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A Comparison of Network Simulators for Wireless Networks

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ABSTRACT: In communication and computer network research, network simulation is a method where a program models the conduct of a system. This is done either by computing the connection between the distinctive system elements utilizing mathematical formulas, or from real time perceptions from a production network. The software which predicts the behaviour of the computer network is known as network simulator. There are number of network simulators such as NS-2, OMNET++. OPNET, Prescan and Veins etc. Therefore, the main problem for the researchers is the selection of network simulator for the evaluation of a particular research work. The main focus of this paper is to compare open source network simulators and to identify an optimal network simulator for the research community. We briefly survey new developments in the field of network simulation and conduct a performance comparison between network simulators ns-2, and OMNET++.

KEYWORDS: OPNET, OMNET++, NS-2, Prescan, Veins..

I.INTRODUCTION

Network simulation is unquestionably a standout amongst the most prevalent assessment approaches in the area of computer networks. It is generally used for development of new communication architectures and network protocols. Network simulation is the mostly used to evaluate different network topologies without real world implementation. Network simulators are used mainly because traditional analytical methods results very complex communication networks for providing an exact understanding of the behaviour of the network. The network of the simulators is generally made with devices, applications etc. and the performance is analysed in simulators. Research community are widely use Network simulators for evaluate new theories and hypotheses. In computer networks, new untested protocols cannot be released in a large scale due to the variation of its successful results [1]. Therefore, by using analytical modelling or simulation tools, the new protocols/schemes are testing. If the new protocols generates promising results after the simulation, the corresponding protocols are implemented in the real world. Most available network simulation tool kits are based on the paradigm of discrete event-based simulation (DES) [1]. Here, when a packet is sent to another node for an instance, the simulator network nodes trigger events. The simulator maintains an event queue sorted by the scheduled event execution time [1].

Computer-based simulation plays an important role in the research work to help the researchers and network designers to understand the behaviour and performance of the networks and its protocols. For testing the planned capacity of networks and to meet customer requirements, computer simulation is commonly used. Other than that, simulation is also used to inquire into a large range of potential protocol designs through rapid evaluation and iteration. In case of researchers, the selection of a network simulator is the main task for the purpose of evaluating research work. However, for evaluating proposed protocols/techniques, different types of simulators require different factors like variable time, memory and computation power.

In this paper, we focus on current developments regarding open source simulators. In Section II, we provide a brief overview of network simulators which have recently gained attention in the research community. In Section III, the main content of the paper i.e. comparison between two simulators ns-2 and OMNET++. In Section IV, we discuss performanceevaluation studies and compare their results. We conclude inSection V with the lessons we learned from this performance comparison.

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II.BACKGROUND OF WORK

There are a wide variety of network simulators, utilized in different situation as per researcher's requisites. Simulators may be perplexing or simple. As the matter of fact all the simulators must enable a user to represent a network topology, designating the nodes on the network, the links between those nodes and the traffic between the nodes. More perplexing simulators may allow the user to specify everything about the protocols used to handle traffic in a network. In this section we have discussed some common simulators in use.

A. PRESCAN

PreScan is a physics-based simulation platform that is used in the automotive industry for development of Advanced Driver Assistance Systems (ADAS) that are based on sensor technologies such as radar, laser, camera and GPS [2]. PreScan is also used for designing and evaluating vehicle to vehicle or V2V communication and vehicle to others or infrastructure (V2I) communication applications as well as autonomous driving applications. PreScan can be used from model-based controller design (MIL) to real time tests with software in the loop (SIL) and hardware in the loop (HIL) systems. PreScan simulation platform consisting of a GUI-based pre-processor to definescenarios and a run-time environment to execute them. PreScan can operate in open-loop & closed-loop, and offline & online mode.

