Energy-Efficient Node Address Naming for Wireless Sensor Networks

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Outline

- What are sensor networks?
- Applications of sensor networks
- MAC & Network Addresses
- Spatial Re-use of Addresses
  - Issues
  - Solutions
- Simulation Results
- Conclusions & Future Work

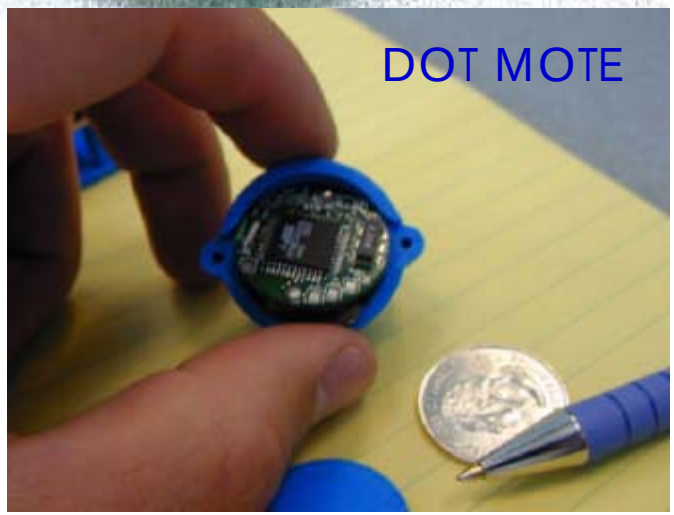
A Sensor Node

Mica MOTE

Berkeley MOTE

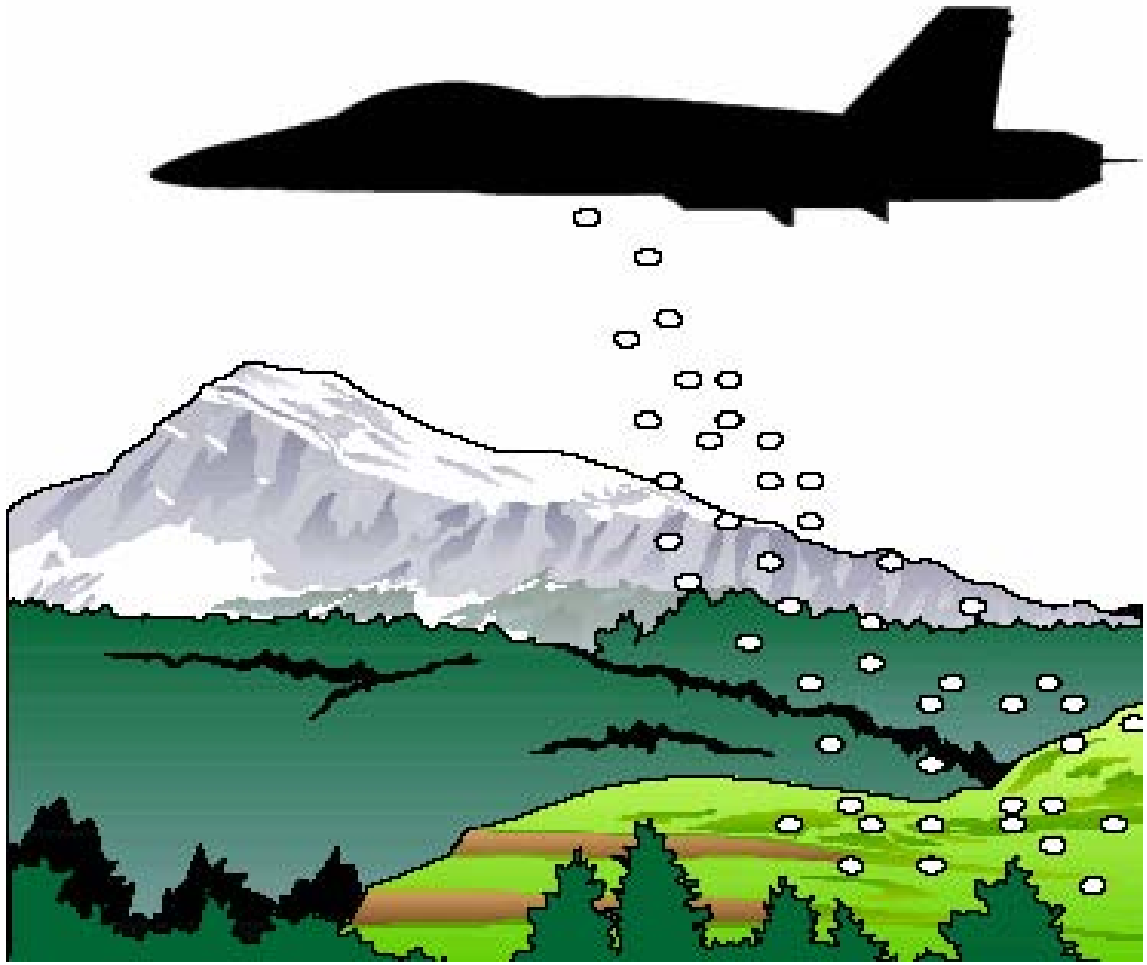
SensUS (LUMS)

DOT MOTE

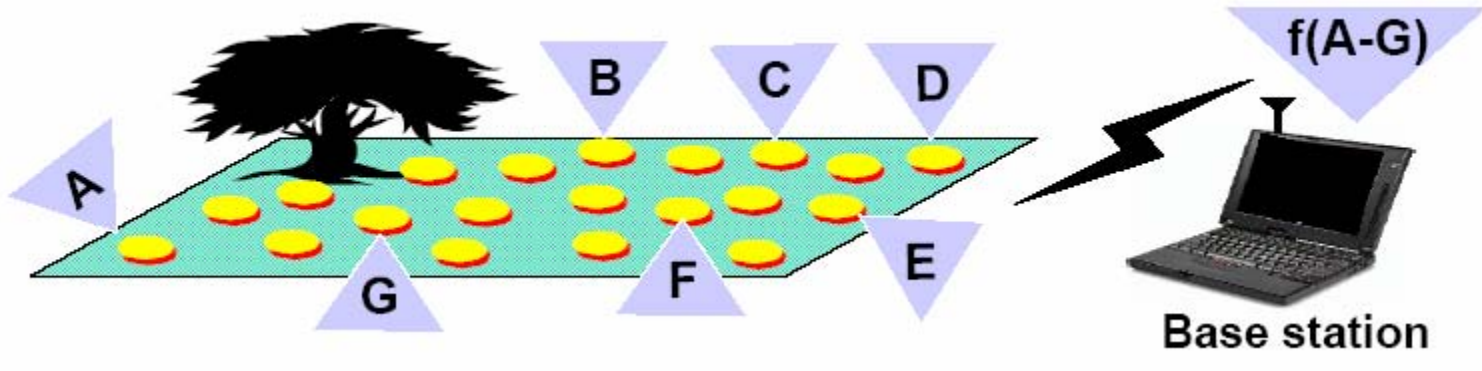


Deployment Example

Micro-sensor nodes could be dropped from planes to enable monitoring of remote or dangerous areas

