Modeling of Humanoid and Multi-agent System

EE 382C.9 Embedded Software Systems Spring 2004

Final Presentation by

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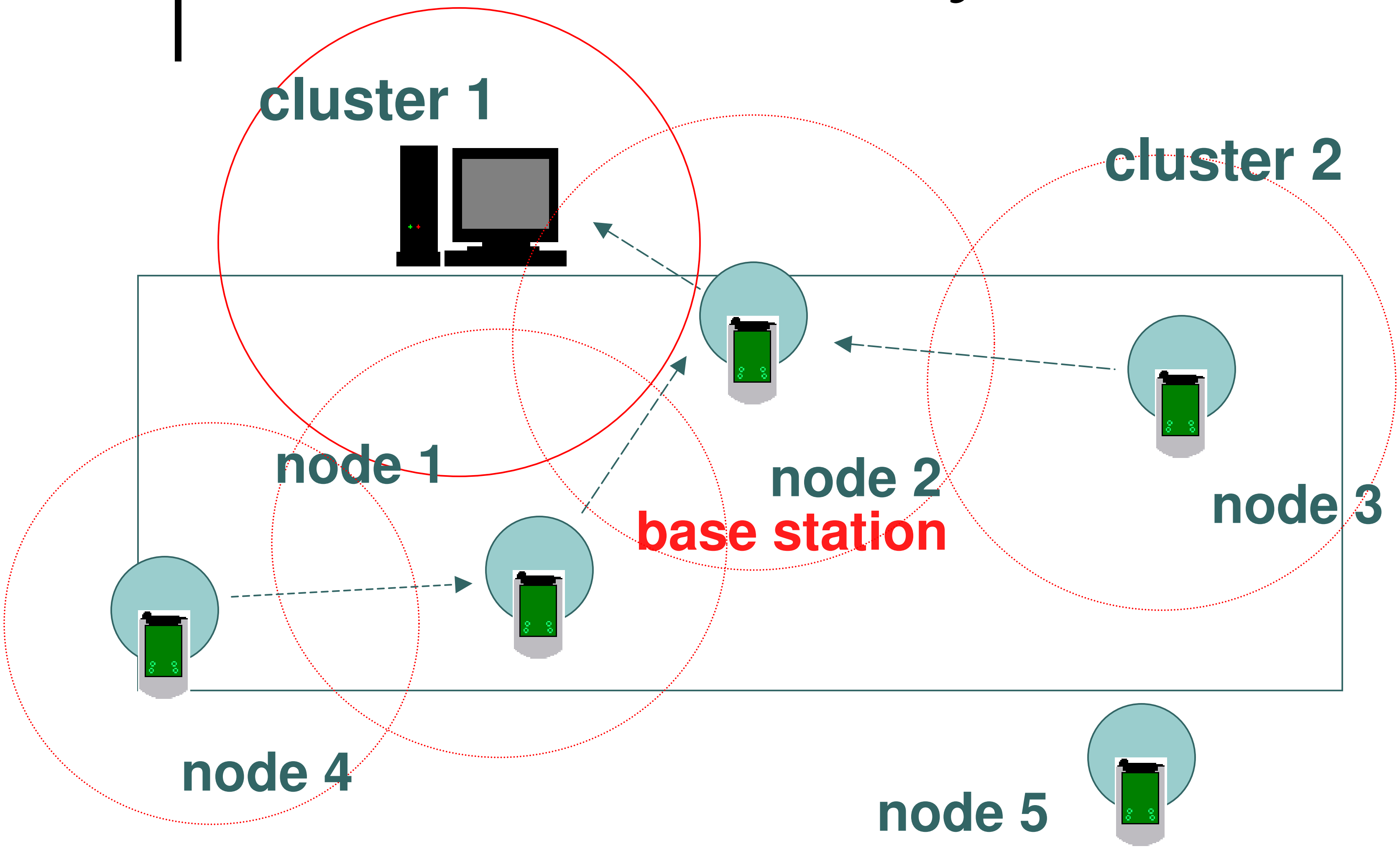
Project Description

