Managing Multi-Container Applications Using `docker-compose`

`docker-compose` is a utility for defining and managing multi-container applications. It simplifies deployment on SUSE Linux Enterprise Server for NVIDIA by using a centralized `compose.yml` file and the `podman-docker` script to seamlessly translate Docker commands to Podman. This allows administrators to deploy, isolate and manage application stacks efficiently without altering their existing Docker scripts.

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1 Tools involved in management of multi-container applications

docker-compose is the tool responsible for creating the multi-container application. By default, it uses Docker, which is not present on SLE for NVIDIA. To bypass Docker and use Podman instead, the `podman-docker` script is used. Therefore, you do not need to change your existing scripts from using Docker to Podman. The following sections provide detailed descriptions of the tools.

1.1 About Podman

Podman is a short name for Pod Manager Tool. It is a daemonless container engine that enables you to run and deploy applications using containers and container images. Podman provides a command-line interface to manage containers.

As Podman does not have a daemon, it provides integration with systemd. This makes it possible to control containers via systemd units. You can create these units for existing containers as well as generate units that can start containers if they do not exist in the system. Podman can run systemd inside containers.

Podman enables you to organize your containers into pods. Pods share the same network interface and resources. A typical use case for organizing a group of containers into a pod is a container that runs a database and a container with a client that accesses the database.

1.1.1 Installation of Podman

Podman is included in SLE for NVIDIA by default. However, if Podman is missing, you can install it as described below:

1. Run the command:

```
> sudo transactional-update pkg install podman
```

2. Restart your system to boot into the new snapshot.

1.2 About `podman-docker`

`podman-docker` is a bash script that changes any **`docker`** command you run into a corresponding **`podman`** command with the same passed arguments. Therefore, you can use all your Docker scripts without any modifications.

1.2.1 Installation of `podman-docker`

The `podman-docker` is not installed on SLE for NVIDIA by default. To install it, proceed as follows:

1. Install the package `podman-docker` by running:

```
transactional-update pkg install podman-docker
```

2. Reboot the system to switch to the latest snapshot.

1.3 About docker-compose

docker-compose is a tool for managing multi-container applications. docker-compose enables you to have multiple isolated environments on a single host, while it supports using variables between environments. Using docker-compose, you can recreate only those containers that have changed without destroying the whole multi-container application.



Important: **`docker`** replaced with the **`podman`** command

On SLE for NVIDIA, the `podman-docker` script is used to call Podman whenever you run docker-compose, as Docker is not present on SLE for NVIDIA by default.

1.3.1 Installing docker-compose

If docker-compose is not present on your system, you can install it by following the steps:

1. Run the command:

```
> sudo transactional-update pkg install docker-compose
```

2. After the installation is complete, reboot your system to boot into the new snapshot.

2 Creating a multi-container application

To create a multi-container application, proceed as follows:

1. Create the configuration file `compose.yml`. For details, refer to *Section 2.1, "Creating `compose.yml`"*.
2. Prepare the required directory structure. We recommend placing the `compose.yml` file at the top of your working directory.
3. If needed, write your own container files specific to services used by the containerized application. For exammple, to deploy a Go application, create a container file for the Go application with the required configuration and dependencies.
   We recommend creating a subdirectory per service in the working directory and placing the service-specific files there.
4. Deploy the multi-container application. For details, refer to *Section 2.2, "Deploying multi-container applications"*.

2.1 Creating `compose.yml`

To create the multi-container application, you need to create a `compose.yml` file preferably placed in the working directory. It can be a single file, or you can use a more granular approach by utilizing fragments and extensions. Multiple docker-compose files can be also merged to define the whole application model.

The file `compose.yml` defines your application. You can include the following parts.

service

A service is a computing component of the application. For details regarding the definition, refer to *Section 2.1.1, "Services definition"*.

networks

You can use the `network` statement to define custom networks and assign particular services to custom networks. For details, refer to *Section 2.1.2, "Networks definition"*.

volumes

A directory managed by the container engine where services store and share data.

Environment variables

You may also need to use a list of environment variables that will be passed to your services. For details, refer to the environment variables reference (https://docs.docker.com/compose/environment-variables/).

configs

All configuration files required by the services must be declared in the `configs` section. For details, refer to the `configs` definition (https://docs.docker.com/compose/compose-file/08-configs/).

