OPS – An Opportunistic Networking Protocol Simulator for OMNeT++

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OMNeT++ Community Summit 2017

University of Bremen, Bremen, Germany

September 07 – 08, 2017

Universität Bremen

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Contents

Motivation

Motivation

- Internet of Things (IoT)
  - Over 50 billion devices by 2020 [1]
- Architecture for communications in the IoT
  - Opportunistic Networking
- IoT Scenarios
  - Social networking to emergencies
  - Nature of applications – higher value of information in locality
- Importance of information propagation
  - Forwarding protocols – Epidemic Routing, ODD, etc.
- Necessity for large-scale evaluations
  - Require simulators – OMNeT++

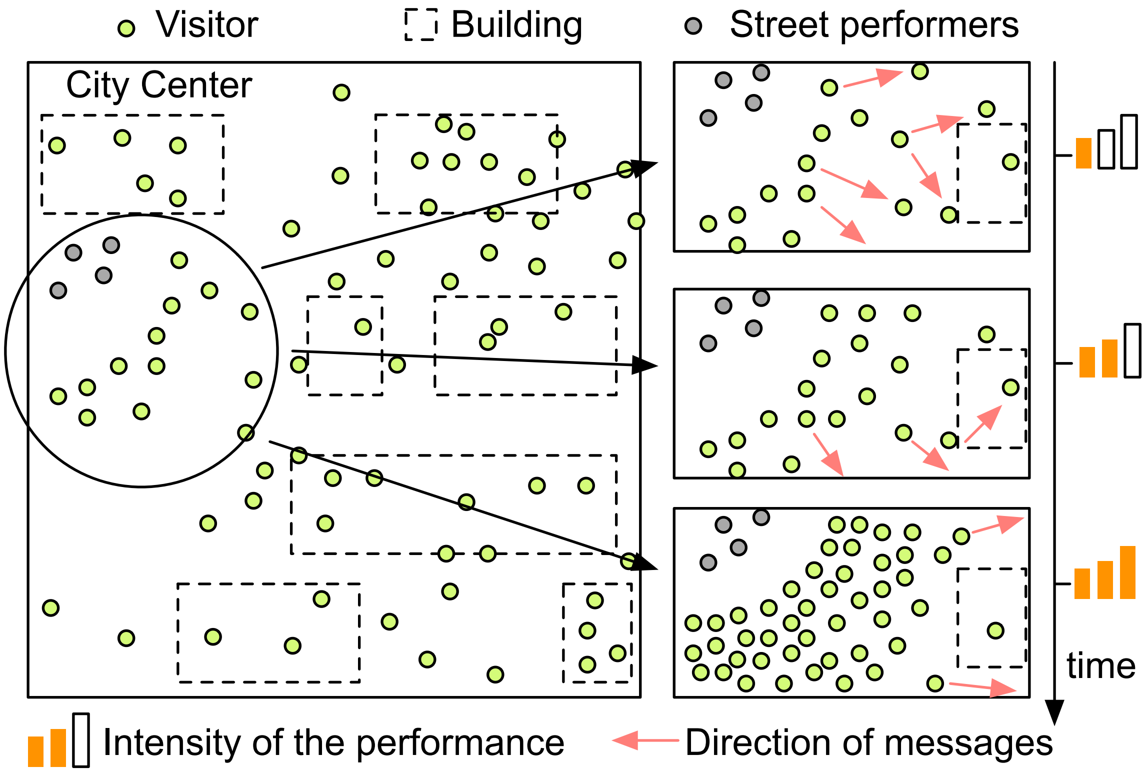
Opportunistic Networks (OppNets)

Characteristics of OppNets

- Information dissemination
  - Interested parties wanting information
  - Value of information higher around the source
- Store-and-Forward architecture
  - Communicate when there is an opportunity to communicate
  - Delayed delivery of information
- Use of peer-to-peer communication technologies
  - E.g., Bluetooth, IEEE 802.15.4
- Importance of the information propagation
  - Capabilities of the forwarding protocol

OppNets Use-case

- Propagation of information about an event
  - Street performers
  - Interested people gather (flash crowd)



