Integrating Peer-to-Peer Functionalities and Routing in Mobile Ad-hoc Networks

WinnComm 2016
16th March 2016

Dr. Grant Millar
Mr. Alexandros Ladas
Dr. Olayinka Adigun
Prof. Christos Politis

Wireless Multimedia & Networking
WMN Research Group
Kingston University London

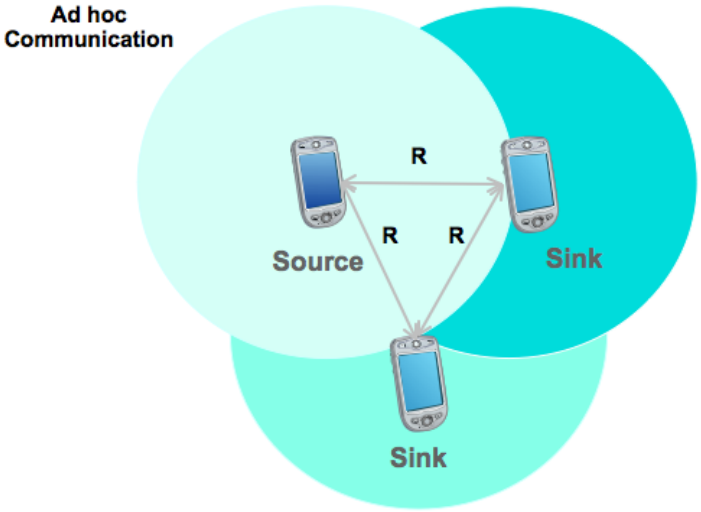
Kingston University London

Outline

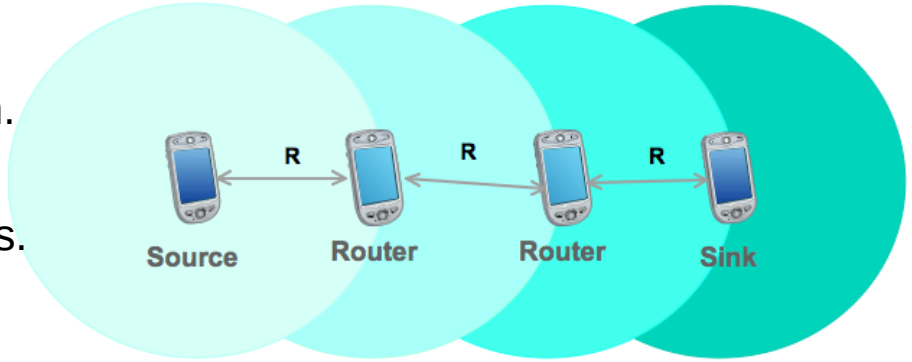
- Introduction
- Routing in MANETs
- DHT-Routing Integration
- Performance Evaluation
- Results
- Conclusion

Introduction

- Mobile Ad Hoc Networks (MANETs)
- No infrastructure required
- Ad hoc Setup:
  - Cost effective remote location
  - Rapid Setup
- Cooperative IP-based communication.
- Source, Destination and Router nodes.
- Packet forwarded within distance R
  - R: Radio transmission range

