

NexTech 2015 Keynote Presentation
July 22, 2015 - Nice, France

**Mobile Medium:
Mobile Ad hoc Network Based Infrastructure**

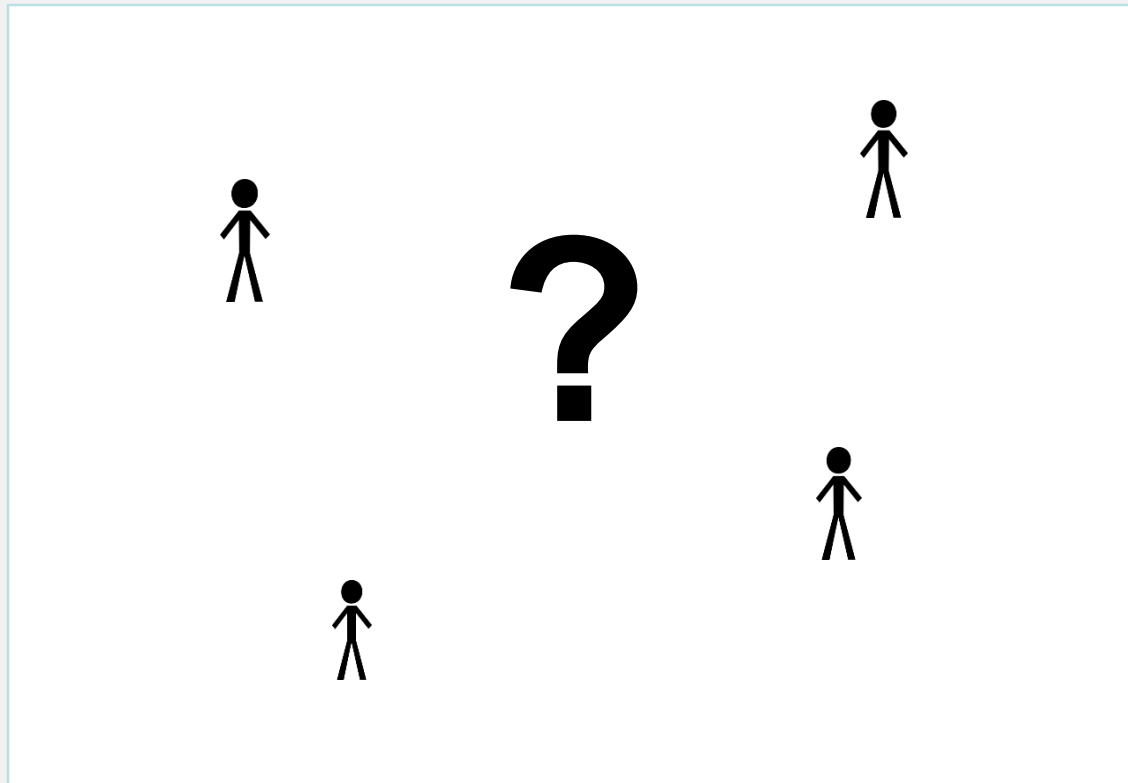
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University of New Brunswick
Fredericton, N.B, Canada

Outline

- No infrastructure? No problem!
- Mobile Medium
 - like an Ad hoc Network
 - emergent properties
 - connectivity vs forwarding
 - movement
 - behavior
 - on simulation tools

(Note: for links to the videos used in the presentation please see the LAST slide)

How to communicate without established infrastructure?

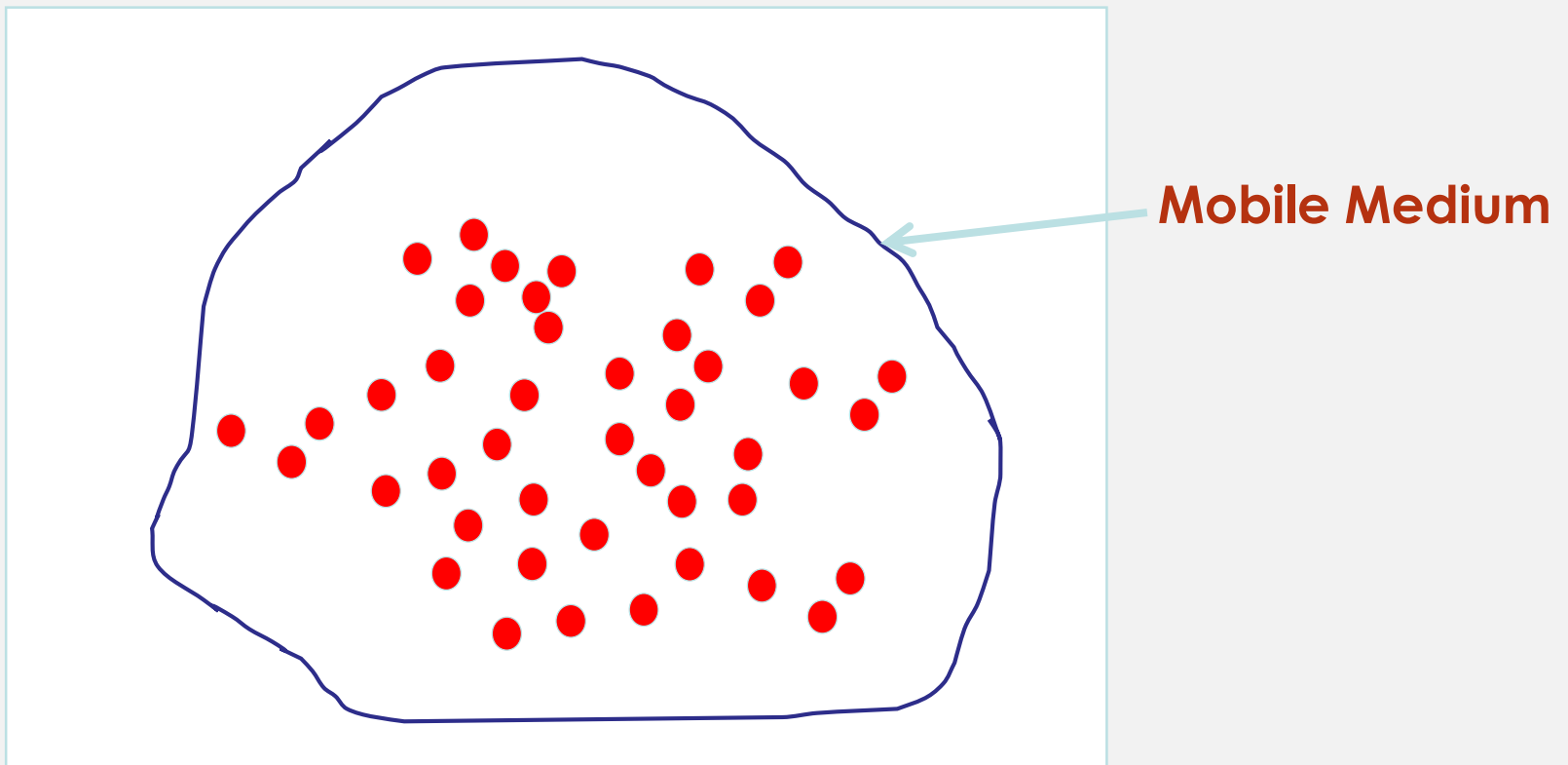


Create a communication medium

- Direct links (walkie talkie)
 - Limited range
 - Cellular network
 - Infrastructure based
 - Ad hoc network
 - End users must cooperate
-
- Mobile Medium
 - Use dedicated mobile forwarding nodes

