

# .NET CORE AZURE VM DEPLOY GUIDE

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ABSTRACT. Simple and easy way to deploy your .NET Core web application to the Azure Ubuntu-based virtual machine.

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## 1. VIRTUAL MACHINE CREATION

Firstly, it is necessary to create a virtual machine (unexpectedly) where deployment to be hosted on. In this guide is considered free virtual machine of type **Standard B1ms** (1 vcpu, 2 GiB memory) with Ubuntu 20.04 operating system. Definitely it won't be considered step by step creation in this document, however required VM parameter are as follows:

- Size: **Standard B1ms** (1 vcpu, 2 GiB memory)
- OS: **Ubuntu Server 20.04 LTS - Gen2**
- Availability options: **No infrastructure required**
- Authentication type: **SSH public key**
- SSH public key source: **Use existing public key (create it before you created VM)**

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*2010 Mathematics Subject Classification.* 26E70, 05A30.

*Key words and phrases.* Azure, DevOps, Virtual machine, Deploy, Nginx, SSH, CI/CD, Azure pipelines, Github actions .

- Public inbound ports: HTTP(80), HTTPS(443), SSH(22)
- OS disk type: Standard SSD
- Encryption type: Default
- Public IP: Basic SKU, Static (be sure to create static IP)
- Select inbound ports: HTTP(80), HTTPS(443), SSH(22)
- Boot diagnostics: Disabled

Chosen parameters of the virtual machine are collected in order to minimize vm's cost. If you are not sure, refer to the screenshots via the reference [Kol22].

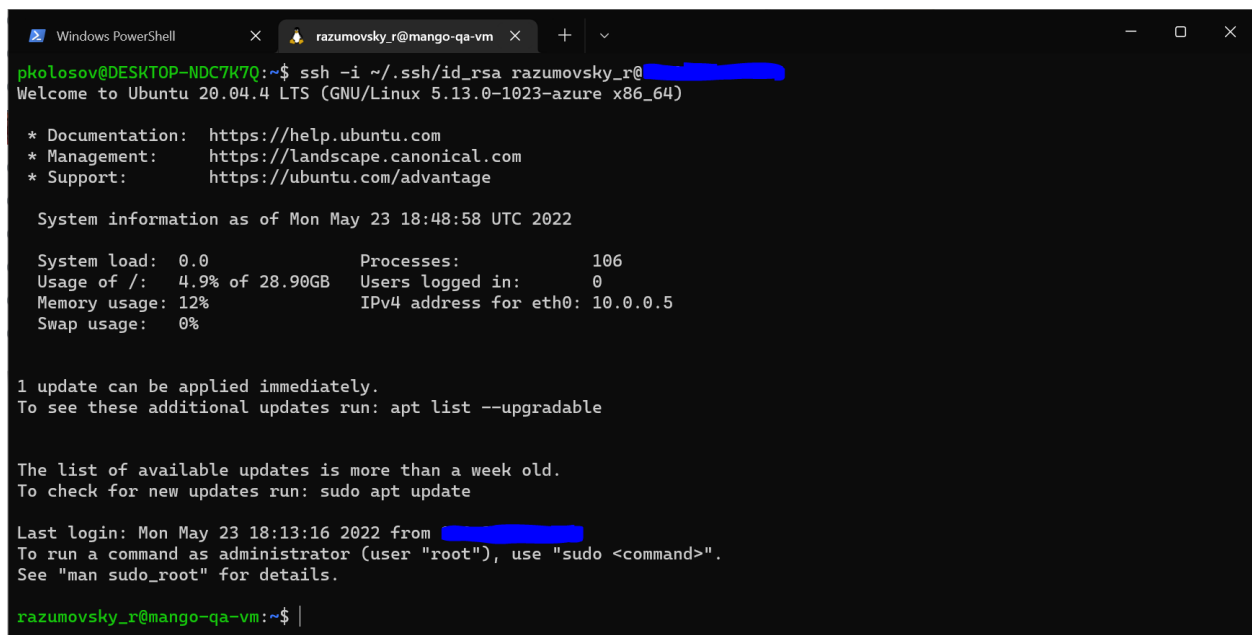
## 2. CONNECT TO VM VIA SSH

In order to configure virtual machine manually (as this guide tends to describe), we have to connect to it via SSH using the specified RSA private and public key-pair. It is assumed that programmer uses WSL2 under Windows 10 in order to work with VM via the SSH. By default, SSH keys are stored under the path `c/Users/username/.ssh`. Assume that RSA key-pair is stored there and have the names `id_rsa` and `id_rsa.pub` for private and public keys respectively. In order to interact the VM via SSH it is necessary to copy RSA keypair to the WSL `username/.ssh` folder, we use the commands under WSL

- `cp /mnt/c/Users/pkolosov/.ssh/id_rsa ~/.ssh/`
- `cp /mnt/c/Users/pkolosov/.ssh/id_rsa.pub ~/.ssh/`

Then connection is available now using the command

- `ssh -i ~/.ssh/id_rsa razumovsky_r@MachineStaticIP`



```
Windows PowerShell
razumovsky_r@mango-qa-vm
pkolosov@DESKTOP-NDC7K7Q:~$ ssh -i ~/.ssh/id_rsa razumovsky_r@
Welcome to Ubuntu 20.04.4 LTS (GNU/Linux 5.13.0-1023-azure x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

System information as of Mon May 23 18:48:58 UTC 2022

System load:  0.0          Processes:      106
Usage of /:   4.9% of 28.90GB Users logged in:  0
Memory usage: 12%         IPv4 address for eth0: 10.0.0.5
Swap usage:   0%

1 update can be applied immediately.
To see these additional updates run: apt list --upgradable

The list of available updates is more than a week old.
To check for new updates run: sudo apt update

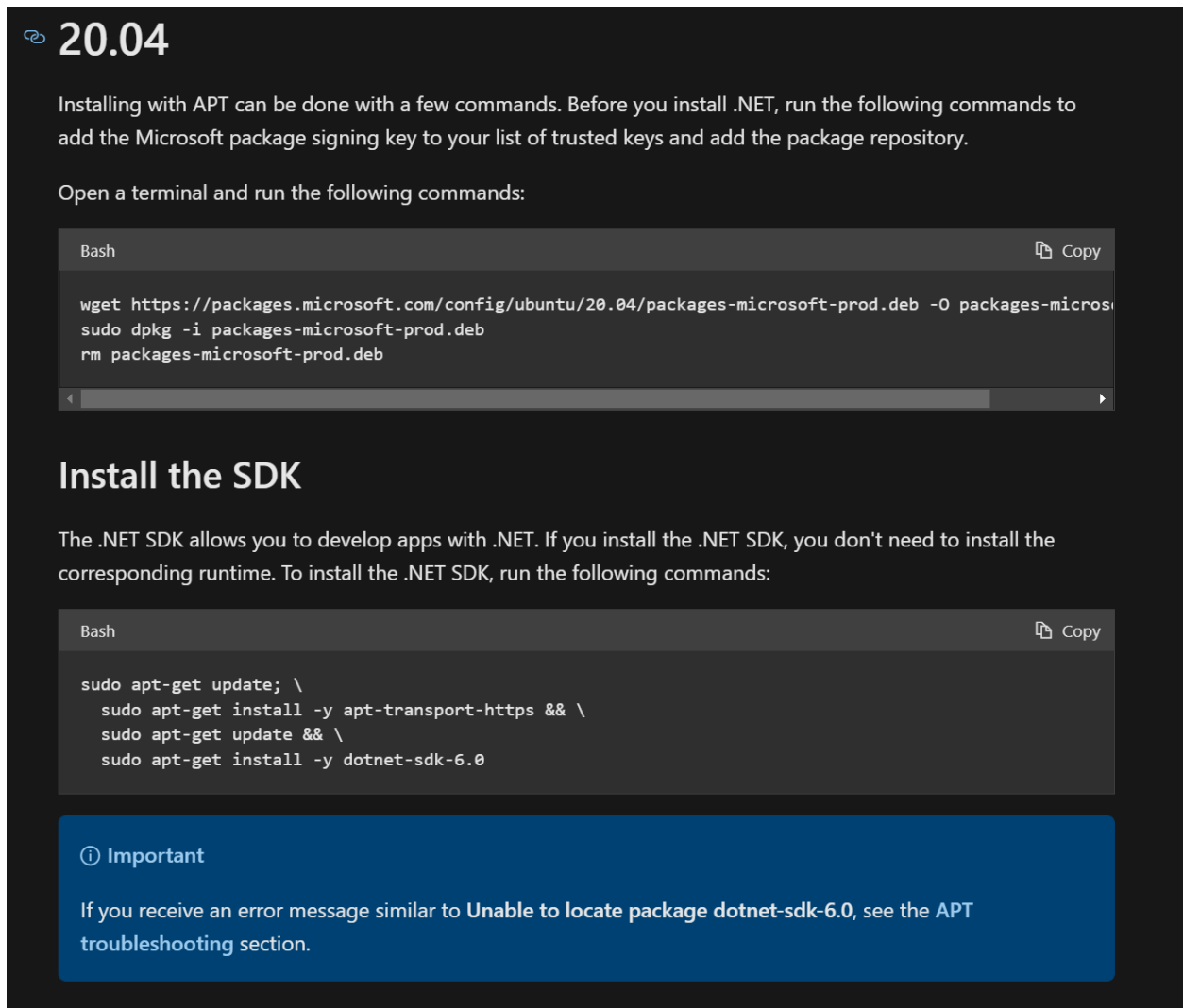
Last login: Mon May 23 18:13:16 2022 from 
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

razumovsky_r@mango-qa-vm:~$
```