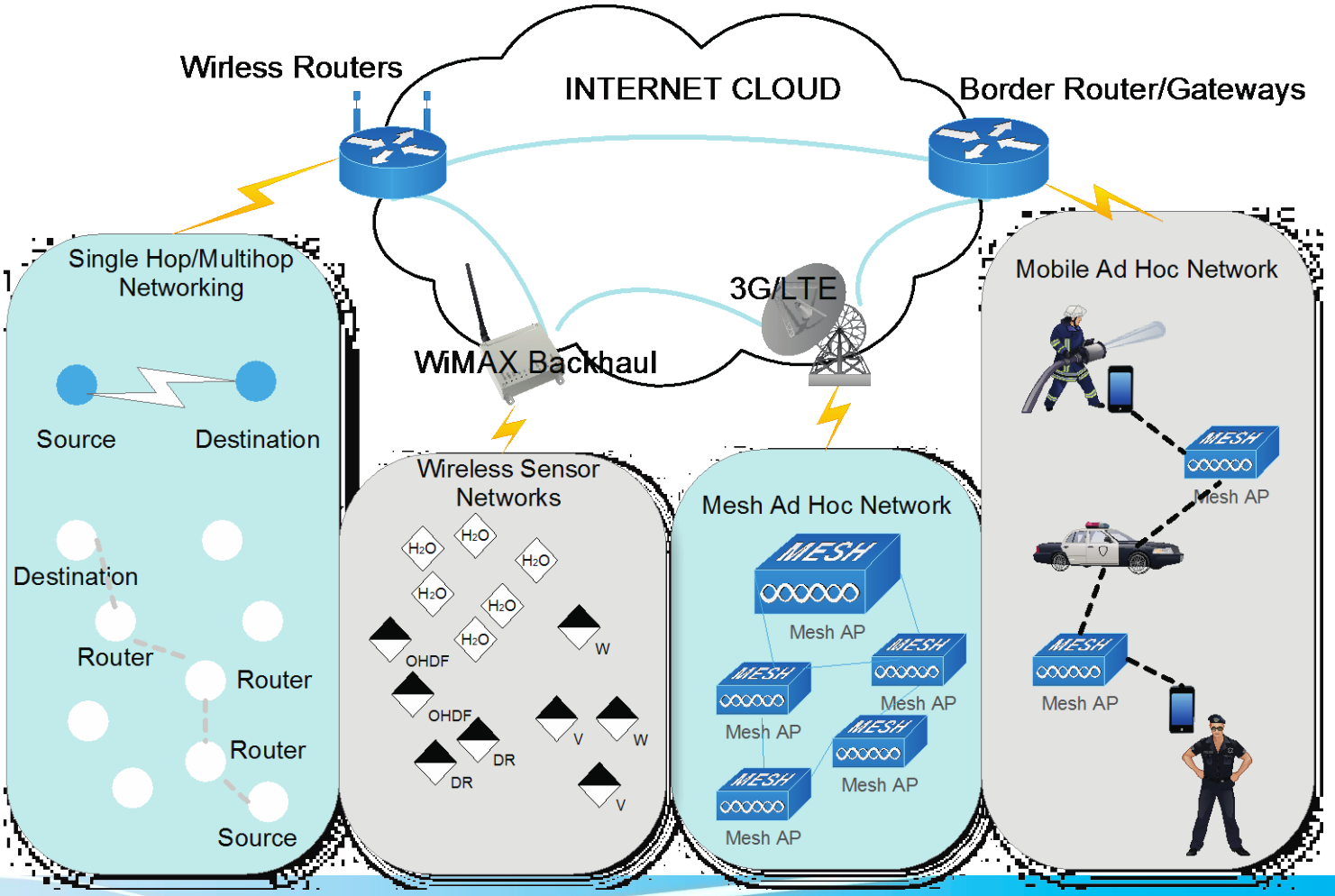


(i) Direct Ad Hoc Communication



(ii) Multihop Ad hoc Communication

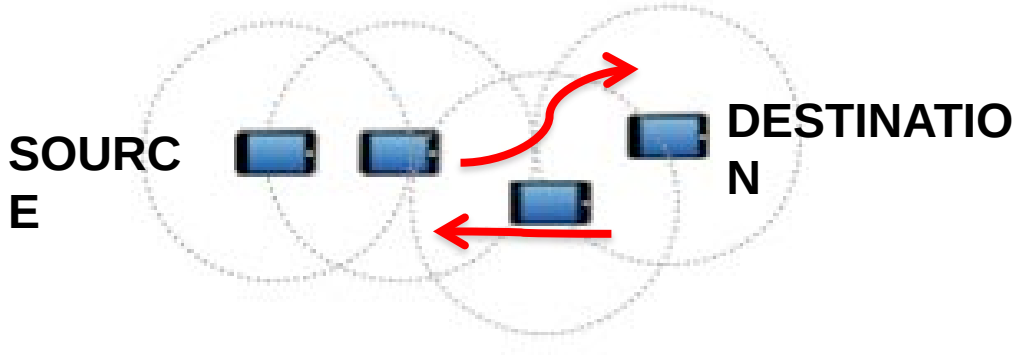
Types of Ad-hoc Networks



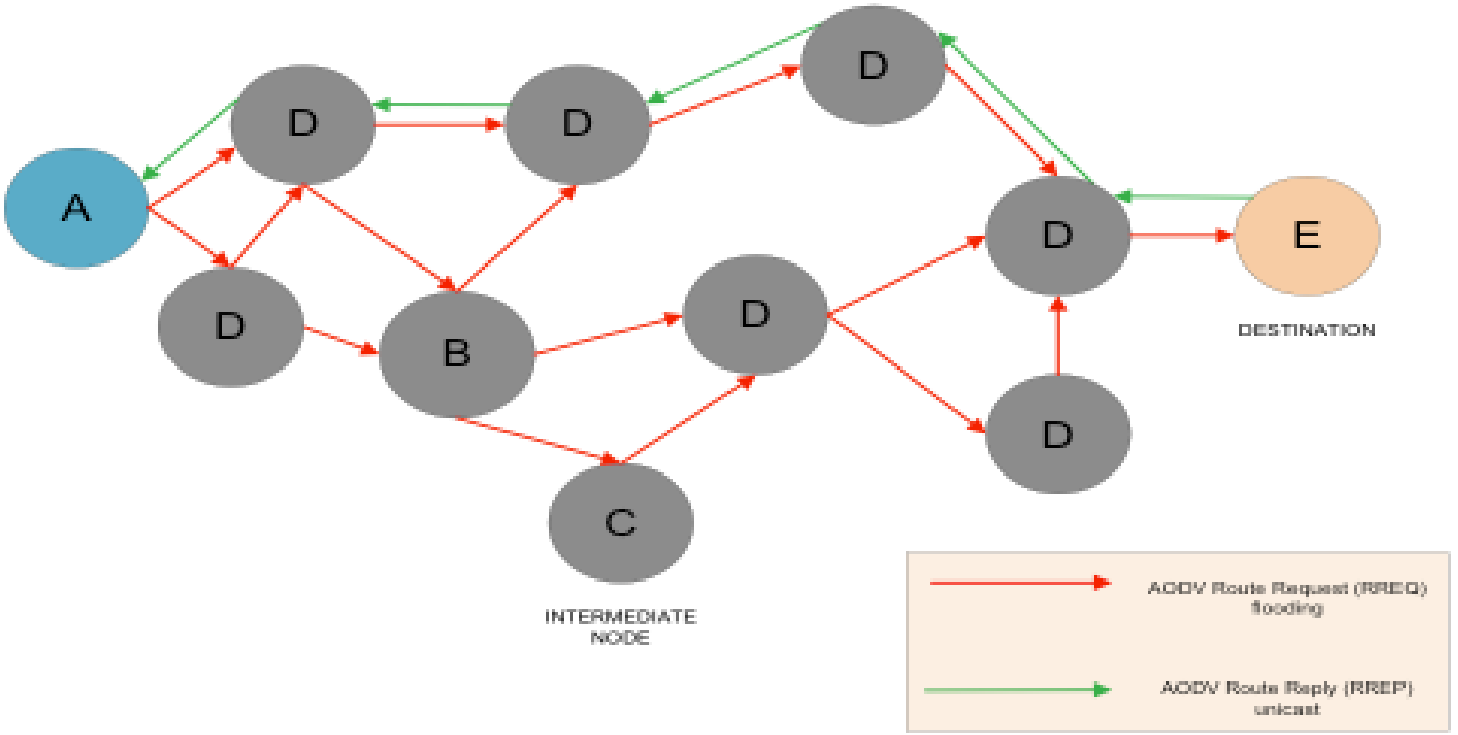
Routing in MANETs

- Mobile Source, Destination and Router nodes.

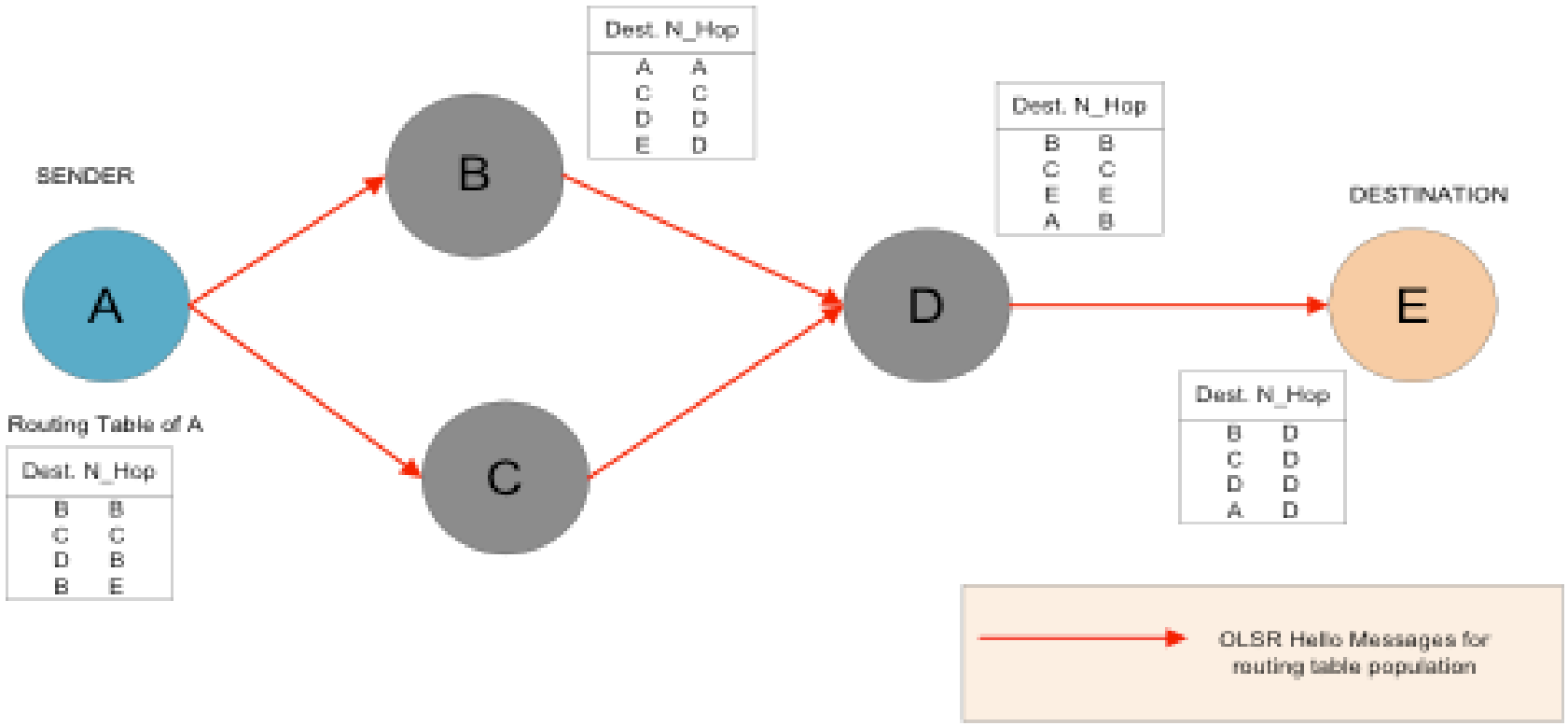
- Routing protocol required that can dynamically:
  - Locate source relative to destination
  - Locate destination relative to router
  - Identify the appropriate routers that can transfer data from source to destination



Reactive Approaches: AODV



Proactive Approaches: OLSR



MANET Routing Scalability

- Routing scalability implies that the routing protocol needs to sustain data routing with minimal delay and overhead for various increasing network sizes

- Scalability is one of the major challenges for deploying MANET.