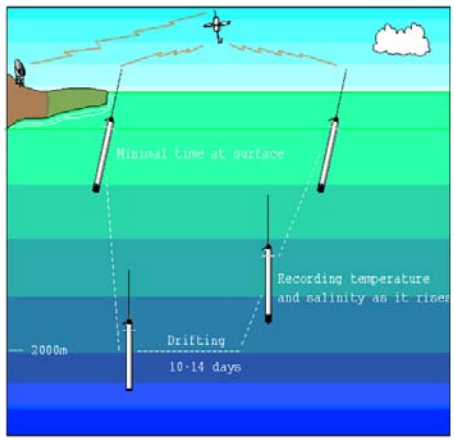


Wireless Sensor Network



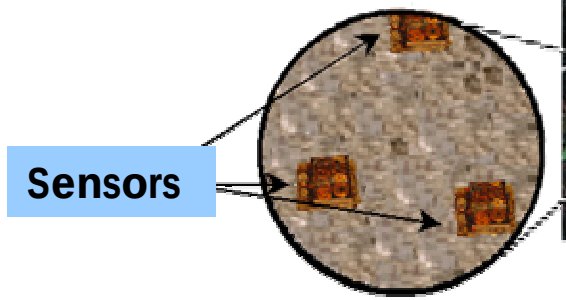
Each node obtains a certain view of the environment. By intelligently combining the view of the nodes, the end-user can remotely monitor events in the environment.

Applications



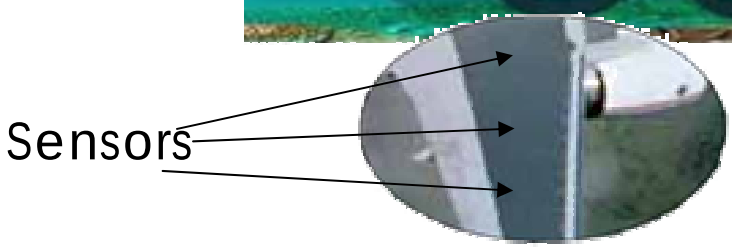
Water Contamination

Habitat Monitoring



Inner wall of storm drain

- Seismic response in buildings
- Aircrafts
- Transportation

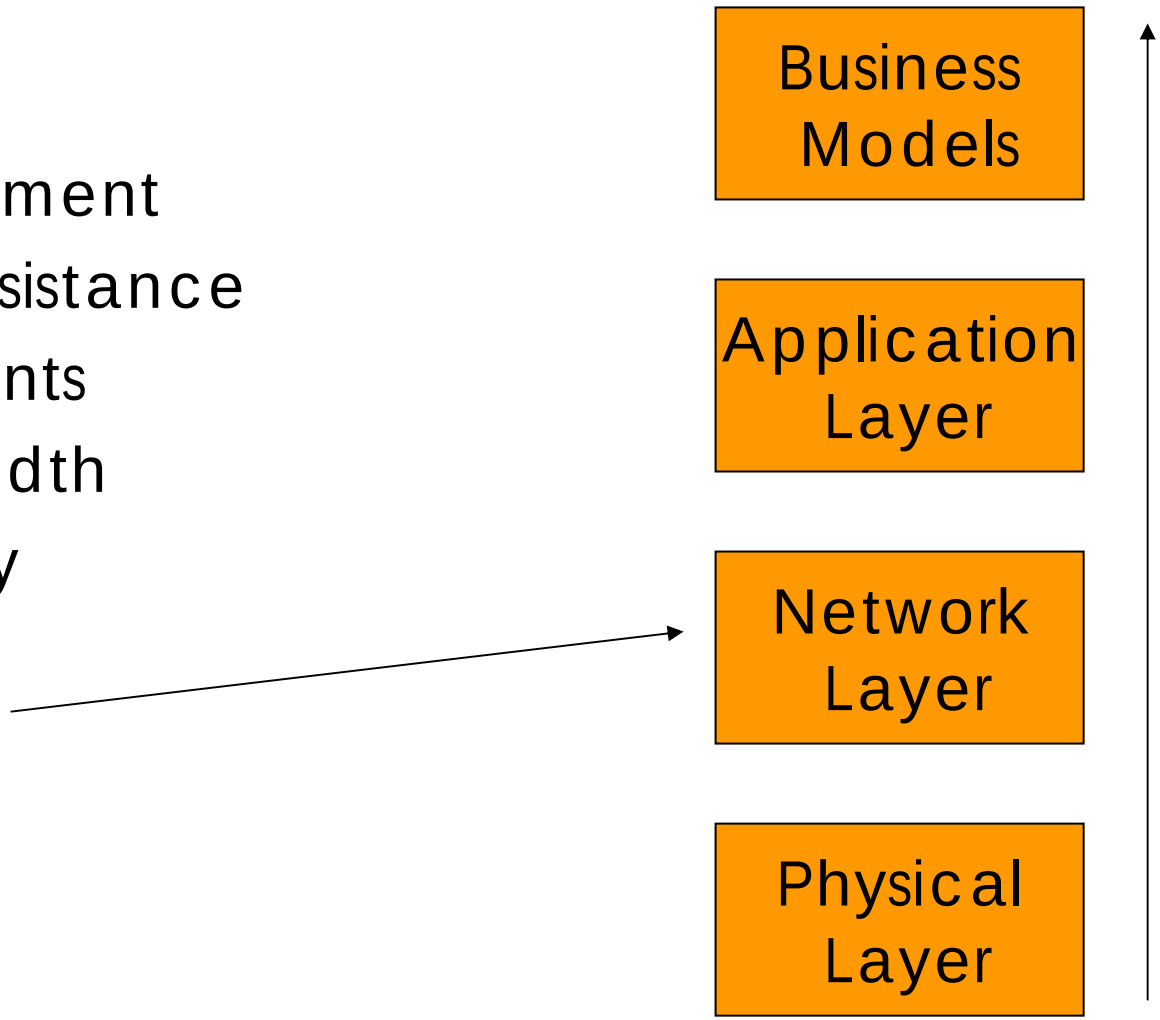


Research Focus

Challenges

- Ad-hoc deployment
- Little remote assistance
- Energy constraints
- Limited bandwidth
- Failure recovery

