Research Consortium in Speckled Computing

MANET Routing Algorithms for Specknets

Siddhu Warrier

School of Informatics, University of Edinburgh

s.warrier@sms.ed.ac.uk

Outline

- Introduction and Rationale
- Background
- Results and Comparisons
- Future Work

Introduction: MANETs

- What is a Mobile Ad-hoc Network (MANET)?
  - Self-configuring network of mobile routers connected by wireless links.
    - Forms arbitrary topology.
    - Rapid, unpredictable topological changes.
- Routing in MANETs:
  - Handle frequent topological changes.
  - Nodes are often power and memory-constrained.

Introduction: MANET vs WSN

- MANETs differ from Wireless Sensor Networks (WSN)
  - WSN nodes smaller and more power and memory-constrained.
  - Typical WSN applications have greater numbers of nodes.
  - WSN applications typically involve routing to sink.
  - Most WSN applications have stationary nodes.

Introduction: MANET vs WSN

"If the earth were flat there would be no oceans as they would run off the edges.
But since they don't, then the earth must be shaped like a saucer."

- These assumptions not always true
  - WSN nodes prone to failure.
    - Failure similar to mobility.
  - Some WSN applications require mobility.

Our assertions

- MANET algorithms suitable for WSNs.
  - Implement MANET algorithms on the ProSpeckz IIK.
- Existence of WSN Application domains where MANET algorithms are suitable.
  - Analyse application domains.
  - Implement demonstrator.

Background: Application Domains

- In-situ network inspection
  - Mobile node moves between networks of static nodes.
  - MANET algorithms allow connecting into network.
- Car park management
  - Static nodes frequently leave and join network.
- Localised Tracking System
  - Track movement of mobile nodes through a static infrastructure.
  - Report changes to mobile minder node.

Background: Classifying Routing Algorithms

- Routing algorithms may be:
  - Proactive
    - Routes known to every node in network.
    - Large routing overhead.
    - Quick.
    - Eg: Destination Sequenced Distance Vector (DSDV).
  - Reactive
    - Only neighbours known; other routes determined on-demand.
    - Small routing overhead.
    - Slower.
    - Eg: Ad-hoc On-demand Distance Vector (AODV).
  - Hybrid
    - Reactive on-demand route determination outside routing zone.
    - Proactive routing within routing zone.
    - More scalable than proactive.
    - Eg: Zone Routing Protocol (ZRP).

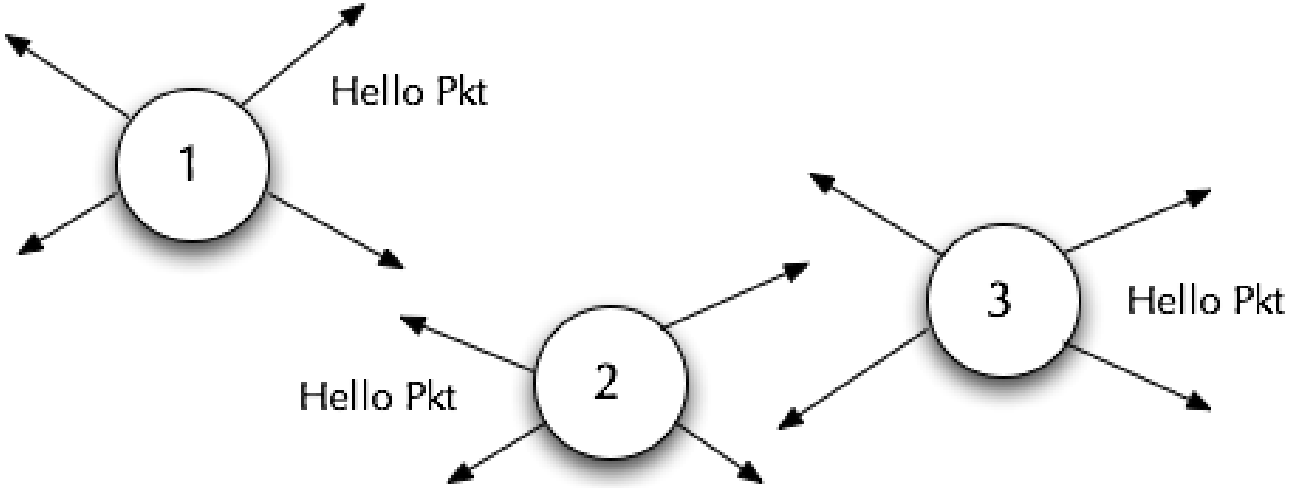
Background: Routing Algorithms chosen

- 1 Proactive and 1 Hybrid routing algorithm.
  - Hybrid routing algorithm uses implementation of proactive routing algorithm within zones.
- Destination Sequenced Distance Vector (DSDV)
  - Proactive
- Zone Routing Protocol (ZRP)
  - Hybrid

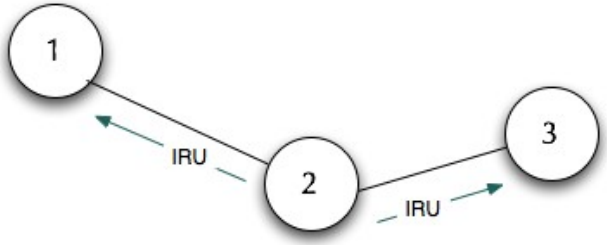
Background: DSDV

- Distance Vector (DV) – based algorithm.
- Uses sequence numbers to prevent count-to-infinity.
  - Information with higher sequence numbers supercede lower sequence number information.
  - Even sequence numbers indicate healthy node/link.
  - Odd sequence numbers indicate failure.

