A-sLEACH : An Advanced Solar Aware Low Energy Adaptive Clustering Hierarchy Protocol for Energy Efficient Routing in Wireless Sensor Networks.

Presented By -

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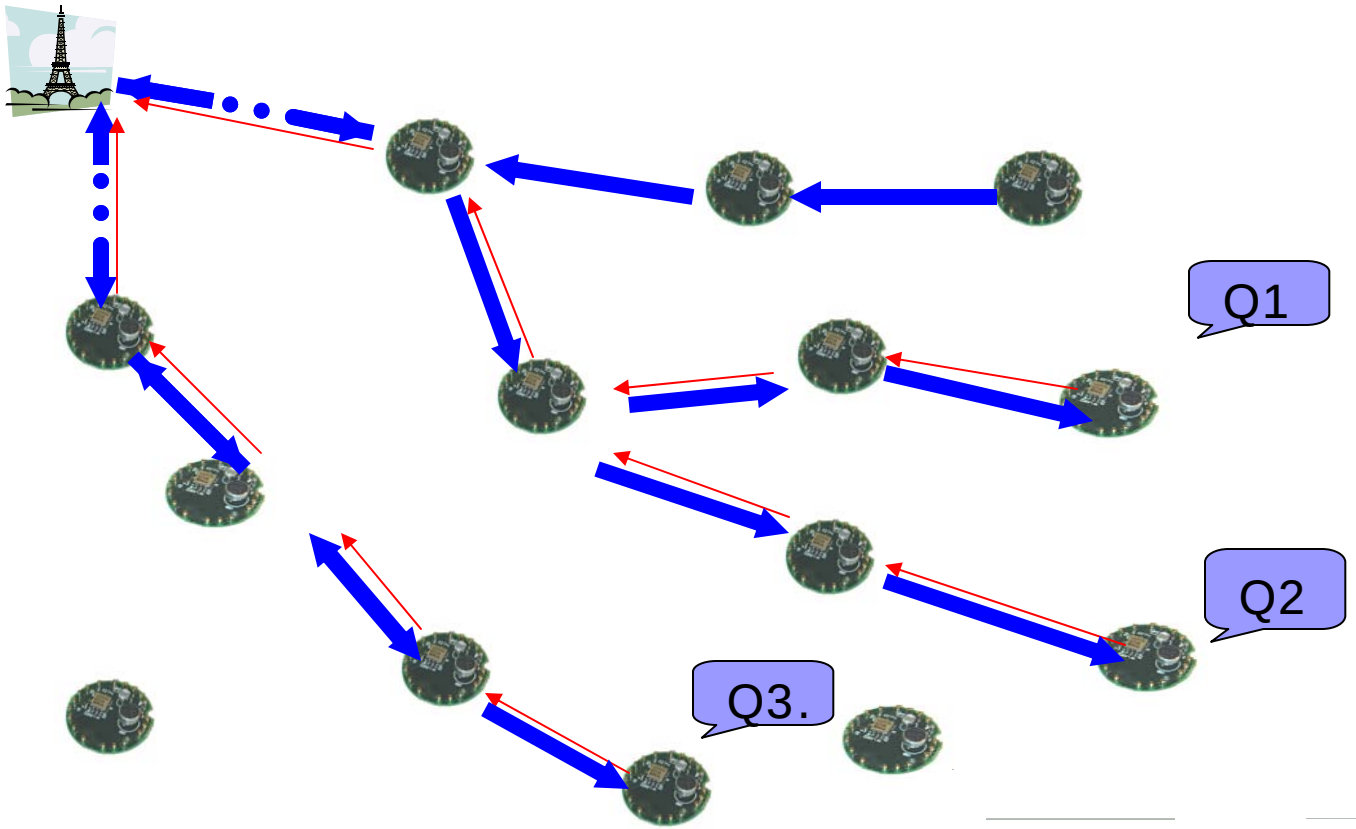
Smart Sensors

- Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems automation, or elsewhere
- Recent terrorist and guerilla warfare countermeasures require distributed networks of sensors that can be deployed using, e.g. aircraft, and have self-organizing capabilities. In such applications, running wires or cabling is usually impractical. A sensor network is required that is fast and easy to install and maintain

