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FIB population in NDN-VANETs

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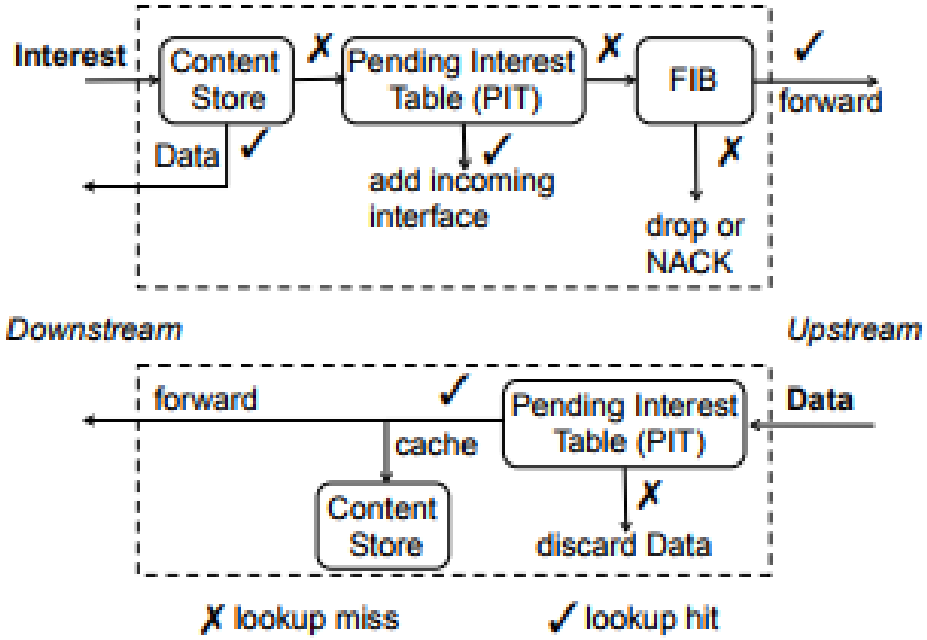
Named Data Networking (NDN)

- Information is forwarded based on content
- 3 Data Structures:
  - Pending Interest Table (PIT)
  - Content Store (CS)
  - Forwarding Information Base (FIB) table
- Two types of messages:
  - Interest
  - Data



Zhang, Lixia, et al. "Named data networking." ACM SIGCOMM Computer Communication Review 44.3 (2014): 66-73.

Vehicular ad-hoc Networks (VANETs)

- No particular infrastructure
- High speeds- Dynamic topology
  - Short-lived intermittent wireless connectivity
- Each application (safety or infotainment) has different QoS requirements
- VANETs produce a lot/few information depending on the density of the network
  - Introduce a routing protocol that could distribute the information in both cases
  - Take advantage any available infrastructure

Motivation

- Enable the communication between vehicles (V2V) and between vehicles and available infrastructure (V2I)
- Reduce the transmissions that occur in Wi-Fi due to its broadcast nature
- Take advantage of
  - Many paths that may exist for the same content
  - available infrastructure:
    - RSUs for distributing messages, both Data and Interests to many paths at the same time
  - Goal is to centralize the network where possible
    - Minimize and free the required resources for communication

Previous Work (1/6)

- Flooding of an Interest message from a requester node
- Content Source responds with Data message
- Intermediate nodes configure FIB tables
  - Creation of paths

- Requirements
  - Identification of node
    - Using MAC addresses
  - Extension of Interest and Data messages to contain MAC addresses
  - Extension of the FIB and PIT table to contain MAC addresses

Kalogeiton, Eirini, Thomas Kolonko, and Torsten Braun. "A Multihop and Multipath Routing Protocol Using NDN for VANETs." (2017).

Previous Work (2/6)

- Flood an Interest message with the MAC address of the node
- Configure PIT entries of intermediate nodes to contain this MAC address of the previous hop
- Content source responding with Data message containing its MAC address
- Data message follows to the MAC addresses from the PIT entries
- Data message contains the MAC address of the previous hop
  - Populate the FIBs of the intermediate nodes and create paths

Previous Work (3/6)

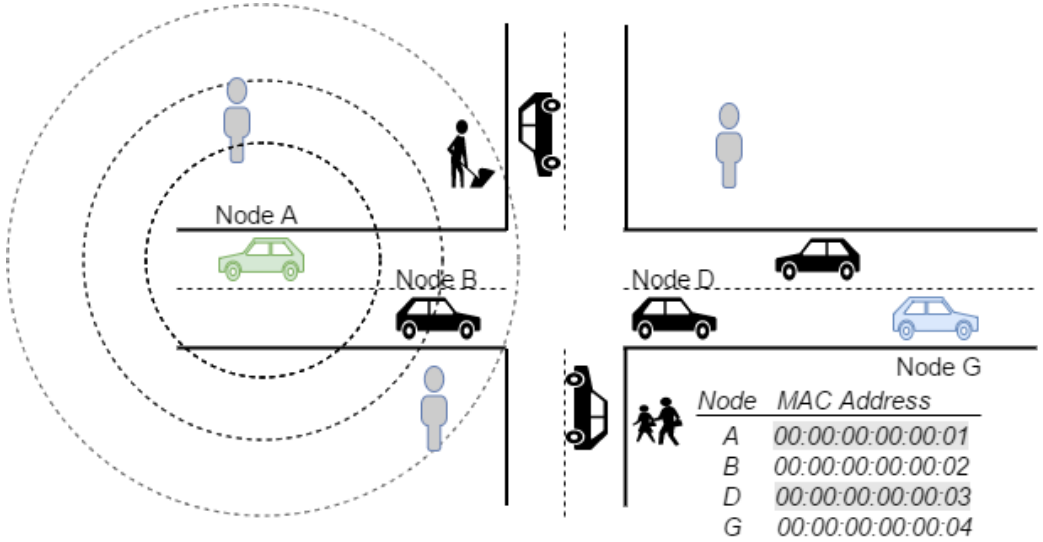


Figure 1: Broadcasting of the Interest by the requester node for the first time/ Flooding