Background: DSDV Operation - Stage 1



Background: DSDV Operation – Stage 2



Routing Table - Node 1

Status: *Full+Valid*
Dest: *2*
Sequence #: *4*
Hops: *1*

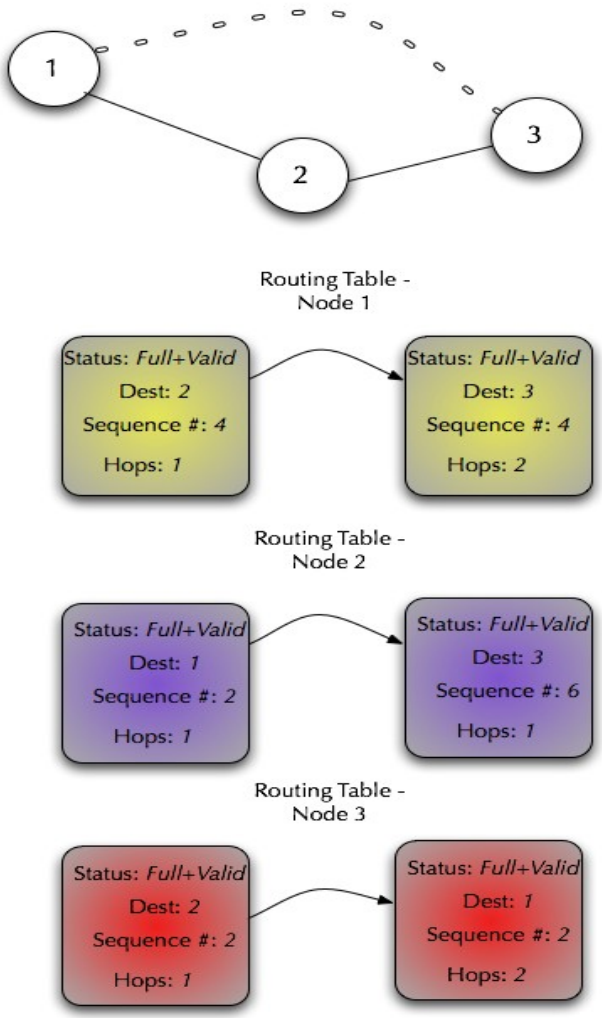
Routing Table - Node 3

Status: *Full+Valid*
Dest: *2*
Sequence #: *2*
Hops: *1*

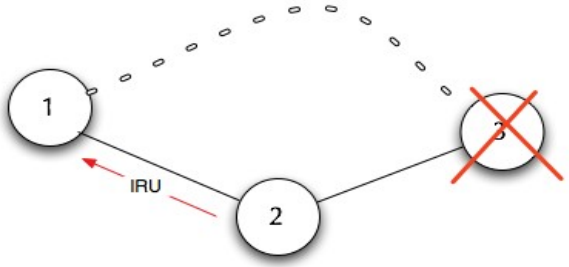
Routing Table - Node 2

Status: *Full+Valid*	Status: *Full+Valid*
Dest: *1*	Dest: *3*
Sequence #: *2*	Sequence #: *6*
Hops: *1*	Hops: *1*

Background: DSDV Operation – Stage 3



Background: DSDV Link Failure – Stage 1



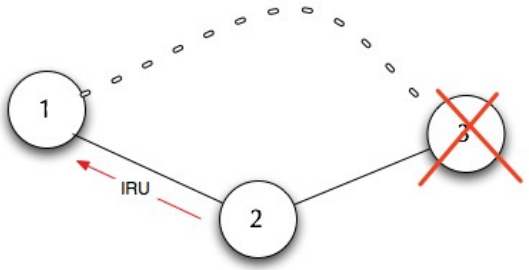
Routing Table - Node 1

Status: *Full+Valid*	Status: *Full+Valid*
Dest: *2*	Dest: *3*
Sequence #: *4*	Sequence #: *4*
Hops: *1*	Hops: *2*

Routing Table - Node 2

Status: *Full+Valid*	Status: *Full+ Invalid*
Dest: *1*	Dest: *3*
Sequence #: *2*	Sequence #: *7*
Hops: *1*	Hops: *1*

Background: DSDV Link Failure – Stage 2



Routing Table - Node 1

Status: *Full+Valid*	Status: *Full+ Invalid*
Dest: *2*	Dest: *3*
Sequence #: *4*	Sequence #: *5*
Hops: *1*	Hops: *2*