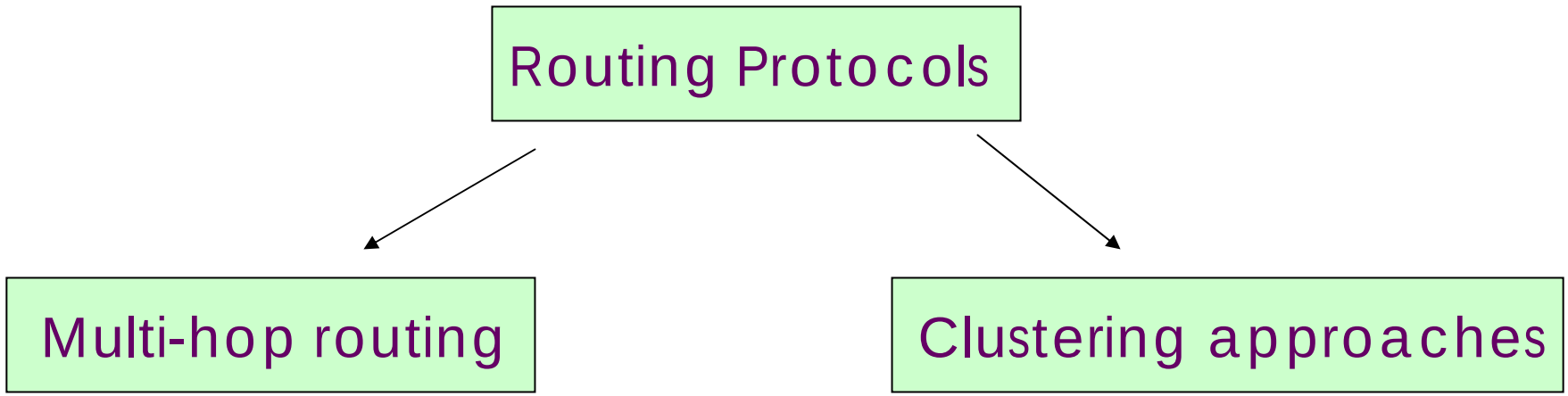
We focus on



Research Problem

- Low data rate (typically 16 bytes per packet)
- Extreme energy constraints
- Globally unique network and MAC address (Internet) add too much header overhead
- We propose spatial reuse of addresses to reduce the no. of bits required by MAC and Network addresses
- Why do we need separate MAC & Network Addresses in sensor networks?

