

Navigo: Interest Forwarding by Geolocations in Vehicular Named Data Networking

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Navigo is a location based packet forwarding mechanism for vehicular Named Data Networking (NDN)

- Navigo discovers the geographic area where the data resides
- It proposes an algorithm to guide the data requests along the shortest path on the V2V channel over the road topology

Outline

1 Introduction

- NDN

2 Navigo

- Design
- Interest forwarding at NDN layer
- Steering Interests

3 Experiments - Simulation

- Scenario
- Results

4 Conclusion

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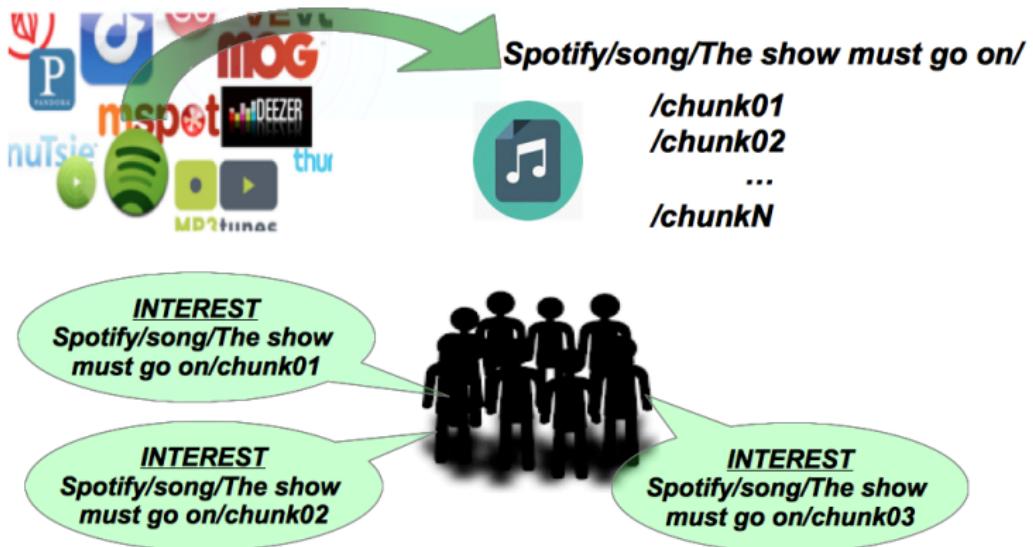
4 Conclusion

NDN - the best fit for VANET

NDN puts **contents** at the center of its communication model

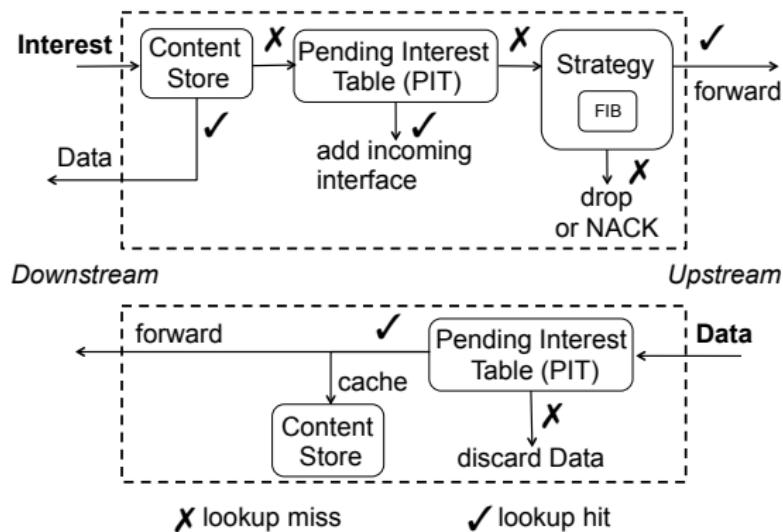
- IP is host centric: it has difficulties coping with mobility and multihoming
- Naming data decouples communication from specific interfaces and endpoints.
- NDN naturally supports multihoming and mobility.
- Each application names the data it wants to fetch or provide
- The network directly uses these names to process the packets

NDN - Naming Data



NDN - Architecture

- The network directly uses these names to process the packets
 - Interest goes through CS, PIT and FIB
 - Content follows the Interest breadcrumbs left in the PIT



V-NDN: the first implementation of NDN for VANET

- It introduces a 2.5 Link Adaptation Layer (LAL) which:
 - Enables NDN over 802.11-broadcast
 - Provides reliability capabilities and duplicate suppression
- Limitations: lack of smart packet forwarding mechanism

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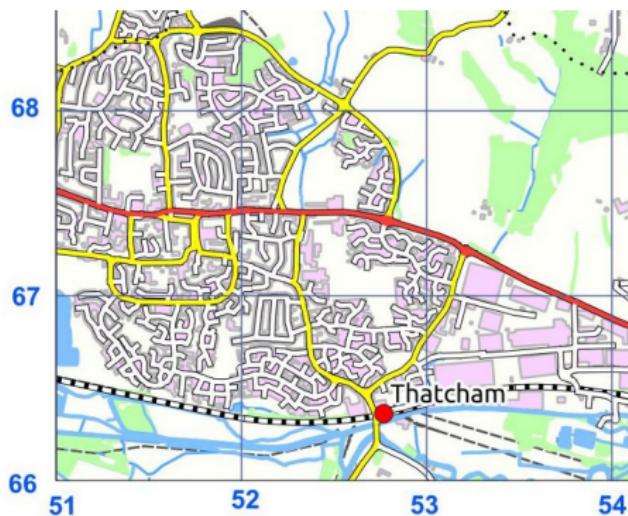
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Naming geographic areas

- The world is divided into regions according to the Military Grid Reference System (MGRS)
- Each area is named with a label
 - i.e. 4QFJ 123 678 identifies a 100x100 meters area

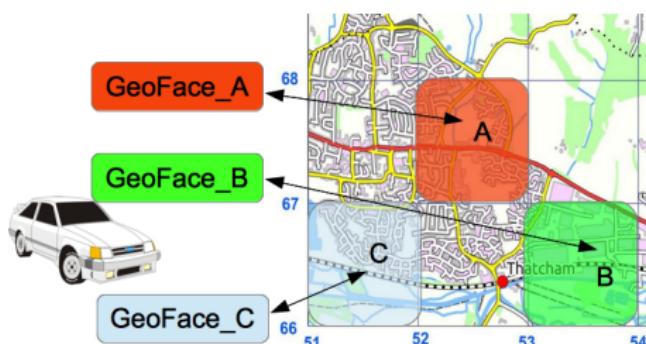


Mapping data names to geo-areas

- Navigo discovers the location (area) of the Data provider (i.e. producer, RSU, caches) and binds it with the Data names
 - The Interest is sent in all the directions if no information about the name is present
 - Data provider attaches its location (MGRS area label) to the Data
 - Nodes learn the new binding

In the NDN architecture there is no such thing as geo-areas

- The forwarding process is based on the FIB, which stores names-faces pairs only
- Navigo introduces the concept of geographical faces (GeoFace): an abstraction to the network physical interface
 - It binds each geo-area to a GeoFace
 - GeoFace_A sends packets only towards the geo-area A and receives Data generated from geo-area A only
 - The FIB stores the binding among data names and GeoFaces
 - An application may bind a name with a GeoFace



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Forwarding Interest I for a Content named N

- No match in the FIB \rightarrow Interest flooding
 - If the Content N comes back from geo-area $X \rightarrow$ registers $N\text{-}F\text{-}X$ into the FIB
- Only 1 GeoFaces $F\text{-}X$ for N
 - With probability p (0.95) \rightarrow use $F\text{-}X$ to forward I
 - With probability $1-p$ \rightarrow Exploration phase: flood I
- Multiple GeoFaces for $N \rightarrow$ round robin among the faces
- If I is not satisfied within a certain amount of time \rightarrow remove the binding GeoFace- N