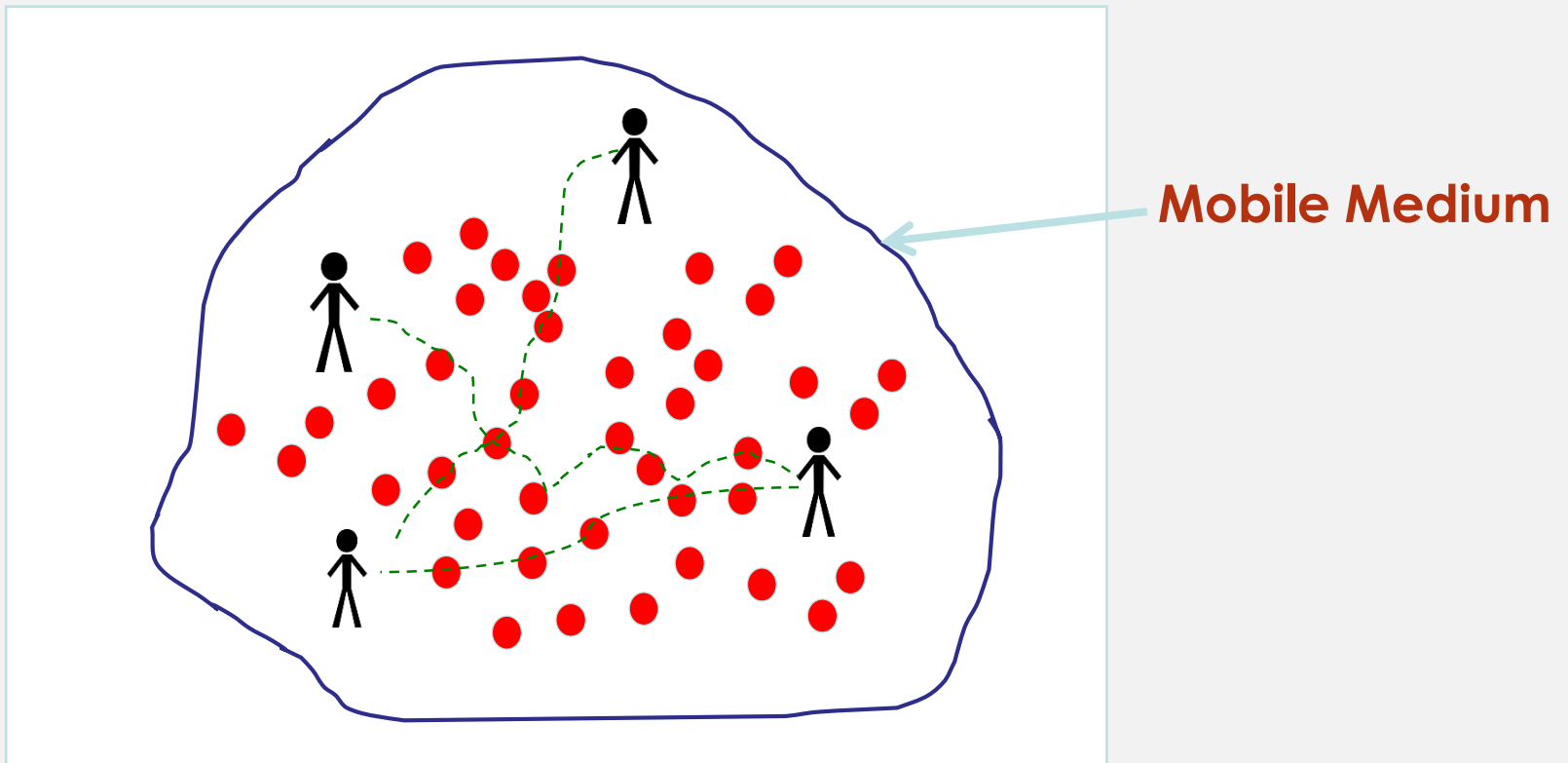
Creating Mobile Medium

- Deploy a large number (a cloud) of forwarding nodes over the area of interest

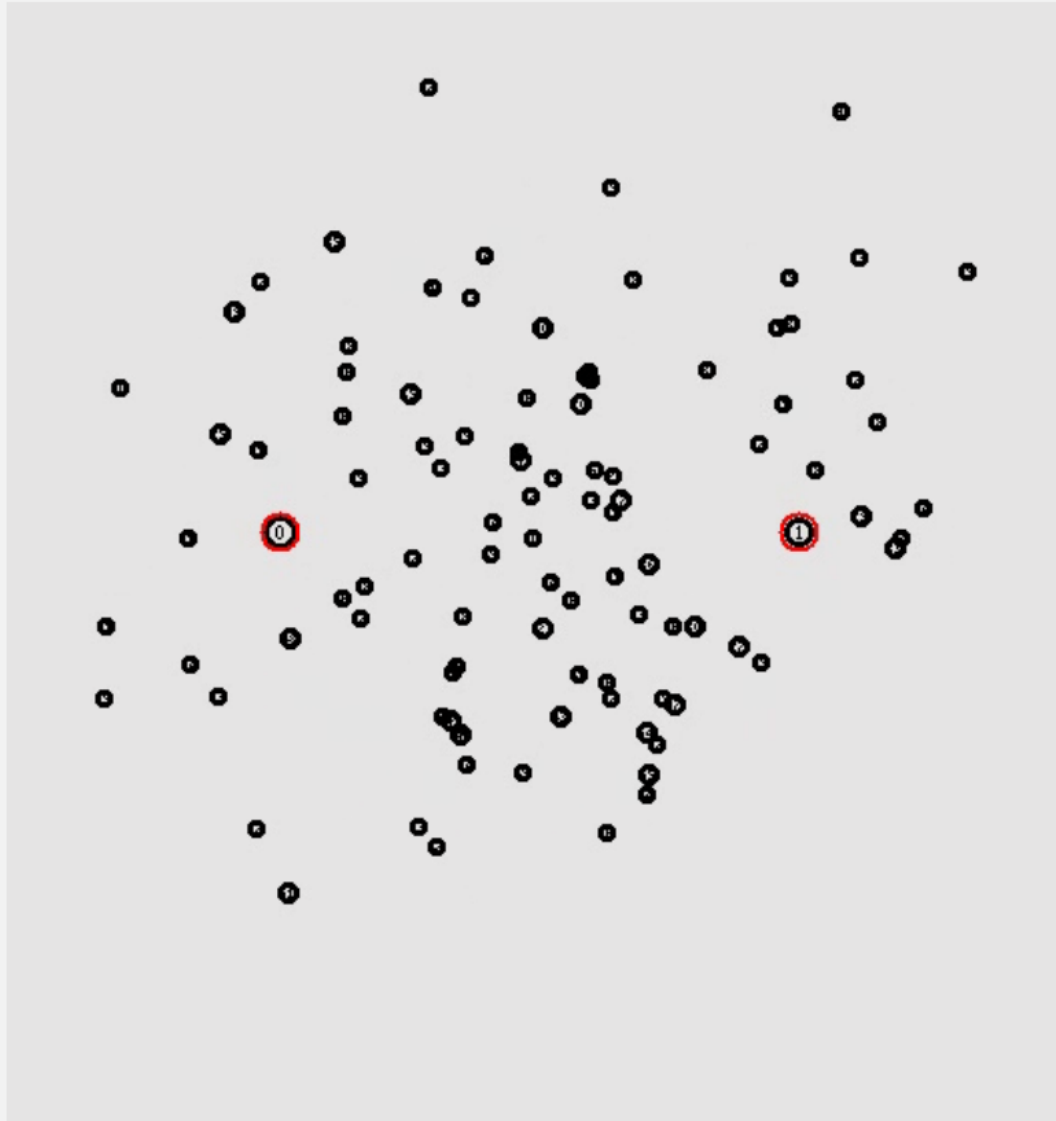


Creating Mobile Medium

- Users connect to the Mobile Medium and the Mobile Medium forwards the data



Sample deployment scenario



*

Possible applications

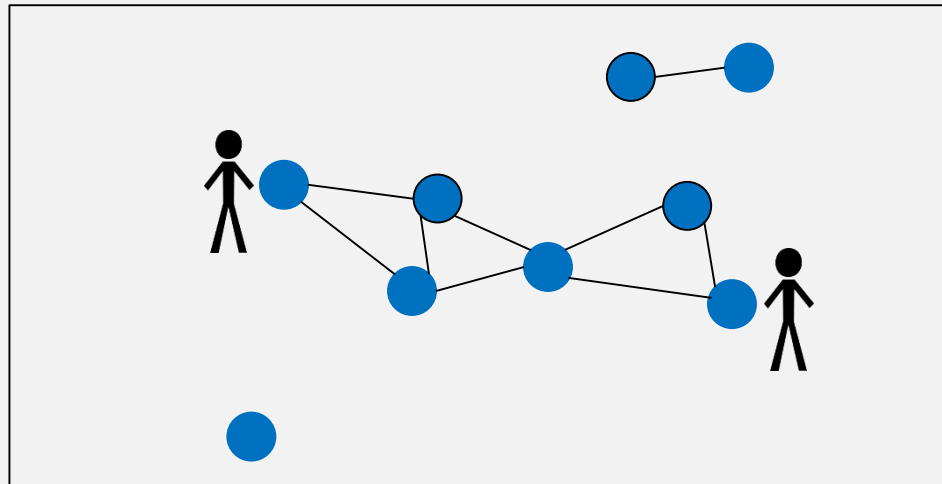
- General communication
 - Wifi at a concert venue
- Emergency response
 - Disaster recovery
 - Forest fires crew communication

M2ANET: Mobile Medium Ad Hoc Network

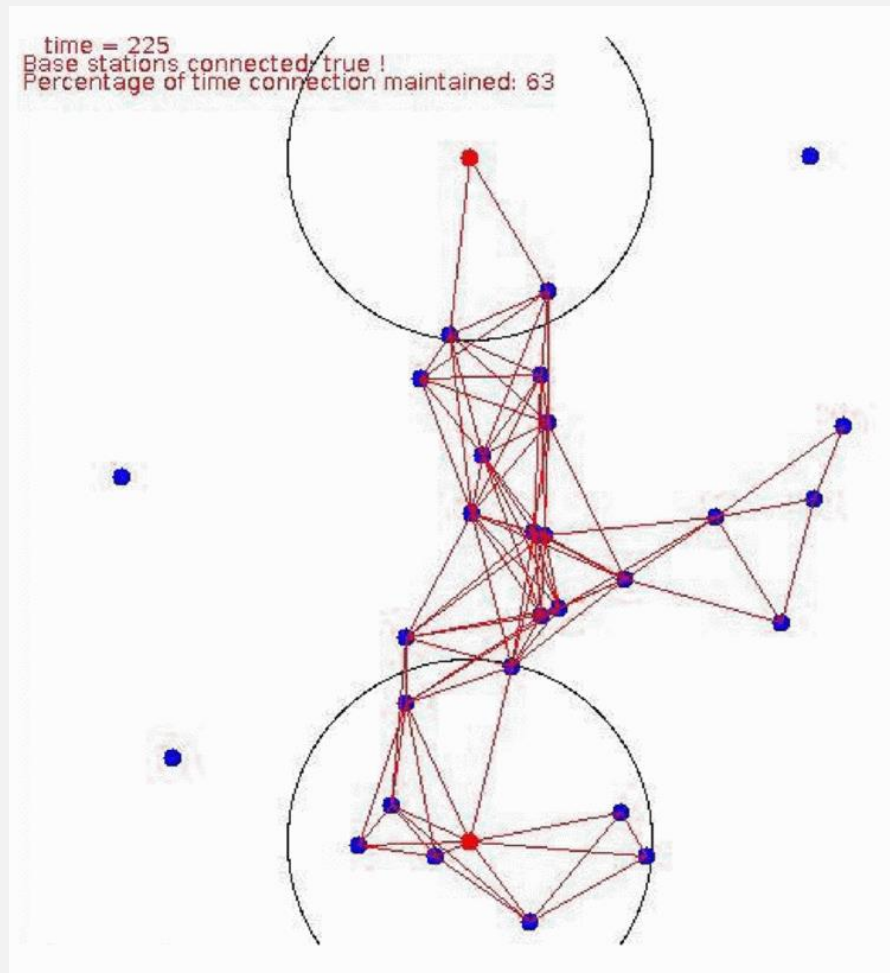
- Similar to MANET
- Two categories of nodes:
 - Forwarding nodes
 - User nodes
- Different design considerations
 - Number of forwarding nodes
 - Routing protocols
 - Node movement control