Related Work



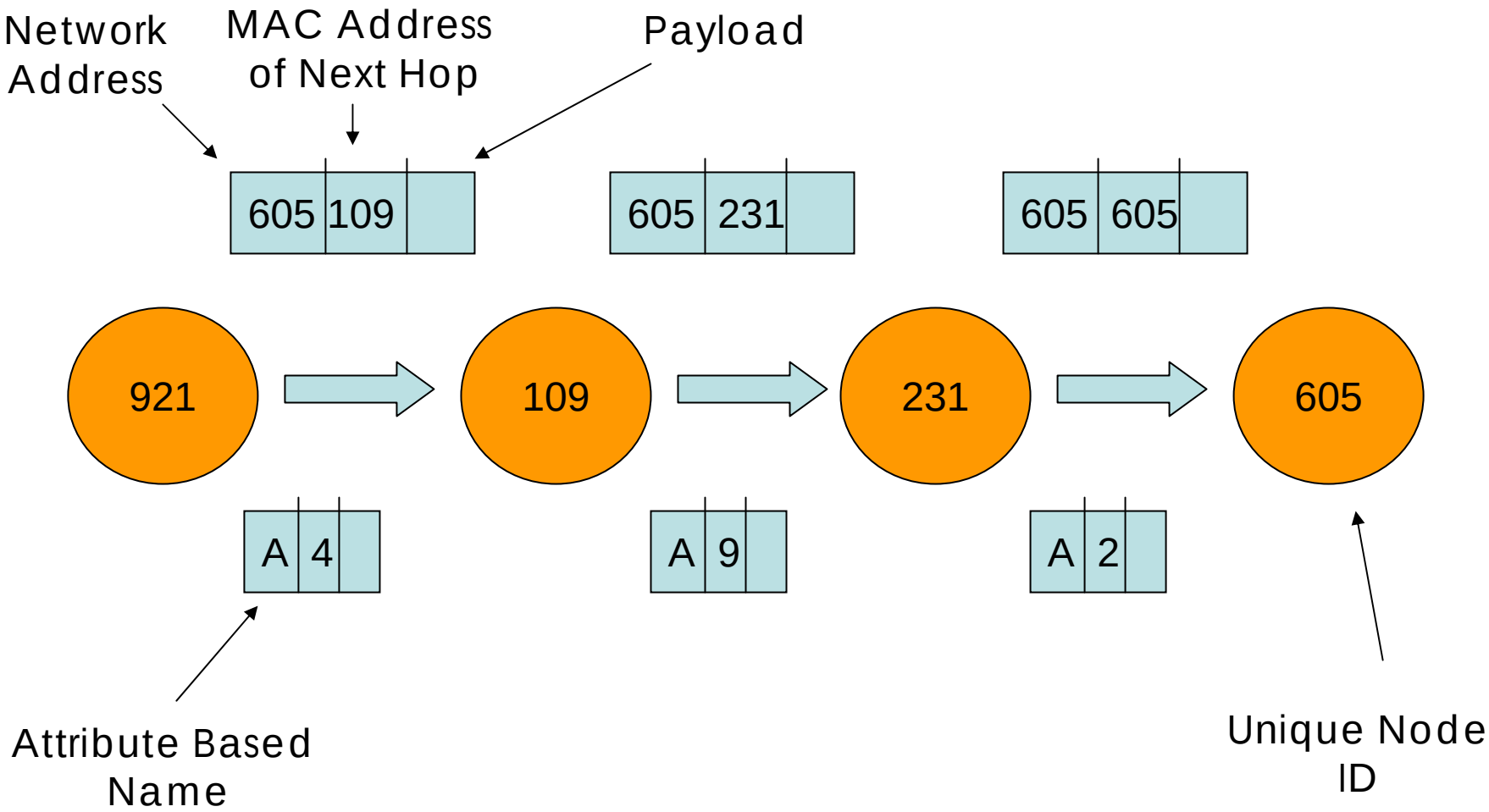
For example

- ASCENT
- Directed Diffusion
- SPIN

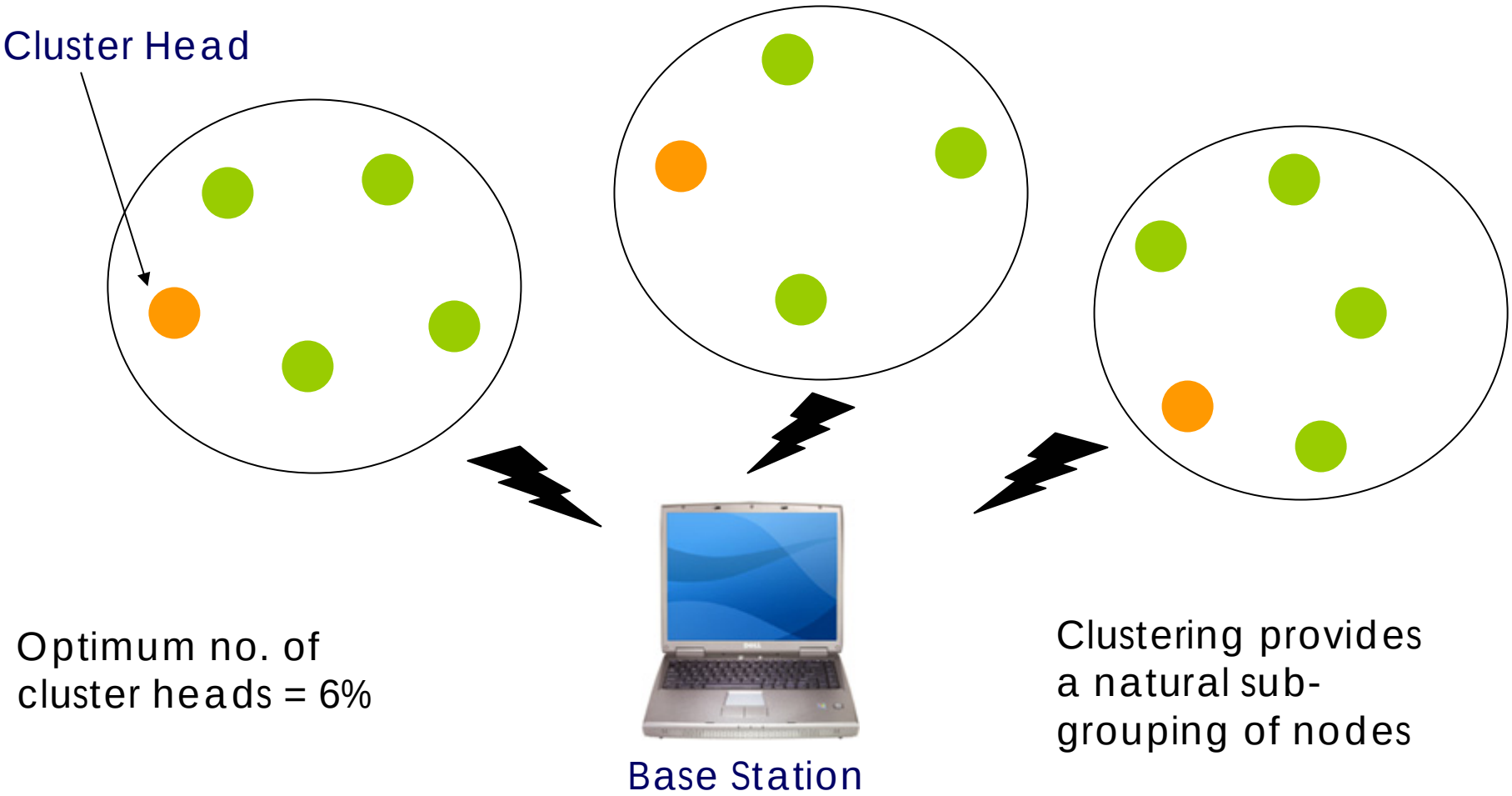
For example

- LEACH
- PEGASUS
- CSN

Address Usage



Clustering



Optimum no. of cluster heads = 6%

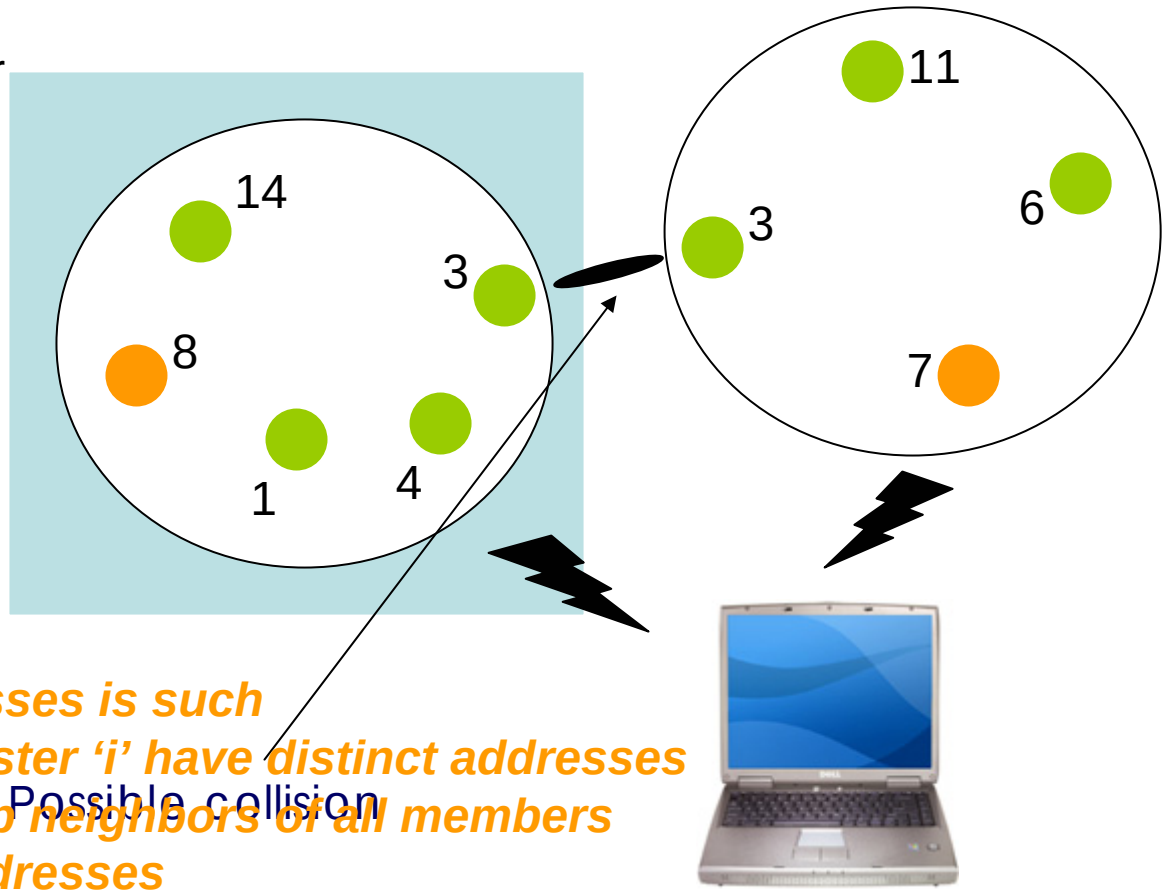
Clustering provides a natural sub-grouping of nodes

