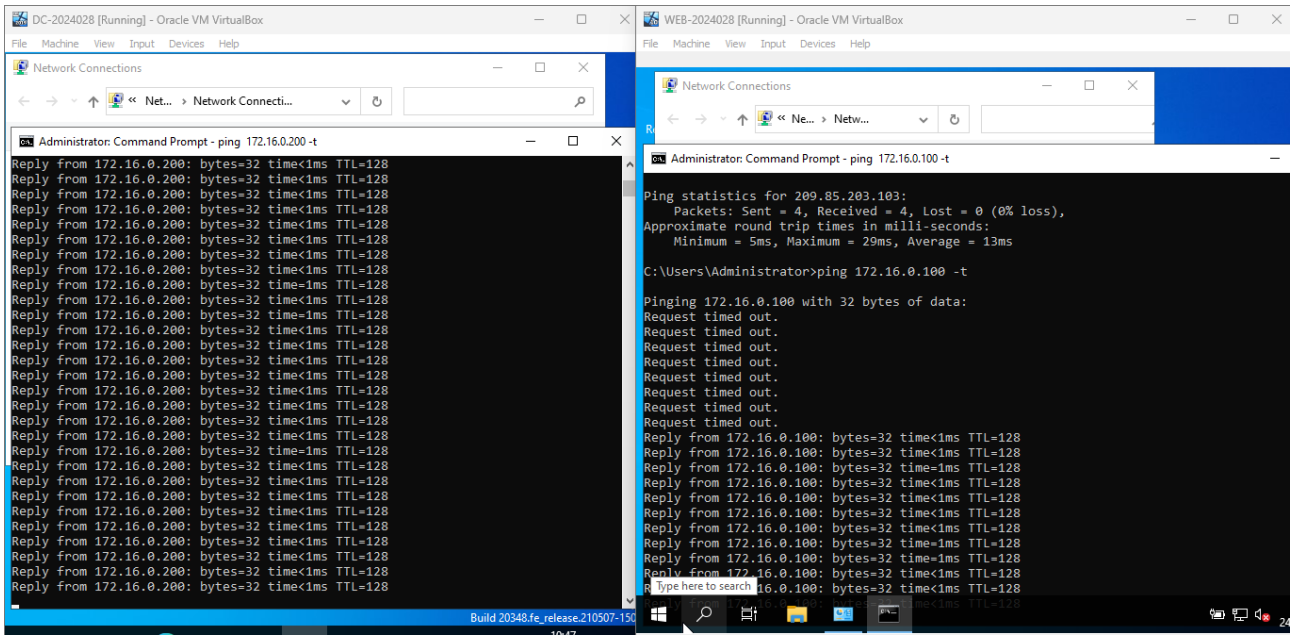


*Image 7: IP's connected and tested with ping.*

The Domain Controller Server's transformation into a Domain Controller, which creates centralized control over user accounts, security settings, and network resources inside an Active Directory domain, highlights the Domain Controller Server's critical role in network management. Alongside this change, the DNS (Domain Name System) service is installed. This is a necessary step in order to enable network connection and domain name resolution. In its capacity as the Domain Controller, the server is in charge of granting user access authorization and authentication, enforcing security regulations, and enabling smooth resource sharing throughout the network. Administrators can improve security, optimize resource usage, and speed network management operations by combining these activities onto a single server. his configuration lays the groundwork for a robust and efficient network infrastructure, capable of meeting the demands of modern enterprise environments.

The creation of the Active Directory domain "Domain-028.abc" represents a significant turning point in network architecture, offering a strong structure for allocating network resources and facilitating centralized services for authorization and authentication. In order to improve security and streamline administrative operations, this domain acts as a central repository for user accounts, group policies, and network configurations. Administrators provide smooth interaction with domain resources and services by facilitating centralized user authentication and access control through the integration of the Web server into the "Domain-028.abc" domain. The Web server can utilize the domain's authentication protocols to safeguard network resources and provide unified user management when it joins the domain. Establishing the groundwork for a robust and scalable network architecture, this integration promotes operational efficiency, streamlines management duties, and improves overall network security.