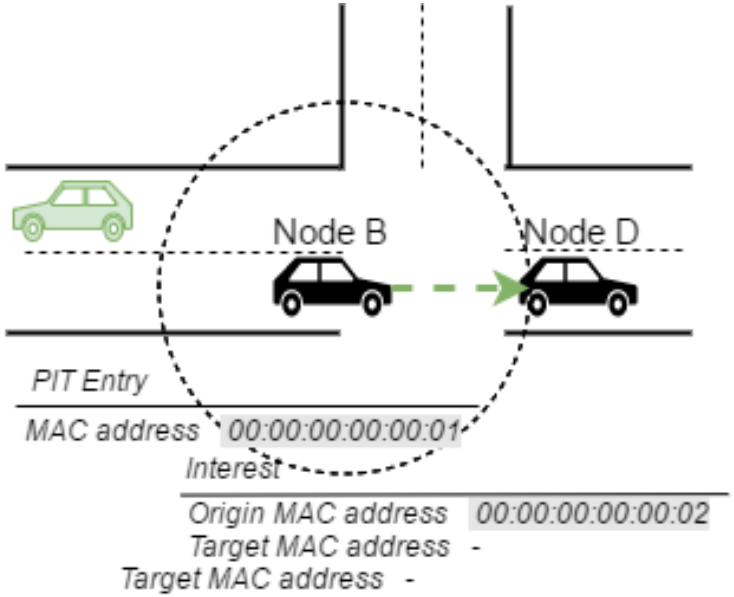
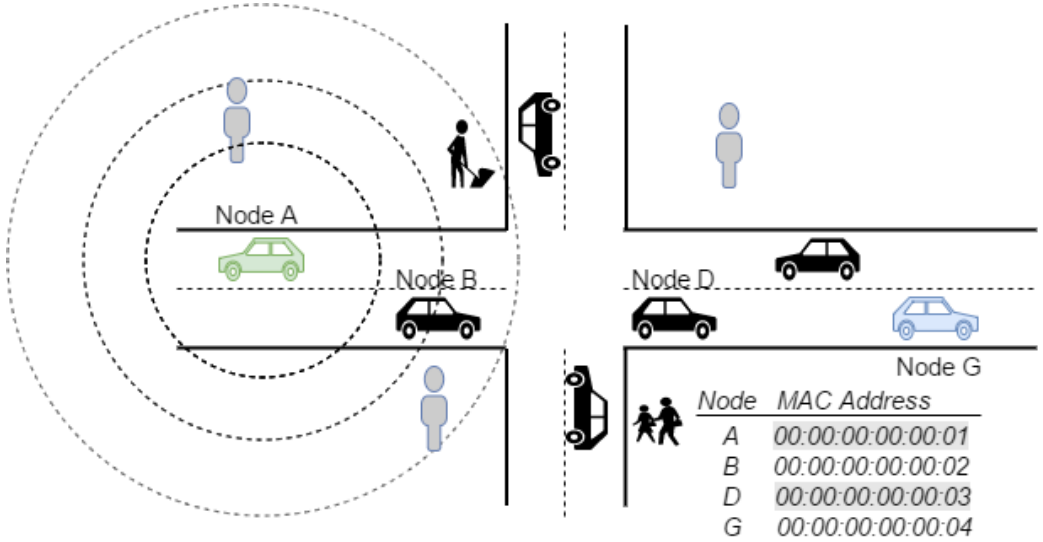


Figure 3: Interest processing and forwarding

Figure 2: Interest broadcast from node A from node B

Previous Work (4/6)



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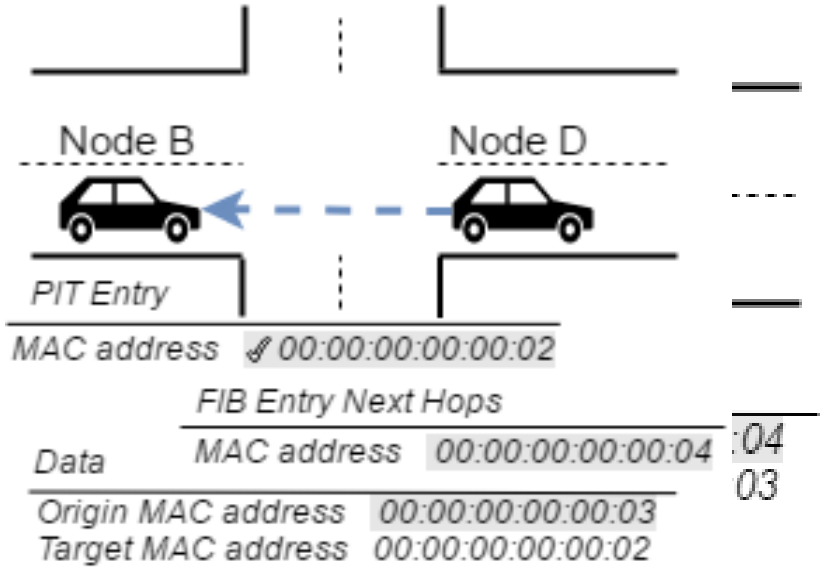


Figure 3: Node D processing and forwards the Data

Previous Work (5/6)