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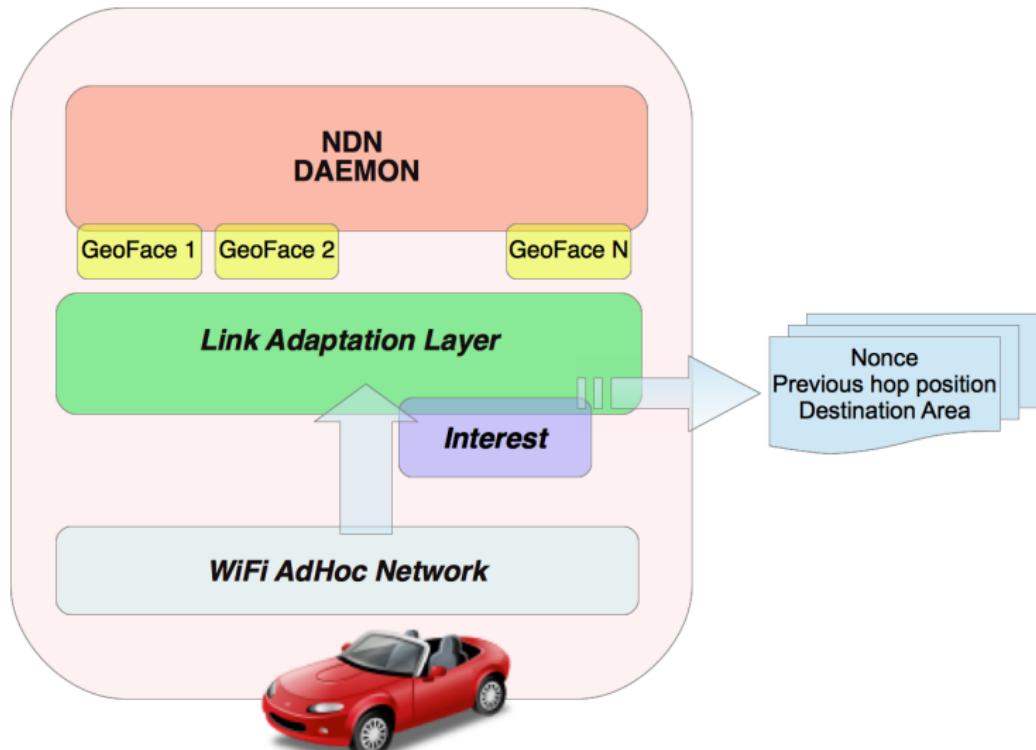
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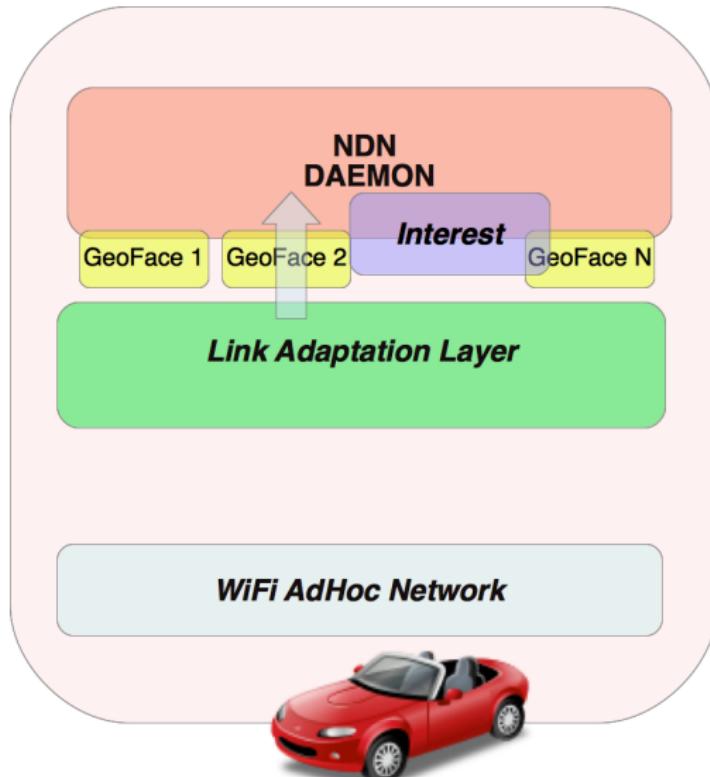
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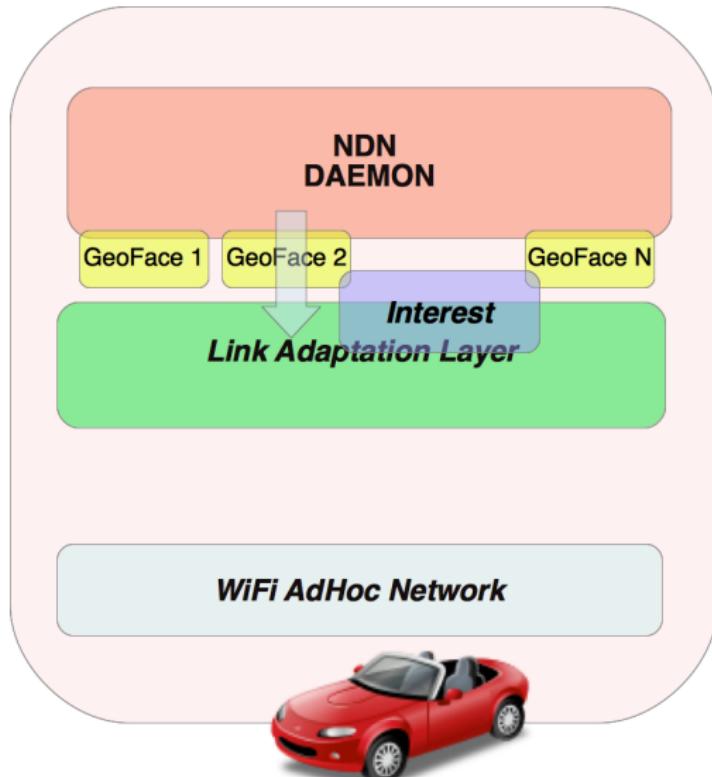
Forwarding process