Mobile medium: connectivity

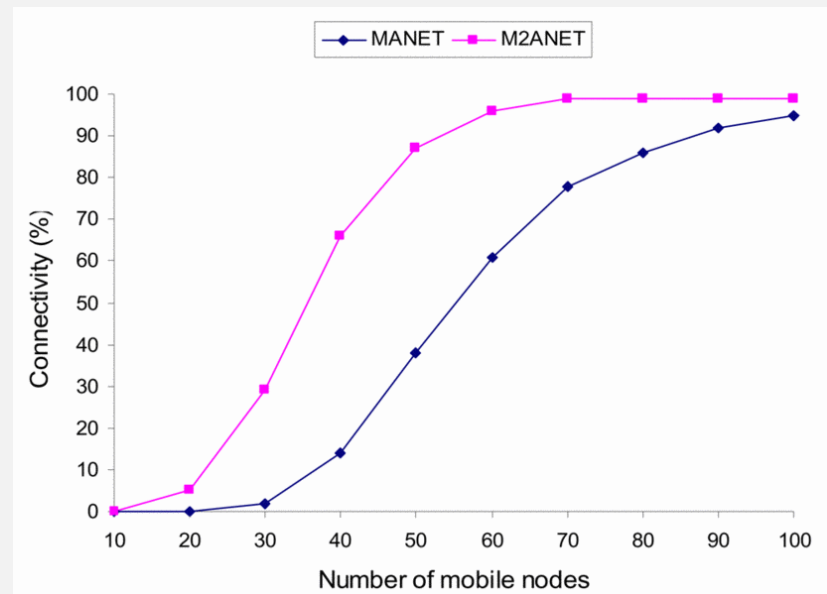
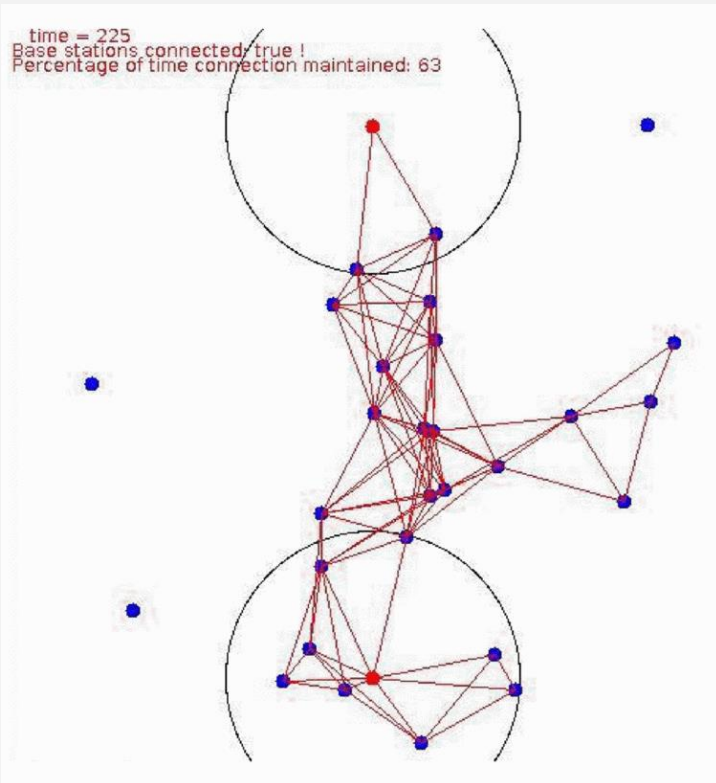
- Full connectivity
- End to end connectivity



End to End connectivity vs Full connectivity

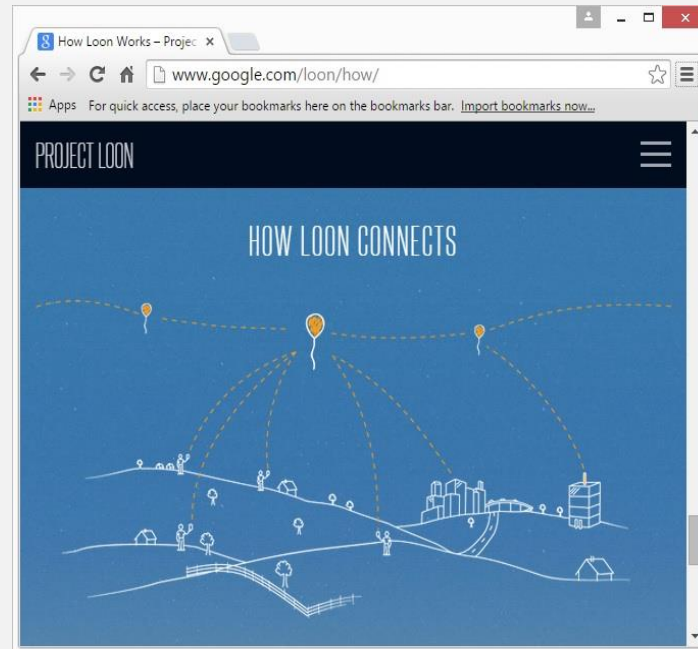


J. DeDourek and P. Pochee, "M²ANET: a Mobile Medium Ad Hoc Network", *Wireless Sensor Networks: Theory and Practice*, The Fourth IFTP International Conference on New Technologies, Mobility and Security NTMS 2011/WSN 2011, Paris, France, pp. 1 - 4, Feb. **2011**.



Other players . . .

MOBILE MEDIUM?

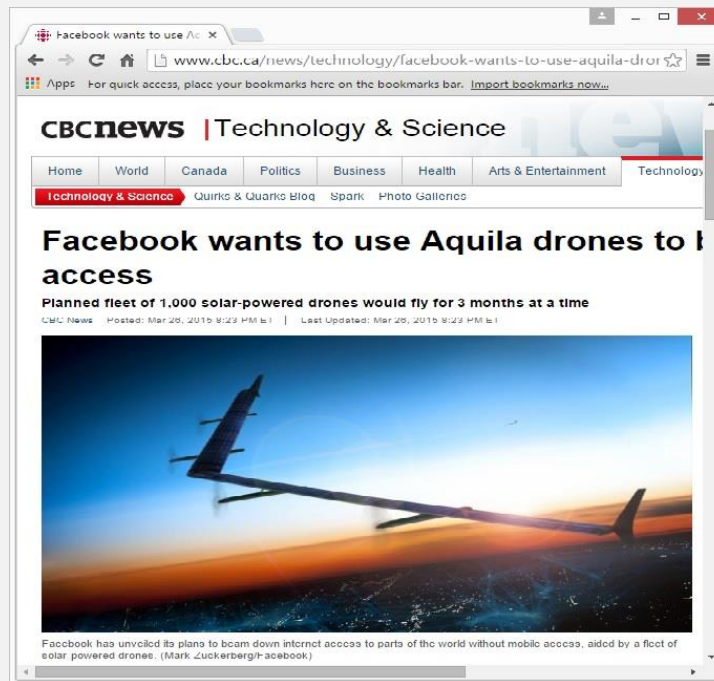


Google Loon (2013)

<http://www.google.com/loon/>

Other players . . .

MOBILE MEDIUM?

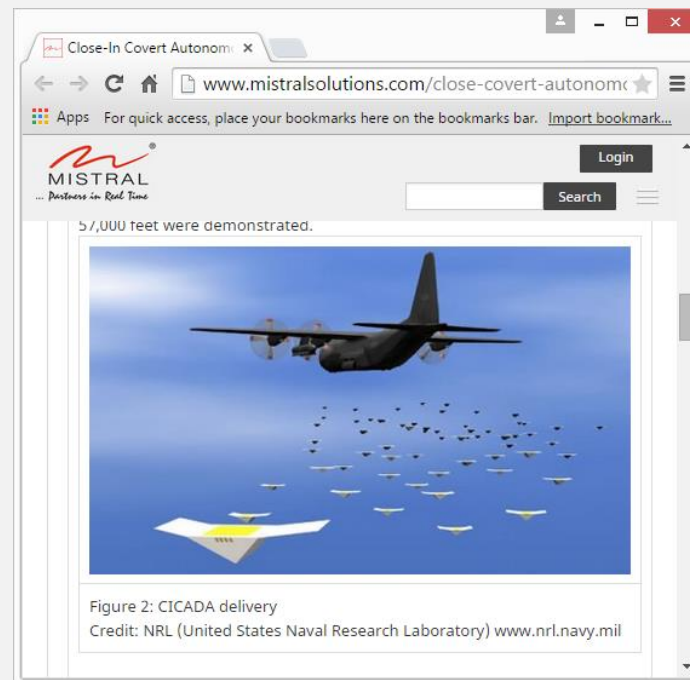


FB drones (2014)

<http://www.cbc.ca/news/technology/facebook-wants-to-use-aquila-drones-to-beam-internet-access-1.3011259/>

Other players . . .

MOBILE MEDIUM?

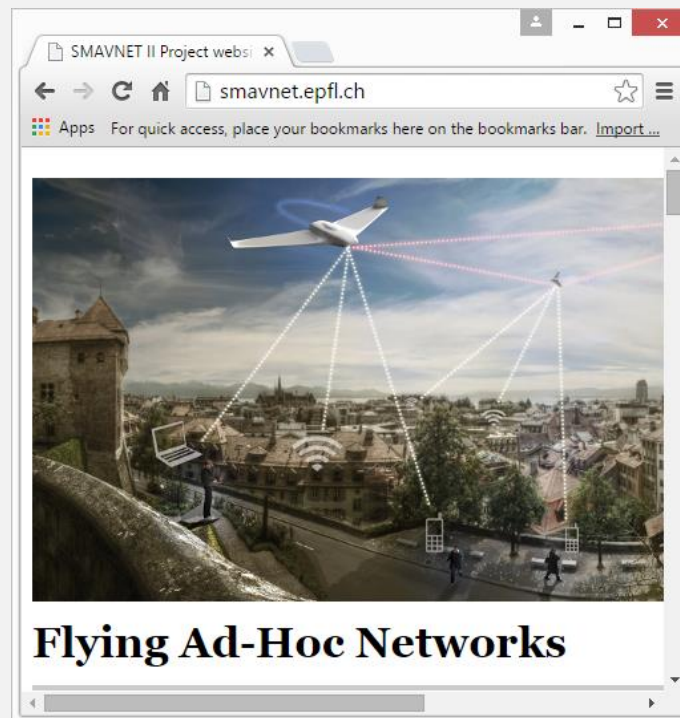


CICADA mini drones (2015)

<http://www.mistralsolutions.com/close-covert-autonomous-disposable-aircraft-cicada-homeland-security/>