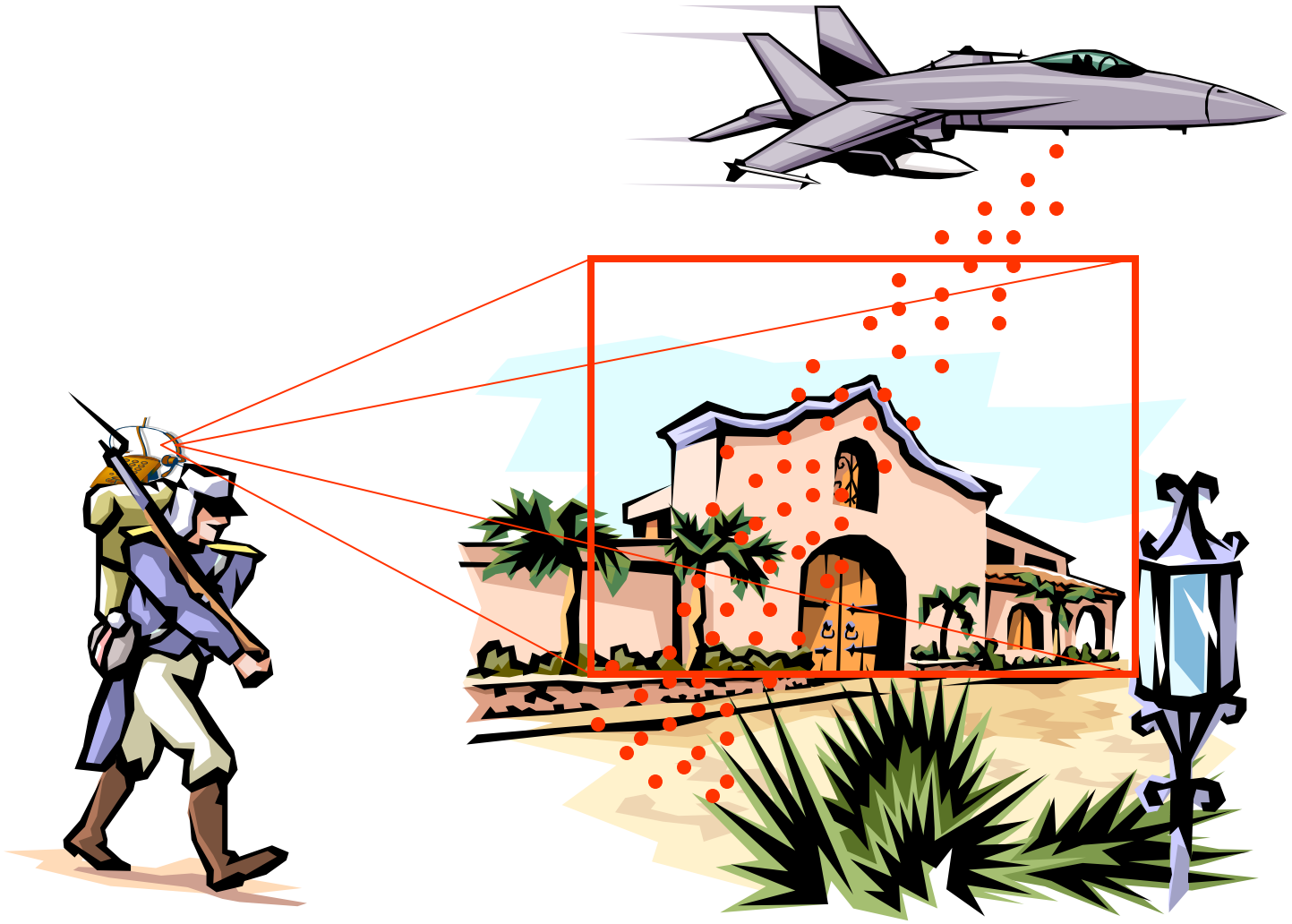
Proposed Protocol

A-sLEACH : An Advanced Solar Aware Low Energy Adaptive Clustering Hierarchy Protocol for Energy Efficient Routing in Wireless Sensor Networks.

Base Station Architecture



Military Applications of Smart Dust

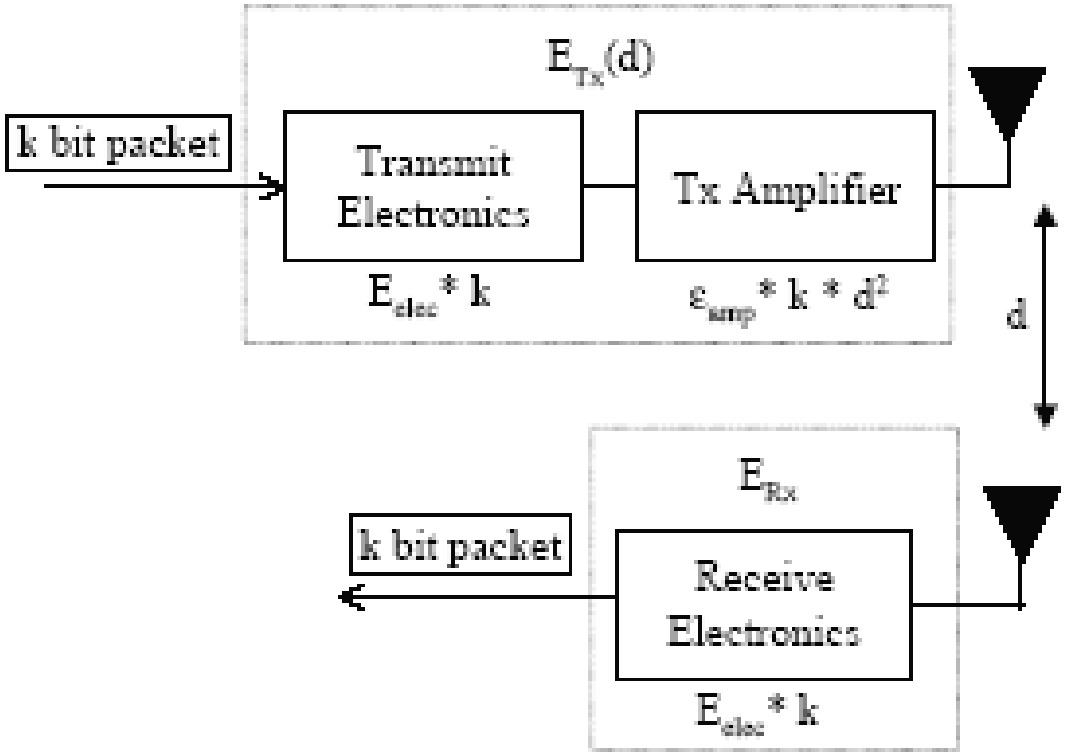


Radio Model

- Radio model is an important consideration in wireless sensor network.
- We consider some parameters –
- Dissipates transmitter or receiver electronics

  $E_{elec} = 50nj / bit$
- Transmit amplifier $\in_{amp} = 100 \ pj / bit / m^2$ for the transmit amplifier to achieve an acceptable signal to noise ratio

Radio model (continued)



Radio model (continued)

- Thus to transmit a k-bit message a distance d using our radio model, the radio expends –

$$E_{Tx}(k,d) = E_{Tx-elec}(k) + E_{Tx-amp}(k,d)$$

$$E_{Tx}(k,d) = E_{elec} * k + \epsilon_{amp} * k * d^2$$

Radio model (continued)

- To receive this message the radio expends –

$$E_{Rx}(k) = E_{Rx-elec}(k)$$
$$E_{Rx}(k) = E_{elec} * k$$

Operation	Energy Dissipated
Transmitter Electronics ($E_{Tx-elec}$) Receiver Electronics ($E_{Rx-elec}$) ($E_{Tx-elec} = E_{Rx-elec} = E_{elec}$)	50 nJ/bit
Transmit Amplifier (ϵ_{amp})	100 pJ/bit/m^2

Energy Analysis Using Radio Model

- We cosider MTE (Minimum Transmission Energy) routing protocol and compare against our proposed radio model.
- In MTE routing node A would transmits to node C via node B if and only if –

$$E_{Tx-amp}(k, d = d_{AB}) + E_{Tx-amp}(k, d = d_{BC}) < E_{Tx-amp}(k, d = d_{AC})$$

or

$$d_{AB}^2 + d_{BC}^2 < d_{AC}^2$$

Radio Equation for MTE routing

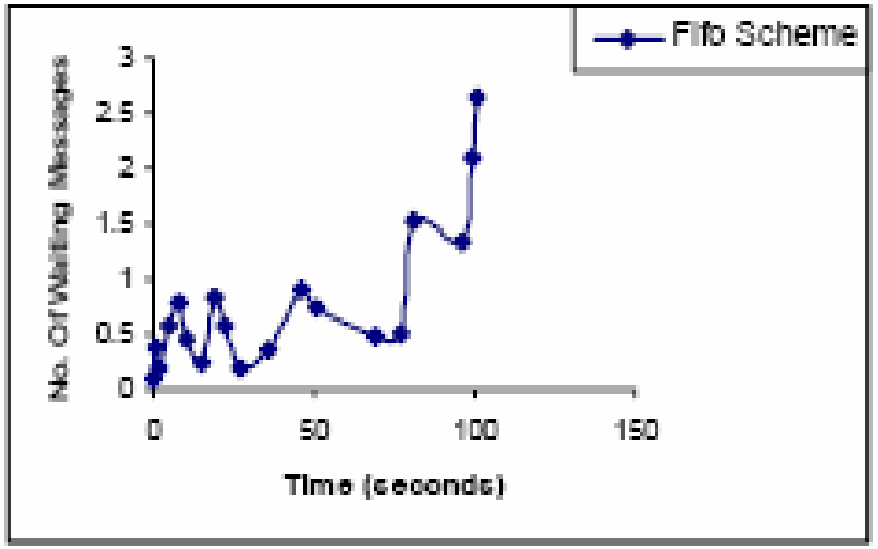
$$E_{MTE} = n * E_{Tx}(k, d = r) + (n-1) * E_{Rx}(k)$$