Addressing

Maximum no. of member nodes per cluster = 16

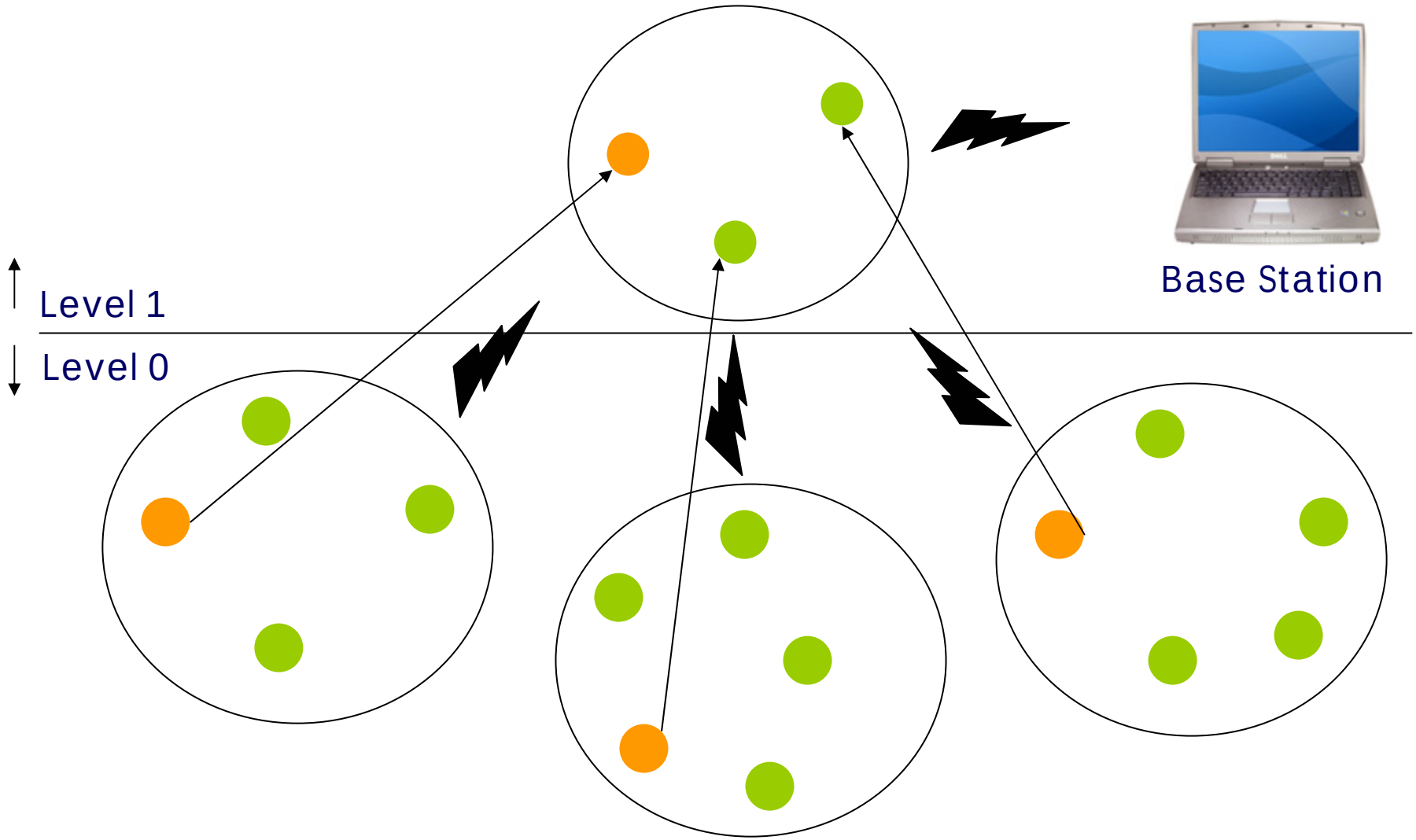
Address space for each cluster = 4-bit

Same address reused over different clusters

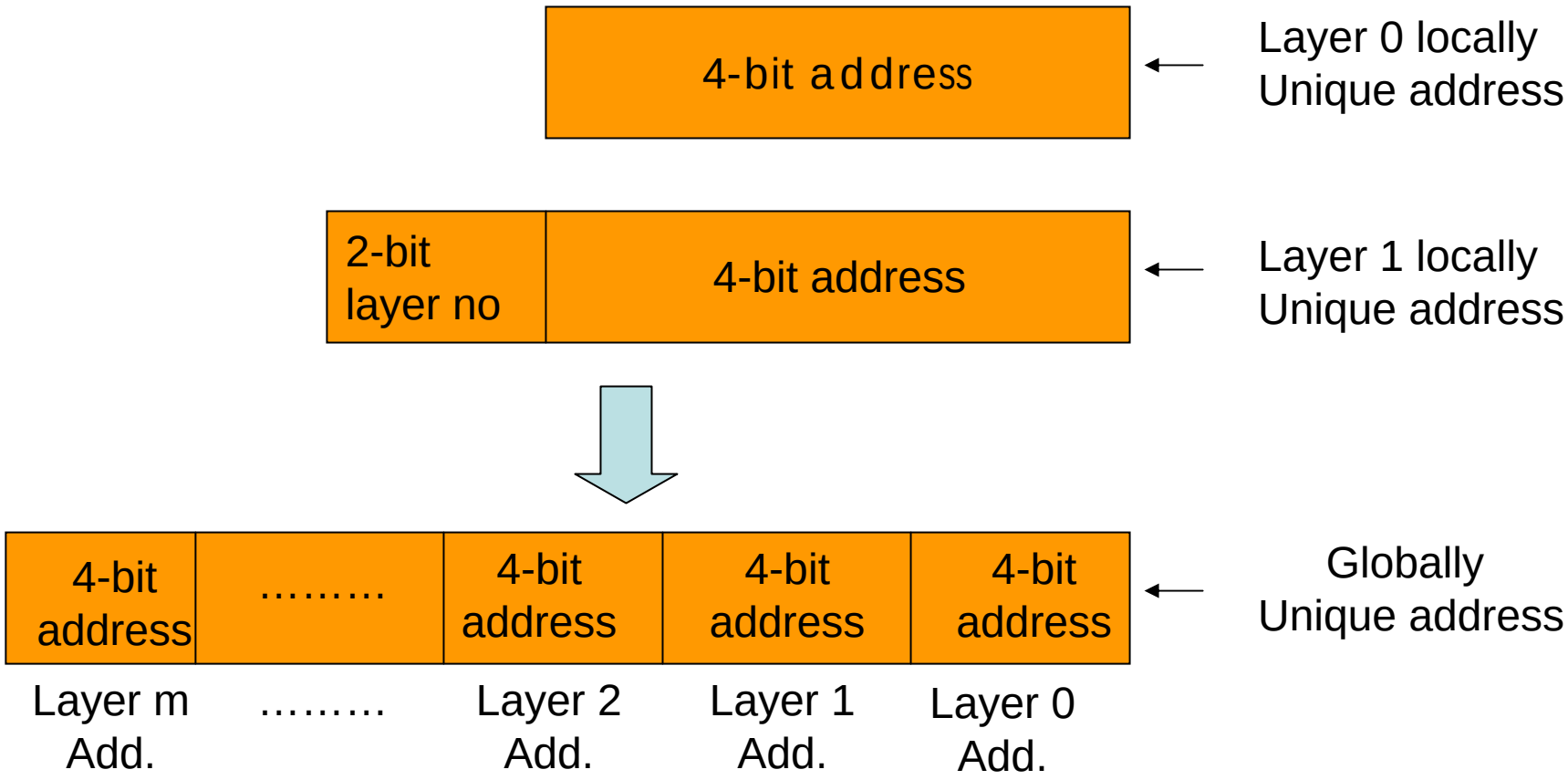


A valid assignment of addresses is such that all member nodes of cluster 'i' have distinct addresses and the non-member one-hop neighbors of all members of cluster 'i' have distinct addresses