B. OPNET

OPNET provides an entire environment to simulate, model and evaluate performances of all types of wireless and wired communication networks and distributed systems. OPNET is available in many platforms like Windows, Linux and Solaris. A set of scenarios includes in a project is represented OPNET simulation. The respective project is created by a editor known as OPNET central interface. This interface can access all the functions of the simulator. The environment of OPNET includes graphical tools for scenarios, data collection, scenarios simulation and data analysis. One of the main functions which is special in OPNET is High Level Architecture (HLA) module. This function allows the communication between different simulators. In OPNET modelling of a network is done within the modelling environment. The modelling environment includes three domains such as network domain, node domain and process domain. Network domain defines the communication network topology to simulate and the node domain includes the nodes defined the network domain and last the process domain explains each and every module that can be programmable by the user. The analysis and visual results is obtained through the analysis tool and filter editor of OPNET. By using analysis tool the results can be generated as graphs. Main drawback of OPNET is, if the specific component have to be developed it is very complex to use.

C. VEINS

Veins is an open source simulator. It is based on two generally used simulators such as OMNeT++ and SUMO. Veins simulatormodels are executed by an OMNeT++ simulator while interacting with a SUMO simulator. Other components of Veins take care other functions such as setting up, running, and monitoring the simulation. Veins includesa big number of simulation models that can be used to vehicular network simulation. It is not needed all of them in every simulation but, for some of them makes sense to instantiate at most one in any given simulation.
As mentioned earlier, to run the veins simulations the other simulators such as SUMO and OMNET++ have to be run parallel for the TCP socket connection. The protocol for this respectivecommunication is standardized as Traffic Control Interface (TraCI). Bi-directionally coupled simulation of road traffic and network traffic allows by this protocol. Movement of vehicles in the road traffic simulator SUMO is reflected as movement of nodes in an OMNET++ simulation [3].

III.COMPARISON OF OMNET++ AND NS-2 SIMULATOR

OMNET++ is an open source, component-based, modular and open architecture environment for discrete event simulation [4]. It is free of charge for academic and non-benefit utilize. Simulation of communication networks is its main application range. It is generally uses in the areas like the simulation of complex IT systems, queuing networks or hardware architectures because of its generic and flexible architecture. OMNET++ is not a network simulator however, it is currently gaining popularity as a network simulation platform in the scientific community as well as in

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industrialones, and building up a large user community [4]. OMNET++is composed of Graphical network editor, Kernel library, Command line interface, a model documentation tool fordocumentation.

Main advantage of OMNET++ is that, it provide powerful GUI. It will makes easy the actions like tracing and debugging as compared to other simulators. Another remarkable one is that it can simulate the power consumption problems in wireless sensor networks. The number of protocols available is not larger enough is one of the limitation of OMNET++. Moreover the compatible problem will occur when each groups in network develop models separately.

NS-2 stands for Network Simulator version two which is firstly developed in 1989. NS-2 is a discrete event network simulator built in Object Oriented extension of Tool Command Language and C++ [5]. It can use both as wire and wireless area and a popular nonspecific simulator. The outputs generated by NS-2 will be in different formats such as General format trace files, NAM format trace files, personalized trace files and all. The interface of NS-2 simulator is shown in figure 1.

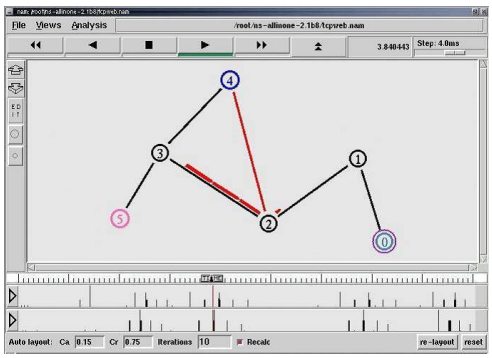

Fig. 1. NS-2 Interface

As compared to OMNET++, NS-2 is cheap and complex scenarios can be easily tested. Also the results will generate very quickly. A large number of protocols in all layers is supported in NS-2 simulator. Main limitation with this simulator is its complexity to model in real time and issue with its scalability. As compared to OMNET++, the main drawback is NS-2 didn't have a GUI which results very poor graphical support. And also the result may not be consistent due to the changing of code base continuously.