2.1.1 Services definition

When defining services, you either need to specify a container image to use, or provide source files to build the service from them.

To create the service container from an image, use the `image` statement:

```
services:
 db:
   image: database
```

Podman checks if the image name declared in the `compose.yml` file is available in the local container storage. If it is not, Podman pulls the image from one of the configured registries.

To build a service from source files, provide the source files and create a container file, both in the same directory. In the `compose.yml`file then use the `build` statement:

```
services:
  db:
    build: PATH_TO_SOURCE_FILES
```

If a particular service must be started after another, you can use the `depends_on` statement:

```
services:
 db:
   image: database
   depends_on:
    system:
      condition: SERVICE_CONDITION
```

The *`SERVICE_CONDITION`* can be one of the following: `service_started`, `service_healthy` or `service_completed_successfully`.

For more information regarding the `services` definition, refer to the `services` specification (https://docs.docker.com/compose/compose-file/05-services/).

2.1.2 Networks definition

By default, docker-compose creates a default network, and each container in the application stack is included in the network. The default network does not have to be declared in the `compose.yml` file as docker-compose creates it automatically.

You can also define custom networks and assign particular services to them. For example, to create two networks, `network1` and `network2`, add the following snippet:

```
networks:
  network1:
    # Use a custom driver
    driver: custom-driver-1
  network2:
    # Use a custom driver and name the network
    driver: custom-driver-2
    name: custom_network
```

You can also use an existing network. In this case, mark the network as external:

```
            networks:
  network1:
    name: network1
    external: true
```

For a complete `networks` specification, refer to the `networks` specification (https://docs.docker.com/compose/compose-file/06-networks/).

2.1.3 Example of `compose.yml`

The following example of `compose.yml` defines an application stack that uses the Prometheus monitoring system and the Grafana analytics system.

```
  services:
  prometheus:
    image: prom/prometheus
    container_name: prometheus
    command:
      - '--config.file=/etc/prometheus/prometheus.yml'
    ports:
      - 9090:9090
    restart: unless-stopped
    volumes:
      - ./prometheus:/etc/prometheus
```

```
      - prom_data:/prometheus
  grafana:
    image: grafana/grafana
    container_name: grafana
    ports:
      - 3000:3000
    restart: unless-stopped
    environment:
      - GF_SECURITY_ADMIN_USER=admin
      - GF_SECURITY_ADMIN_PASSWORD=grafana
    volumes:
      - ./grafana:/etc/grafana/provisioning/datasources
volumes:
  prom_data:
```

The project structure in this example must look as follows:

```
.
├── compose.yaml
├── grafana
│   └── datasource.yml
├── prometheus
│   └── prometheus.yml
└── README.md
```

2.2 Deploying multi-container applications

After you create the proper directory structure and the `compose.yml` file, you can deploy the multi-container application:

1. Verify that the container you intend to run doesn't already exist:

   ```
   > podman ps --all
   ```

   If needed, remove the particular container:

   ```
   > podman rm -f CONTAINER_ID
   ```

2. Start the multi-container application by running the following command from the directory where `compose.yml` is located:

   ```
   > docker compose up -d
   ```

   docker-compose creates a separate network for the multi-container application.

3. You can verify that containers are running and ports are mapped by listing running containers:

```
> podman ps
```

3 Management of a multi-container application

After you create your multi-container application, you can use the **`docker-compose`** command to perform management operations. The command syntax is the following:

```
> docker compose [OPTIONS]
  COMMAND
```

Run the command from the same directory where the `compose.yml` file of the multi-container application you want to manage is located. Alternatively, provide a path to the `compose.yml` file using the `-f, --file` option. For example, to exit and remove the multi-container application:

```
> docker compose -f ./test/compose.yml down
```

Other useful commands:

images

To list all images used by the containers in the multi-container application.

```
> docker compose images
```

pause

To pause all containers.

```
> docker compose pause [SERVICE]
```

ps

To list containers in the multi-container application.

```
> docker compose ps
```

rm

To remove stopped containers.

```
> docker compose rm
```

start/stop

To start or stop containers.

```
> docker compose stop [SERVICE]
```

For a complete list of options and commands, run:

```
> docker-compose --help
```

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