Figure 1. SSH connected successfully.

### 3. INSTALL .NET SDK AND RUNTIME TO THE UBUNTU 20.04

Next, we should install the .NET SDK (unexpectedly again) in order to run our application. Proceeding, we refer to the Microsoft documentation article named [Install the .NET SDK or the .NET Runtime on Ubuntu](#) [Cor22], precisely the version is 20.04. As per documentation, consider the following commands to install .NET 6.0 SDK to your Ubuntu VM



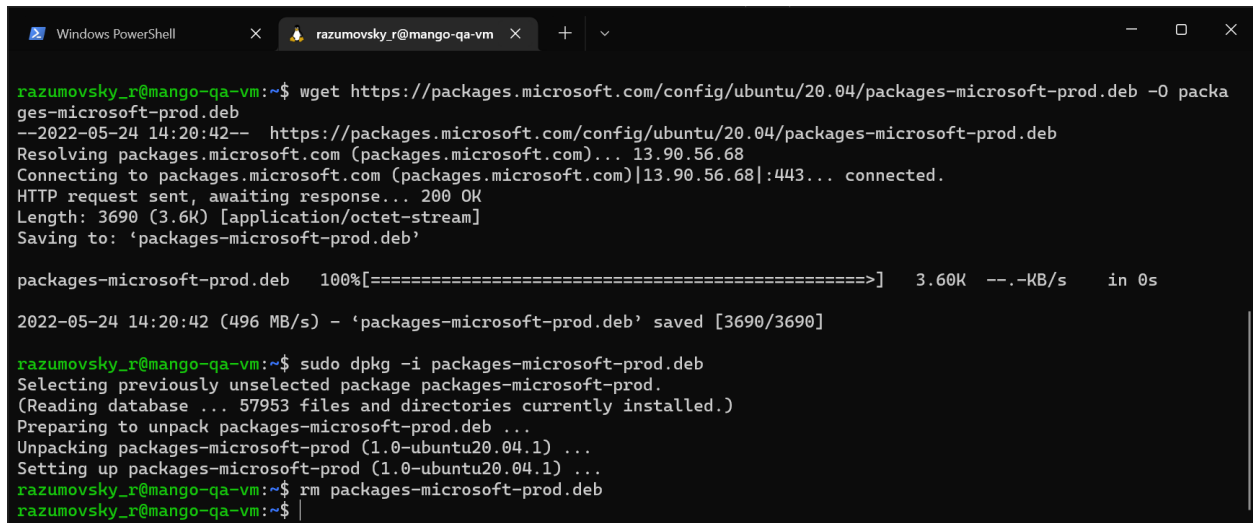
The screenshot shows a dark-themed web page titled "20.04" with a link icon. The main text states: "Installing with APT can be done with a few commands. Before you install .NET, run the following commands to add the Microsoft package signing key to your list of trusted keys and add the package repository." Below this, it says "Open a terminal and run the following commands:" followed by a terminal window showing the commands: `wget https://packages.microsoft.com/config/ubuntu/20.04/packages-microsoft-prod.deb -O packages-microsoft-prod.deb`, `sudo dpkg -i packages-microsoft-prod.deb`, and `rm packages-microsoft-prod.deb`. Below the terminal is a section titled "Install the SDK" with the text: "The .NET SDK allows you to develop apps with .NET. If you install the .NET SDK, you don't need to install the corresponding runtime. To install the .NET SDK, run the following commands:" followed by another terminal window showing: `sudo apt-get update; \`, `sudo apt-get install -y apt-transport-https && \`, `sudo apt-get update && \`, and `sudo apt-get install -y dotnet-sdk-6.0`. At the bottom, there is a blue box labeled "Important" with the text: "If you receive an error message similar to **Unable to locate package dotnet-sdk-6.0**, see the APT troubleshooting section."

**Figure 2.** Ubuntu 20.04 install .NET 6.0 SDK MSDN.

Prepare your virtual machine applying the commands

- `wget https://packages.microsoft.com/config/ubuntu/20.04/packages-microsoft-prod.deb -O packages-microsoft-prod.deb`
- `sudo dpkg -i packages-microsoft-prod.deb`
- `rm packages-microsoft-prod.deb`

The terminal output is as follows



```
razumovsky_r@mango-qa-vm:~$ wget https://packages.microsoft.com/config/ubuntu/20.04/packages-microsoft-prod.deb -O packages-microsoft-prod.deb
--2022-05-24 14:20:42-- https://packages.microsoft.com/config/ubuntu/20.04/packages-microsoft-prod.deb
Resolving packages.microsoft.com (packages.microsoft.com)... 13.90.56.68
Connecting to packages.microsoft.com (packages.microsoft.com)|13.90.56.68|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3690 (3.6K) [application/octet-stream]
Saving to: 'packages-microsoft-prod.deb'

packages-microsoft-prod.deb  100%[=====] 3.60K  --.-KB/s  in 0s

2022-05-24 14:20:42 (496 MB/s) - 'packages-microsoft-prod.deb' saved [3690/3690]

razumovsky_r@mango-qa-vm:~$ sudo dpkg -i packages-microsoft-prod.deb
Selecting previously unselected package packages-microsoft-prod.
(Reading database ... 57953 files and directories currently installed.)
Preparing to unpack packages-microsoft-prod.deb ...
Unpacking packages-microsoft-prod (1.0-ubuntu20.04.1) ...
Setting up packages-microsoft-prod (1.0-ubuntu20.04.1) ...
razumovsky_r@mango-qa-vm:~$ rm packages-microsoft-prod.deb
razumovsky_r@mango-qa-vm:~$
```

Figure 3. Virtual machine preparation..