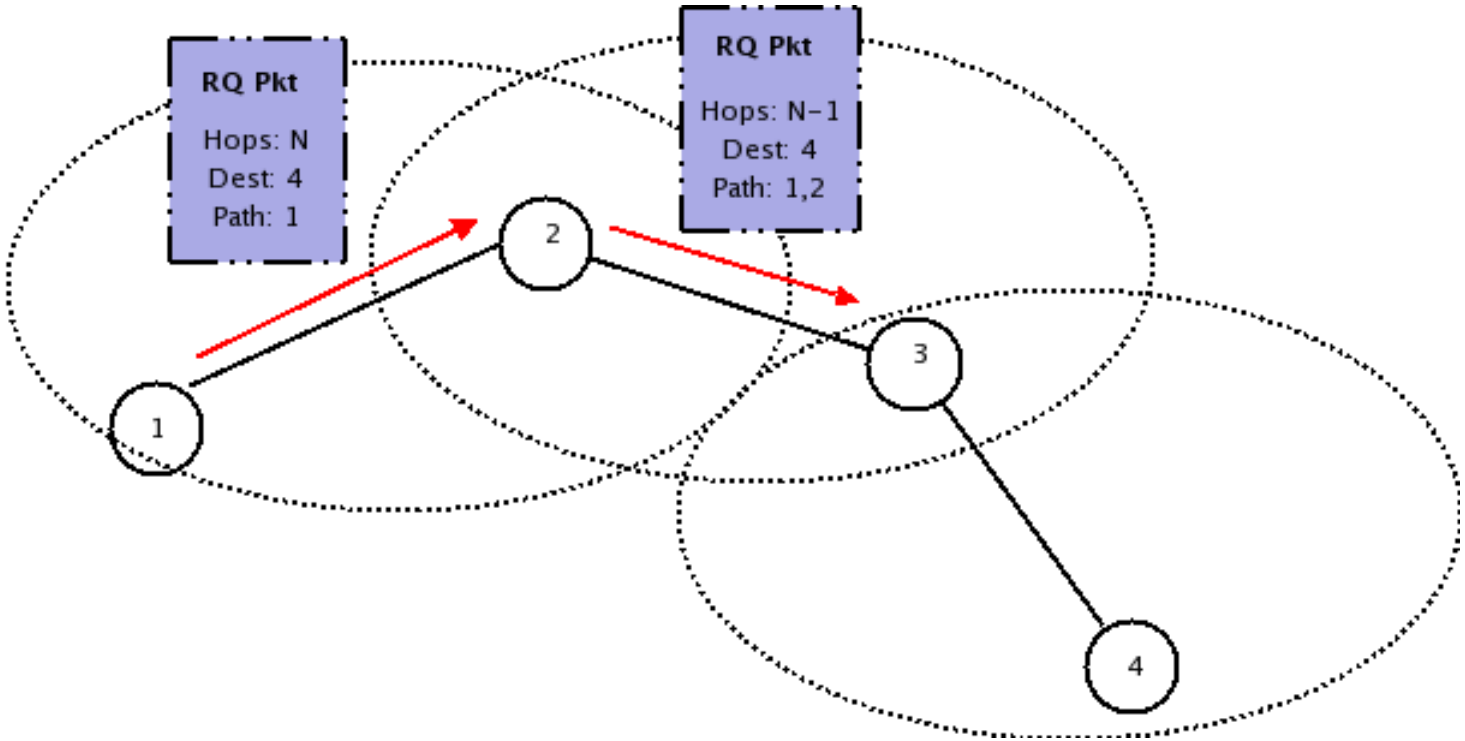
Routing Table - Node 2

Status: *Full+Valid*	Status: *Full+ Invalid*
Dest: *1*	Dest: *3*
Sequence #: *2*	Sequence #: *7*
Hops: *1*	Hops: *1*