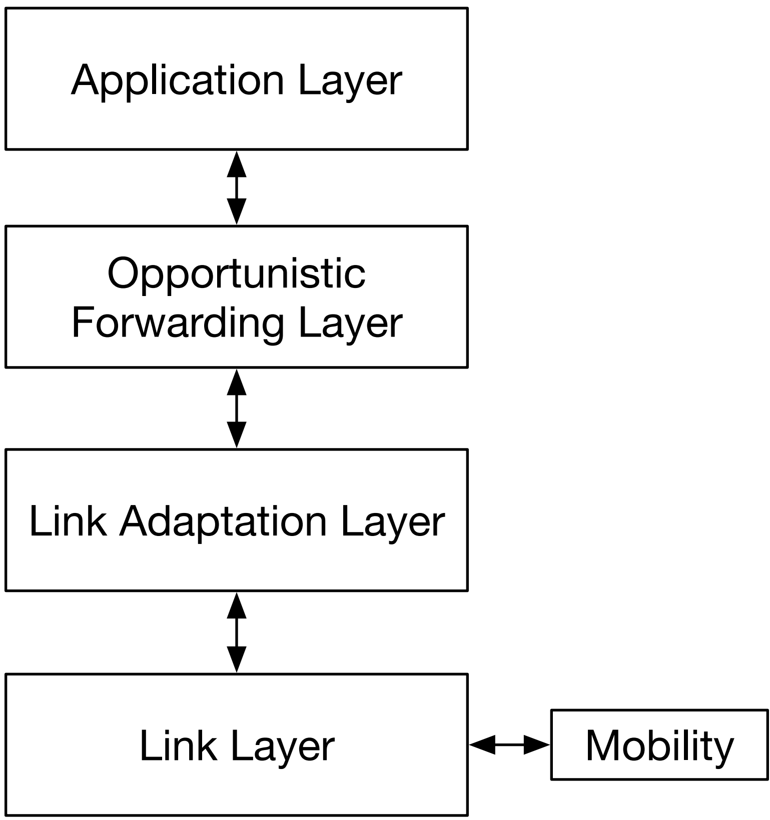
Opportunistic Networking Protocol Simulator (OPS)

Objectives

- Pluggable protocol layer architecture
  - Node model can handle new protocol implementations
  - Clear interface between layers
- Large-scale simulations
  - IoT-scale devices
- Mobility
  - Synthetic, trace-based and hybrid

Protocol Stack

- Node model – 4 layer protocol stack
- Protocol layers
  - **Application layer** – Data generators
  - **Forwarding layer** – Data propagation mechanisms
  - **Link Adaptation layer** – Conversions to different link technologies
  - **Link layer** – Link technology coupled with mobility



Models

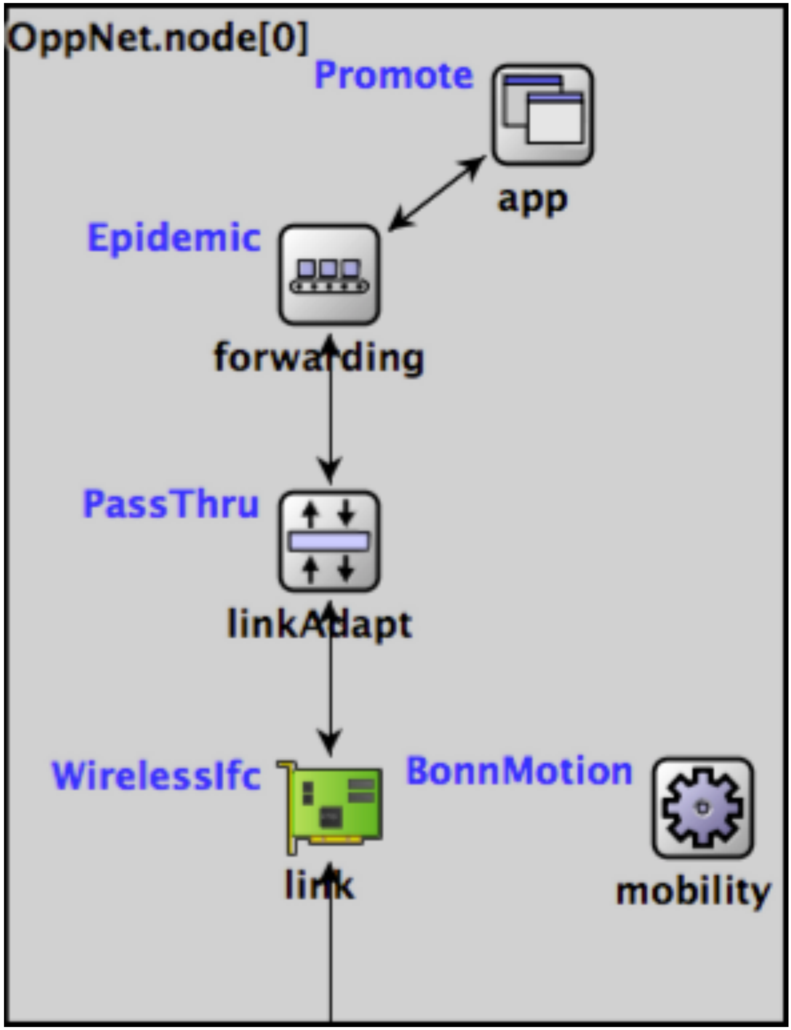
- Application layer
  - **Promote** – Generates random data as constant traffic, uniformly distributed traffic or exponentially distributed traffic
  - **Herald** – Generates pre-determined set of data where nodes assigned “likeness” value to data
- Opportunistic forwarding layer
  - **Caching data** – Employs store-and-forward
  - **Neighborhood communications** – Communications with the changing neighborhood
  - **Epidemic Routing** – Nodes negotiate and exchange data [2]
  - **Organic Data Dissemination (ODD)** – Dissemination of data based on popularity of data [3]
  - **Randomized Rumor Spreading (RRS)** – Random dissemination of data

