Implementing DPDK based Application Container Framework with SPP

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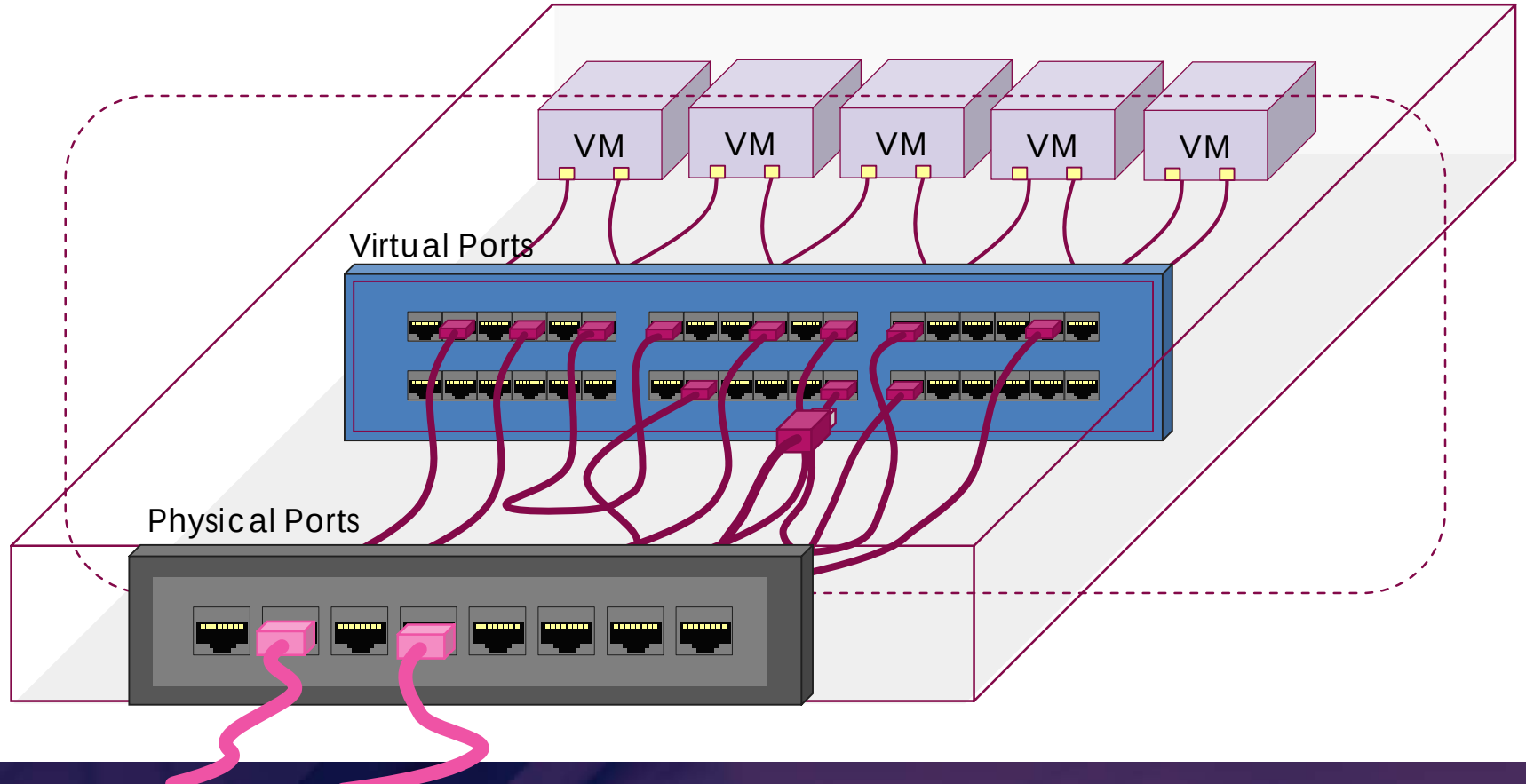
Agenda

- Introduction of SPP
- SPP Container
- Containerize DPDK Apps
- SPP Container Tools
- Usecases
- Limitations and Restrictions
- Debugging

