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Combine Simulation Environments for Dynamic Communication Network

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Abstract: Simulators are popular in nearly every field of engineering, like vehicle dynamics, network communication, and electronics. When it comes to simulate the behaviour of an intelligent system (IS), these fields suddenly overlap which calls for a combined simulation environment, where sensing, electronics and communication need to be simulated. Due to the fact that a future IS most likely uses wireless communication, this communication becomes the backbone of the intelligent system (IS). Then Realistic simulation is a necessary tool for the proper evaluation of newly developed protocols for Vehicular Ad Hoc Networks (VANETs). Modifying the structure of Network Simulator ns-3 and opportunity of interconnection with external application within the limits of combined simulation environment creating. To show the way how too softly change simulator to the specific goal. The second objective for the project is to check the TCP performances. These evaluations must take road traffic details and conditions, wireless communication characteristics and drivers' behaviour into consideration. In particular, the performance evaluation of research on vehicular networks depends mainly on simulations. This work is dedicated to modifying the structure of ns-3 network simulator in order to enable interactions with simulator of dynamic models SIMULINK / MATLAB.

Keywords: NS3, Intelligent System (IS), Ad hoc Network, Sensor Network, Vehicular Networks.

I. INTRODUCTION

This Designing and launching an intelligent transport system is a complex and difficult task, due to large amount of components with their parameters that need to be considered both during design and launch. Although, there is a clear picture of the requirements and specification of the ITS (Intelligent Transport System) from an overall perspective down to component level, these specifications rarely capture the complexity which is added by the distributed character of the functionality. Problems that arise due to this added complexity are usually hard to capture in analytical analysis and thus often neglected. Additionally, the outcome of the analysis is also usually affected by uncertainties, due to simplifications and approximations. In order to achieve a higher level of a-priori certainty on the validity of the functionality, virtual verification through using simulator is very helpful and probably the only feasible tool. Additionally, simulator studies can reveal problems in early stages and thereby speed-up both design and launch. Simulators are popular in nearly every field of engineering, like vehicle dynamics, network communication, and electronics, only to mention some. Clearly, when it comes to simulate the behaviour of an ITS, these fields suddenly overlap which calls for a combined simulation environment, where vehicular motion together with sensing, electronics and communication need to be simulated. Due to the fact that a future ITS most likely uses wireless communication, this communication becomes the backbone of the ITS. Proper analysis is therefore indispensable from perspectives of vulnerability, dependability and performance, especially, as road infrastructure is a harsh environment [2].

ITS (Intelligent Transport Systems):

ITS Intelligent Transport Systems is the integration of information and communications technology with transport infrastructure, vehicles and users. By sharing vital information, ITS allows people to get more from transport networks, in greater safety and with less impact on the environment.

The main priorities OR Objective of ITS are:

A] Safe-Mobility: Safety is a key issue for European mobility today. More than 40,000 people die on the road each year and road accidents cost the European economy around 200 billion euro every year [1]. These systems can detect dangers on the road ahead, inform drivers of them even before they are visible, keep vehicles at a safe distance from one another and inform drivers of the local conditions.

B] Eco-Mobility: Mobility is a vital component of modern society, but at the same time, mobility is placing increased pressure on our environment. ITS applications have a key part to play in making transport greener. They have the potential to reduce energy consumption, improve energy efficiency, cut greenhouse gas emissions and reduce our dependence on fossil fuels.

C] Info-Mobility: Real time traffic and travel information is the backbone of any intelligent mobility service. Real time, reliable and personalized traffic and travel information is the key to ensure safer, smarter and more efficient transport systems. Context aware services

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consider the needs, preferences and accumulated travel bonuses of individuals, their environmental signature (CO2 measurements etc), their travel habits etc. The data used by ITS applications must be reliable, accurate and continuously available, also across borders.