Apply the following commands in order to install the SDK

- `sudo apt-get update`
- `sudo apt-get install -y apt-transport-https`
- `sudo apt-get update`
- `sudo apt-get install -y dotnet-sdk-6.0`

The terminal output after .NET 6.0 SDK installation is as follows

```

razumovsky_r@mango-qa-vm:~$ sudo apt-get update
Hit:1 http://azure.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://azure.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:3 http://azure.archive.ubuntu.com/ubuntu focal-backports InRelease [108 kB]
Get:4 http://azure.archive.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Get:5 https://packages.microsoft.com/ubuntu/20.04/prod focal InRelease [10.5 kB]
Get:6 http://azure.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [1810 kB]
Get:7 http://azure.archive.ubuntu.com/ubuntu focal-updates/main Translation-en [333 kB]
Get:8 http://azure.archive.ubuntu.com/ubuntu focal-updates/restricted amd64 Packages [994 kB]
Get:9 http://azure.archive.ubuntu.com/ubuntu focal-updates/restricted Translation-en [141 kB]
Get:10 http://azure.archive.ubuntu.com/ubuntu focal-security/main amd64 Packages [1467 kB]
Get:11 http://azure.archive.ubuntu.com/ubuntu focal-security/main Translation-en [252 kB]
Get:12 http://azure.archive.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [930 kB]
Get:13 http://azure.archive.ubuntu.com/ubuntu focal-security/restricted Translation-en [132 kB]
Get:14 https://packages.microsoft.com/ubuntu/20.04/prod focal/main arm64 Packages [26.8 kB]
Get:15 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 Packages [161 kB]
Get:16 https://packages.microsoft.com/ubuntu/20.04/prod focal/main armhf Packages [21.7 kB]
Fetched 6614 kB in 2s (3659 kB/s)
Reading package lists... Done
razumovsky_r@mango-qa-vm:~$ sudo apt-get install -y apt-transport-https
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  apt-transport-https
0 upgraded, 1 newly installed, 0 to remove and 31 not upgraded.
Need to get 1704 B of archives.
After this operation, 162 kB of additional disk space will be used.
Get:1 http://azure.archive.ubuntu.com/ubuntu focal-updates/universe amd64 apt-transport-https all 2.0.8 [1704 B]
Fetched 1704 B in 0s (56.4 kB/s)
Selecting previously unselected package apt-transport-https.
(Reading database ... 57961 files and directories currently installed.)
Preparing to unpack .../apt-transport-https_2.0.8_all.deb ...
Unpacking apt-transport-https (2.0.8) ...
Setting up apt-transport-https (2.0.8) ...
razumovsky_r@mango-qa-vm:~$ sudo apt-get update
Hit:1 http://azure.archive.ubuntu.com/ubuntu focal InRelease
Hit:2 http://azure.archive.ubuntu.com/ubuntu focal-updates InRelease
Hit:3 http://azure.archive.ubuntu.com/ubuntu focal-backports InRelease
Hit:4 http://azure.archive.ubuntu.com/ubuntu focal-security InRelease
Hit:5 https://packages.microsoft.com/ubuntu/20.04/prod focal InRelease
Reading package lists... Done

```

Figure 4. Ubuntu 20.04 install .NET 6.0 SDK terminal output.

```

razumovsky_r@mango-qa-vm:~$ sudo apt-get install -y dotnet-sdk-6.0
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  aspnetcore-runtime-6.0 aspnetcore-targeting-pack-6.0 dotnet-apphost-pack-6.0 dotnet-host dotnet-hostfxr-6.0 dotnet-runtime-6.0 dotnet-runtime-deps-6.0
  dotnet-targeting-pack-6.0 netstandard-targeting-pack-2.1
The following NEW packages will be installed:
  aspnetcore-runtime-6.0 aspnetcore-targeting-pack-6.0 dotnet-apphost-pack-6.0 dotnet-host dotnet-hostfxr-6.0 dotnet-runtime-6.0 dotnet-runtime-deps-6.0 dotnet-sdk-6.0
  dotnet-targeting-pack-6.0 netstandard-targeting-pack-2.1
0 upgraded, 10 newly installed, 0 to remove and 31 not upgraded.
Need to get 123 MB of archives.
After this operation, 501 MB of additional disk space will be used.
Get:1 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-host amd64 6.0.5-1 [55.7 kB]
Get:2 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-hostfxr-6.0 amd64 6.0.5-1 [142 kB]
Get:3 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-runtime-deps-6.0 amd64 6.0.5-1 [2806 B]
Get:4 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-runtime-6.0 amd64 6.0.5-1 [22.6 MB]
Get:5 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 aspnetcore-runtime-6.0 amd64 6.0.5-1 [6604 kB]
Get:6 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-targeting-pack-6.0 amd64 6.0.5-1 [2125 kB]
Get:7 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 aspnetcore-targeting-pack-6.0 amd64 6.0.5-1 [1307 kB]
Get:8 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-apphost-pack-6.0 amd64 6.0.5-1 [3509 kB]
Get:9 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 netstandard-targeting-pack-2.1 amd64 2.1.0-1 [1476 kB]
Get:10 https://packages.microsoft.com/ubuntu/20.04/prod focal/main amd64 dotnet-sdk-6.0 amd64 6.0.300-1 [84.9 MB]
Fetched 123 MB in 4s (31.9 MB/s)
Selecting previously unselected package dotnet-host.
(Reading database ... 57965 files and directories currently installed.)
Preparing to unpack .../0-dotnet-host-6.0.5-1_amd64.deb ...
Unpacking dotnet-host (6.0.5-1) ...
Selecting previously unselected package dotnet-hostfxr-6.0.
Preparing to unpack .../1-dotnet-hostfxr-6.0.5-1_amd64.deb ...
Unpacking dotnet-hostfxr-6.0 (6.0.5-1) ...
Selecting previously unselected package dotnet-runtime-deps-6.0.
Preparing to unpack .../2-dotnet-runtime-deps-6.0.5-1_amd64.deb ...
Unpacking dotnet-runtime-deps-6.0 (6.0.5-1) ...
Selecting previously unselected package dotnet-runtime-6.0.
Preparing to unpack .../3-dotnet-runtime-6.0.5-1_amd64.deb ...
Unpacking dotnet-runtime-6.0 (6.0.5-1) ...
Selecting previously unselected package aspnetcore-runtime-6.0.
Preparing to unpack .../4-aspnetcore-runtime-6.0.5-1_amd64.deb ...
Unpacking aspnetcore-runtime-6.0 (6.0.5-1) ...
Selecting previously unselected package dotnet-targeting-pack-6.0.
Preparing to unpack .../5-dotnet-targeting-pack-6.0.5-1_amd64.deb ...
Unpacking dotnet-targeting-pack-6.0 (6.0.5-1) ...
Selecting previously unselected package aspnetcore-targeting-pack-6.0.
Preparing to unpack .../6-aspnetcore-targeting-pack-6.0.5-1_amd64.deb ...
Unpacking aspnetcore-targeting-pack-6.0 (6.0.5-1) ...
Selecting previously unselected package dotnet-apphost-pack-6.0.
Preparing to unpack .../7-dotnet-apphost-pack-6.0.5-1_amd64.deb ...
Unpacking dotnet-apphost-pack-6.0 (6.0.5-1) ...
Selecting previously unselected package netstandard-targeting-pack-2.1.

