

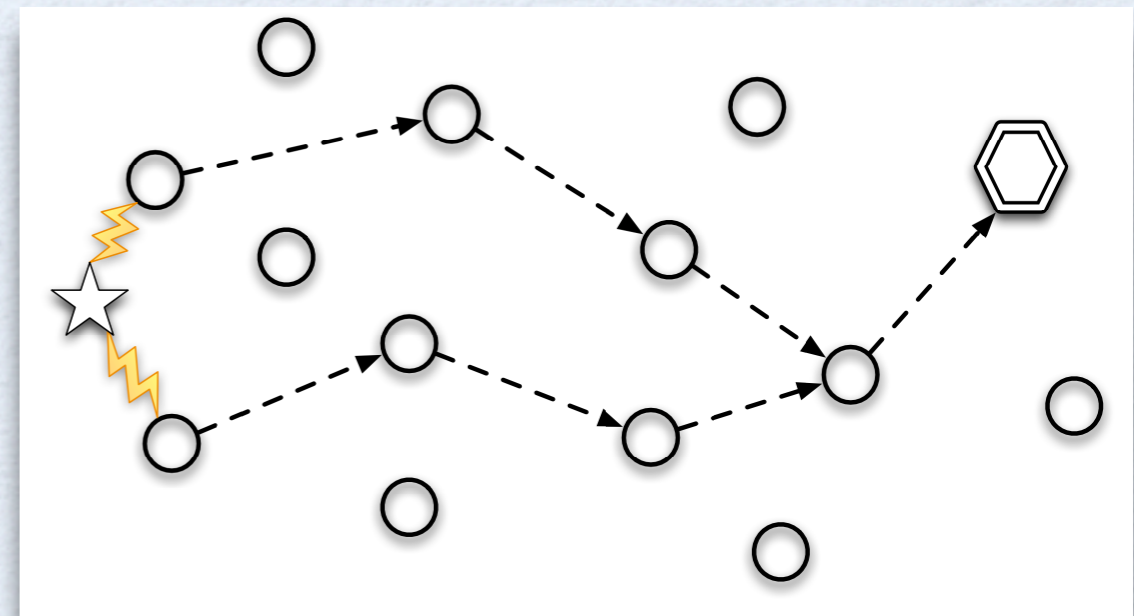
Multiple Coverage with Controlled Connectivity in Wireless Sensor Networks

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Tahiry Razafindralambo
INRIA Lille - Nord Europe

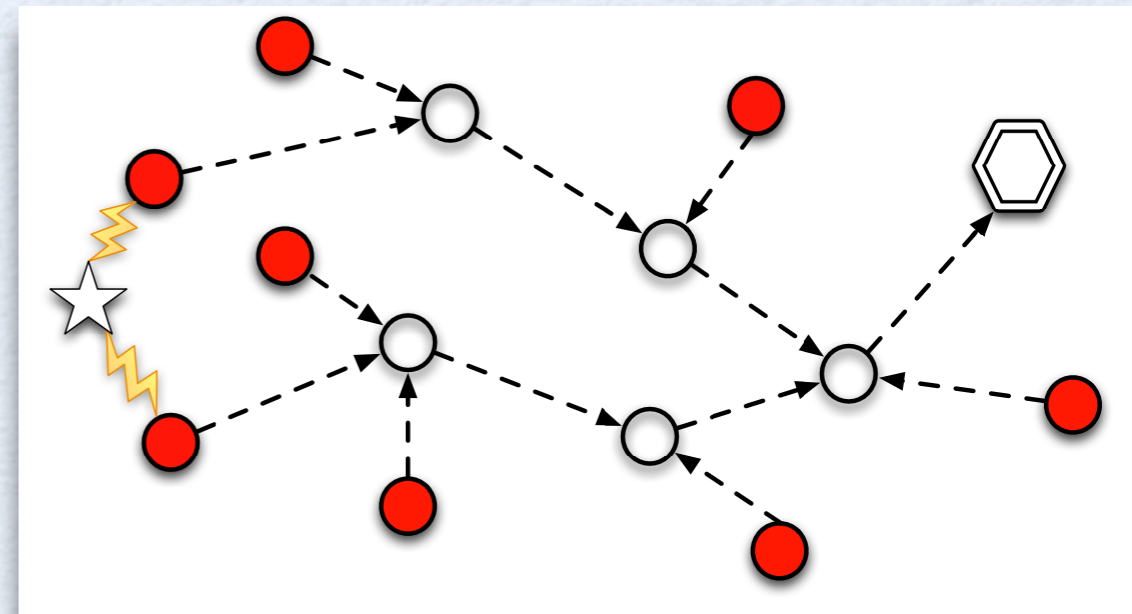
Introduction

- Wireless sensor network
 - autonomous entities
 - strong energy constraints
- Reduce energy consumption
 - put a subset of nodes in sleeping mode
 - limit radio usage (most energy-intensive component)



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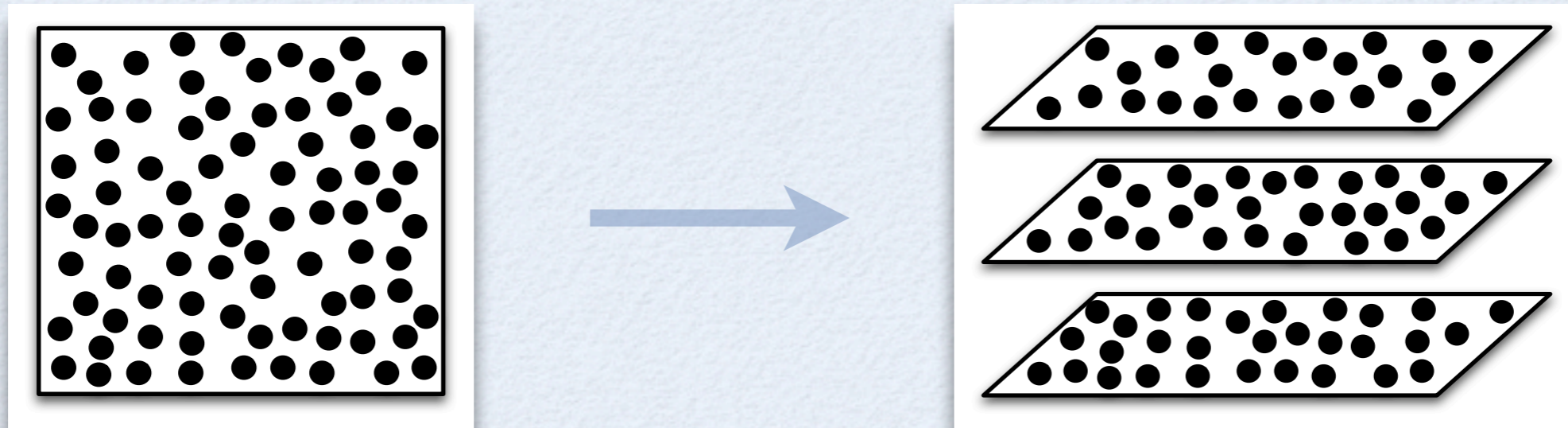


