Enabling ITS Real World Experimentation in NITOS Future Internet facility

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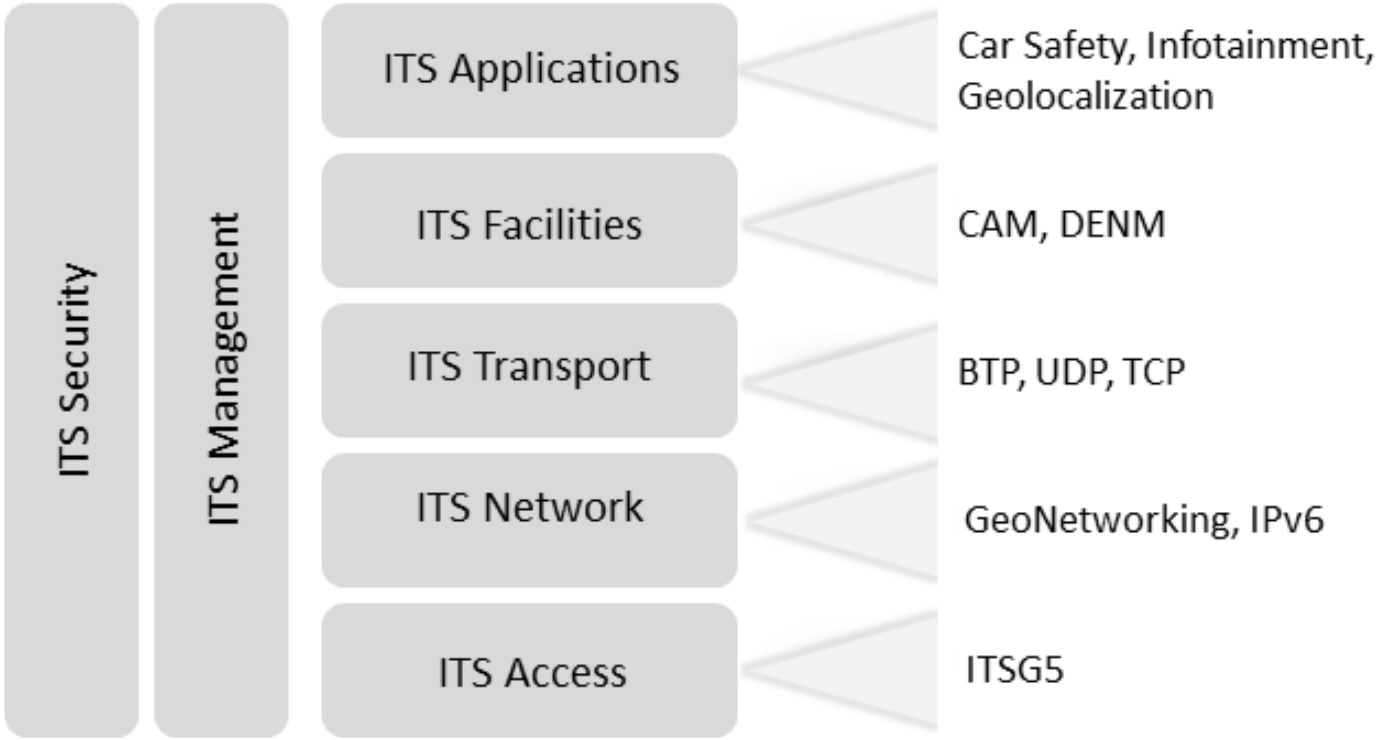
Overview

- **Introduction – Background Knowledge**
- Motivation
- Implementation
- Evaluation
- Future Work

Background Material

- The ITS protocol stack:



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Background Material

- ETSI TS 102 436-4-1 : Intelligent Transport Systems (ITS); Vehicular communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality
- Location Information included in every packet sent out of the ITS station.
- Different types of messages: Beacons, Single Hop Broadcast, Topologically Scoped Broadcast, GeoBroadcast/GeoAnycast, GeoUnicast, Location Service

