Docker

Introduction

THIS DOCUMENT COVERS

- Introduction

Why Docker?

Multiple services require difference versions of the OS or different versions of dependencies. With docker each container can have its own dependencies, libraries, processes, networks, and mounts.

The purpose of docker is to package and containerise applications so we can ship them and run them as many times as we need.

Many products are containerised on Dockerhub repository. Such products include OS versions, database versions etc.

All containers share the same OS kernel.

Docker commands

General

	Column Header
Version	docker --version
Pull image from Dockerhub	docker pull <image-name>
Start container from image	docker run <image-name>
List all running containers	docker ps
Stop container	docker stop <contId>
List all containers including stopped	docker ps -a
Delete container	docker rm <container-id>
Image List	docker images
Delete image	docker rmi <image-name>
Map container port to host port	docker run -p <host-port>:<container-port> myapp
Map container directory to host directory	docker run -v <host-dir> <cont-dir>
Inspect running container	docker inspect <image-name>
Execute command on container	

Run

	Column Header
Start a container	docker run hello-world
Start container in background	docker run -d hello-world
Start container with std in/out	docker run -i -t <image>

Port mapping

The following runs a container and maps port 80 on the container to port **4000** on the container host.

```
docker run -d -p 4000:80 --name myapp2 aspnetapp
```

Copy

The following shows how to copy a file from a docker container to the host. 306 is the first few characters of the docker container id.

```
docker cp 306:/var/opt/mssql/data/JsonObjects.bak C:\Users\rps\
```

If we want to copy a file from the host to the container, we simply reverse the process.

```
docker cp C:\Users\rps\JsonObjects.bak 306:/var/opt/mssql/data/
```

Docker logs

We can list the logs for the container using the following command.

```
docker logs <container-id>
```

The following shows a simple example.

```
> docker logs 6ff

> Hosting environment: Production
> Content root path: /app/
> Now listening on: http://[::]:80
> Application started. Press Ctrl+C to shut down.
```

Docker Inspect

We can list the entire information for a container using. This also gives the container IP Address.

```
docker inspect <container-id>
```

Viewing the directory structure of running container

If the container is Linux based, we can execute a shell to log on and see what is happening on a running container.

```
docker exec -i -t 7d bash
```

We now have a shell onto the container.

Dockerize ASP.Net core

We will Dockerize a simple ASP.NET core server to familiarize ourselves with how we can use docker. To start with we setup a super simple end point.

Without Docker

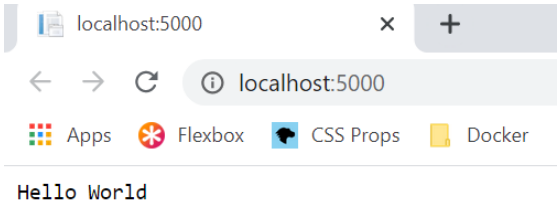
```
public class Program
{
    public static void Main(string[] args)
    {
          string message = args.Length > 0 ? args[0] : "Hello";
          var webHost = new WebHostBuilder()
                .UseKestrel()
                .Configure(app =>
                {
                      app.Run(async ctx =>
                      {
                            await ctx.Response.WriteAsync(message);
                      });
                })
                .Build();

          webHost.Run();
    }
}
```

And a simple `launchSettings.json` as follows.

```
{
  "profiles": {
    "ASPHelloWorld": {
      "commandName": "Project",
      "launchBrowser": true,
      "applicationUrl": "http://localhost:5000",
      "environmentVariables": {
        "ASPNETCORE_ENVIRONMENT": "Development"
      }
    }
  }
}
```

Running this application inside of Visual Studio and connecting to http://localhost:5000 gives the following.



With Docker

Let us now work through step by step the process of creating a docker image that will run our ASP.NET Core application inside a container. We will use some tricks that will enable us to log onto the container and see what has happened at each stage. All the instructions we use are documented here.

https://docs.docker.com/engine/reference/builder/#workdir

CREATE THE DOCKER FILE

FROM

All Dockerfile files must start with a `FROM` instruction. The `FROM` instruction initializes a new build stage and specifies the base image for the instructions that follow it.

> **BASE IMAGE**
>
> An image with no parent image. Its first line will be `FROM scratch`

If we give the FROM instruction an optional `AS` argument, we can assign a name to this build stage which enables us to refer to it from subsequent `FROM` and `COPY` instructions to refer to this stage.