Constraints

- Preserve multiple coverage of the area of interest
- Maintain full connectivity of the network
- Limit communication overhead
- Dynamic topologies
 - Radio environnement
 - Mobility
 - Node failure
- Keep solely localized or distributed solutions

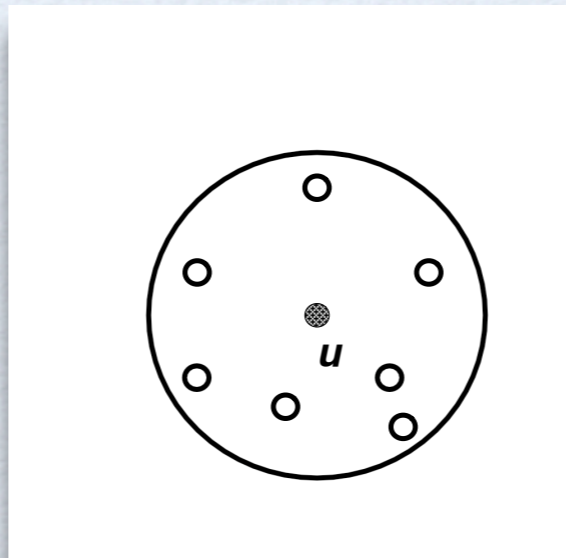
Multiple area coverage

- Two multiple area-coverage schemes
 - Positive-Only
 - Positive-Retreat
- Simple, localized and with low overhead
- Layered approach



Multiple area coverage

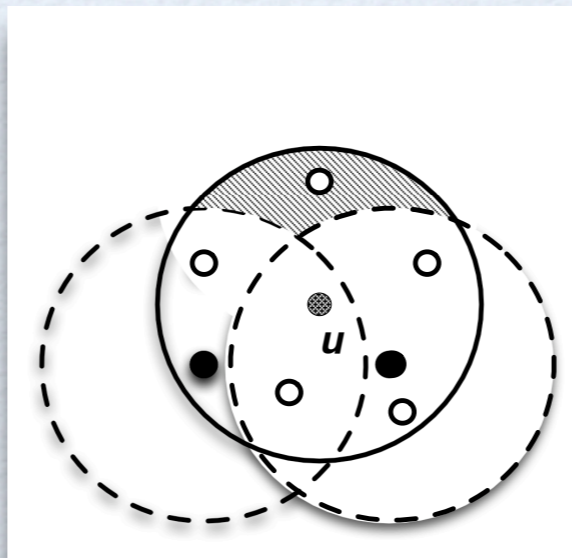
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Node u has no active neighbors. He is not covered and must remain active in this layer

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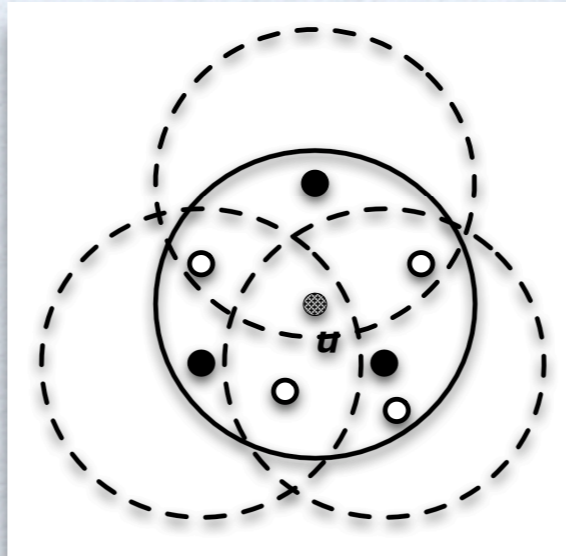
Black nodes, with shortest timeout, do not cover node u , which remain active in this layer

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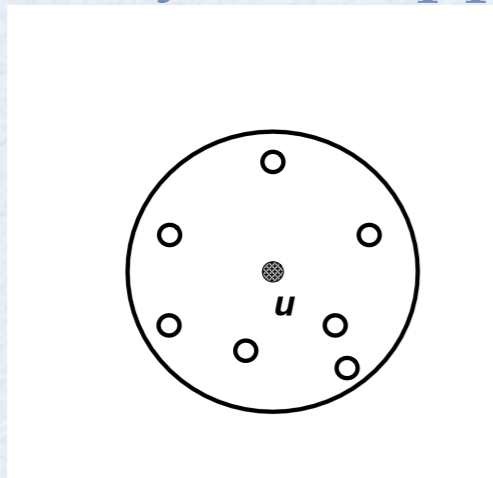
Black nodes fully cover node u , which must evaluate coverage for the next layer or enter passive mode if no more layer

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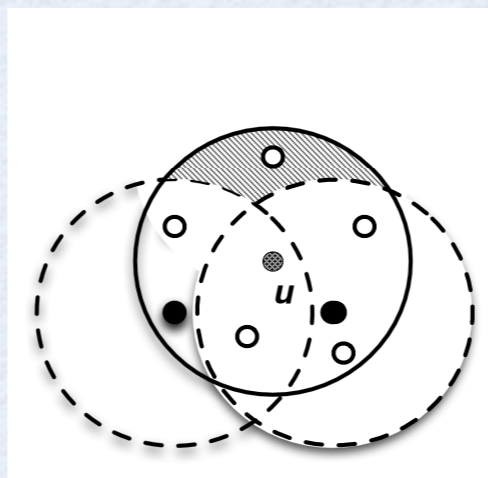
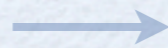
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Multiple area coverage

