UNIVERSITÄT BERN

Bachelor Thesis – Final Presentation

Multipath Transmission for CCN in Vehicular ad-hoc Networks

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Introduction to Named Data Networking (NDN)

- Current network is dominated by content distribution
- It is based on host-to-host communication

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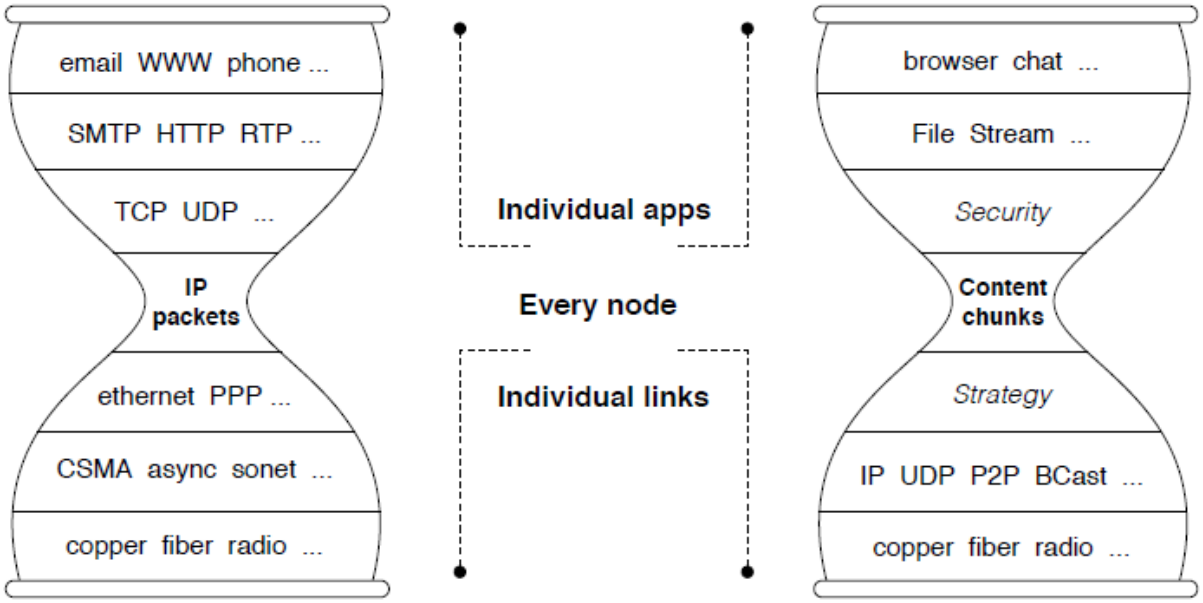
Problems:

- Huge amount of data that need to be re-distributed
- Mobility and the Internet of Things (IoT)
- Security Considerations
- “HTTPS by default” still not used by 79% of top websites (Google Transparency Report)

