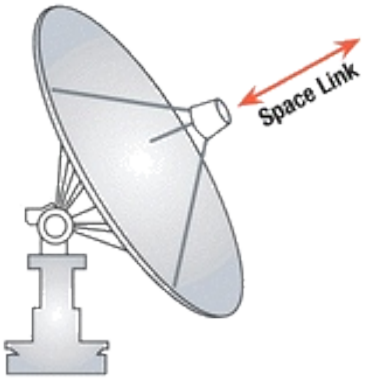
A Case Study on Position-Based Routing Protocol for a Wireless Mobile Ad-hoc Network

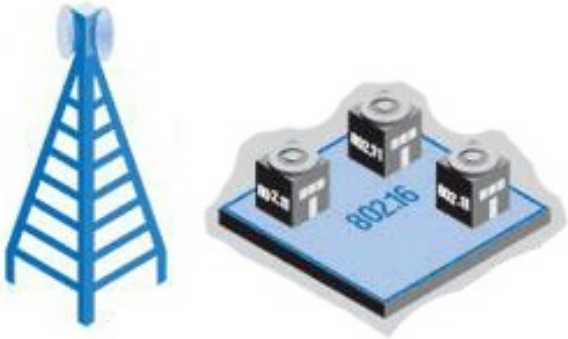
Introduction

Overview

Maritime Internet Connectivity



Future



Satellite

Highly Reliable and Robust

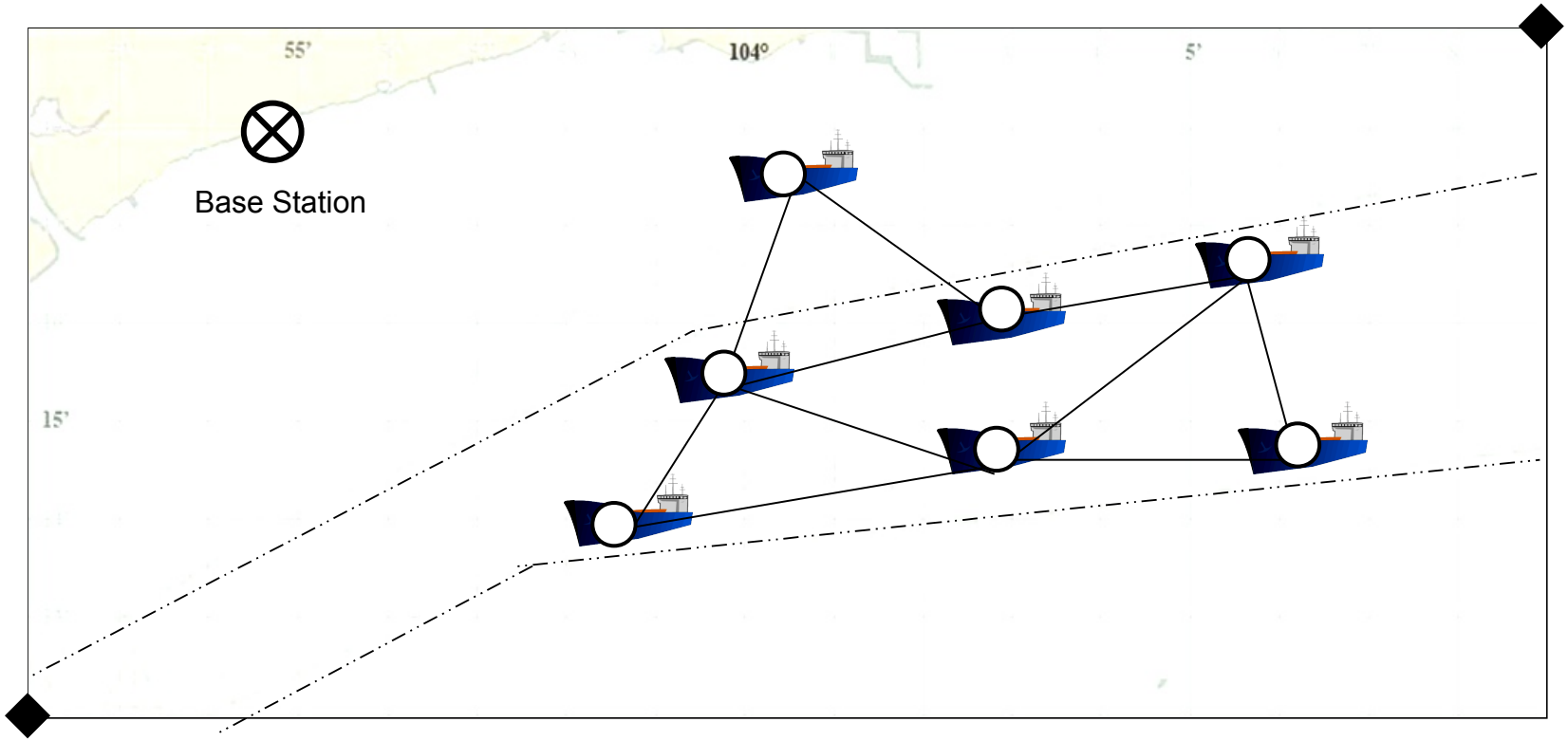
Uplink and Downlink bandwidth
Spectrum Availability
Latency issues
High Cost