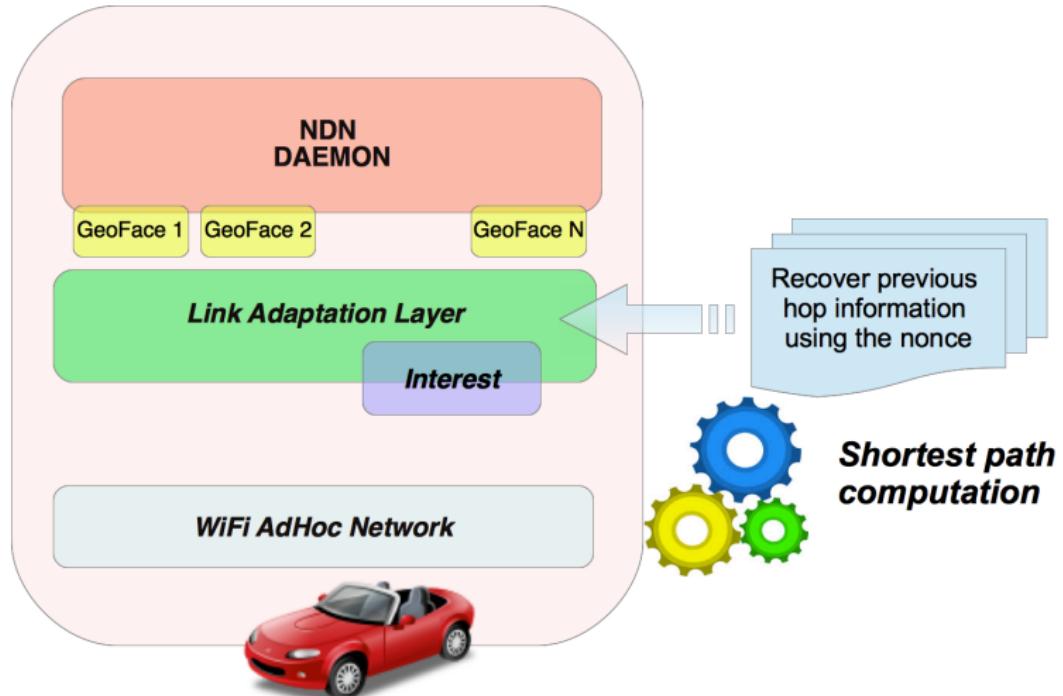
Forwarding process



Forwarding process



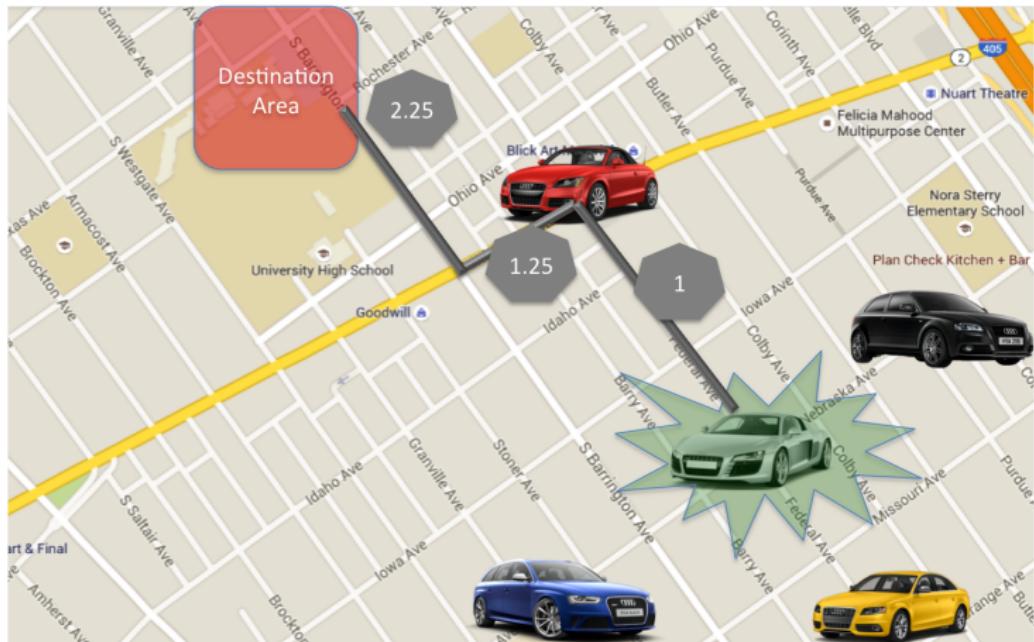
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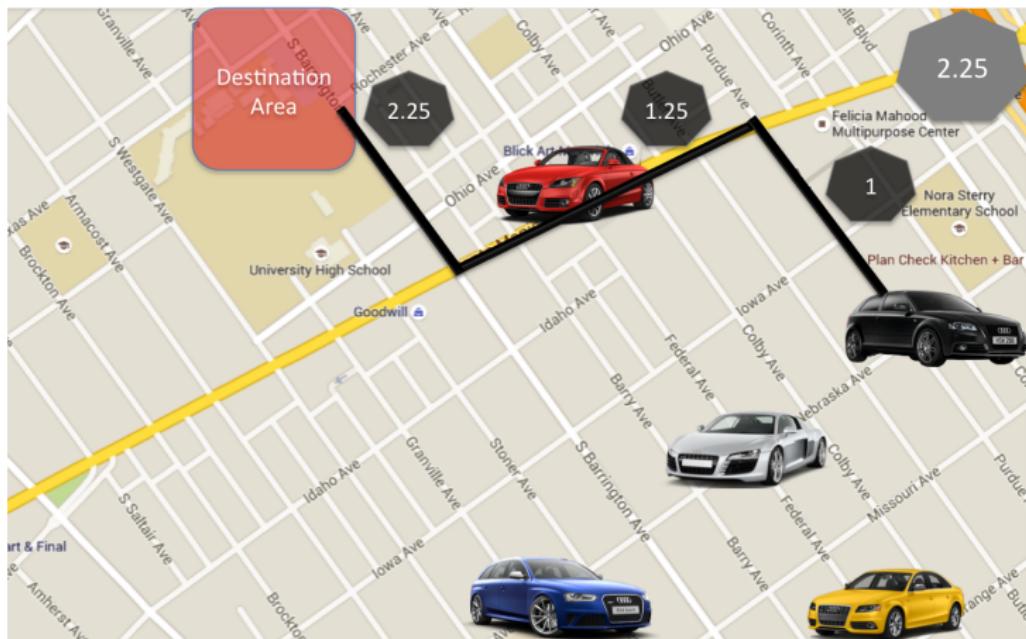
Road topology as forwarding graph

- Using cars as building block of a path exposes the communication to vehicles movement
- Using roads as path for the packet is more reliable
- Navigo uses Dijkstra on the road graph to compute the shortest path to reach a destination area
- Main roads have priority over small streets

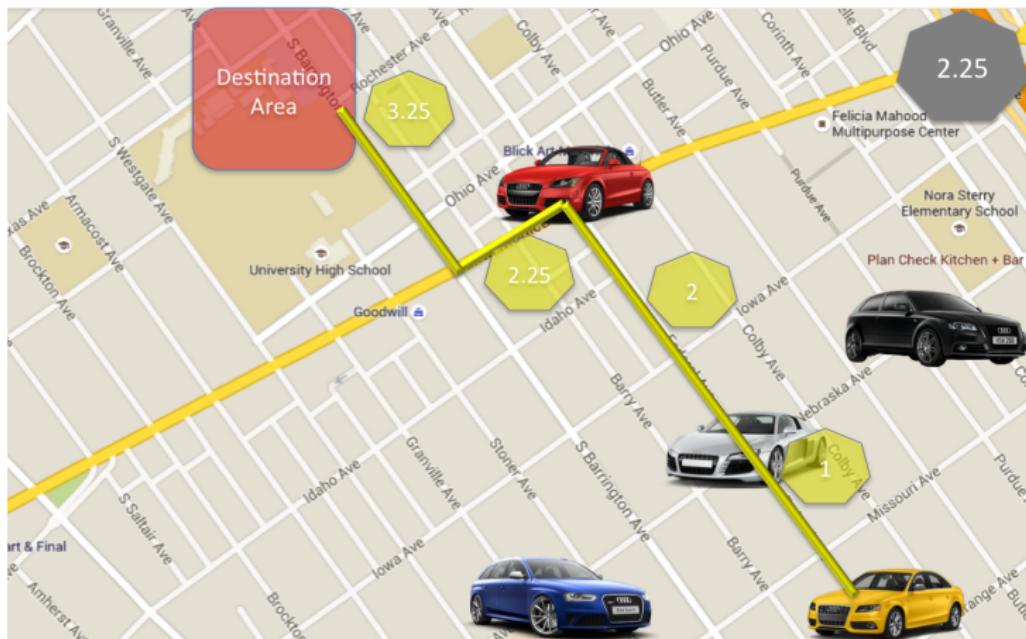
Shortest Path



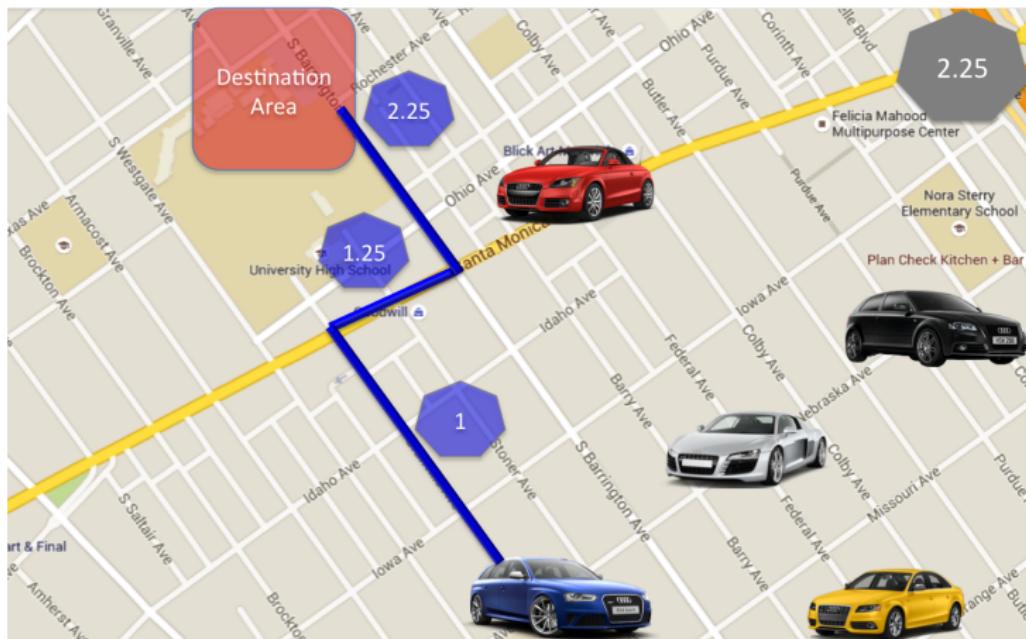
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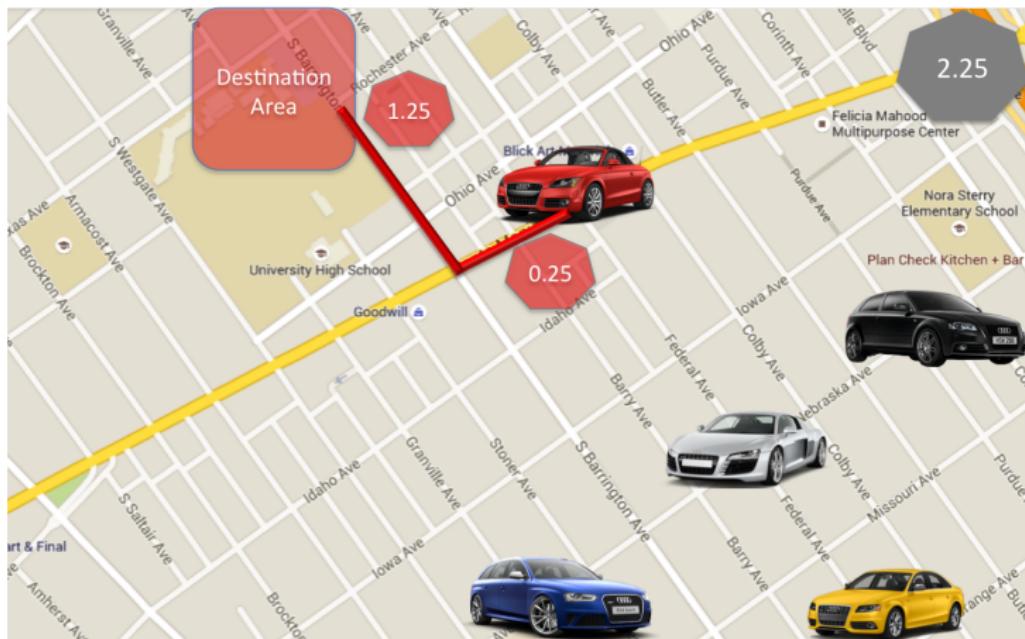
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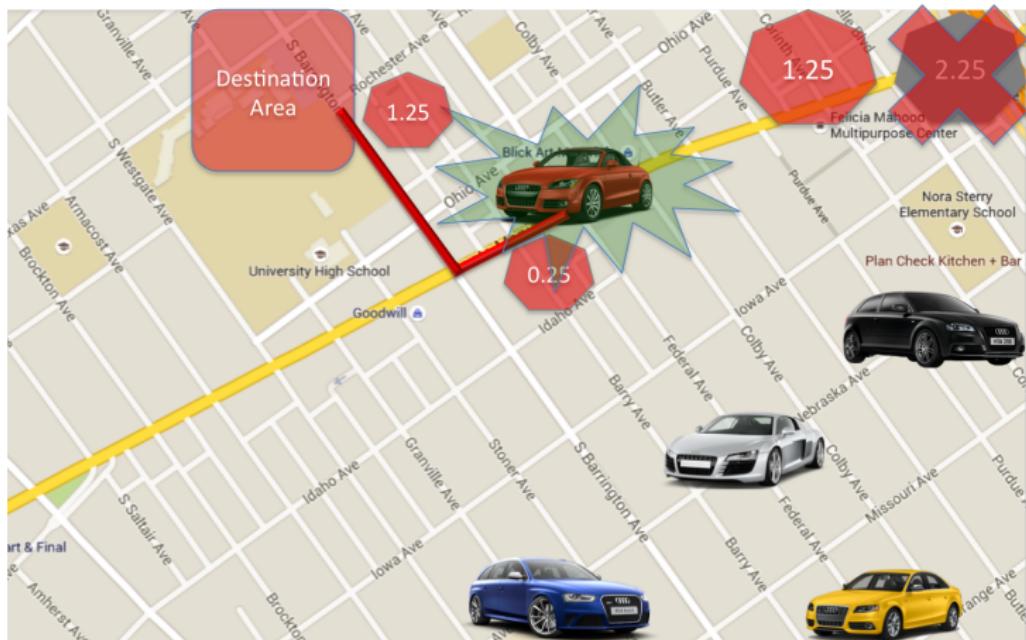
Shortest Path