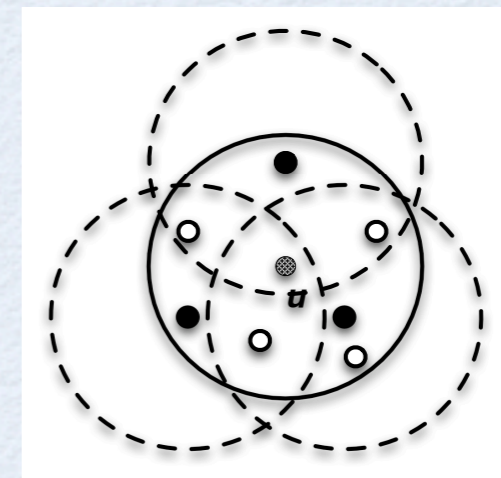
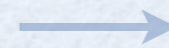
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A sole local connectivity test at a the first layer is sufficient to
guarantee full connectivity of the network

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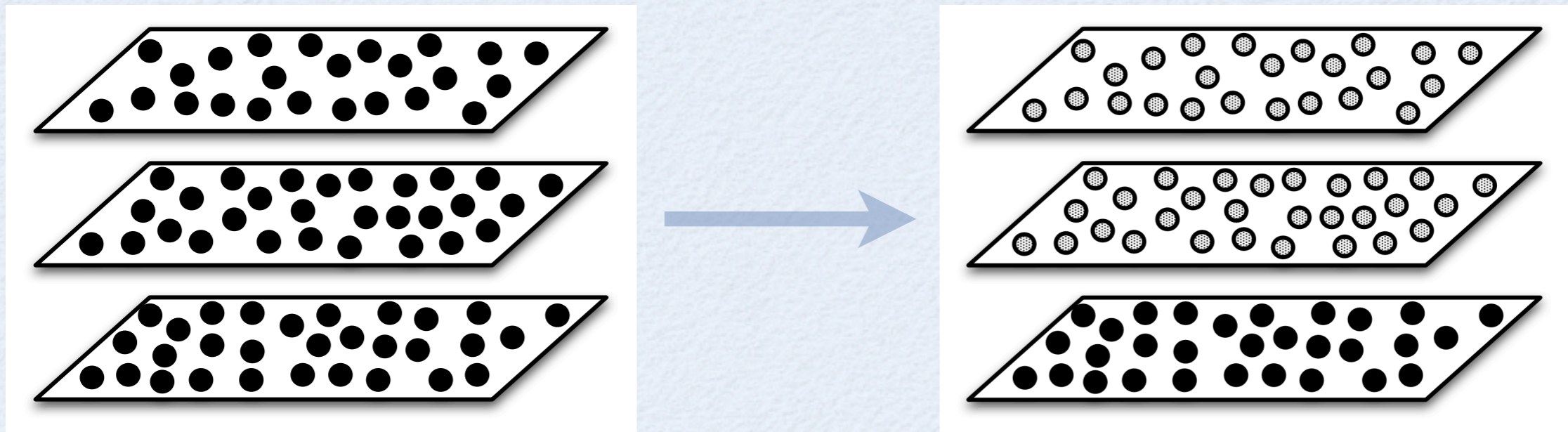
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Sensing-Only state

- A subset of node may not be essential to maintain full connectivity of the network
- These nodes can enter a low-power mode by cutting their radio off in reception (Sensing-Only)
- Sensing-Only nodes do not participate in the routing process (i.e. do not relay information), but still relay their information up to the sink
- Radio being the most energy-intensive component, Sensing-Only state induce large energy savings

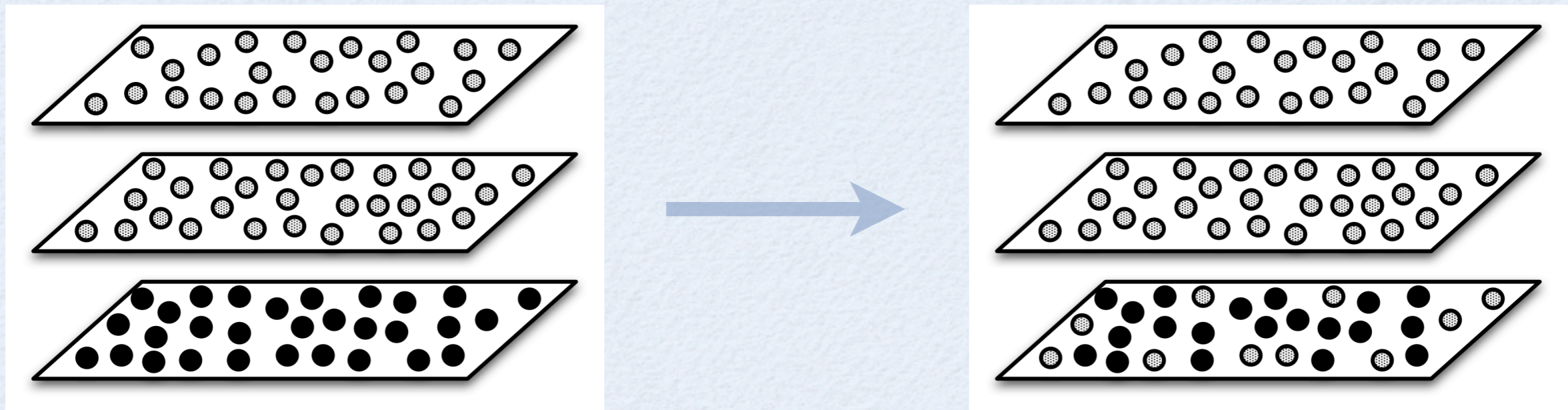
Characterization of Sensing-Only subset

- Nodes at upper layers can enter Sensing-Only state without endangering connectivity