IEEE 802.16 WiMax

Internet access
Low Cost
Required bandwidth
Transmission range
High throughput

Introduction

The System

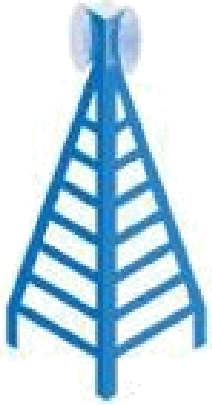


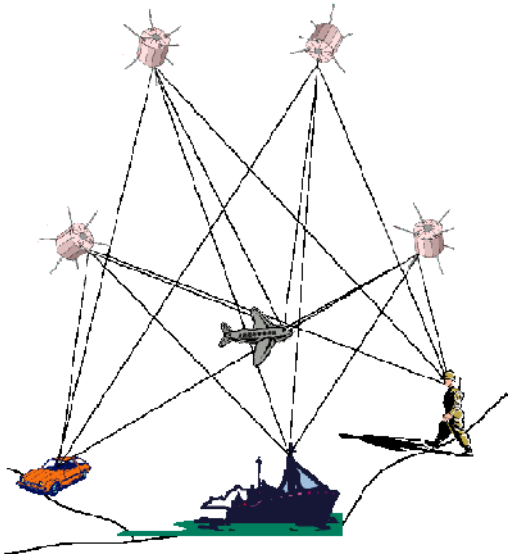
Node – a router and hosts forwarding packets

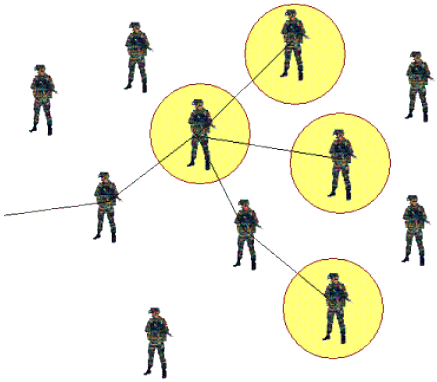
Dynamically changing Mesh network
Point to Multipoint Hop (PMP)
Mobile Ad-Hoc Network (MANET)

Introduction

System Components







Internet Gateway (IGW)

Provides internet Access
Mobile nodes detect IGW

Location Service

Global Positioning System
External Service
Used by the sender
Current position information

Geocasting

Geographic messaging
Addressing model
<latitude, longitude>

Background

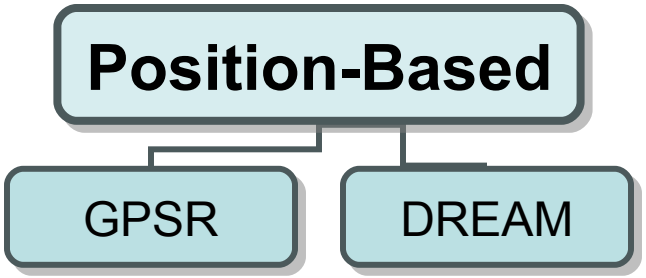
Routing Protocols

For Mobile Ad-hoc Networks

Topology Based	Position Based
Maintain routing information for all routes	Does not require the maintenance of routes
Require large bandwidth if network changes	Does not require large bandwidth
Forwarding decision is determined from the source node	Forwarding decision is based on the position of destination and the node's immediate one hop neighbour
	Eg. Fleetnet – Internet on the Road Inter-vehicle communication

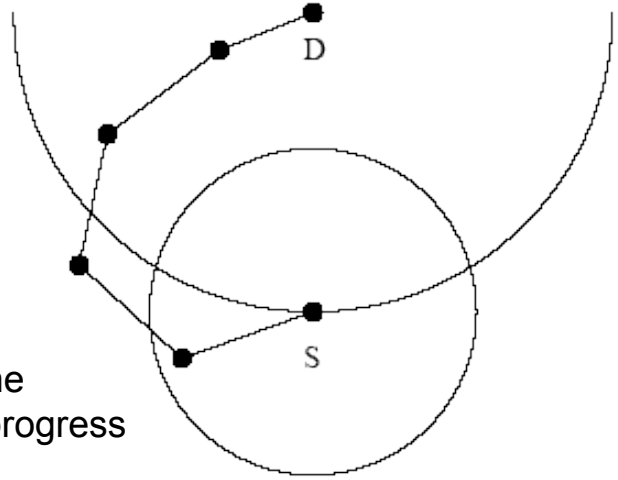
Background

Position-Based Algorithm



Greedy Perimeter Stateless Routing

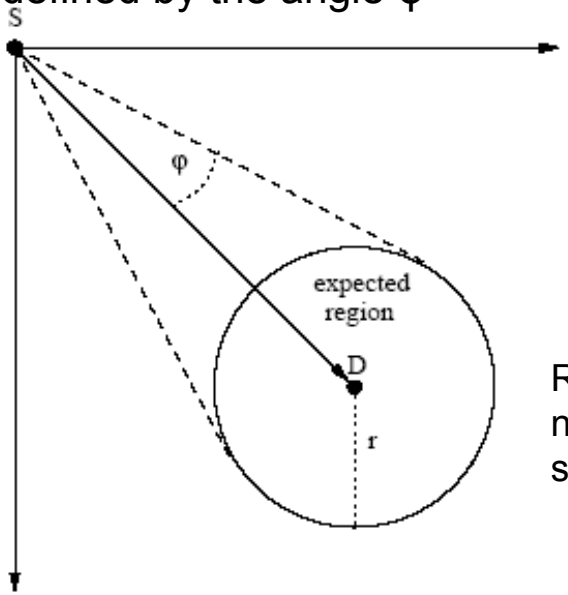
When a local optimum has been reached:
Perimeter routing – planar graph traversal to find a way out of the local optimum



Next node has the least backward progress

Distance Routing Effect Algorithm for Mobility

The next hop lies within the Expected Region defined by the angle φ



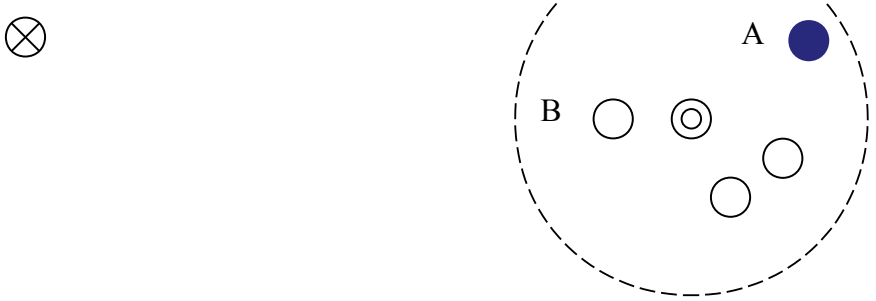
Recovery procedure is not part of DREAM specifications