$$= n(E_{elec} * k + \epsilon_{amp} * k * r^2) + (n-1) * E_{elec} * k$$

$$= k((2n-1)E_{elec} + \epsilon_{amp} n r^2)$$

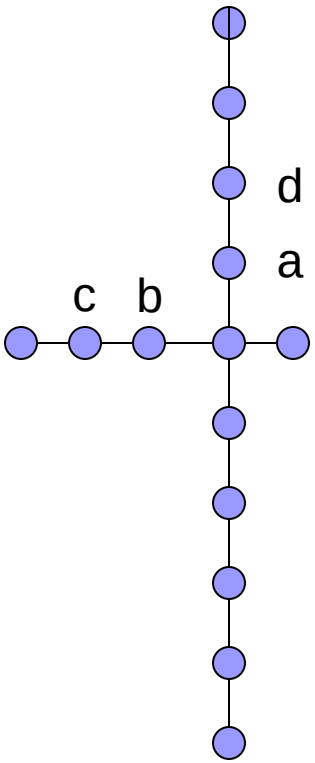
Data Gathering Technique

- We introduce an enhanced scheme for data gathering, called FIFO priority scheme.
- In this scheme ties are broken arbitrarily.
- Packets take the shortest path from its origin to destination.

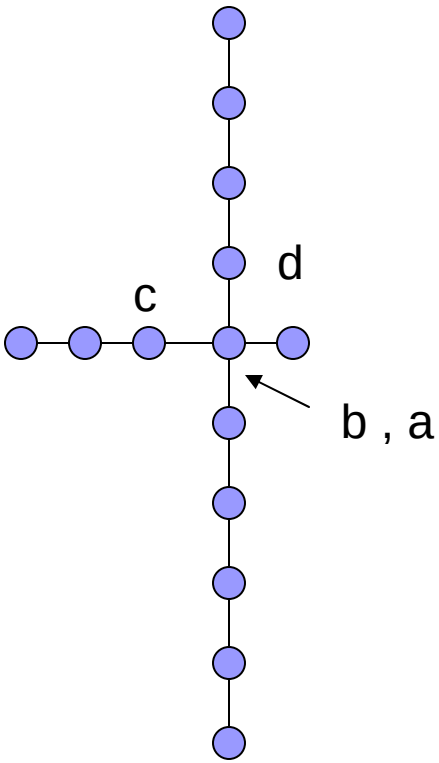


FIFO Based Data Gathering

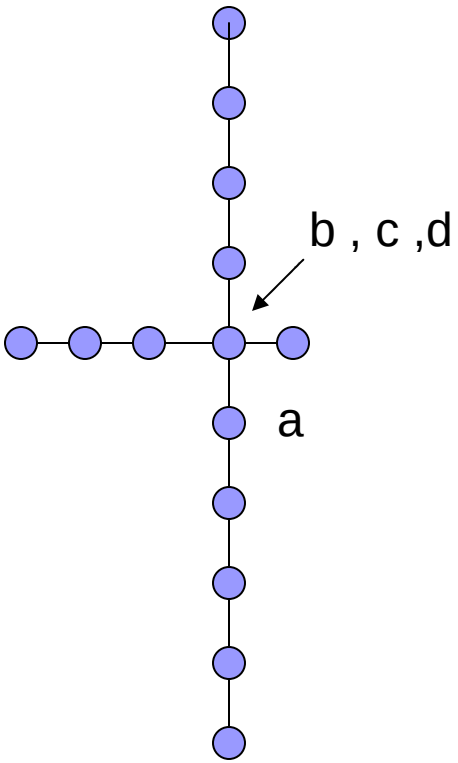
AT t=0



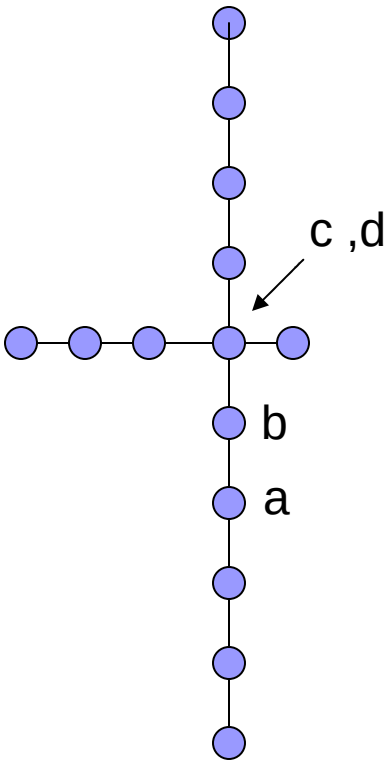
AT t=1



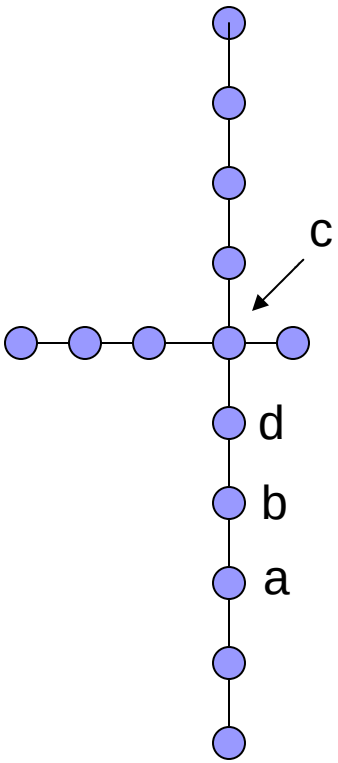
AT t=2



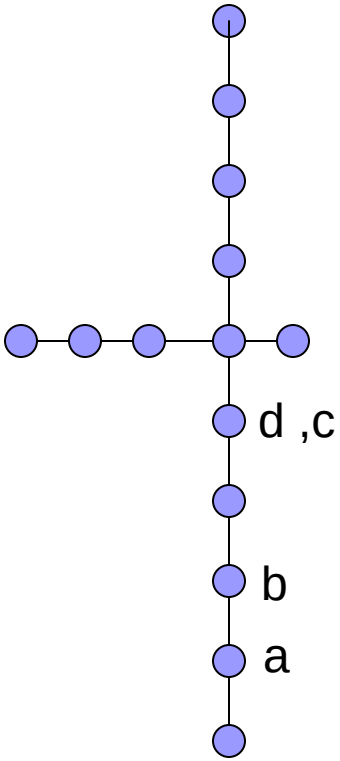
AT t=3



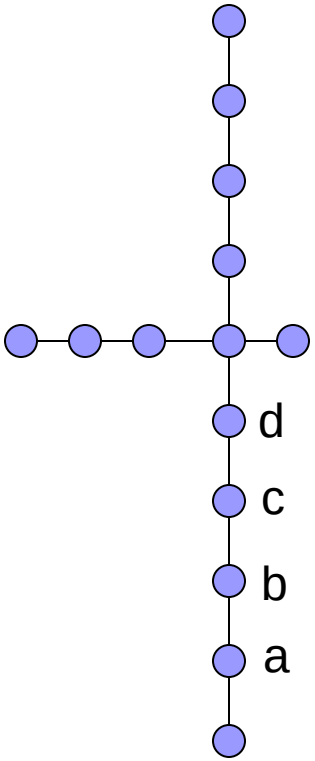
AT t=4



AT t=5



AT t=6



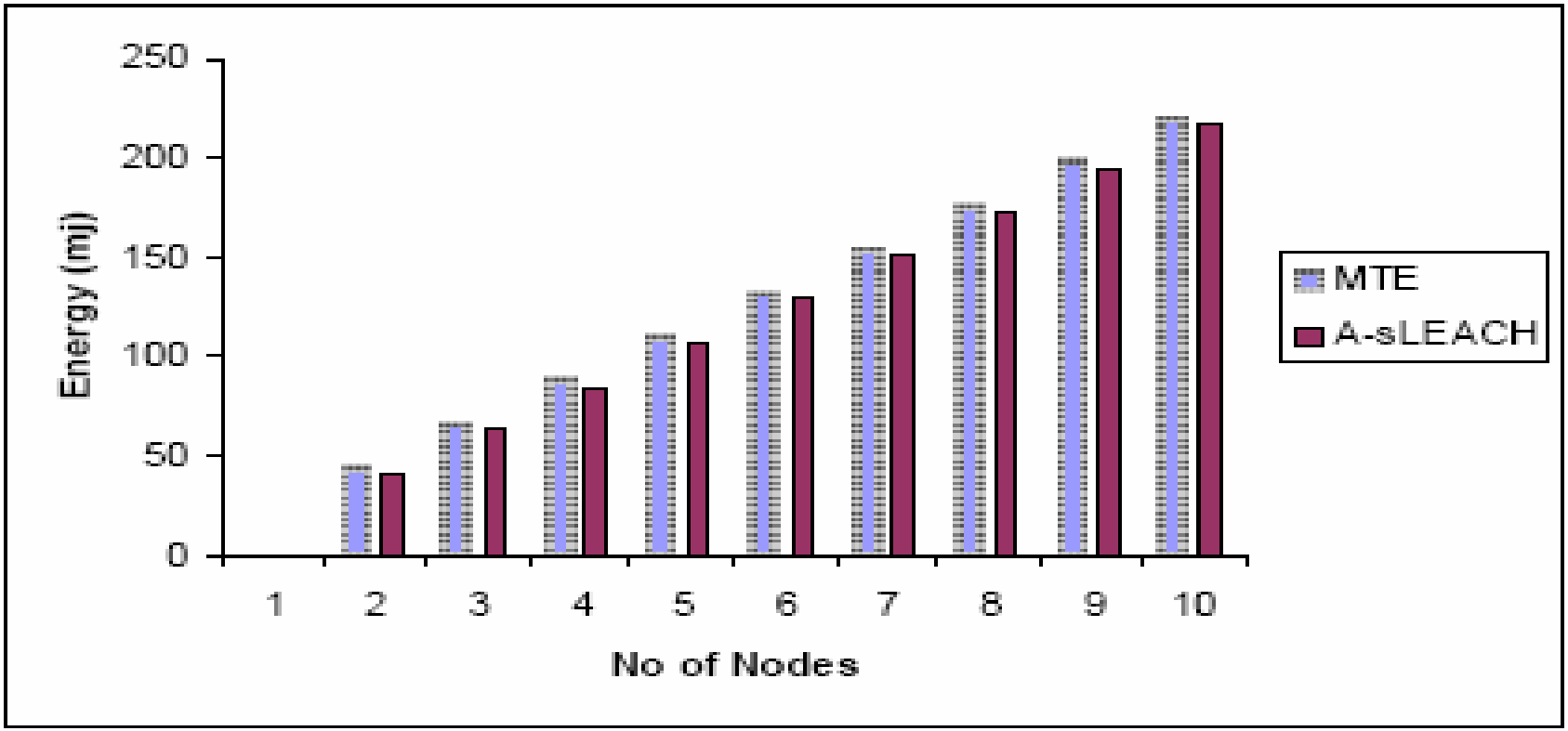
Proposed Radio Model

- In our proposed protocol A-sLEACH where we introduce FIFO Priority scheme in data gathering consider the following Radio Model Equation –

$$E_{FIFO} = (n-1) * E_{Tx}(k, d = r) + n * E_{Rx}(k)$$

$$= (n-1) * (E_{elec} * k + \in_{amp} * k * r^{2}) + n * E_{elec} * k.$$

Simulation


250
200
150
100
50
0
Energy (mj)
1
2
3
4
5
6
7
8
9
10
No of Nodes
MTE
A-sLEACH

Existing sLEACH Protocol:

The existing Solar Aware LEACH Protocol proposed by *Thiemo Voigt* for energy efficient routing is-

❖The base station is fixed and located far from the solar aware sensor nodes.

❖ The cluster head will be chosen by the base station initially. At the next round a handover rule will be followed to choose the other cluster-heads for the preceding rounds.

❖The cluster-Head will be chosen following a simple heuristic. First k+3 nodes with the highest remaining energy will be chosen. The simple heuristic is – removing the cluster-heads with the minimal distances among each other.

❖The Base Station (BS) broadcasts a message containing the cluster head ID for each node; known as Advertisement Message.

❖ The cluster head will send the aggregated data to the BS using a non-persistent CSMA protocol.

❖ Scheduling of nodes will be performed using the TDMA scheme by the cluster head.