- The routing protocol has to guarantee the required QoS for packet delivery latency.

Peer-to-Peer (P2P) Networks

- Decentralized application layer overlay networks where traffic flows on top of the physical network.
- P2P networks are formed dynamically on-the-fly and rely on no fixed infrastructure.
- P2P overlays and MANETs share a common notion of rapid network setup.
- P2P networks can use DHTs to achieve key look-up.

Distributed Hash Table (DHT)

- Class of a decentralized distributed system
- Widely used today on the Internet in various peer-to-peer systems
- Provides name look-up services such as P2PSIP
- Keeps track of peers in a file sharing system such as BitTorrent

MANETs and P2P Networks

Both P2P networks and MANETs share some common properties such as being:

- Decentralized and self-organizing
- Participants sharing their network resources to relay packets for others.
- The algorithms for routing in both technologies are focused on searching the network.
- MANETs focuses on searching for a route to a specific destination IP

MANETs and P2P Networks

- P2P networks focuses on searching for a route to a specific destination key and retrieving the data associated with the key.
- MANETs use routing protocols running on the network layer whereas P2P networks can use DHTs to achieve key look-up.
- DHTs are based on storing data using a unique ID called a key ID which is then mapped to the peer with the numerically closest peer ID in the DHT.
- In many DHTs, the key ID and the peer ID are computed using a uniformly distributed hash function such as Secure Hash Algorithm (SHA-1).

Proposed Protocols

Integrates DHT functionality at the network layer in MANETs.

- Two new protocols: Proactive MANET DHT (PMDHT) and Reactive MANET DHT (RMDHT) are proposed
- Based on both a proactive and reactive MANET routing protocol.
- Unnecessary overheads and duplicated functionalities in the MANETs and P2P are avoided the network. E.g. neighbourhood discovery.
- Evaluated against other protocols in literature in order to ascertain performance for different scenarios.

Proposed Protocols

Our work is based on OpenDHT also known as Bamboo DHT

- The main improvements adapted from OpenDHT and incorporated in our DHT architectures are;

  (i) reactive recovery from failures whereby peers replace a failed neighbor in a fixed periodic manner rather than a reactive manner

  (ii) calculation of message timeouts during lookups

Scenario Setup

- Simulation time: 1000s
- Network Size (Scalability): 25, 50, 75, 100, 125
- Network size (Mobility effect): 50
- Node velocity (Scalability): 1m/s
- Node velocity (Mobility effect): 0m/s, 5m/s, 10m/s, 15m/s, 20m/s
- Mobility model: Random Way Point
- MAC layer: 802.11
- Link bandwidth: 11 Mbit/s
- Maximum transmission range: 250 m
- Proximity synchronization interval: 60s

Performance Indicators

- Network Overhead
- Network Latency
- Packet Loss
- Look up Success Rate
- Average Path Length
- Overlay Stretch