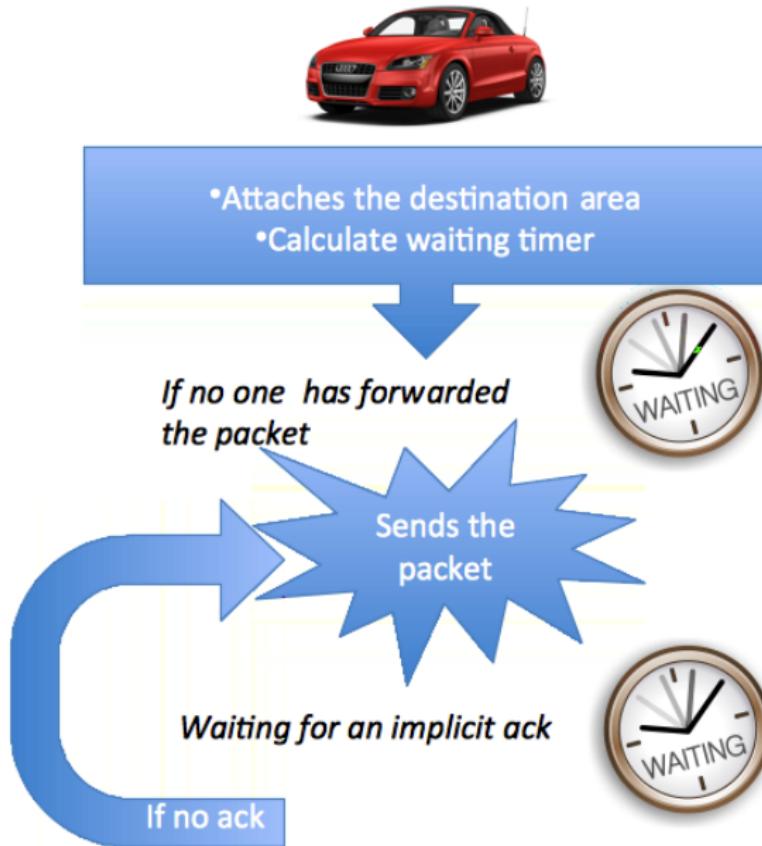
Shortest Path



Shortest Path



Forwarding process

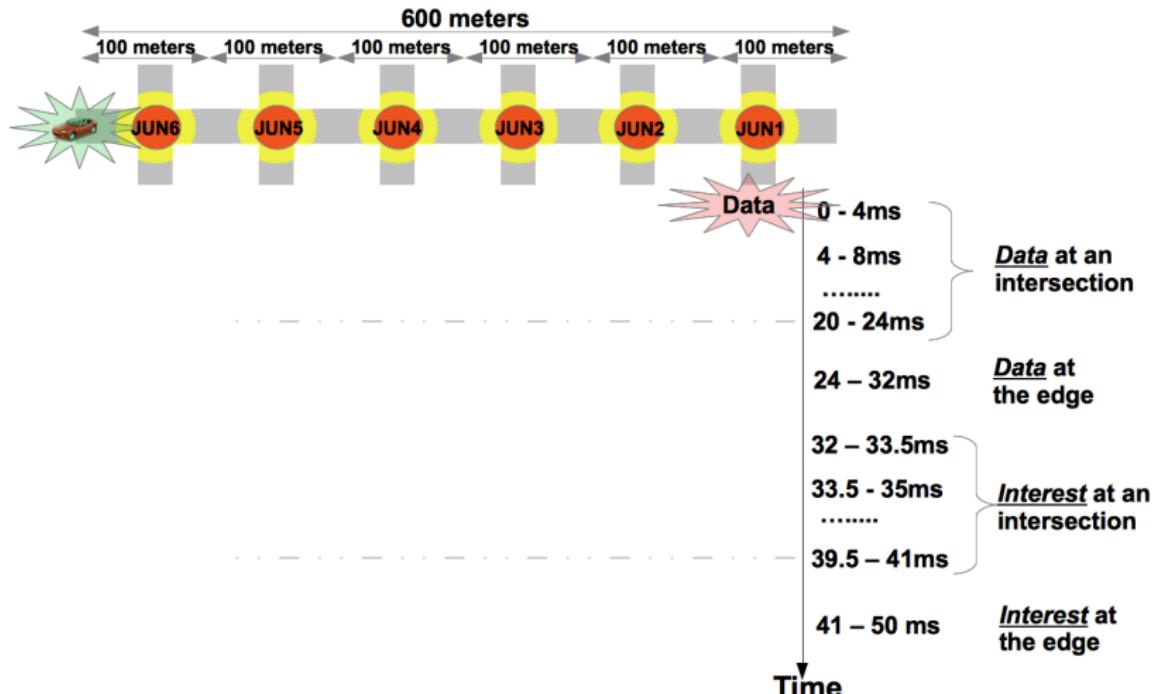


Waiting timer

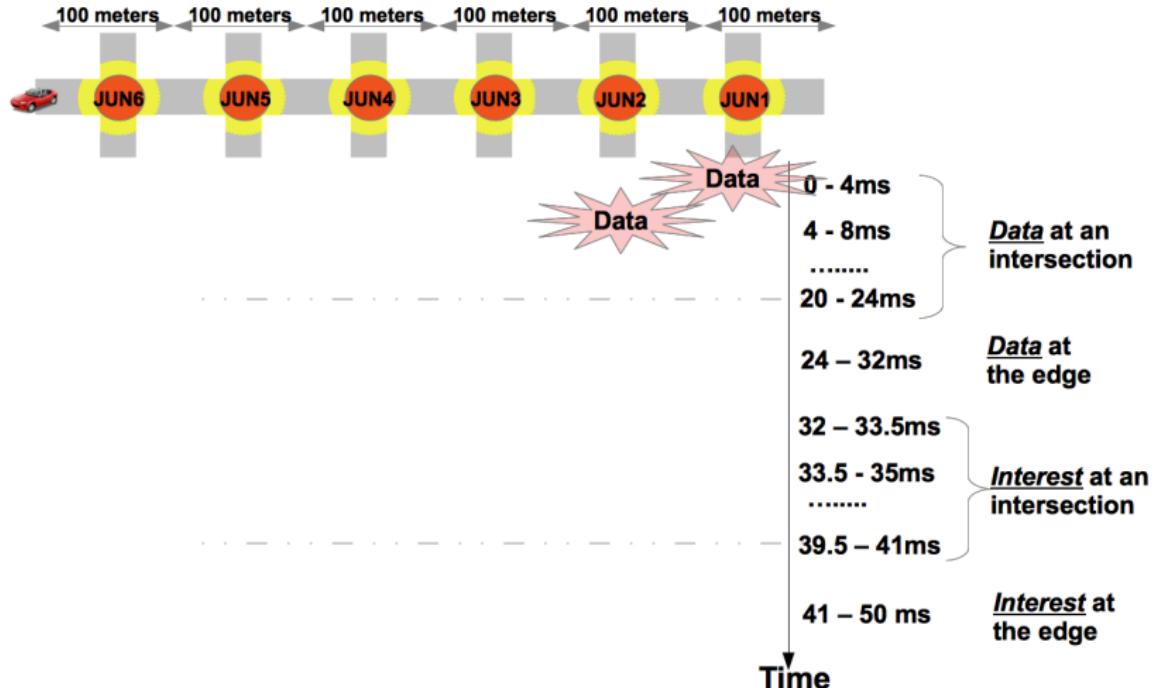
A node postpones a packet transmission based on its position and the type of packet