- Objective
  - develop a network deployment algorithm for sensor network Humanoid Multi-agent System (HMAS)
  - Mobile ad hoc network (MANET)
  - Sensor network (SN)
- Problem
  - expensive to achieve energy efficiency (NP-complete) [Li 2004]
- Museum problem [LaMarca et al 2002]
  - surveillance SN to cover the entire museum

Contributions

- Proposed a genetic algorithm (GA) for network deployment considering power matrices
  - artificial intelligence mapping
  - power
- Simulated and gathered statistical data of the GA algorithm
- What is GA?
  - a mimic of Darwin's Evolution Theory

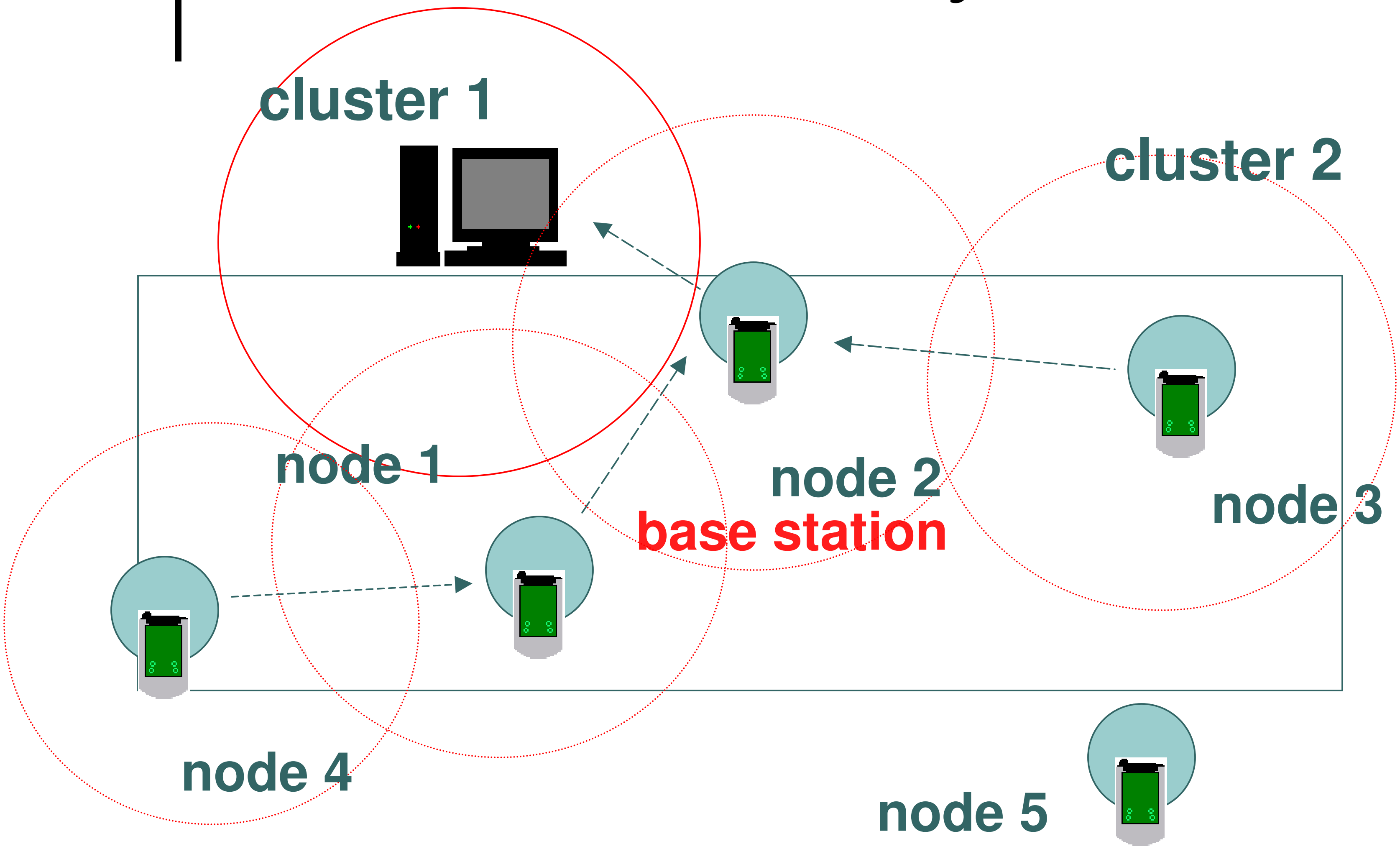
Network Hierarchy



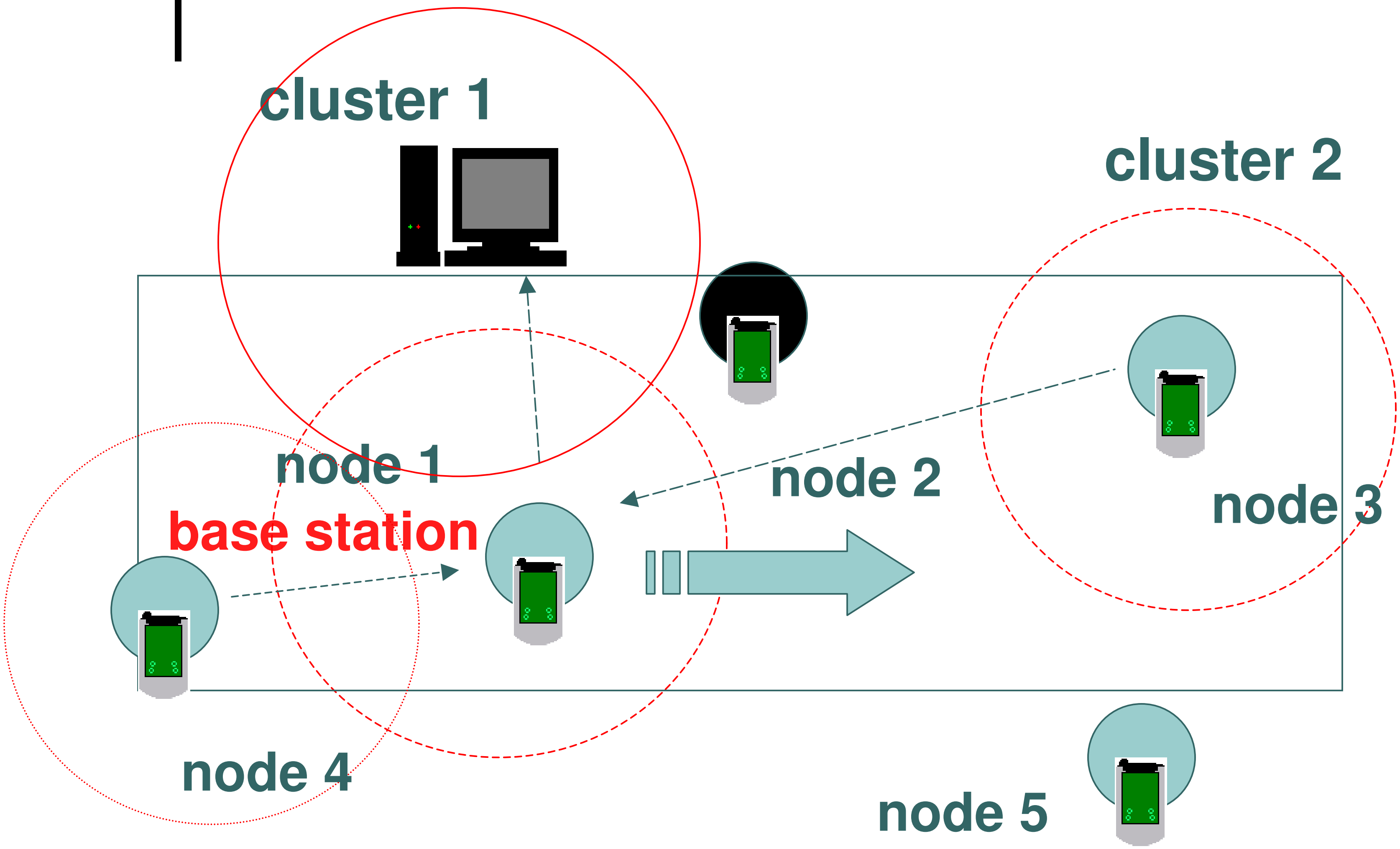
Algorithm

- Randomization
  - direction vectors (1 for each node)
- Collect sensor vector after duration t
  - receiver power matrices (rpm)
  - coverage information (cov)
- Generate a fitness value
  - current rpm