Let us go ahead and set the first line of our Dockerfile. We will specify the .NET sdk as the base image for the first stage and name it `build`.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
```

WORKDIR

The WORKDIR instruction sets the working directory for subsequent RUN, CMD, ENTRYPOINT, COPY and ADD instructions. If it does not exist it will be created. We can call the command multiple times in which case subsequent relative paths are relative to the path of the previous WORKDIR command.

Let us go ahead and set the working directory that we want to work in on the docker container.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
```

After this stage and each subsequent stage we will create an image from the partial Dockerfile up to that point and run it up so we can log onto the container and take a look at what is does.

```
docker build -t  aspdotnetapp .
docker run -d aspdotnetapp sleep 120
docker exec -i -t d bash


>> root@d5c7d231d835:/kennyswebapp#
```

COPY

The COPY instruction copies files and directories from the host container to folders on the container. We now add logic to our Dockerfile to copy over the solution file to the container.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
```

If we do out little test exercise, we expect to see a .sln file on the container in the /kennysapp folder.

```
docker build -t  aspdotnetapp .
docker run -d aspdotnetapp sleep 120
docker exec -i -t be7  bash

>> root@be7bd4d1026c:/kennyswebapp# ls
>> ASPHelloWorld  ASPHelloWorld.sln
```

RUN

Execute a given command into a new layer on top the current image and commit the results. We use run to use NuGet to restore dependencies.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
```

We now use our little test exercise to see the results. Notice the NuGet results in the `APSHelloWorld/obj/` folder.

```
>> root@ff8594c555af:/kennyswebapp# ls ASPHelloWorld/obj/
>> ASPHelloWorld.csproj.nuget.dgspec.json  project.assets.json
>> ASPHelloWorld.csproj.nuget.g.props      project.nuget.cache
>> ASPHelloWorld.csproj.nuget.g.targets
```

COPY (The Source Code)

We now add another copy to copy over the source code from the host to the container.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/
```

Build and publish the app

We now use add lines to build the application and publish the application.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/
WORKDIR /app/ASPHelloWorld
RUN dotnet publish -c Release -o out
```

FROM

FROM creates a new stage and sets a new base image. This time we want the base image to be the .NET runtime rather than the .NET SDK we were using in the previous stage.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/
WORKDIR / kennyswebapp /ASPHelloWorld
RUN dotnet publish -c Release -o out
FROM mcr.microsoft.com/dotnet/aspnet:5.0 AS runtime
WORKDIR /app
```

COPY

We need to access the directories from the previous stage from the new stage so we use a special form of copy.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/
WORKDIR /kennyswebapp/ASPHelloWorld
RUN dotnet publish -c Release -o out
FROM mcr.microsoft.com/dotnet/aspnet:5.0 AS runtime
WORKDIR /mydeploydir
COPY --from=build /kennyswebapp/ASPHelloWorld/out ./
```

Notice how we reference the name we assigned in line 1 using the AS argument. If we run our little test exercise, we should now have a deployed application.

```
>> root@dc5e8b374be2:/mydeploydir# ls
>> ASPHelloWorld            ASPHelloWorld.pdb
>> appsettings.json
>> ASPHelloWorld.deps.json  ASPHelloWorld.runtimeconfig.json  web.config
>> ASPHelloWorld.dll        appsettings.Development.json
```

Start up our application.

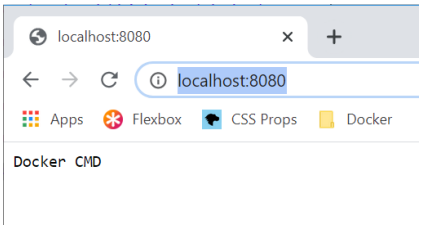
The final two steps start up our application.

```
FROM mcr.microsoft.com/dotnet/sdk:5.0 AS build
WORKDIR /kennyswebapp
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/
WORKDIR /kennyswebapp/ASPHelloWorld
RUN dotnet publish -c Release -o out
FROM mcr.microsoft.com/dotnet/aspnet:5.0 AS runtime
WORKDIR /mydeploydir
COPY --from=build /kennyswebapp/ASPHelloWorld/out ./
ENTRYPOINT ["dotnet", "ASPHelloWorld.dll"]
CMD ["Docker CMD"]
```

If we rebuild the image, we are ready to run it. We need one more thing. the docker image runs in the container on port 80. The launchSettings.json is ignored. For this reason, we map port 80 on the container to port 8080 on the container host so we can access it from localhost.

```
docker run -d -p 8080:80 --name myapp aspnetapp
```

When we connect to our application from a browser, we see the value of the CMD is returned.

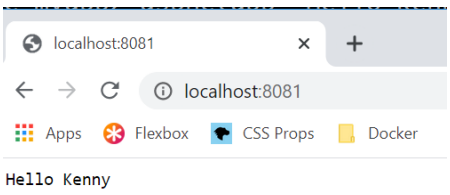


https://stackoverflow.com/questions/48669548/why-does-aspnet-core-start-on-port-80-from-within-docker

Overriding value of CMD

If we want to override the value of CMD we can do this from the command line. We create a second instance on a different port and with a different message.

```
docker run -d -p 8081:80 --name myapp2 aspnetapp "Hello Kenny"
```



Mapping directory from docker container to host.