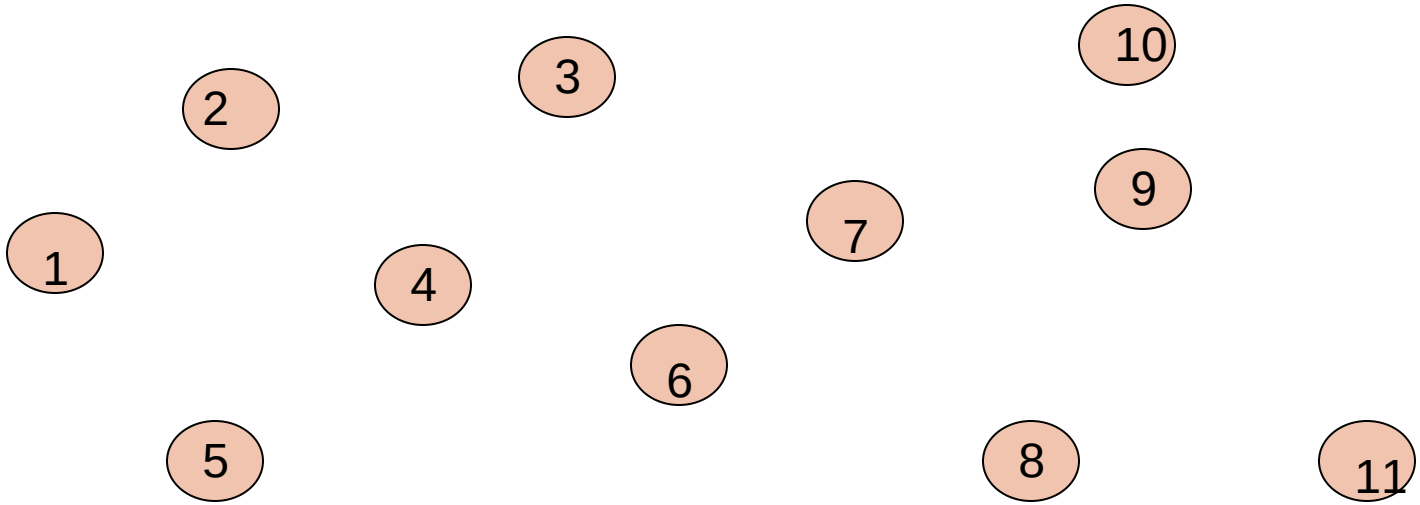
PROPOSED A- sLEACH :

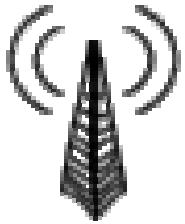
Our power consumption reduced scheduled routing scheme includes the following features:

- The base station is fixed and located far from the solar aware sensor nodes.
- The cluster head will be chosen by the base station using a proposed scanning technique, considering the cluster nodes as the points of a convex hull and the next cluster heads will be chosen by the previous cluster heads.
- The Base Station (BS) broadcasts a message containing the cluster head ID for each node; known as Advertisement Message.
- The cluster head will send the aggregated data to the BS using a non-persistent CSMA protocol where to avoid collision or minimizing the waiting state, a contention slot will be chosen randomly.
- Scheduling of nodes will be performed using the TDMA scheme by the cluster head and data aggregation will be performed by the enhanced FIFO priority technique.

A-sLEACH Continued…

- Some scattered Sensor Nodes with Base-Station in a particular area.