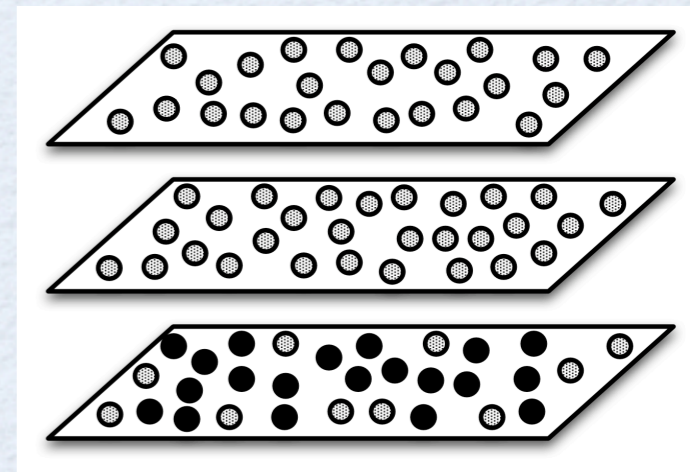
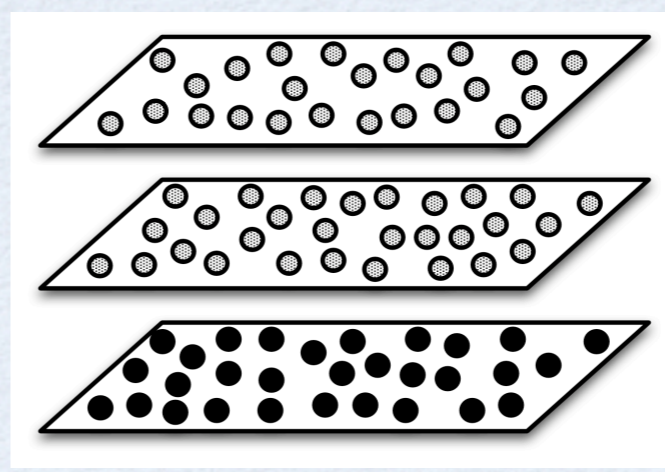
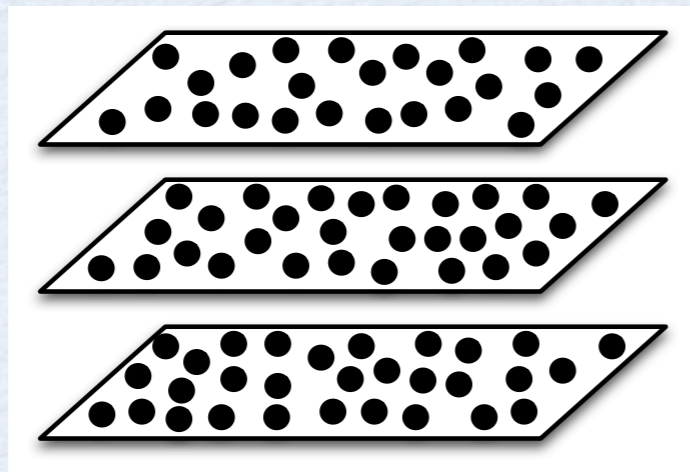
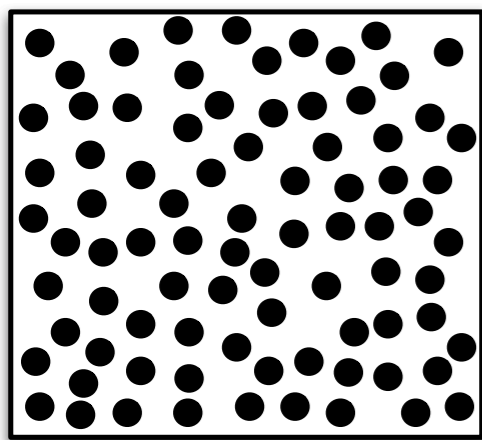
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 - gradient construction
 - each node at a locally maximal layer is considered as Sensing-Only



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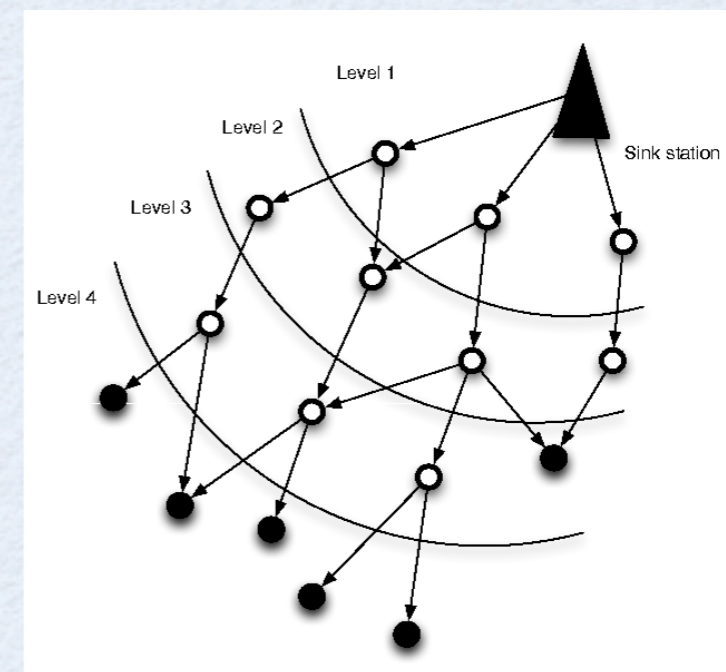
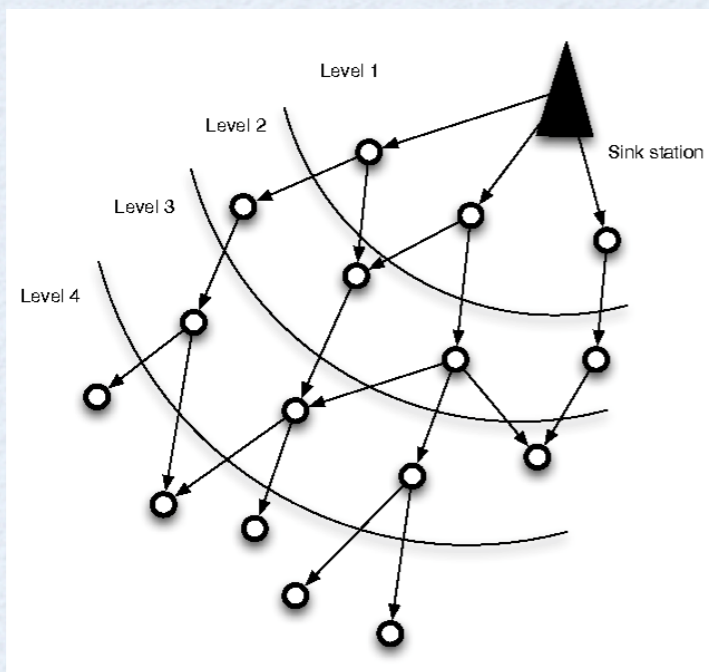