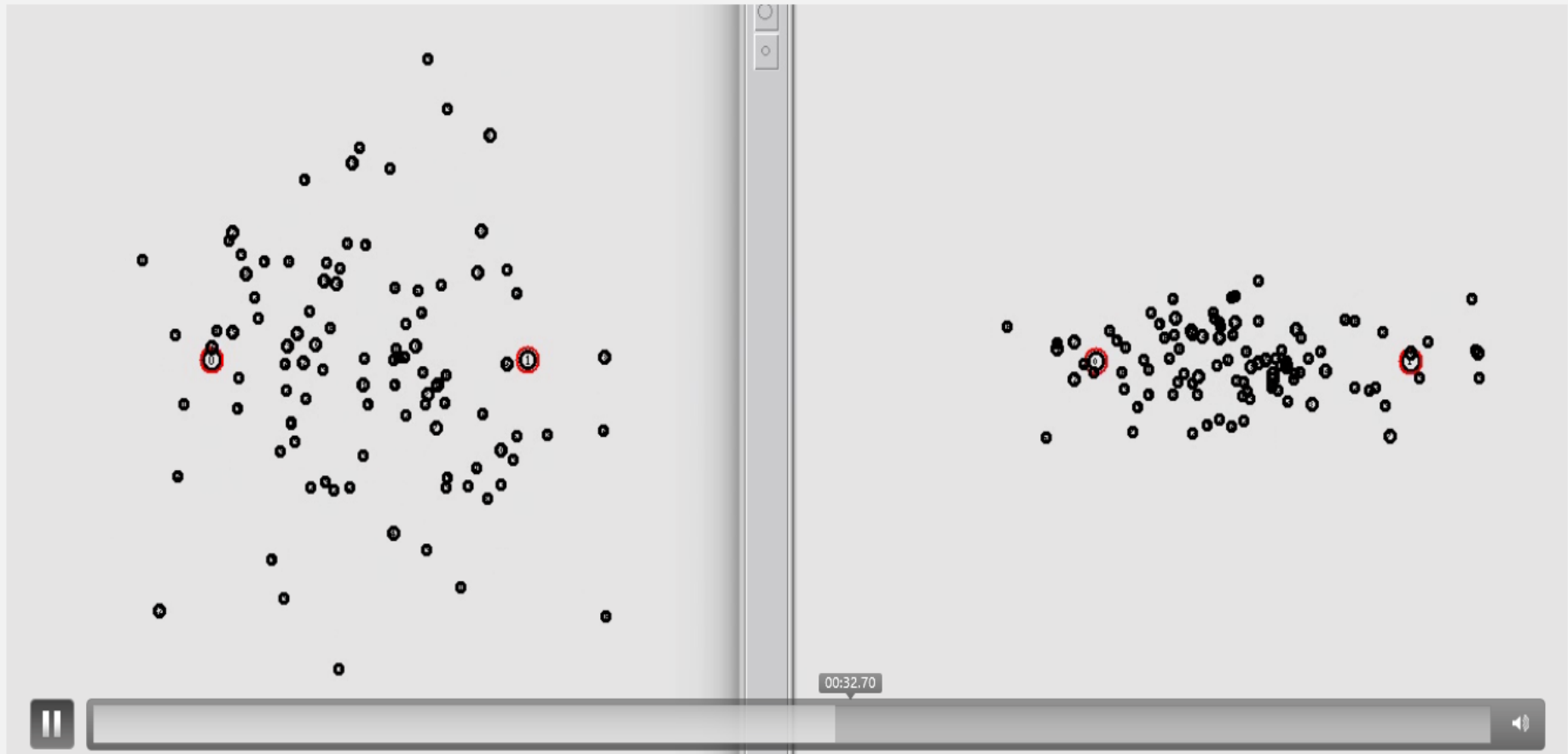
Other players . . .

MOBILE MEDIUM?



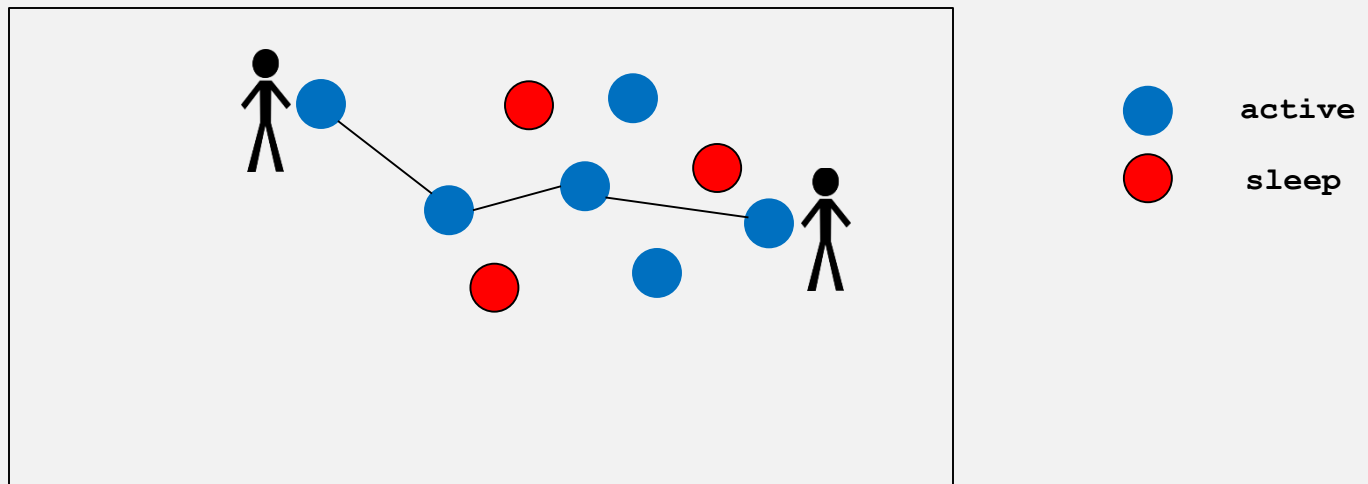
SMAVNET (2012)

Deployment consideration: maintaining node density

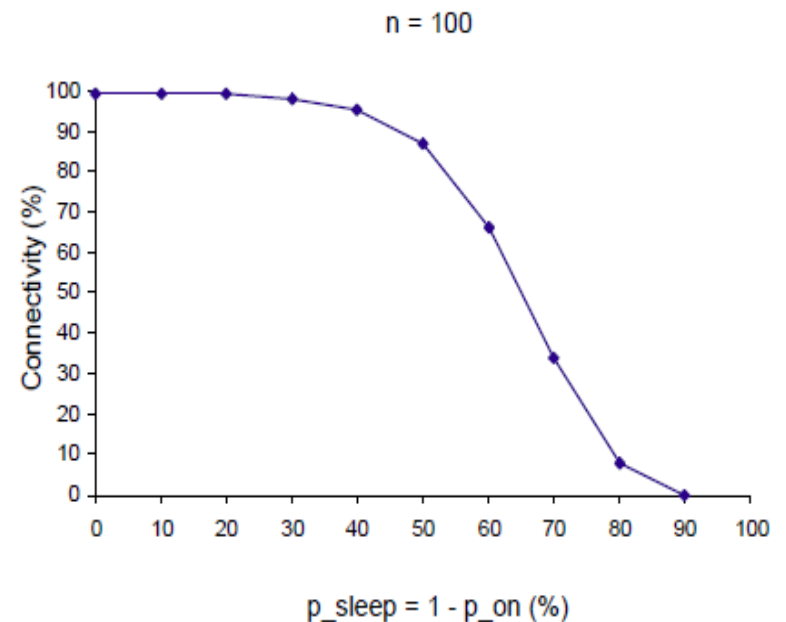
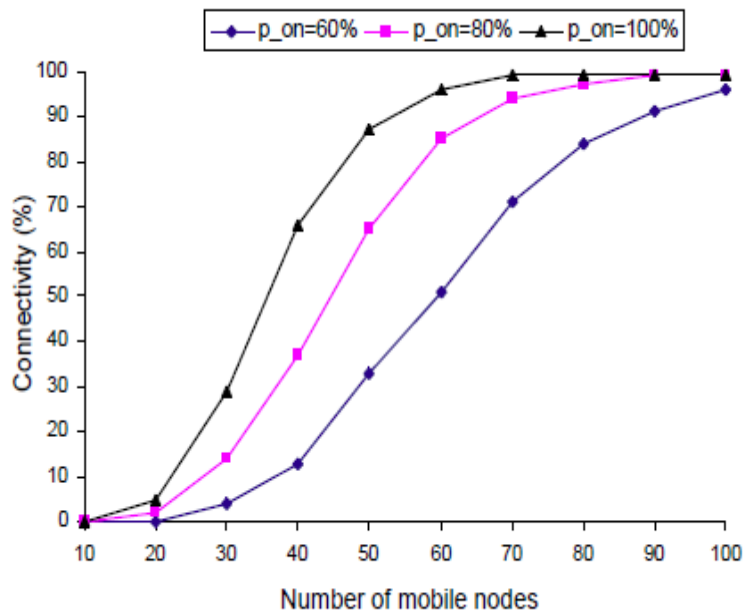


Mobile medium: emergent properties

- Performance of mobile medium is depends on the node density, and not on the performance of any one individual node.
 - > Experiment: allow individual nodes to switch off temporarily, and then observe the global performance of the mobile medium:

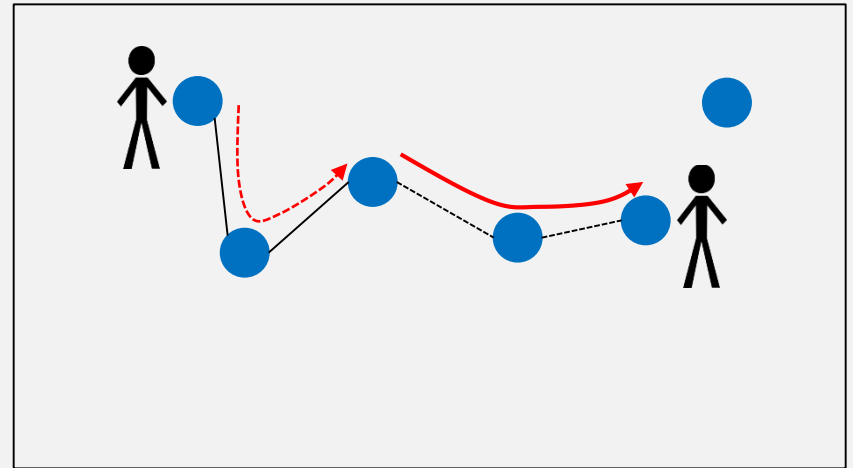
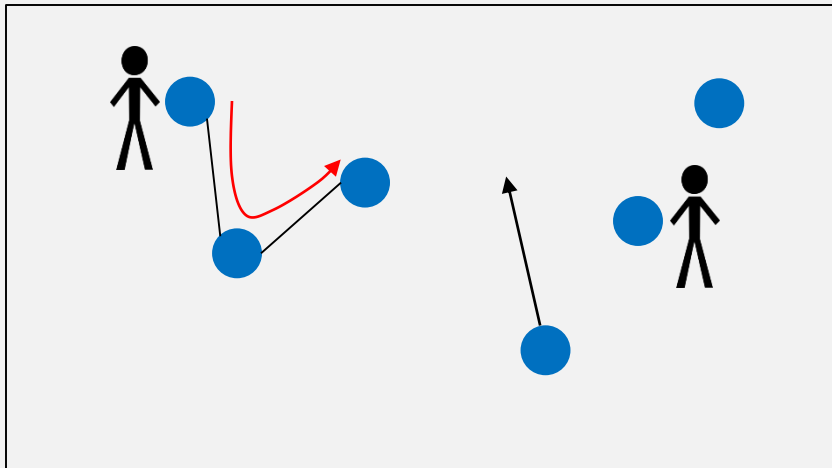


Kerul Patel, J. DeDourek and P. Pochech, M²ANET Performance Under Variable Node Sleep Times, The Third International Conference on Advances in Future Internet, AFIN2011, Nice, France, pp. 31-34, Aug. 2011.