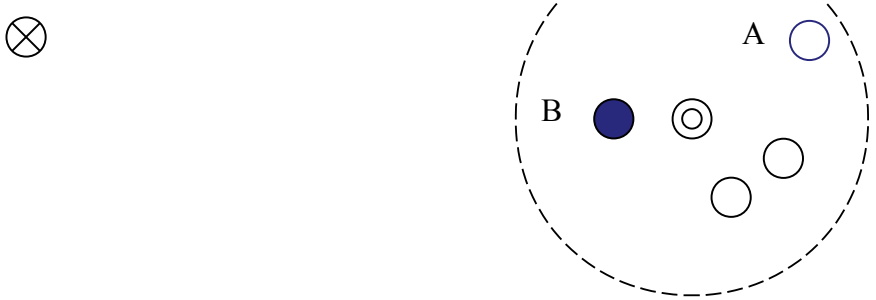
Background

Forwarding Strategies

For Mobile Ad-hoc Networks

MFR	MFR+
Most Forward with fixed radius R	Positively most forward with fixed radius R
Maximum forward progress within the Transmission range	Only members with positive progress are admitted



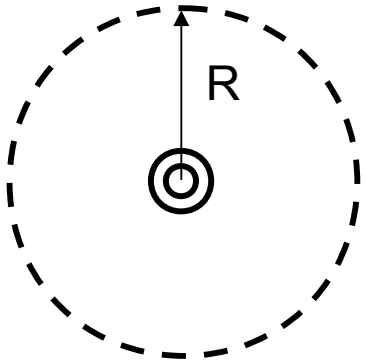


Simulation

Inputs

Simulation program in C++

- Node for next hop
- Source Node
- Internet Gateway / Base Station
- t — Interpolation interval time (sec)



- Transmission radius (km)

Each node is referred as MMSI
Contact Nodes for next hop

Simulation

Raw Data

```
MMSI 565156000 Last seen at 14/6/2006 0:56:13 UTC
Name AEGEAN BREEZE 1 Latitude N 1°17.648'
Callsign 9VAG8 Longitude E 103°55.883'
IMO number 9314466 Heading 212°
Length 80 m Speed 0.1 knots
Beam 12 m Destination SINGAPORE
Draught 5.0 m ETA 5/4/2006 21:00:00 UTC
Vessel Type Tanker Status Under way using engine
Extra Info N/A
MMSI 564313000 Last seen at 14/6/2006 0:53:38 UTC
Name AMANDA STAR Latitude N 1°15.677'
Callsign 9V6037 Longitude E 103°53.094'
IMO number 9017147 Heading 11°
Length 0 m Speed 0.0 knots
Beam 0 m Destination
Draught 4.2 m ETA 31/12/9999 23:59:59 UTC
Vessel Type Tanker Status Under way using engine
Extra Info
```

AIS Format → 7 data

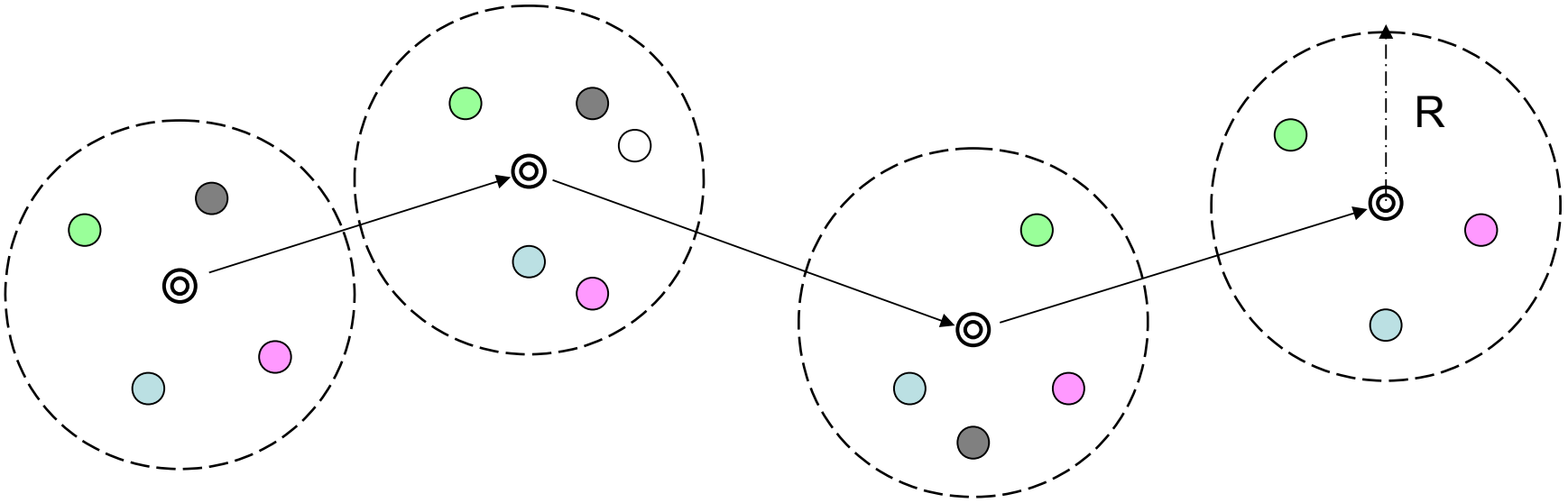
MMSI	Date	Time	Lat	Long	Head	Speed
211233290	14/6/2006	6:2:13	1.21987	103.891	30	5.4
211233290	14/6/2006	6:15:53	1.23998	103.89	338	4.1
211233290	14/6/2006	6:30:52	1.24263	103.888	14	0.3
211233290	14/6/2006	6:45:23	1.2427	103.889	89	0.2
211233290	14/6/2006	6:59:44	1.2428	103.888	144	0.2
211233290	14/6/2006	7:15:37	1.24263	103.888	155	0.1
211233290	14/6/2006	7:27:38	1.24278	103.888	157	0.2
211233290	14/6/2006	7:44:8	1.24267	103.888	101	0.1
211233290	14/6/2006	7:59:47	1.2426	103.888	104	0.1
211233290	14/6/2006	8:15:12	1.24235	103.888	107	0.1
211233290	14/6/2006	8:30:27	1.24293	103.889	86	0.1
211233290	14/6/2006	8:45:36	1.23908	103.873	295	11.5

