Beginning with NFD

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Abstract—**Despite being a very useful tool for developers and researchers in NDN [3] area, NFD is a not very didactic tool, we can easily find how to install, articles about how it works, about the logical part of the program, even topics about some usual problems, but it is still poor the documentation about how to in fact use the tool, basic commands and about how see a code working through it. The purpose of this document is to help NFD beginners that still doens't had the "breakthrough" the hard start occasionade for the lack of the docummentation about how to start using this tool, this document intends to be a practical guide for beginning to run codes in small NDN networks.**

Keywords—**NFD,ICN, ndnSIM, NDN, ndn-cxx.**

I. INTRODUCTION

NFD is one of the most powerful tools for NDN researchers and developers since it can emulate the core of a NDN node, making the user able to test algorithms for all the jobs the NDN node core have to do and generate thought it more realistics results than many other tools. While NFD can emulate a more realistic NDN network than ndnSIM, for example,the amount of data about how to use it goes the opposite, while ndnSIM have a wide community with articles about how to use it, not just for being based in NS-3 a network simulator already widely used, but for this simulator itself, having even video lessons on youtube with hours about how to develop simple simulations, NFD is still corrected when searched on google. NFD is not a undocummented project it actually have a very well detailed guide, the NFD Developers Guide [5] which detail the program and its classes with a lot of graphs demonstrating abou how the program works besides some commands, syntax and meanings and is the appropriate document to be read if you wnat to be a NFD master. But for a beginner, read all that data can be not just tiring, but there is the risk to read all of that, understand all the logic of the program and at the end still doens't know how to do yout own simulation.

II. INSTALLATION

You can find all the details about how to install NFD on NFD official site [2] but doing a synthesis, for Linux users the steps are below.

A. ndn-cxx

ndn-cxx [1] is a library written in C++ that implements NDN primitives and is being used in many NDN application such as NFD, so to use NFD we have to install this library first. Prerequisites:

- `python >= 2.6`
- `libsqlite3`
- `libcrypto++`
- `OpenSSL >= 1.0.1`
- `pkg-config`
- `Boost libraries >= 1.54`

You can install all the Prerequisites on linux using the following command: sudo apt-get install build-essential libcrypto++-dev libsqlite3-dev libboost-all-dev libssl-dev. After installing the prerequisites, you can download ndn-cxx source code from the github ndn-cxx oficial repository with this command: git clone https://github.com/named-data/ndn-cxx. To build the library, enter in the folder that contains the ndn-cxx source code and use this commands in this order:

- `./waf configure`
- `./waf`
- `./waf install`

This commands check if all the configurations and prerequisites are ok, compile the codes and install the library. After the Installation, still in the source code folder, if you are a linux user, type the comand

- sudo ldconfig

Now your ndn-cxx library should be installed and prepared to run.

B. NFD

After installing the ndn-cxx library we can move forward starting the installation of NFD itself

1) Prerequisites:

- `ndn-cxx`
- `pkconfig`
- `libpcap`

Commands to install these prerequisites:

- ndn-cxx installation is explained in the subsection above.
- `sudo apt-get install pkg-config`
- `sudo apt-get install libpcap-dev`

After installing the prerequisites, NFD source code can be downloaded from the NFD official repository with the command : git clone –recursive https://github.com/named-data/NFD (the –recursive attribute in the command is very important, don't forget to type it or you will have problem with the websocket folder). Having the prerequisites installed and the source code downloaded, to install NFD, use the same commands you used on the installation of ndn-cxx, but now on NFD source code folder

- `./waf configure`
- `./waf`
- `./waf install`

Now your NFD should be up to run. Run the NFD with the command: nfd-start If it shows any fatal errors, check if all the steps were excuted right or check the NFD official site [2] for more information.

III. STARTING TO USE

This section will demonstrate how to start using NFD, but first lets remember that NFD is not a simulator, it is a forwarder, a program that emulate a NDN node, so to actually emulate a NDN network, we will need more than one NFD(emulate node) running, which means that we have to install it in at least two different computers or if you have just one computer available and to make the process easier, virtual machines. Normal virtual machines use too much hardware resources to be a suitable way to emulate a more wide network, in that case, the best tool to have some virtual machines running NFD without making them competing for all your hardware resources is docker [6].

A. Docker

Docker [6] is a software container platform, its containers are able to run softwares without needing to emulate the whole operational system, permiting to emulate machines without needing too much resources, thats why docker is a suitable solution to emulate networks with NFD in the case you have just one

computer available. All the instructions about how to install and use docker are on Docker official website. (https://www.docker.com). All the commands below should be used with "sudo" since Docker needs root privileges. There are ways do give docker root privileges, but thats not the focus here.

1) Containers and Images: To use docker is important to know the difference between image and cointainer since these are the main work objects of this tool.

- Image: Image is the "static" data of the machine, the saved part of a container that were running and can be run as container with the run command
- Container: Container is the emulate machine itself, it is build from a image and works like a normal machine.

After installing docker and getting a image,to run that image in a cointainer use: `docker run --rm --name <containerName> -it <imageName>:<version>`. The attribute –rm is optional, it makes the container stop running in the background when you exit it, if you don't want to kill the cointer after exit it, don't use the –rm attribute. Into the terminal of at least one container, you have to do all the steps in the installation section, after that use: `docker commit <cointainerID> <imageName>:<version>` to save the actual cointainer as a image. To see the cointainer ID use in a terminal outside a container the command: `docker ps` to see the cointainers that are running and its codes. Now you should have a docker image saved with NFD installed and you can use it to create as many containers you need or can to simulate your NDN network. To create a docker network use `docker creat network <networkName>`, since you create a docker network once, you don't need to create again, like images the the networks structures are saved and can be used at anytime after the creation, but the containers connected to it, if killed, do not remain there. To connect a container to a created network the command `docker network connect <networkName> <containerName>`, to simulate a NDN network you should probably run and connect more than one container to the same network.

2) Main Docker Commands:

- `docker run --name <containerName> -it <imageName>:<version>` Run a saved image as a container
- `docker ps` Shows the cointainers which are running

- `docker images` Shows the saved images
- `docker commit <cointainerID> <imageName>:<version>` Commit the changes in the container as a image
- `docker network create <networkName>` Create a docker network
- `docker network connect <networkName> <containerName>` Connect a container to a existent docker network
- `docker rm <containerName>` Remove/kill a container running
- `docker rmi <imageName>` Delete a saved/-commited image
- `exit` Exit the terminal or the current container

B. NFD

NFD have a bunch of useful commands, but having all the steps above done, the main command you will have to use is `nfd-start` to get NFD running and `nfdc register udp4://<containerIP>` to connect the current container or machine to the container or machine with the given IP, it is important to make sure that the machines or cointainers binded with this commands are in the same network. To check the I of the docker containers you can use inside the container the same commands that are used in normal terminals, such as `ifconfig`.

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