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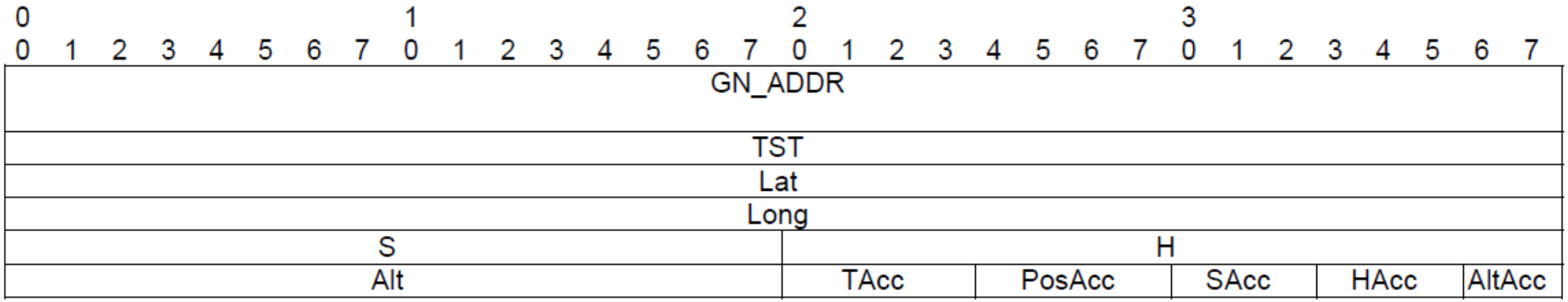
What type of Location Information?

- Using Long Position Vectors, included in every packet.
- If the ITS station is a relay, it adds it's own LPV.
- Contains geographical information of each ITS STA.



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Background Material

- GeoNetworking Interoperability: Using an IPv6 adaptation sublayer
- Usually employed when data needs to be transmitted to the Internet
- The ITS Station offloads them to the Road Side Unit (RSU) which takes care for removing the GeoNetworking headers.

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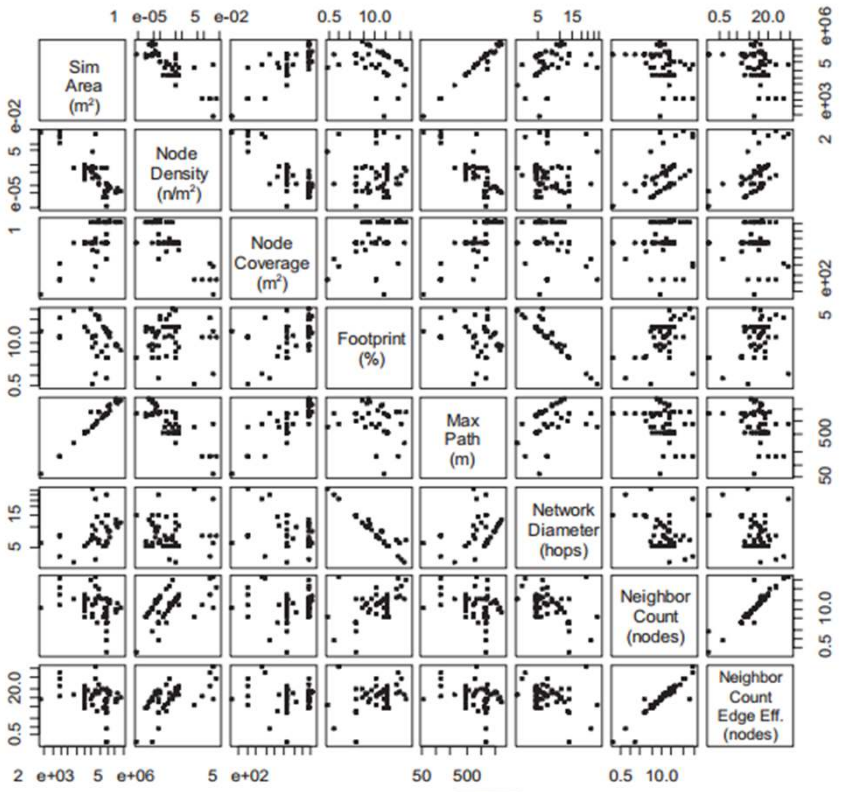
Motivation

- IVC research is mainly conducted using simulations
- When involving the wireless medium, simulations seem to be inaccurate compared to evaluation under real world settings.
- Simulation parameters reported across 61
  Mobile Ad-Hoc Network (MANET) papers



Stuart Kurkowski, Tracy Camp, and Michael Colagrosso. 2005. MANET simulation studies: the incredibles. *SIGMOBILE Mob. Comput. Commun. Rev.* 9, 4 (October 2005), 50-61.