Total Ships – **317 MMSI**

Ships above 1 knot – **147 MMSI**

Simulation

Version 1.3



MMSI	Time	Lat	Long
215532000	34500	1.25279	103.986
215532000	34600	1.2506	103.98
215532000	34700	1.24841	103.974
215532000	34800	1.24622	103.967
215532000	34900	1.24402	103.961
215532000	35000	1.24183	103.954
215532000	35100	1.23964	103.948
215532000	35200	1.23745	103.941
215532000	35300	1.23479	103.935
215532000	35400	1.23197	103.929
215532000	35500	1.22916	103.923
215532000	35600	1.22635	103.917

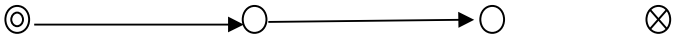
Contact Time: 1100s

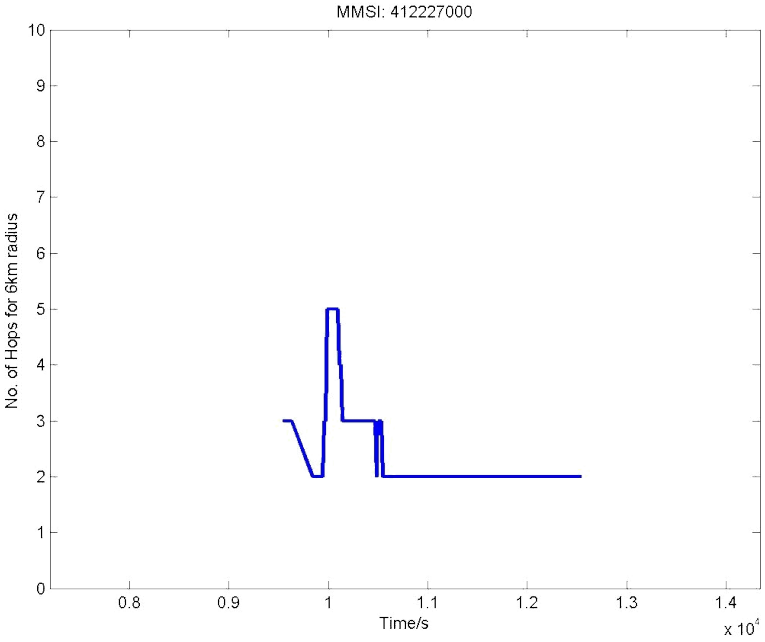
Contact nodes based on a target MMSI

Simulation

Connection with IGW

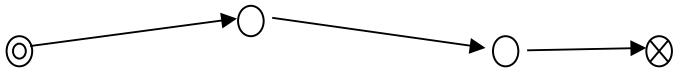
Incomplete path with 2 hops

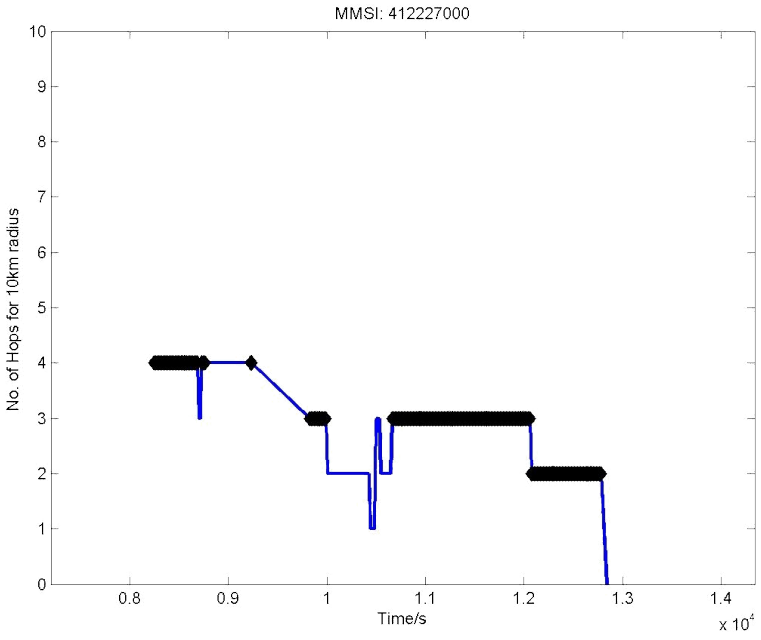




Incomplete path

Complete path with 3 hops





Incomplete path

Complete path

Simulation

Algo Parameters

Source MMSI
string name
int time
double Latitude
double longitude

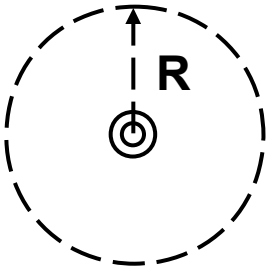
Source MMSI
string name
int time
double Latitude
double longitude

Source Node

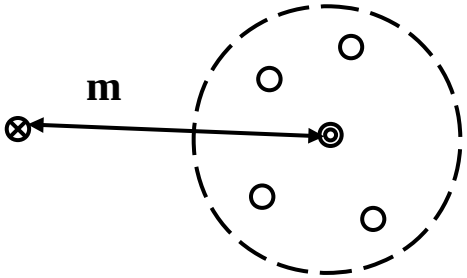
Contact MMSI
string Source MMSI name
string Contact MMSI name
int time
double Latitude
double longitude
double distance, d