- Data has priority over Interest
- Cars at the intersection have priority
- Farther is a car from the previous hop, less it waits

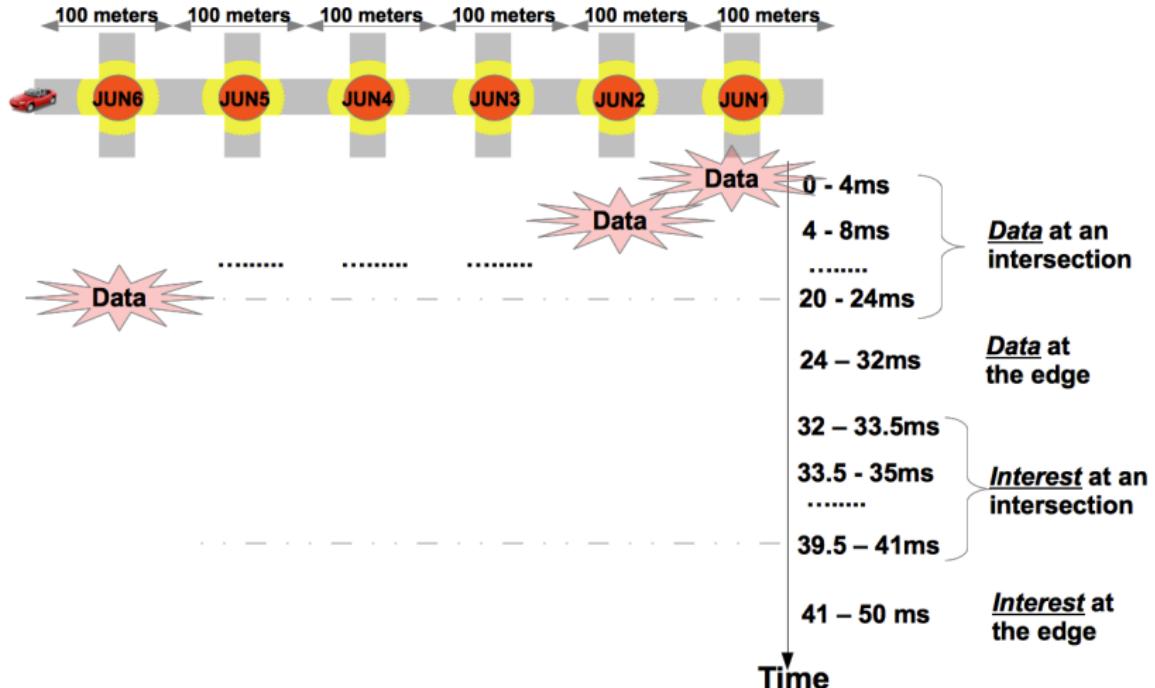
Forwarding process



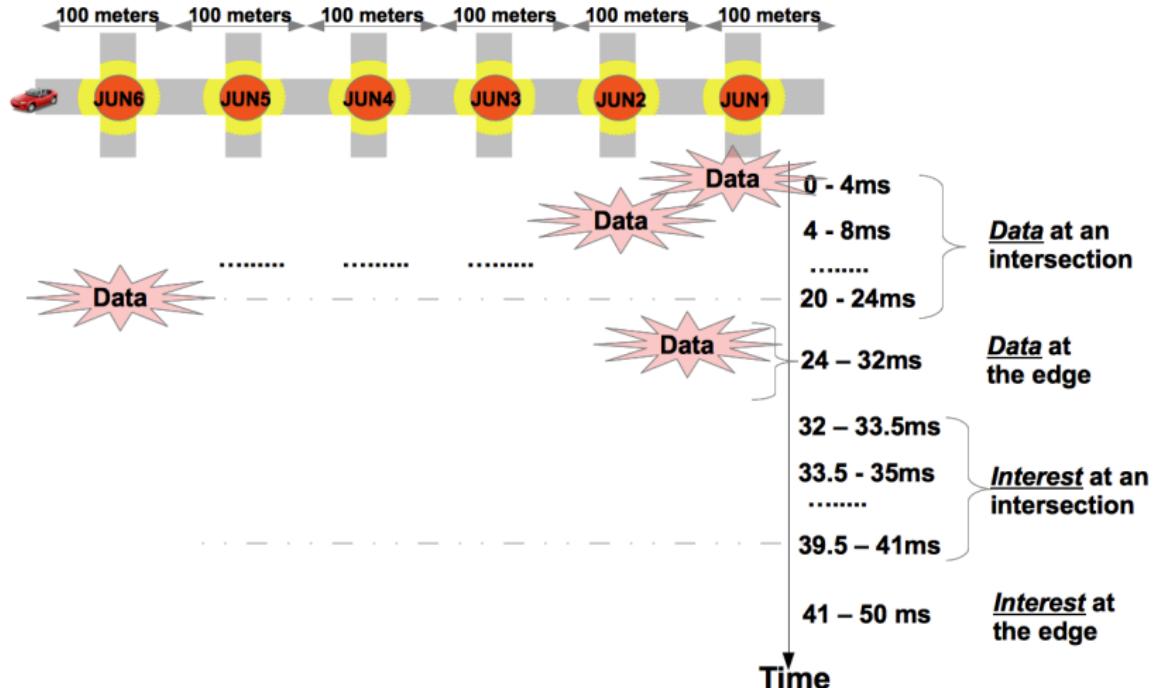
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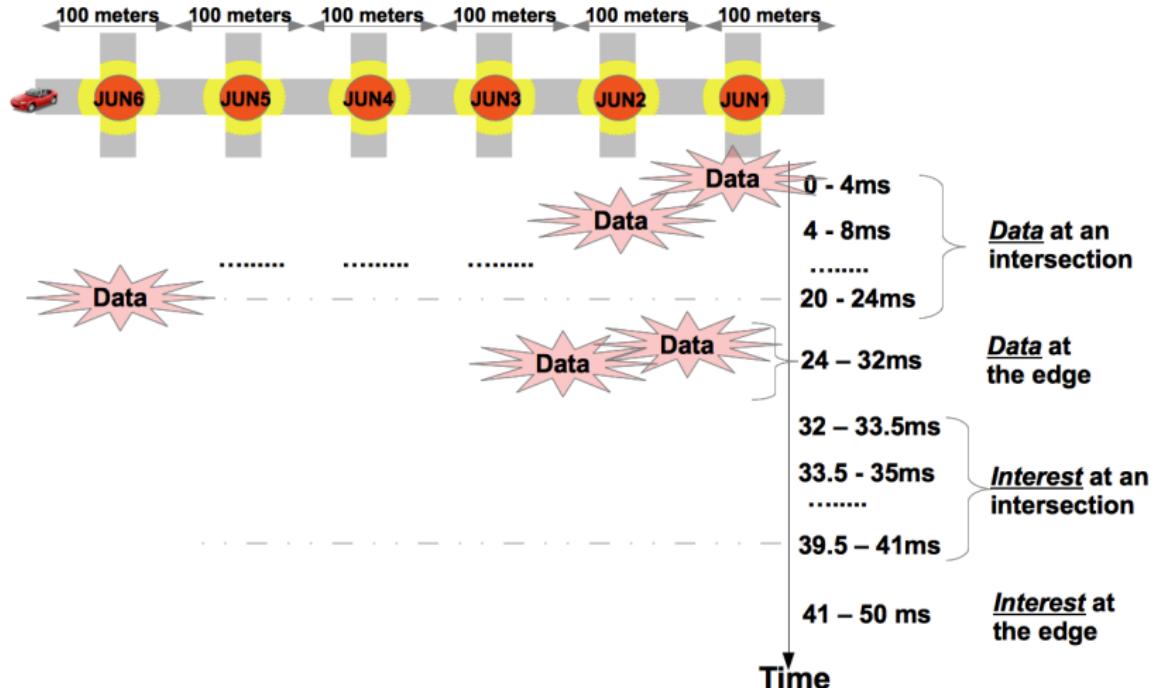
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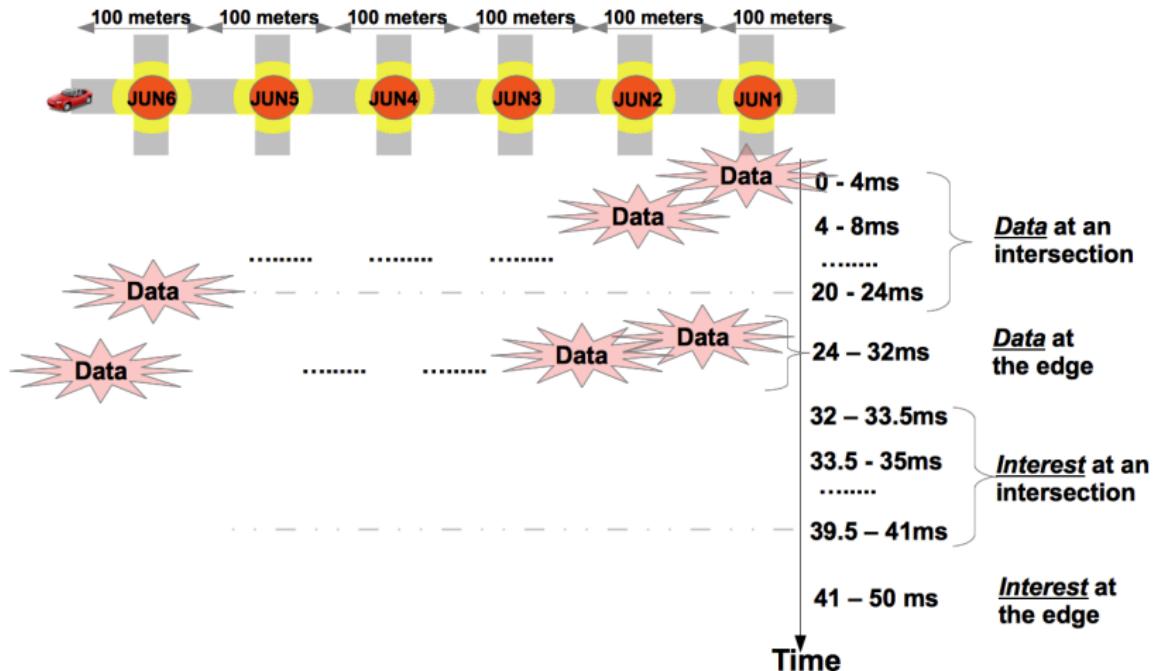