Now consider the situation where our application logs to the container via Serilog. The configuration is as follows.

Serilog (appsettings.config)

```
"WriteTo": [
  {
    "Name": "File",
    "Args": {
      "path": "/var/tmp/logs/log.txt",
      "rollingInterval": "Day"
    }
  },
  {
    "Name": "Console"
  }
]
```

We create the directory `/var/tmp` in the Dockerfile.

Dockerfile

```
WORKDIR /app
COPY *.sln .
COPY ASPHelloWorld/*.csproj ./ASPHelloWorld/
RUN dotnet restore
COPY ASPHelloWorld/. ./ASPHelloWorld/

WORKDIR /app/ASPHelloWorld
RUN dotnet publish -c Release -o out

FROM mcr.microsoft.com/dotnet/core/aspnet:3.1 AS runtime
WORKDIR /app
RUN mkdir -p /var/tmp/logs
COPY --from=build /app/ASPHelloWorld/out ./

ENTRYPOINT ["dotnet", "ASPHelloWorld.dll"]
CMD ["Docker CMD"]
```

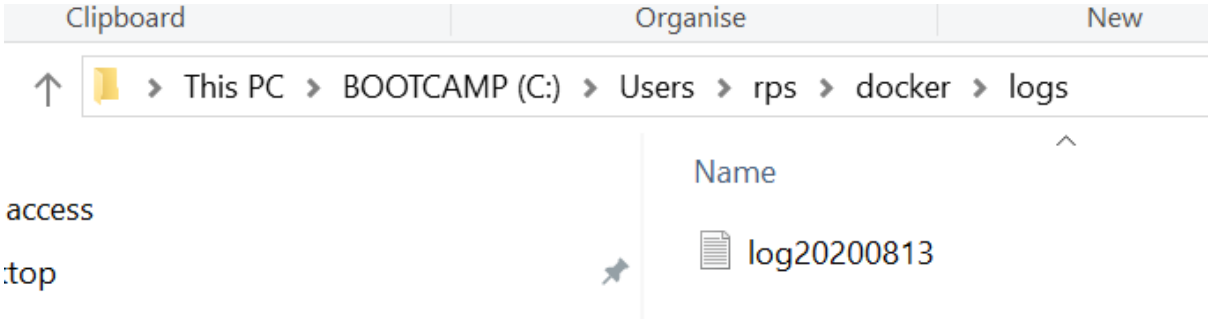
We now build the container.

```
docker build -t aspdotnetapp .
```

Finally, we run the container and map the container log file `/var/tmp/logs` to the folder `C:\Users\rps\docker\logs` on the container host

```
docker run -d -p 8080:80 -v C:\Users\rps\docker\logs:/var/tmp/logs
aspdotnetapp
```

When we attach a browser to the port localhost:8080 we will see the log file shows up in the docker host filesystem in directory **`C:\Users\rps\docker\logs`**



We can also view the mount that maps the directory by running the docker inspect command on the running container

```
Docker inspect 7d
```

And inside the output we see

```
"Mounts": [
    {
        "Type": "bind",
        "Source": "/host_mnt/c/Users/rps/docker/logs",
        "Destination": "/var/tmp/logs",
        "Mode": "",
        "RW": true,
        "Propagation": "rprivate"
    }
],
```

A docker image captures the private filesystem that the that your containerized component will run in. The image contains just what the component needs. The image isolates all the dependencies your component needs.

A Dockerfile describes how to assemble a private filesystem for a container. This file provides step by step instructions on how to build up the image.

Docker Compose

Linking Containers

Consider a simple example where one container runs an instance of MongoDB and other container runs a script that uploads data. The upload container needs to have access to the MongoDB container IP address. The way we do this is with links. Consider the following. The bold pieces link together the containers for mongohost.

docker-compose.yaml

```
version: '3'
services:
    mongohost:
        image: mongo

        ports:
            - 27010:27017
    mongo-load:
        build:
            context: MongoPopulate
            dockerfile: Dockerfile
        links:
            - mongohost
```

MongoPopulate/Dockerfile

```
FROM mongo
COPY myarchive /myarchive
COPY populate.sh /populate.sh
CMD "./populate.sh"
```

MongoPopulate/populate.sh

```
echo "Doing the load"
sleep 10
mongorestore --uri="mongodb://mongohost:27017" --drop --archive=myarchive
--gzip
echo "Finished"
```

Docker Theory

Overview of Docker

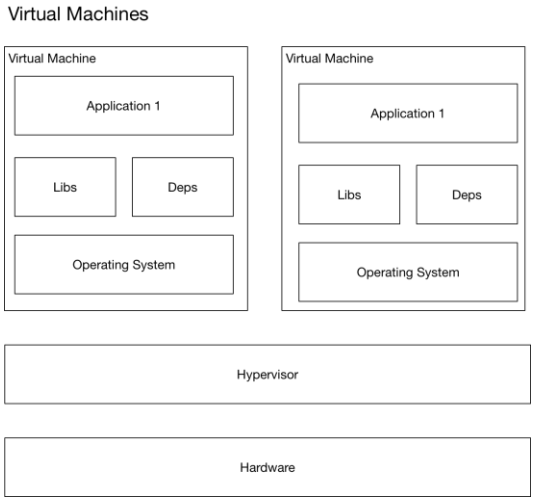
Docker runs on the OS and manages multiple containers. Each container has its own set of libraries and other dependencies. These dependencies are used by the application that runs inside the container.