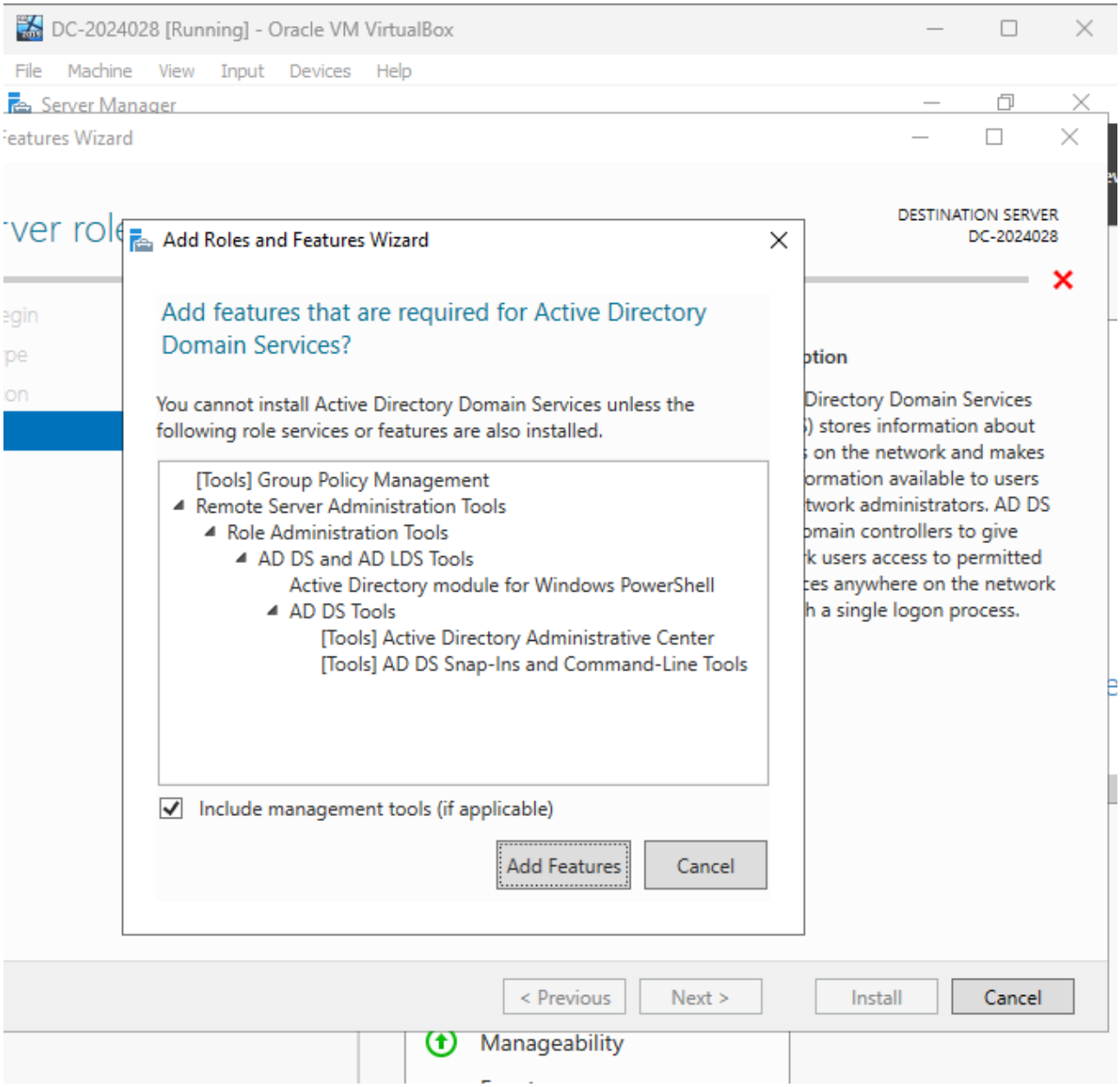


*Image 8: First step to convert into domain.*

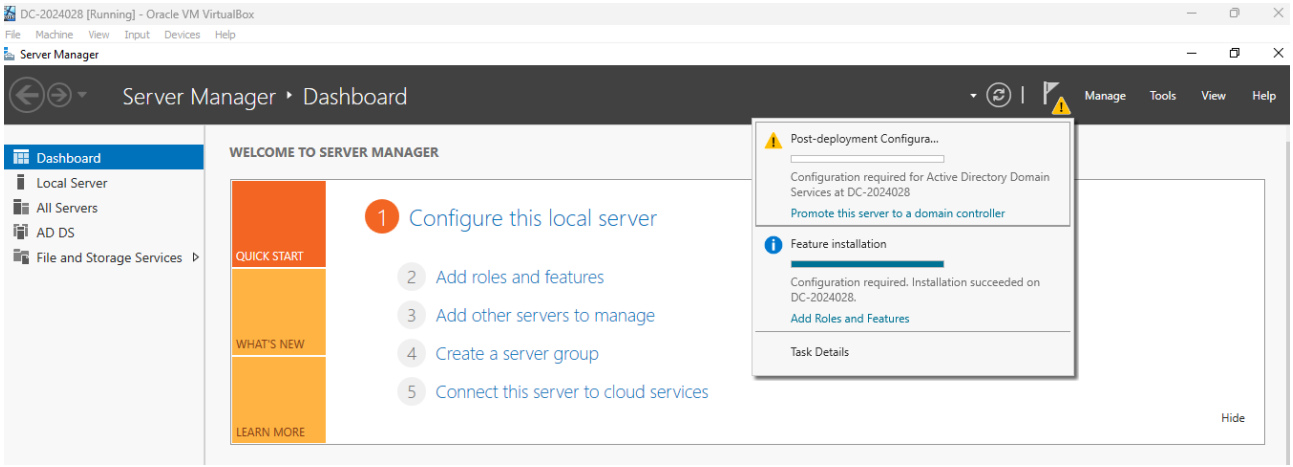


*Image 9: Second step to convert into domain.*

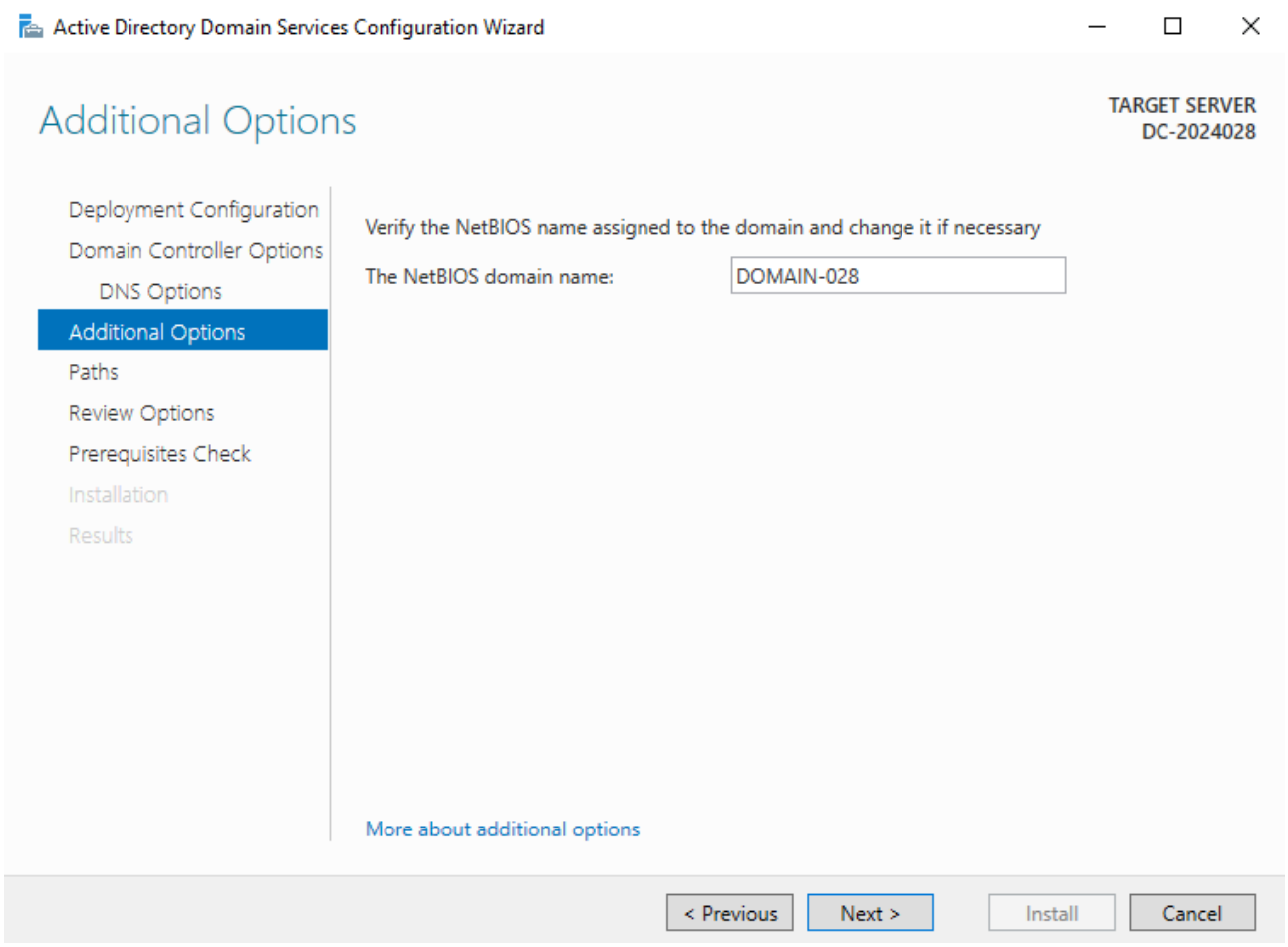


*Image 10: Finishing the creation of the domain.*

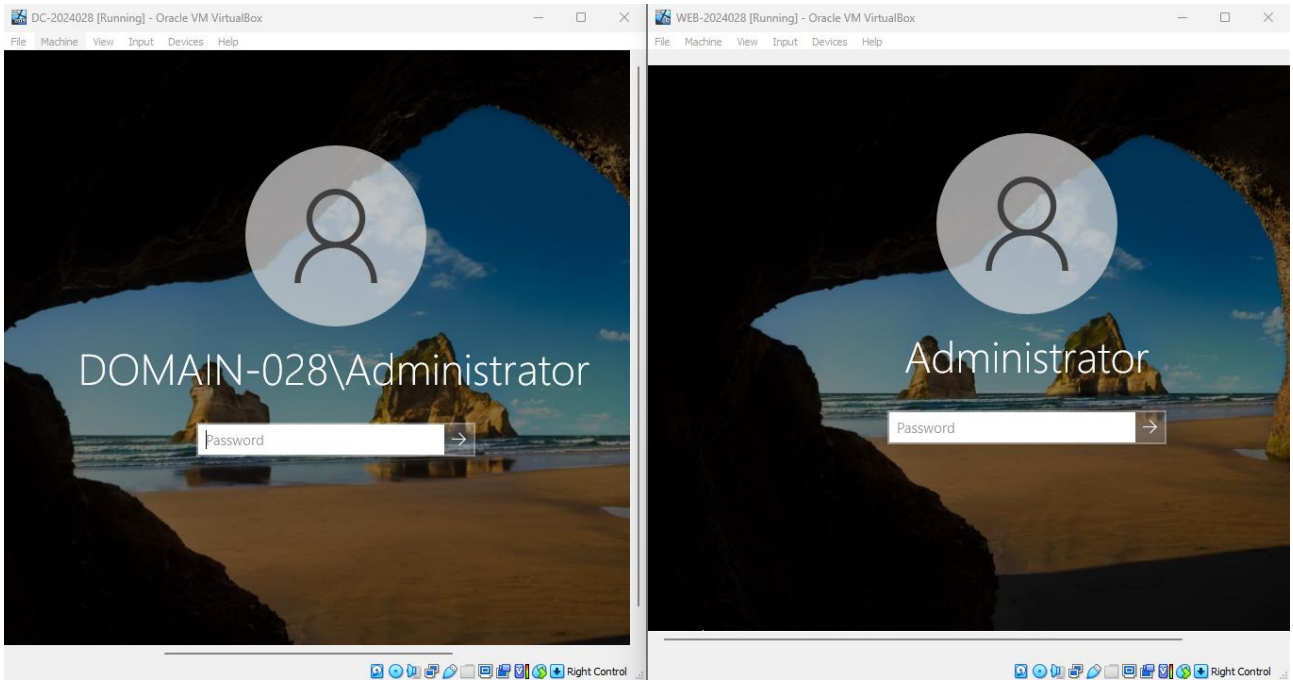


*Image 11: Proof of the domain and the web computer together.*

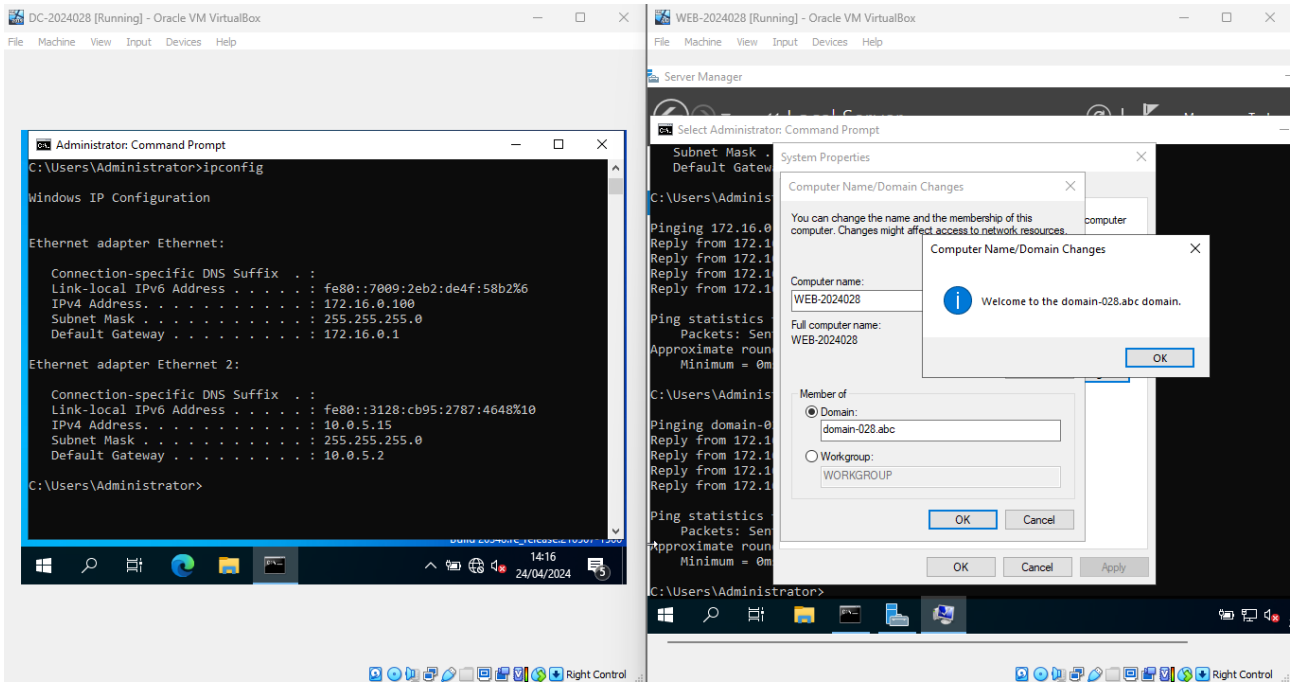


*Image 12: Web started to be part of the domain.*

## Setting up a Website

PowerShell instructions are used to speed up the Windows IIS (Internet Information Services) Web hosting software installation on the Server 2 machine. A more efficient and convenient way to automate software installation activities is