```

Figure 5. Ubuntu 20.04 install .NET 6.0 SDK terminal output.

```

Selecting previously unselected package netstandard-targeting-pack-2.1.
Preparing to unpack .../8-netstandard-targeting-pack-2.1.2.1.0-1_amd64.deb ...
Unpacking netstandard-targeting-pack-2.1 (2.1.0-1) ...
Selecting previously unselected package dotnet-sdk-6.0.
Preparing to unpack .../9-dotnet-sdk-6.0.300-1_amd64.deb ...
Unpacking dotnet-sdk-6.0 (6.0.300-1) ...
Setting up dotnet-host (6.0.5-1) ...
Setting up dotnet-apphost-pack-6.0 (6.0.5-1) ...
Setting up netstandard-targeting-pack-2.1 (2.1.0-1) ...
Setting up dotnet-targeting-pack-6.0 (6.0.5-1) ...
Setting up dotnet-runtime-deps-6.0 (6.0.5-1) ...
Setting up aspnetcore-targeting-pack-6.0 (6.0.5-1) ...
Setting up dotnet-hostfxr-6.0 (6.0.5-1) ...
Setting up dotnet-runtime-6.0 (6.0.5-1) ...
Setting up aspnetcore-runtime-6.0 (6.0.5-1) ...
Setting up dotnet-sdk-6.0 (6.0.300-1) ...
This software may collect information about you and your use of the software, and send that to Microsoft.
Please visit http://aka.ms/dotnet-cli-eula for more information.
Welcome to .NET!
-----
Learn more about .NET: https://aka.ms/dotnet-docs
Use 'dotnet --help' to see available commands or visit: https://aka.ms/dotnet-cli-docs

Telemetry
-----
The .NET tools collect usage data in order to help us improve your experience. It is collected by Microsoft and shared with the community. You can opt-out of telemetry by setting
the DOTNET_CLI_TELEMETRY_OPTOUT environment variable to '1' or 'true' using your favorite shell.

Read more about .NET CLI Tools telemetry: https://aka.ms/dotnet-cli-telemetry

Configuring...
-----
A command is running to populate your local package cache to improve restore speed and enable offline access. This command takes up to one minute to complete and only runs once.
Processing triggers for man-db (2.9.1-1) ...

```

**Figure 6.** Ubuntu 20.04 install .NET 6.0 SDK terminal output.

In order to install the .NET Runtime we refer again to the Microsoft documentation, that is

## Install the runtime

The ASP.NET Core Runtime allows you to run apps that were made with .NET that didn't provide the runtime. The following commands install the ASP.NET Core Runtime, which is the most compatible runtime for .NET. In your terminal, run the following commands:

Bash

Copy

```

sudo apt-get update; \
  sudo apt-get install -y apt-transport-https && \
  sudo apt-get update && \
  sudo apt-get install -y aspnetcore-runtime-6.0

```

### Important

If you receive an error message similar to **Unable to locate package aspnetcore-runtime-6.0**, see the **APT troubleshooting** section.

As an alternative to the ASP.NET Core Runtime, you can install the .NET Runtime, which doesn't include ASP.NET Core support: replace `aspnetcore-runtime-6.0` in the previous command with `dotnet-runtime-6.0`:

Bash

Copy

```

sudo apt-get install -y dotnet-runtime-6.0

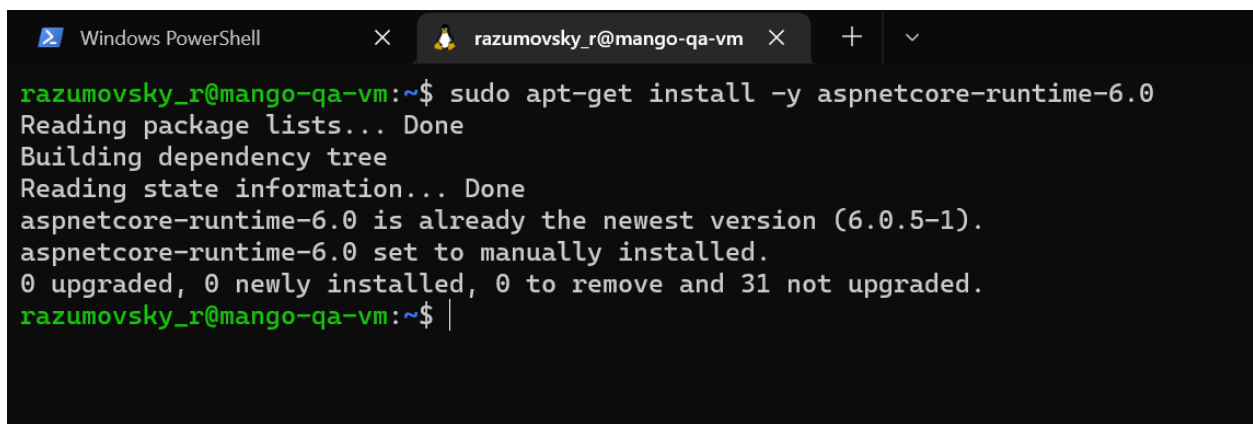
```

**Figure 7.** Install the .NET SDK or the .NET Runtime on Ubuntu MSDN.

We install .NET runtime using the commands

- `sudo apt-get update`
- `sudo apt-get install -y apt-transport-https`
- `sudo apt-get update`
- `sudo apt-get install -y aspnetcore-runtime-6.0`

Terminal output as follows

A screenshot of a terminal window titled 'razumovsky\_r@mango-qa-vm'. The terminal shows the command 'sudo apt-get install -y aspnetcore-runtime-6.0' being executed. The output indicates that the package is already installed at the latest version (6.0.5-1) and is set to manually installed. The terminal text is as follows:

```
razumovsky_r@mango-qa-vm:~$ sudo apt-get install -y aspnetcore-runtime-6.0
Reading package lists... Done
Building dependency tree
Reading state information... Done
aspnetcore-runtime-6.0 is already the newest version (6.0.5-1).
aspnetcore-runtime-6.0 set to manually installed.
0 upgraded, 0 newly installed, 0 to remove and 31 not upgraded.
razumovsky_r@mango-qa-vm:~$ |
```

**Figure 8.** Ubuntu 20.04 install .NET 6.0 Runtime terminal output.

#### 4. COPY BUILD FILES TO THE VM VIA SSH

Now we have to build our .NET Core Web Application to the specified folder, say /mango-linux-build/src. Note that it is much better to build it on behalf of Windows 10 main machine, not WSL 2.0 one. We use the following commands to build .NET Core Web App with Release configuration

- `cd E:/RiderProjects/MangoMessengerAPI/MangoAPI.Presentation`
- `dotnet publish "MangoAPI.Presentation.csproj" -r linux-x64 -o /mango-linux-build/src`