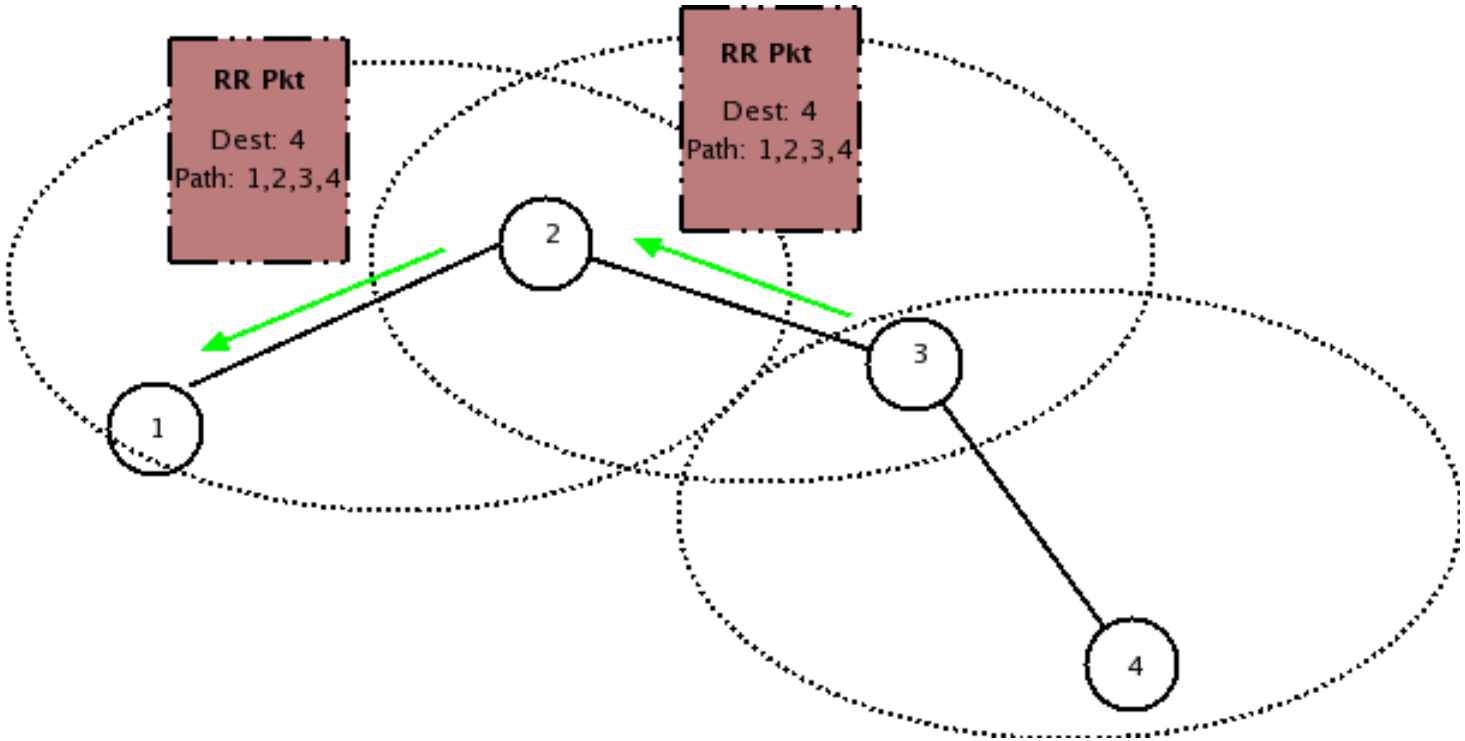
Background: ZRP

- ZRP is a hybrid routing algorithm.
- Network divided into zones.
  - Proactive IntrA-zone Routing Protocol (IARP) used within zones.
    - DSDV implementation used.
  - Reactive IntEr-zone Routing Protocol (IERP) used to determine routes outside zones.
    - Route queries “Bordercast”.
      - Sent to all nodes at the edge of the routing zone.