Introduction of SPP

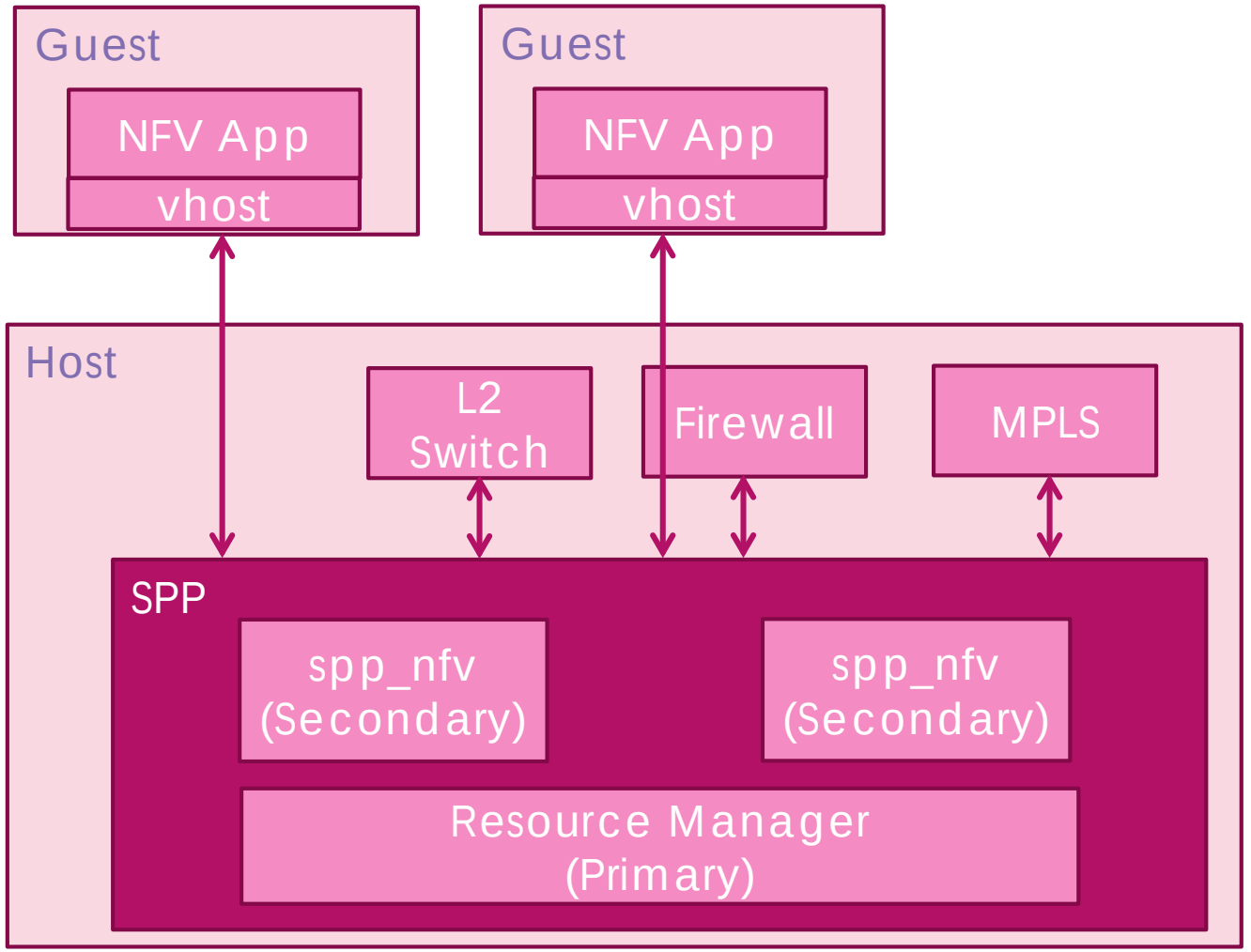
- Change network path with patch panel like simple interface
- High-speed packet processing with DPDK
- Update network configuration dynamically without terminating services



Design

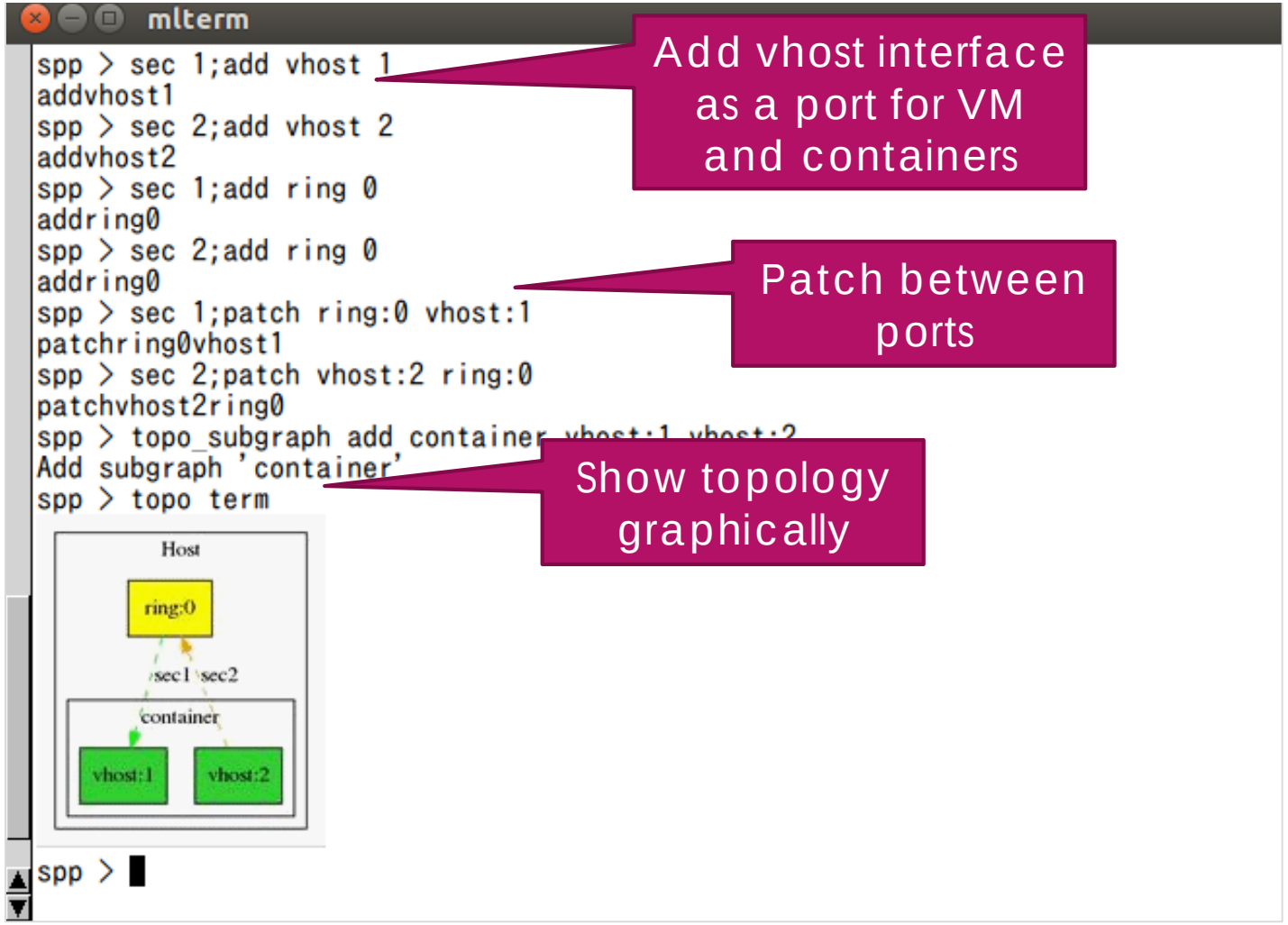
- Multi-process Application
  - Primary process is a resource manager
  - Secondary processes are workers for packet forwarding
    - spp_nfv (Direct forwarding)
    - spp_vf (SR-IOV features)
    - spp_mirror (TaaS)
- Several Virtual Port Support
  - ring pmd
  - vhost pmd
  - pcap pmd