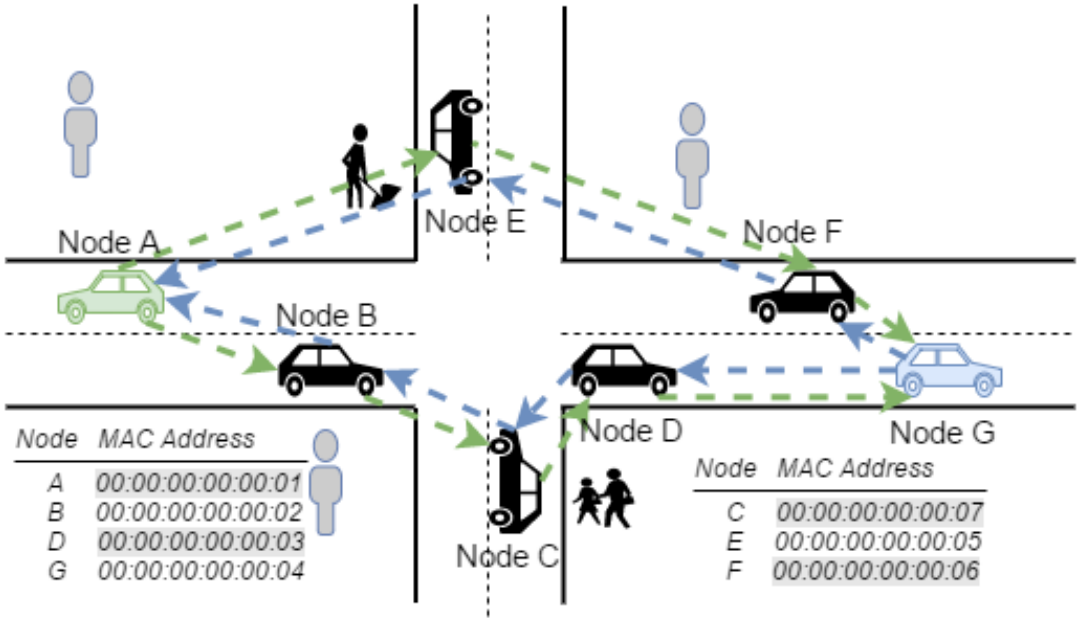


Figure 6: Paths that are established after a broadcast Interest

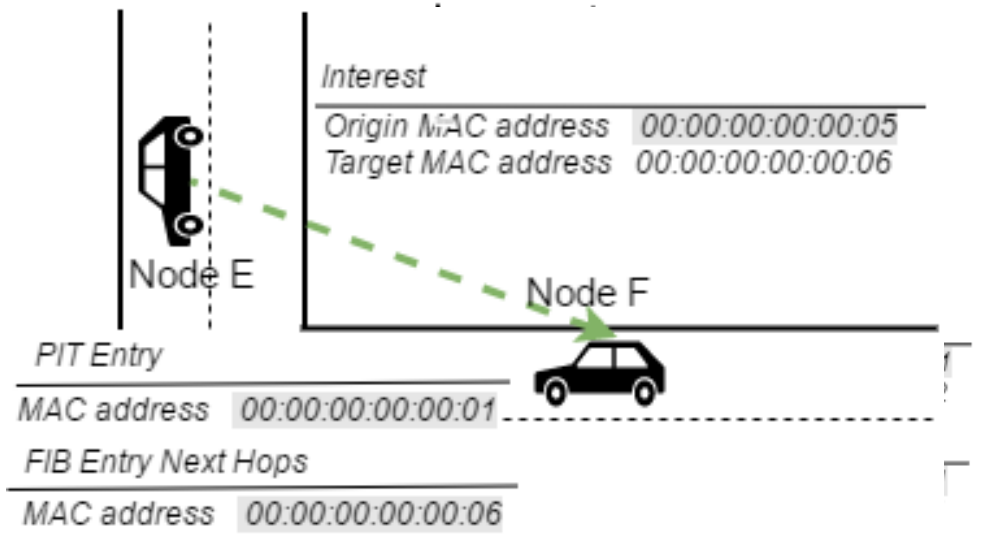
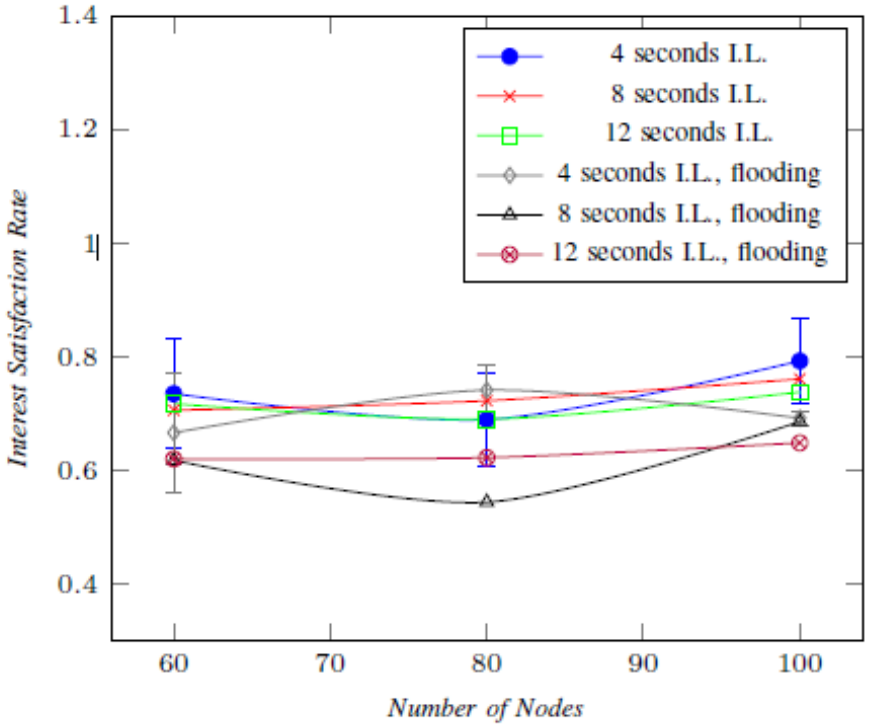
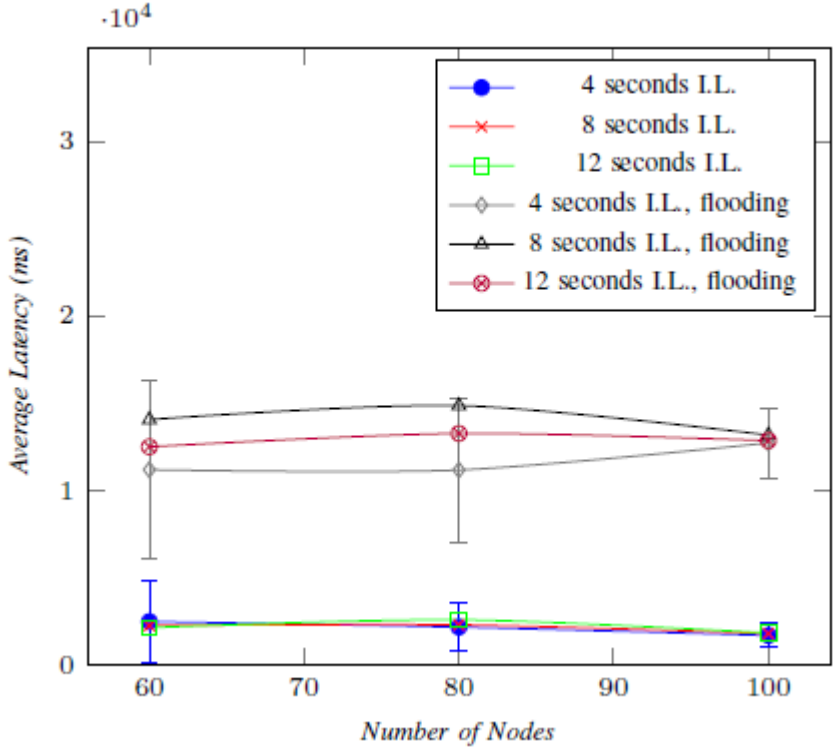