Results

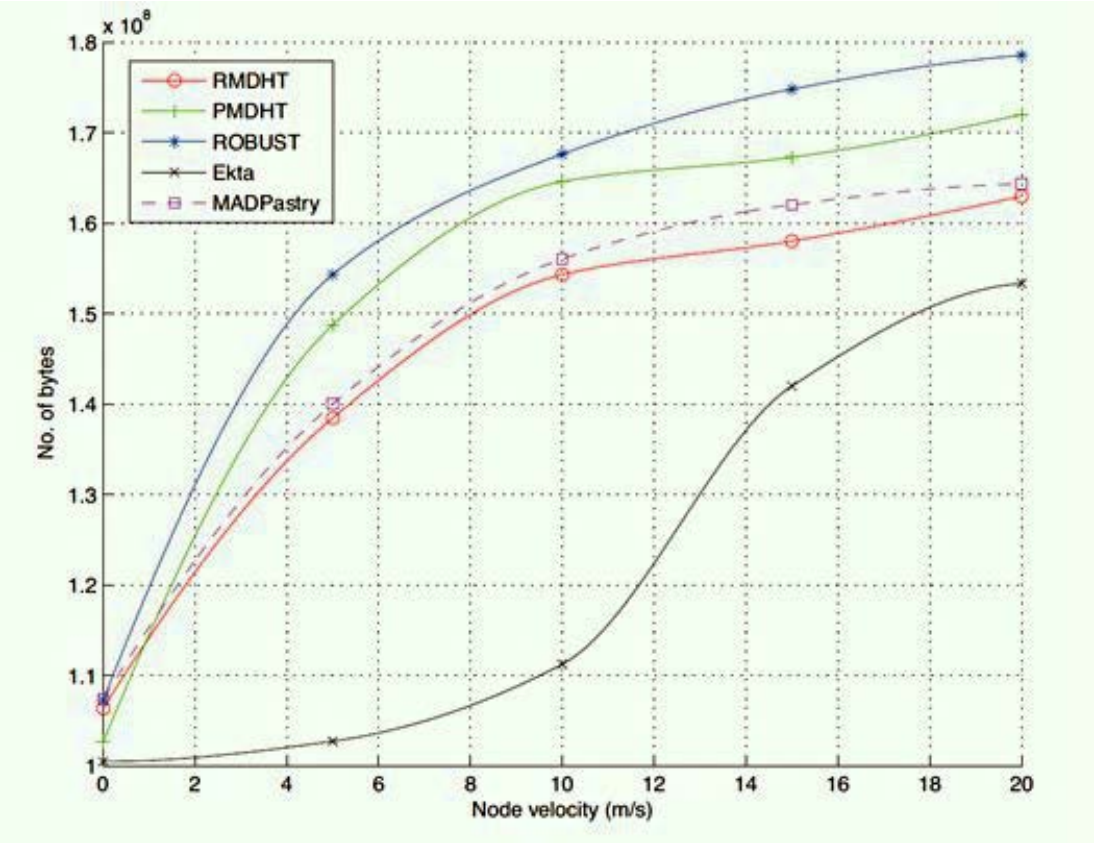


Fig.1 :DHT Overhead in Bytes vs Node Speed

Results (2)

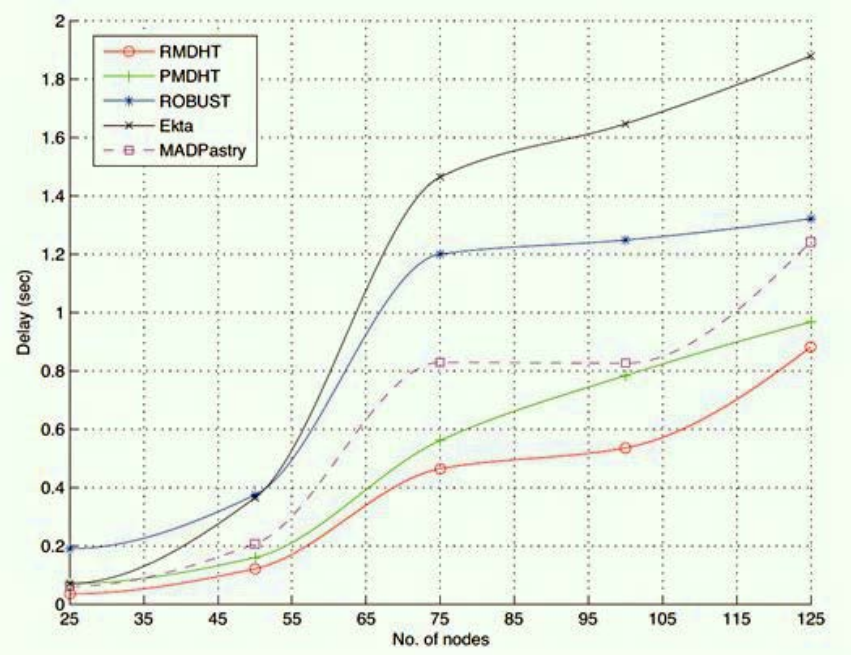


Fig.2: (a) E2E Delay vs Scalability

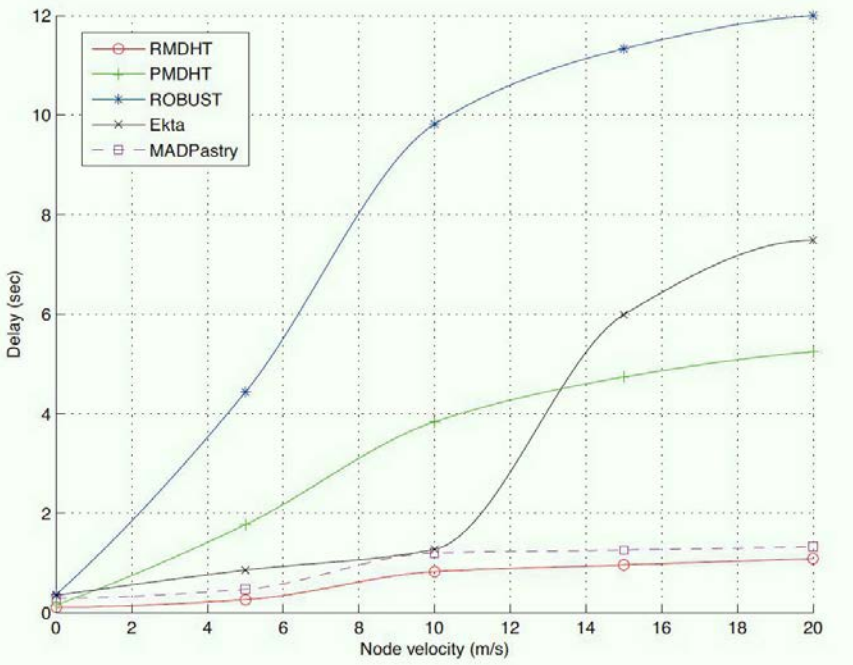


Fig.2: (b) E2E Delay vs Node Speed

Results (3)