  etc.

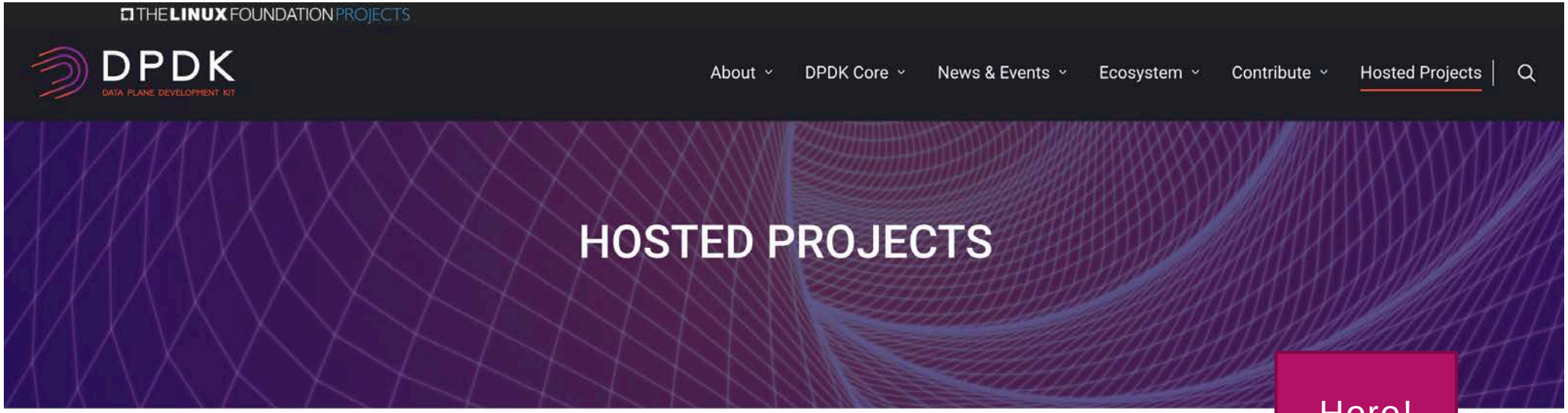


Patch Panel-like Interface

- Simple to add ports and connect them



Hosted Project



Here!