Figure 7: Interest processing and forwarding from node E

Previous Work (6/6)

> Results





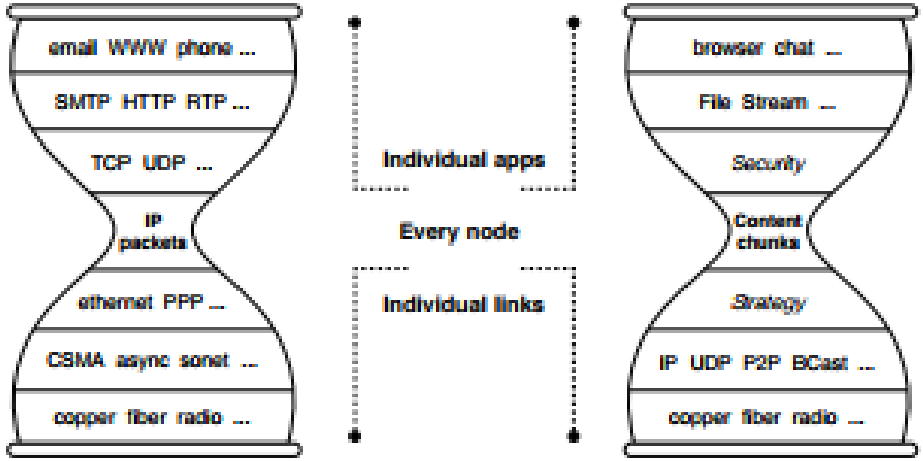
Approach- FIB population (1/2)

- Exploit RSUs (fixed nodes) that are installed on the street
- Node that holds the content sends a message to the RSU indicating its MAC address
  - Populate the FIB of the RSUs

- RSU sends its FIB information to nodes (1 hop communication)

Approach- FIB population (2/2)

- Change the implementation of the previous approach
  - Interest and Data messages contain no information about the MAC addresses
- Goal is to populate FIBs
  - Extracting information from the Strategy layer
- Flooding an Interest
  - Configure PIT entries to contain MAC addresses that are extracted from the Strategy layer
  - Responding with Data following the PIT entries
  - Configuring the FIBs by extracting the MAC addresses from the Strategy layer



Implementation (1/4)

- Using ndnSIM v.2.3.
- Extension of FIB table by including MAC address

FIBentry: Name

Nexthop1 : Face, Cost, **MAC address**

Nexthop2 : Face, Cost, **MAC address**

Implementation (2/4)