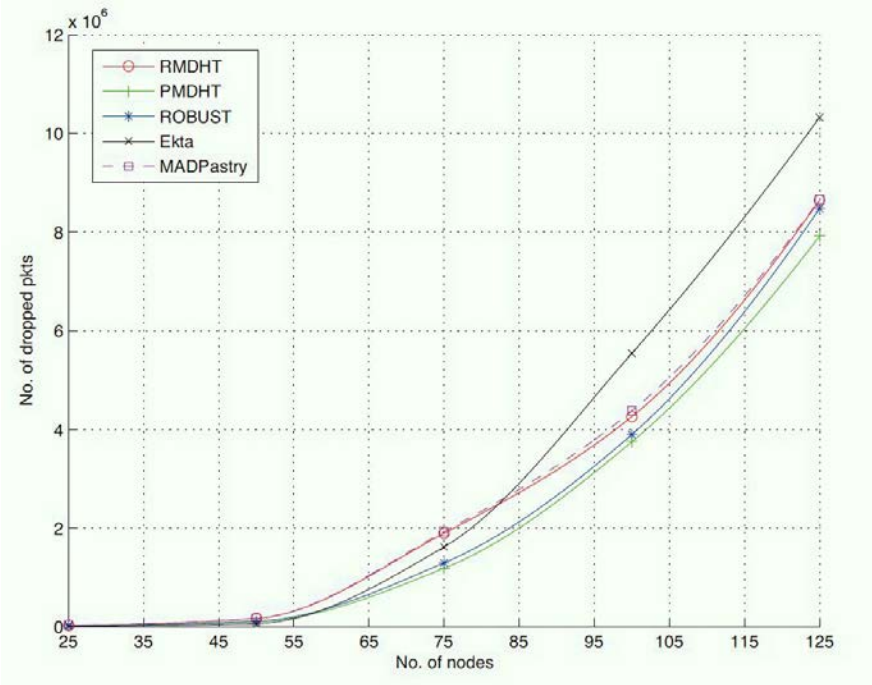


Fig.3: (a) Dropped Packets vs Scalability

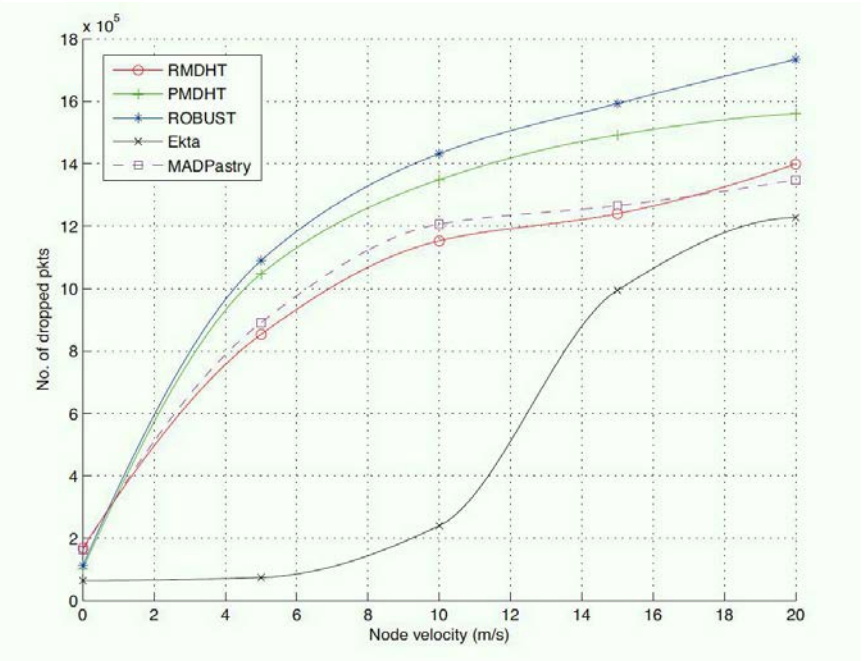


Fig.3: (b) Dropped Packets vs Scalability

Results (4)