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Motivation

- Therefore, the need for wireless testbeds is obvious.
- Currently, no testbed is able to offer experimentation with the ITS stack!
- Several other implementations exist, but they lack in providing the whole stack rather than single components (eg. CarGeo6).

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Implementation

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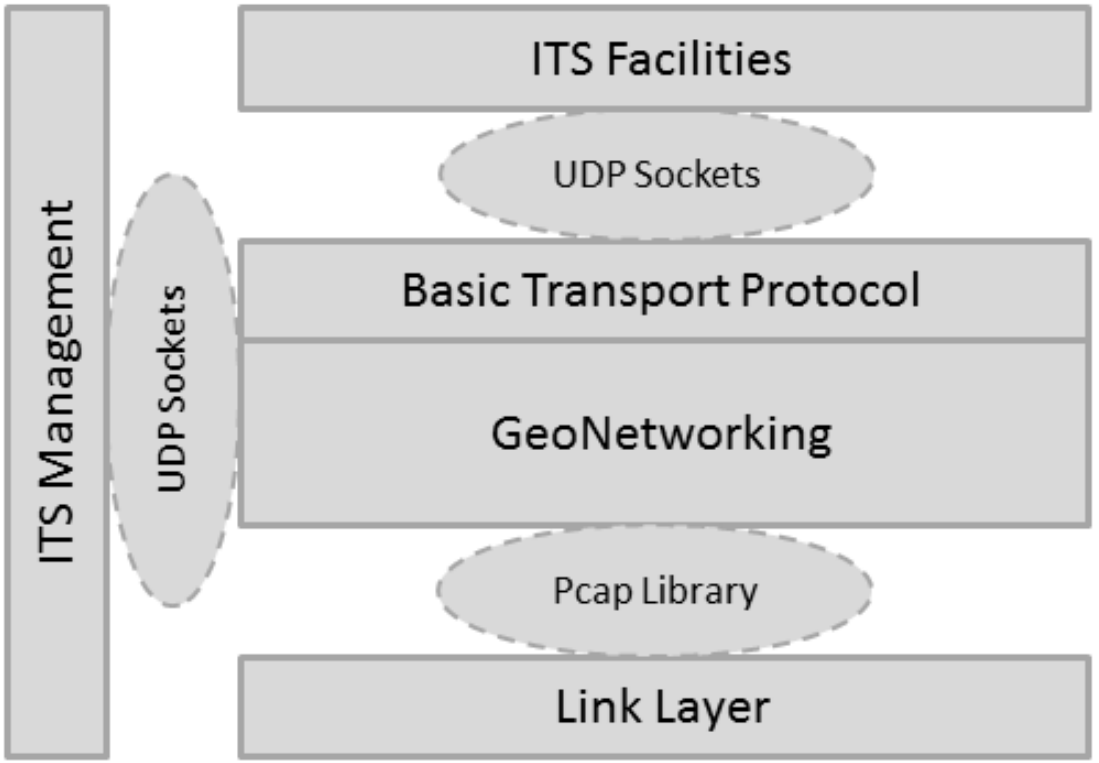
Components used



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Facility Layer

- Used to generate traffic over our platform
- Supports encapsulation of packets in Cooperative Awareness Messages (CAM) or Decentralized Environmental Notification Messages (DENM) (ETSI TS 102 637-3: ”Intelligent Transport Systems (ITS); Vehicular communications; Basic Set of Applications; Part 2 & 3)
- The selection of the Facilities layer protocol is triggering a different transport protocol.
- Facility layer is running as a separate application that the GeoNetworking Core.