- Using ndnSIM v.2.3.
- Extension of PIT table by including MAC address

Pit entry: Name
InRecords : Face, **MAC address**

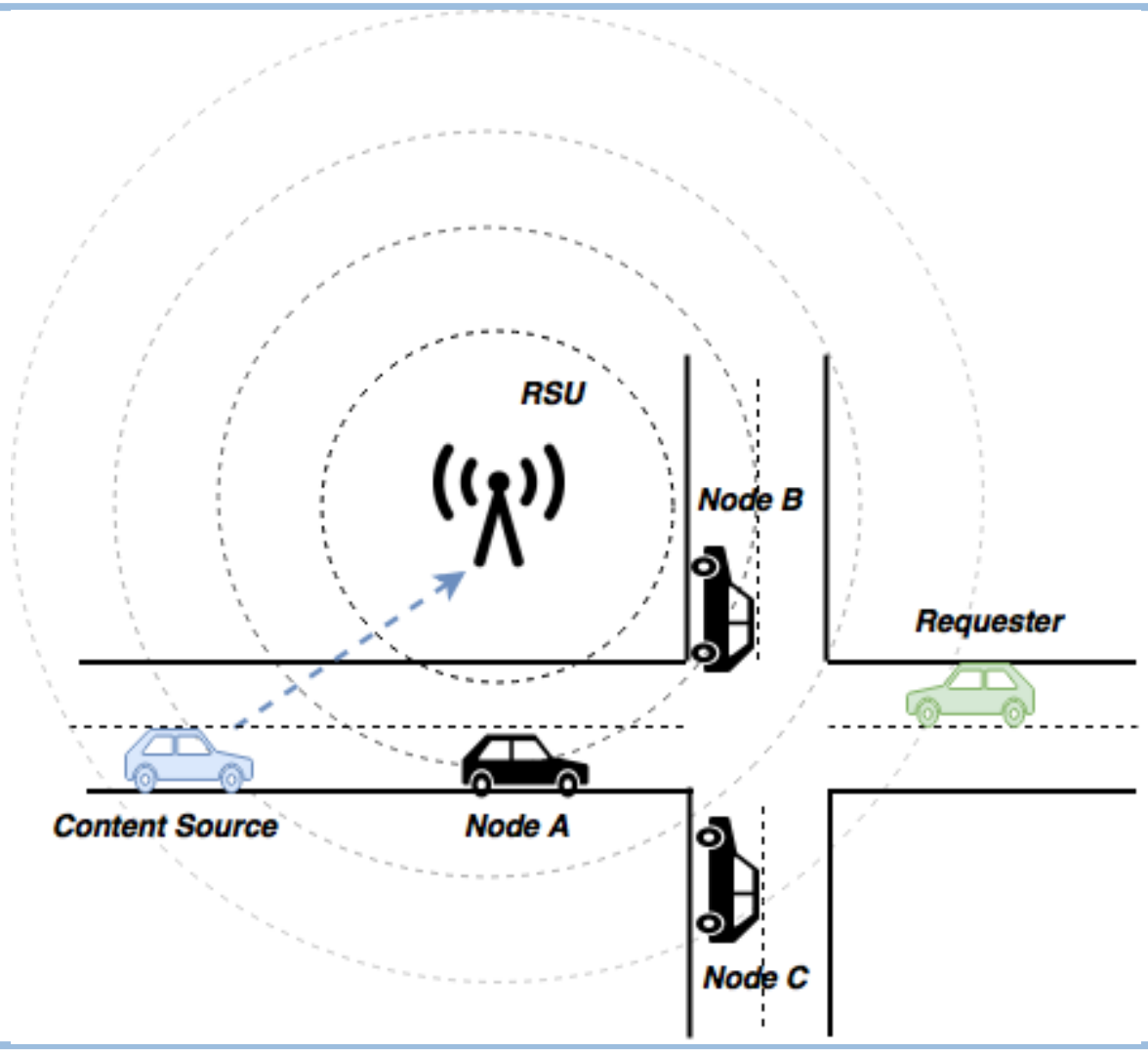
Implementation (3/4)

- Assume that all nodes know the MAC address of the RSU
- Content Source sends a message to the RSU
  - Indication of the RSUs MAC address
- RSU receives the message and configures its FIB table
  - Adding a new FIB entry containing the name of the content that the Content Source holds
  - The incoming face that the message was received
  - The MAC address of the Content Source

Implementation (4/4)

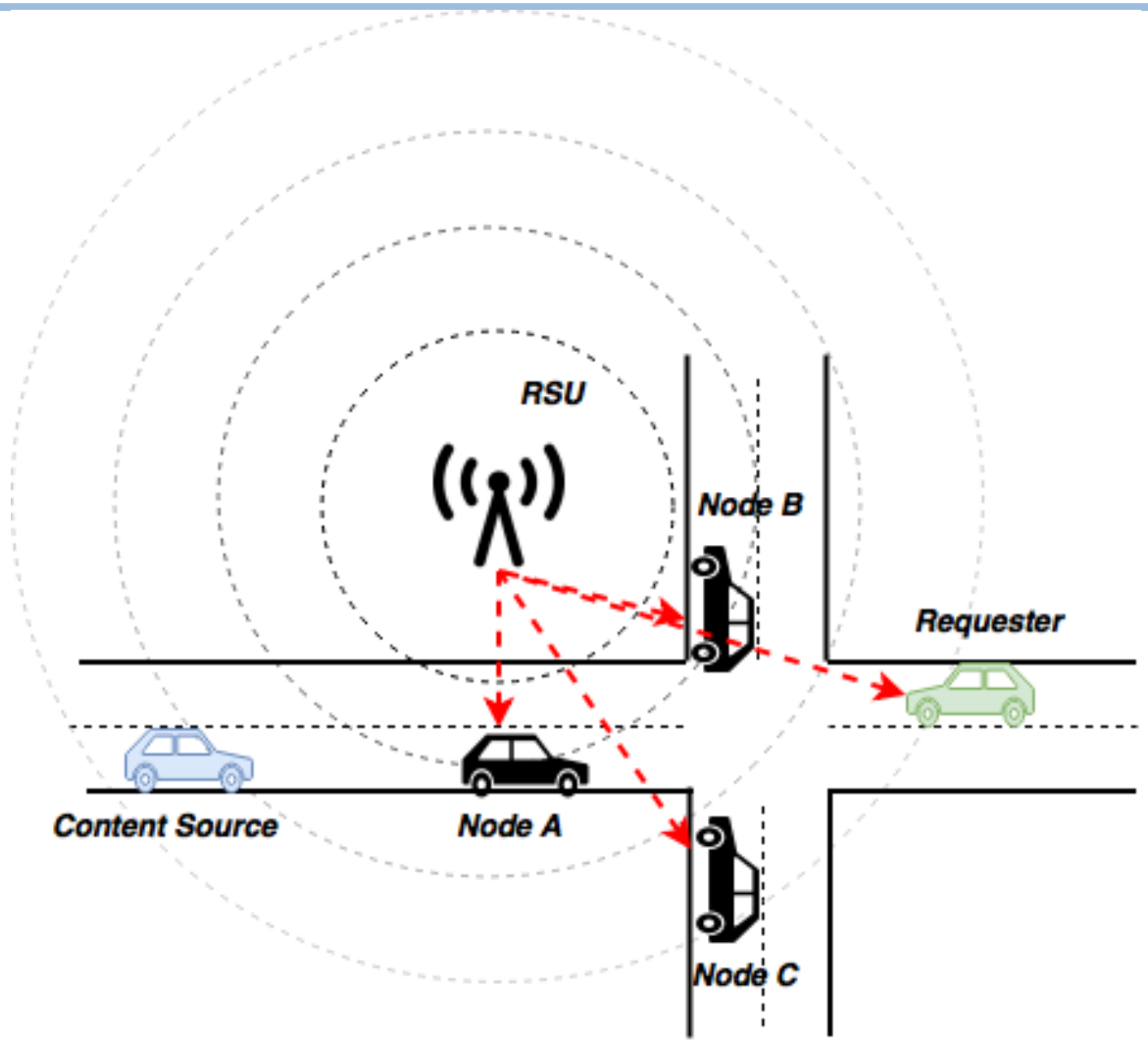
- Create an application that is installed in the RSU
- Application broadcast a message to the nodes
  - Message contains the FIB information of the RSU
- Intermediate nodes that receive the message decrypt the message information
  - Add the information from the message to their FIBs