  - previous cov
- Recombine direction vectors
- Mutate the direction vector
- Termination

Network Hierarchy



Network Transform



Modification to the algorithm

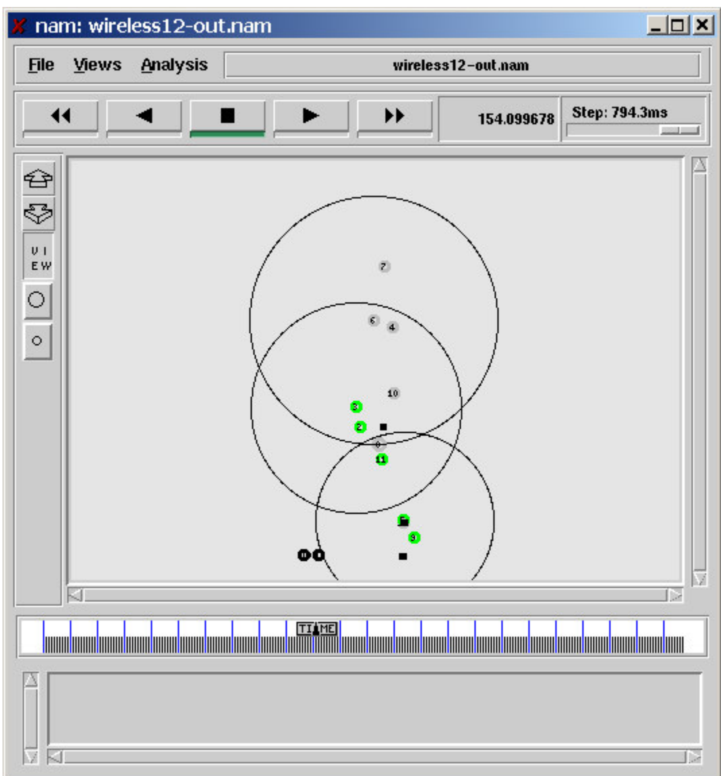
- Global area coverage monitored by the global base station
  - sensor vector of boundary nodes of each cluster

- Local optima is avoided by altering the assignment of the base station in each cluster, and re-clustering the nodes
  - base station set