IV.PERFORMANCE COMPARISON

For the comparison of two simulators, a basic network is generated as a reference model as shown in figure 2. In this corresponding network, a sending node generates a packet of message in every second and sends to neighbours. Theunseen messages of neighbouring nodes creates delay in network and results flooding the entire network. By delaying the simulation events execution and the explicit queueing policy is not implementing in nodes, the propagation delay is directly implemented. Packets dropped in the channel by a fixed probability which is same in all links.

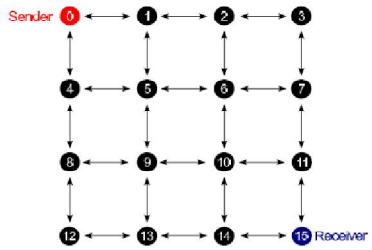

Fig. 2. Reference Network[1]

Simulation Run-Time: It means that the total time taken by the simulator for a simulation of particular network. The Simulation run time representation of OMNET++ and NS-2 simulator is shown in figure 3. For a network size of 3000

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nodes, NS-2 takes more time as compared to OMNET++. This performance measure is undergone in Java platform and slight variations can be occur if it's in other platforms. Totally the run-time performance of OMNET++ is slightly better than the NS-2 simulator.

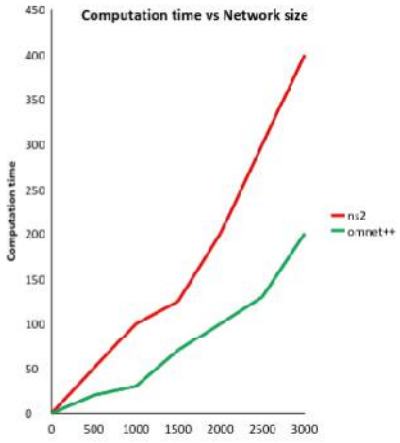

Fig. 3. Simulation Run Time representation

Memory Usage: Similar to the analysis of simulation run-time, the memory usage of OMNET++ and NS-2 is represented in figure 4. Here Memory usage means that how much memory is using while the simulation runs by a corresponding simulator. As the figure represents, the memory usage performances of both the simulators are similar linear growth of memory usage. But slightly OMNET++ has more efficient than NS-2 in the case of memory usage.

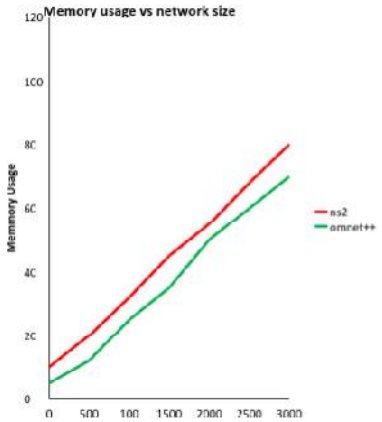

Fig. 4. Memory Usage representation

V. CONCLUSION

In the present scenario, simulators are widely used fordifferent types of applications like Cooperative IntelligentTransport Systems and all. Connected and automated drivingscenarios are happening in near future. Connected andautomated functions in vehicles need to be thoroughly testand evaluate. Connected and automated functions meansthat vehicles are able to communicate with other vehicleswith reduced or without direct human operation. Simulationis one cost efficient and safe way alternative to performtesting and evaluation. Simulation is one cost-efficient andsafe way alternative to perform testing and evaluation. Alsothe simulators provided a path to reproduce new testing conditions and a testing environment.

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In this paper, we checked the performance requirements and the memory usage of two different simulators. In both cases, OMNET++ performance is slightly inferior than NS-2 simulator. As the use of different research work, researchers must consider the advantages and limitations of different simulators under different conditions. The NS-2 and OMNET++are best choices in terms of open source simulators in research.NS-2 is generally common in academic research but the main limitation is its complicated architecture. OMNET++ is generally used in industrial area and as compared to NS-2, it has well designed simulation engine and powerful GUI.

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