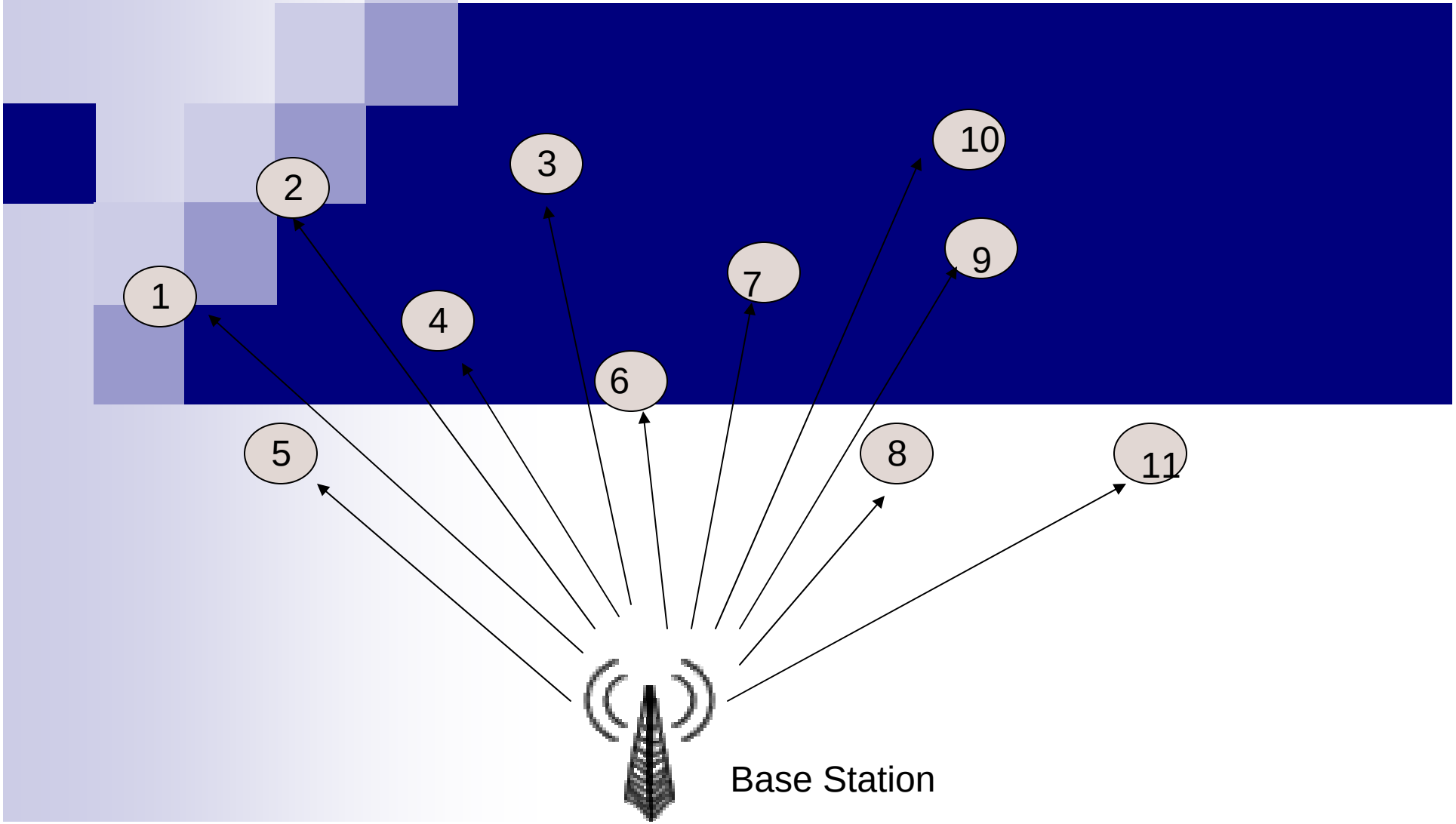




Base Station

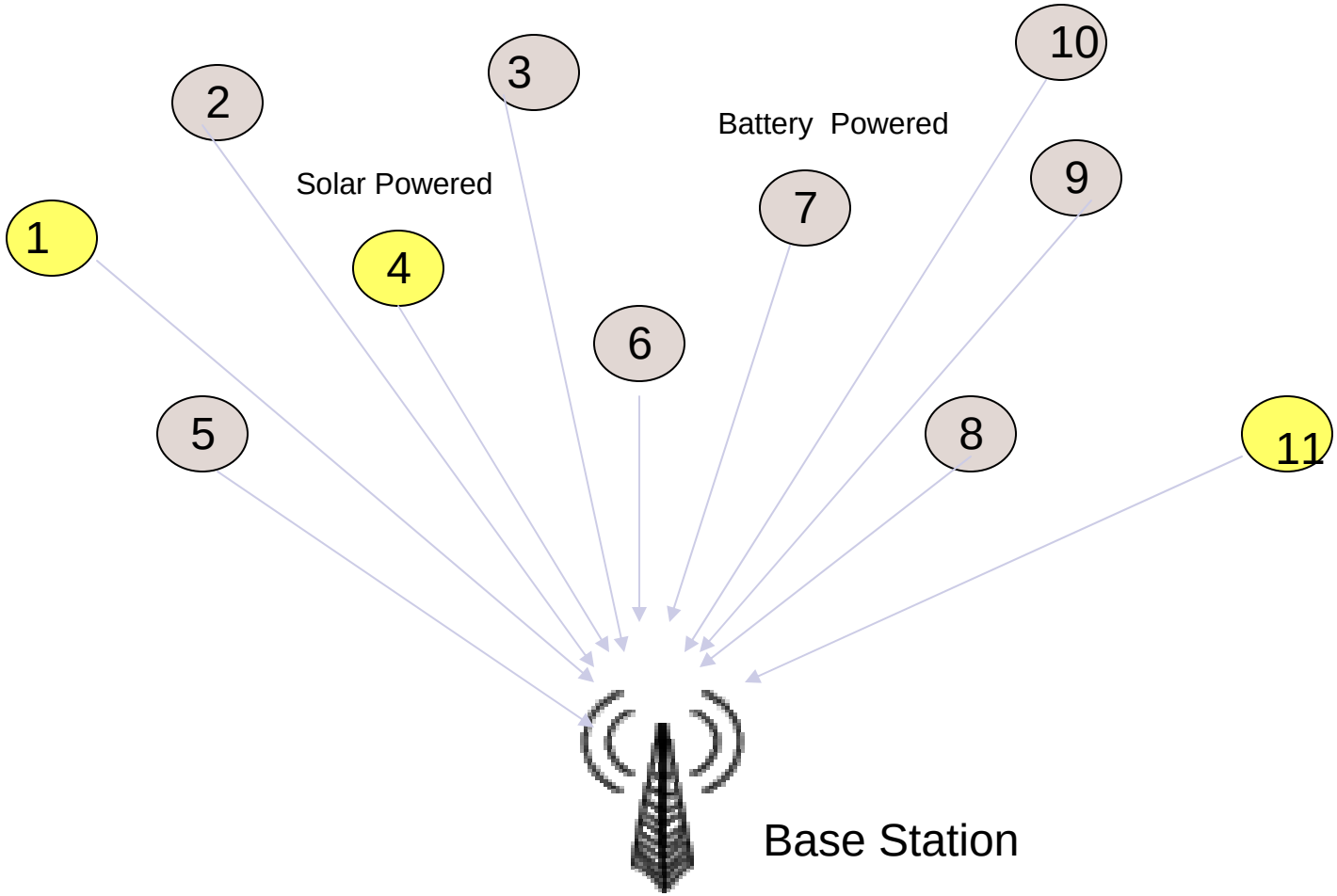
A-sLEACH Continued…

- All Sensor Nodes are connected with the Base Station.