Terminal output is as follows

```

razumovsky_r@mango-qa-vm: x Windows PowerShell x + v
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/powershell

PS C:\Users\pkolosov> cd E:\RiderProjects\MangoMessengerAPI\MangoAPI.Presentation
PS E:\RiderProjects\MangoMessengerAPI\MangoAPI.Presentation> dotnet publish "MangoAPI.Presentation.csproj" -r linux-x64 -o /mango-linux-build/src
Microsoft (R) Build Engine version 17.1.1+a02f73656 for .NET
Copyright (C) Microsoft Corporation. All rights reserved.

Determining projects to restore...
  Restored E:\RiderProjects\MangoMessengerAPI\MangoAPI.Application\MangoAPI.Application.csproj (in 277 ms).
  Restored E:\RiderProjects\MangoMessengerAPI\MangoAPI.Domain\MangoAPI.Domain.csproj (in 277 ms).
  Restored E:\RiderProjects\MangoMessengerAPI\MangoAPI.DataAccess\MangoAPI.DataAccess.csproj (in 278 ms).
  Restored E:\RiderProjects\MangoMessengerAPI\MangoAPI.BusinessLogic\MangoAPI.BusinessLogic.csproj (in 9.85 sec).
  Restored E:\RiderProjects\MangoMessengerAPI\MangoAPI.Presentation\MangoAPI.Presentation.csproj (in 9.9 sec).
C:\Program Files\dotnet\sdks\6.0.203\Sdks\Microsoft.NET.Sdk\targets\Microsoft.NET.Sdk.targets(1110,5): warning NETSDK1179: One of '--self-contained' or '--no-self-contained' option
s are required when '--runtime' is used. [E:\RiderProjects\MangoMessengerAPI\MangoAPI.Presentation\MangoAPI.Presentation.csproj]
C:\Program Files\dotnet\sdks\6.0.203\Sdks\Microsoft.NET.Sdk\targets\Microsoft.NET.Sdk.targets(1110,5): warning NETSDK1179: One of '--self-contained' or '--no-self-contained' option
s are required when '--runtime' is used. [E:\RiderProjects\MangoMessengerAPI\MangoAPI.DataAccess\MangoAPI.DataAccess.csproj]
C:\Program Files\dotnet\sdks\6.0.203\Sdks\Microsoft.NET.Sdk\targets\Microsoft.NET.Sdk.targets(1110,5): warning NETSDK1179: One of '--self-contained' or '--no-self-contained' option
s are required when '--runtime' is used. [E:\RiderProjects\MangoMessengerAPI\MangoAPI.BusinessLogic\MangoAPI.BusinessLogic.csproj]
C:\Program Files\dotnet\sdks\6.0.203\Sdks\Microsoft.NET.Sdk\targets\Microsoft.NET.Sdk.targets(1110,5): warning NETSDK1179: One of '--self-contained' or '--no-self-contained' option
s are required when '--runtime' is used. [E:\RiderProjects\MangoMessengerAPI\MangoAPI.Domain\MangoAPI.Domain.csproj]
MangoAPI.Domain -> E:\RiderProjects\MangoMessengerAPI\MangoAPI.Domain\bin\Debug\net6.0\MangoAPI.Domain.dll
MangoAPI.Application -> E:\RiderProjects\MangoMessengerAPI\MangoAPI.Application\bin\Debug\net6.0\MangoAPI.Application.dll
MangoAPI.DataAccess -> E:\RiderProjects\MangoMessengerAPI\MangoAPI.DataAccess\bin\Debug\net6.0\MangoAPI.DataAccess.dll
MangoAPI.BusinessLogic -> E:\RiderProjects\MangoMessengerAPI\MangoAPI.BusinessLogic\bin\Debug\net6.0\MangoAPI.BusinessLogic.dll
MangoAPI.Presentation -> E:\MangoLinux-build\src\
PS E:\RiderProjects\MangoMessengerAPI\MangoAPI.Presentation>

```

**Figure 9.** Publish .NET Web app terminal output.

Let's create the folder mango-backend where build files to be stored. Do not forget to connect to your Azure VM via SSH. Do not also forget to assign read-write privileges to the folder, using the commands

- `sudo mkdir /mango-backend`
- `sudo chmod a+rwX /mango-backend`

Terminal output:

```

Windows PowerShell x x x
razumovsky_r@mango-qa-vm x + v
razumovsky_r@mango-qa-vm:~$ sudo mkdir ~/mango-backend
razumovsky_r@mango-qa-vm:~$ ls -l
total 4
drwxr-xr-x 2 root root 4096 May 24 18:07 mango-backend
razumovsky_r@mango-qa-vm:~$ sudo chmod a+rwX mango-backend
razumovsky_r@mango-qa-vm:~$

```

**Figure 10.** Create folder at remote VM.

As next step consider to copy build files to the remote folder on your Azure VM so that we execute our program after. We copy the build files on behalf of WSL2 this time. In order to copy the build files we use following commands

- `cd /mnt/e/mango-linux-build`



```
• scp -r -i ~/.ssh/id_rsa ./src/*
razumovsky_r@VM_IP_ADDRESS:/home/razumovsky_r/mango-backend
```