Hierarchical Clustering

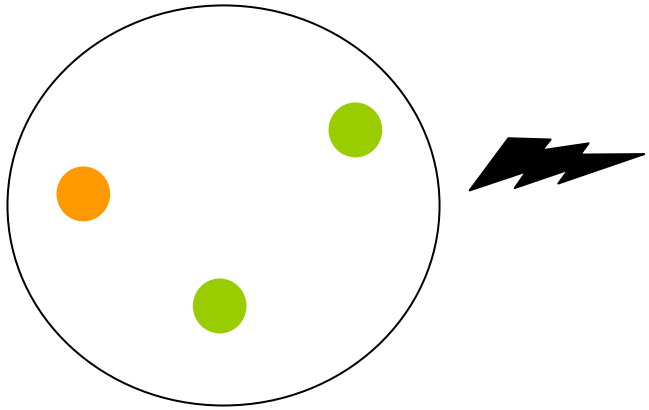


Dynamic Addressing



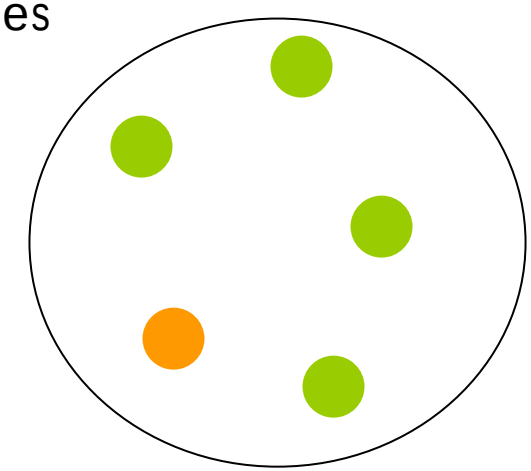
Dynamic Addressing

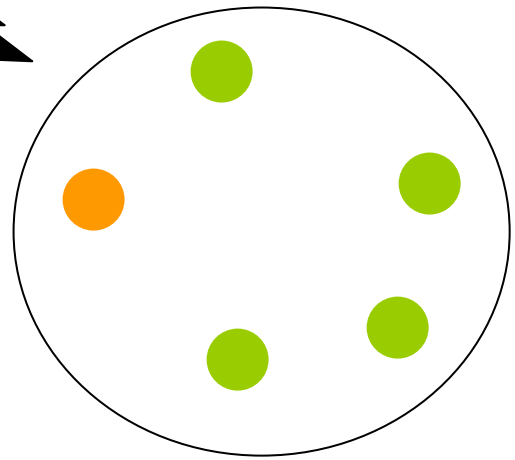
Inter-cluster communication at all higher virtual layers use the 6-bit address



Base Station

All intra-cluster communication, route through the head nodes





For inter-cluster operations e.g. data aggregation, locally unique 4-bit addresses are used

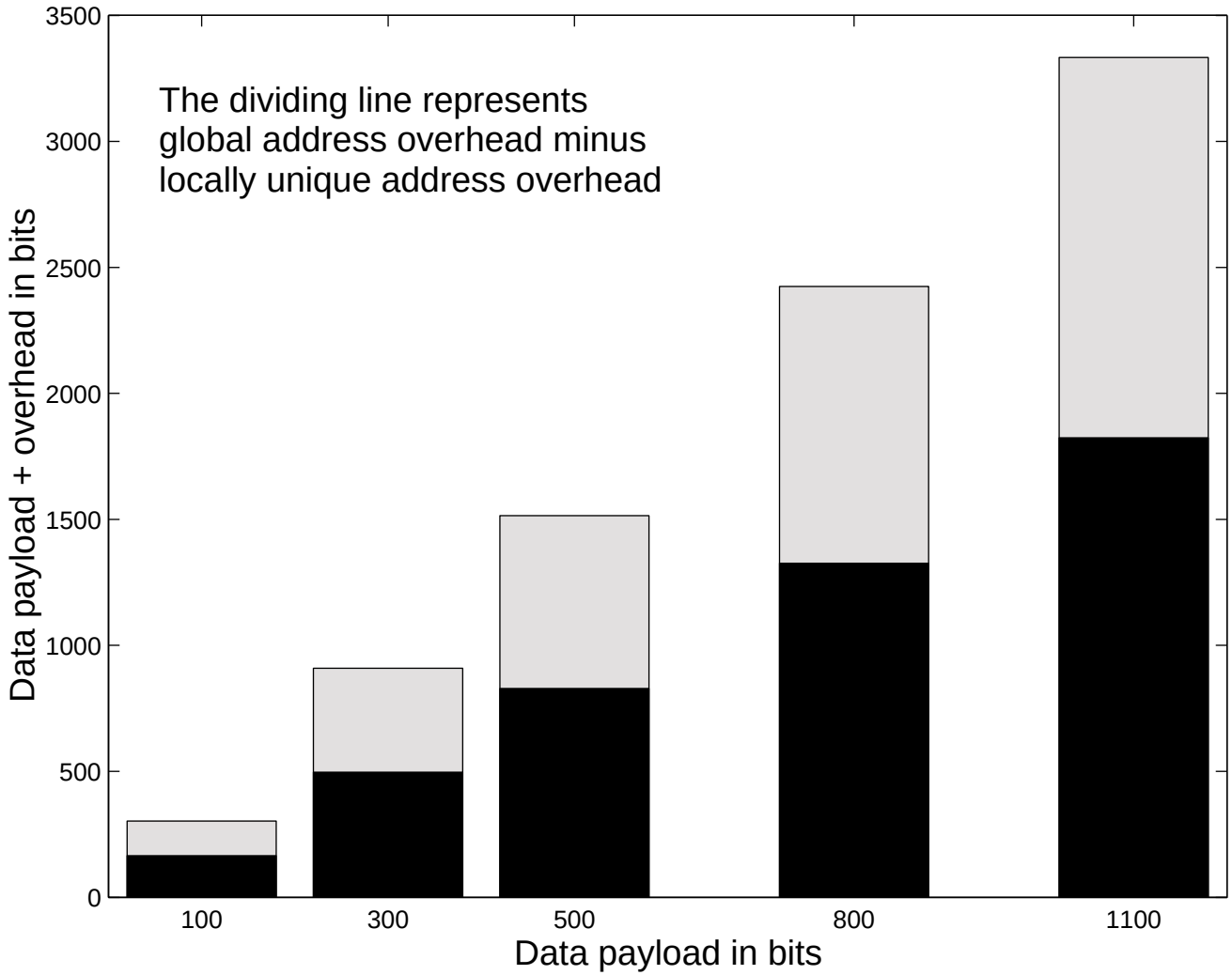
Simulation Results

- Test bed for sensor networks developed in C/C++
- Simulator uses First Order Radio Model:

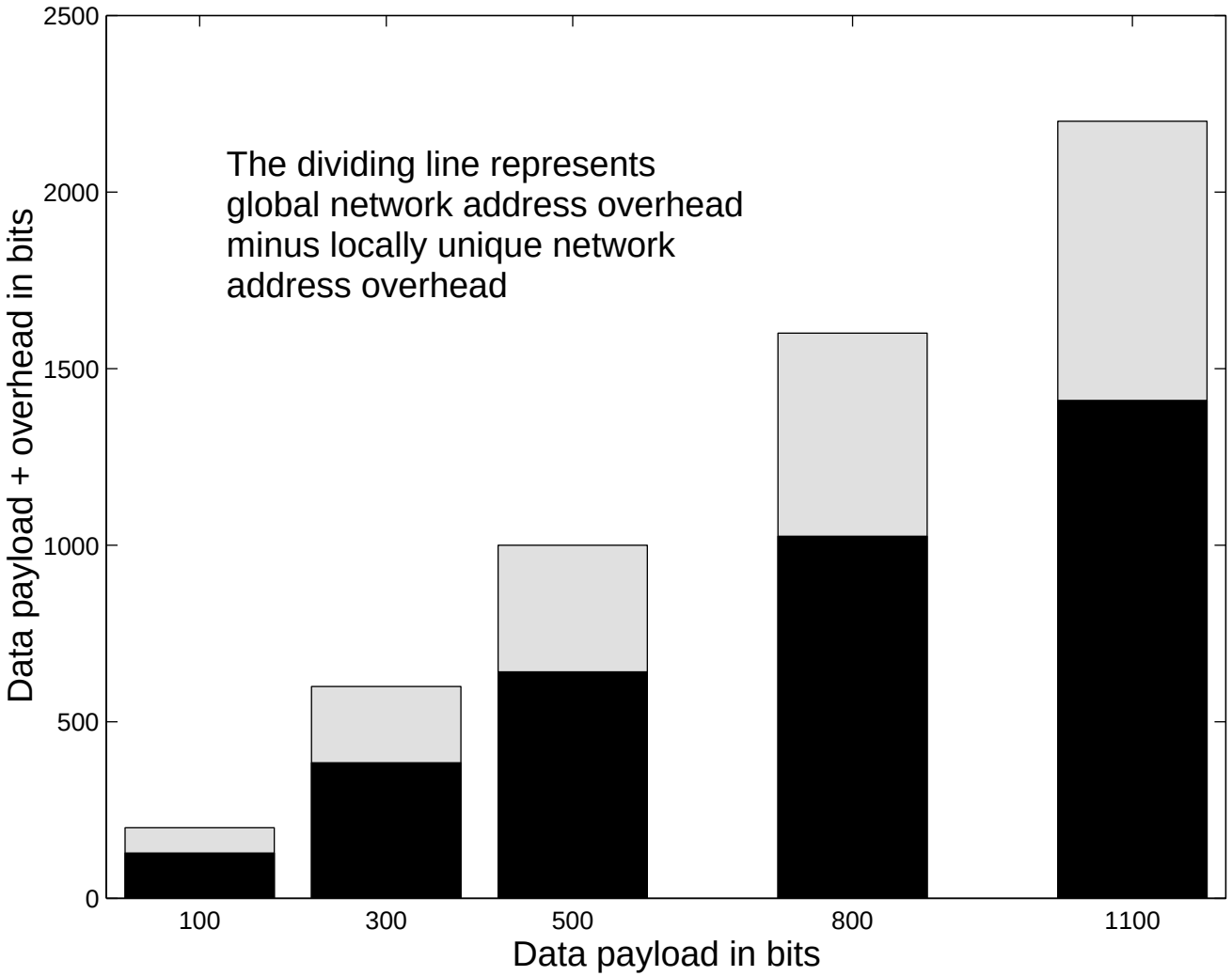
$$E_{transmit}(k,d) = E_{electric} * k + E_{amplifier} * k * d2$$
$$E_{receive}(k) = E_{electric} * k$$

k = k-bits per packet
d = distance

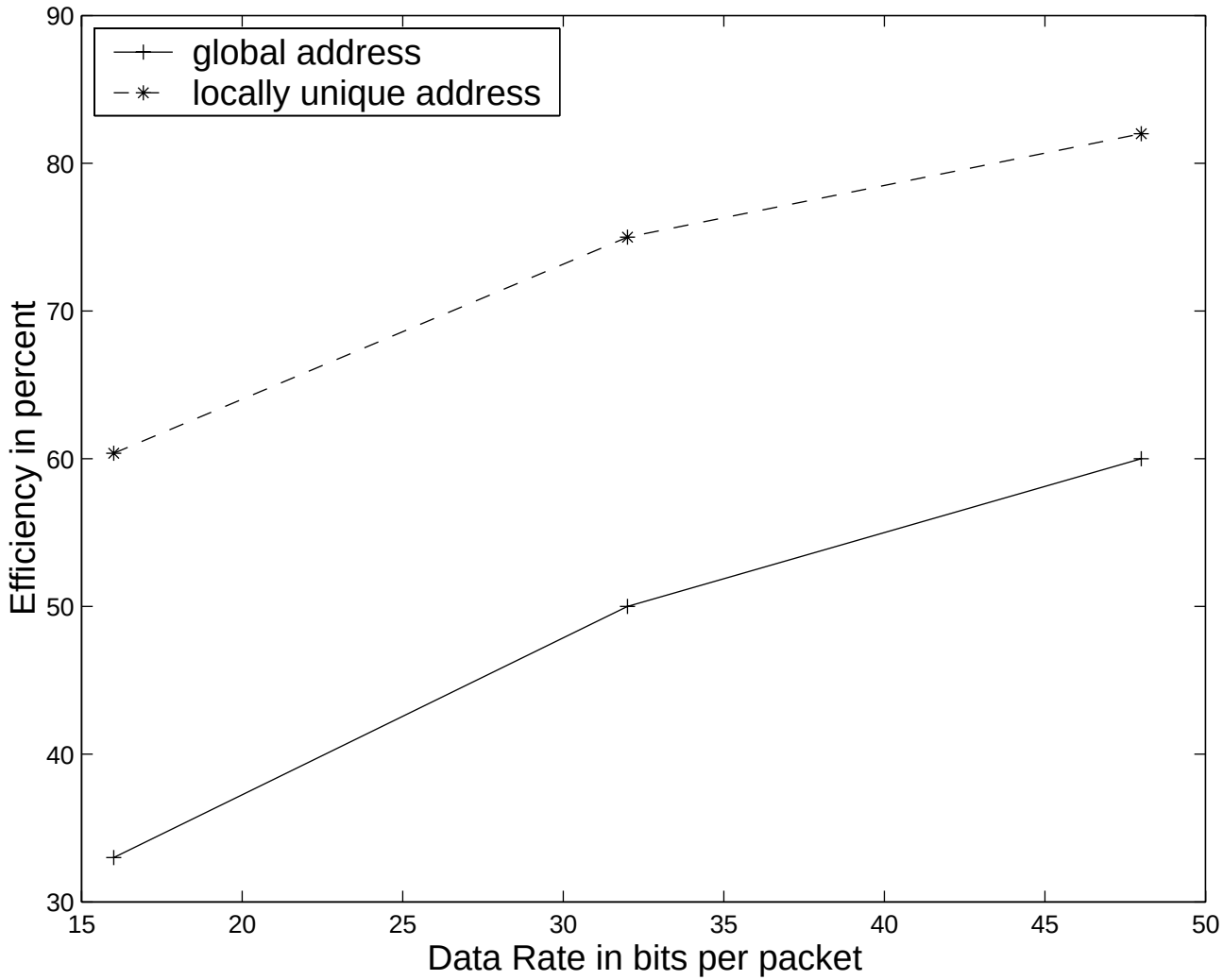
Overhead (MAC & Network Address)