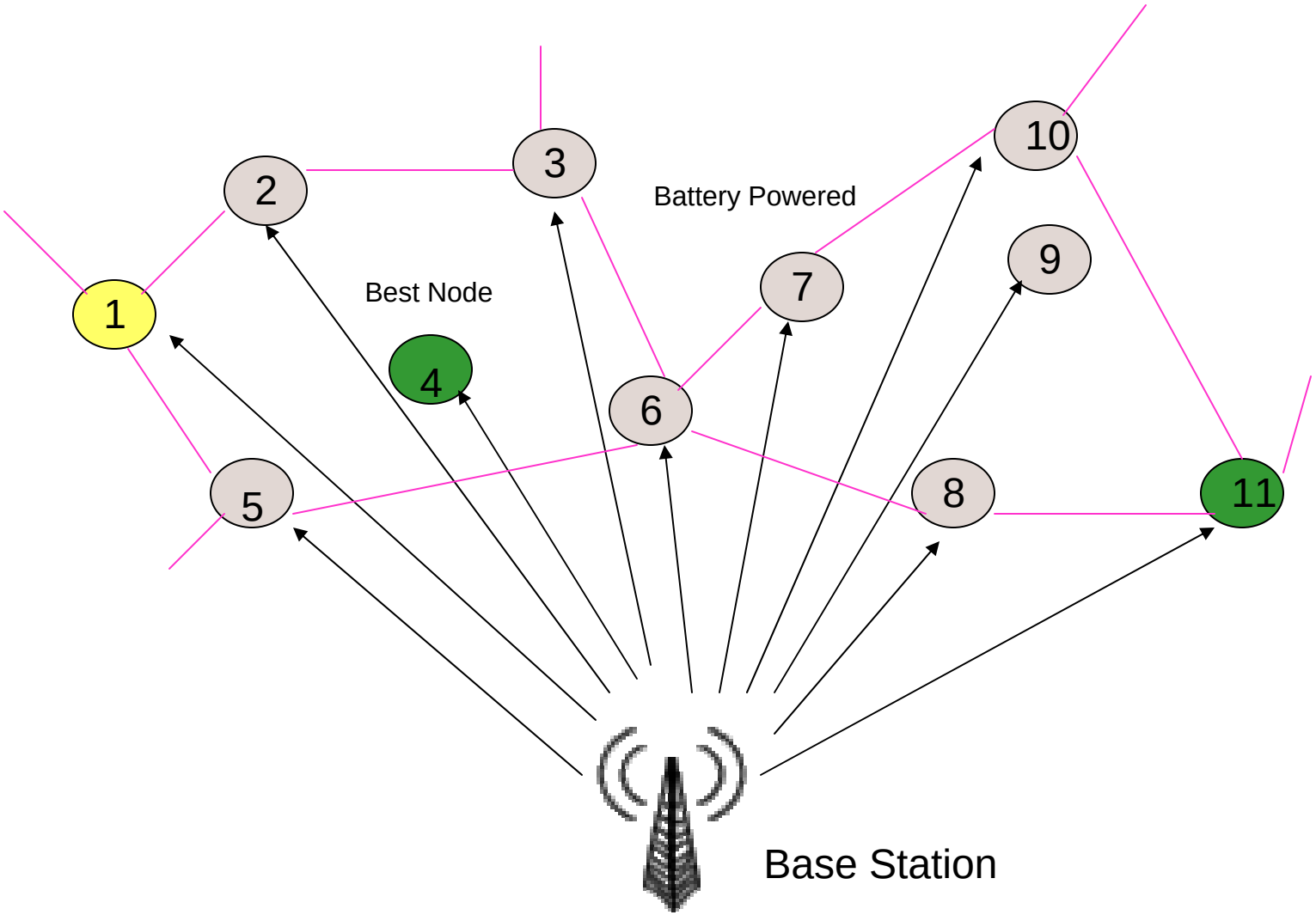
A-sLEACH Continued…

- All Sensor Nodes Send Their Status to the Base Station



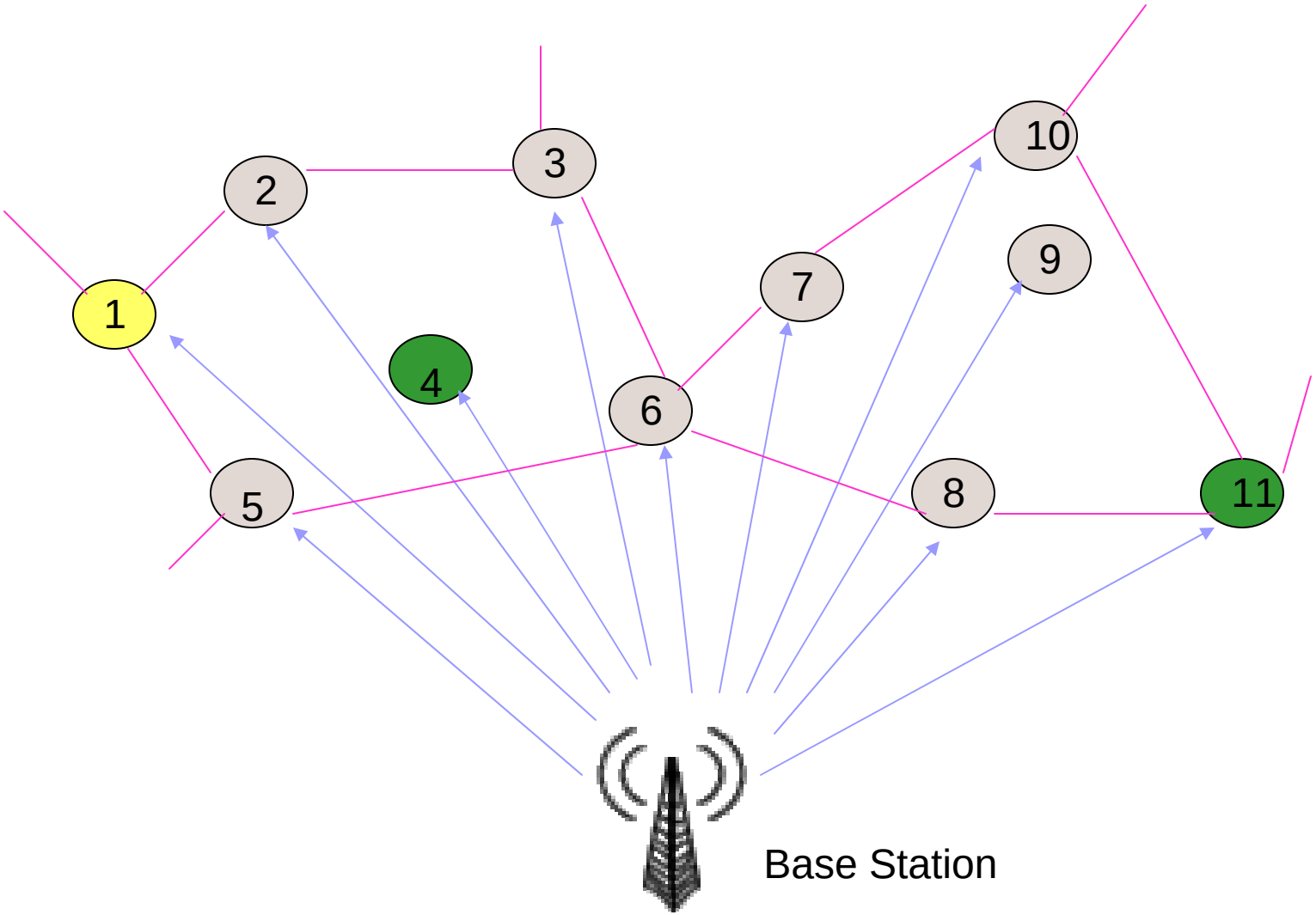
A-sLEACH Continued…

- Cluster is Formed in the Entire Network.
- Best Node is Selected to Become Cluster-Head in a Certain Round.



A-sLEACH Continued…

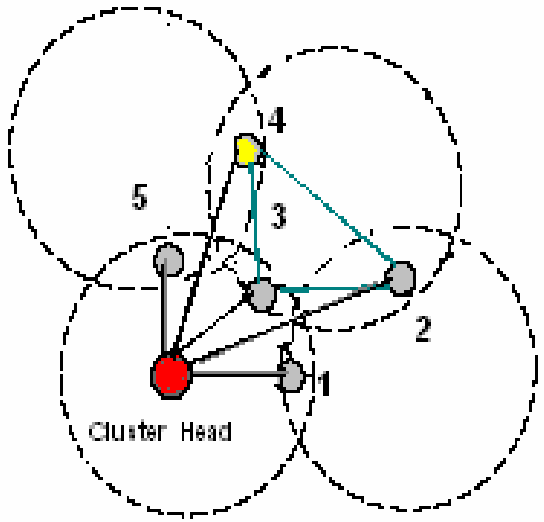
•The Advertisement Message will be Broadcast to all other Sensor Nodes having the Cluster-Head ID.