to use PowerShell, which streamlines the setup procedure. The Windows IIS software is quickly installed by running the relevant PowerShell instructions, opening the door for hosting web applications and services on the server. After installation, Windows IIS gives the server the ability to host websites by supplying the infrastructure

required for web hosting. The smooth amalgamation of PowerShell automation with Windows IIS functionalities expedites the deployment of web services on the server and streamlines the configuration procedure, hence augmenting productivity and optimizing operations.

The instructions used in the PowerShell is given bellow:

Install-WindowsFeature -Name Web-Server -IncludeManagementTools

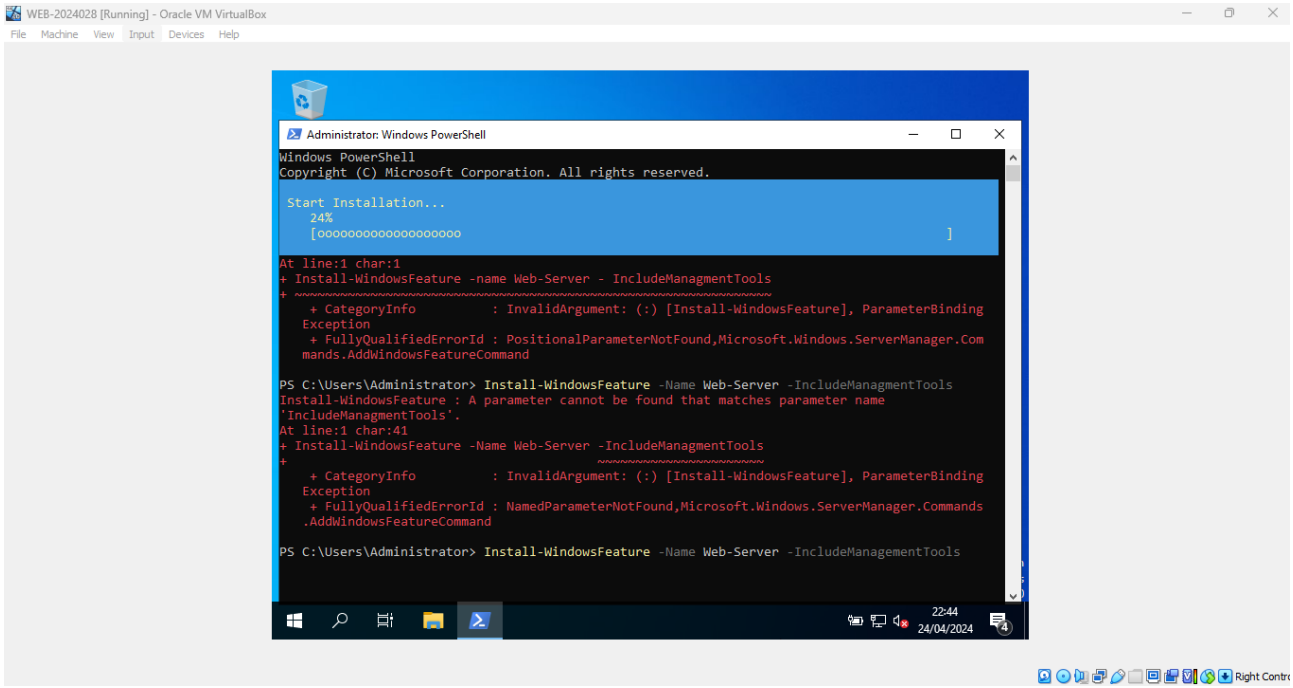


*Image 13: PowerShell running the instruction.*

With the expertise in HTML and web construction, it was made a one page website for DigiTech.abc that included the name of the firm, a synopsis, a picture, and the student details. This indicates a basic understanding of web design. I installed Windows IIS on the web Server using PowerShell instructions to expedite setup. PowerShell's automation ensures effective setup by streamlining program installation. Website deployment is made easier by Windows IIS, which makes hosting web applications and services possible. An efficient method of web hosting is demonstrated by the smooth combination of PowerShell automation with web construction expertise.