where id\_rsa is the private key. Terminal output:

```

pokolosov@DESKTOP-NDC7K7C:~$ cd /mnt/e/mango-linux-build
pokolosov@DESKTOP-NDC7K7C:~/mnt/e/mango-linux-build$ scp -r -i ~/.ssh/id_rsa ./src/* razumovsky_r@20.185.240.255:/home/razumovsky_r/mango-backend
AutoMapper.Extensions.Microsoft.DependencyInjection.dll 100% 13KB 42.3KB/s 00:00
AutoMapper.dll 100% 248KB 401.9KB/s 00:00
Azure.Core.dll 100% 245KB 863.3KB/s 00:00
Azure.Storage.Blobs.dll 100% 1035KB 2.2MB/s 00:00
Azure.Storage.Common.dll 100% 85KB 520.2KB/s 00:00
FluentValidation.DependencyInjectionExtensions.dll 100% 16KB 102.0KB/s 00:00
FluentValidation.dll 100% 433KB 1.1MB/s 00:00
Humanizer.dll 100% 334KB 1.5MB/s 00:00
MangoAPI.Application.dll 100% 24KB 138.7KB/s 00:00
MangoAPI.Application.pdb 100% 19KB 120.5KB/s 00:00
MangoAPI.BusinessLogic.dll 100% 274KB 1.1MB/s 00:00
MangoAPI.BusinessLogic.pdb 100% 72KB 308.0KB/s 00:00
MangoAPI.DataAccess.dll 100% 197KB 1.1MB/s 00:00
MangoAPI.DataAccess.pdb 100% 26KB 157.6KB/s 00:00
MangoAPI.Domain.dll 100% 29KB 166.9KB/s 00:00
MangoAPI.Domain.pdb 100% 17KB 109.0KB/s 00:00
MangoAPI.Presentation 100% 139KB 734.3KB/s 00:00
MangoAPI.Presentation.deps.json 100% 199KB 1.1MB/s 00:00
MangoAPI.Presentation.dll 100% 89KB 504.0KB/s 00:00
MangoAPI.Presentation.pdb 100% 40KB 202.7KB/s 00:00
MangoAPI.Presentation.runtimeconfig.json 100% 42B 2.0KB/s 00:00
MediatR.Contracts.dll 100% 665B 41.3KB/s 00:00
MediatR.Extensions.Microsoft.DependencyInjection.dll 100% 18KB 115.9KB/s 00:00
MediatR.dll 100% 47KB 296.6KB/s 00:00
Microsoft.AI.DependencyCollector.dll 100% 128KB 500.1KB/s 00:00
Microsoft.AI.EventCounterCollector.dll 100% 41KB 209.6KB/s 00:00
Microsoft.AI.PerfCounterCollector.dll 100% 209KB 920.5KB/s 00:00
Microsoft.AI.ServerTelemetryChannel.dll 100% 116KB 688.1KB/s 00:00
Microsoft.AI.WindowsServer.dll 100% 68KB 421.4KB/s 00:00
Microsoft.ApplicationInsights.AspNetCore.dll 100% 100KB 606.5KB/s 00:00
Microsoft.ApplicationInsights.dll 100% 37KB 1.7MB/s 00:00
Microsoft.AspNetCore.Antiforgery.dll 100% 100KB 635.2KB/s 00:00
Microsoft.AspNetCore.Authentication.Abstractions.dll 100% 53KB 335.7KB/s 00:00
Microsoft.AspNetCore.Authentication.Cookies.dll 100% 105KB 563.2KB/s 00:00
Microsoft.AspNetCore.Authentication.Core.dll 100% 80KB 389.7KB/s 00:00
Microsoft.AspNetCore.Authentication.JwtBearer.dll 100% 40KB 250.6KB/s 00:00
Microsoft.AspNetCore.Authentication.OAuth.dll 100% 95KB 468.3KB/s 00:00
Microsoft.AspNetCore.Authentication.dll 100% 144KB 695.8KB/s 00:00
Microsoft.AspNetCore.Authorization.Policy.dll 100% 57KB 366.4KB/s 00:00
Microsoft.AspNetCore.Authorization.dll 100% 86KB 509.2KB/s 00:00
Microsoft.AspNetCore.Components.Authorization.dll 100% 46KB 206.4KB/s 00:00
Microsoft.AspNetCore.Components.Forms.dll 100% 61KB 396.5KB/s 00:00
Microsoft.AspNetCore.Components.Server.dll 100% 715KB 1.7MB/s 00:00
Microsoft.AspNetCore.Components.Web.dll 100% 286KB 1.4MB/s 00:00
Microsoft.AspNetCore.Components.dll 100% 544KB 1.7MB/s 00:00
Microsoft.AspNetCore.Connections.Abstractions.dll 100% 64KB 312.0KB/s 00:00
Microsoft.AspNetCore.CookiePolicy.dll 100% 48KB 300.7KB/s 00:00
Microsoft.AspNetCore.Cors.dll 100% 79KB 464.6KB/s 00:00

```

Figure 11. Copy build files via SSH.

Ensure build files are copied successfully to the remote VM, use the command `ls -l mango-backend/`. Terminal output:

```

razumovsky_r@mango-qa-vm:~$ ls -l mango-backend/
total 109356
-rwxrwxr-x 1 razumovsky_r razumovsky_r 13312 May 24 18:26 AutoMapper.Extensions.Microsoft.DependencyInjection.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 253440 May 24 18:26 AutoMapper.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 251304 May 24 18:26 Azure.Core.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 1060240 May 24 18:26 Azure.Storage.Blobs.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 87440 May 24 18:26 Azure.Storage.Common.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 15872 May 24 18:26 FluentValidation.DependencyInjectionExtensions.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 442880 May 24 18:26 FluentValidation.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 342120 May 24 18:26 Humanizer.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 24064 May 24 18:26 MangoAPI.Application.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 19104 May 24 18:26 MangoAPI.Application.pdb
-rwxrwxr-x 1 razumovsky_r razumovsky_r 280576 May 24 18:26 MangoAPI.BusinessLogic.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 73596 May 24 18:26 MangoAPI.BusinessLogic.pdb
-rwxrwxr-x 1 razumovsky_r razumovsky_r 201728 May 24 18:26 MangoAPI.DataAccess.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 27072 May 24 18:26 MangoAPI.DataAccess.pdb
-rwxrwxr-x 1 razumovsky_r razumovsky_r 29696 May 24 18:26 MangoAPI.Domain.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 17636 May 24 18:26 MangoAPI.Domain.pdb
-rwxrwxr-x 1 razumovsky_r razumovsky_r 142840 May 24 18:26 MangoAPI.Presentation
-rwxrwxr-x 1 razumovsky_r razumovsky_r 203748 May 24 18:26 MangoAPI.Presentation.deps.json
-rwxrwxr-x 1 razumovsky_r razumovsky_r 90624 May 24 18:26 MangoAPI.Presentation.dll
-rwxrwxr-x 1 razumovsky_r razumovsky_r 40580 May 24 18:26 MangoAPI.Presentation.pdb

```

Figure 12. Check files at remote VM.

## 5. CONFIGURE UBUNTU SERVICE

In this section the main aim is to implement an Ubuntu service such that runs our previously built .NET Core web application. It means that we have to configure the environment variables used in our application as well as to configure the firewall rules so that application will be able to communicate with another resources like databases, blobs etc. Ubuntu server refers to the entry point of the web app, that is

```
/home/razumovsky_r/mango-backend/MangoAPI.Presentation
```

Use the command to create service

```
sudo vim /etc/systemd/system/mangoback.service
```

Paste the following text there

[Unit]

```
Description=Mango Messenger Backend Service for Azure Dev Environment
After=network.target
```

[Service]

```
Environment=ASPNETCORE_URLS=http://+:8080/
Environment=MANGO_JW_ISSUER="https://front.mangomessenger.company"
Environment=MANGO_JWT_AUDIENCE="https://back.mangomessenger.company"
Environment=MANGO_JWT_SIGN_KEY="d32d7cea-4cb8-4488-aa94-323ffb8cbdf4"
Environment=MANGO_EMAIL_NOTIFICATIONS_ADDRESS="mango@gmail.com"
Environment=MANGO_FRONTEND_ADDRESS="https://front.mangomessenger.company/"
Environment=MANGO_DATABASE_URL="database.connection.string"
Environment=MANGO_SEED_PASSWORD="seedPass"
Environment=MANGO_BLOB_URL="blob.url.connection.string"
Environment=MANGO_BLOB_CONTAINER="container.name"
Environment=MANGO_BLOB_ACCESS="blob.access.url"
Environment=MANGO_MAILGUN_API_KEY="mailgun.api.key"
Environment=MANGO_MAILGUN_API_BASE_URL="https://api.mailgun.net"
Environment=MANGO_MAILGUN_API_BASE_DOMAIN="back.mangomessenger.company"
Environment=MANGO_BACKEND_ADDRESS="https://back.mangomessenger.company/"
Type=simple
WorkingDirectory=/home/razumovsky_r/mango-backend
ExecStart=/home/razumovsky_r/mango-backend/MangoAPI.Presentation
User=razumovsky_r
Group=razumovsky_r
```

[Install]

