Microservices Deployment in VirtualBox

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Course/Project: Cloud Computing & Virtualization Assignment

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1. Introduction

The objective of this assignment was to create and configure multiple virtual machines (VMs) using Oracle VirtualBox, set up networking between them, and deploy a simple microservice-based application. The final deliverables include:

- A detailed report (this document)
- An Network diagram of the deployed simple system
- A GitHub repository containing the source code and deployment configuration
- A recorded video demonstration of the process

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2. Environment Setup and VirtualBox Installation

a. VirtualBox Installation

- **Download:** I downloaded the latest version of VirtualBox from the Oracle VirtualBox website.
- **Installation:** The installation was straightforward, following the on-screen instructions. The extension pack was also installed to enable advanced networking features and USB support.

b. Ubuntu Installation on VM

- **ISO Verification:** I downloaded the Ubuntu Server ISO and verified its checksum using the provided SHA256 hash to ensure file integrity.
- **VM Creation:**
  - I created a new VM named "First Ubuntu VM 24.04" with the following settings:
    - **Type:** Linux, Ubuntu (64-bit)
    - **RAM:** 4092 MB (minimum recommended for Ubuntu Server)
    - **Virtual Hard Disk:** A dynamically allocated VDI of 25 GB
  - The ISO file was attached as a boot medium, and the default boot order was set to boot from the optical drive.
- **Installation Issues:**
  - During the installation, I initially encountered an error (which turned out to be due to insufficient resources and an incorrect boot order). I resolved it by increasing the allocated memory and verifying that the boot order prioritized the ISO image.

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3. Creating and Cloning Virtual Machines

a. Original VM Setup

- The "First Ubuntu VM 24.04" VM was successfully installed and updated via:
  `sudo apt update && sudo apt upgrade -y`
- Essential packages such as Git and curl were installed:
  `sudo apt install git curl -y`

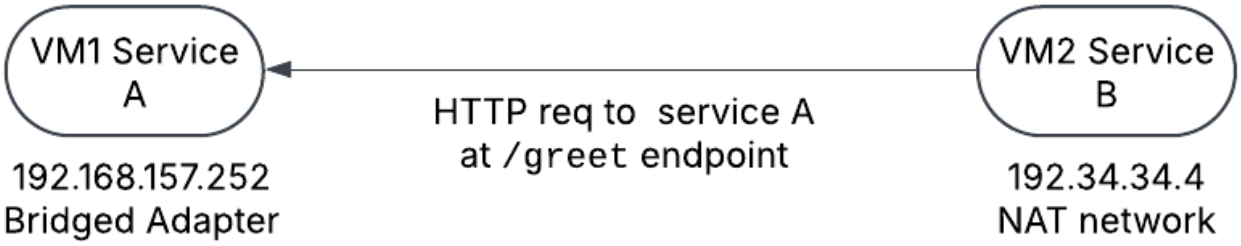
b. Cloning the VM

- To simulate a microservice architecture with two VMs, I cloned the "First Ubuntu VM 24.04" VM.
- **Problem Encountered:**
  After cloning, both VMs showed the same MAC address (and hence received the same IP address) when connected to my configured NAT network (192.34.34.0/24).
- **Reason:**
  - I discovered that VirtualBox clones by default copy the original VM's MAC address.
  - Using the VBoxManage command-line tool, I reinitialized the MAC address for the cloned VM:

```
VBoxManage modifyvm "Ubuntu-Clone" --macaddress1 080027A1B2C3
```
  - Alternatively, I also edited the "Ubuntu-Clone.vbox" configuration file manually (after backing it up) to update the `<Adapter slot="1" ... MACAddress="...">` value.
- **Outcome:**
  After changing the MAC address and renewing the DHCP lease (using `sudo dhclient -r && sudo dhclient` inside the guest), the cloned VM still had the same IP
- **Solution** I then i decided to keep two different VMs with different network configs one with Bridged adapter and other with NAT network so that both VMs have same Ip addresses.

c. Network Adapter Configuration Summary

- **VM for Service B (Greeting Service):**
  - **Network Mode:** Bridged Adapter
  - **IP Address:** 192.34.34.4
  - **Reason:** Bridged mode was chosen so that this VM appears as a full member of the physical network.
- **VM for Service A (Time Service):**
  - **Network Mode:** NAT Network (with a custom network configured as 192.34.34.0/24)
  - **IP Address:** 192.168.157.252 (This IP address can change as its dependent on host OS).
  - **Reason:** NAT mode provides an isolated internal network while still enabling internet connectivity.



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4. Microservice Application Deployment

I developed a simple microservices application using Node.js and Express that consists of two services communicating with each other.

a. Application Overview

- **Service B – Greeting Service:**
  - **Port:** 3000
  - **Function:** Provides a `/greet` endpoint that calls Service B to obtain the current time and then returns a greeting message.
  - **Deployed on:** VM with **NAT network** (IP: 192.34.34.4)
- **Service A – Time Service:**
  - **Port:** 3001
  - **Function:** Provides a `/time` endpoint that returns the current server time in ISO format.
  - **Deployed on:** VM with **Bridged Adapter** (IP: 192.168.157.252)

b. Code Details

Service A – Time Service

- **Directory:** `service-a/`
- **package.json:**

```
{
  "name": "service-a",
  "version": "1.0.0",
  "description": "Time service microservice",
  "main": "index.js",
  "scripts": {
```

```
    "start": "node index.js"
  },
  "dependencies": {
    "express": "^4.18.2"
  }
}
```