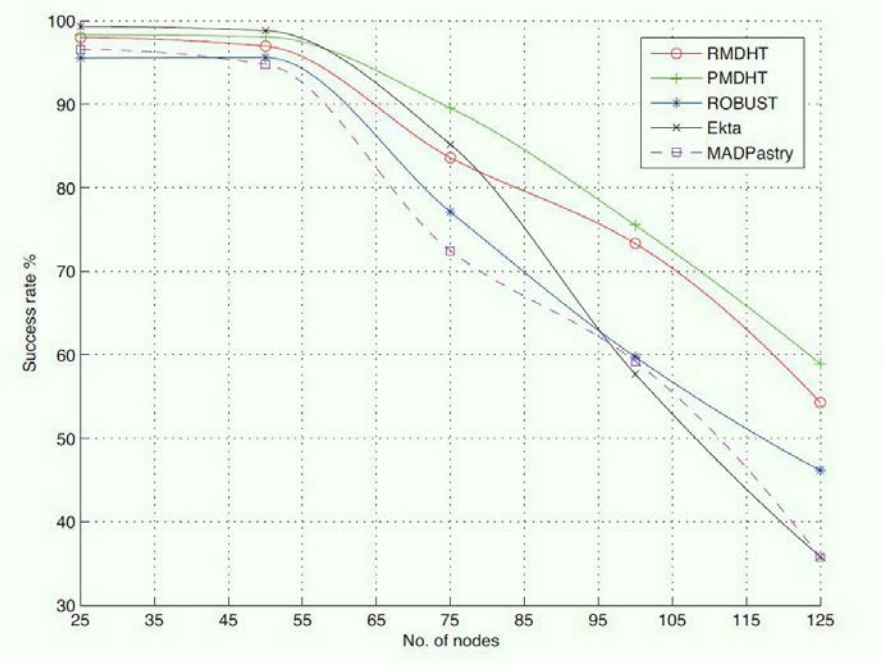


Fig.4: (a) Look-up Success Rate vs Scalability

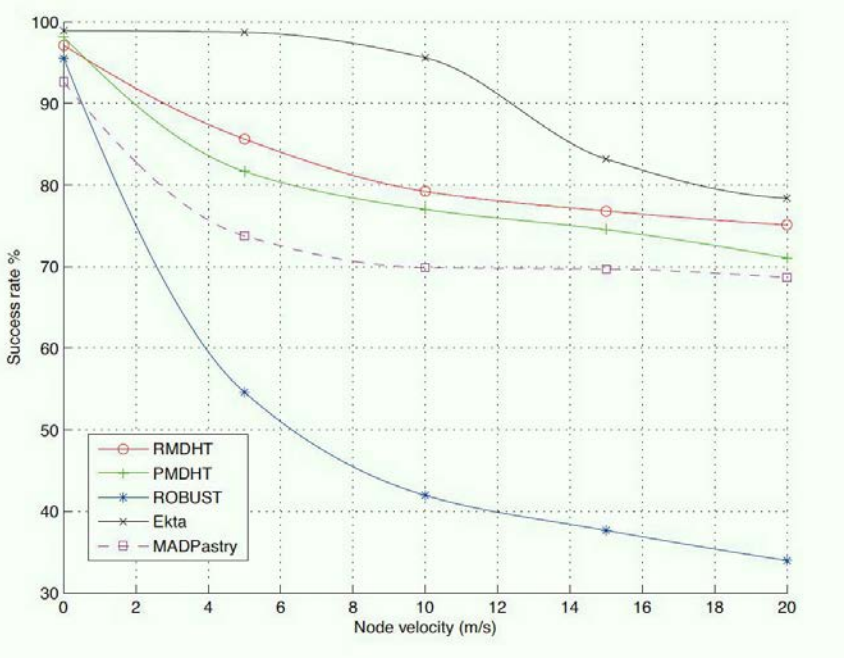


Fig.4: (b) Look-up Success Rate vs Node Speed

Results (5)

