

SIMULATION SCENARIOS FOR THE ANALYSIS OF MOBILE TRANSPORT NETWORK BEHAVIOR

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Abstract: This paper deals with finding ideal emulation environment for simulating mobile transport network. On top of that, two simulation scenarios were created and configured in chosen emulating programs. Further, this article briefly describes the architecture of a mobile transport network with an emphasis on using network protocols. The individual connections between the devices and their purpose of this network are described here.

Keywords: Simulation Scenario, GNS3, EVE-NG, ESXi, Mobile Transport Network, Cisco

1 INTRODUCTION

Mobile networks are used by everyone on daily basis. However, users or even experts in mobile technologies are not that familiar with the transport part of a mobile network. It is a crucial part, connecting RAN (Radio Access Network) part of the network with EPC (Evolved Packet Core) or UMTS (Universal Mobile Telecommunication System) core network. Nevertheless, the transport network is still very often neglected part in the description of functionality.

This paper focuses on choosing the best environment and creating simulation scenarios for a better understanding the concept of the transport network in mobile communications. The outcome could be used for newcomers in the commercial sphere or for students, who are interested in this topic.

For purposes of this work, ESXi server was created. The server was used as a default environment for comparison of two chosen emulation programs with a goal to determine preferable one for ordinary laptop or PC. One of the emulation programs was EVE-NG (Emulated Virtual Environment—Next Generation) and the other one GNS3 (Graphical Network Simulator—3). Currently they are the only free ones available in the market.

Two simulation scenarios were created. The Scenario 1 is explained in this article. Scenario 2 is not included, because of limit space; however, it is based on Scenario 1. It contains troubleshooting of operating configuration.

2 CREATION OF SERVER FOR TESTING PURPOSES AND COMPARISON OF EMULATION PROGRAMS

As hardware for ESXi server was used computer with main parameters: Intel Core i5 CPU650 @3.20GHz, RAM 16 GB Kingston Genesis DDR3 and network card Realtek 8111E Gigabit LAN. Due to supporting virtualization on this hardware configuration, native hypervisor ESXi v6.0 by VMware could be installed. Subsequently, two virtual environments were installed on this server.

2.1 EMULATION PROGRAMS EVE-NG AND GNS3

EVE-NG is a tool to use around virtual devices and interconnect them with other virtual or physical devices. EVE-NG provide a GUI (Graphical User Interface) via a web browser. It can be deployed as

a virtual machine in hypervisors like VMware Workstation, Player and ESXi. Nonetheless, it means that any nodes deployed within EVE-NG will be nested and it cause degraded performance. For purposes of this work, it is completely satisfactory, also from the point of view of an ordinary laptop, expected to be used by final user of proposed scenarios. However, EVE-NG can be installed directly on physical hardware, without hypervisor (“bare metal”) to give maximum performance. [1]

GNS3 is used to emulate, configure, test and troubleshoot virtual and real networks. It is probably most used graphical network simulator worldwide. GNS3 consists of two software components GUI “GNS3-all-in-one software” and virtual machine “GNS3 VM”. GUI is installed on a computer, which is used for graphical access to the server. The virtual machine cannot be installed directly on physical hardware, as EVE-NG can be. [2]

2.2 TESTING OF EMULATION PROGRAMS

A series of tests covering basic requirements of future simulation scenarios (using the Test scenario that was created for this purpose) with these two emulation programs were performed in order to compare their parameters: load test, total loading time and RAM requirements. Both of them have a maximal available amount of 16GB RAM allocated on ESXi server and 300GB ROM.

2.2.1 LOAD TEST

This test was measured from the beginning of the mass start of all devices in the Test scenario to the stabilization moment. The load in percentage was monitored. In both emulation programs the results were almost identical. The biggest load was in starting point, during calculating hash and initialization, around 65%. This state took 5 min for EVE-NG, in the case of GNS3 it was for little bit longer, 7 min. After this time, there was a decrease to 35-37% during when the start-up configuration was loaded, it took 2.5 min for both emulation programs. Following by the steady-state, where the load for EVE-NG was about 23%, for GNS3 it was less, only 20%.

2.2.2 TOTAL LOADING TIME

Another parameter that was measured is the total load time. The timer was started at the beginning of the mass start and was stopped after loading the start-up configuration. The results are shown in Tab.1.

Table 1: The time taken to load images

	EVE-NG	GNS3
Loading time	12 min 20 s	12 min 30 s

2.2.3 RAM REQUIREMENTS

The increase and decrease in RAM memory usage have the same trajectory as in case of the load test. However, there are some minor differences between EVE-NG and GNS3. In the beginning, during calculating hash and initialization, EVE-NG needed almost 15GB of RAM, GNS3 took just 13GB of RAM. On the other hand in steady-state EVE-NG was using 4GB and GNS3 needed 2GB more, i.e. 6GB.

The results for both environments were really similar in each of tested scenarios. The difference in measurements was not very noticeable and would not affect the operation and behavior of the mobile transport network simulation. The outcome shows that it depends only on user preferences and it does not matter for this particular simulation scenario from a hardware perspective, which emulation programs user will use.

3 SIMULATION SCENARIO

3.1 MOBILE TRANSPORT NETWORK

The mobile transport network is independent on used technology in RAN part of a mobile network. Only treats 3G, 4G or even 5G differently from QoS (Quality of Service) and bandwidth perspective because it is based on All-IP technology. This simulation scenario is an example of possible topology of transport part of mobile network. The transport network is divided into three parts; see Fig. 1.