Models …contd

- Link adaptation layer
  - **PassThru** – Simple packet traversal
- Link layer
  - **WirelessInterface** – Simple wireless interface that models bandwidth, delays, wireless range (with UDG) and queuing
- Interfaces
  - Use of an extensible packet format

Node Model Implementation

- An example node model used in an experiment
- Use of trace based mobility
  - **BonnMotion** – Cartesian trace of an actual GPS trace – SFO Taxi trace [4]



Evaluation Metrics

- Focus of performance evaluations is slightly different compared to classical networks
- Data related metrics
  - **Liked Data** – Preferred data received
  - **Non-liked Data** – Not preferred but still received
  - **Traffic Spread** – How well is packet traffic spread in the network
  - **Data Delivery Ratio** – Delivery ratio of destined data
  - **Delivery Time** – Delivery time of destined data
- Mobility related metrics
  - **Average Contact Time** – Duration of a contact
  - **Number of Contacts** – Number of times in contact

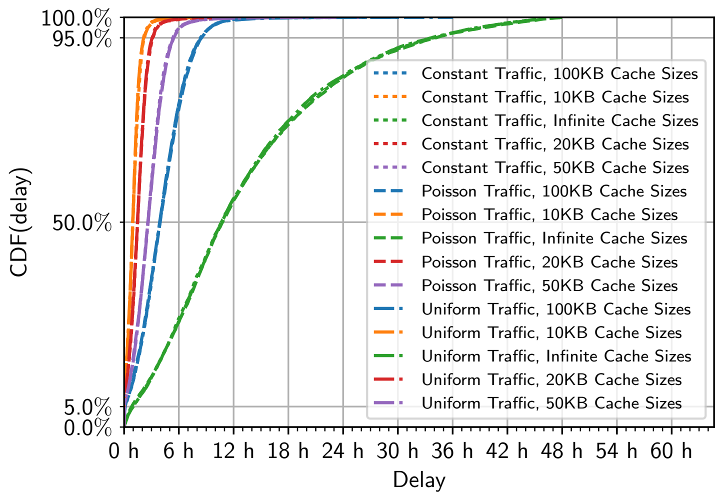
Evaluations

Evaluation Scenario

- OPS is being used extensively in our research
  - Results of some evaluations
  - Used in an IEEE Survey on OppNets [5]
- General scenario details
  - Nodes – 50-node network
  - Mobility – SFO Taxi Trace [4]
  - Data generation – 2 hour interval
  - Run for 24 days

Influence of Traffic Models & Caching

- Scenario specific parameters
  - Different traffic generation models and different cache sizes
  - Evaluation of data delivery times
- Analysis
  - Traffic generation model has no influence
  - But, caching policy influences delay



Performance of Mobility Models

- Scenario specific parameters
  - 3 different mobility models (synthetic, trace-based and hybrid)
  - Models parameterized as closely as possible to trace-based model
- Analysis
  - Trace-based takes the longest time (but realistic)
  - Closest performance is given by the hybrid model (SWIM)

Model	RWP	SWIM	Bonn Motion
Simulation Time	4 min	59 min	109 min
Memory used	74 MB	86 MB	127 MB
Average Delivery Rate	3 %	96%	92 %
Average Delivery Delay	20.6 h	16.25 h	13.16 h
Total Number of Contacts	190	46,752	155,757
Average Contact Duration	117.14 sec	150.12 sec	584.39 sec

Verification of the Models

- Survey compared OPS with 3 other OppNets implementations
  - ONE [6], Adyton [7] and ns-3
- Analysis
  - OPS provides a comparatively close performance (in metrics listed above)

Summary and Future Work

Summary

- OPS – OMNeT++ based modular simulator to evaluate the performance of OppNets
- Node model architecture with pluggable protocol layers
- OppNets focused evaluation metrics
- Available at Github
  - https://github.com/ComNets-Bremen/OPS

Future Work

- Constant improvements, additions to OPS
- Current projects
  - Forwarding protocols (e.g. Spray and Wait)
  - Applications
  - User behavior models
  - Mobility models

References

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Thank You.

Questions?