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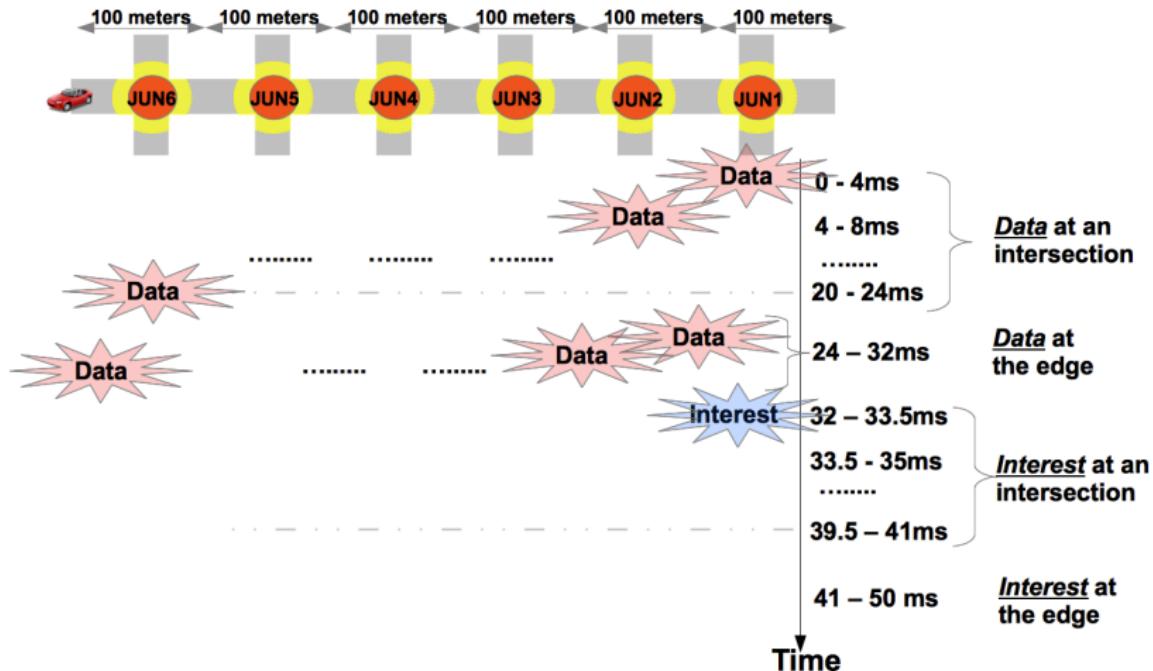
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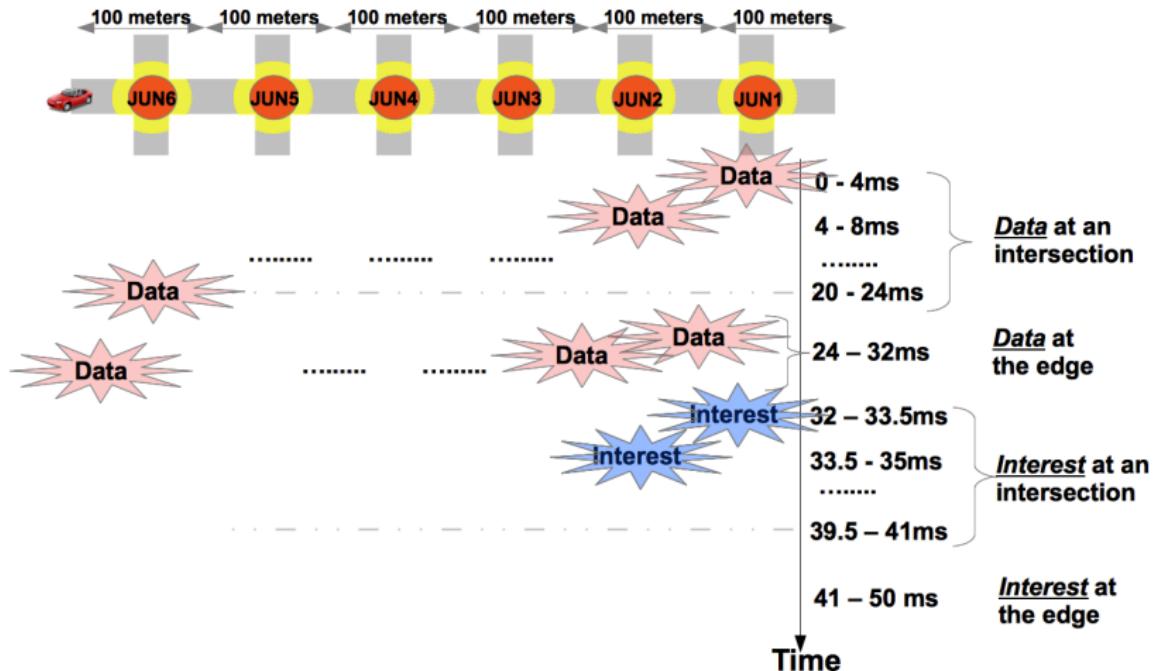
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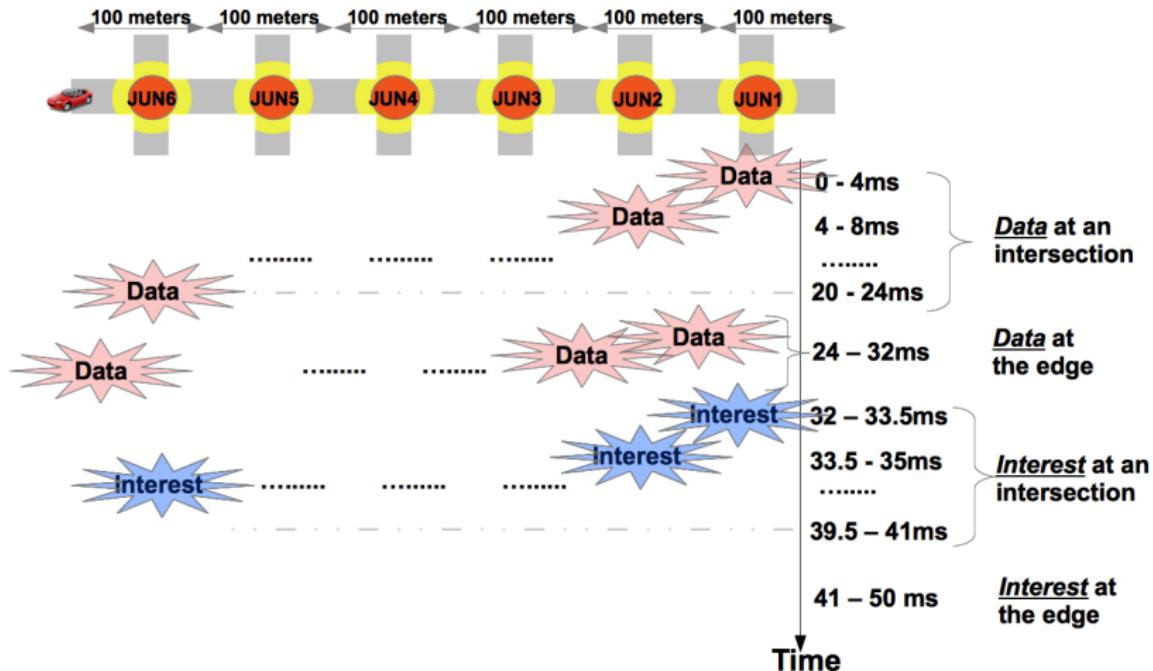
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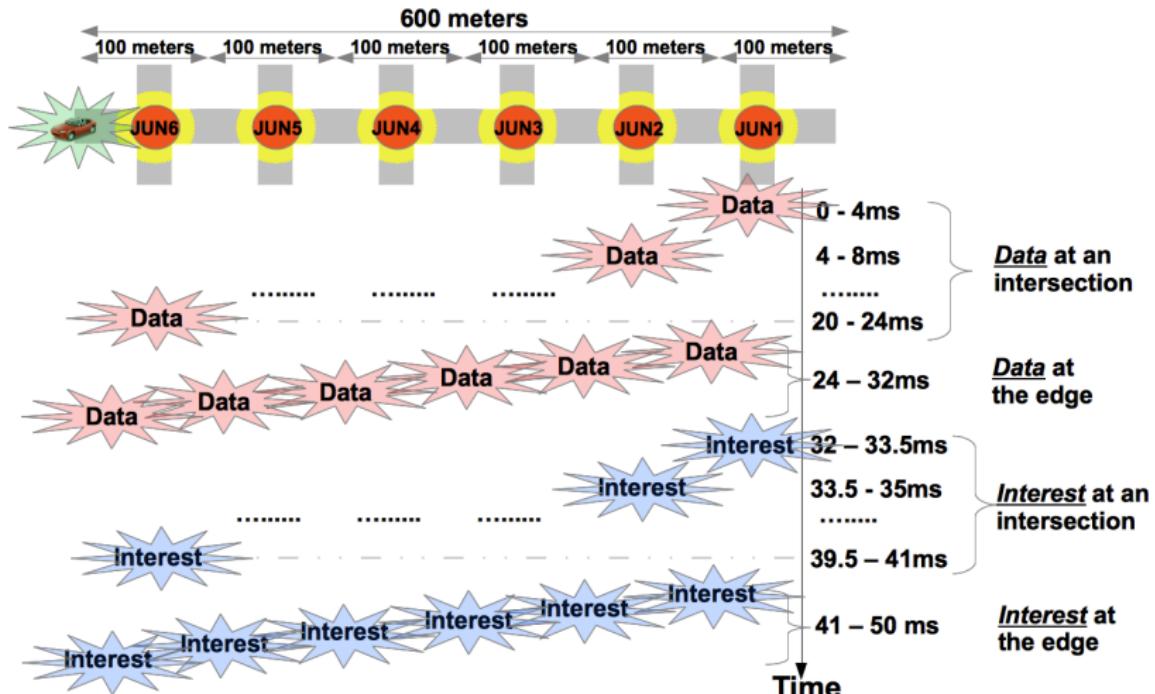
Forwarding process