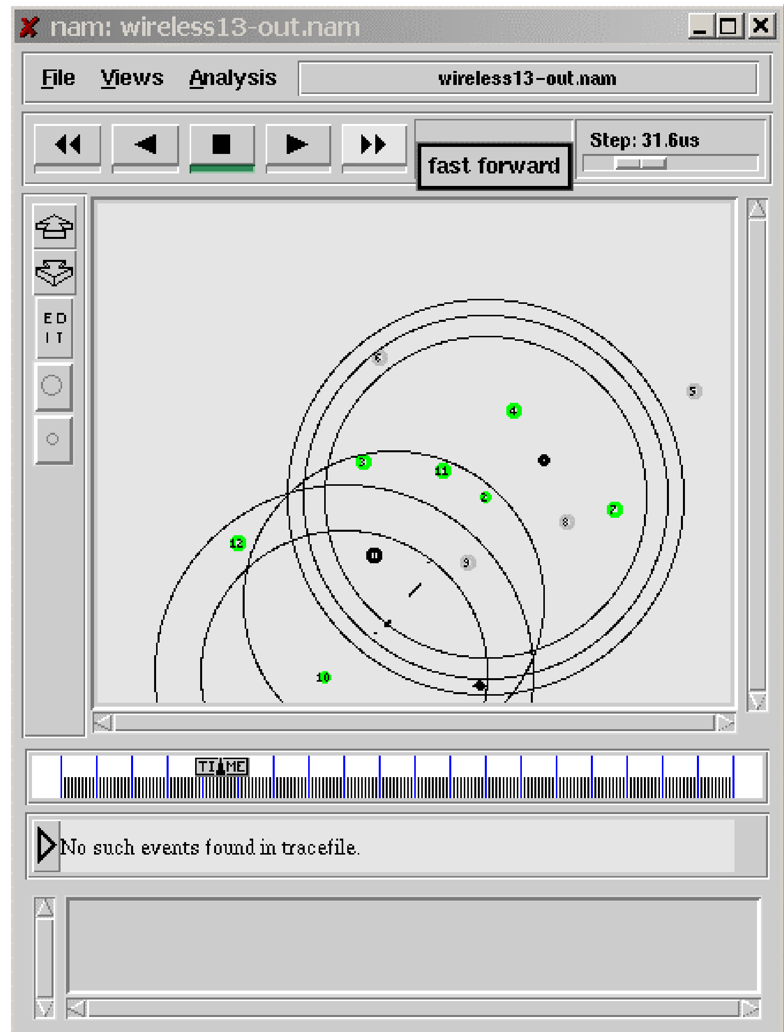
Simulation

Network Simulator Version 2

random movement trace



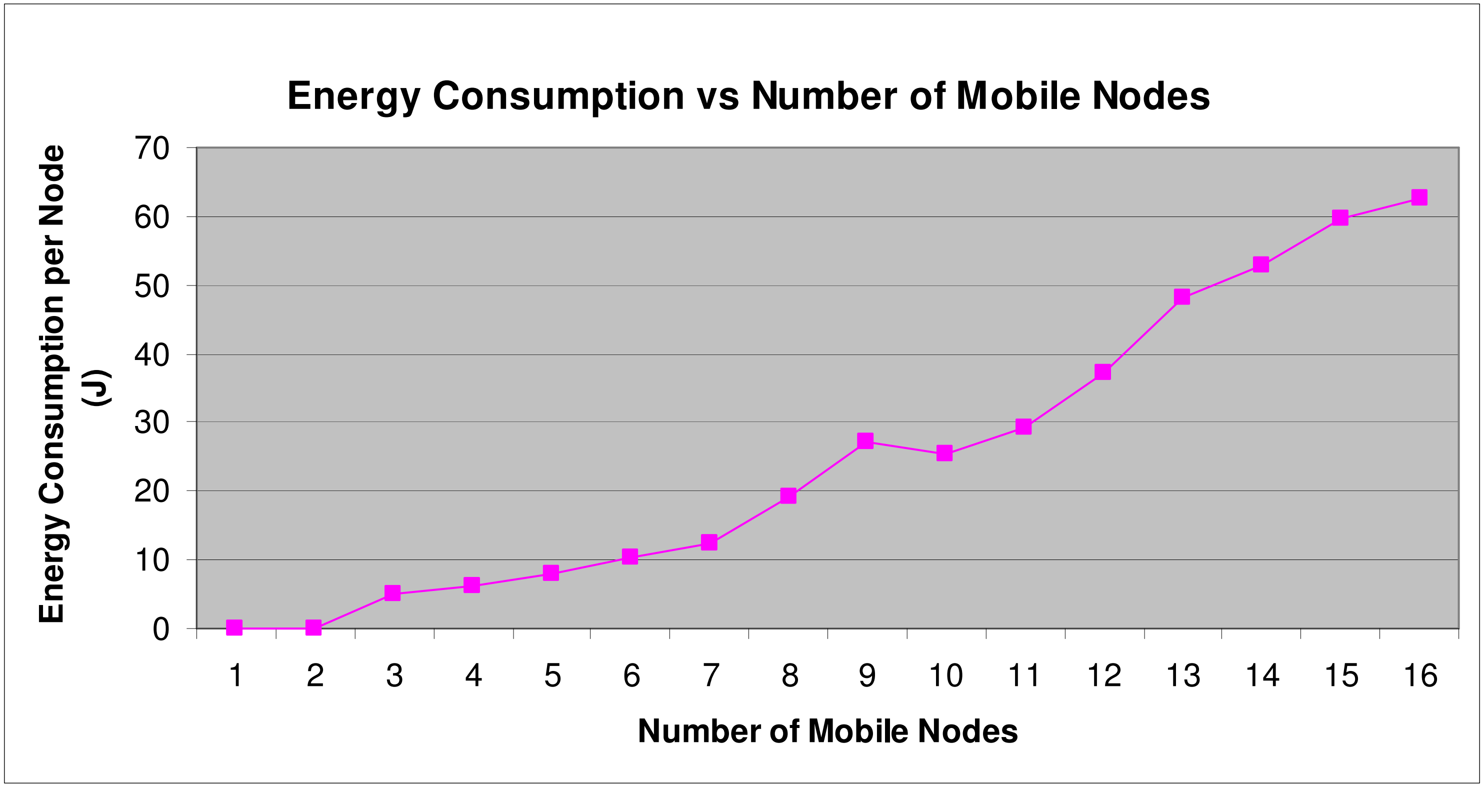
GA movement trace



Simulation Result

- Specification
  - Hierarchy
    - 2 domains, 3 clusters
    - 2 base stations, 11 mobile nodes
    - t_m = 60s
  - Wireless
    - 11Mbps, 20us delay
    - packet size: 512Kb
    - Mac Layer protocol:IEEE 802.11
    - constant bit rate source
- Result
  - Packet Loss
    - 0.05% without GA
    - 0.02% with GA
  - Energy
    - 0.1W model
    - N/A without GA
    - ~37.2 J with GA

Simulation Result



mobility: 0.5J/m
wireless: 0.1W

Conclusion

- GA improved deployment performance in energy and time
- From ultra-wide band to GA network deployment
- Potentials

Algorithm II

Deployment(MANET)

i. random direction generation for the nodes: direction_vector and base_station_set

ii. recombine direction_vector of each node

iii. after t_m each end node sends a sensor vector to its router

sensor_vector = {id, coverage[t], power[t][ ]}

power[ ]: receiver power vector of neighboring nodes

t: current time stamp

iv. the router sorts the sensor_vector by a fitness function

fitness(coverage[t], power[t][ ], coverage[t-t_m], power[t-t_m][ ])

that returns

power[t+t_m][] and coverage[t+t_m]

to decide the next direction of movement, so that:

a. $power_t$ < power[t+t_m][r] < power[t][r] < power[t-t_m][r] where r = id(router)

b. power[t+t_m][i] < power[t][i] < power[t-t_m][i] for all i != r

c. coverage[t+t_m] < coverage[t] < coverage[t-t_m]

$power_t$: lowest receiver power defined by network

power[t+t_m][i] and coverage[t+t_m]: expected next receiver power and next coverage

v. if t_m= 0, return

if (power[t+t_m] == $power_t$ and power[t+t_m][i] ~ 0 for all i)

mutate direction_vector and base_station_set and decrease t_m by t_{delta}

else repeat ii.