II. PAGE LAYOUT

Survey of routing protocols, network simulator, mobile ad-hoc network, wireless sensor network, traffic simulator and Traffic Control Interface module used to couple both network and traffic simulator is presented. VANETs consist of mobile nodes having dynamic topology hence the mechanism of finding, maintaining and using routes for communication is not trivial for fast moving vehicles. Short lifetime of communication link, less path redundancy, unpredictable node density and strict application requirements make routing in VANETs quite challenging. In the related and similar domain of MANETs, there has been extensive research about the routing protocols during the past decade however there is a lack of a systematic comparison and performance evaluation study that presents results about the performance of routing protocols in VANET environment.

Simulation Using NS3

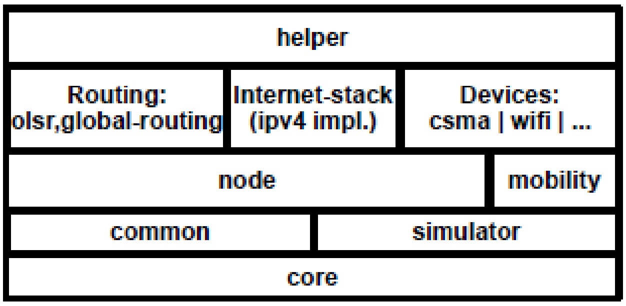


Fig.1 NS-3 Structure

Simulator that is intended to eventually replace the aging NS-2 simulator. NS-3 officially started around mid 2006, and the rst stable version was released in June 2008, containing models for TCP/IP, WiFi, OLSR, CSMA (Ethernet), and point-to-point links, routing", among others. Additional stable versions have been subsequently released, including Python bindings, learning bridge, and real-time scheduler for version 3.2, emulation, ICMP, and IPv6 addresses in NS-3.3, WiFi improvements, object naming system, and \tap bridge" in NS-3.4. Even though NS-2 still has a greater number of models included in the distribution, NS-3 has a good development momentum and is believed to have a better core architecture, better suited to receive community contributions. Core architecture features such as a COM-like interface aggregation and query model, automatic memory management, call back objects, and realistic packets, make for a healthier environment in which to develop new complex simulation models. In addition, it is reportedly one of the better performing simulation tools available today. [09] A wireless network simulator used in VANET research often provides a stack of protocols reflecting the ISO OSI reference model) on top of which the protocol or application under test is implemented. A component managing (possible) connections between nodes often works in conjunction with the propagation model in order to evaluate which nodes are affected by a transmission. The results could be that a node correctly receives a message or receives garbled bits due to a collision. A mobility model can be used to move the nodes around as is generally the case in a VANET either based on measured or generated traffic traces [6], an embedded mobility model [7], [8] or a coupling with traffic simulation software [9], [10]. A simulation can have two goals:

1] Perform a statistical exploration to gain insight in how a system will work in a generic environment, or

2] Perform a site-specific evaluation of a system to gain insight in the operational properties in a specific environment.

Wireless Sensor Network

A sensor network is a set of small autonomous systems, called sensor nodes which cooperate to solve common applications. Their tasks include some kind of perception of physical parameters. A basic sensor node comprises five main components [2] Fig 2.

Controller: A controller to process all the relevant data, capable of executing arbitrary code.

Memory: Some memory to store programs and intermediate data; usually, different types of memory are used for programs and data.

Sensors and actuators: The actual interface to the physical world: devices that can observe or control physical parameters of the environment.

Communication: Turning nodes into a network requires a device for sending and receiving information over a wireless channel.

Power supply: As usually no tethered power supply is available, some form of batteries is necessary to provide energy. Sometimes, some form of recharging by obtaining energy from the environment is available as well (e.g. solar cells).

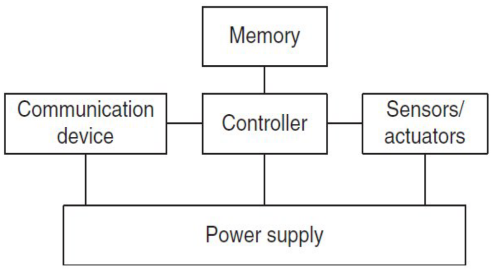


Fig 2: Overview of main sensor node hardware components

A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm (several nodes may forward data packets to the base station). These networks can be used in the following applications: disaster relief applications, environment control and biodiversity mapping, intelligent buildings, facility management, machine surveillance and preventive maintenance, precision agriculture, medicine and health, logistics, telematics. All these applications are performed by one of the following tasks, which sensor networks perform: event detection, periodic measurements, function approximation and edge detection, tracking.