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Simulation description

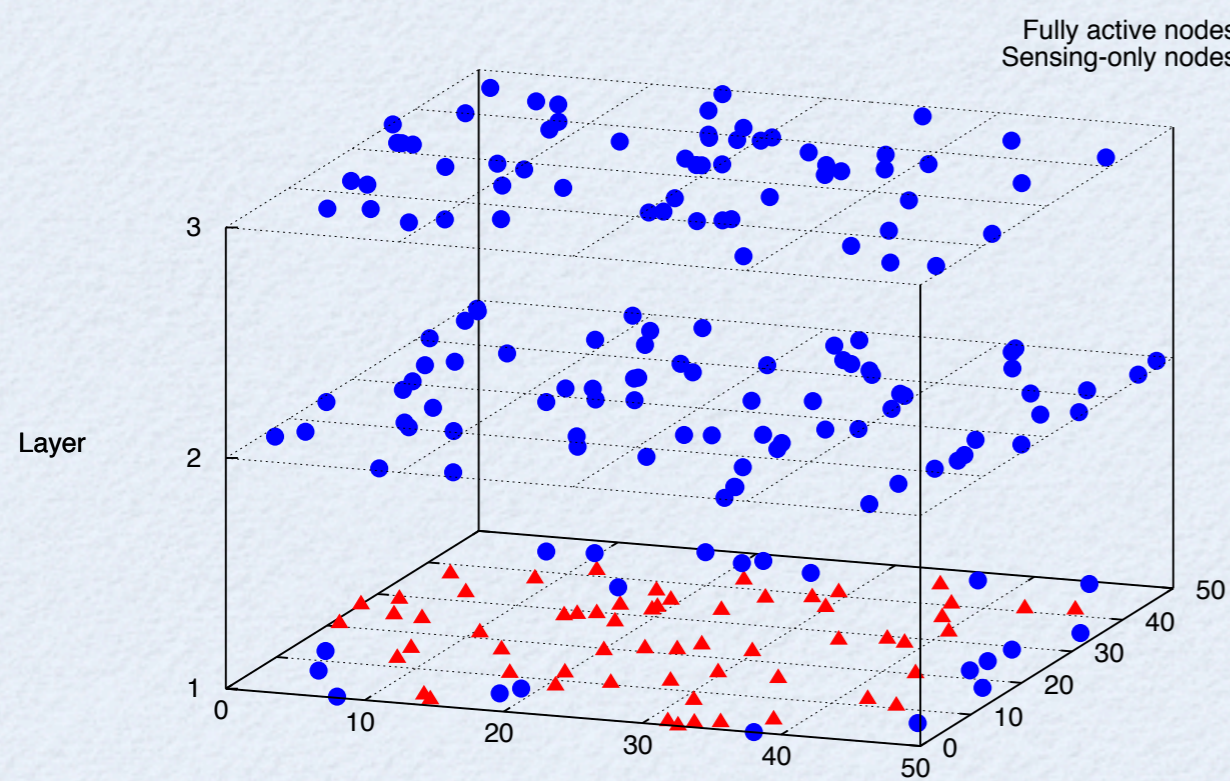
WSNet¹ simulator

- Area of interest : 50m x 50m
- Deployed wireless sensors : from 300 to 1000 nodes
- Communication range and sensing range : 10m
- MAC layer : 802.15.4 CSMA/CA
- Homogeneous and heterogeneous topologies

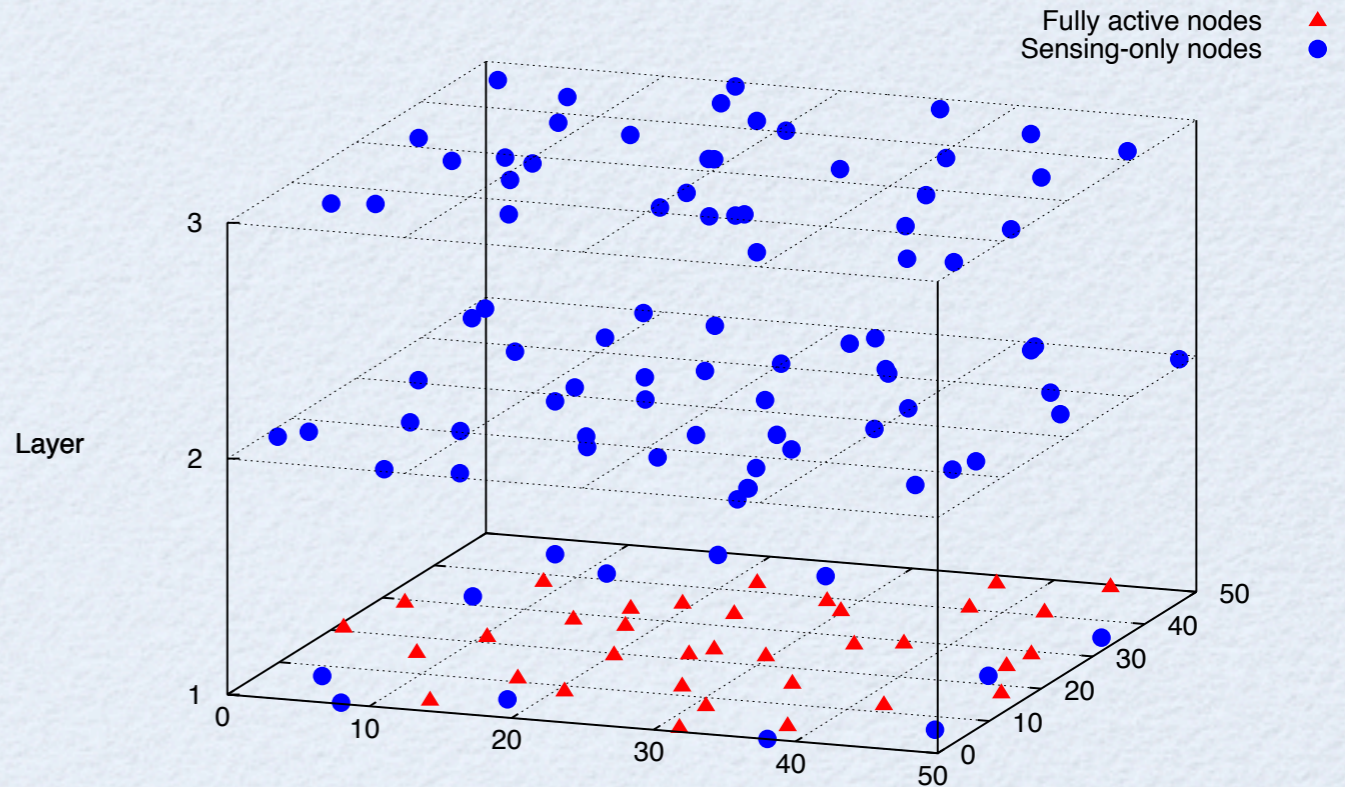
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Resulting topology