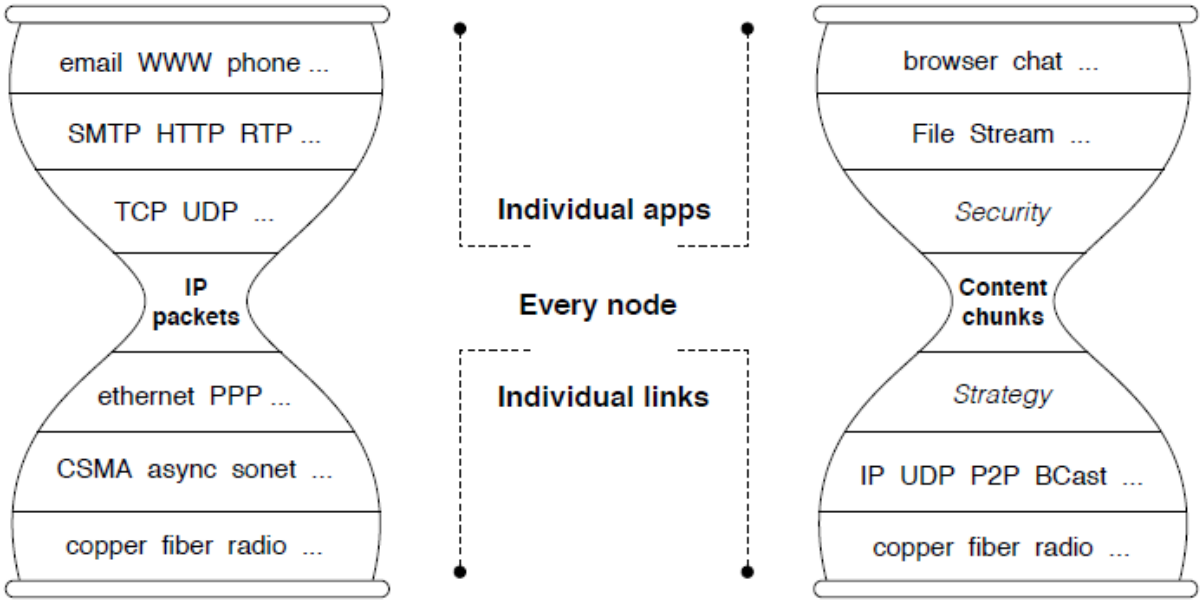
Components of NDN



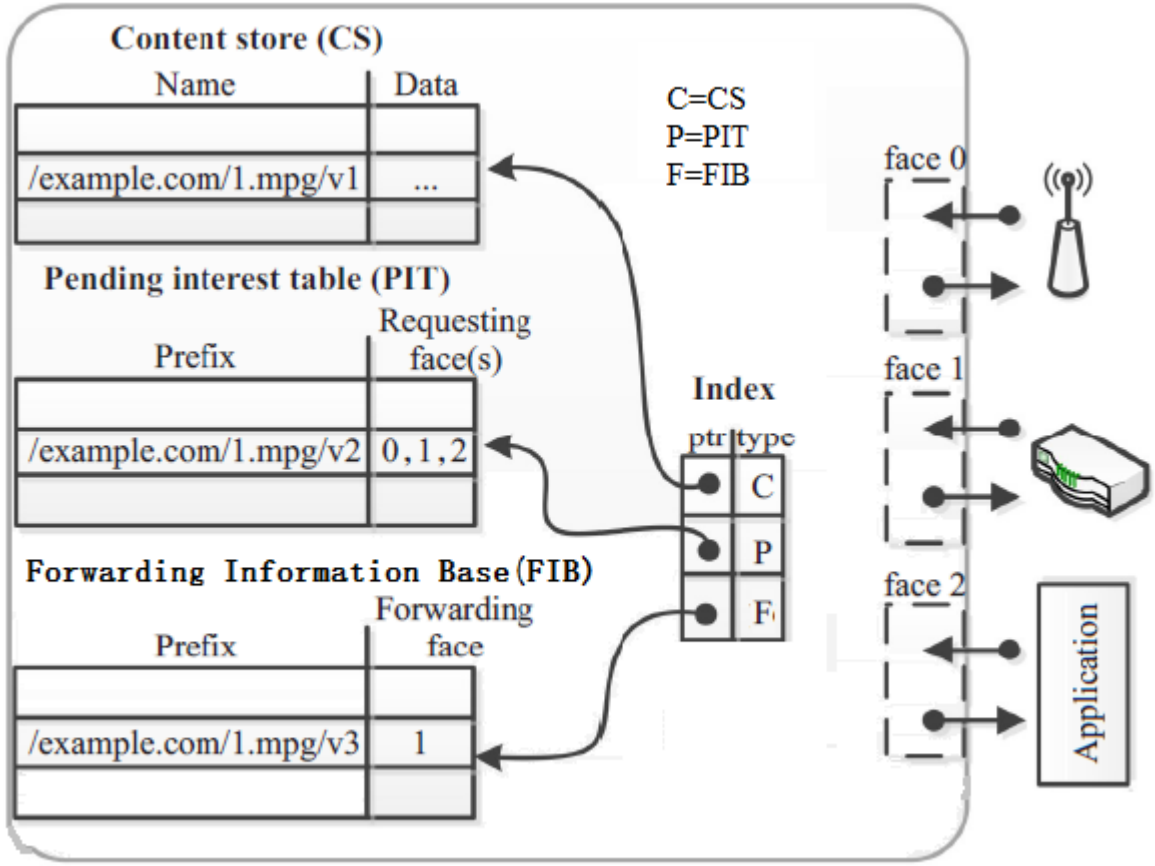
Components of NDN

- Content
- Consumer
- Producer
- Interest
- Data
- Node
- Interface
- Router

- FIB
- CS
- PIT



The main tables of NDN



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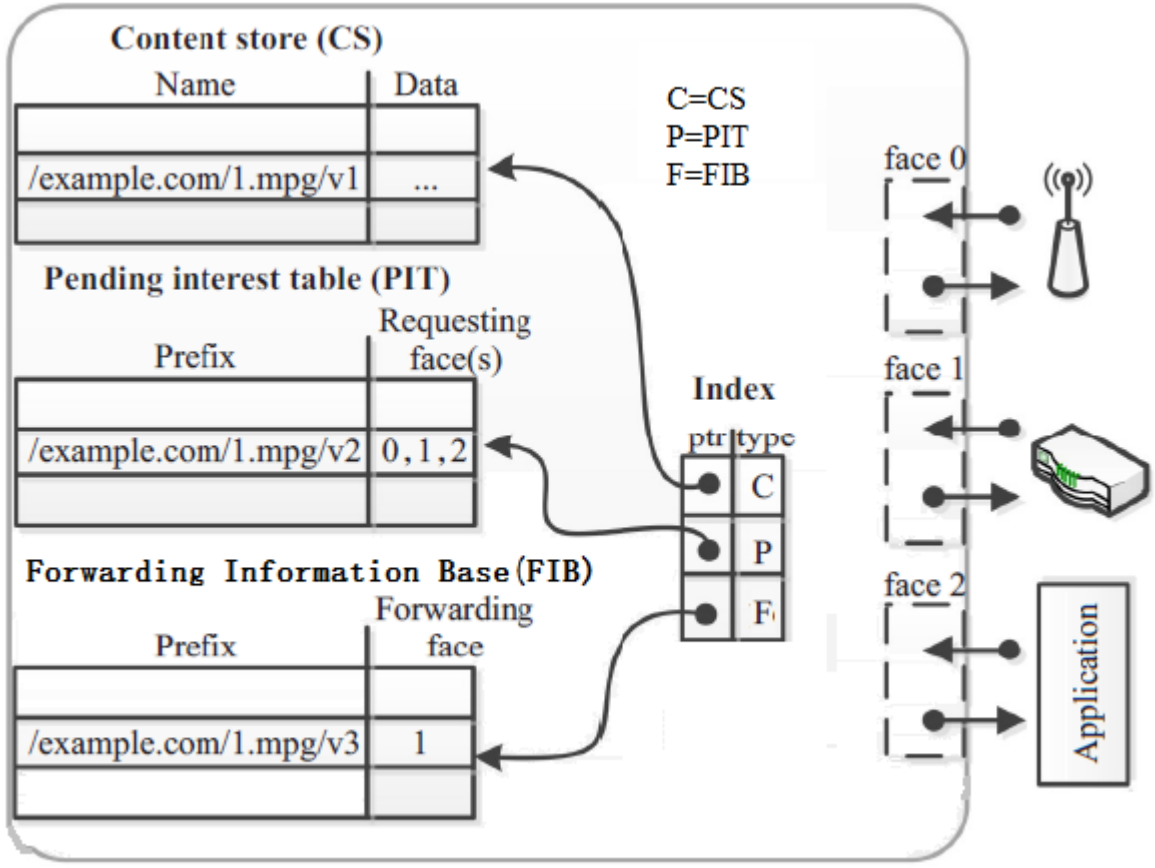

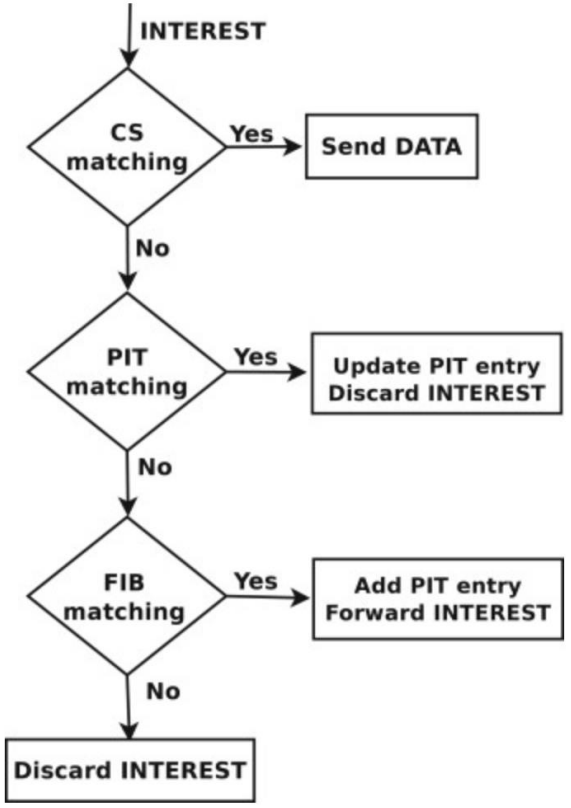

Simulation framework: ns-3 and ndnSIM

- ns-3 is a network simulator
  - 1) Topology definition
  - 2) Model development
  - 3) Node and link configuration
  - 4) Execution
  - 5) Performance analysis
  - 6) Graphical Visualization

- ndnSIM is an implementation of the basic components of a NDN network.

Current implementation in ndnSIM v2.0

- Used default strategy: broadcast strategy
- Every Interest is being broadcast to all upstream faces
- Data is broadcast to all downstream faces „following“ the PIT entries left by the Interests

Problems:

- Broadcasting slows down the network and creates unnecessary traffic which leads to congestions
- Multihop currently (v2.0) not possible with wireless communication
- Forwarding through faces not feasible for wireless connections

Goals and implementation

- Change several datastructures in order to support origin and target node identification
- Change the NDN headers for Interest and Data packets
- Implement new forwarding strategy that is more efficient than the current default implementation

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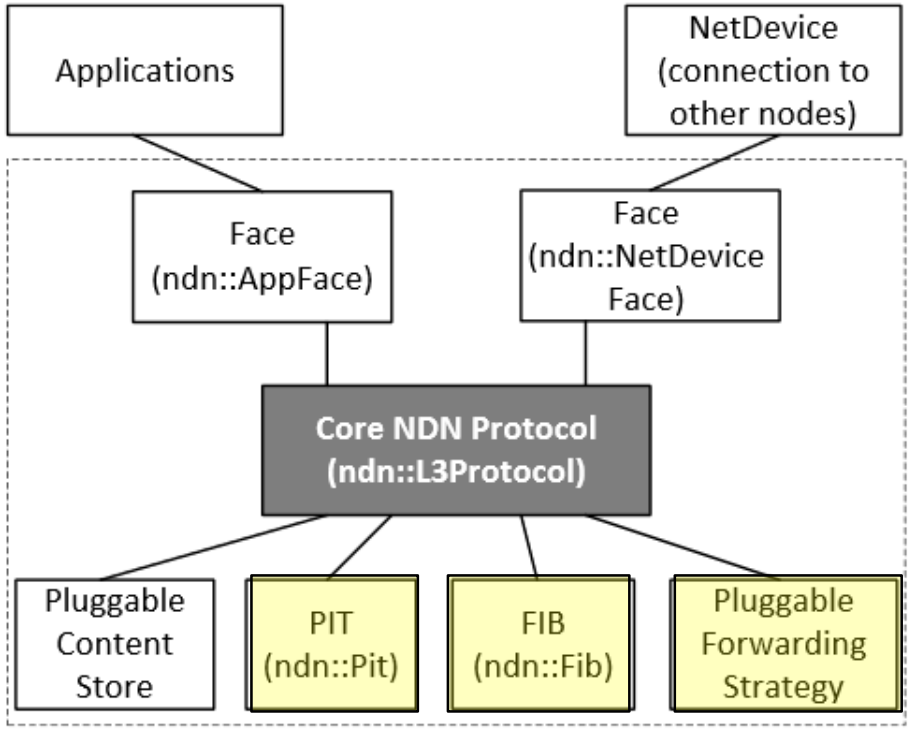