Mobile medium: mobile nodes can "carry" data

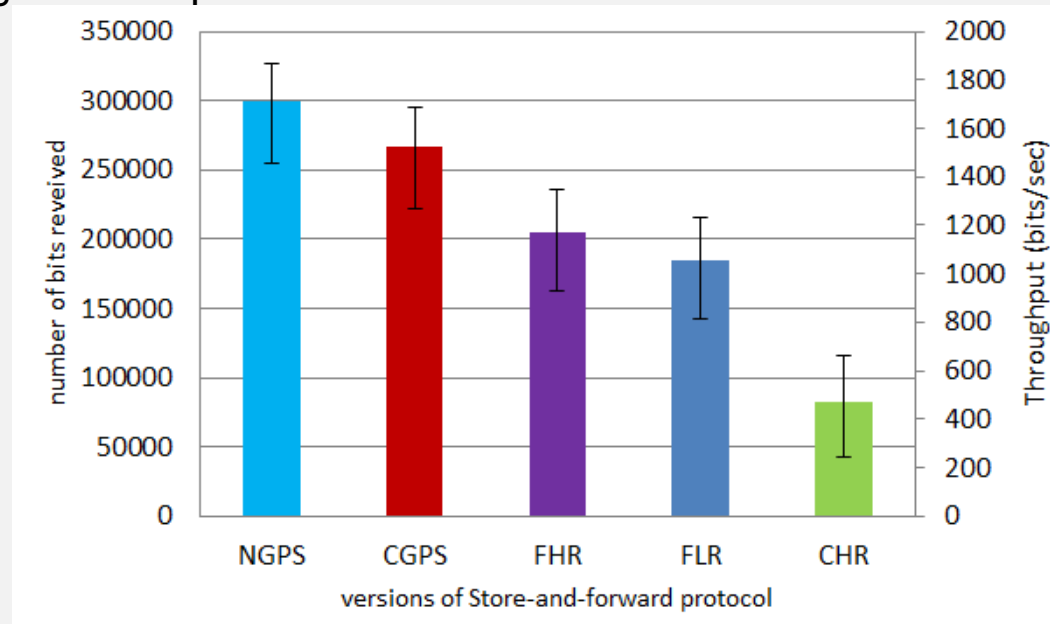
- When no closed path exists allow the node to carry the data and pass it along when the connectivity is reestablished



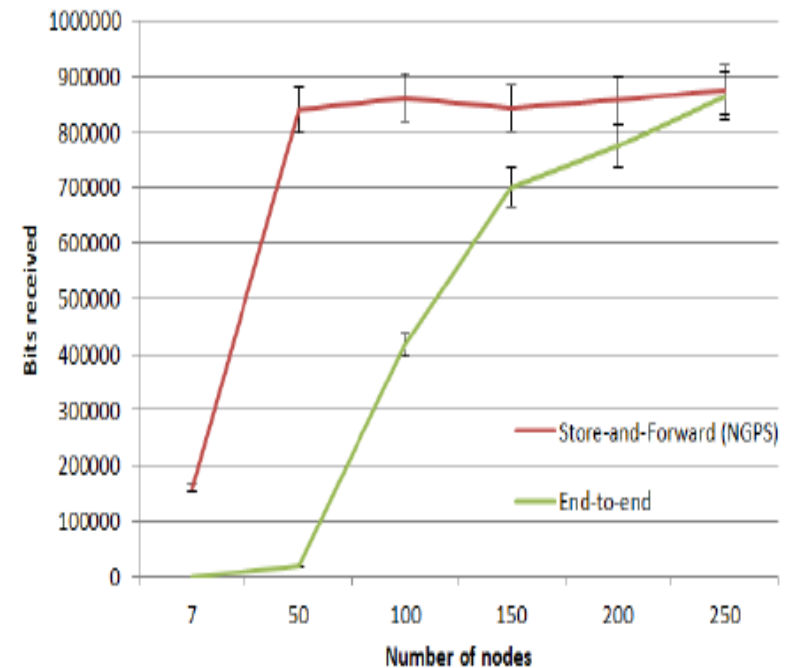
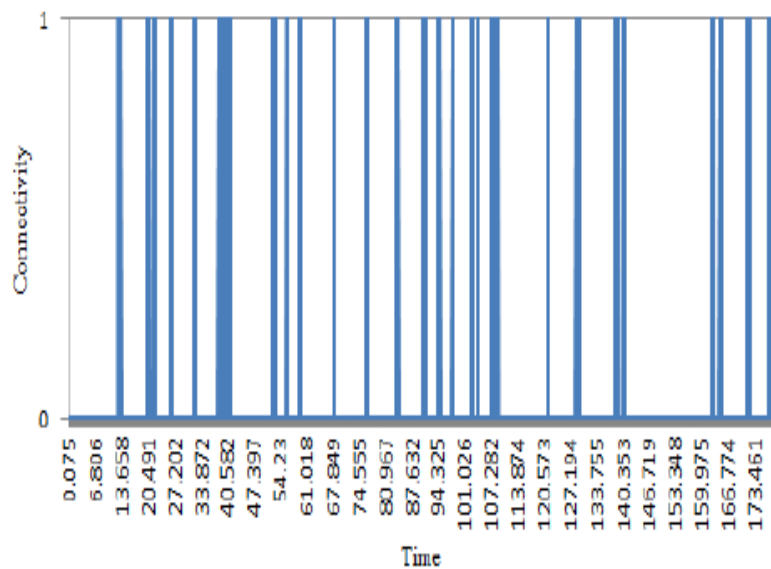
Mobile medium: mobile nodes can "carry" data

Experiment: implement different versions of the store and forward protocol in the mobile medium

- first hop in the list routing (FLR),
- closest hop routing (CHP),
- farthest hop routing (FHR),
- the closest to the destination routing (CGPS),
- forwarding to the hop that has the best next location to the destination (NGPS)

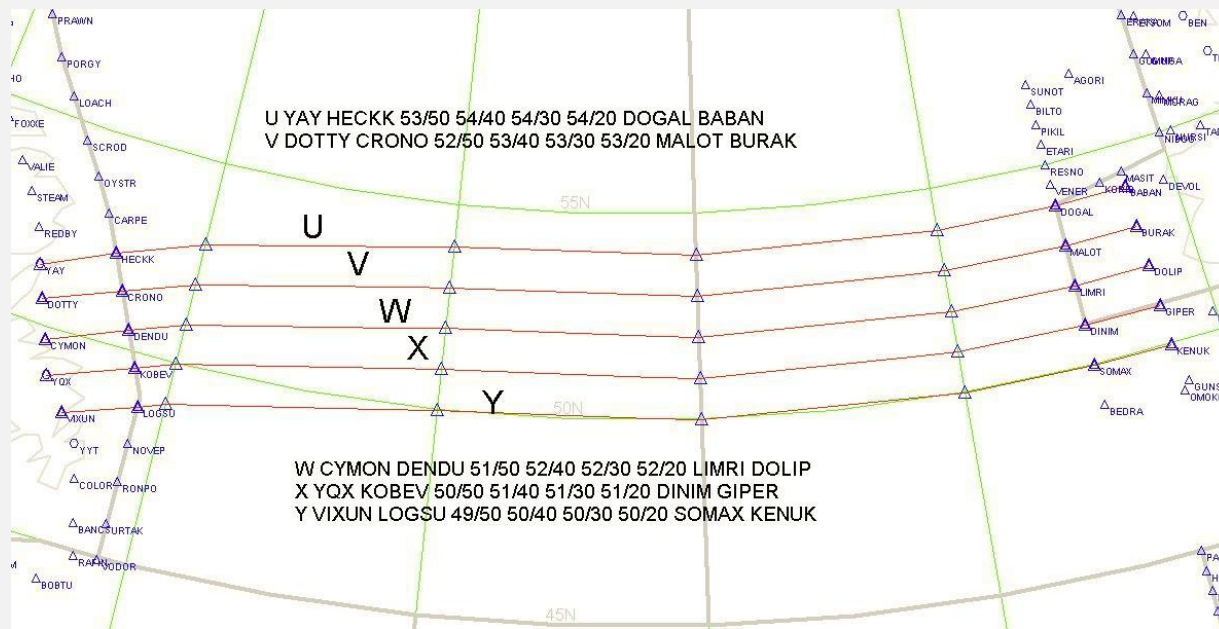


Ahmed Alghamdi, Raid Alghamdi, J. DeDourek and P. Pochee,
Store-and-Forward Protocol Advantage in a M2ANET Network, The
Fourth International Conference on Advances in Future Internet,
AFIN2012, Rome, Italy, pp. 42-47, Aug. 2012.



Mobile medium: restricting the movement of mobile nodes

- Mobile nodes move on parallel paths
- Data is forwarded on the direction of node movement, or not.



North Atlantic Tracks for the eastbound crossing on the evening of May 4, 2006,
http://en.wikipedia.org/w/index.php?title=North_Atlantic_Tracks&oldid=518517067.

Mohammed Alzaylaee, J. DeDourek and P. Pochech, " Linear Node Movement Patterns in MANETS", The Ninth International Conference on Wireless and Mobile Communications ICWMC 2013, Nice, France, pp. 162-166, July 21-26, 2013.

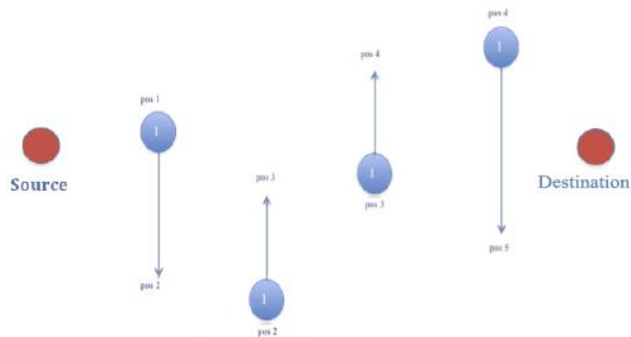


Figure 2. Vertical motion.