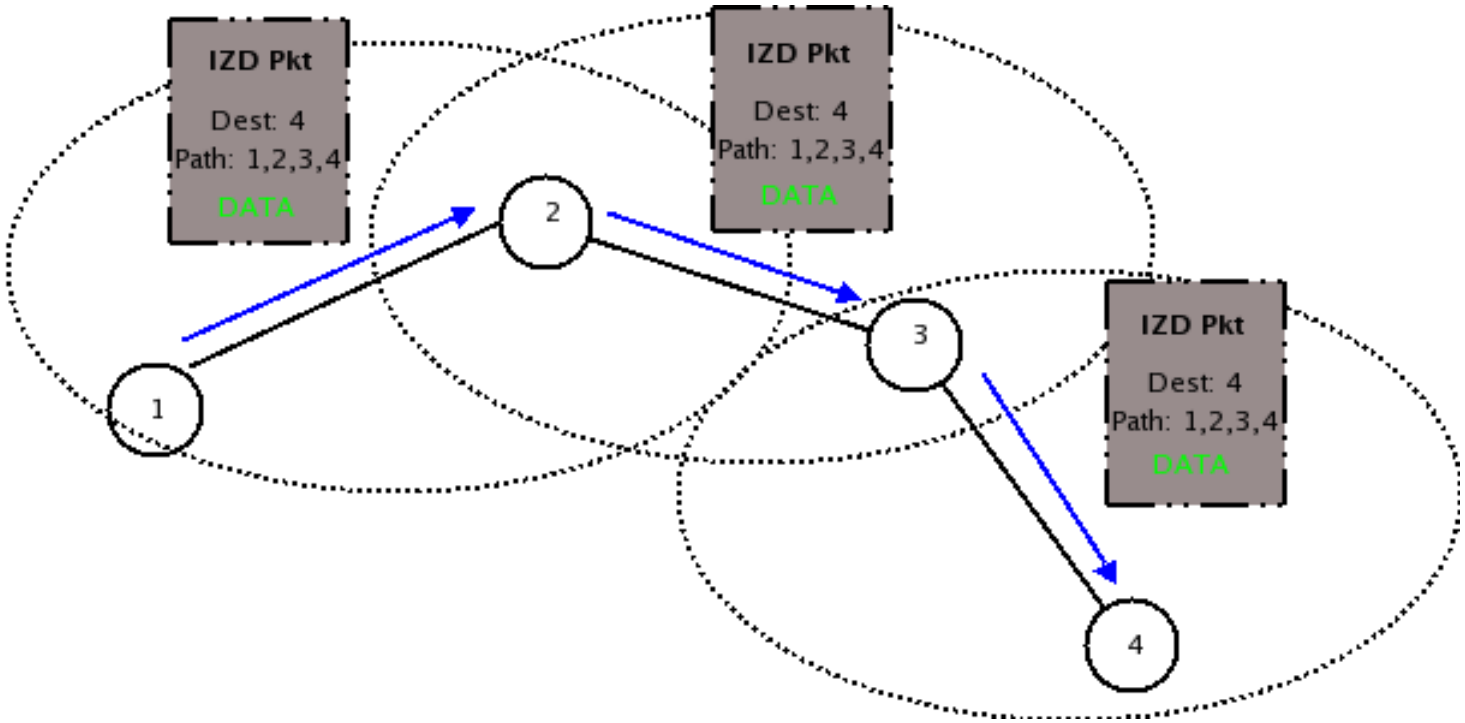
Background: ZRP Operation – Stage 1



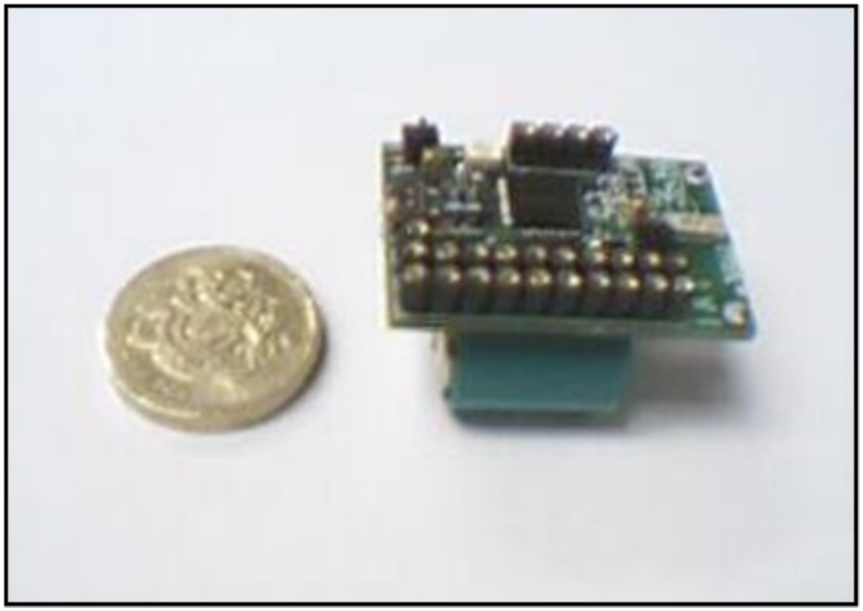
Background: ZRP Operation – Stage 2



Background: ZRP Operation – Stage 3



Platform

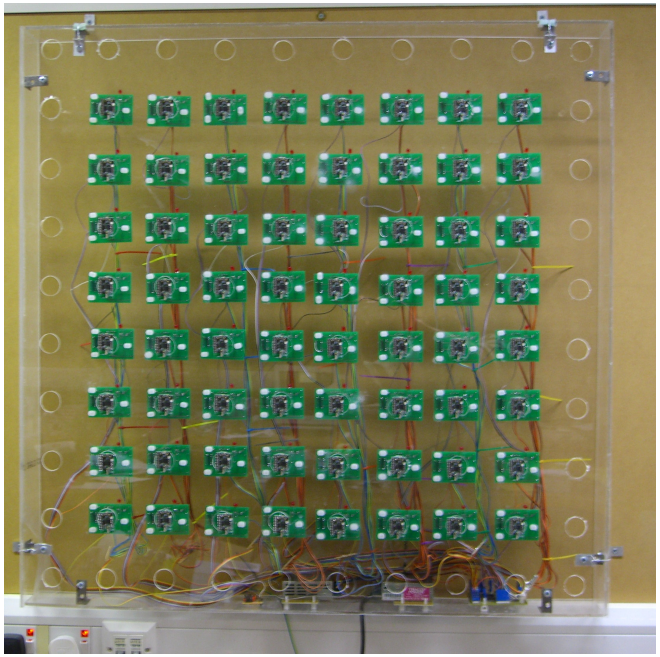


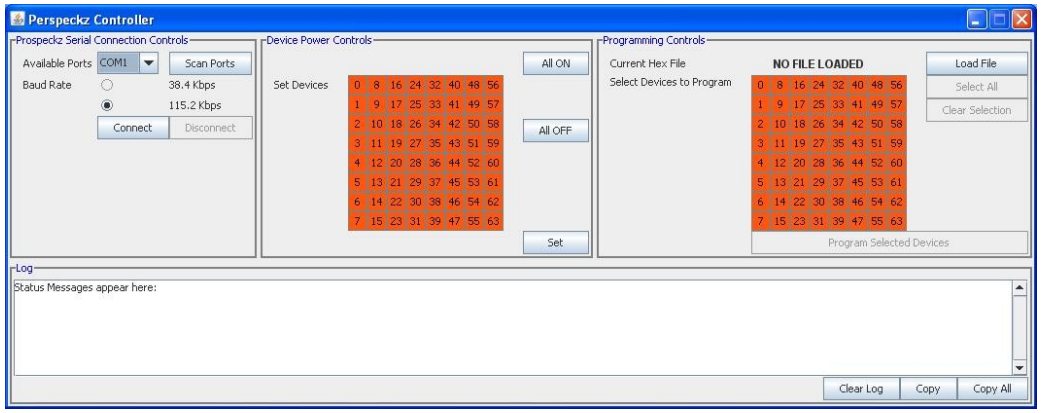
- *Hardware: ProSpeckz IIK.*
- *MAC Algorithm:* SpeckMAC

Experimental Methodology

- Routing algorithms compared against controlled flood and each other.
- *Metrics:* Number of packets transmitted, Transmitter/Receiver (Tx/Rx On-time), Delivery ratio.
- DSDV vs ZRP: Number of routing table entries, and consequent routing overhead.