Here bellow is shown the code used to created the website:

```
<!DOCTYPE html>
<html>
<head>
    <title>DigiTech.abc</title>
</head>
<body>
    <h1>Welcome to DigiTech.abc</h1>
    <p>This is a website created for CCT class.</p>
    <img src="digitechlogo.JPG" alt="Your Image">
    <p>Created by: Publio Filho <br> Student Number: 2024028</p>
</body>
</html>
```

I used Internet Information Server (IIS) on the assigned Web server (different from the Domain Controller) to set up the DigiTech.abc website. I set up the website settings using the IIS administration interface, adding binding details, the physical route, and other relevant data. The smooth operation of the website is guaranteed by this thorough configuration. I used a web browser to view the website after configuration to ensure that it worked and that everything had been set up correctly. This stage emphasizes how crucial testing and validation are to guaranteeing that the website is usable and accessible to people online and confirming that it is ready for distribution.

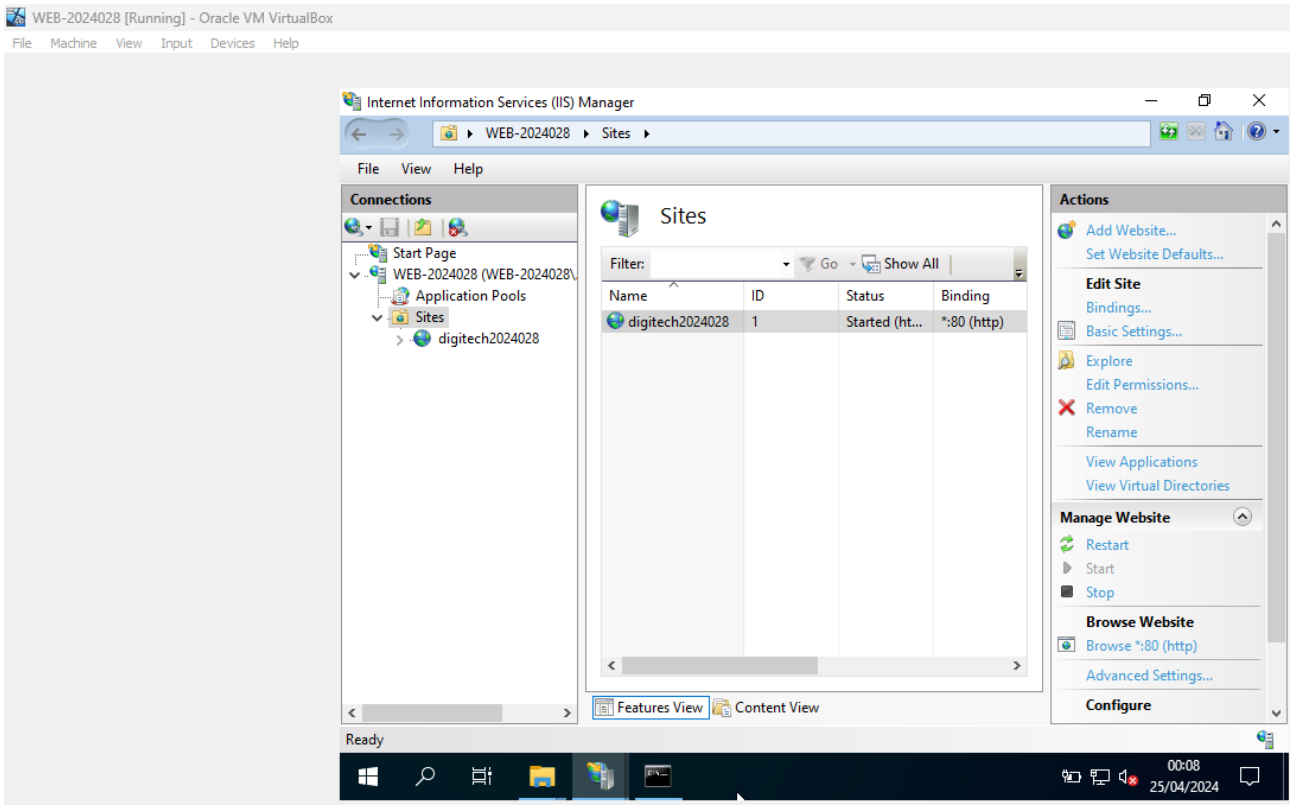


*Image 14: Setting up the website in the webserver.*

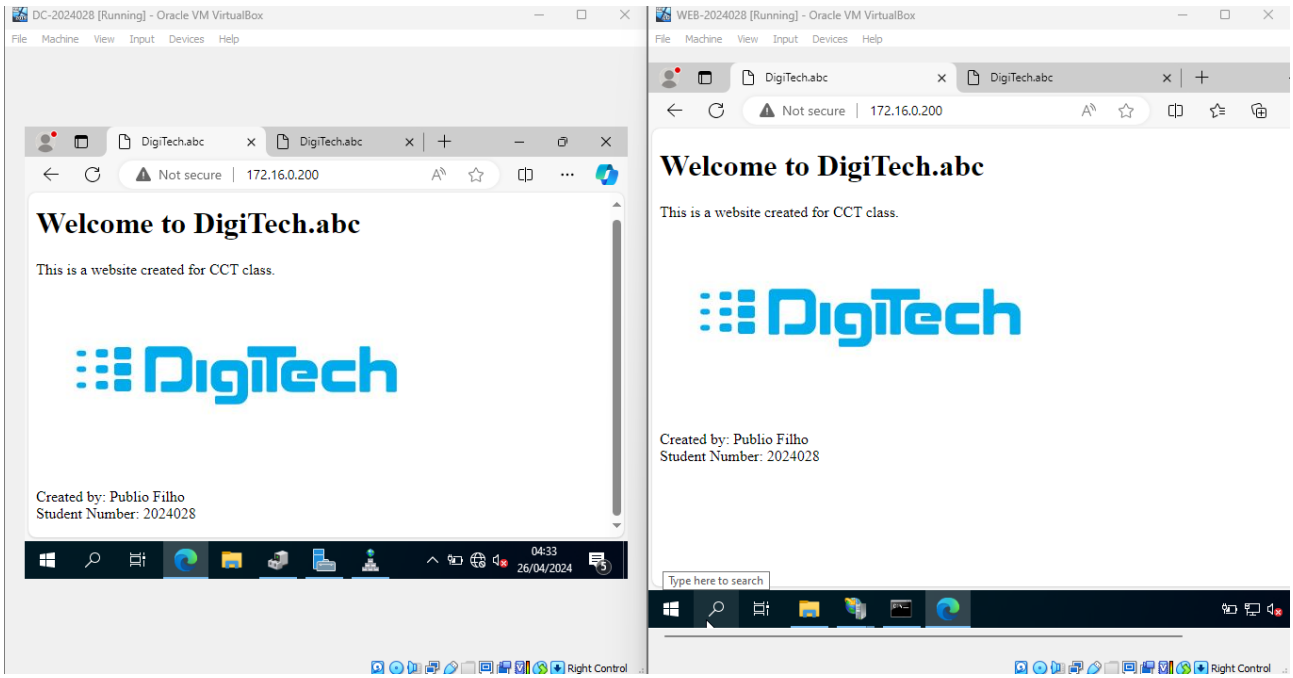


*Image 15: Website working in both machines by the IP.*

**Research topics: Micro and macro architecutres**

Micro and macro architectures, which cover everything from small embedded systems to massive computing platforms, are crucial to take into account when talking about a broad spectrum of computer architectures. The Raspberry Pi and Arduino are two well-known microcomputer designs.

The Raspberry Pi is a versatile single-board computer (SBC) designed for educational purposes and hobbyist projects. It usually has an ARM processing architecture and a Broadcom system-on-chip (SoC), which provides good performance for its size and low power consumption. The Raspberry Pi's General Purpose Input/Output (GPIO) ports, which allow for communication with external sensors, actuators, and other peripheral devices, are the focal point of its architecture. The Raspberry Pi is frequently used for media centers, home automation, retro gaming consoles, and instructional programming initiatives. It is affordable and tiny, making it suitable for a wide range of users, including novice and expert developers.

On the other hand, the Arduino platform emphasizes simplicity and usability for embedded applications and is largely focused on microcontroller-based devices. Low-level control over hardware components is provided via the Atmel AVR or ARM-based microcontroller found on most Arduino boards. The microcontroller chip at the heart of the Arduino architecture communicates via digital and analog pins with a variety of sensors, motors, and other peripherals. Arduino is a popular platform for automation applications, DIY electronics projects, and prototyping. Programming jobs are made easier by its large library of pre-written software (sketches), which makes it a great option for both novices and experts.

In conclusion, there are two different microcomputer architectures—the Raspberry Pi and Arduino, each with special characteristics and uses. Arduino shines in embedded systems and real-time control applications, whereas the Raspberry Pi provides a more versatile computing platform

appropriate for a variety of applications. These platforms have made electronics and computers more accessible to the general public, enabling individuals to experiment and develop in the field of digital technology.