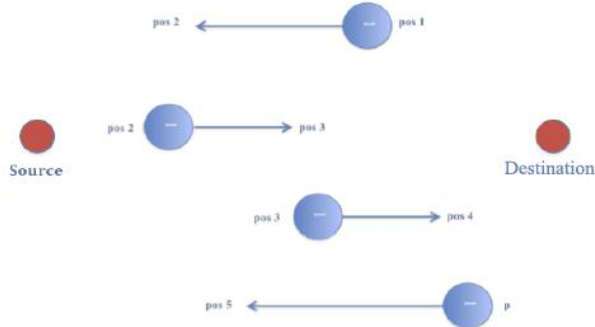
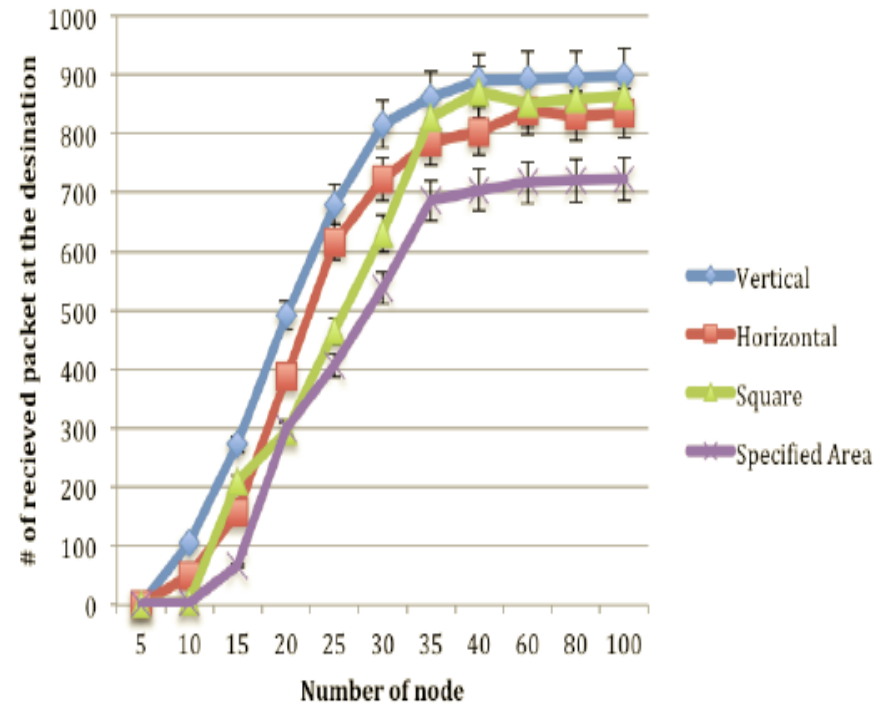


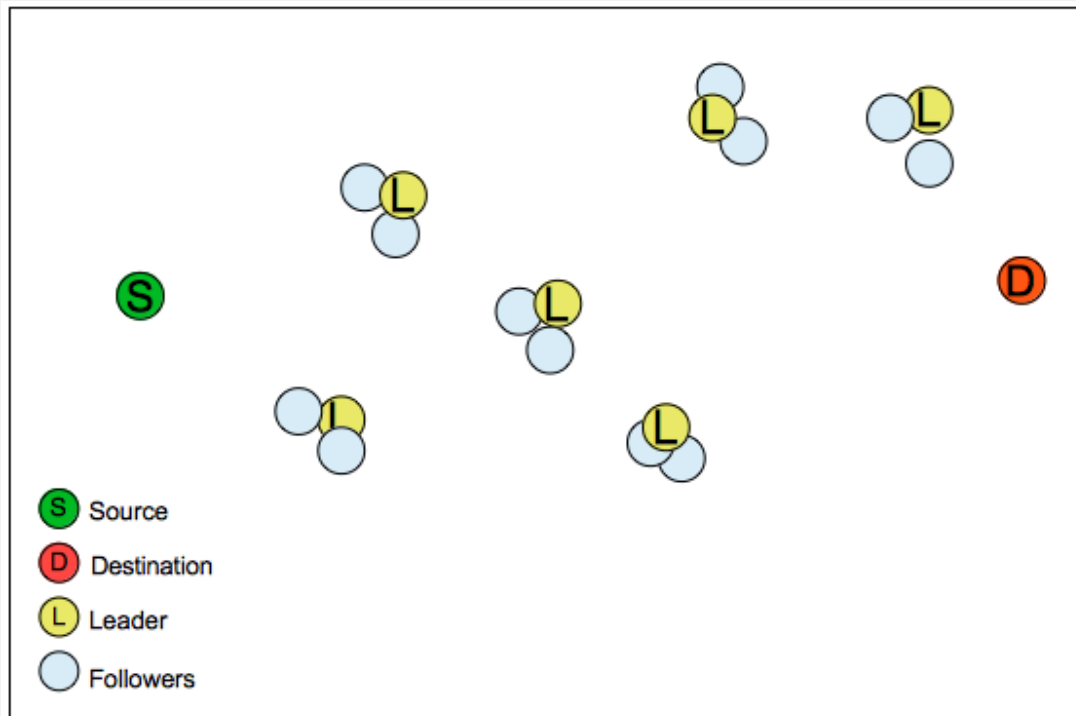
Figure 3. Horizontal motion.

Comparing different motions with high speed

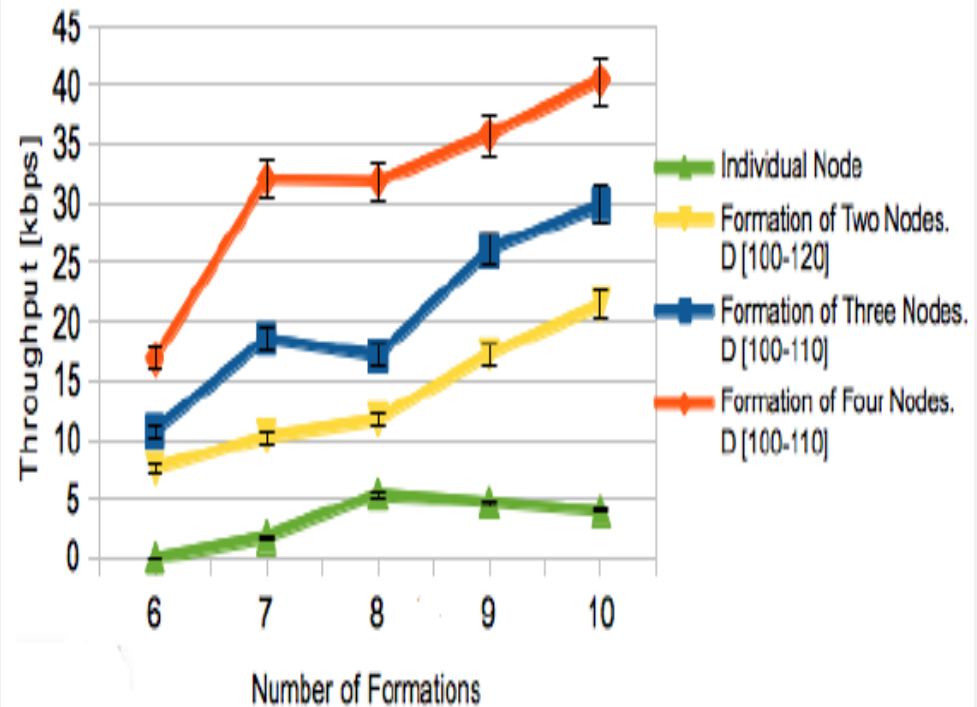
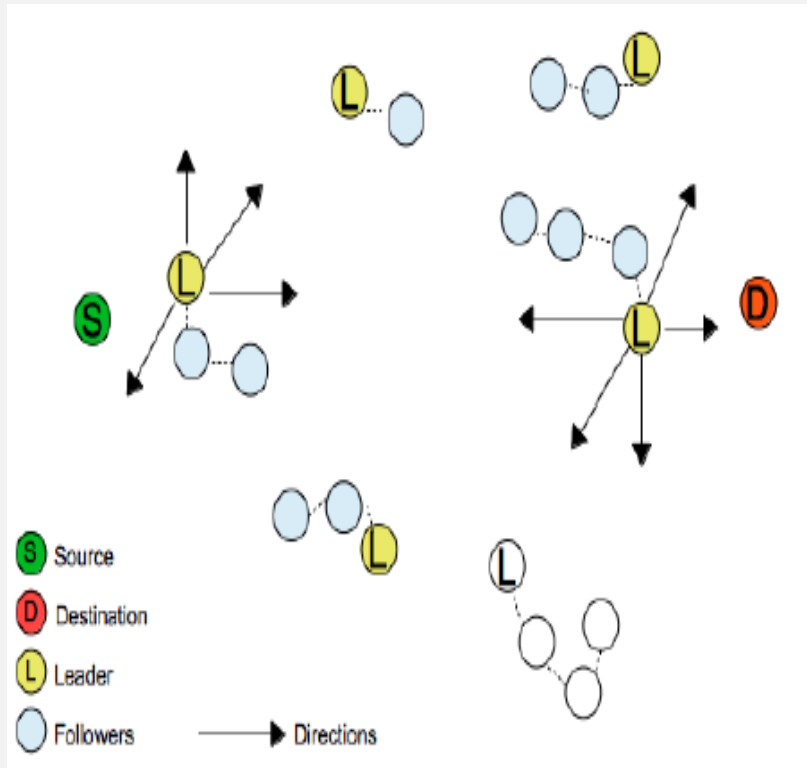


Mobile medium: moving nodes in packs

- Towing formation: a type of group mobility
- Leader node followed by other nodes
- Lessens the control complexity of the followers

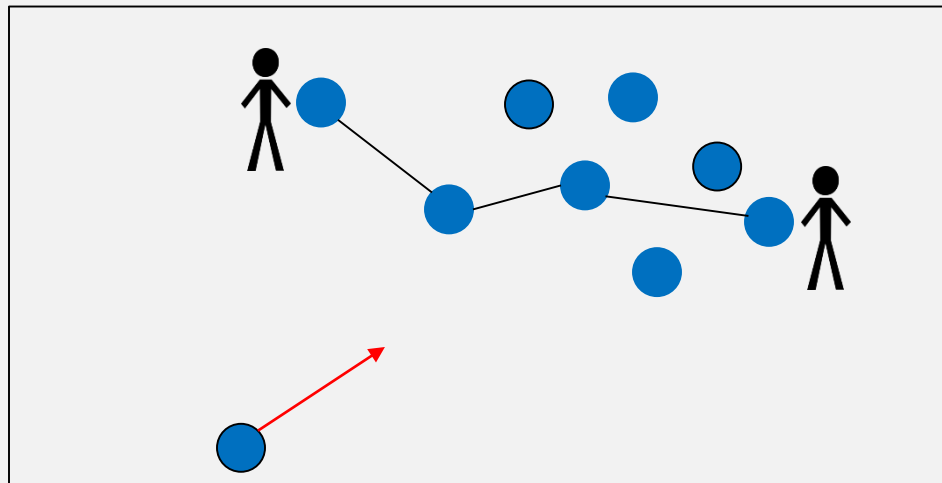


Abdullah Alshehri, J. DeDourek and P. Pochee, " The Advantage of Moving Nodes in Formations in MANETs and M2ANETs", The Ninth International Conference on Wireless and Mobile Communications ICWMC 2013, Nice, France, pp. 228-232, July 21-26, 2013.

