

Modeling and Simulation of WAVE 1609.4-based Multi-channel Vehicular Ad Hoc Networks

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I. Introduction

IEEE 1609.4 Standard for Wireless Access in Vehicular Environments (WAVE) has been proposed to enhance the performance of vehicular networks with multi-channel operations that allow for the coexistence of safety-related and non-safety related vehicular applications. At present, the evaluation of 1609.4-based Vehicular Ad Hoc Networks (VANETs) constitutes an open issue due to the lack of simulation tools that can provide a complete modeling of the IEEE WAVE 802.11p/1609.4 stack.

Given the popularity of ns2 among researchers in wireless networking, and in particular ITS, we opted to develop an implementation of the IEEE 1609.4 protocol for that environment. We believe that this will be especially welcomed by researchers who already have ongoing work in ns2 and therefore could use our implementation to further this work.

In this document, we describe the needed steps to install the WAVE-1609 Tool. For further details about our implementation of the IEEE 1609.4 protocol and its current integration with the existing ns2 implementation of the 802.11p MAC protocol, please refer to the following paper:

Ali J. Ghandour, Marco Di Felice, Hassan Artail and Luciano Bononi, "Modeling and Simulation of WAVE 1609.4-based Multi-channel Vehicular Ad Hoc Networks", 5th ACM International Conference on Simulations Tools and Techniques (SIMUTools 2012), March 19-23, 2012, Sirmione-Desenzano, Italy (Best Paper Award runner-up).

II. Installation

Please follow the following steps carefully to install the WAVE-1609 Tool:

1. Download ns-allinone-2.34 release. You can do this at the following link:
<http://sourceforge.net/projects/nsnam/files/allinone/ns-allinone-2.34/ns-allinone-2.34.tar.gz/download>
2. Extract ns-allinone-2.34.tar.gz.
3. Download and extract the WAVE1609_R1 patch from the following page:
<http://alighandour.info/wave-1609tool/>
4. Copy the patch to the folder: ns-allinone-2.34 (**NOT** ns-allinone-2.34/ns-3.34).
5. Apply the patch using the following commands on your terminal:

```
cd ns-allinone-2.34
```

```
patch -p1 < WAVE1609_R1.patch
```

6. Install Ns2 using the following commands:

```
./install
```

```
sudo make install
```

III. Configuration

To use the WAVE1609 tool, set the *ifq* value in the Tcl code to *Queue/DSRC*. You can do this using the following command:

```
set val(ifq) Queue/DSRC ;
```

A sample Tcl code is made available at the following page: <http://alighandour.info/wave-1609tool/>

The list of affected source codes is available in the following table:

File Name	Remarks
ns-2.34/dsrc/dsrc.h	Main tool
ns-2.34/dsrc/dsrc.cc	Main tool
ns-2.34/dsrc/channel_sched.h	Main tool
ns-2.34/dsrc/channel_sched.cc	Main tool
ns-2.34/dsrc/dsrc_app.h	Main tool
ns-2.34/dsrc/dsrc_app.cc	Main tool
ns-2.34/dsrc/dsrc_const.h	Main tool
ns-2.34/dsrc/round_robin.h	Main tool
ns-2.34/dsrc/round_robin.cc	Main tool
ns-2.34/mac/mac.h	Changes that can be avoided in later releases
ns-2.34/mac/mac-802_11Ext.h	Changes that can be avoided in later releases
ns-2.34/mac/mac-802_11Ext.cc	Changes that can be avoided in later releases
ns-2.34/mac/wireless-phyExt.h	Changes that can be avoided in later releases
ns-2.34/common/packet.h	
ns-2.34/tcl/lib/ns-default.tcl	
ns-2.34/tcl/lib/ns-packet.tcl	
ns-2.34/trace/cmu-trace.cc	

IV. Conclusion

For any inquiry related to the tool, feel free to contact Ali Ghandour at ajg04@aub.edu.lb.

Please cite the following paper when using this tool:

Ali J. Ghandour, Marco Di Felice, Hassan Artail and Luciano Bononi, “Modeling and Simulation of WAVE 1609.4-based Multi-channel Vehicular Ad Hoc Networks”, 5th ACM International Conference on Simulations Tools and Techniques (SIMUTools 2012), March 19-23, 2012, Sirmione-Desenzano, Italy (Best Paper Award runner-up).

Also, you are encouraged to consider and cite the following two papers:

Marco Di Felice, Ali J. Ghandour, Hassan Artail and Luciano Bononi, “On the Impact of Multi-channel Technology on Safety-Message Delivery in IEEE 802.11p/1609.4 Vehicular Networks”, 21st IEEE International Conference on Computer Communication Networks (ICCCN 2012), July 30 – August 2, 2012, Munich, Germany.

Marco Di Felice, Ali J. Ghandour, Hassan Artail and Luciano Bononi, “Enhancing the performance of safety applications in IEEE 802.11p/WAVE Vehicular Networks”, 13th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2012), June 25-28, 2012, San Francisco, USA.

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