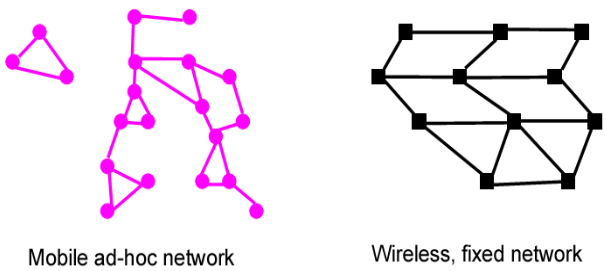


Fig. 3 Ad-Hoc Network

Ad-hoc Network
An ad hoc network is a group of wireless mobile computers (or nodes), in which nodes cooperate by forwarding packets for each other to allow them to communicate beyond direct wireless transmission range. Ad Hoc networks are multi-hop wireless networks where nodes may be mobile. These types of networks are used in situations where temporary network connectivity is needed. Ad hoc networks are formed on a dynamic basis, i.e. a number of users may wish to exchange information and services between each other on an ad hoc basis, in order to do this they will need to form an Ad Hoc network. An example of this may be found in a disaster relief situation. Here an Ad Hoc network could enable emergency services to co-ordinate emergency services more effectively or enable medics in the field to retrieve patient history from hospital databases (assuming that one or more of the nodes in the Ad Hoc network has connectivity to the Internet). Smart spaces are defined as environments that allow people to perform tasks efficiently by offering unprecedented levels of access to information and assistance from computers. Ad Hoc networks will play a significant part in these environments, allowing people to exchange information and services; for example, people at a meeting could create an Ad Hoc network using their PDA's or Laptops and exchange information relevant to the meeting. Indeed there are endless examples of where their use could be found [17].

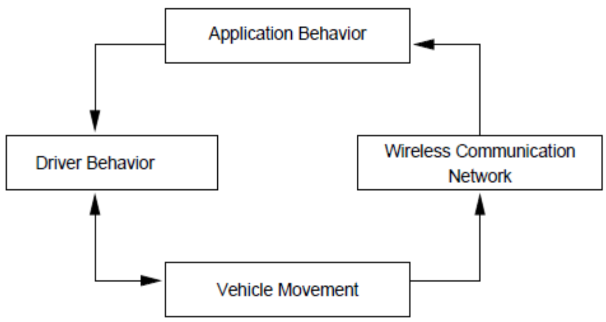
III. SYSTEM MODEL

In general, traffic effects for either safety or efficiency require a changed behaviour in longitudinal and lateral control of single vehicles based on additional information obtained by car-to-car communication. Simulating the traffic, calculating vehicle positions, and then feeding a network simulator with this data is fine for simulating network behaviour in general but provides no means for the traffic simulator to change the movement of the vehicles based on the information received. Traffic flow improvement and active safety applications pose different requirements on the simulation environment. For traffic flow analysis, it is important to model traffic behaviour and route choices drivers are taking with their vehicles based on information they have. Change of behaviour means choosing a different route along the street network based on information on the current traffic situation. Usually, there is some time in the order of seconds or minutes for the single vehicle changing its route after a certain event happened. [22]

System Architecture
NS3: The Network Simulator (NS-3) [1] is a discrete-event network simulator. NS-3 is not backward compatible with NS-2; instead, it is built from the scratch. It is written in C++ and Python Programming Language can be optionally used as an interface. It has extensive doxygen documentation [2], NS-3 is trying to tackle problems present in NS-2 such as lack of memory management, coupling between different models (C++ weak base class problem) etc.