Pktgen

Traffic generator powered by DPDK

Git Repo | Latest Release | Docs | Mailing List

SPP

Soft Patch Panel – DPDK Resource Management Framework

Git Repo | Latest Release | Docs | Mailing List

DTS

DPDK Test Suite

Git Repo | Latest Release | Docs | Test Plans

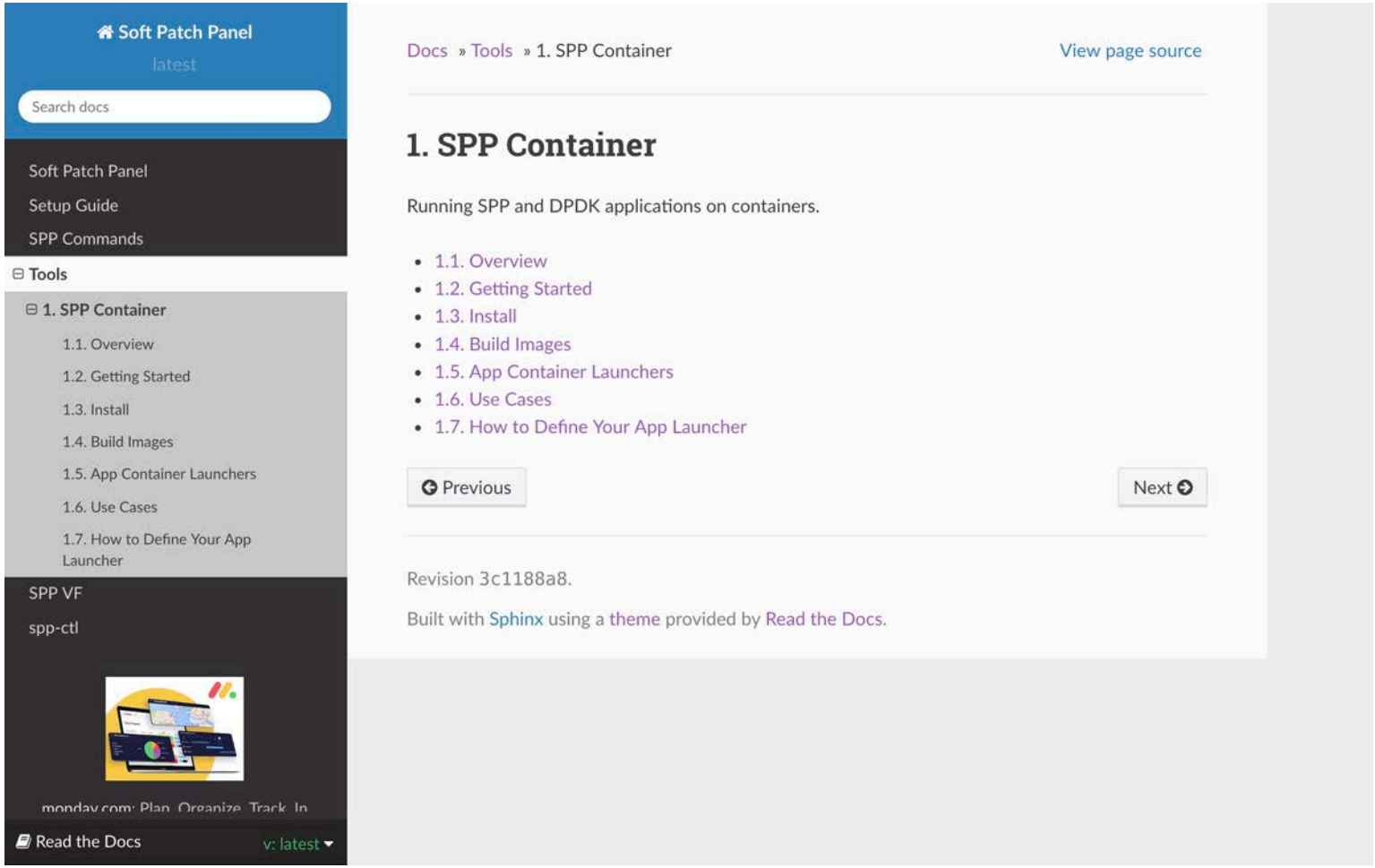
NFF-Go

Network Function Framework for Go

Git Repo

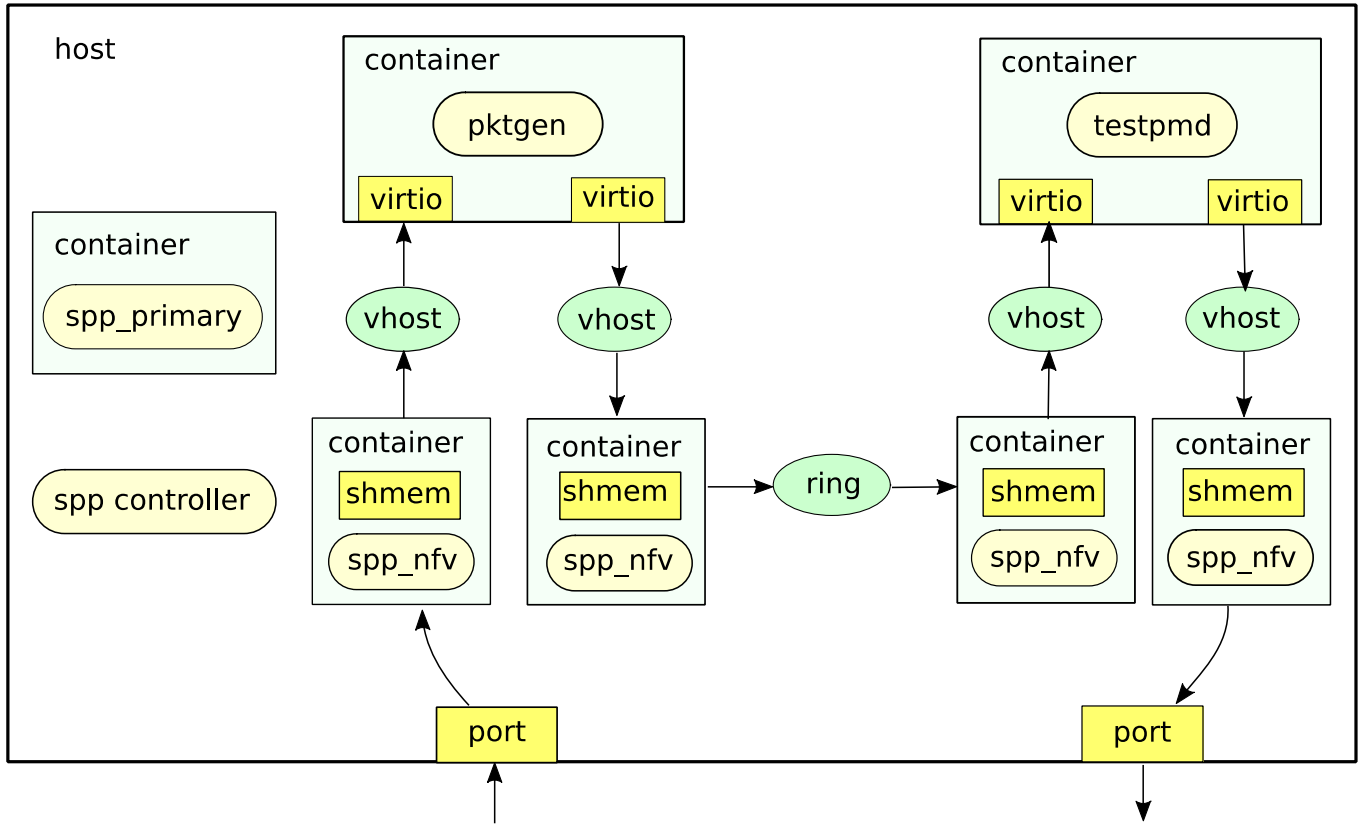
The Latest Documentation

https://spp.readthedocs.io/en/latest/



SPP Container

- Toolset for easy deployment of containerized DPDK apps
- Containerize DPDK apps for running as App containers
- SPP is also launched as App containers for configuring network



Containerize DPDK Apps

- Build container images with dedicated Dockerfiles
- Launch DPDK App via docker command with specifying ...
  - Docker options for resources shared between host and container (socket file , hugepages, etc.)
  - The name of binary
  - Options for DPDK’s EAL and application itself