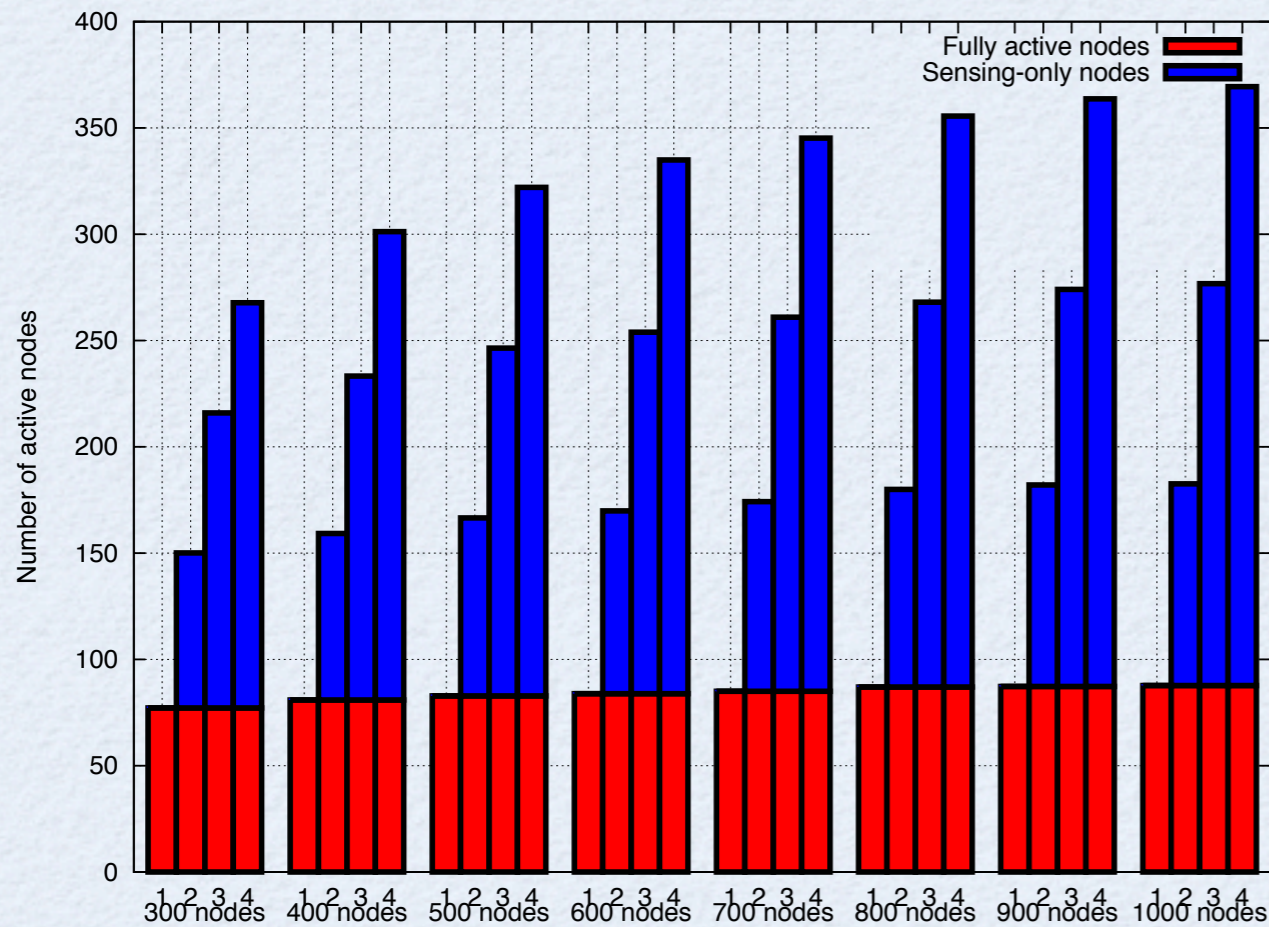
Positive-Only



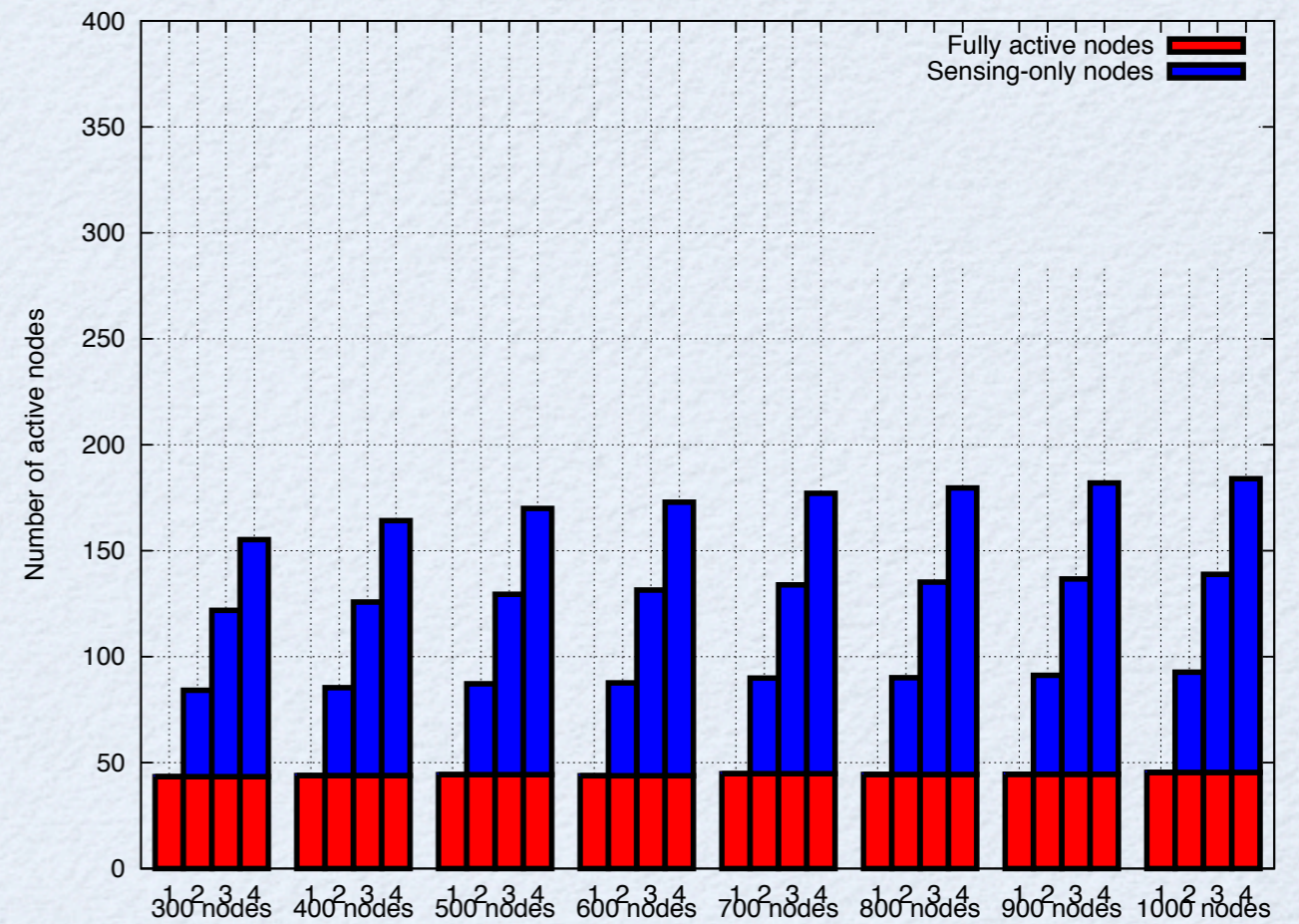
Positive-Retreat

Performance evaluation

Number of fully active and Sensing-Only nodes in the network