Scenario (1/4)



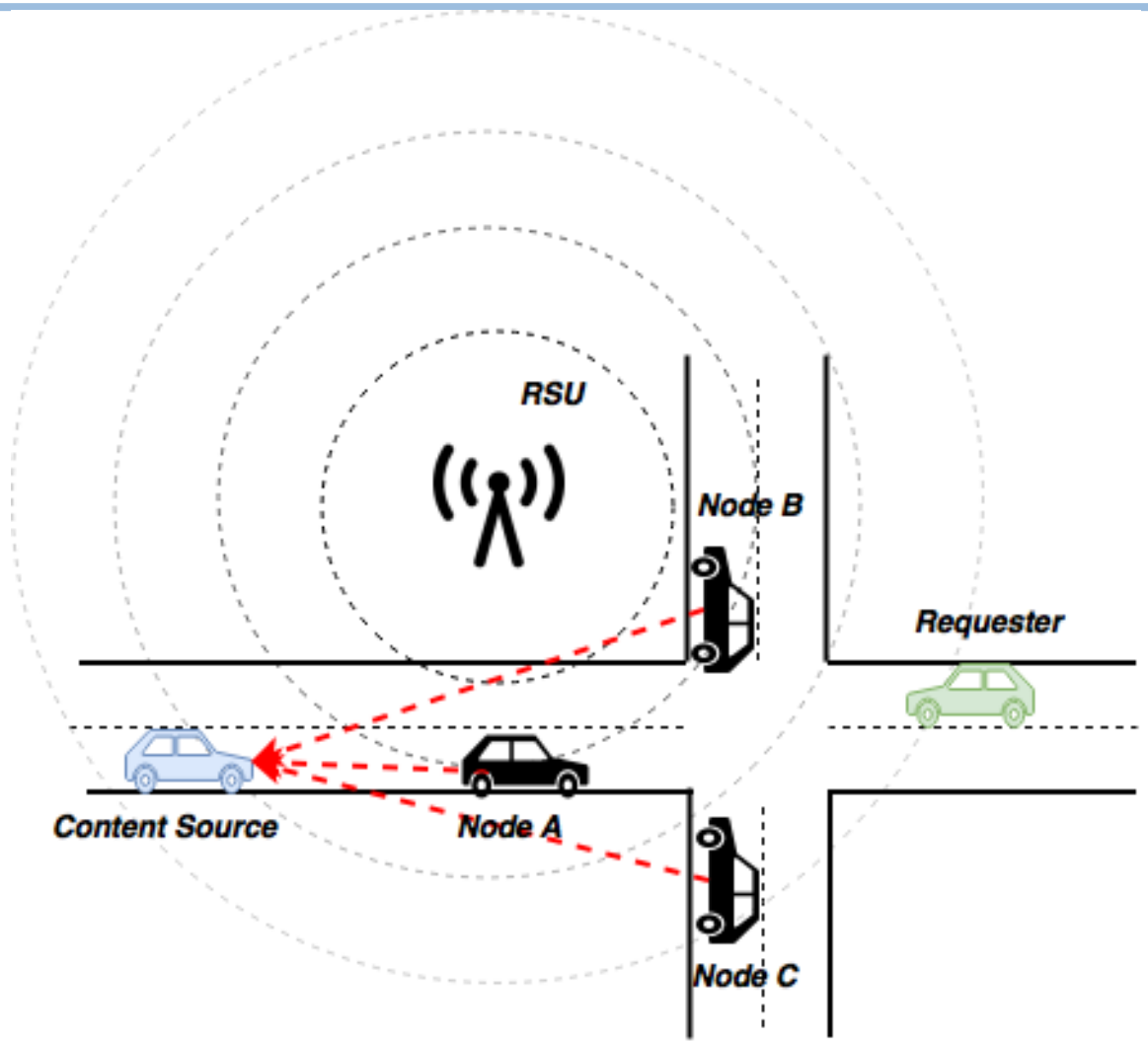
- Simple scenario that contains 6 nodes
- Content Source sends a message to the a RSU
  - Message contains the MAC address of the content source
- RSU creates a new FIB entry with the MAC address of the content source: i.e: 00:01

Scenario (2/4)