Experimental Setup



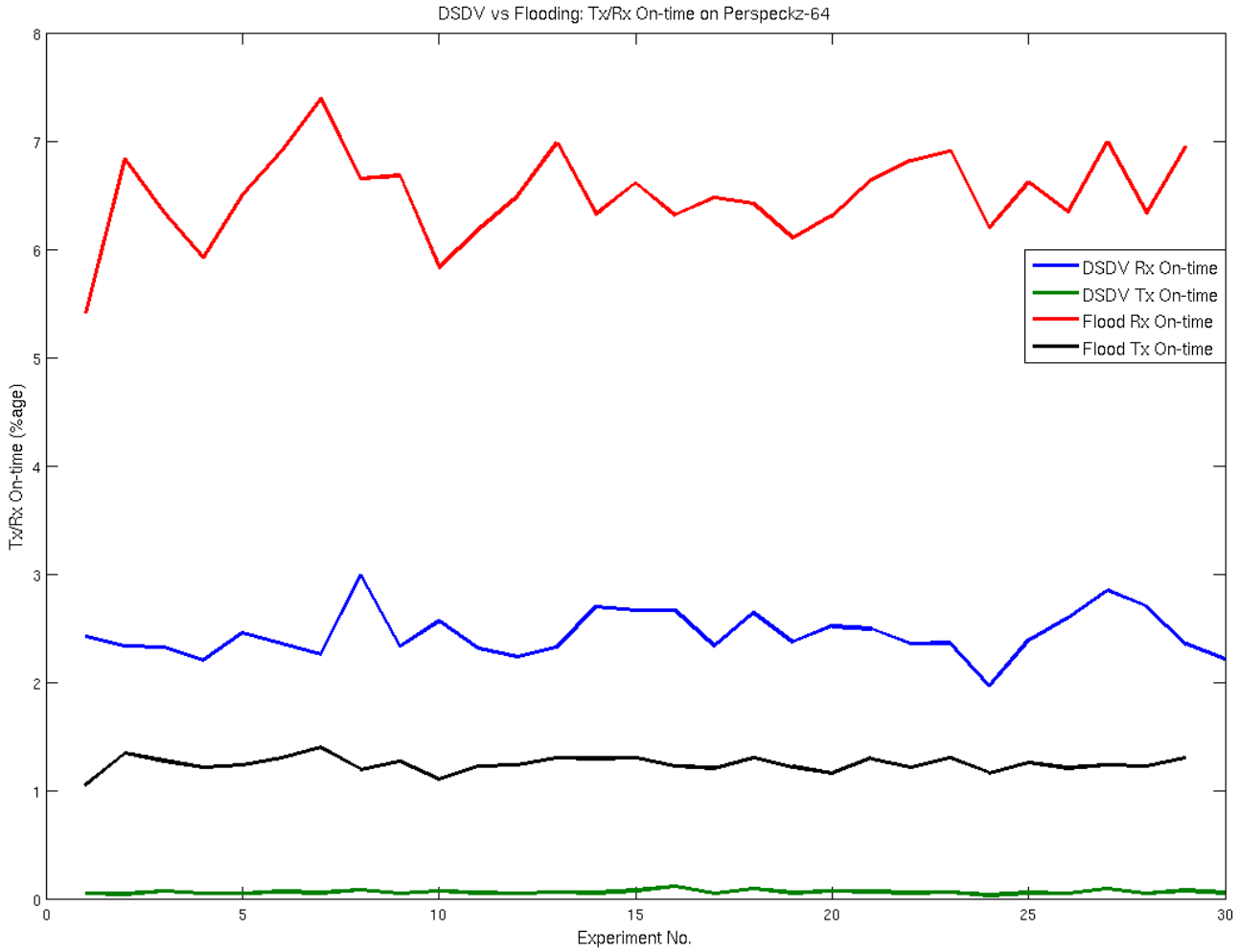


- Perspeckz -64, 64 node test-bed used.
- GUI Controller to control operation.