Positive-Only



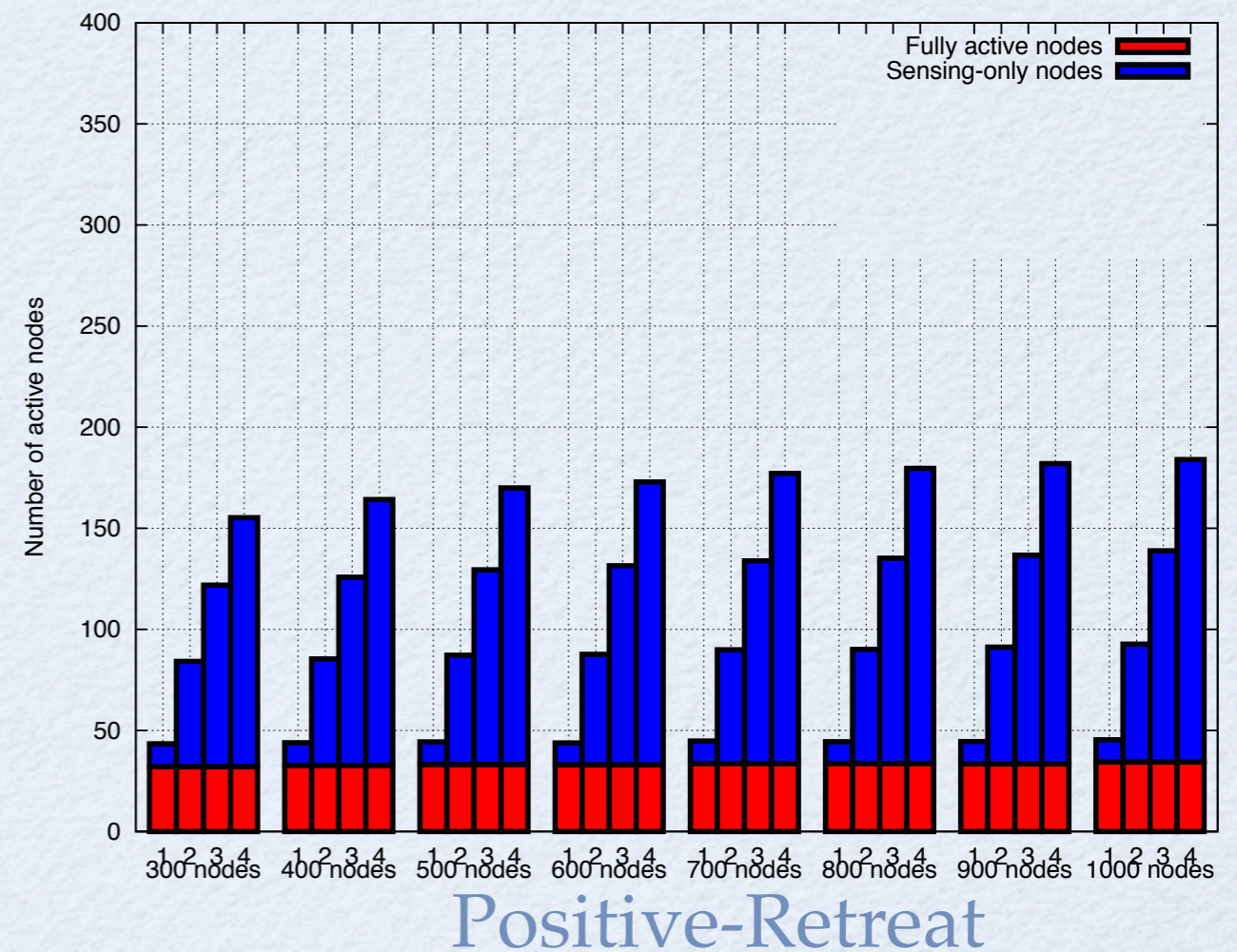
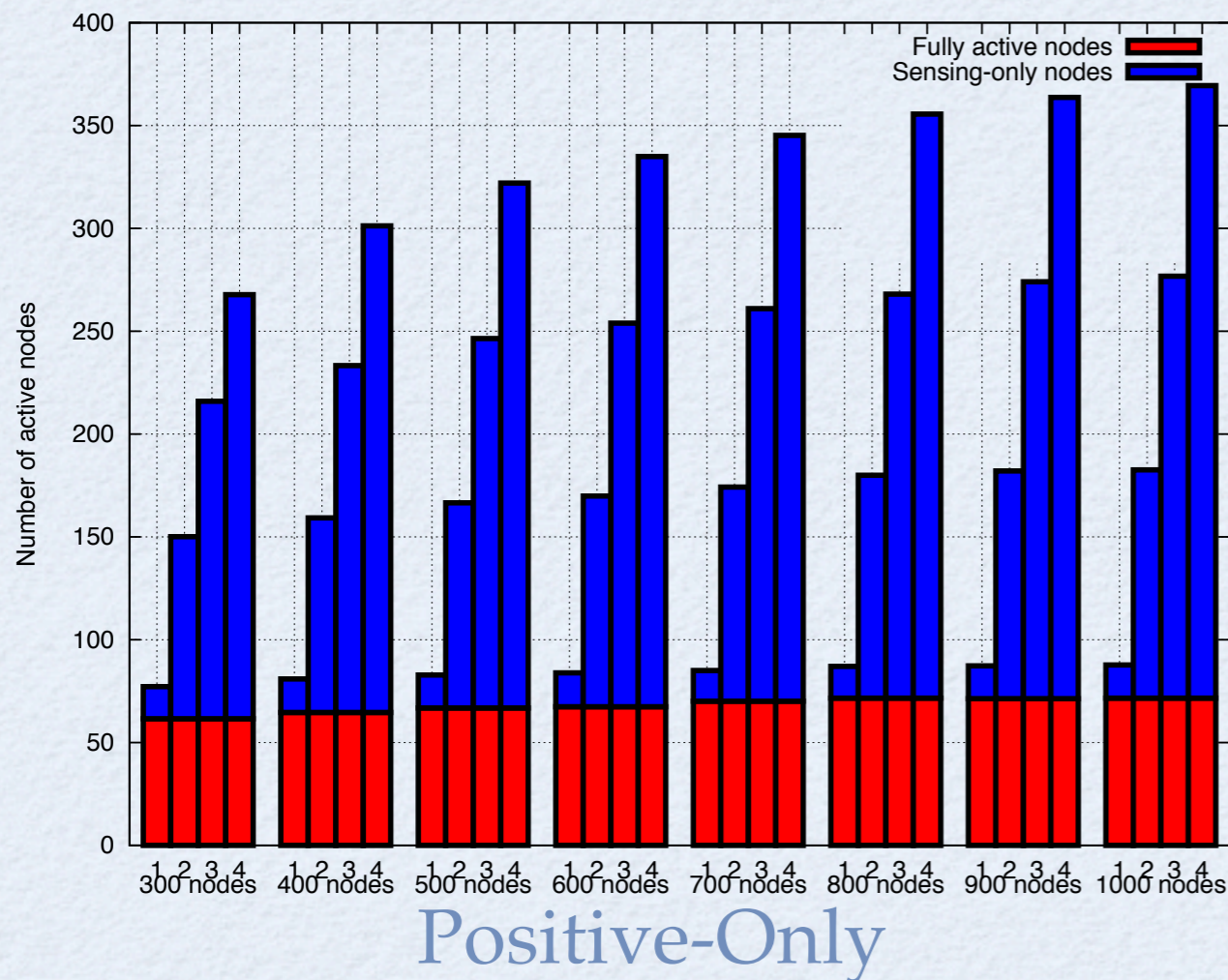
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Performance evaluation