NDN Headers for Interest and Data Packets

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- Interest packet:
  - MAC address field: std::string m_interestOriginMacAddress
  - MAC address field: std::string m_interestTargetMacAddress
  - Route taken so far: std::string m_macInterestRoute

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- Data packet:
  - MAC address field: std::string m_dataOriginMacAddress
  - MAC address field: std::string m_dataTargetMacAddress
  - Route taken so far: std::string m_macDataRoute

PIT / FIB entries

- Make the Information from the packets persist within the nodes

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  - List of origin MAC addresses
  - Latency
  - Setters and getters

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- The PIT entries were extended:
  - List of origin MAC addresses
  - Latency
  - Setters and getters
- The FIB entries were extended:
  - List of target MAC addresses
  - Setters and getters

Forwarding Strategy

- Flooding of the Network
  - 1) Interest arrives at some node
  - 2) PIT is updated with Interest name and origin MAC address
  - 3) Current node‘s MAC address is added to the Interest
  - 4) FIB is checked and found empty → Broadcast Interest with empty target MAC
  - 5) Neighboring nodes receive the broadcast and check if a target MAC is present on Interest
    - 5.1) no target MAC was added to Interest → accepted!

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  - 6) Repeat from 2) until some Producer is reached

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  - 6) Repeat from 2) until some Producer is reached
  - 7) Data arrives at some node
  - 8) PIT is checked if Data is solicited
  - 9) If it is solicited add current node‘s MAC address and target MAC from PIT entry to Data.
  - 10) Add Next Hop to FIB entry
  - 11) Broadcast data.

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  - 9) If it is solicited add current node‘s MAC address and target MAC from PIT entry to Data.
  - 10) Broadcast data.
  - 11) Add Next Hop to FIB entry
  - 12) Repeat from 7) until the Consumer is reached.

Forwarding Strategy

Algorithm 1 Interest forwarding from requester node

```
1:  procedure CHECK FIB
2:      if FIBEntry = ∅ then
3:          OriginMAC ← MyMAC
4:          TargetMAC ← NULL
5:          forward(Interest, nexthop)
6:      else
7:          OriginMAC ← MyMac
8:          TargetMAC ← Select(nexthop)
9:          forward(Interest, nexthop)
10:     end if
11: end procedure
```

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6:      else
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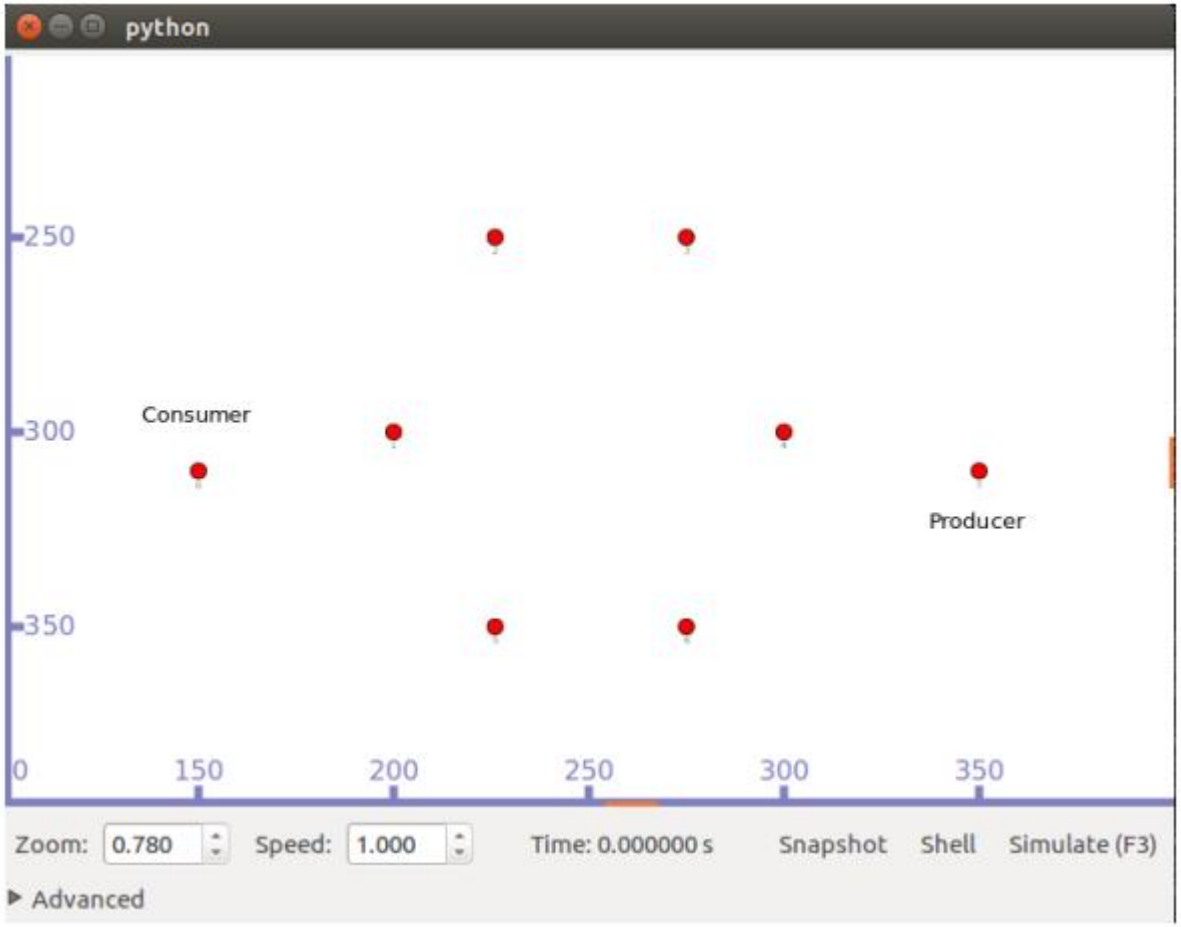
8:          TargetMAC ← Select(nexthop)
9:          forward(Interest, nexthop)
10:     end if
11: end procedure
```

Algorithm 2 Data forwarding from intermediate node