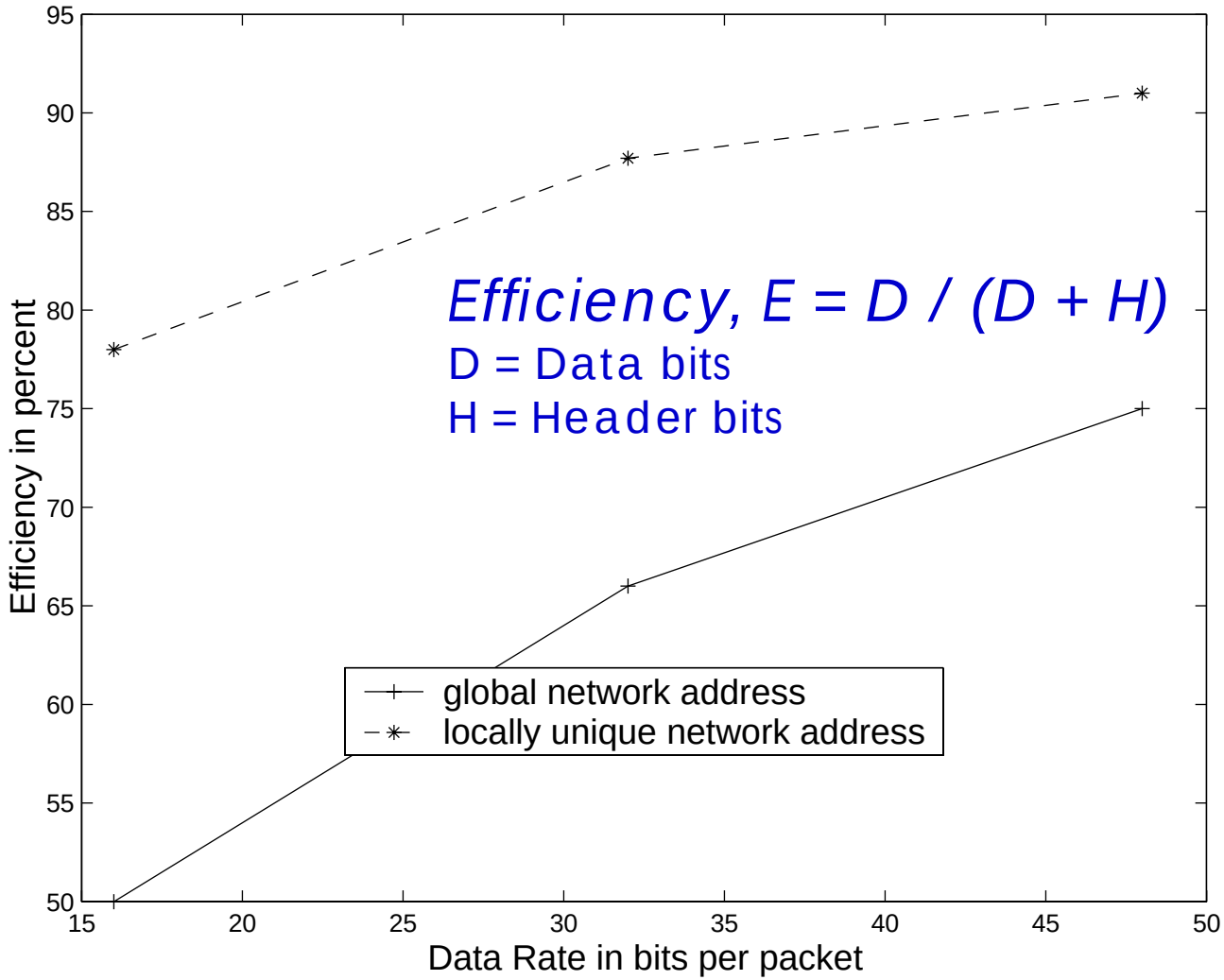
Overhead (Network Address)



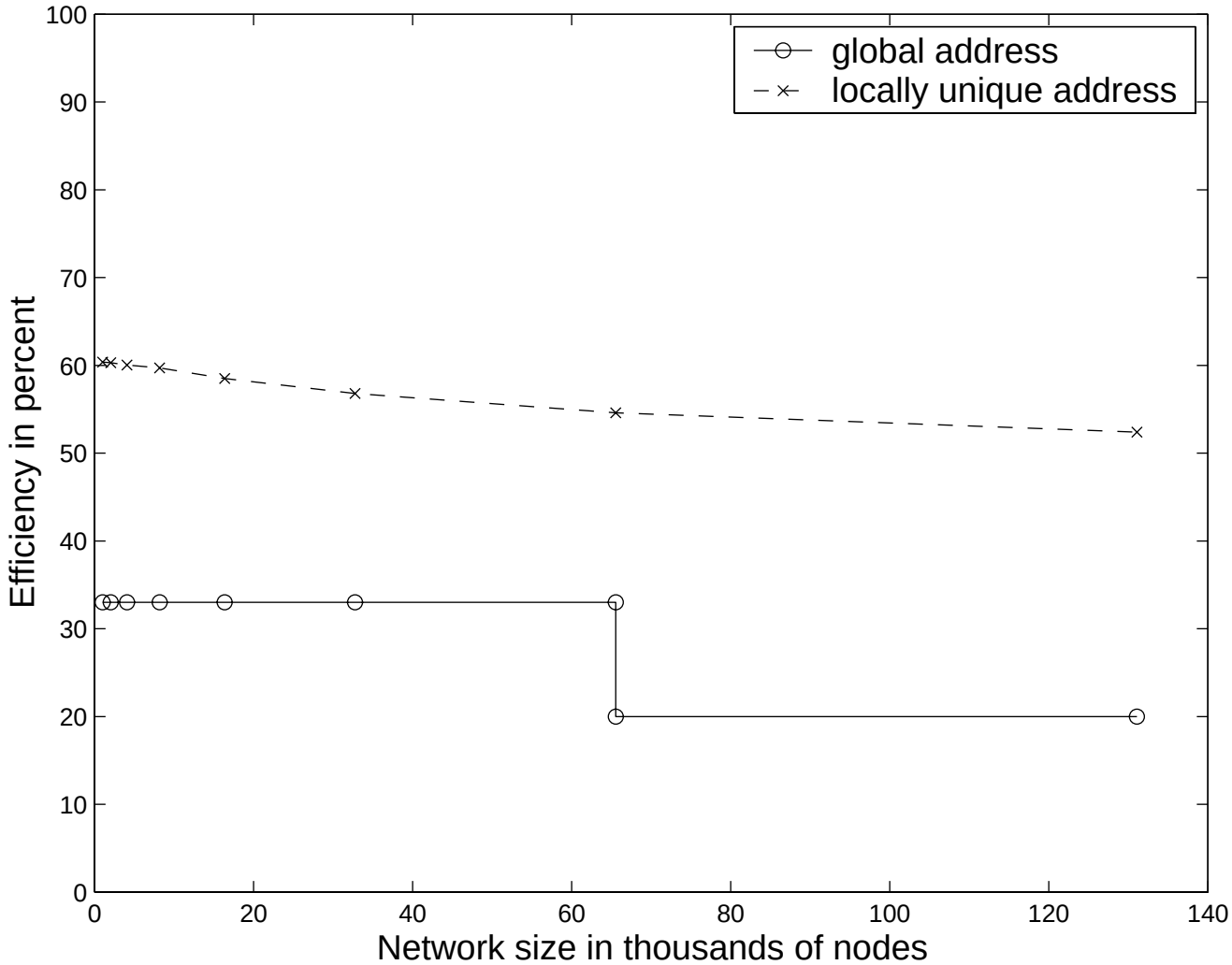
Efficiency (MAC & Network Address)



Efficiency (Network Address)



Scalability



Conclusion & Future Work

Presented a locally unique spatially reusable addressing scheme for cluster-based sensor networks

Results in greater payload efficiency 60.37% compared to globally unique addresses (33.5%)

Need to carry out experimentations on *real* test beds (using Berkeley MOTES)

Further Information

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Thank You !