WantedBy=multi-user.target

From the vim it should look as follows

```
[Unit]
Description=Mango Messenger Backend Service for Azure Dev Environment
After=network.target

[Service]
Environment=ASPNETCORE_URLS=http://*:8080/
Environment=MANGO_JWT_ISSUER=https://front.mangomesenger.company"
Environment=MANGO_JWT_AUDIENCE=https://back.mangomesenger.company"
Environment=MANGO_JWT_SIGN_KEY="[REDACTED]"
Environment=MANGO_EMAIL_NOTIFICATIONS_ADDRESS="mango.messenger.notify@gmail.com"
Environment=MANGO_FRONTEND_ADDRESS=https://front.mangomesenger.company/"
Environment=MANGO_DATABASE_URL="[REDACTED]"
Environment=MANGO_SEED_PASSWORD="[REDACTED]"
Environment=MANGO_BLOB_URL="[REDACTED]"
Environment=MANGO_BLOB_CONTAINER=mangodevqastoragecontainer"
Environment=MANGO_MAILGUN_API_KEY="[REDACTED]"
Environment=MANGO_MAILGUN_API_BASE_URL="https://api.mailgun.net"
Environment=MANGO_MAILGUN_API_BASE_DOMAIN=back.mangomesenger.company"
Environment=MANGO_BACKEND_ADDRESS=https://back.mangomesenger.company/"
Type=simple
WorkingDirectory=/home/razumovsky_r/mango-backend
ExecStart=/home/razumovsky_r/mango-backend/MangoAPI.Presentation
User=razumovsky_r
Group=razumovsky_r

[Install]
WantedBy=multi-user.target
```

**Figure 13.** Ubuntu service opened in vim.

Make sure all resources are listening from the outside, check firewall rules on database side prior to run the service. Start and check health of the service using

- `sudo systemctl start mangoback`
- `sudo systemctl status mangoback`

Terminal output:

```
razumovsky_r@mango-qa-vm:~/mango-backend$ sudo systemctl status mangoback
● mangoback.service - Mango Backend Service for Azure Dev Environment
   Loaded: loaded (/etc/systemd/system/mangoback.service; disabled; vendor preset: enabled)
   Active: active (running) since Tue 2022-05-24 20:57:05 UTC; 13s ago
 Main PID: 24932 (MangoAPI.Presen)
    Tasks: 16 (limit: 2289)
   Memory: 55.3M
   CGroup: /system.slice/mangoback.service
           └─24932 /home/razumovsky_r/mango-backend/MangoAPI.Presentation

May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: dbug: 05/24/2022 20:57:09.455 CoreEventId.ContextDisposed[10407] (Microsoft.EntityFrameworkCore.Infrastructure)
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Microsoft.PostgresDbContext' disposed.
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Microsoft.Hosting.Lifetime[14]
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Now listening on: http://[::]:8080
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Microsoft.Hosting.Lifetime[0]
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Application started. Press Ctrl+C to shut down.
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Microsoft.Hosting.Lifetime[0]
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Hosting environment: Production
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Microsoft.Hosting.Lifetime[0]
May 24 20:57:09 mango-qa-vm MangoAPI.Presentation[24932]: info: Content root path: /home/razumovsky_r/mango-backend
razumovsky_r@mango-qa-vm:~/mango-backend$
```

**Figure 14.** Run ubuntu service and check status, terminal output.

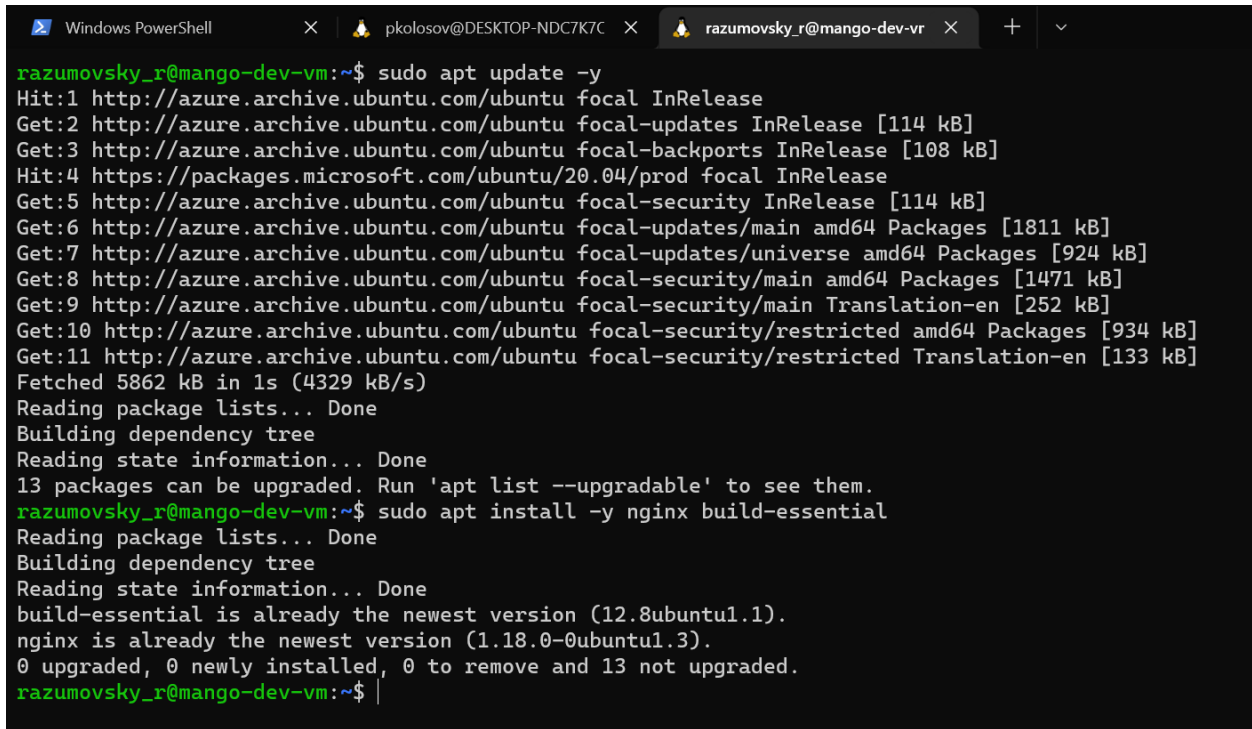
This completes the section.

## 6. INSTALL AND CONFIGURE NGINX SERVER

Now we have to configure the **nginx** server in order to expose our .NET Core web application to the outside. As a result of this section web app will be exposed and accessible via VM's external IP address. Let's install it using the commands

- `sudo apt update -y`
- `sudo apt install -y nginx build-essential`

Terminal output:

A screenshot of a Windows PowerShell terminal window with three tabs. The active tab is titled 'razumovsky\_r@mango-dev-vr'. The terminal shows the output of two commands. The first command, 'sudo apt update -y', updates the package lists and reports that 13 packages can be upgraded. The second command, 'sudo apt install -y nginx build-essential', shows that both 'nginx' and 'build-essential' are already the newest versions installed on the system.

```
razumovsky_r@mango-dev-vm:~$ sudo apt update -y
Hit:1 http://azure.archive.ubuntu.com/ubuntu focal InRelease
Get:2 http://azure.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:3 http://azure.archive.ubuntu.com/ubuntu focal-backports InRelease [108 kB]
Hit:4 https://packages.microsoft.com/ubuntu/20.04/prod focal InRelease
Get:5 http://azure.archive.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Get:6 http://azure.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [1811 kB]
Get:7 http://azure.archive.ubuntu.com/ubuntu focal-updates/universe amd64 Packages [924 kB]
Get:8 http://azure.archive.ubuntu.com/ubuntu focal-security/main amd64 Packages [1471 kB]
Get:9 http://azure.archive.ubuntu.com/ubuntu focal-security/main Translation-en [252 kB]
Get:10 http://azure.archive.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [934 kB]
Get:11 http://azure.archive.ubuntu.com/ubuntu focal-security/restricted Translation-en [133 kB]
Fetched 5862 kB in 1s (4329 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
13 packages can be upgraded. Run 'apt list --upgradable' to see them.
razumovsky_r@mango-dev-vm:~$ sudo apt install -y nginx build-essential
Reading package lists... Done
Building dependency tree
Reading state information... Done
build-essential is already the newest version (12.8ubuntu1.1).
nginx is already the newest version (1.18.0-0ubuntu1.3).
0 upgraded, 0 newly installed, 0 to remove and 13 not upgraded.
razumovsky_r@mango-dev-vm:~$
```

Figure 15. Ubuntu install nginx terminal output.