```
1:  procedure RECEPTION OF DATA
2:      if PITEntry ≠ ∅ then
3:          if TargetMAC ≠ MyMAC then
4:              Create/Update(FIBEntry, OriginMac)
5:          else
6:              Create/Update(FIBEntry, OriginMac)
7:              OriginMAC ← MyMAC
8:              TargetMAC ← PITEntry(nexthop)
9:              forward(Data, nexthop)
10:         end if
11:     end if
12: end procedure
```

Results for the static 8 nodes scenario

- Static scenario with 8 nodes
- Simulation for 100s, 200s, 300s and 600s
- 3 network interfaces
- Interest Lifetime of 4 seconds
- Retransmission timer of 500ms



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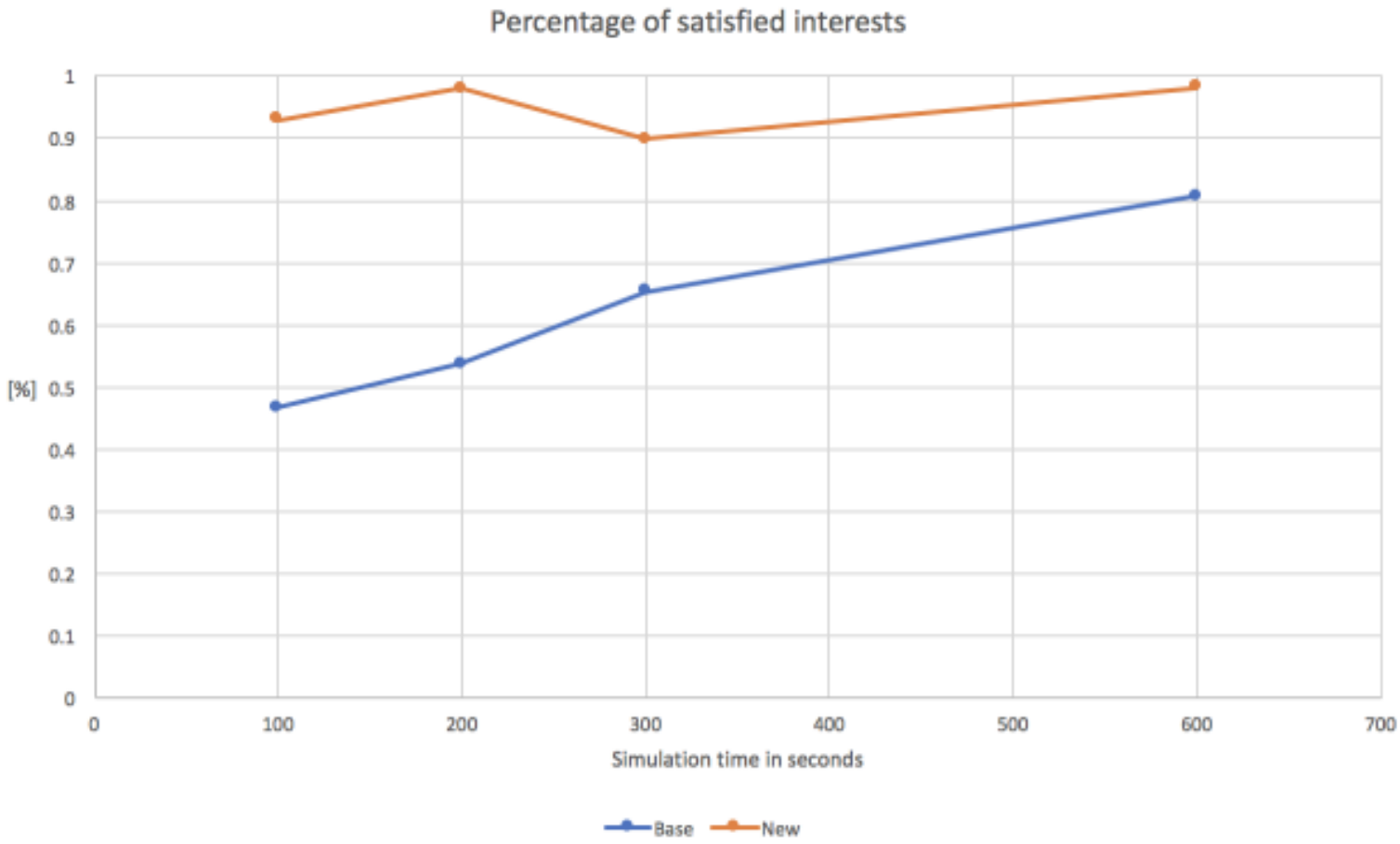

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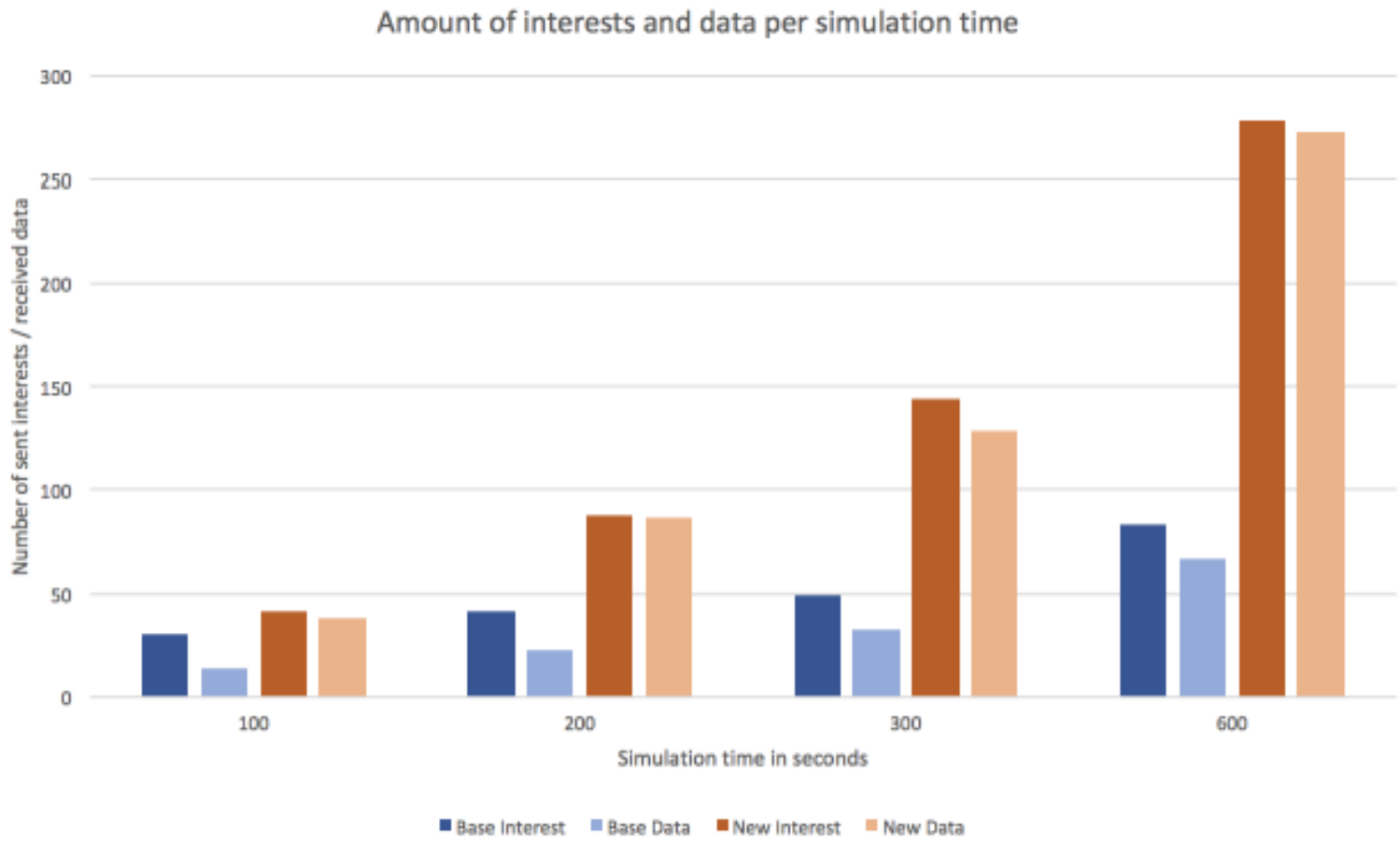

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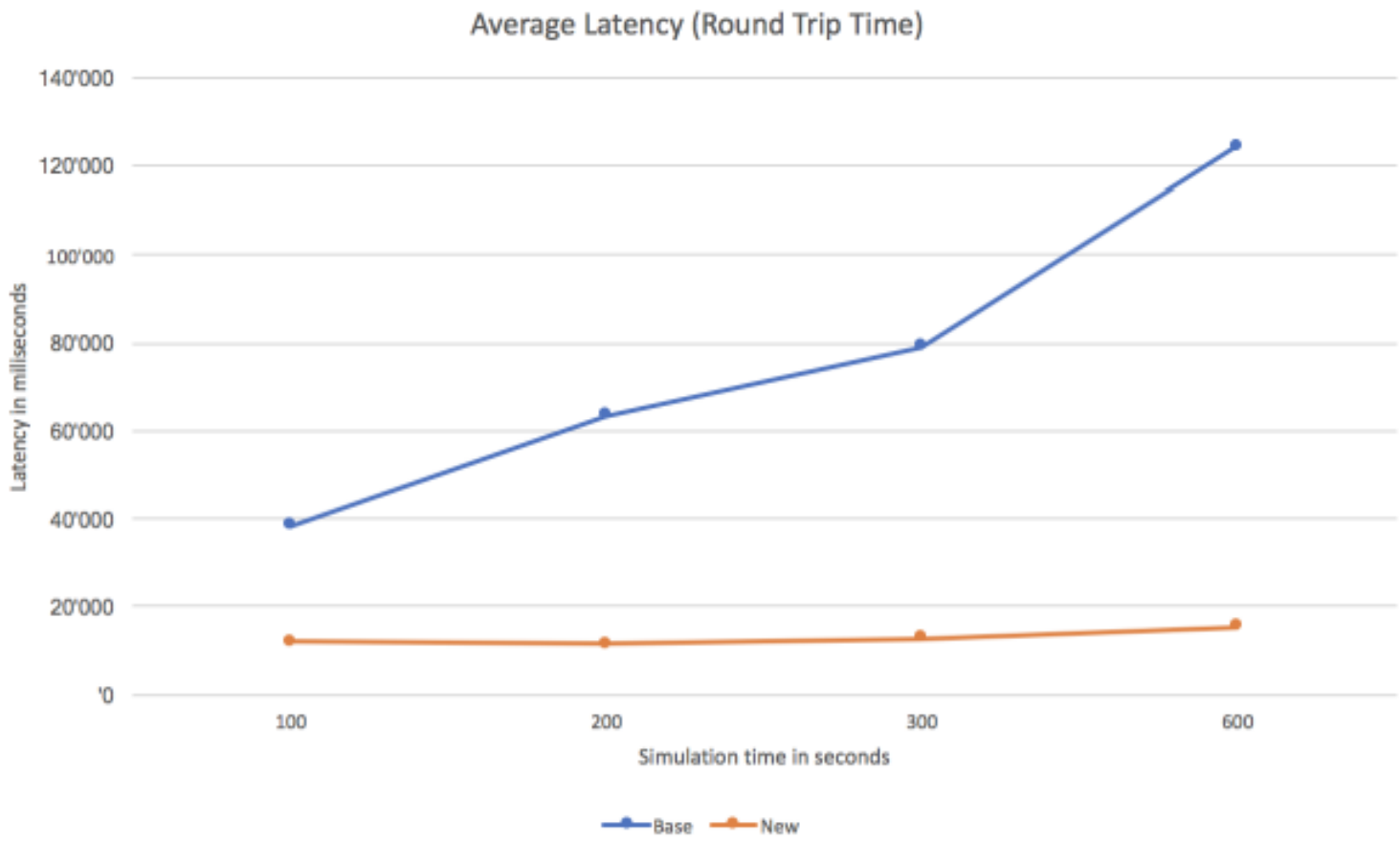

Results for the dynamic 16 nodes scenario

- Dynamic scenario with 16 moving nodes
- Simulation for 100s, 200s, 300s and 600s
- 3 network interfaces