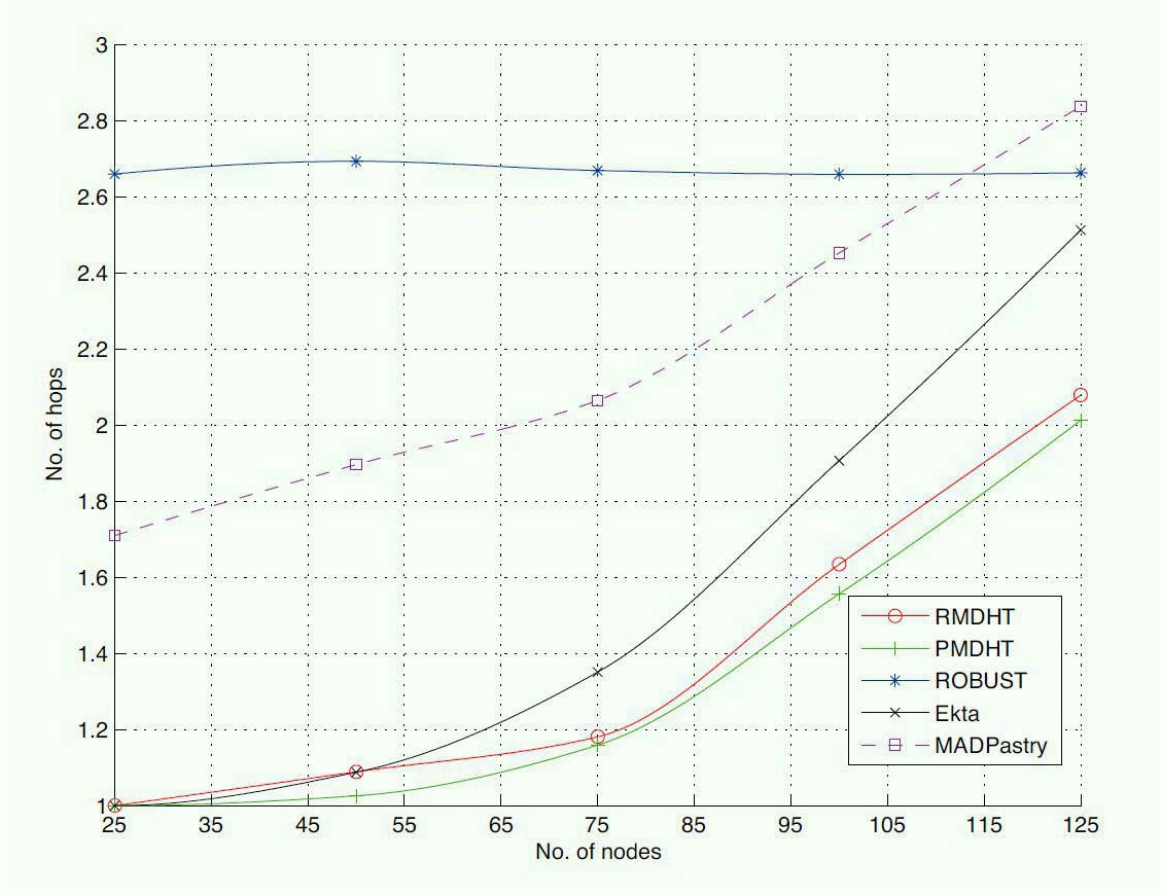


Fig.5: Look-up Average Path Length

Results (6)

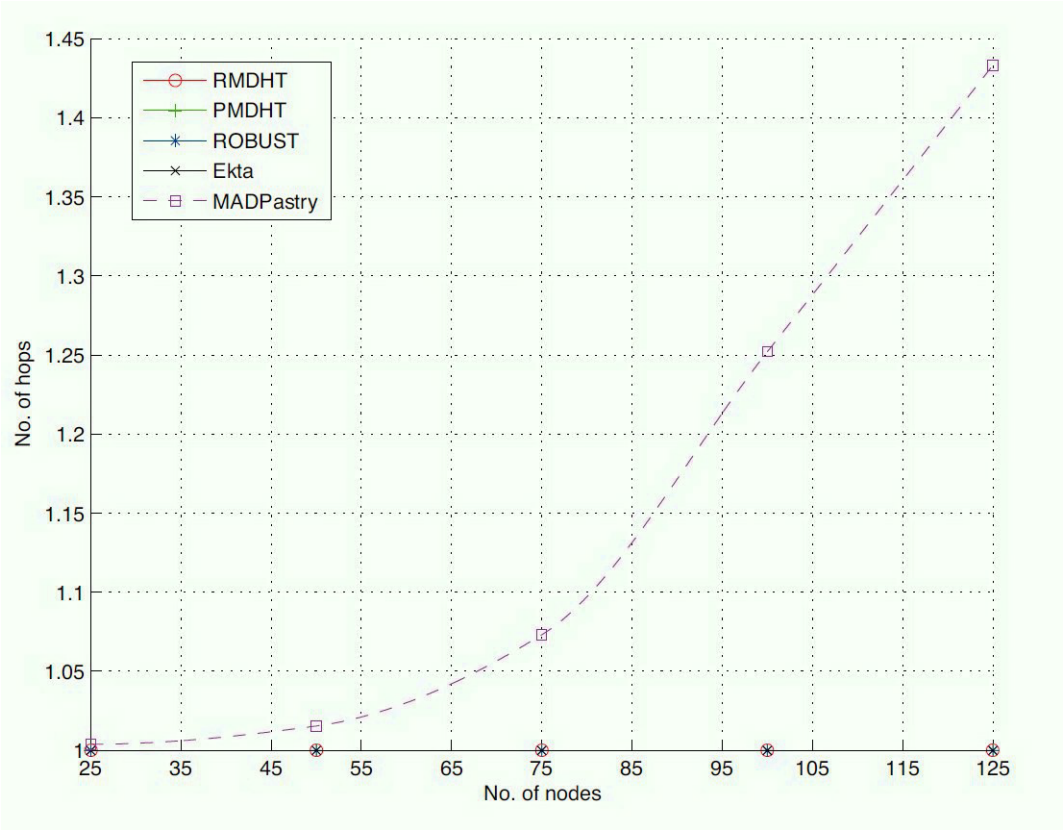


Fig.6: Logical Path vs Physical Path Stretch

Conclusion

- Two protocols that integrate peer-to-peer functionalities and routing were proposed.
- Duplicated functionalities in the MANETs and P2P networks are avoided in order to reduce overheads and complexity.
- Both RMDHT and PMDHT perform better than the rest of the protocols in some scenarios when scaling the network size due to shorter average path length caused by utilizing MANET routing protocol routes.
- The performance of RMDHT and PMDHT differs as the network size and node speed varies in various scenarios.

Thank You!

ANY QUESTIONS?

- Grant Millar (grant@seednet.eu)
- Alexandros Ladas (a.ladas@kingston.ac.uk)
- Olayinka Adigun (o.adigun@Kingston.ac.uk)
- Christos Politis (c.politis@kingston.ac.uk)