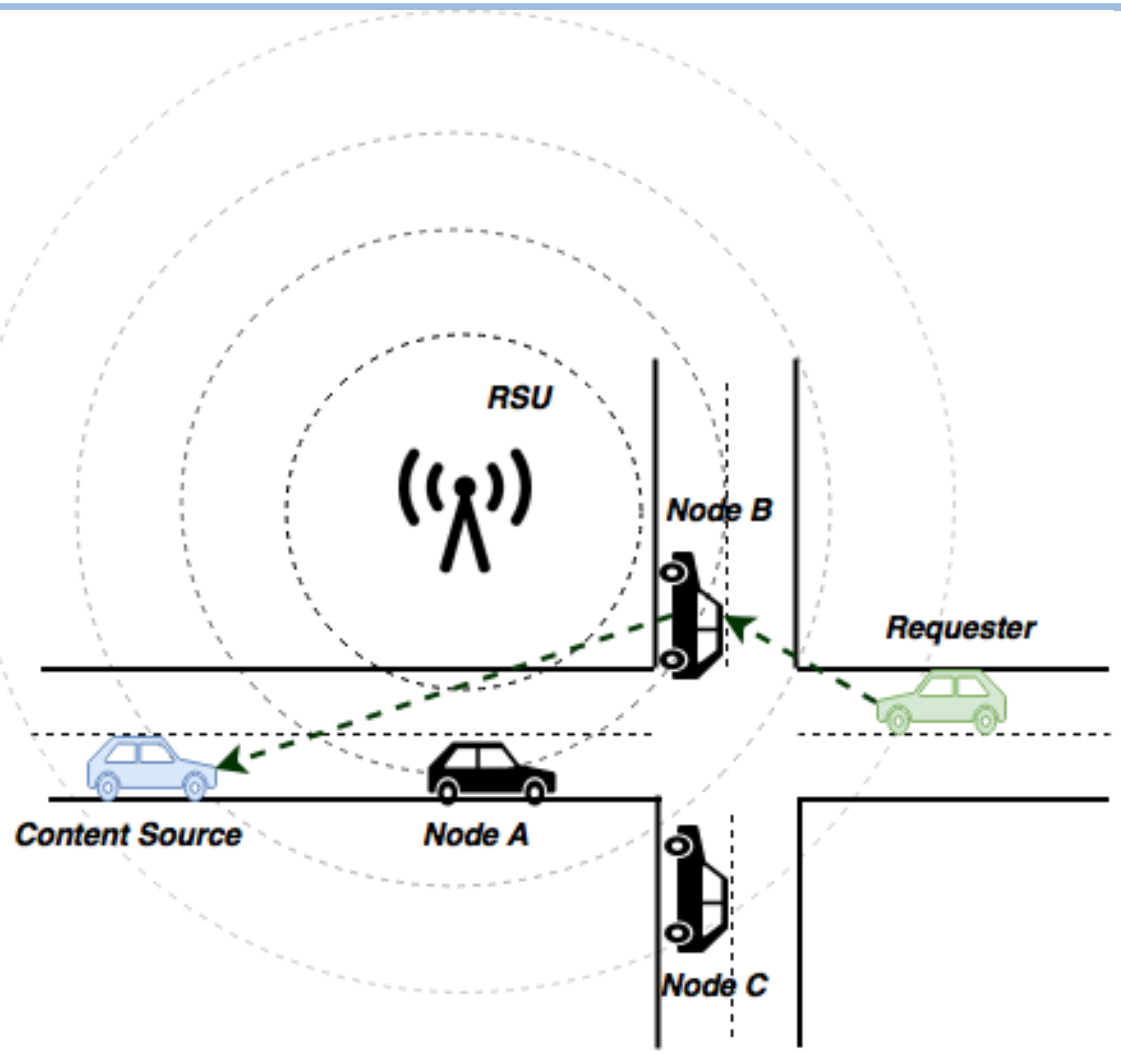
- RSU broadcast a message that contains the fields of the FIB entry
- Intermediate nodes (node A,B,C, requester) add a new entry into their FIBs
  - Entry: Name of Data, Incoming Face, Cost, 00:01

Scenario (3/4)



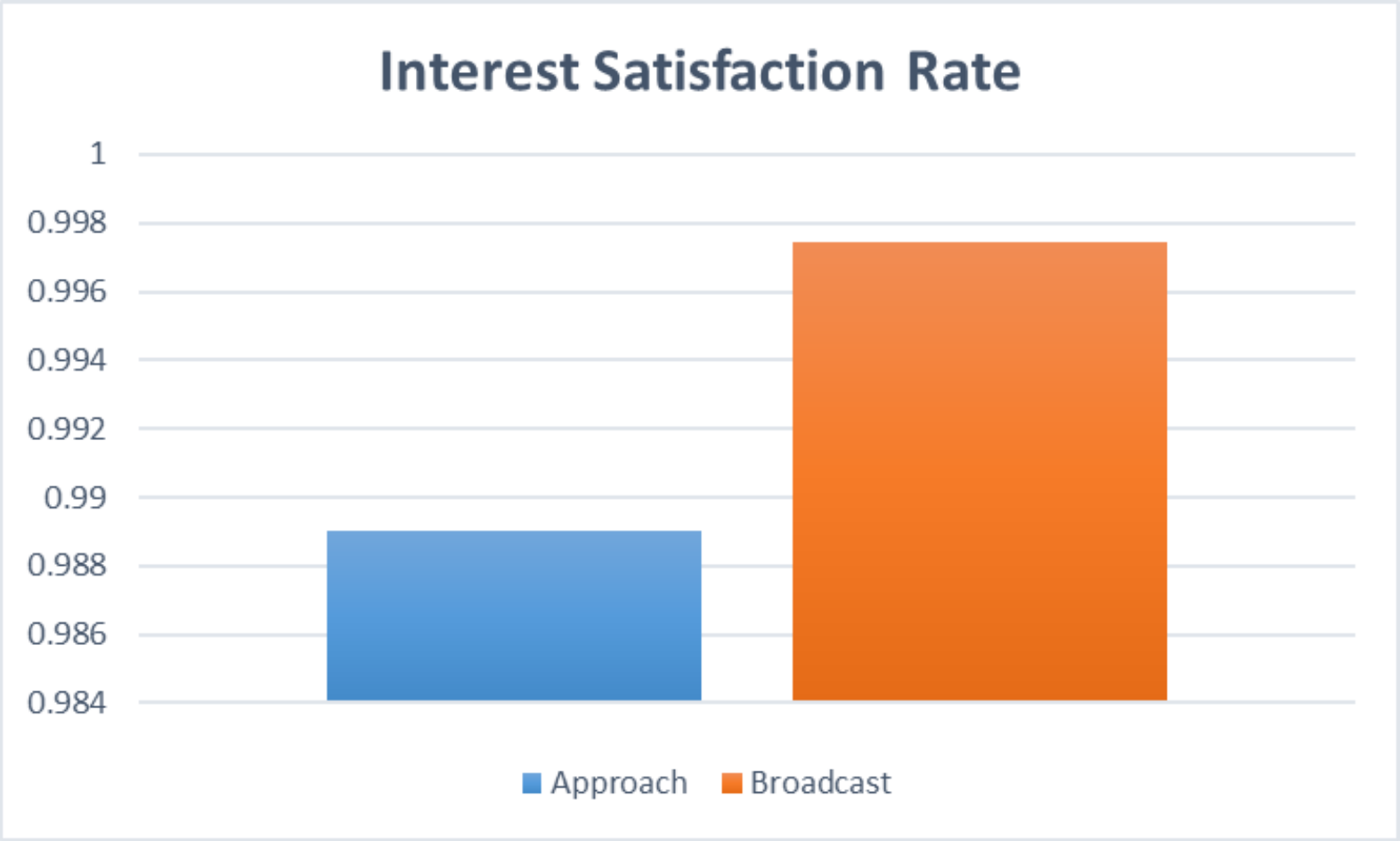
- If node A,B,C send a request they will send it to the content source directly by following their FIB entries