- **index.js:**

```
const express = require('express');
const app = express();
const port = process.env.PORT || 3001;

app.get('/time', (req, res) => {
    const currentTime = new Date().toISOString();
    res.json({ time: currentTime });
});

app.listen(port, () => {
    console.log(`Service A (Time Service) listening on port ${port}`);
});
```

Service B – Greeting Service

- **Directory:** `service-b/`
- **package.json:**

```
{
  "name": "service-b",
  "version": "1.0.0",
  "description": "Greeting service microservice",
  "main": "index.js",
  "scripts": {
    "start": "node index.js"
  },
  "dependencies": {
    "axios": "^1.3.4",
    "express": "^4.18.2"
  }
}
```

- **index.js:**

```
const express = require('express');
const axios = require('axios');
const app = express();
const port = process.env.PORT || 3000;

// The SERVICE_A_URL should be set to the IP of the VM running Service A.
// In our setup, set SERVICE_A_URL=http://192.34.34.4:3001
const serviceAUrl = process.env.SERVICE_A_URL || 'http://localhost:3001';

app.get('/greet', async (req, res) => {
    try {
        // Fetch current time from Service B
        const response = await axios.get(`${serviceAUrl}/time`);
        const time = response.data.time;
        res.json({ greeting: `Hello! The current time is ${time}` });
    } catch (error) {
        console.error('Error fetching time from Service A:', error);
        res.status(500).json({ error: 'Could not retrieve time from Service A' });
    }
});

app.listen(port, () => {
    console.log(`Service B (Greeting Service) listening on port ${port}`);
});
```

c. Deployment Steps on the VMs

- **For Service A (Time Service):**
  1. On the VM with NAT network (IP: 192.168.157.252), open a terminal.
  2. Clone the GitHub repository:
     ```
     git clone https://github.com/adit4443ya/microservice_vcc.git
     cd microservice_vcc/service-a
     ```
  3. Install dependencies:
     ```
     npm install
     ```
  4. Start the service:
     ```
     npm start
     ```
- **For Service B (Greeting Service):**
  1. On the VM with bridged adapter (IP: 192.34.34.4), open a terminal.
  2. Clone the repository:
     ```
     git clone https://github.com/adit4443ya/microservice_vcc.git
     cd microservice_vcc/service-b
     ```
  3. Set the environment variable so that Service A knows where to reach Service B:
     ```
     export SERVICE_A_URL=http://192.168.157.252:3001
     ```
     (On Windows, use `export SERVICE_A_URL=http://192.168.157.252:3001` in Command Prompt.)
  4. Install dependencies:
     ```
     npm install
     ```
  5. Start the service:
     ```
     npm start
     ```

d. Testing the Application

- **Service A:**
  From any terminal (or browser) on the VM (or via port forwarding from the host), access:

  `http://192.168.157.252:3001/time`

  You should receive a JSON response with the current time.

- **Service B:**
  From a terminal or browser on the VM or host, access:

  `http://192.34.34.4:3000/greet`

  This endpoint will fetch the time from Service A and return a greeting message.

- **Inter-VM Communication:**
  Verify that Service B (on the NAT VM) can reach Service A (on the bridged VM) by checking logs and using tools like `curl`:

  `curl http://192.168.157.252:3000/greet`

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5. Difficulties and Troubleshooting

a. Ubuntu Installation Issues

- **Problem:**
  Initial installation errors occurred due to resource allocation and boot order misconfigurations.
- **Resolution:**
  - Increased VM RAM allocation.
  - Verified boot order to ensure the ISO was prioritized.
  - Checked the ISO checksum to confirm file integrity.

b. Cloning and Duplicate MAC Addresses

- **Problem:**
  When cloning the VM, both clones inherited the same MAC address, causing them to receive the same IP address from the DHCP server.
- **Resolution:**
  - Used VBoxManage with the command
    `VBoxManage modifyvm "Ubuntu-Clone" --macaddress1 080027A1B2C3`

to generate a new MAC address.
  - When the GUI option was not clickable, I manually edited the VM's `.vbox` configuration file.
  - After keeping two different network configurations i got different IP addresses.

c. Network Adapter Modes

- **Approach:**
  - Configured one VM to use NAT network mode (resulting in IP 192.34.34.4) and the other to use Bridged Adapter mode (resulting in IP 192.168.157.252).
- **Testing:**
  - Verified connectivity using `ifconfig`, `ip addr`, and `ping` between the VMs.
  - Ensured that the NAT network was correctly configured with the custom subnet (192.34.34.0/24).

d. Microservice Communication Setup

- **Problem:**
  Setting the correct environment variable for inter-service communication.
- **Resolution:**
  - In Service A's startup process, the environment variable `SERVICE_A_URL` was set to `http://192.168.157.252:3001`.
  - This allowed Service A to successfully call Service B's `/greet` endpoint.

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6. Conclusion

In summary, the assignment was completed successfully by:

- Installing VirtualBox and configuring Ubuntu VMs.
- Troubleshooting installation and cloning issues (duplicate MAC addresses) using VBoxManage and manual editing of configuration files.
- Configuring one VM with a NAT network (IP: 192.34.34.4) and the other with a bridged adapter (IP: 192.168.157.252).
- Deploying a simple Node.js microservices application with Service B (Greeting Service) and Service A (Time Service).
- Validating inter-VM communication and ensuring that Service B could retrieve data from Service A.

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7. Deliverables

- **Source Code Repository:**
  https://github.com/adit4443ya/microservice_vcc
- **Video Demo:**
  Video on Drive
- **Plagiarism Clause:**
  I hereby declare that the implementation, code, documentation, and all associated materials submitted as part of this assignment are entirely my own original work.