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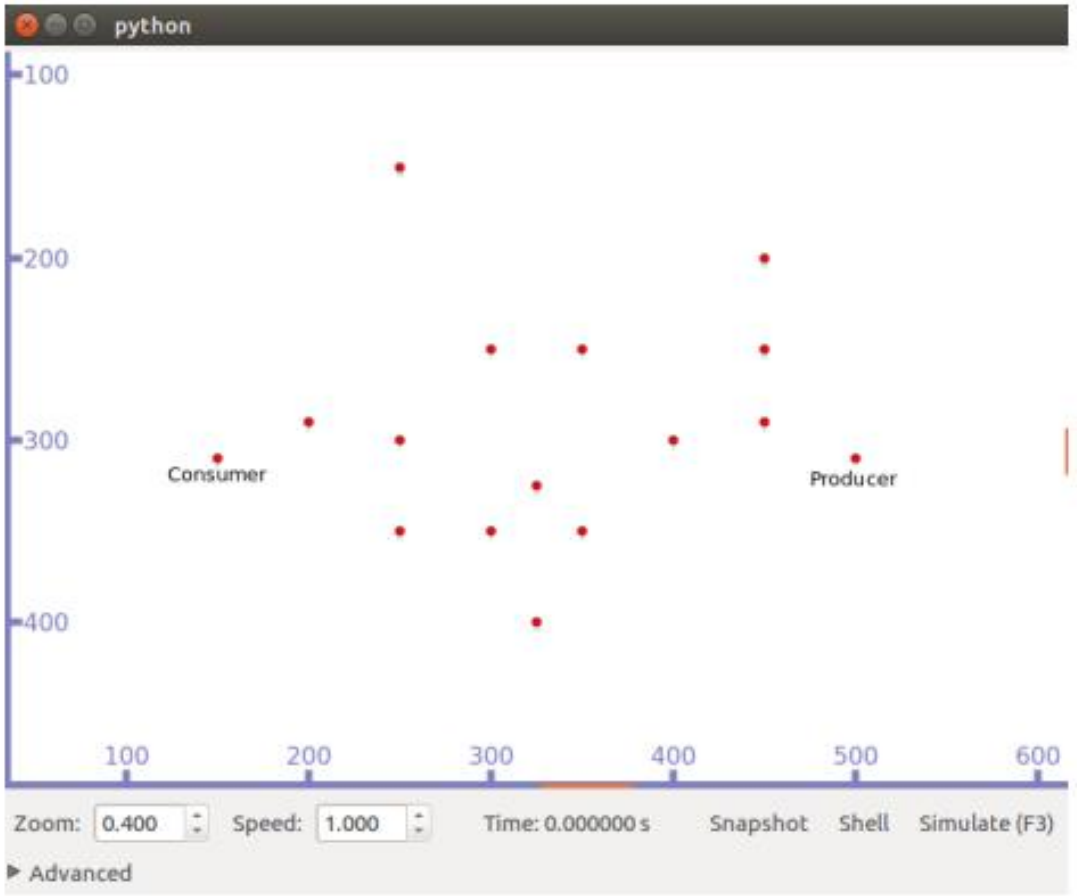

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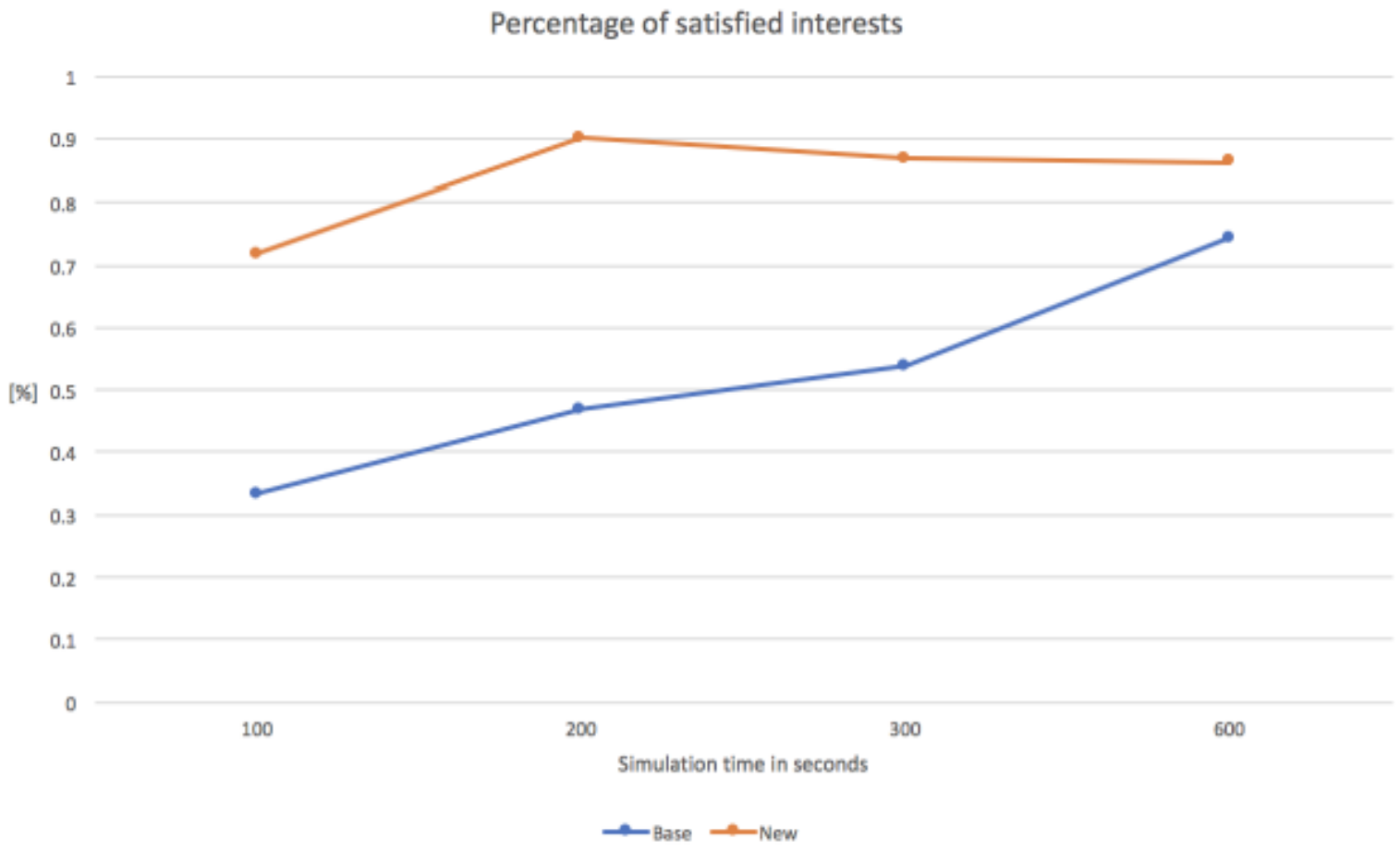

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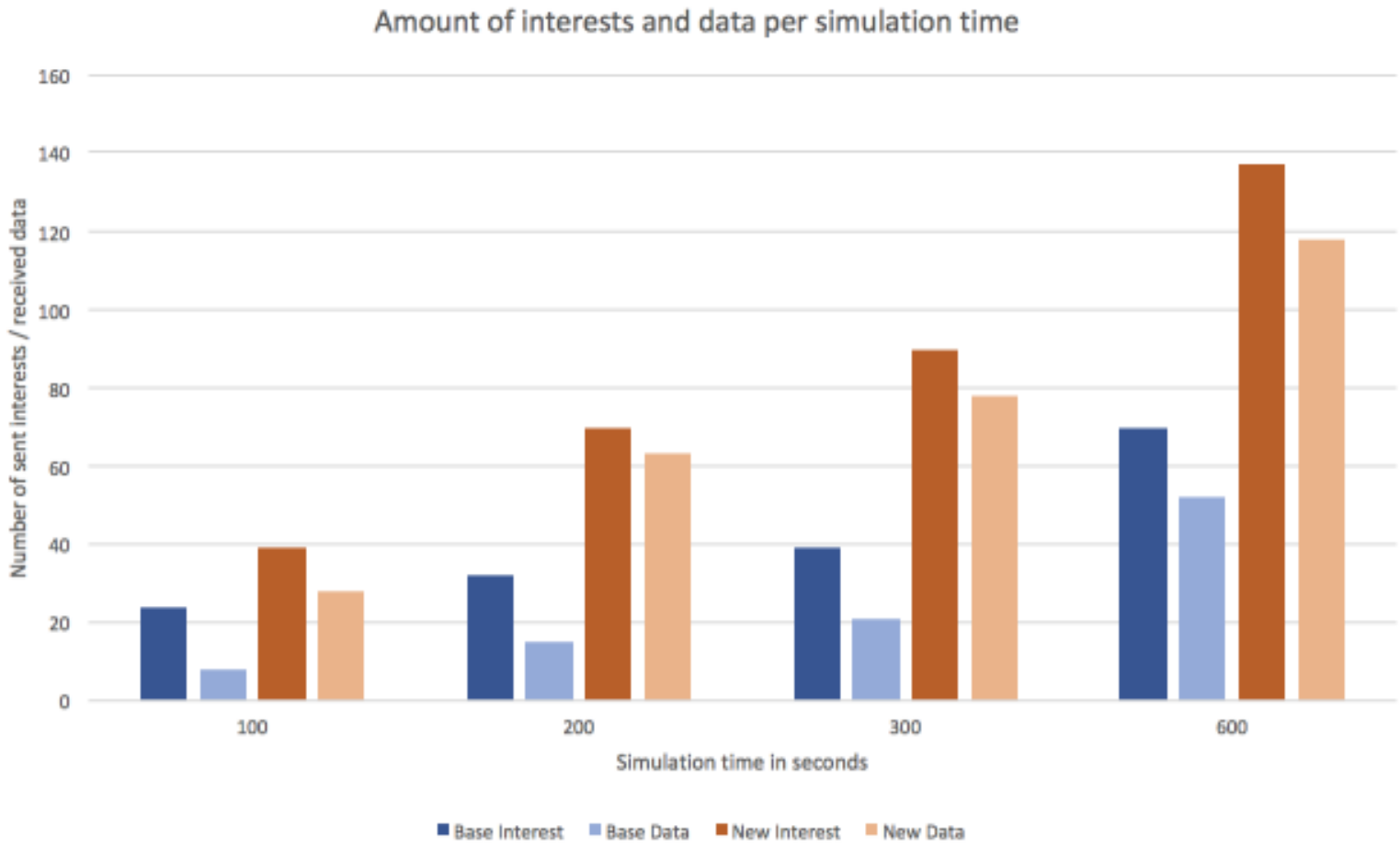

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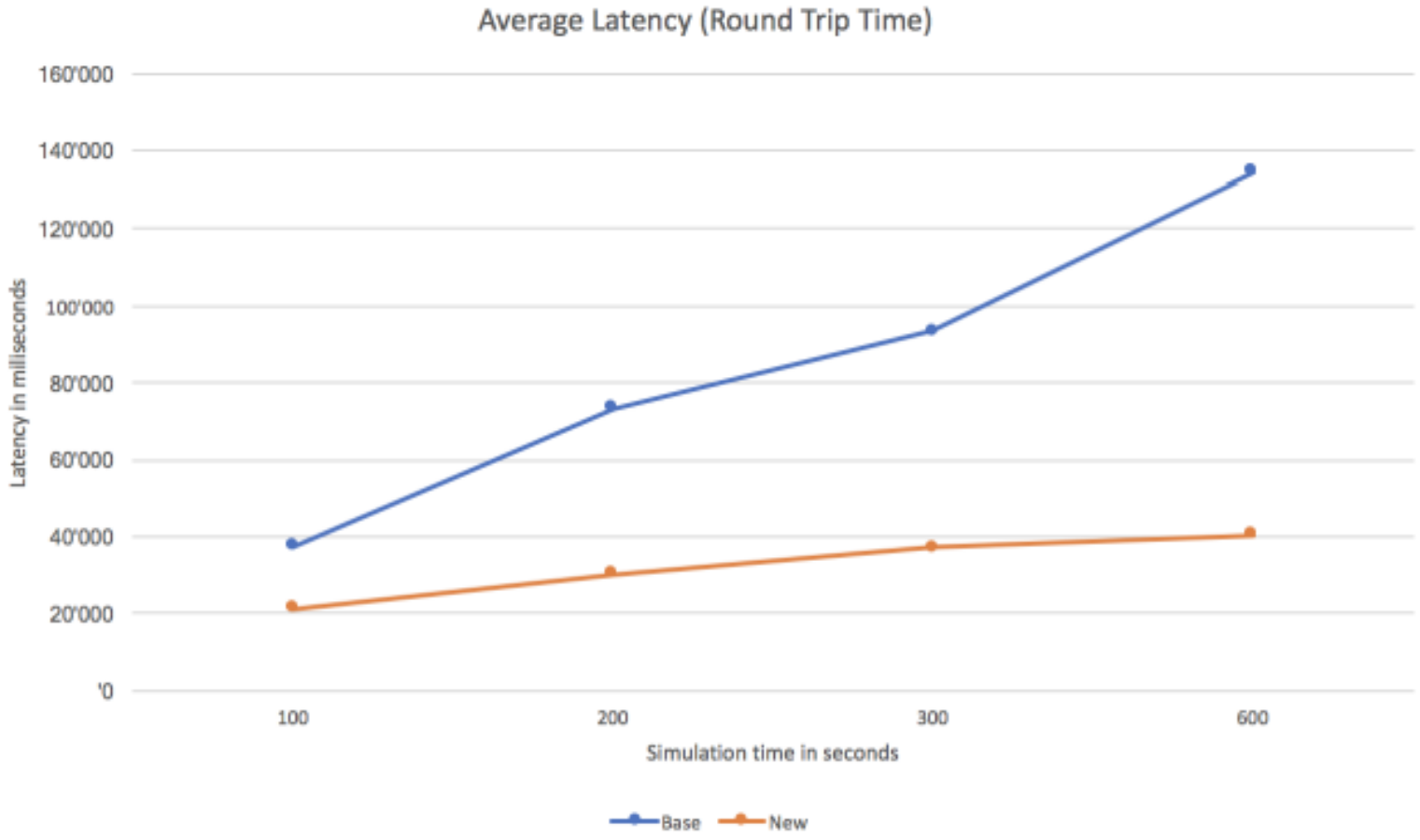


Future Work

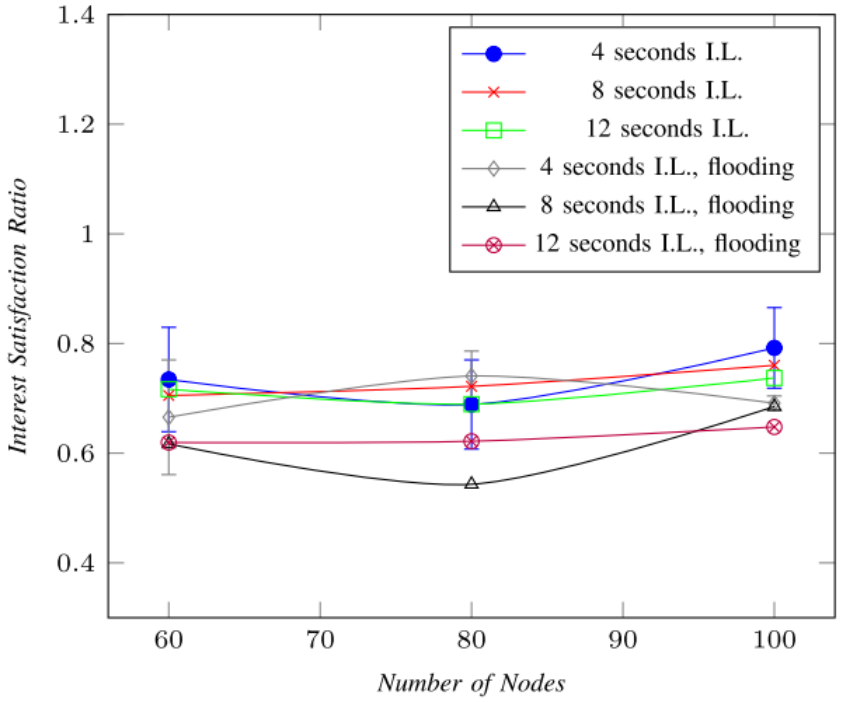
- Improve on dynamic route selection
- Incrementing/Decrementing the cost of the FIB next hop according to some network parameters