Build Container Image

```
FROM ubuntu:16.04
ARG rte_sdk
ARG rte_target
ARG home_dir
ARG dpdk_repo
ARG dpdk_branch
ENV PATH ${rte_sdk}/${rte_target}/app:${PATH}
ENV RTE_SDK ${rte_sdk}
ENV RTE_TARGET ${rte_target}
RUN apt-get update && apt-get install -y ¥
    git gcc python pciutils make libnuma-dev gcc-multilib ¥
    libarchive-dev linux-headers-$(uname -r) libpcap-dev pkg-config ¥
    && apt-get clean && rm -rf /var/lib/apt/lists/*
WORKDIR $home_dir
RUN git clone $dpdk_branch $dpdk_repo
# Compile DPDK
WORKDIR $rte_sdk
RUN make install T=$rte_target
RUN make app T=$rte_target
RUN make examples T=$rte_target
# Set working directory when container is launched
WORKDIR ${home_dir}
ADD env.sh ${home_dir}/env.sh
RUN echo "source ${home_dir}/env.sh" >> ${home_dir}/.bashrc
```

```
$ sudo docker build ¥
 --build-arg home_dir=/root ¥
 --build-arg rte_sdk=/root/dpdk ¥
 --build-arg rte_target=x86_64-native-linuxapp-gcc ¥
 --build-arg dpdk_repo=http://dpdk.org/git/dpdk ¥
 --build-arg dpdk_branch= ¥
 -f ./build/ubuntu/dpdk/Dockerfile.16.04 ¥
 -t sppc/dpdk-ubuntu:16.04 ¥
 ./build/ubuntu/dpdk
```

Install packages with apt-get

Compile DPDK and apps

Activate environments

Launch Containerized DPDK App

- Example of launching l2fwd with two vhost ports

```
$ sudo docker run -d --privileged ¥
 -v /tmp/sock5:/var/run/usvhost5 ¥
 -v /tmp/sock6:/var/run/usvhost6 ¥
 -v /dev/hugepages:/dev/hugepages ¥
 sppc/dpdk:16.04 ¥
 /root/dpdk/examples/l2fwd/x86_64-native-linuxapp-gcc/l2fwd ¥
 -l 3,4 ¥
 -n 4 ¥
 -m 1024 ¥
 --proc-type auto ¥
 --vdev virtio_user5,queues=1,path=/var/run/usvhost5 ¥
 --vdev virtio_user6,queues=1,path=/var/run/usvhost6 ¥
 --file-prefix spp-l2fwd-container5 ¥
 -- ¥
 -p 0x03
```

Run with “--privileged” to share sockets and hugepages

Use “--file-prefix” for preparing metadata file for the process

SPP Container Tools

- A set of Python scripts and Dockerfiles for building and launching
- ‘build’ tool is used for creating container images
  - Support several distributions and versions (but only Ubuntu currently)
  - Apps included in DPDK, Pktgen and SPP
- Each of app containers are launched via ‘app’ tools
  - testpmd
  - pktgen
  - DPDK sample apps (l2fwd, etc.)
  - SPP

```
dpdk1805@lancer:~/spp/tools/sppc$ tree
├── app
│   ├── __init__.py
│   ├── l2fwd.py
│   ├── spp-nfv.py
│   ├── ...
│   └── testpmd.py
├── build
│   ├── main.py
│   ├── ...
│   └── ubuntu
│       ├── dpdk
│       │   ├── Dockerfile.16.04
│       │   ├── Dockerfile.18.04
│       │   ├── Dockerfile.latest
│       │   └── env.sh
│       ├── ...
├── conf
│   ├── env.py
│   ├── ...
├── lib
│   ├── __init__.py
│   ├── ...
```

Build tool

- Expand to ‘docker build’ with options for your target environments
- Choose the Dockerfile and define the name of container image from the options

```
$ python ./build/main.py
--dist-name ubuntu ¥
-t dpdk ¥
--dist-ver 16.04 ¥
--dpdk-repo https://github.com/yasufum/dpdk-custom.git
```

```
├── build
│   └── ubuntu
│       ├── dpdk
│       │   ├── Dockerfile.16.04
│       ├── ...
```

```
sudo docker build ¥
 --build-arg home_dir=/root ¥
 --build-arg rte_sdk=/root/dpdk ¥
 --build-arg rte_target=x86_64-native-linuxapp-gcc ¥
 --build-arg dpdk_repo=https://github.com/yasufum/dpdk-custom.git ¥
 --build-arg dpdk_branch= ¥
 -f ./build/ubuntu/dpdk/Dockerfile.16.04 ¥
 -t sppc/dpdk-ubuntu:16.04 ¥
 ./build/ubuntu/dpdk
```

Dockerfile

Container image

App tool

- Expand to ‘docker run’ with options of docker docker, DPDK EAL and the app
- Vhost is simply assinged by giving IDs with ‘-d’ option

```
$ ./app/l2fwd.py --dist-ver 16.04 -p 0x03 -l 1-2 -d 1,2
```

```
sudo docker run ¥
 -d ¥
 --privileged ¥
 -v /tmp/sock1:/var/run/usvhost1 ¥
 -v /tmp/sock2:/var/run/usvhost2 ¥
 -v /dev/hugepages:/dev/hugepages ¥
 sppc/dpdk-ubuntu:16.04 ¥
 /root/dpdk/examples/l2fwd/x86_64-native-linuxapp-gcc/l2fwd ¥
 -l 1-2 -n 4 -m 1024 ¥
 --proc-type auto ¥
 --vdev virtio_user1,queues=1,path=/var/run/usvhost1 ¥
 --vdev virtio_user2,queues=1,path=/var/run/usvhost2 ¥
 --file-prefix spp-l2fwd-container1 ¥
 -- ¥
 -p 0x03
```