**Research topics: Seymour Cray's contribution to computer science**

Seymour Cray is recognized for his noteworthy contributions to the advancement of mainframe computers and for being a pioneer in the field of computer engineering. His inventions significantly advanced computer technology by increasing computers' speed, efficiency, and ability to do difficult computational tasks. The following three significant inventions are credited to Seymour Cray:

Vector Processing: The invention of vector processing technology is one of Cray's most significant accomplishments. By executing a single command on several data components at once, vector processing allows for the rapid computing of scientific and mathematical computations. Large arrays of data may be processed quickly and effectively using vector processing units, a feature of Cray's designs, including the CDC 6600 and later Cray supercomputers. Weather forecasting, scientific simulations, and other computationally demanding jobs were greatly expedited by this invention. For instance, the 1976 release of the Cray-1 supercomputer, which revolutionized computational research, allowed for extraordinary processing rates through the use of vector processing capabilities.

Parallel Processing: Cray also invented the technique of using several processors to collaborate on separate portions of a computation at the same time in mainframe computers. By breaking up large workloads into smaller subtasks and performing them concurrently across several processing units, parallel processing improves computing efficiency. A characteristic of Cray's designs, including the Cray X-MP and Cray-2, was its scalable architecture, which coupled several processing parts via fast communication channels. Due to the effective parallel task execution made possible by this design, performance improvements were substantial. For example, to attain enormous computing capacity, contemporary supercomputers such as the Cray XC series use thousands of linked processing nodes. This has allowed for advancements in big data analytics, artificial intelligence, and scientific research.

Liquid Cooling technologies: To solve the thermal issues related to high-performance computing, Cray not only invented novel cooling technologies but also made significant strides in computational design. Supercomputers such as the Cray-2 and later variants, which are equipped with Cray's liquid cooling systems, effectively disperse heat produced by powerful processors, guaranteeing peak performance and dependability. Liquid cooling maximizes computing throughput by keeping temperatures within ideal operating limits, which permits larger processor density and clock rates. Since densely packed processor nodes in supercomputing centers need effective thermal control to avoid overheating and preserve system stability, this invention has become essential.

In conclusion, Seymour Cray made significant contributions to computer science that have influenced the development of mainframe computers and supercomputing technologies, such as vector processing, parallel processing, and liquid cooling systems. His creative innovations have opened the door for improvements in computer efficiency, which have facilitated advances in data analysis, engineering simulations, and scientific research.