A docker image is a template that is used to create docker containers. Each container is hence an instance of the image. A container is created using the docker run command. Dockerhub is a public repository of images for applications such as MongoDB and Node.js. We can also create our own images.

A container is a running process with some added features to keep it isolated from the host and from other containers. Each container has its own private filesystem. The filesystem is provided by the docker image.

Docker vs Virtual Machines

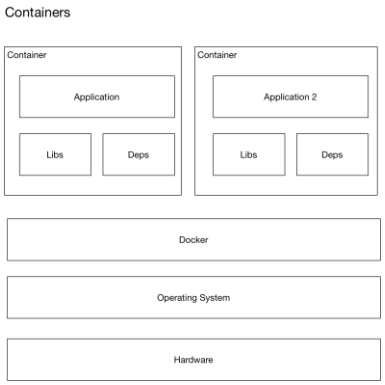
Consider the following diagram that shows how virtualization works.



- Multiple virtual machines running on the same hardware.
- Heavyweight solution
- Each virtual machine has its own operating system.
- Each VM typically requires GB of desk space as it runs whole OS.
- Complete Isolation
- High overhead
- Start-up time can be minutes as OS needs to start.

Risk and Pricing Solutions

Now let us look at Docker.



- Lightweight solution
- Each container typically MB in size
- Starts up in second.
- Docker has less isolation as more resources are shared across containers (kernel)

Docker Run

As mentioned earlier each container is an instance of an image. A container is created using the docker run command.

Tags

If you look up an image on Dockerhub.com you will find all the supported tags for that image. Tags enable us to specify different versions of the image.

```
docker run redis:4.0
```

STDIN/STDOUT

By default, docker containers run in a non-interactive form. They do not listen to stdin. In this form there is no terminal to read input from. To provide input we must map stdin from our host to the docker container.

```
docker run -i <image>
```

If we want a prompt and terminal, we need to add a terminal too.

```
docker run -i -t <image>
```

Port Mapping

Consider we run a simple webapp.

```
docker run kodekloud/webapp
```

If we want to know the IP of a docker container we run the command.

```
docker inspect --format='{{range .NetworkSettings.Networks}}{{.IPAddress}}{{end}}'
$INSTANCE_ID
```

If we want to map a port from our docker container to the docker host, we run the command as follows

```
docker run -p80:5000  kodekloud/webapp
```

RUNNING COMMANDS

Containers are meant to run a specific task or process e.g. to host an instance of a web server or database. Once the task is complete the container exits. The container only lives if the process inside it is alive. Once a web server stops the container exits. We can instruct docker to run a command on our container.

```
docker run ubuntu  sleep 120
```

Now we can execute a command on this ubuntu container while it is running

```
C:\Users\rps>docker exec ce55  cat /etc/hosts
127.0.0.1       localhost
::1     localhost ip6-localhost ip6-loopback
fe00::0 ip6-localnet
ff00::0 ip6-mcastprefix
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
172.17.0.2      ce5539c1b552
```

docker run image:tag	Docker run redis:	Show the version of docker installed

Installation

Docker For Windows

I am installed Docker Community Edition for Windows.

https://hub.docker.com/editions/community/docker-ce-desktop-windows

There are two ways to use Docker on windows. Docker Toolbox is a legacy application, so we only consider Docker desktop for windows.

DOCKER DESKTOP FOR WINDOWS

Docker for windows uses the windows virtualization technology Hyper V. Because of this dependency Docker for Windows requires Windows Professional or Enterprise. The default option is to run Linux underneath. In this configuration all containers are Linux containers.

There is now also an option for Windows Container where each container runs on windows.

Introduction Questions

Why docker?

Multiple services require difference versions of the OS or different versions of dependencies. With docker each container can have its own dependencies, libraries, processes, networks, and mounts.

The purpose of docker is to package and containerise applications so we can ship them and run them as many times as we need.

Many products are containerised on Dockerhub repository. Such products include OS versions, database versions etc.

All containers share the same OS kernel.

What is an image?

A template used to create containers

What are containers?

Running instances of containers that are isolated and have their own processes

How long does a container live?

As long as the process inside it