Sock files are mounted as ‘/var/run/usvhost*’ to be shared

Assigned with ‘--vdev’ on the container

Create App Container of Your App

- You can launch your own application by building a container image and install your application
- Define Dockerfile for your application
  - Packages installation
  - Get and compile DPDK and your app from repos
  - Configure env on the container
- Create App Container Script

App Container Script

- To understand how to implement app container script, ‘app/helloworld.py’ is the best example
- There are just three parts should be changed for your app
  - Path of binary of your app
  - File prefix for metadata file
  - Options for your app (not includes EAL opts)
- Docker and DPDK EAL options are setup by helper methods
  - app_helper.setup_docker_opts()
  - app_helper.setup_eal_opts()

```
32 def main():
33     args = parse_args()
34
35     # Check for other mandatory opitons.
36     if args.dev_ids is None:
37         common.error_exit('--dev-ids')
38
39     # Setup for vhost devices with given device IDs.
40     dev_ids_list = app_helper.dev_ids_to_list(args.dev_ids)
41     sock_files = app_helper.sock_files(dev_ids_list)
42
43     # Setup docker command.
44     docker_cmd = ['sudo', 'docker', 'run', '\\']
45     docker_opts = app_helper.setup_docker_opts(
46         args, target_name, sock_files)
47
48     # Setup helloworld run on container.
49     cmd_path = '%s/examples/helloworld/%s/helloworld' % (
50         env.RTE_SDK, env.RTE_TARGET)
51
52     hello_cmd = [cmd_path, '\\']
53
54     file_prefix = 'spp-hello-container%d' % dev_ids_list[0]
55     eal_opts = app_helper.setup_eal_opts(args, file_prefix)
56
57     # No application specific options for helloworld
58     hello_opts = []
59
60     cmds = docker_cmd + docker_opts + hello_cmd + eal_opts + hello_opts
61     if cmds[-1] == '\\':
62         cmds.pop()
63     common.print_pretty_commands(cmds)
64
65     if args.dry_run is True:
66         exit()
67
68     # Remove delimiters for print_pretty_commands().
69     while '\\' in cmds:
70         cmds.remove('\\')
71     subprocess.call(cmds)
```