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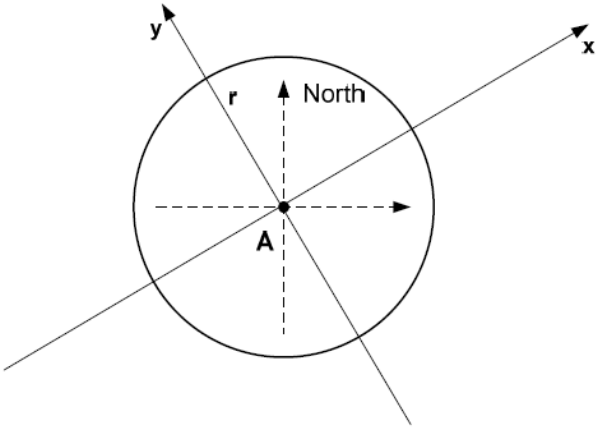
GeoNetworking Core

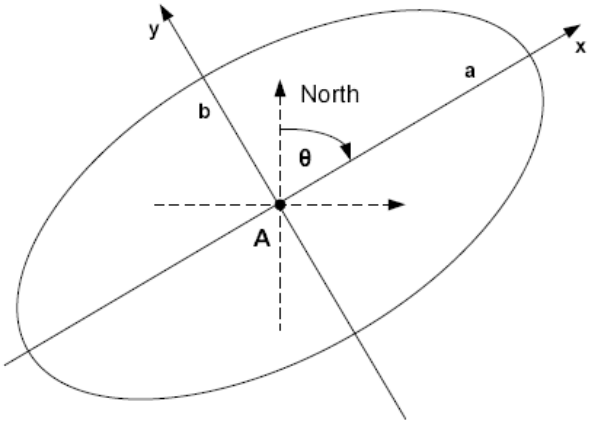
- Running as a multithreaded daemon.
- Implemented full GeoNetworking functionality.
- Integrated the ETSI TS 102 636-5-1 standard, used for implementing the Basic Transport Protocol (BTP).
- What about Geographical areas?

GeoNetworking Core

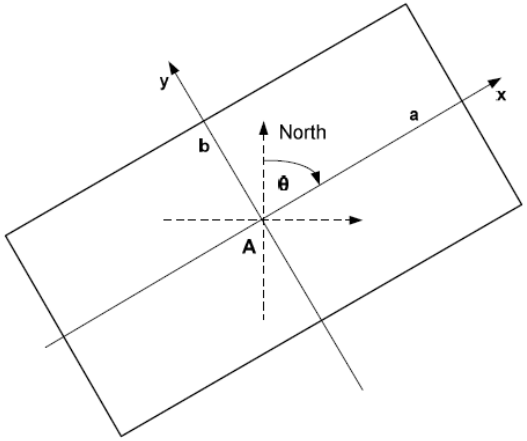
- ETSI EN 302 931
- Defining 3 different types of areas, using 3 variables.



Circular Area



Elliptical Area



Rectangular Area

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Link Layer

- Using the Microtic R52 card,
  able to transmit in the 5.9GHz band
- Compatible with the ath5k
  Open Source driver which supports
  injection of packets.
- Pcap library used to directly inject
  packets on the driver.

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Mobility Emulation

- Usually a testbed's nodes are static.
- Using gpsd and gpsfake we enable mobility at the GeoNetworking layer of the node.
- gpsfake is used to parse NMEA sentences from a text file and then directly feed them to gpsd.
- gpsd can be queried at any time by any other application about a node's position, returning it in a JSON format.
- Management Layer: Separate application used for updating the position of the GeoNetworking Station.
- Queries gpsd, and sends the appropriate Position Update Messages to the Geonetworking Core.

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Implementation

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Evaluation of the Platform

- The evaluation took place in the NITOS Future Internet facility.
- Started in 2008 and has been supported by several EU funded programmes.
- Currently: 50 outdoor nodes using heterogeneous wireless technologies (WiFi, WiMAX, LTE), SDR and SDN.
- We conduct our experiments using a subset of the nodes and WiFi or Ethernet technology.
- We evaluate our platform against the CarGeo6 Open Source implementation.