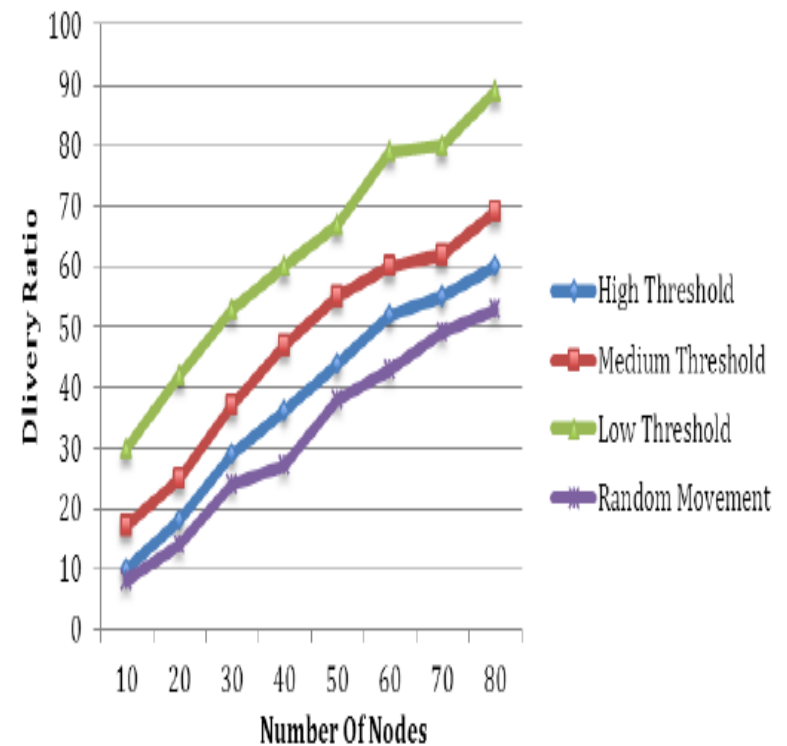
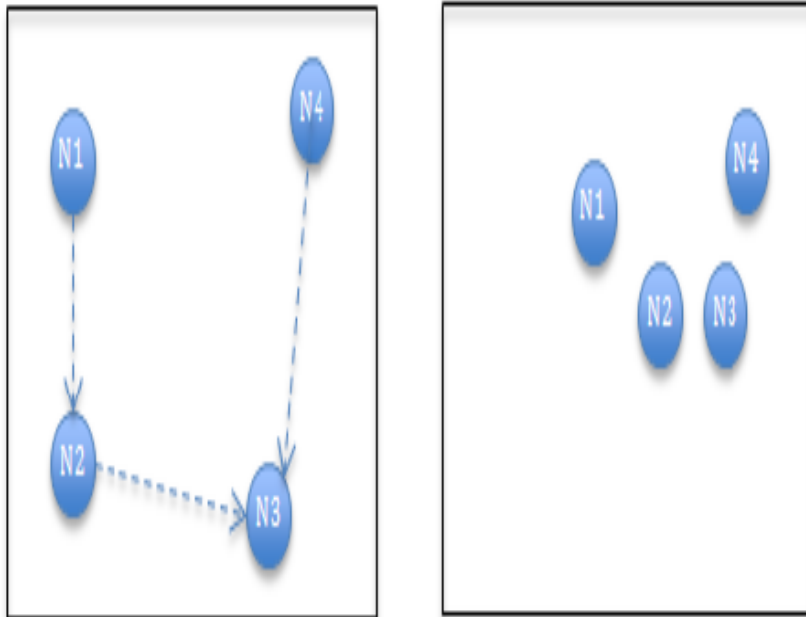


Mobile medium: keeping nodes together (a herd or a cloud)

- RWP moving nodes tend to wander all over the available space
- Mobile medium works best with sufficient node density
- Attraction/repulsion based mechanism for keeping nodes together

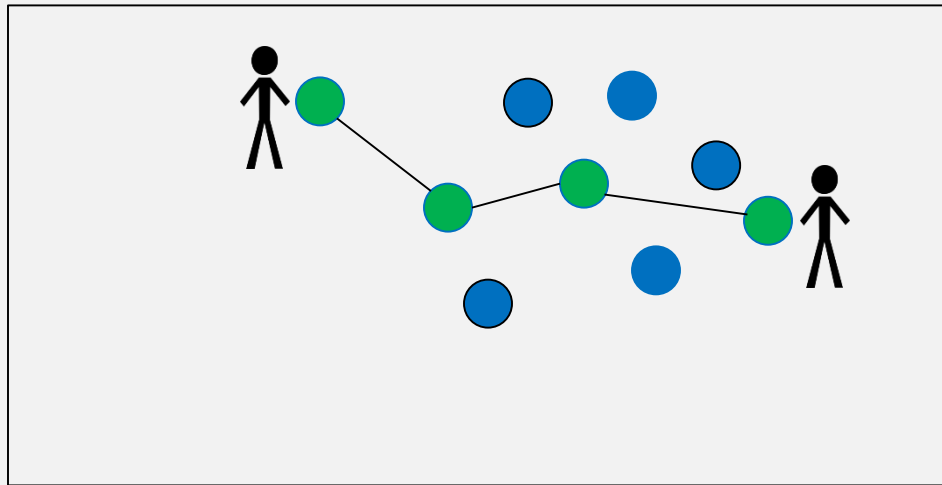


Nada Alsalmi, J. DeDourek and P. Pochee, “Self-organizing Mobile Medium Ad hoc Network”, The Fourth International Conference on Mobile Services, Resources, and Users MOBILITY 2014, July 20 - 24, 2014 - Paris, France.

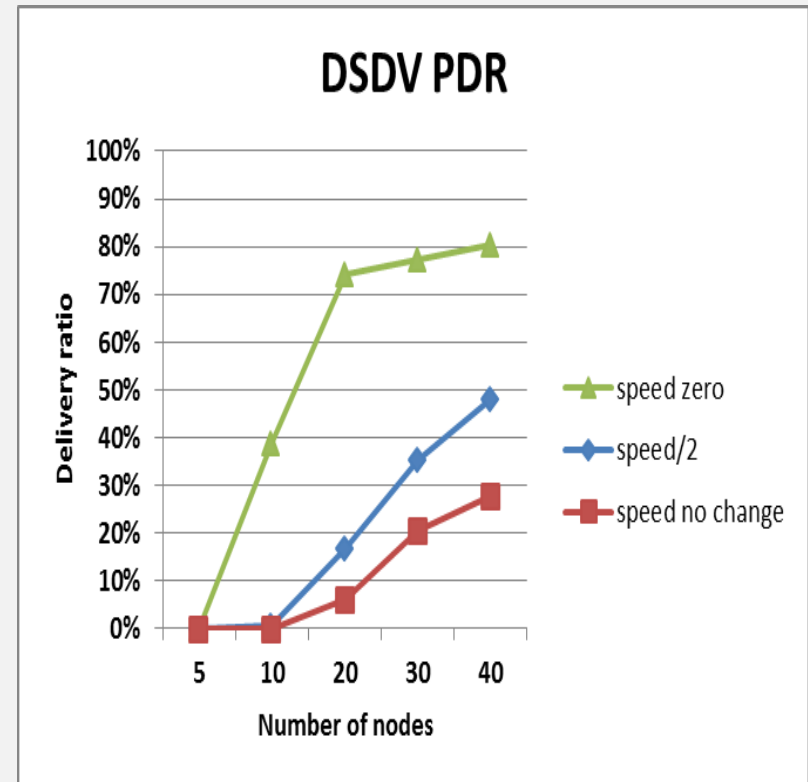
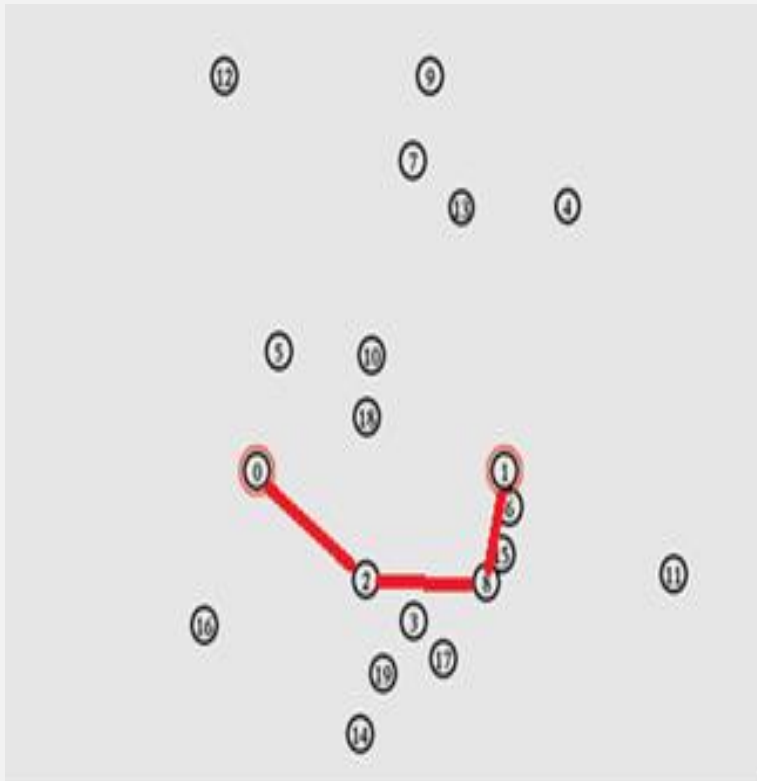


Mobile medium: keeping active (forwarding) nodes active

- Each node that is actually forwarding is very important to the operation of the network
- Keep actively forwarding nodes where they are to avoid breaking the connection!