- Adding NACKs for better retransmission decisions
- Introduce CS and more nodes (consumers/producers)
- Timer for FIB entries (deletion of it forces flooding)

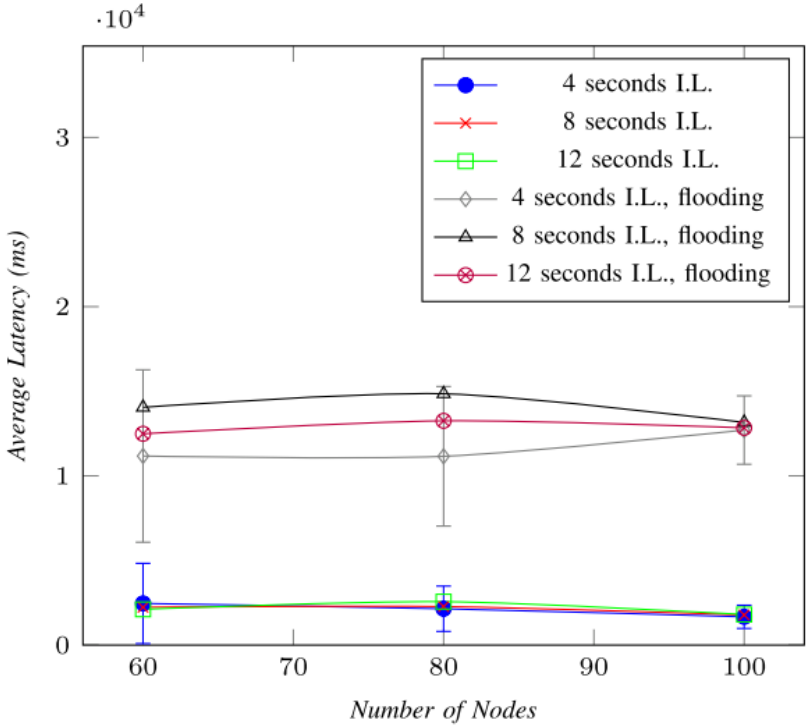
Future Works implemented

- Implemented
  - per node latency for better route detection
  - Incrementing cost for more distinct routes
  - Improved strategy to choose from several parameters
  - Real MANHATTEN scenario with 60 / 80 and 100 moving nodes
  - Tweaking with paramters like Interest Lifetime

New Results (from Paper)

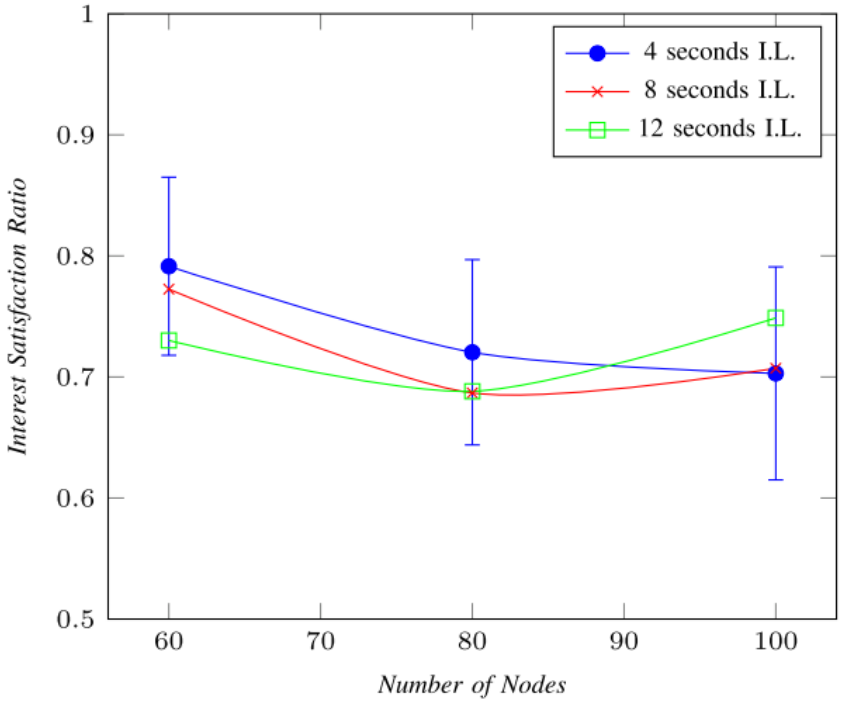