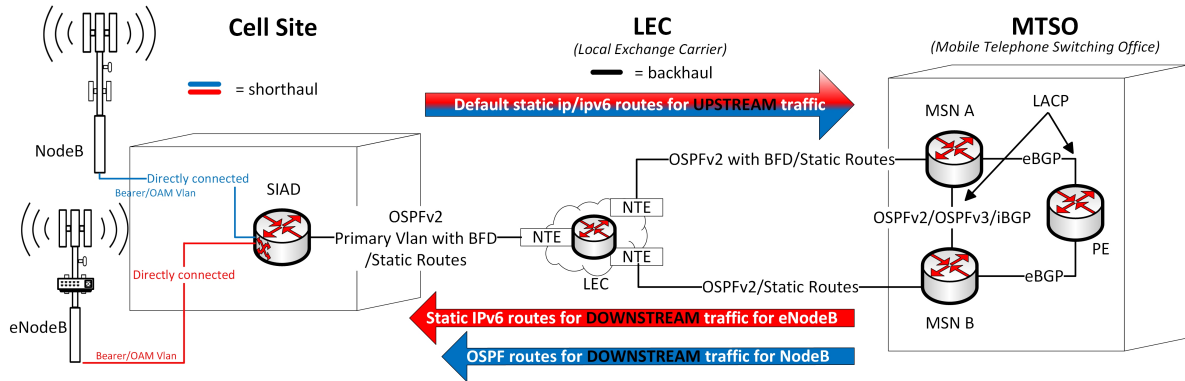


Figure 1: Transport architecture in simplified form with protocols used in simulation scenario

First part is Cell Site, where mobile antennas for 3G and 4G are located. Usually, under these antennas are shelters, there is also SIAD (Smart Integrated Access Device). SIAD directs data traffic through IP protocol from shorthaul (3G and 4G antennas) to NTE switch. Shorthaul for 3G is using UTP cable with RJ45 interface and maximal data rate 100Mb/s, for 4G optical fiber is used with maximal data rate 1Gb/s. The connection between SIAD and NTE switch is fiber optic (max. data rate 1Gb/s) and it is called backhaul.

NTE switch is an entrance gate to LEC (Local Exchange Carrier), which is the second part of the transport network. This is actually an unique concept used by several mobile providers. This part of the transport network is usually owned by different companies and using different technologies, thus this part is not closely simulated. It provides a connection between Cell Sites and MTSO (Mobile Telephone Switching Office), which can be tens of kilometers away. [3]

Last part of the transport network is represented by a pair of MSNs (Multi Service Node), which are part of MTSO as other important devices even from Core part of a mobile network. MSNs are last nodes before PE (Provider Edge), which is part of CBB (Core Back Bone). Each of these MSNs has usually more than 200 SIADs connected.

3.2 CONCEPTION OF SIMULATION SCENARIO 1

The goal of this scenario is to perform whole configuration of mobile transport network including IP addresses plan, routing strategies, QoS policies and protocols for management in order to practise the configuration steps without interrupting live network. For a graphical overview of used protocols, see Fig.1.

RAN part is created by two Qemu emulators with packet generator Ostinato 0.9 for simulation of NodeB (3G) and eNodeB (4G). SIAD uses Qemu emulator with Cisco CSR 1000v image. The same image is used for LEC part and even for MSNs and PE routers. Whole scenario is divided into several steps as described below.

The first step is setting interfaces with IP addresses in the whole topology. Next step is the right setting of packet generator Ostinato. Ostinato will be responsible for generating traffic to the network with QoS tags. Traffic will be divided if it is coming from Bearer VLAN (data) or OAM VLAN (maintaining). In the end, Wireshark will be used to check details about traffic and see the differences. By setting correct IP addresses in shorthaul, connection between NodeB, eNodeB and SIAD is set. NodeB is directly connected through IPv4, eNodeB through IPv6.

The second step is to add routing strategies. It is important to say that LEC part is not visible from configuration perspective for SIAD and MSN pair. Static IPv4 routes are used between SIAD and MSNs as default gateways and handle upstream traffic. IPv6 follows the same procedure. However, it is important for IPv6 to set static routes also in opposite direction, from MSNs for the purpose to provide return route for downstream traffic to eNodeB. Downstream traffic for IPv4 in backhaul is possible thanks to OSPFv2 (Open Shortest Path First), especially for NodeB. OSPFv2 is working in combination with BFD (Bidirectional Forwarding Detection) protocol between SIAD and MSN_A and without BFD protocol to MSN_B, which is there as a backup link in case of primary link outage. OSPFv2 is also used between MSN pair to handle IPv4 traffic. [4]

Furthermore, there is a port-channel between MSNs merging two physical links, which are connected to the MSNs to provide redundancy. The port-channel uses LACP (Link Aggregation Control Protocol) allowing two selected physical links to work as one logical link. OSPFv3 is used for Layer 3 support of port-channel, redistributing IPv6 static routes and allows Inter-chassis between MSNs to act as backup for each other. Between MSNs and PE routers is BGP (Border Gateway Protocol) also with a port-channel protocol.

The last step is to configure SNMP (Simple Network Management Protocol) in the whole topology and also control of QoS through policy-maps and class-maps on SIAD and MSNs.

4 CONCLUSION

Scenario 1 was described briefly. Details about particular steps are going to be part of diploma thesis. Moreover, Scenario 2 is also included. It starts from the end of Scenario 1 and is focused on troubleshooting of particular issues in this network. Scenarios 1 and 2 are implemented in both tested environments, which both proved to be fully functional and fulfill required premises expected for final user of proposed scenarios. Particular results of environments testing are also included in diploma thesis.

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