A Validation Tool for PPDR Architectures based on ns-3

[Extended Abstract]

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ABSTRACT

This paper presents a framework for the definition of ns-3 simulations, in order to evaluate networks and services under a Public Protection and Disaster Relief (PPDR) point of view. The main goal is to provide a tool for the evaluation of technologies and architecture concepts identified as promising for future PPDR systems, communications and services. By default, it provides an easy way to reproduce the outcomes in terms of performance of a number of applications on pre-defined scenarios. However it is designed to permit the creation of different scenarios, with different topologies, users count, and applications, and also to be extendible in order to support new technology introduction or new application/service modeling.

1. INTRODUCTION

Man-provoked and natural disasters are forcing governments to utilize their resources more efficiently. The traditional security objectives are changing as new challenges and threats emerge and there is a need for better integration and co-operation with the emergency services at national, European and international levels. The concept of Homeland Security is being adopted across Europe in the context of a framework for increased cooperation between Police, Fire, Rescue, Health and Military.

The FP7 PPDR-TC (*Public Protection and Disaster Relief - Transformation Centre*, http://www.ppdr-tc.eu) project, is based on three main elements: identification of current PPDR status and requirements for the future, data synthesis and scenarios development, and technical, economical and political analysis for future PPDR development.

More specifically, PPDR-TC aims at validating the technical performance of the identified options for PPDR reference services and architecture through the development and setup of a validation tools chain, dedicated to the identified evolutions scenarios of PPDR systems, services and communications.

This presentation focuses on the tool developed by UNI-MORE, based on ns-3 [1] for the evaluation of technologies and architecture concepts, identified as promising in early development stages, for future PPDR systems. Such tool allows simulating the main features of the PPDR network, in order to characterize the network behaviour for different services and different user basis.

The remainder of this paper is organized as follows: Section 2 shows the background work done in early development stages, Section 3 describes the design principles and how to use the tool, while Section 4 shows some output examples. The conclusions are drawn in Section 5.

2. BACKGROUND WORK

A brief timeline of the actions, performed by the project, which have lead to the final simulation tool for PPDR agencies is depicted.

The consortium has started its work by defining three main scenarios representing typical PPDR missions (current and potential future ones) [2]. Then, by identifying PPDR services and applications needed in such scenarios [3]. The services and the applications have been classified, according to their potential for adoption in future PPDR systems [4], and the key options for the PPDR reference system architecture have been investigated and presented [5].

After all this data has been gathered, a more technical view of the properties (IP compatibility, type of data, quality of service, etc.) for each architectural possibility have been published [6]. Finally, the systems architecture to test are presented in [7], along with three reference scenarios to be simulated, which are actually abstractions (suitable for a network simulation tool) of the detailed scenarios presented earlier.

3. METHOD

As a general picture, the tool can be used to evaluate networks and services, and it can be easily configured in order to simulate the effect of traffic growth (or user growth) over the same scenario. It is extendible in order to support new technology introduction or new application/service modeling.

The key features of the tool have been defined such in a way that, for the final users, the LAN, the backhaul, and the users of the network (with relative applications) would be easy to lay down. As interface between the tool and the users, it has been chosen a configuration file in INI format, in order to be human-readable and human-editable. Each section of the INI configuration file specifies the properties of a well-defined subsection of the overall network.
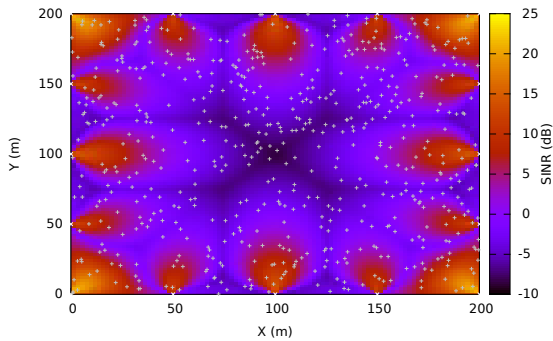
Figure 1: REM for the planned scenario

Figure 2: Example output

General: Defines general properties about the simulation (duration, prefix for output files, remote nodes, and so on)

LAN: Defines the properties (and the type) for the LAN network. Currently it supports LTE and point-to-point, but development to include WiMAX is currently ongoing.

Backhaul: Defines the properties and the type for the backhaul network, i.e. the network which connects LAN clients to remote nodes through a number of gateways.

Statistics: Enable or disable carefully chosen metrics, in order to output data usage for the network. For instance, for each flow in the network, the throughput, the delay and the jitter could be obtained, togheter with queue usage and NetAnim animation.

Network users: For each client, gateway or remote node, a section is created. It defines the mobility model and some other properties about the node itself (queue type, transmission power, etc.).

Applications: Each application has its own section, where it can be defined the node on which is installed on and connected to (for sinks, the keyword *any* can be used). The type of application (and properties) can be defined as well using an abstraction between real application and the model for it. For example, a video stream can be modeled as an *OnOff* application, with *OnTime* and *OffTime* as example of various other parameters which can be set. Following is provided the configuration directive to install a PacketSink on the node named `client24` which is listening over UDP `0.0.0.0:24`.

```
[app1]
AppType = PacketSink
ConnectedTo = any
InstalledOn = client24
Port = 444
Protocol = UDP
```

4. PRELIMINARY RESULTS

For space constraint, we present only a fraction of the results obtained through the tool so far. We choose the *planned* scenario, where 600 PPDR users attending an important football match are connected through a LTE network over a field of 200 m^2. There are 16 eNB, placed at the edge of the controlled area. The applications involved are modelling a number of video stream, audio stream, and backlogged transfers. In Figure 1 is reported the RE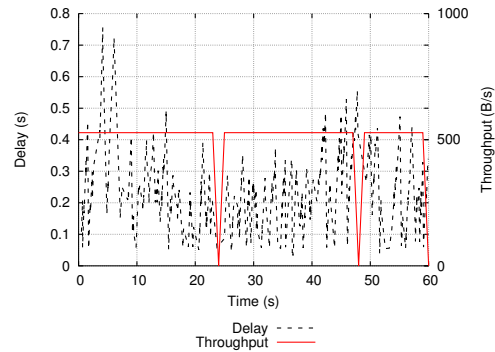M (Radio Environment Map) of such scenario (white dots are PPDR nodes). In Figure 2, we show an example output (delay and throughput) for a VoIP application between two nodes.

5. CONCLUSIONS

This work presented a tool for the definition of ns-3 simulations. In particular, the tool allows to design a network architecture, along with users and application, to support network and services evaluation for PPDR purposes through the use of human-editable configuration files. As output, the tool provides performance measurement (throughput, delay, jitter) for each flow of the network, along with queue and physical layer statistics. As future work, we plan to integrate output aggregation techniques, in order to provide to PPDR stakeholders a complete tool to evaluate the future PPDR networks.

6. ACKNOWLEDGMENTS

7. REFERENCES

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[5] "Options for PPDR Reference Architecture and Services." Project Deliverable D3.3, December 2014.
[6] "Specification of validation scenarios and tools." Project Deliverable D5.1, December 2014.
[7] "Preliminary report on technical validation of future PPDRs technologies and architectures." Project Deliverable D5.2, December 2014.