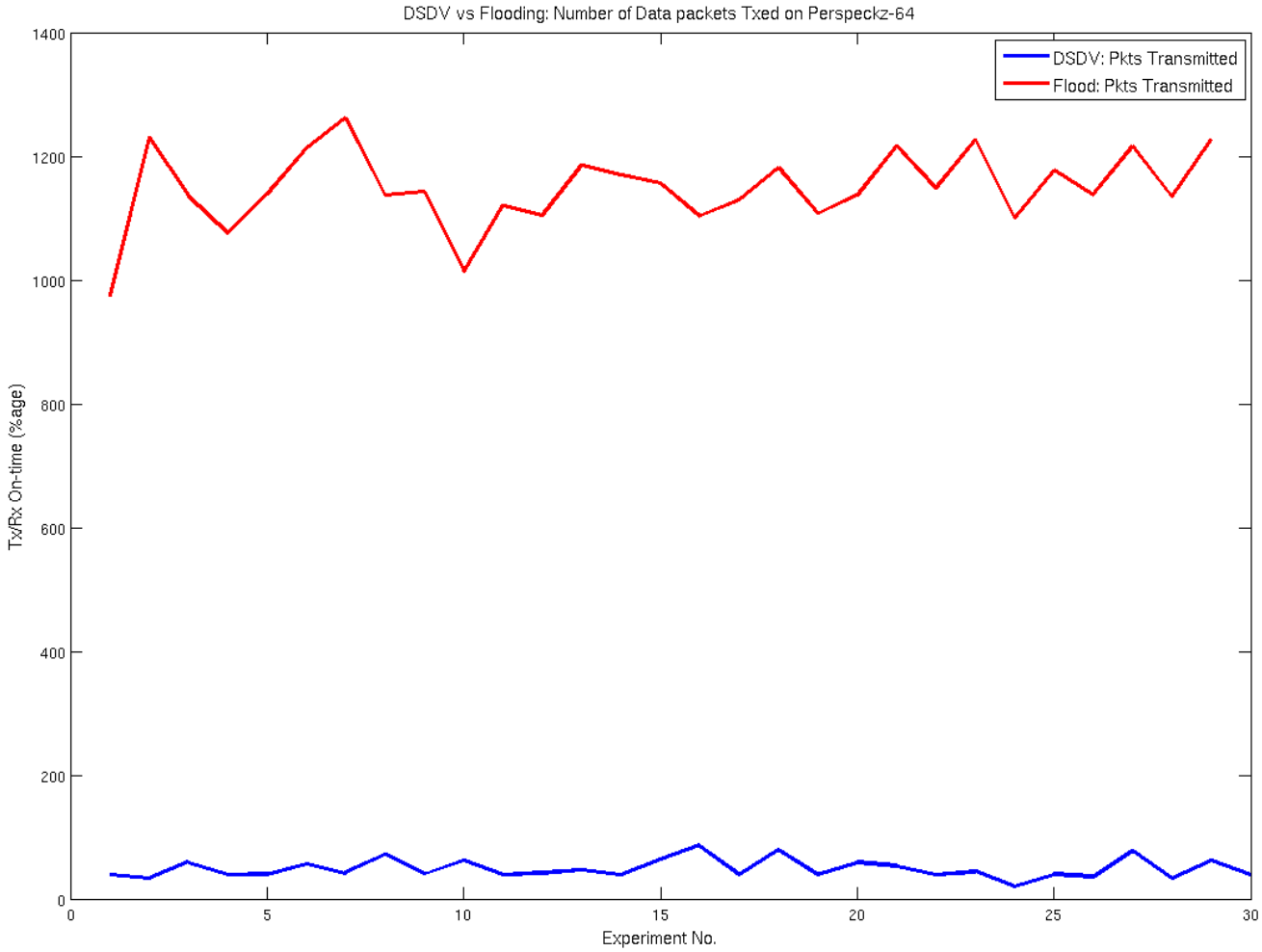
Experimental Setup (contd.)

- Data packets sent from a sending node to a receiving node.
  - once every 2 seconds.
  - Data packet payload size: 2 bytes.
  - Each run involved 20 packets.
- Route setup time, and route maintenance overhead – for DSDV and ZRP – ignored.