Next, it is necessary to create nginx configuration that exposes our application, that is

```
server {
    server_name STATIC_IP_ADDRESS_OF_VM;

    location / {
        include proxy_params;
        proxy_pass http://127.0.0.1:8080;
    }

    location /swagger {
        include proxy_params;
        proxy_pass http://127.0.0.1:8080;
    }

    location /api {
        include proxy_params;
```

```
    proxy_pass http://127.0.0.1:8080;
}

location /notify {
    proxy_pass http://127.0.0.1:8080;
    proxy_http_version 1.1;
    proxy_set_header Upgrade $http_upgrade;
    proxy_set_header Connection "upgrade";
    proxy_set_header Host $host;
    proxy_cache_bypass $http_upgrade;
}
}
```

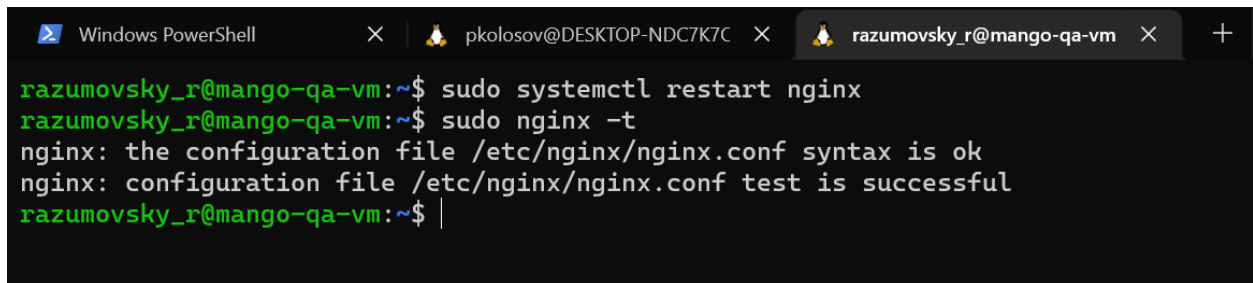
We create it at the following path on behalf of our Azure VM via SSH

```
sudo vim /etc/nginx/conf.d/back.mangomesenger.company.conf
```

Restart nginx and validate its state using the commands

- `sudo systemctl restart nginx`
- `sudo nginx -t`

Terminal output:

A screenshot of a terminal window with three tabs: 'Windows PowerShell', 'pkolosov@DESKTOP-NDC7K7C', and 'razumovsky\_r@mango-qa-vm'. The active tab is the third one. The terminal shows the following commands and output:

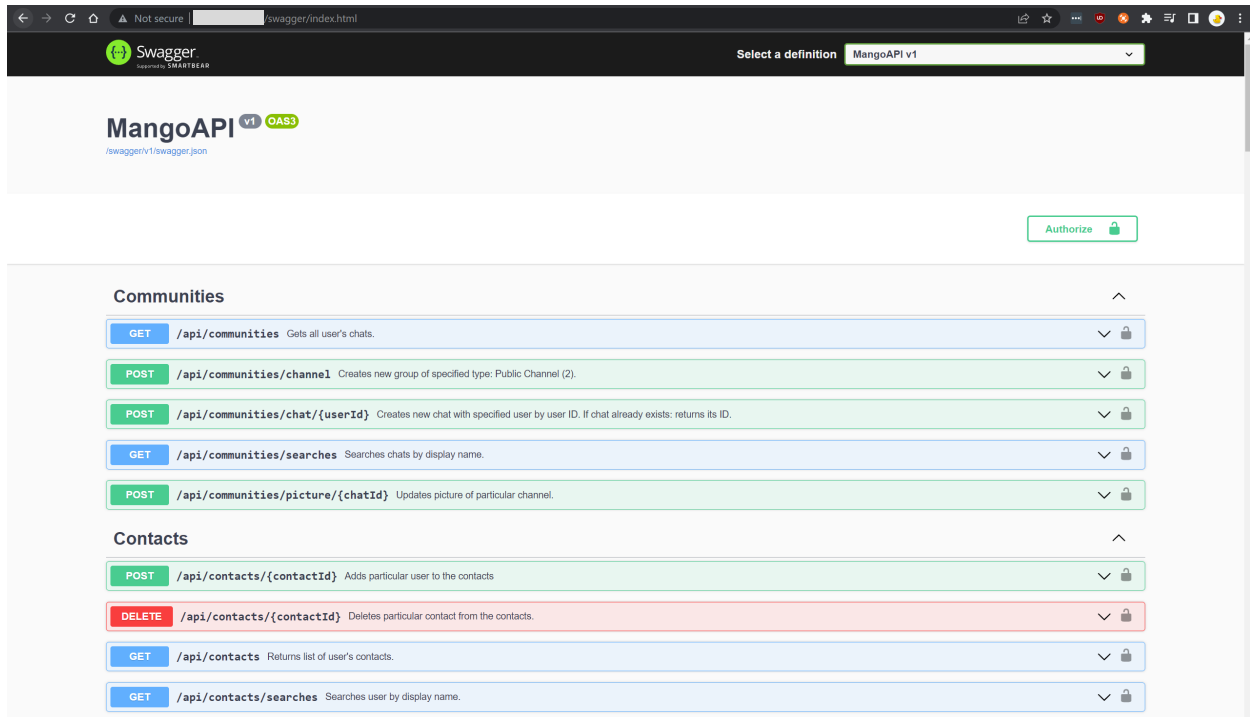
```
razumovsky_r@mango-qa-vm:~$ sudo systemctl restart nginx
razumovsky_r@mango-qa-vm:~$ sudo nginx -t
nginx: the configuration file /etc/nginx/nginx.conf syntax is ok
nginx: configuration file /etc/nginx/nginx.conf test is successful
razumovsky_r@mango-qa-vm:~$ |
```

**Figure 16.** Restart and test nginx terminal output.

Now we must be able to find our application listening to the

```
http://STATIC_IP_ADDRESS_OF_THE_VM
```

And actually it works as expected



**Figure 17.** .NET Core web app accessed via browser using static IP address of the virtual machine.

## 7. CONFIGURE DOMAIN NAME AND SSL

## 8. DEPLOY FRONTEND PROJECT

## 9. CONCLUSIONS

Conclusions of your manuscript.

## REFERENCES

- [Cor22] Microsoft Corporation. "Install the .NET SDK or the .NET Runtime on Ubuntu". published electronically at <https://docs.microsoft.com/en-us/dotnet/core/install/linux-ubuntu>, 2022.
- [Kol22] Petro Kolosov. "VM Creation screens". published electronically at <https://drive.google.com/file/d/1odouQARBd1mV-tV60Tnj5B-bxkl0N40J/view?usp=sharing>, 2022.

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