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Scenario

- Urban scenario (a 2Km x 2Km residential area of Los Angeles) with dense traffic (812 - 1048 cars)
- Traffic shaped based on the importance of roads
- 4 RSUs connected to the Internet
- Application: music streaming (i.e. Spotify)

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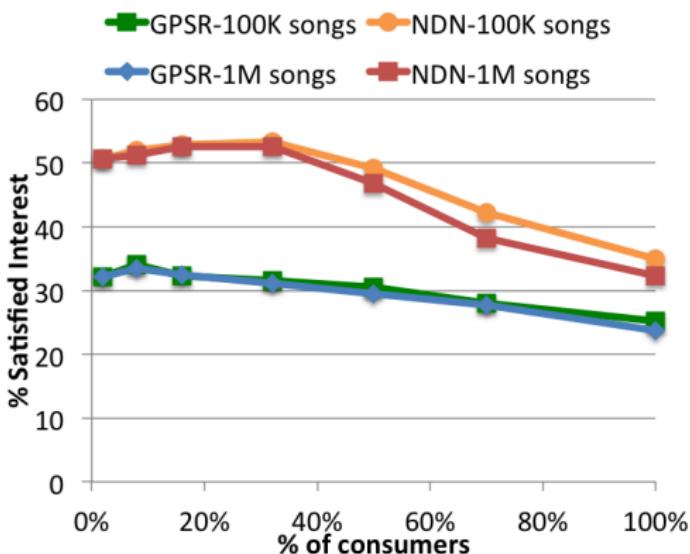
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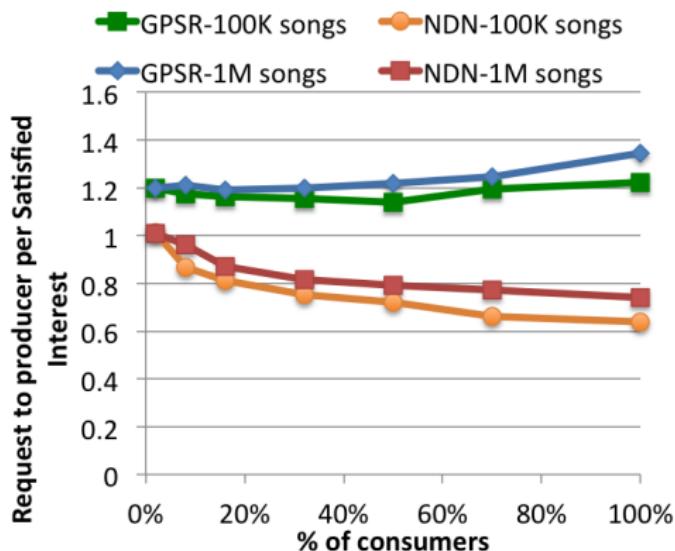
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Results: Success rate



Results: Load on the infrastructure



Conclusion

Navigo: a self-learning scheme for data delivery in highly dynamic vehicular scenarios

- Navigo enables applications to contribute to the forwarding process
- It learns data geographical location without requiring any additional location service
- Future works: study the system under congestion

That's all

Thank you for your attention



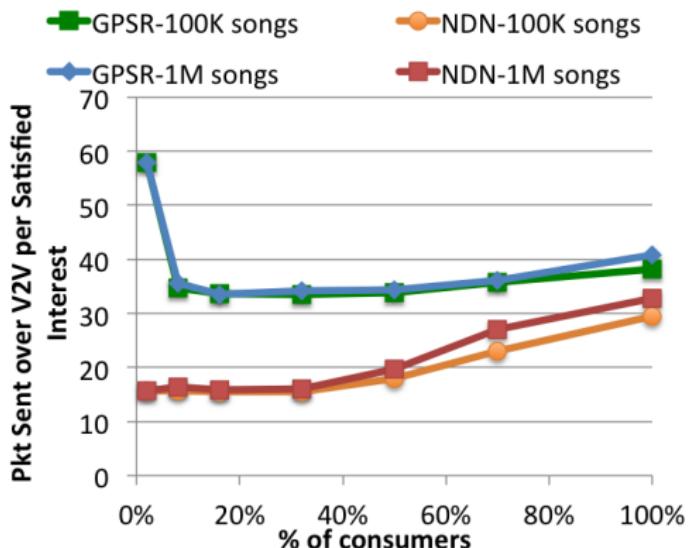
Questions?

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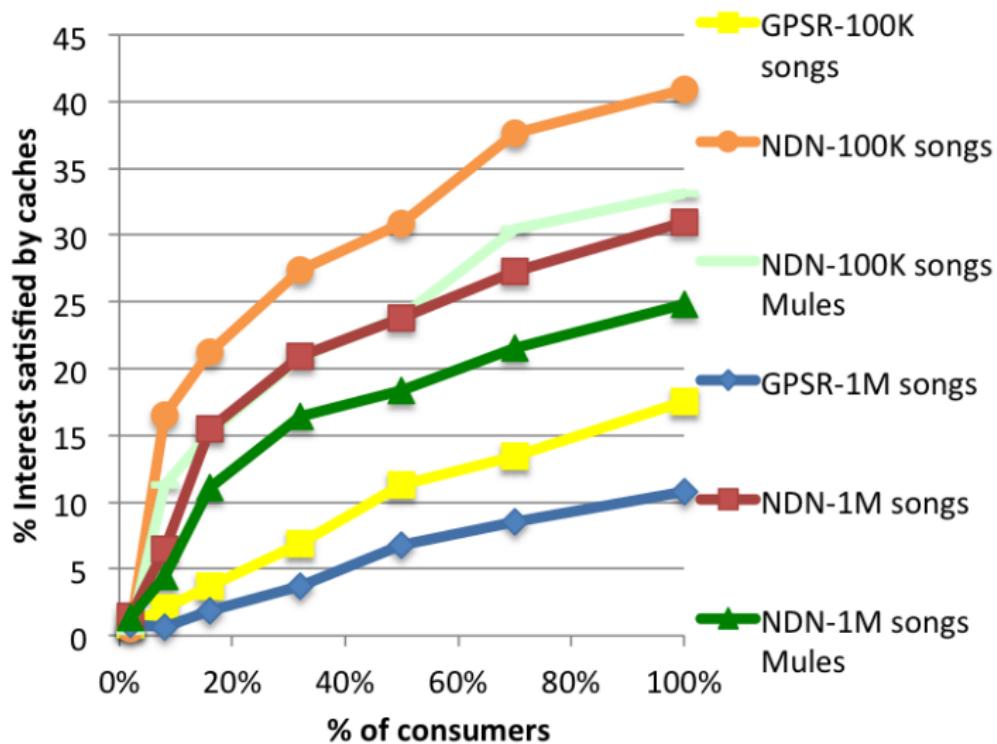
Previous publications:

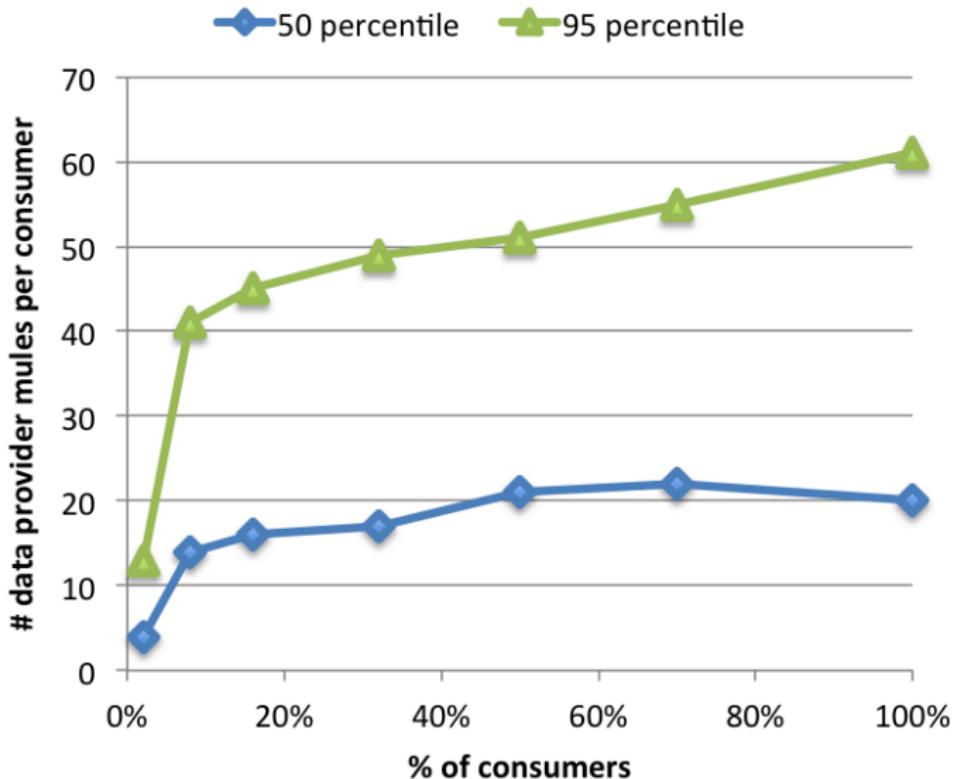
- (V-NDN) VANET via Named Data Networking (IEEE INFOCOM Workshop on Name Oriented Mobility (NOM), 2014)

Results: Protocol overhead

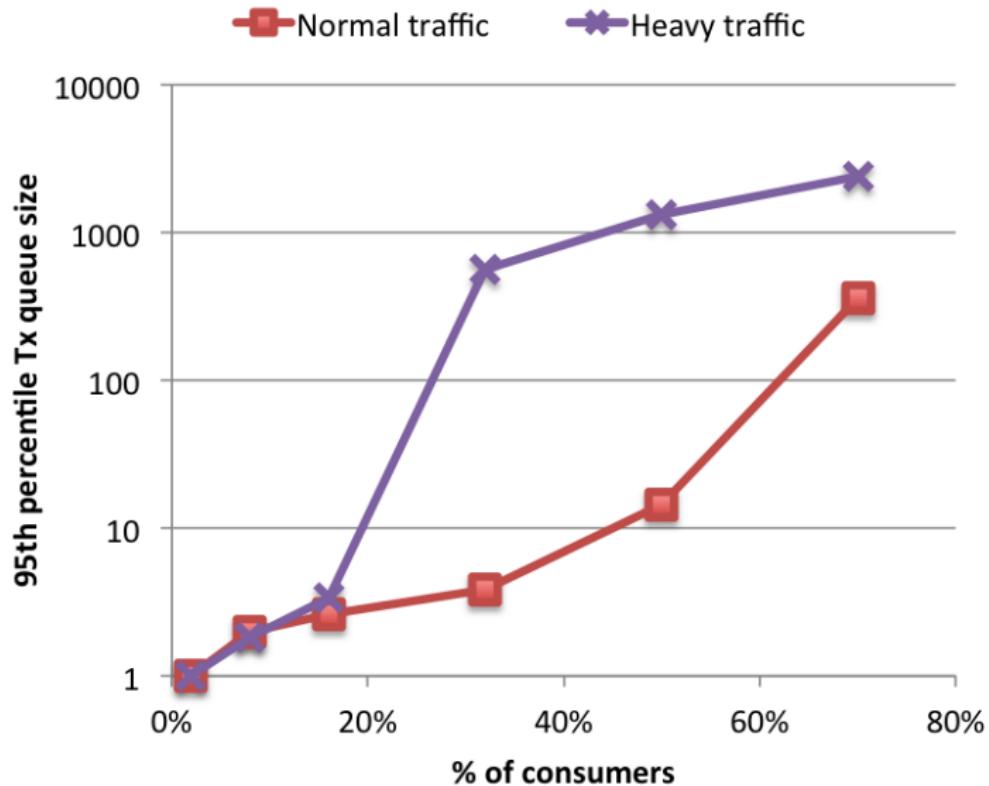


Caches

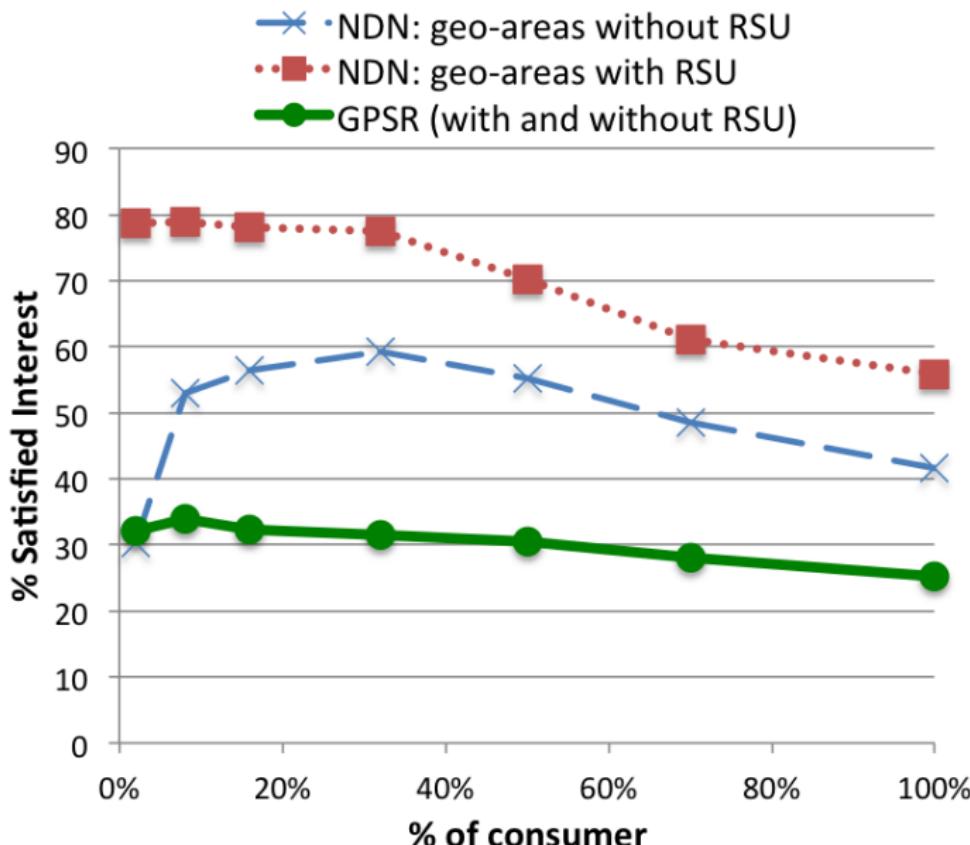




Tx queues



Success Rate by Areas



Results: User satisfaction