Fig. 4 Overall Simulation System Concepts

Net Device: It used to be the case that if you wanted to



connect computers to a network, you had to buy a specific kind of network cable and a hardware device called (in PC terminology) a peripheral card that needed to be installed in your computer. If the peripheral card implemented some networking function, they were called Network Interface Cards, or NICs. Today most computers come with the

Fig. 5 System Architecture

network interface hardware built in and users don't see these building blocks
Channel: In the real world, one can connect a computer to a network. Often the media over which data flows in these

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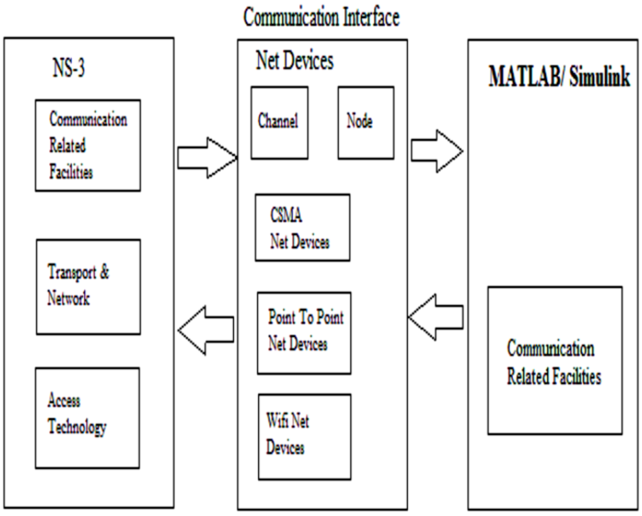

networks are called channels. When you connect your Ethernet cable to the plug in the wall, you are connecting your computer to an Ethernet communication channel. In the simulated world of ns-3, one connects a Node to an object representing a communication channel.

Node: In Internet jargon, a computing device that connects to a network is called a host or sometimes an end system. Because ns-3 is a network simulator, not specifically an Internet simulator, we intentionally do not use the term host since it is closely associated with the Internet and its protocols. Instead, we use a more generic term also used by other simulators that originates in Graph Theory the node. In ns-3 the basic computing device abstraction is called the node.

Simulink: Simulink is a tool for simulating dynamic systems with a graphical interface specially developed for this purpose. Within the MATLAB environment, Simulink is a MATLAB toolbox that differs from the other toolboxes, both in this special interface and in the special "programming technique" associated with it. There is a further difference, in that the source code of the Simulink system is not open, but this is of no concern for our purposes. The goal of this chapter is to introduce simple manipulations with Simulink and to clarify the interaction of Simulink with MATLAB.

IV. Discussion

After successful installation of input and output specification i.e. software go for the developing process. There are only two nodes in this simulation with installed "UdpEchoClientNew" and "UdpEchoServerNew" on both nodes. To have a connection it is necessary to simplify receive/send structures in ns-3 so much as it is possible. For this interaction structure contained two integer variables. This structure used for receiving and for transmission. In case when ns-3 receive structure from MATLAB, first of variable is instruction to transmission or to not for first node and second variable is the same information for second node. In opposite case, first variable is information about first node status (received or not) and the second one for second node. Simulation time is 10 seconds, and simulation was planned by next scenario: during all simulation time, at the end of each simulation step (default 200 milliseconds) data exchange take a place.

V. Conclusion

This work is aimed to creation of a combined simulation environment, which allows spending the different scenarios of vehicle traffic on the roads with sensor nodes with good approximation to reality. The design of sensor networks on the real parts of a road. As outcome of simulation are firstly result of vehicle traffic, rather, reaction of driver on the work of applications which installed on the nodes; secondly result of network communications between nodes. Combined simulation will allow us how simulators are behaving each other & how socket work. The detecting of possible problems in communication between nodes in depended of environment. Problem during this work was to understand the working principle of program ns-3 and understand how the scheduler is filling by events and how the simulation performed. Our main goal is to enable detailed and realistic evaluation of Vehicular Ad-Hoc Network at networking with the help of wireless sensor network. The stated goals were performed in this work. Network simulator ns-3 was supplemented by module for communication with external application via a Socket. All changes were described. This allows adapting this modification of the simulator for specific, & type of TCP/IP version for VANET this is the high level goals in the future.

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