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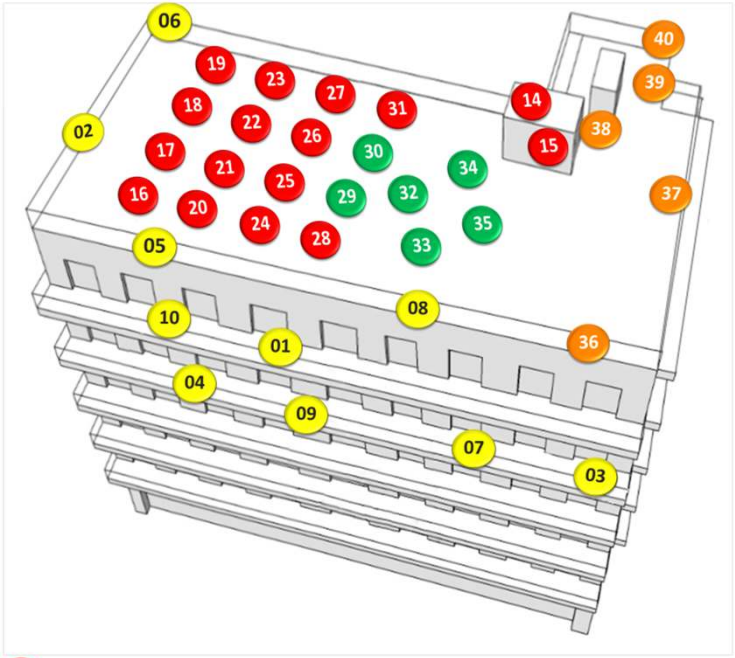
3-Hop Delay Measurement

- We measure the 3-hop delay by generating CAM packets encapsulated in TSB messages.
- Compare it to traditional IP routing.
- Used the dummynet application to filter the incoming requests per MAC address.
- ~60% performance degradation when using the GeoNetworking implementation.



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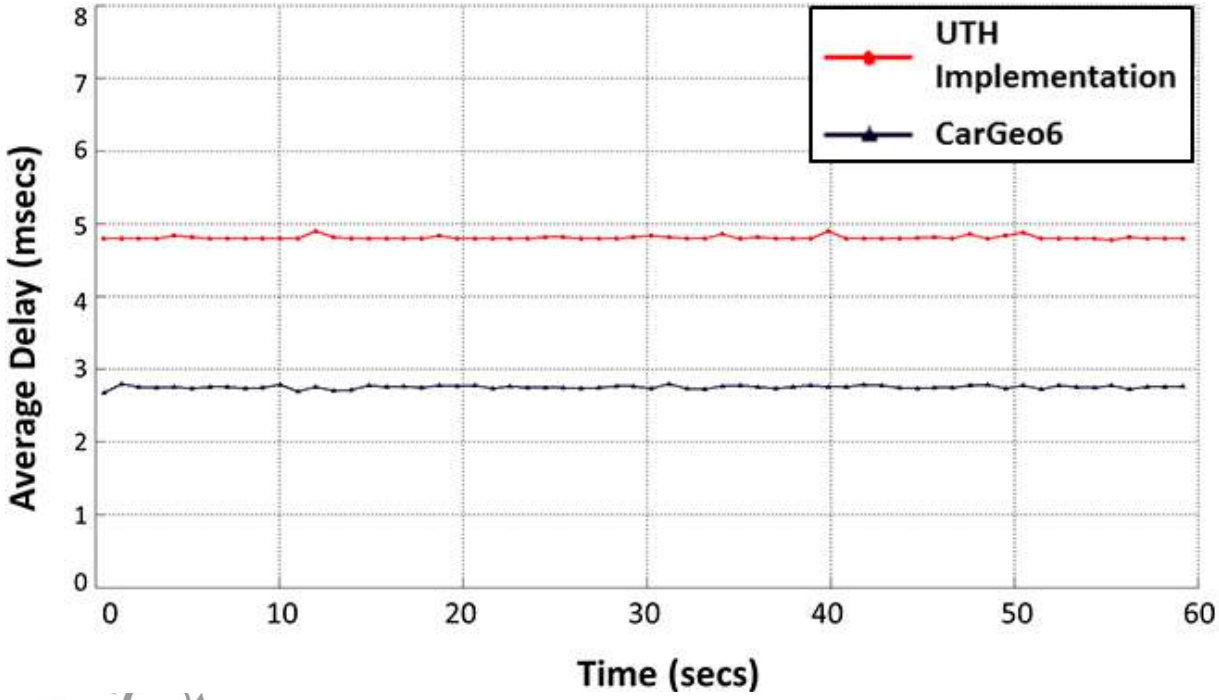
Comparison with CarGeo6 (1/2)

- As CarGeo6 only provides the GeoNetworking Core, we had to alter it in order to communicate with our facility layer.
- We measure one hop delay over the Ethernet link for cases of variable traffic conditions.