Scenario (4/4)



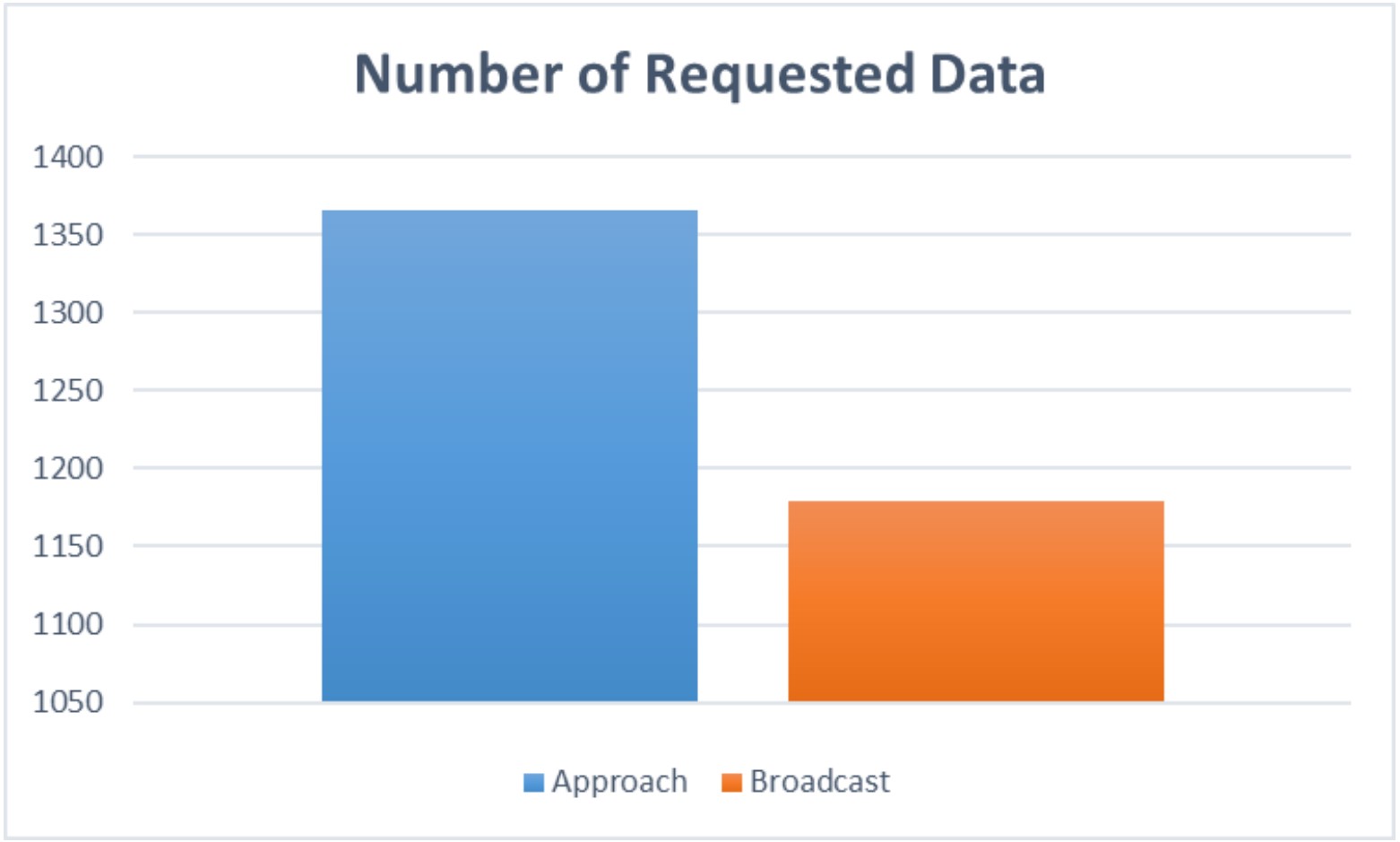
- Requester sends a request to the 00:01 node.
- There is no connection between requester and Content source
- Intermediate nodes will receive the message and check their FIBs
  - If they have an entry with the requested MAC address they will forward the message
  - If they do not they discard the message

Results (1/2)



- Compare the approach with the broadcast scheme
- Interest Satisfaction Rate= Number of received Data messages that were requested by the requester node/ total number of Interest messages being sent

Results (2/2)



- Compare the approach with the broadcast scheme
- Number of Requested Data
  - How many Interests the consumer node (requester) sends

Future Work

- Try this approach in a dynamic scenario
- Implementation of multiple hops
  - For the FIB population
  - For the Content source content advertisement

- Populate the FIB with current and future location of a vehicle
- RSU collect information about start and destination of content source
  - Location prediction techniques to predict the future location of the vehicle
  - Send these predictions together with the MAC addresses and populate the FIBs of nodes

Thank you for your attention!