Contact MMSI
string Source MMSI name
string Contact MMSI name
int time
double Latitude
double longitude
double distance, d

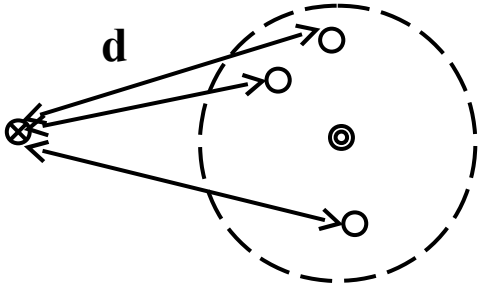
Contact Node



R – Transmission Radius



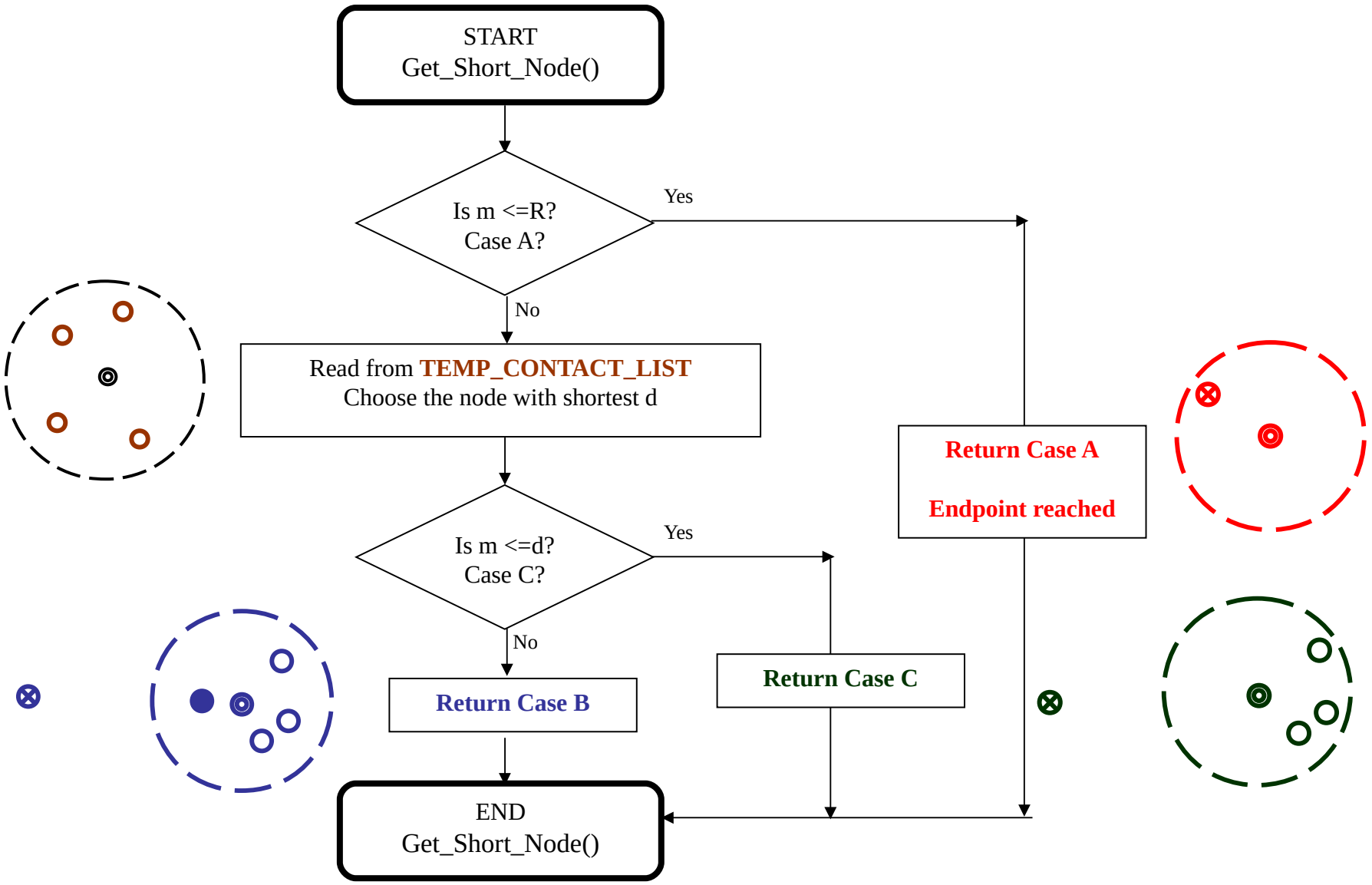
m – distance from source node to End



d – distance from contact node to end

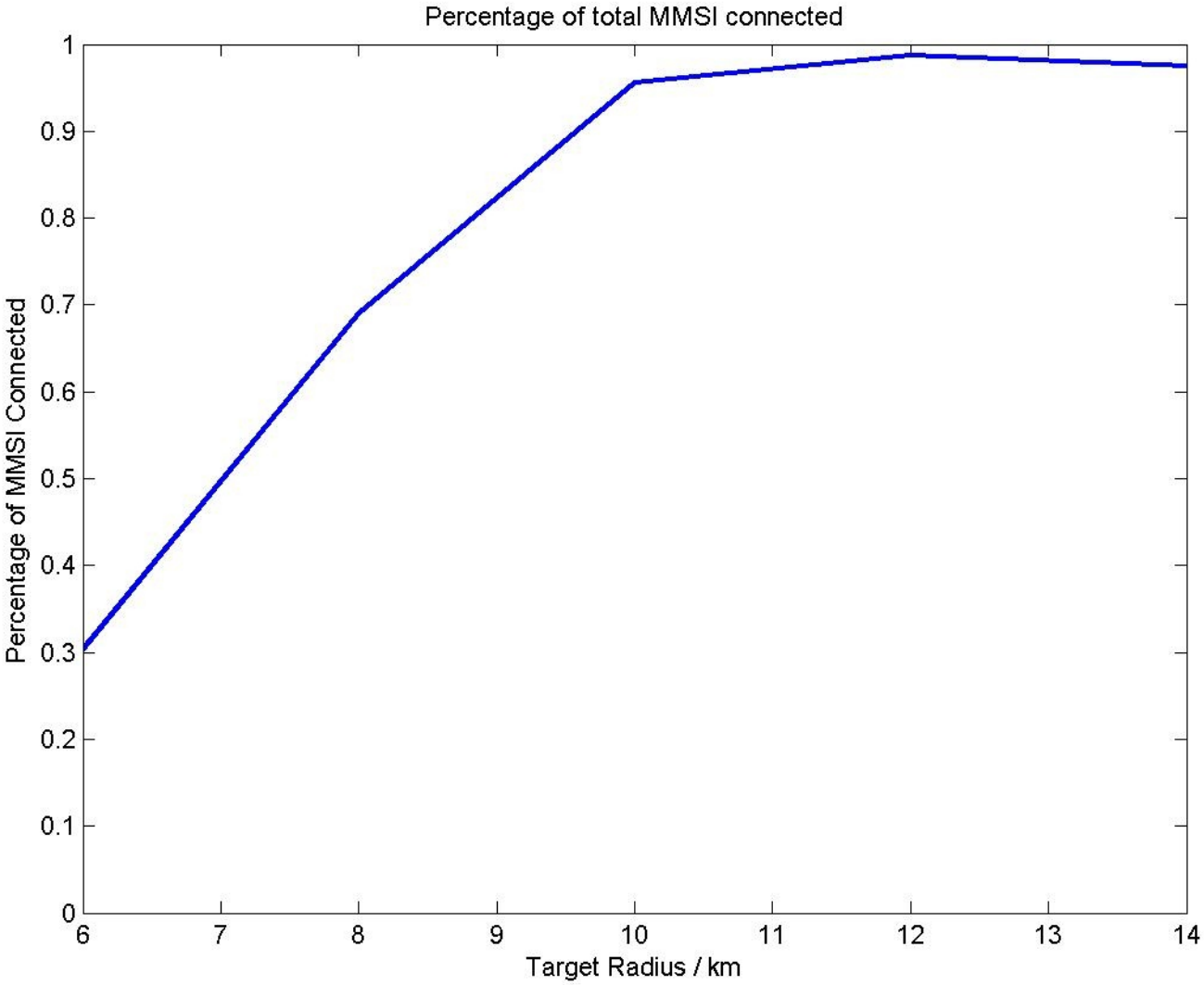
Simulation

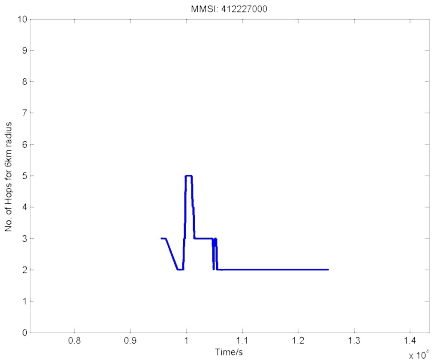
Position-Based Algo



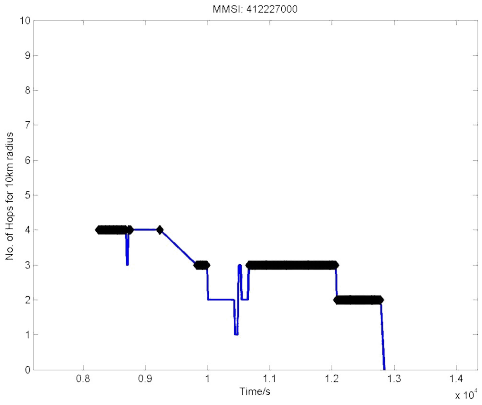