**Research topics: The architectures and uses of modern Mainframe computers**

Given their superior performance, dependability, and scalability for applications that are vital to an organization, modern mainframe computers are still indispensable to many different sectors of the economy. Usually, these systems are powered by specialized operating systems designed to handle heavy transactional workloads and large-scale data processing. One of the top platforms for contemporary mainframe computing is IBM Z, formerly known as IBM System z. It runs Linux, z/OS, and z/VM operating systems.

z/OS: IBM created the extremely scalable operating system known as z/OS, which was created especially for mainframe settings. Numerous applications are supported by it, such as database administration, online transaction processing (OLTP), and batch processing. Advanced capabilities for security, dependability, and workload management make z/OS the perfect choice for tasks that are crucial to business operations.

z/VM: For IBM Z mainframes, z/VM is a hypervisor-based virtualization platform. It makes it possible to combine several virtual machines (VMs) onto one physical server, which promotes effective job separation and resource usage. Hosting virtualized environments and supporting a variety of application workloads are popular uses for z/VM.

Linux on IBM Z: A version of the Linux operating system designed specifically for mainframe platforms is called Linux on IBM Z. By supporting a large selection of open-source applications and development tools, it helps businesses take advantage of Linux's scalability and flexibility while using IBM Z hardware.

**Applications and Uses:**

**Financial Services:** In the financial services sector, mainframe computers are widely utilized for processing high transaction volumes, monitoring client accounts, and facilitating real-time analytics. For instance, ATM transactions, internet banking, and stock market trading are all handled by banks using mainframes.

**Healthcare:** In healthcare businesses, mainframes are essential for processing medical claims, managing electronic health records (EHRs), and assisting clinical decision-making systems. Mainframes are essential to the healthcare sector because they provide data confidentiality, privacy, and adherence to regulatory requirements.

**Government and Public Sector:** Governmental and private sector entities handle citizen services, administer tax systems, and process administrative data using mainframe computers. Large-scale data processing is supported by mainframes, which also offer reliable infrastructure for crucial government functions.

**Mainframes in Ireland:** Major financial institutions, governmental organizations, and significant businesses in Ireland probably use mainframe technology to support their operations, even though precise information regarding mainframe installations in the country may not be readily available to the general public. Usually, the previously mentioned firms own or lease the secure data centers where these mainframes are kept. It is plausible to presume that Ireland has mainframe installations

given the significance of mainframe computing across a range of businesses, even if the public may not have easy access to the precise locations and data.

**Research topics: Patch management**

Patch management is the process of organizing, implementing, and keeping an eye on software updates, or patches, in order to reduce vulnerabilities, boost system stability, and increase security. Patches must first be identified and prioritized, then tested in a controlled setting before being deployed to the relevant systems on an organization's network. Patch management is necessary to keep computer networks and systems secure and intact.

**Importance of Patch Management for Network Servers:**

Network servers, which act as major centers for data storage, application hosting, and network connectivity, require patch management in particular. Cyberattackers find servers appealing targets because they frequently operate vital services and applications that are accessible by numerous users or clients. Organizations can address known vulnerabilities and guard against possible security breaches by routinely applying patches to server systems. In addition, patch management fixes software defects and compatibility problems, ensuring system performance and dependability.

**Why Server Computers Should Not Get Automatic Updates:**

**Downtime:** Automatic updates have the potential to interfere with server functionality and cause downtime or compatibility problems with important applications. Organizations can regulate the deployment and scheduling of updates by putting in place a patch management system, which enables testing and validation prior to patching production systems.

**Compatibility issues:** Server stability and data integrity may be at risk due to unexpected problems or configuration conflicts brought about by automatic updates. Patch management practices allow enterprises to thoroughly test and validate updates in order to analyze their impact and mitigate risks.

**Regulatory Compliance:** Organizations must follow certain patch management procedures to stay in compliance with data protection and security regulations in a number of industries and regulatory standards. Organizations can have more visibility and control over compliance activities using manual patch management systems, which guarantee that updates are applied in compliance with regulatory requirements.

**Case Study: Case Study: SolarWinds Supply Chain Attack:**

A recent instance that highlights the significance of appropriate patch management protocols is the supply chain attack on SolarWinds. It was discovered that threat actors had gained access to SolarWinds' software development infrastructure, giving them the ability to insert malicious malware into upgrades for the company's Orion platform. Numerous governmental organizations and big businesses were among the hundreds of SolarWinds clients that received these poisoned updates. The attackers gained illegal access to the targeted networks by taking advantage of flaws in the software supply chain, which led to extensive data breaches and espionage operations.

The SolarWinds event serves as an eye-opener of how important it is for businesses to put strong patch management procedures in place, including thorough testing and validation of software upgrades prior to distribution. Proactive risk mitigation measures are crucial since improper patch management practices can expose enterprises to serious security vulnerabilities and possible data breaches.

**Challenge Tasks: Properly set up DNS Server for the website.**

The DNS server must be configured appropriately in order to guarantee that the DigiTech website housed on Server 2 is properly accessible. The DigiTech website's hostname is mapped to Server 2's IP address via a DNS entry made with Server 1's DNS console. When a customer accesses the website, this entry enables them to resolve the hostname to the relevant IP address. The accuracy of the DNS entry is confirmed by using the "nslookup" command to verify the DNS settings. The website's accessibility is then tested using a web browser on Server 1, showing that users can successfully visit the DigiTech website by typing its hostname into the address bar of their browser.