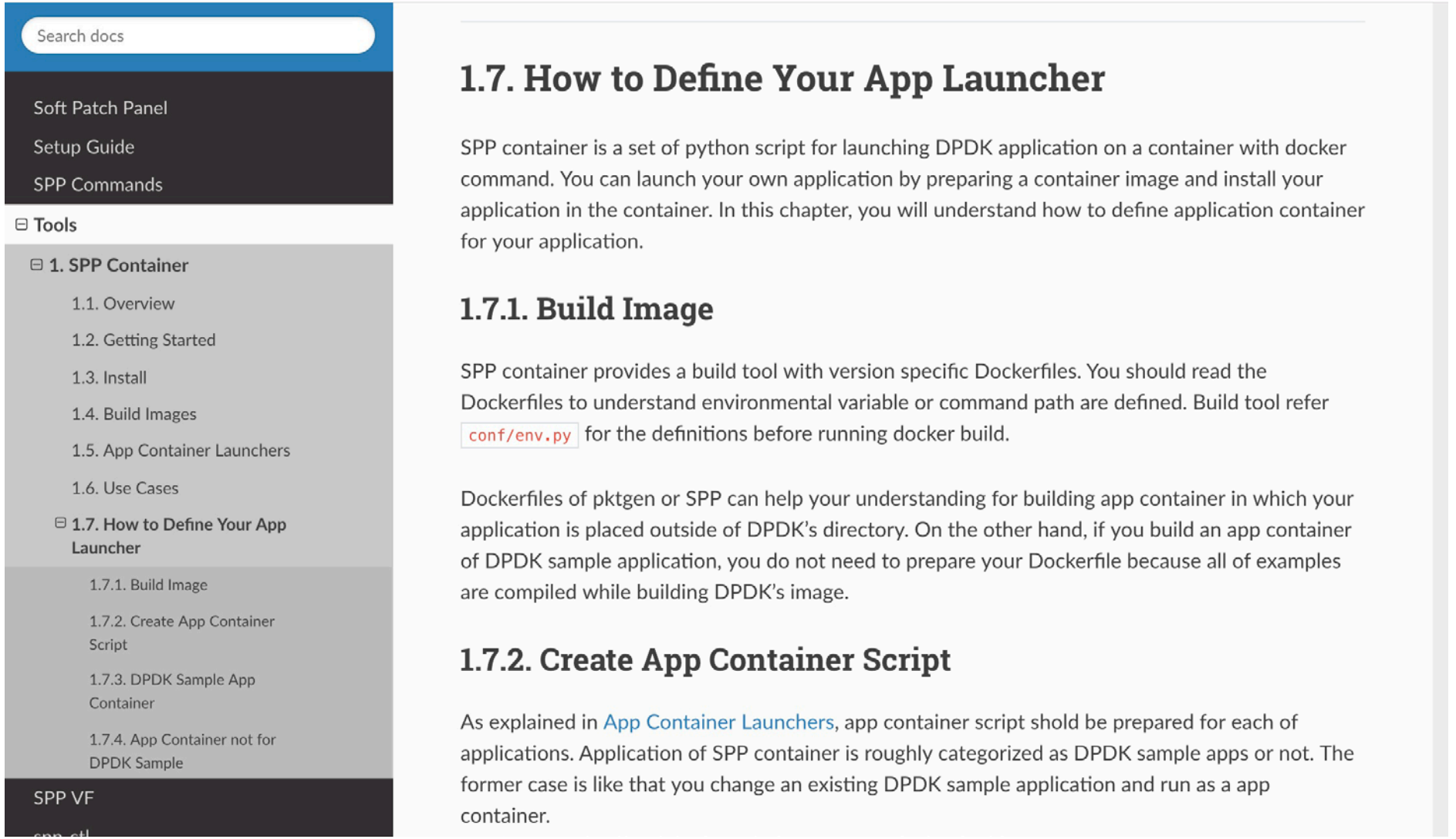
Path of binary of your app

File prefix

Options for your app

Create App Container of Your App

https://spp.readthedocs.io/en/latest/tools/sppc/howto_launcher.html



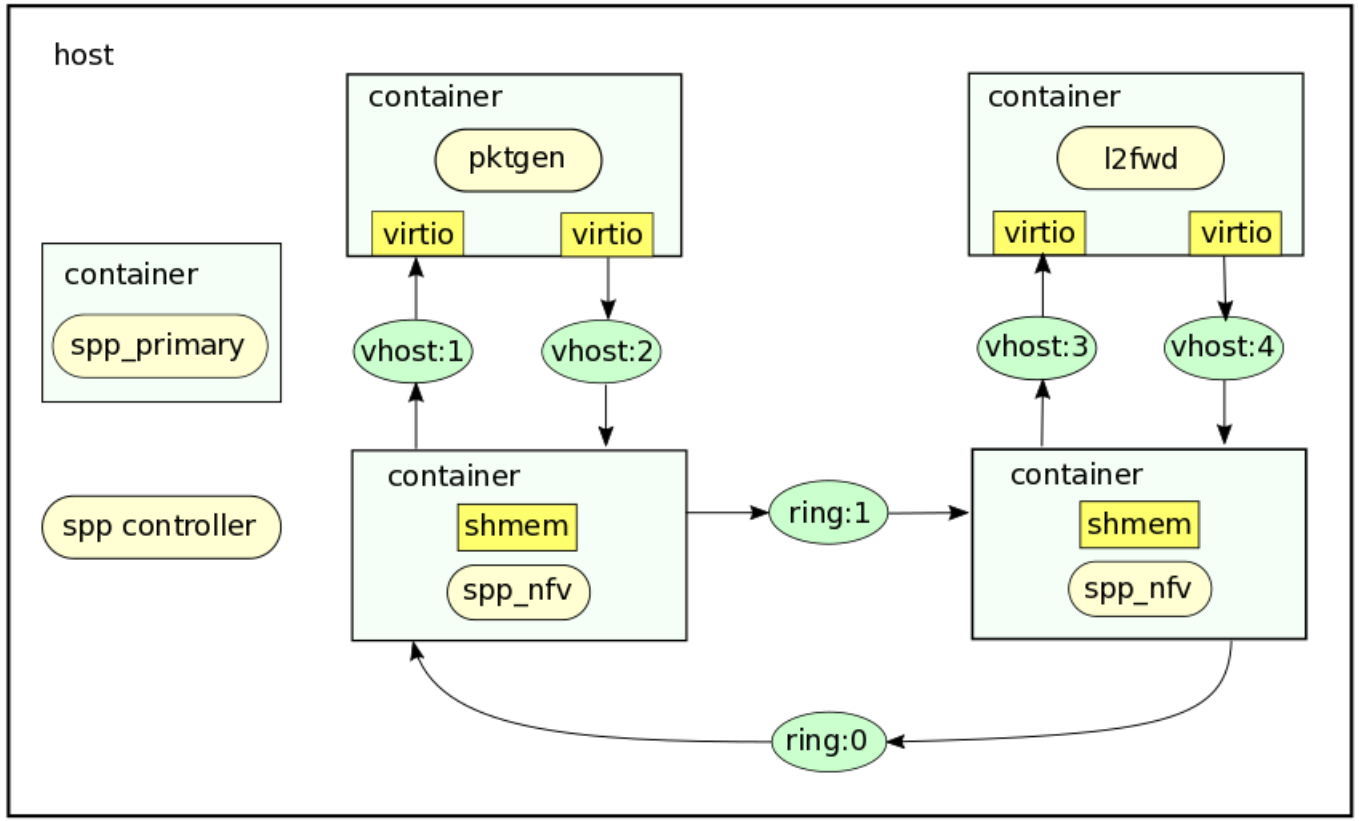
Usecases

- Several usecases suitable for using containerized DPDK apps
  - NFV’s service function chaining by using fewer resources than VMs
    - Service entities running on containers are instantiated and removed cleanly
    - Less time to launch container than VM and start service
  - High performance packet forwarding via shared memory
    - Enable to zero-copy packet forwarding between each of containers of a multi-process application
    - It is still insufficient performance of vhost for some of telco’s requirements