Number of fully active and Sensing-Only nodes in the network with gradient construction



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Conclusion

- Reduction of the subset of fully active nodes
- Guaranteed multiple coverage of the area of interest and connectivity of the network
- A large subset of node enter an energy-preserving Sensing-Only state
 - via the construction of a gradient structure
 - with the use of upper layers properties

Perspectives

- Develop contributions on large-scale sensor testbed

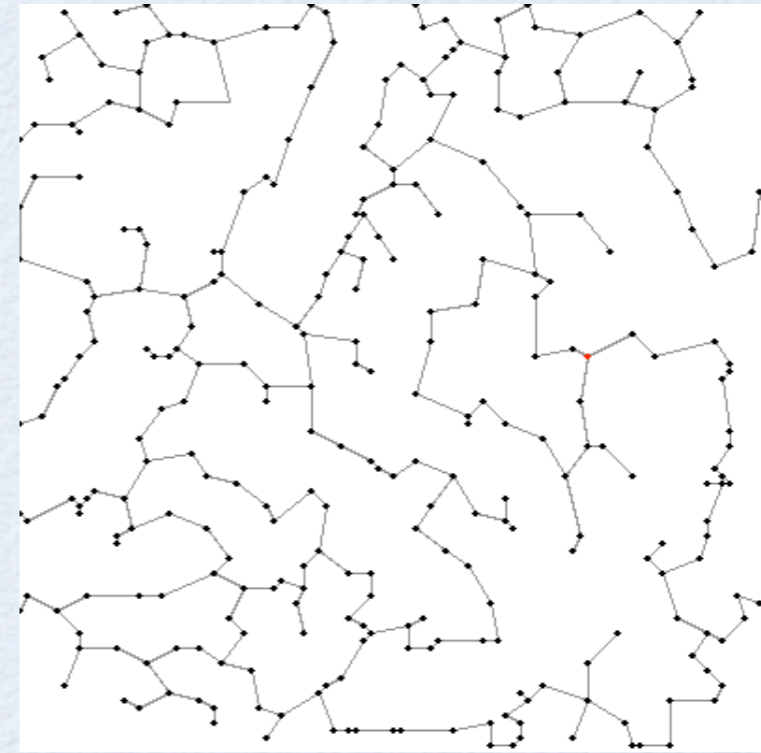
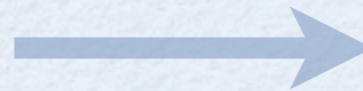
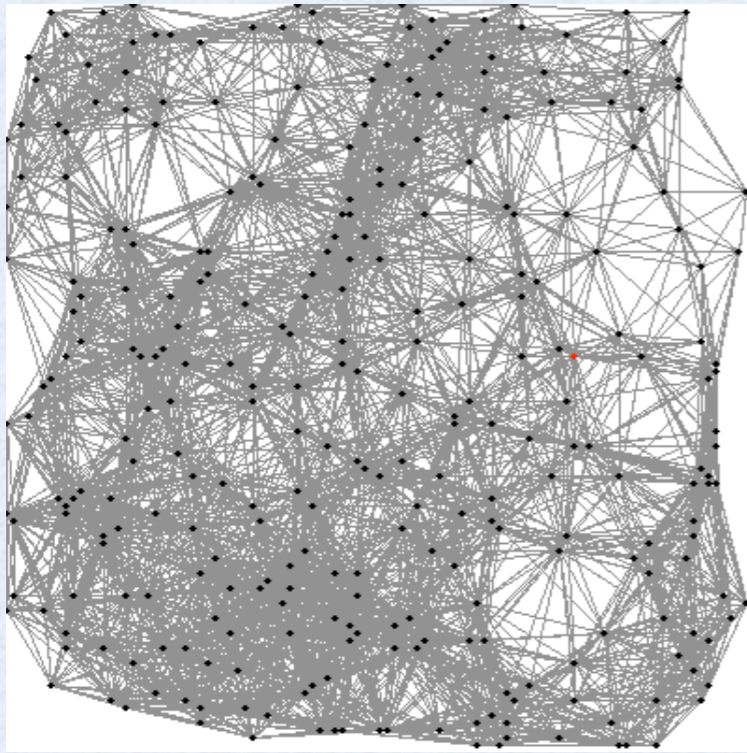


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Perspectives

- Develop contributions on realistic sensor testbed
- Study of several other solution to maximize the subset of Sensing-Only nodes (e.g. MST, MLST)



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Thank you for your attention !

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