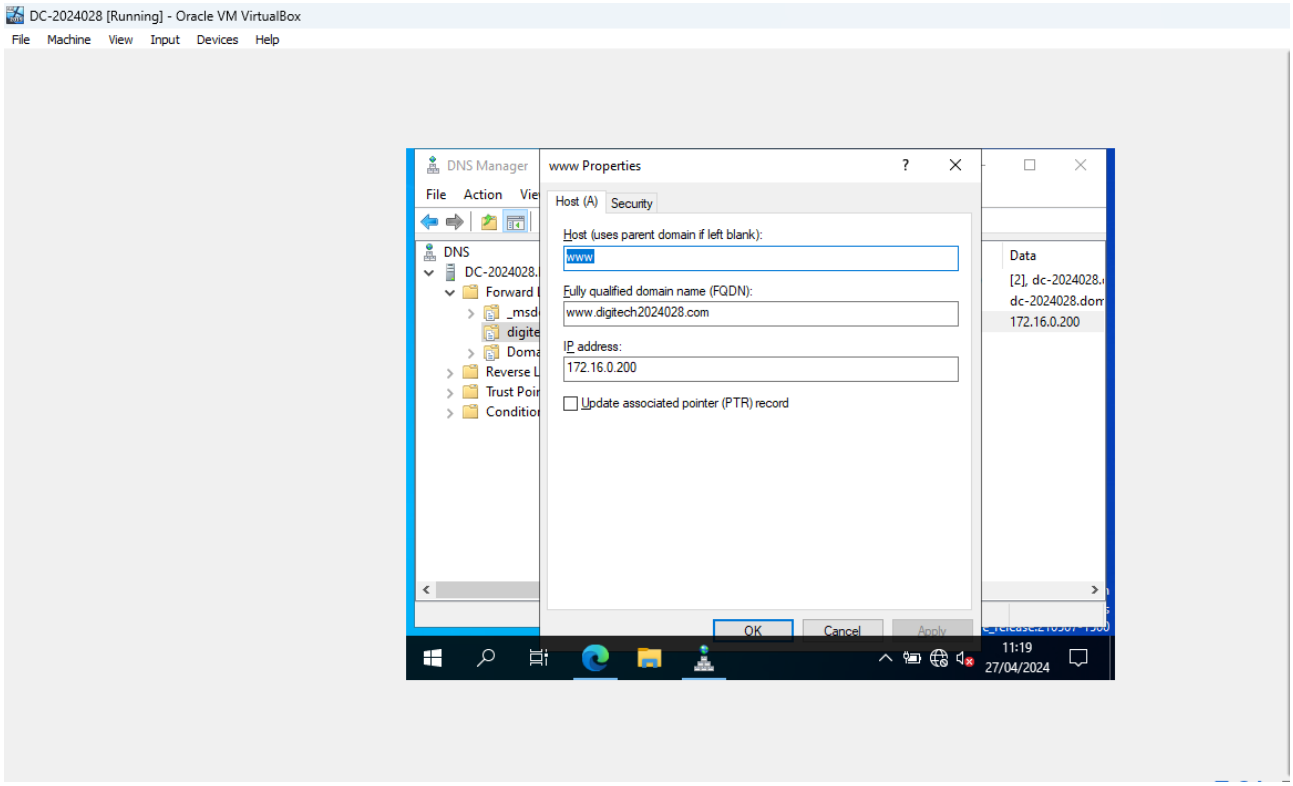


*Image 15: Set up DNS Server for the website.*

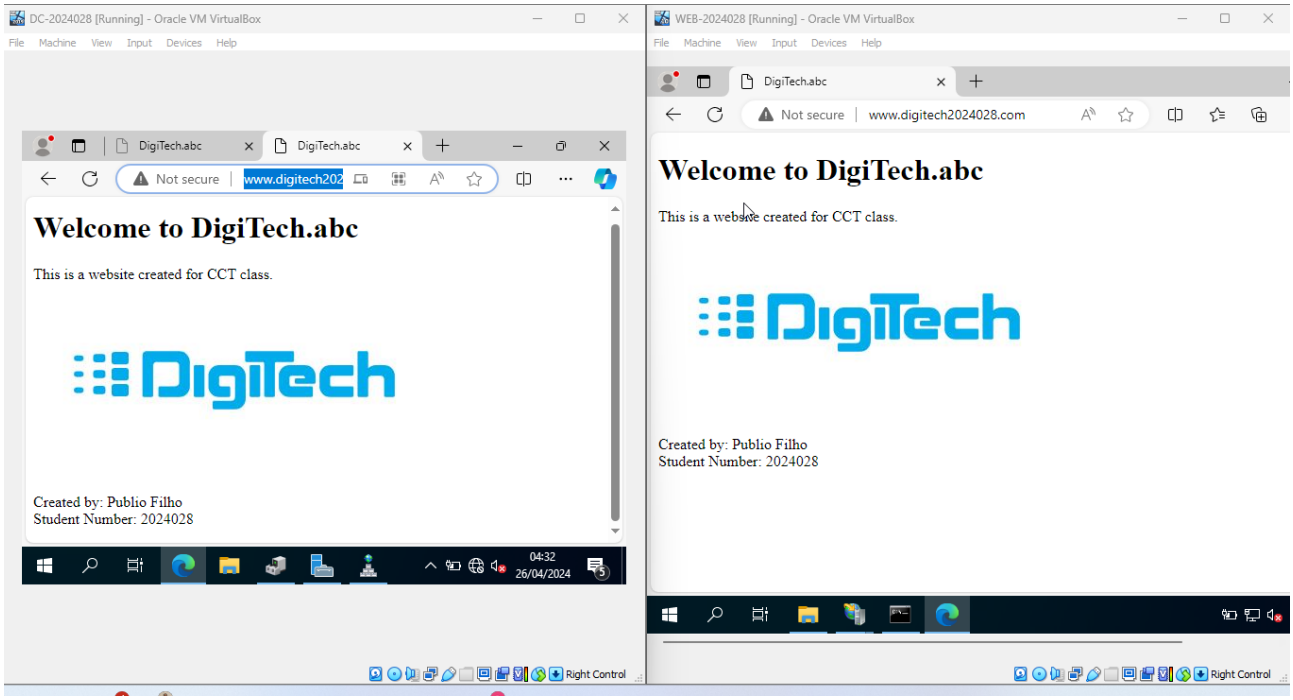


*Image 16: Website working in both machines by the name of the site.*

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