Usecase 1

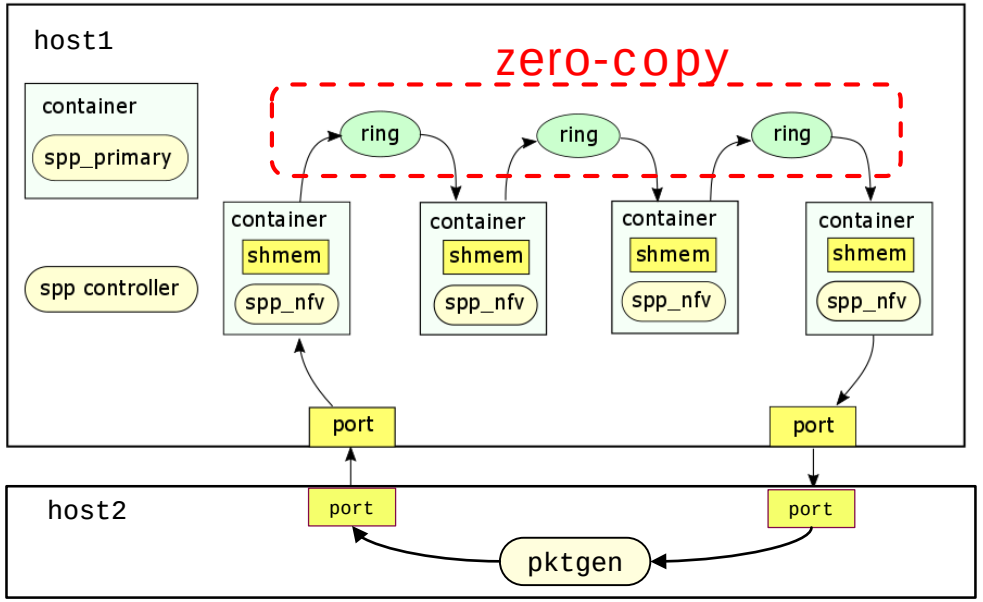
Testing two NFV apps as simple service function chaining

- Totally 7 lcores are required for this usecase
  - One lcore for spp_primary container.
  - Three lcores for four spp_nfv containers.
  - Two lcores for pktgen container.
  - One lcores for l2fwd container.



Usecase 2

High performance packet forwarding via shared memory



	Supermicro Mini Tower Intel Xeon D-1587
CPU	Intel Xeon-D-1587 (1.7 GHz, 32 cores)
Memory	32GB
SSD	Intel SSDSC2BB240G6
OS	Linux (Ubuntu 16.04 LTS)
DPDK	v18.02
pktgen-dpdk	v3.4.9
SPP	v18.02

Limitations

There are several limitations in ‘Virtio_user for Container Networking’

- Cannot work with –huge-unlink option. As we need to reopen the hugepage file to share with vhost backend.
- Cannot work with –no-huge option. Currently, DPDK uses anonymous mapping under this option which cannot be reopened to share with vhost backend.
- Cannot work when there are more than VHOST_MEMORY_MAX_NREGIONS(8) hugepages. If you have more regions (especially when 2MB hugepages are used), the option, –single-file-segments, can help to reduce the number of shared files.
- Applications should not use file name like HUGEFILE_FMT (“%smap_%d”). That will bring confusion when sharing hugepage files with backend by name.
- Root privilege is a must. DPDK resolves physical addresses of hugepages which seems not necessary, and some discussions are going on to remove this restriction.

https://doc.dpdk.org/guides/howto/virtio_user_for_container_networking.html#limitations

Restrictions

- Containerized DPDK apps, including multi-process app work fine with DPDK v18.02

- For v18.05, it works in some of few cases but ...
  - Two or more secondary processes cannot be launched
  - Vhost networking does not work possibly

- Does not work for v18.08

Launch Multiple Secondary Processes

- The reason for several sec process cannot be launched is a change of initializing memseg files.
  - The name of memseg file is defined with PID

```
// lib/librte_eal/linuxapp/eal/eal_memalloc.c
static int
secondary_msl_create_walk(const struct rte_memseg_list *msl,
                void *arg __rte_unused)
{
        struct rte_mem_config *mcfg = rte_eal_get_configuration()->mem_config;
        struct rte_memseg_list *primary_msl, *local_msl;
        char name[PATH_MAX];
        ...
        /* create distinct fbarrays for each secondary */
        snprintf(name, RTE_FBARRAY_NAME_LEN, "%s_%i",
                primary_msl->memseg_arr.name, getpid());
```

  - It cannot ensure unique name because PID is assigned from 1 in each of containers

```
rte_fbarray_init(): couldn't lock /var/run/dpdk/rte/fbarray_memseg-1048576k-0-0_1:
Resource temporarily unavailable
```

  - To avoid this error, need to change to use unique ID for containers

→ I succeeded to launch multiple secondaries, and going to send a patch for DPDK v18.11

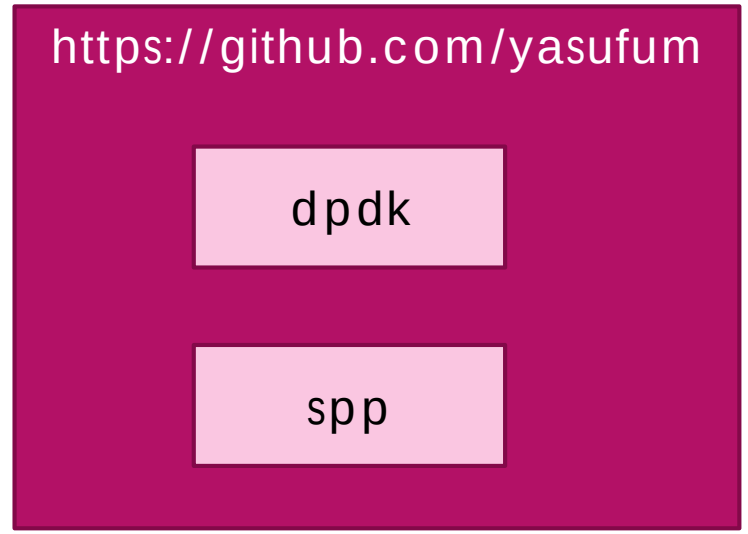
Debugging

- How to debug SPP container

1. Create dev version of DPDK and SPP repos on github
2. Create container image of SPP dev

```
$ python ./build/main.py
-t spp ¥
--dist-ver 16.04 ¥
--dpdk-repo https://github.com/yasufum/dpdk.git
--spp-repo https://github.com/yasufum/spp.git
...
... waiting for long time ...
```

3. Debug and update source code
4. Push the changes to github, and return to the 2nd step



... Need to be improved for more efficient way

Thank you

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