Delay measurement for intense traffic

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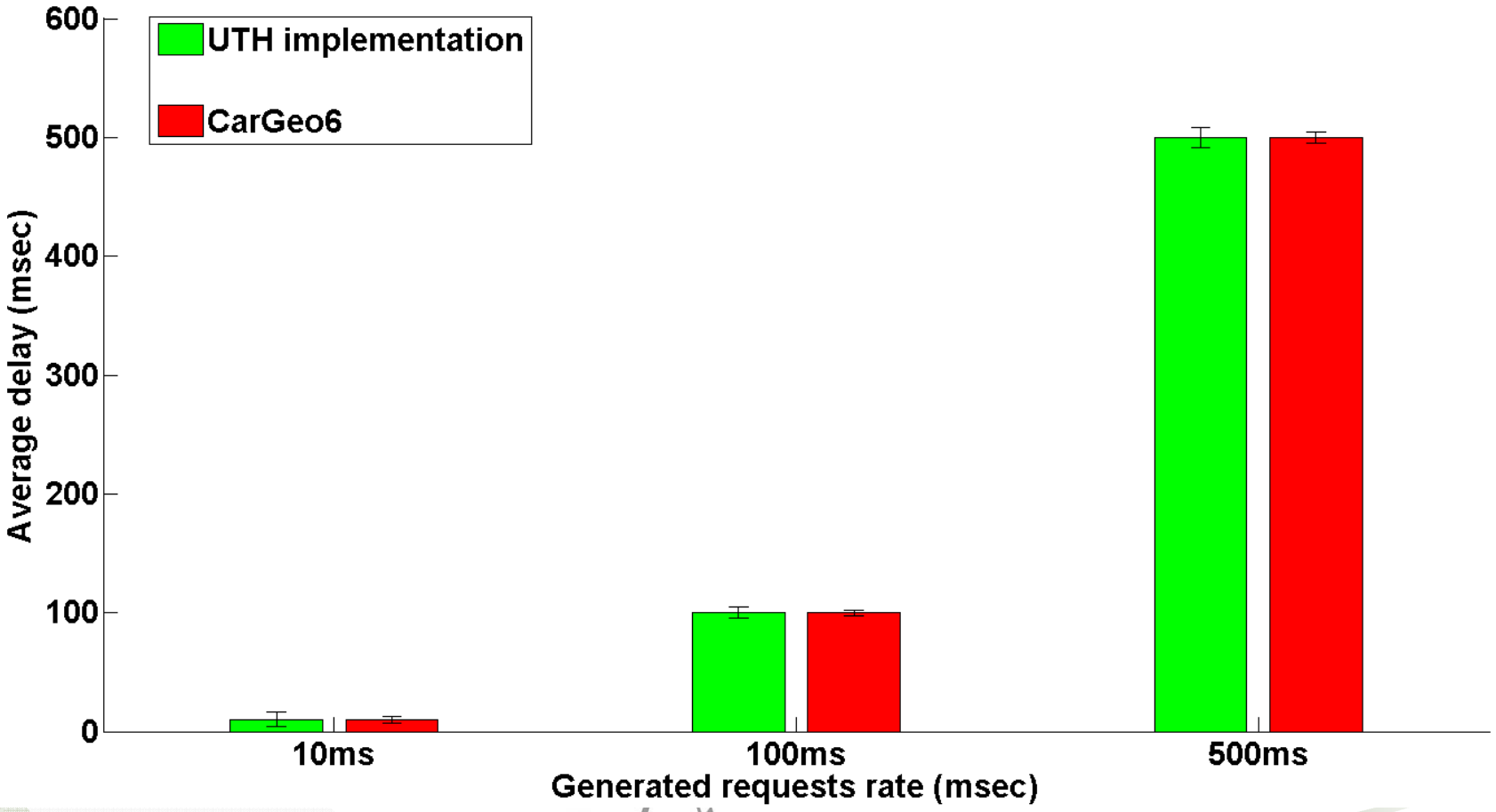
Comparison with CarGeo6 (2/2)

- Delay measurement for traffic generated at different rates



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Future Work - Conclusions

- Change the access mechanism over the network
- Implement the IPv6 Adaptation Sublayer that will enable using GeoNetworking with existing applications.
- Cross Layer Optimizations with the Open Source driver that runs at the MAC layer.

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Thank you!