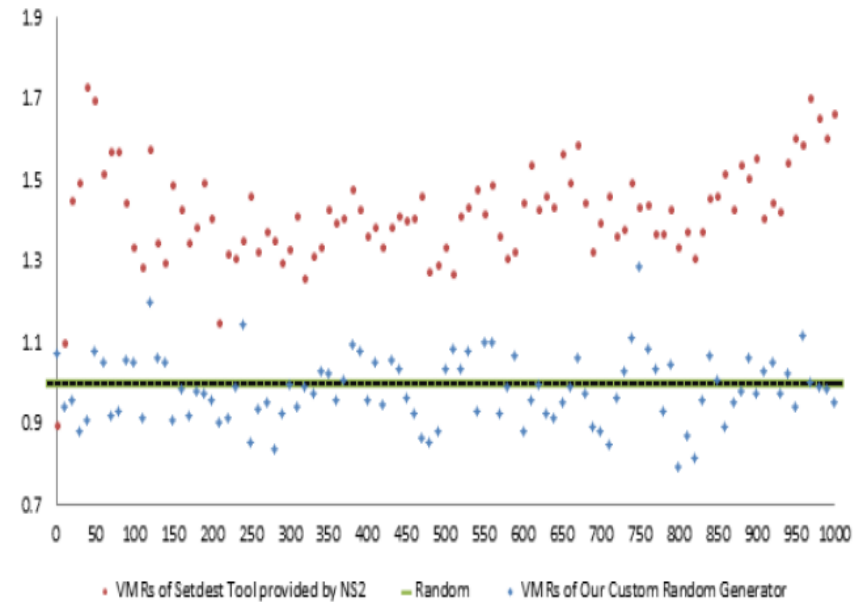
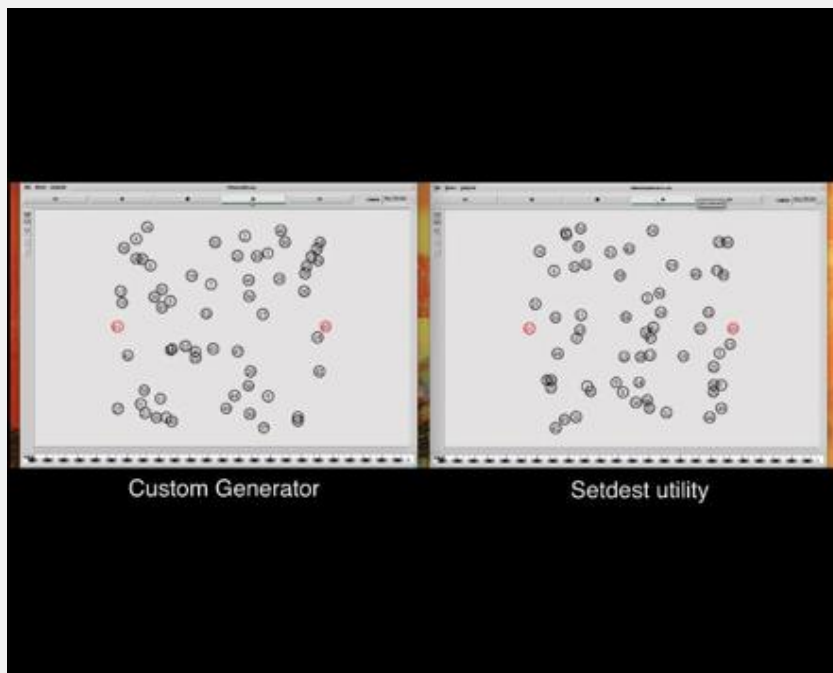
Hanin Almutairi, J. DeDourek and P. Pochee, “Dynamic Node Movement Control in a Mobile Medium Ad hoc Network”, The Seventh International Conference on Emerging Networks and Systems Intelligence, EMERGING 2015, July 19 - 24, 2015 - Nice, France



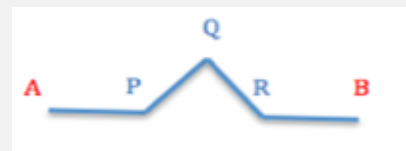
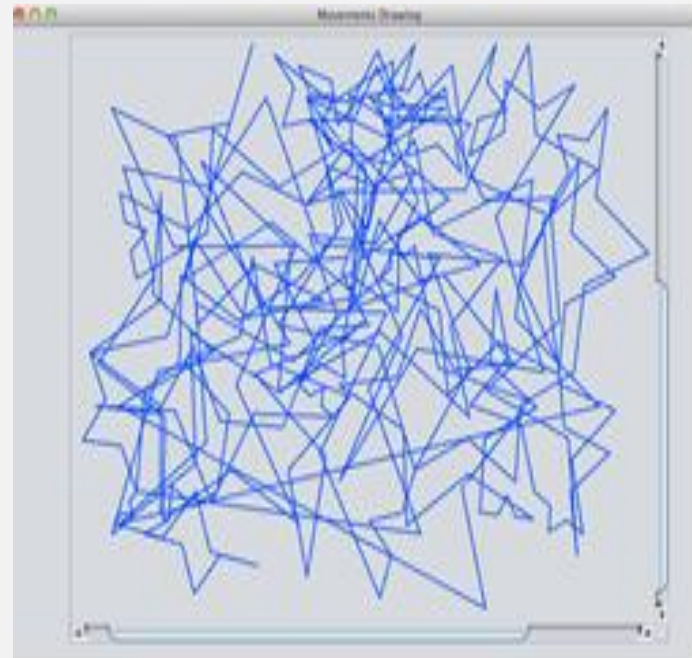
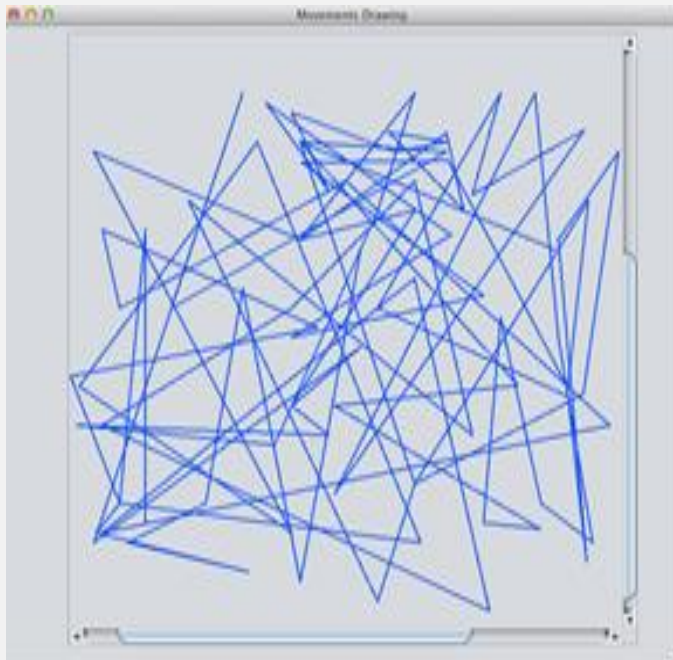
Mobile medium: simulation tools

- Random movement generators:
 - improved RWP generator without the border effect
- Processing movement instructions:
 - changing each linear step into a (fractal) curve
- Simulation tools for 3D modelling

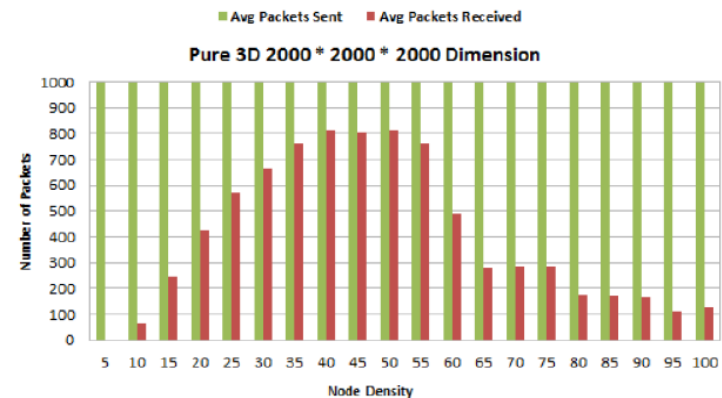
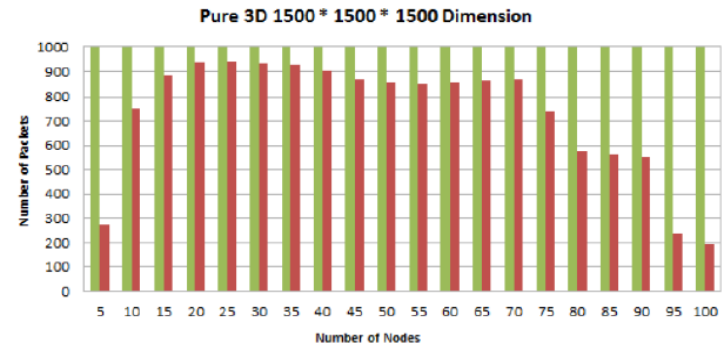
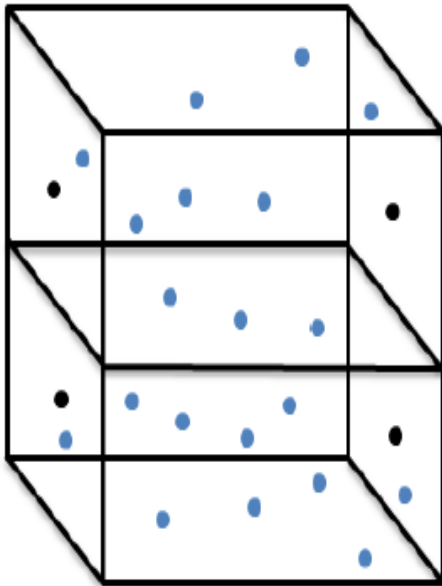
Raid Alghamdi, J. DeDourek and P. Pochee, "Avoiding Border Effect in Mobile Network Simulation", The Twelfth International Conference on Networks ICN 2013, Seville, Spain, pp. 184-189, Jan 27 - Feb 1, 2013.



Hawra Alseef, J. DeDourek and P. Pochee, "A Method for Custom Movement Generation in Wireless Mobile Network Simulation", The Seventh International Conference on Emerging Networks and Systems Intelligence, EMERGING 2015, July 19 - 24, 2015 - Nice, France



Nasir Mahmood, J. DeDourek and Przemyslaw Pocheć, "M2ANET simulation in 3D in ns2", The Sixth International Conference on Advances in System Simulation SIMUL 2014, October 12 - 16, 2014 - Nice, France.



Acknowledgement

1. The research described in this presentation is a joint work with Prof. John DeDourek.
2. The following graduate students participating in M2ANET related projects were funded by the Ministry of Higher Education of Saudi Arabia:
 - Ahmed Alghamdi
 - Raid Alghamdi
 - Hanin Almutairi
 - Nada Alsalmi
 - Hawra Alseef
 - Abdullah Alshehri
 - Mohammed Alzaylaee

Final word . . .

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Videos used in the presentation

- Sample deployment scenarios/ keeping the nodes together:
http://www.cs.unb.ca/~pochech/video_convergence.ogv
- Full connectivity vs a point to point link, Java animation (not signed):
<http://www.cs.unb.ca/~pochech/demoMANET2/MANET.html>
- Custom movement generator vs setdest utility:
<http://www.cs.unb.ca/~pochech/ShortClip.mpg>