Results

MMSI Connection





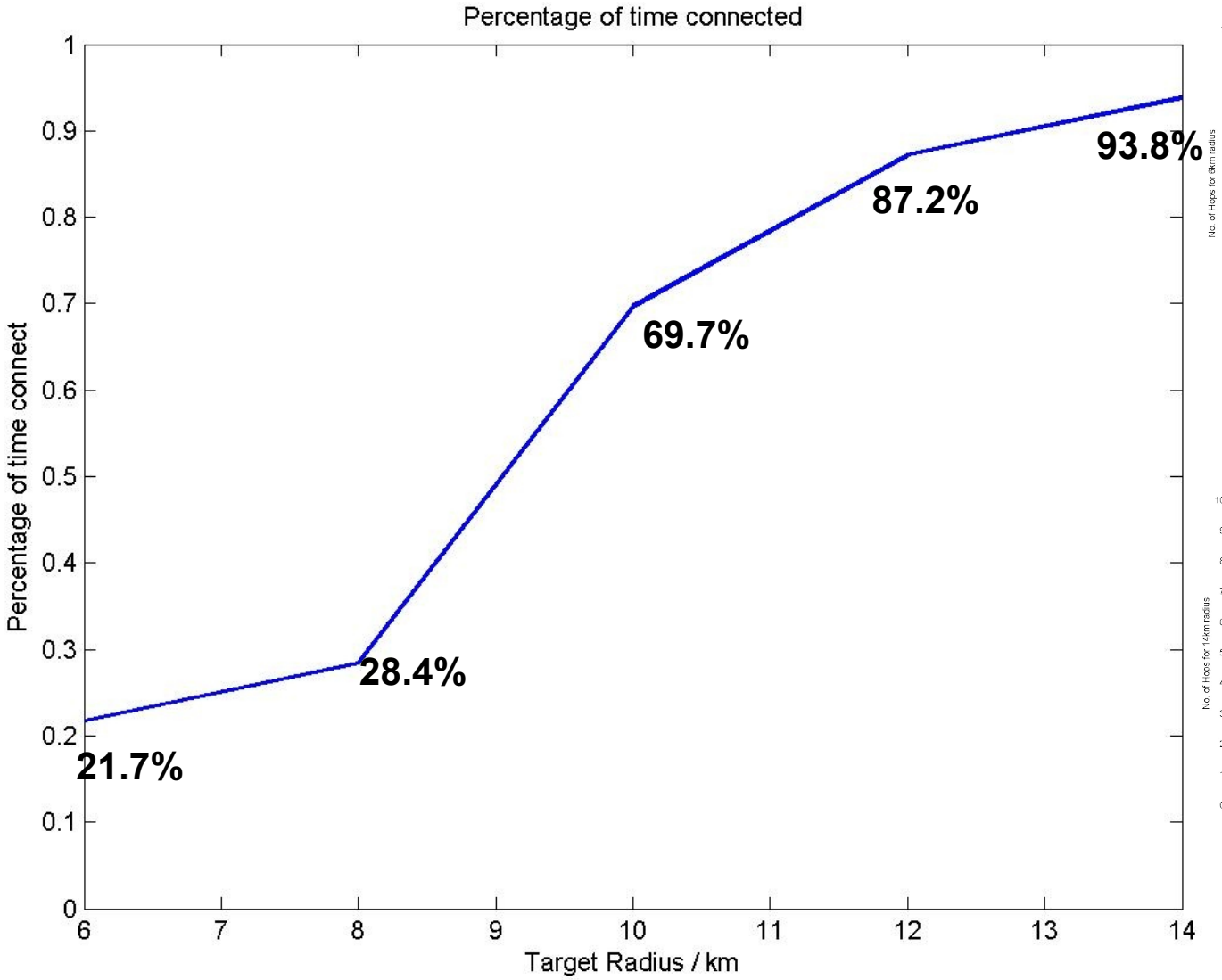
Not connected at all

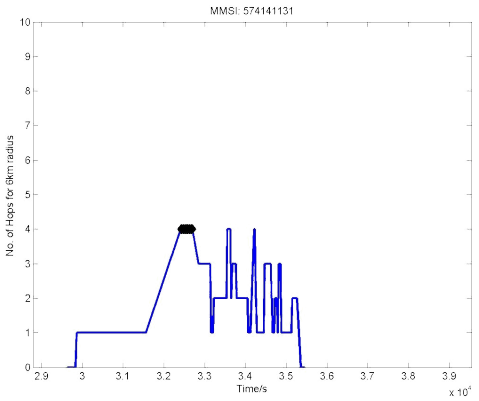


Connected for some times

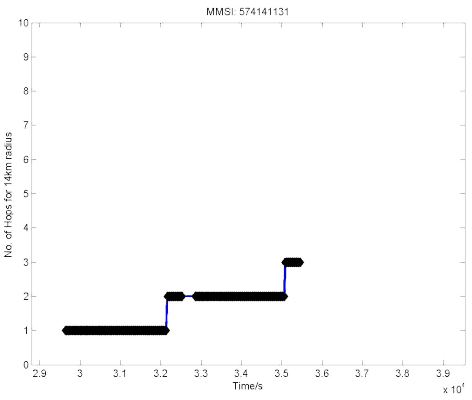
Results

Connection Times





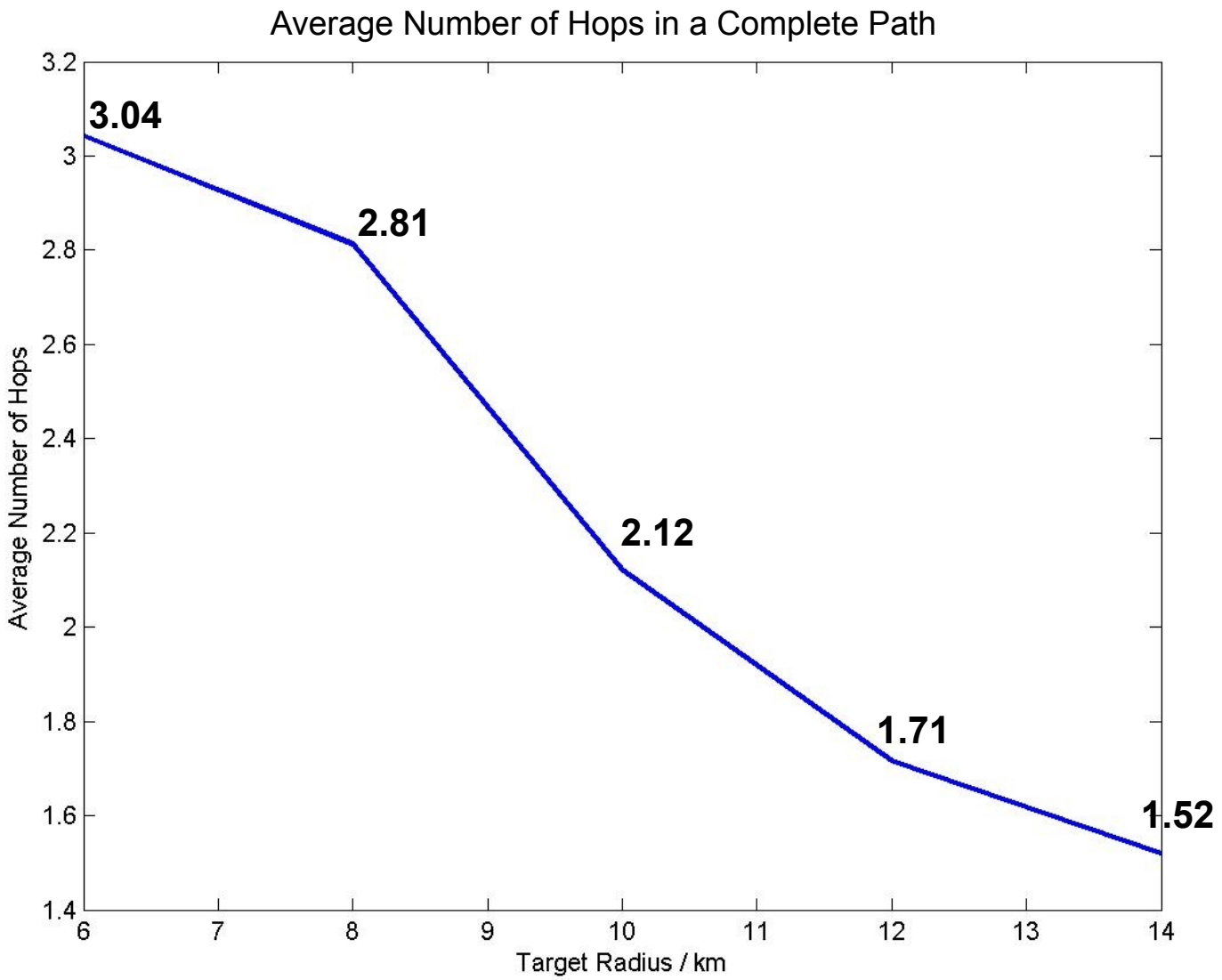
Low connection time



High connection time

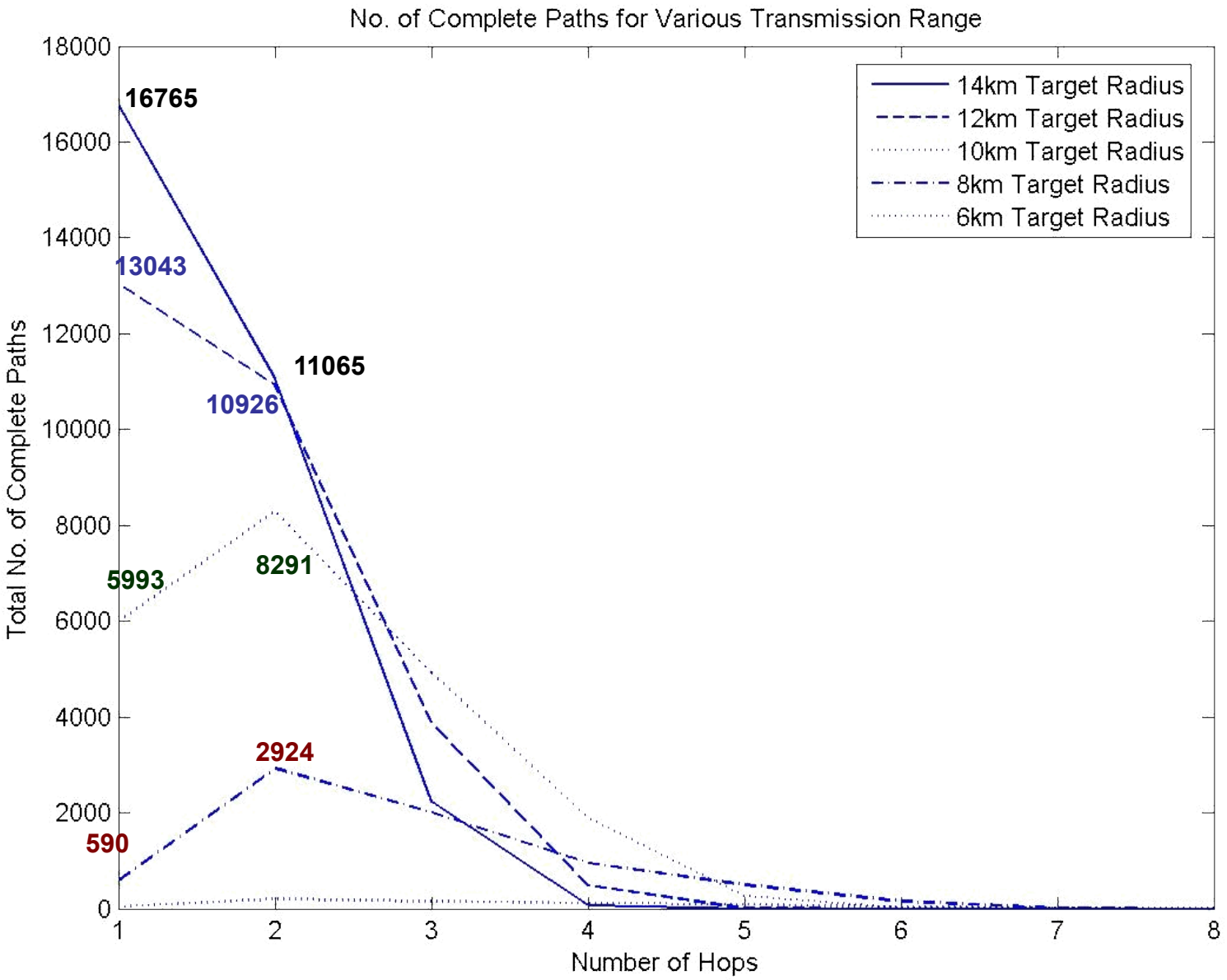
Results

Average Hops



Results

Number of Hops



Conclusion

Analysis

For MANET system, a dynamic routing protocol is needed

At **14km** radius, **97.5%** of the ships were connected for at least one time period

At **14km** radius, there was connection with the IGW **93.8%** of the time

At **14km** radius, on average only **1.52** hops were needed for a complete path

Position-Based routing protocol is suited for this system

A large number of mobile nodes were handled – 147 MMSI

Conclusion

Further Work

Further simulations involving:

1. various forwarding strategies
2. different recovery strategies
3. 2 or more Internet Gateway
4. Comparative study of GPSR and DREAM
5. Other parameters affecting delay time and throughput
6. Varied packet size
7. Different days and time of raw mobility data


Thanks!

References

Research Papers

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12. “Shipborne Automatic Identification System (AIS) Fact Sheet”, *Australian Maritime Safety Authority Canberra*, (December 2003)

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