> First Scenario where the FIB next hops are chosen by the counter variable

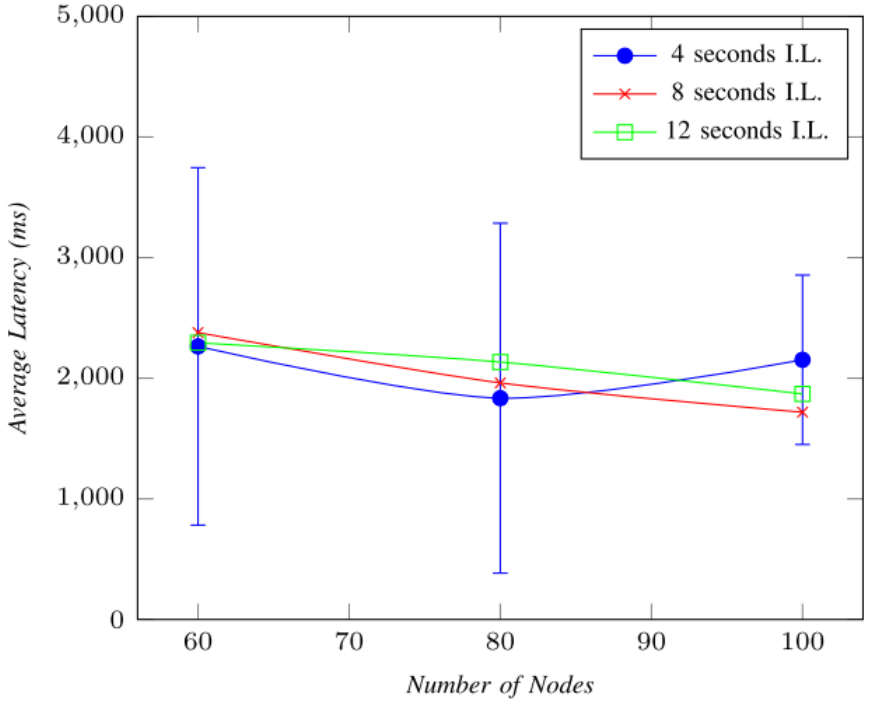




New Results (from Paper)

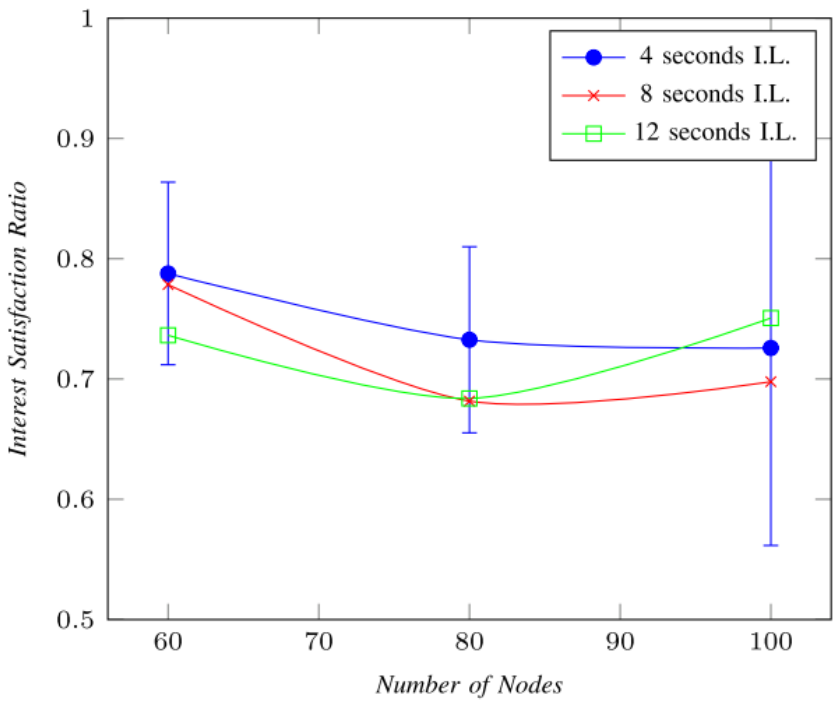
> Second Scenario where the FIB next hops are chosen by the latency information in each node

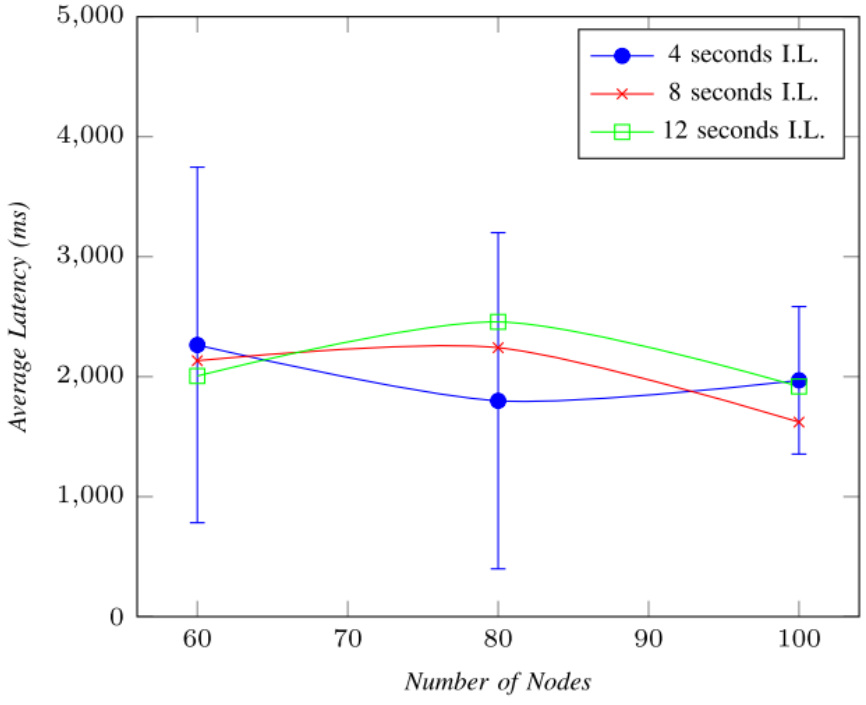




New Results (from Paper)

> Third Scenario where the FIB next hops are chosen by the counter variable and the latency information.





Questions?

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