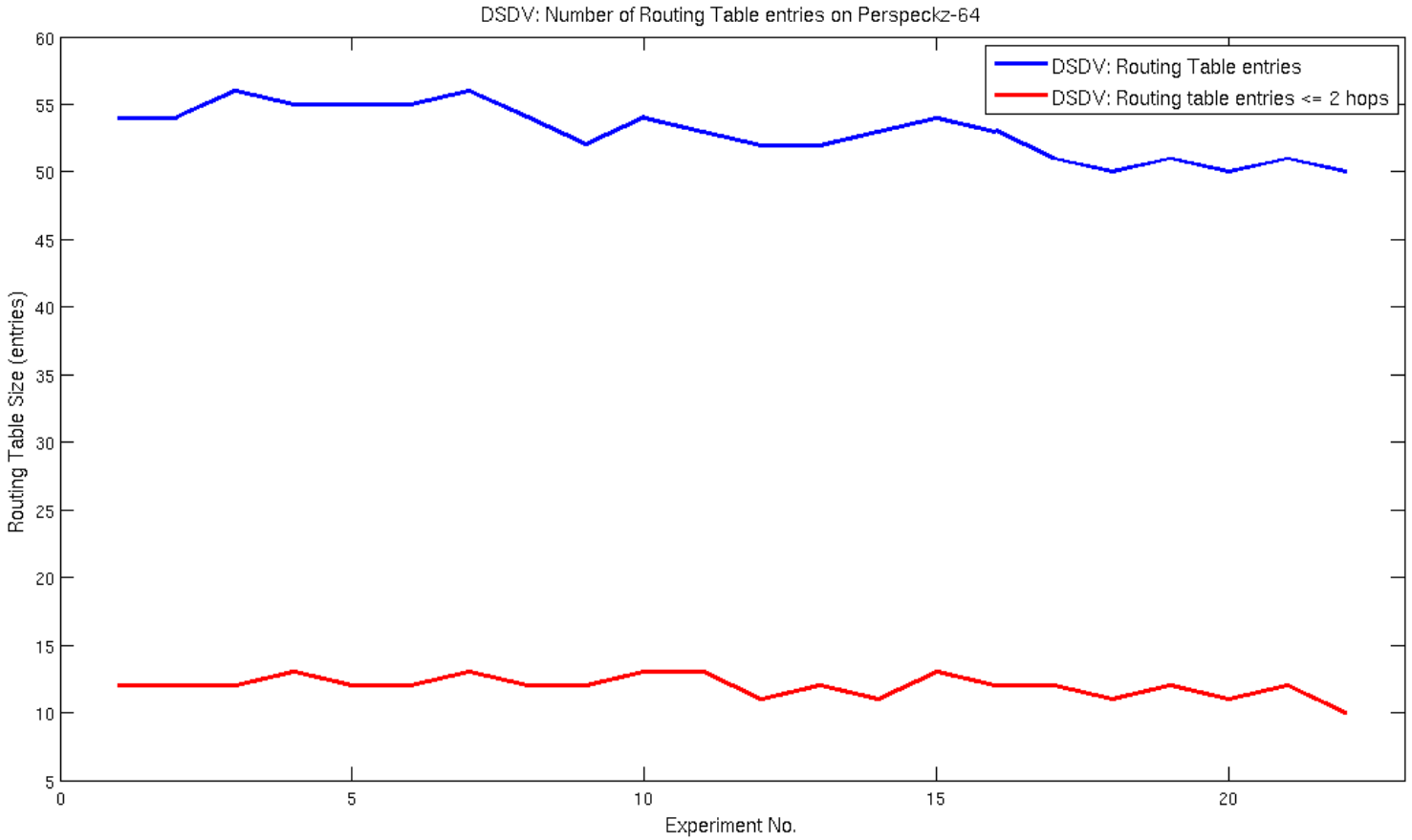
DSDV vs Flood: Tx/Rx On-time



DSDV vs Flood: Packets Transmitted



DSDV: Average Routing Table Size



DSDV vs Flood: Comparison

- Tx/Rx On-time:
  - *Flood:* 1.24%/6.499%
  - *DSDV:* 0.058%/2.412%
- (Data) packets Transmitted:
  - *Flood:* 1148.379 packets = 2296.758 bytes
  - *DSDV:* 46.23 packets = 92.46 bytes
- Delivery Ratio:
  - *Flood:* 97.9%
  - *DSDV:* 97.14%
- Routing Table Size:
  - *Flood:* N/A
  - *DSDV:* 52 entries = 260 bytes (5 bytes/entry)

DSDV vs Flood: Comparison (contd.)

- Upon including routing overhead:
  - Given 1 IRU/5 seconds, number of IRUs sent: 12
  - Packet payload size: 32 bytes.
  - Size of Routing Table: 260 bytes.
  - Total number of IRU packets each update: 9
  - Total bytes of routing overhead (excl. headers): 260*12 = 3120 bytes
  - Total bytes transmitted: 3212.46 bytes.
- Flooding then performs better than DSDV.

DSDV vs Flood: Comparison

- If data rate were doubled to 2 bytes/sec,
  - *Flood:* Packets transmitted = 2296.758 = 4593.516 bytes.
  - *DSDV:* Packets transmitted = 108 IRU packets + 92.46 Data packets = 3304.92 bytes.
- DSDV then performs better.

DSDV vs ZRP

- ZRP experiments carried out as proof-of-concept on smaller scale.
- Comparison is theoretical.
- In DSDV experiments,
  - 52 routing table entries.
  - 11 routing table entries with hops <=2.
- If ZRP zone radius is set to 2,
  - Number of routing table entries: 11
  - Given same IRU frequency, number of IRU packets: 2
  - Total bytes sent: 752.46 bytes.
- Thus, preliminary indications are that ZRP is more scalable than DSDV.

Conclusions

DSDV has delivery ratio equivalent to flood.

- DSDV is not scalable.
  - Performs better than controlled flood only at high data rates.
- Preliminary results indicate:
  - ZRP scales better than DSDV, and is better than flood on large-scale, dense networks.
  - ZRP takes longer for route determination.
    - Results from small-scale tests (9.3 seconds vs 18 seconds for ZRP).
- Demonstrator results indicate:
  - MANET routing algorithms are suitable for application considered (because of low power consumption, and high node lifetime).

Future Work

- Characterising ZRP on the Perspeckz-64.
- Developing Adaptive DSDV.
  - IRU interval increased exponentially.
  - Hello packets to maintain contact with neighbours.
- Implementing a Car Park management scheme using MANET algorithms.
  - Prove suitability of MANET routing algorithms for specified application domains.
  - Current scheme uses controlled flooding.
    - Contrast approaches.

Thank You