A-sLEACH Continued…

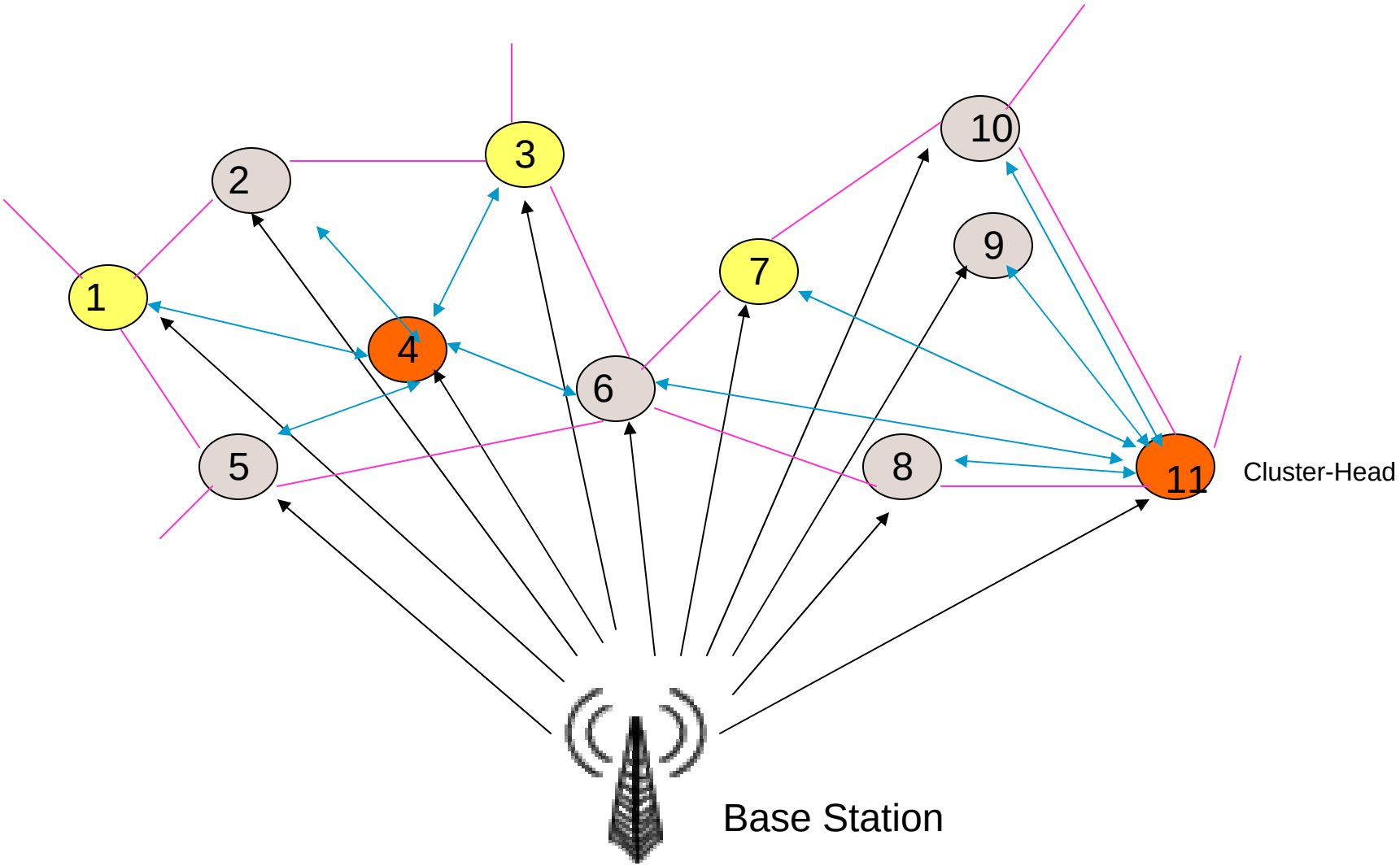
PROPOSED ALGORITHM()

- Let *po* be the point in given set with the minimum *y*-coordinate or leftmost point.
- Let <*p*1, *p*2, …, *pm*> be the remaining points in , sorted by polar angle in counterclockwise order with respect to *po*.
- TOP [S] = 0
- PUSH (*po*, S)
- PUSH (*p*1, S)
- PUSH (*p*2, S)
- **for** *i* = 3 **to** m **do**
  while {angle between NEXT_TO_TOP[S], TOP[S], and *pi* makes a nonleft turn}
  do
  PUSH (S, *pi*)
- return S



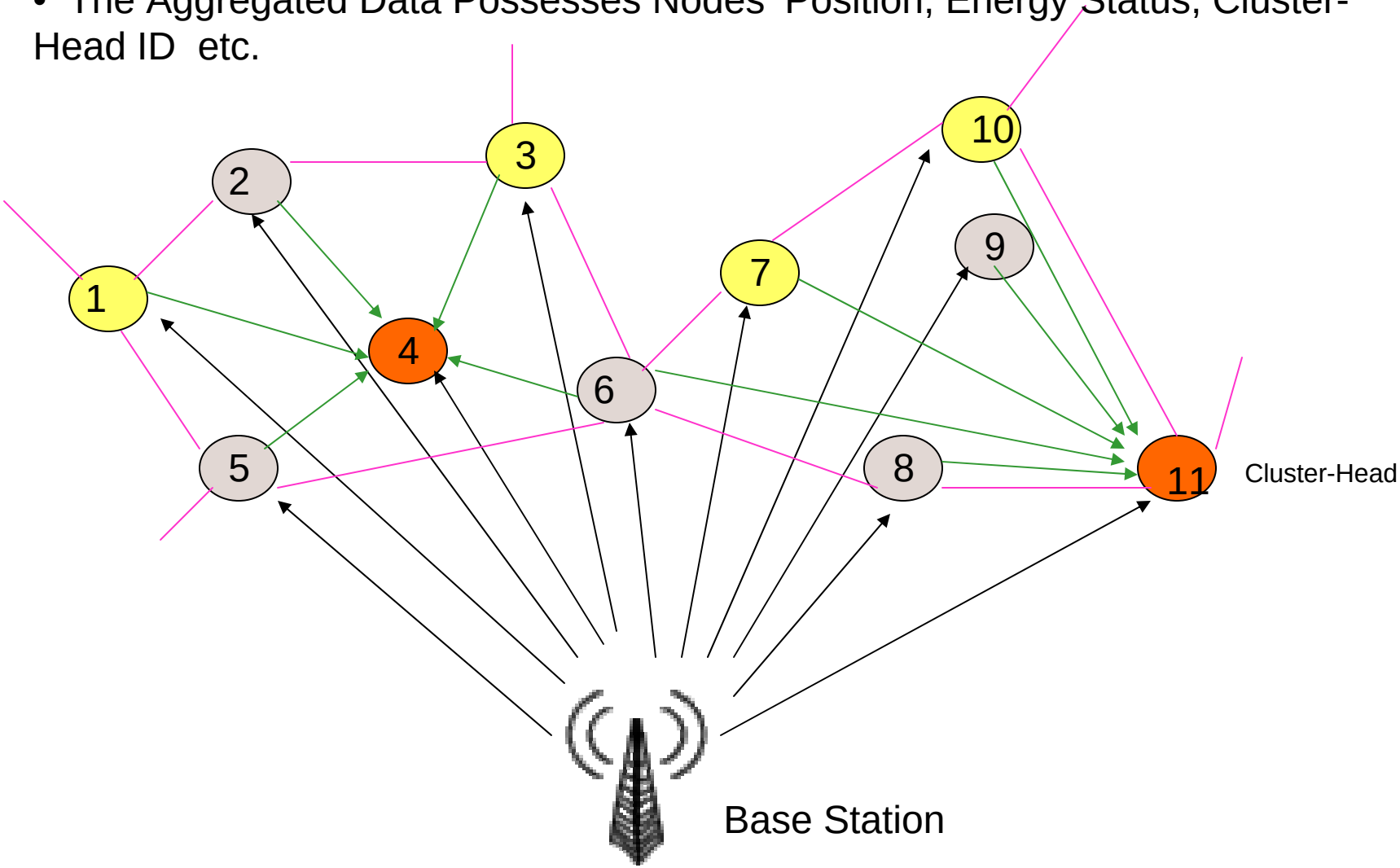
A-sLEACH Continued…

- Cluster-Heads Schedule the Nodes With TDMA Scheme
- Other Nodes Becoming Solar-Powered



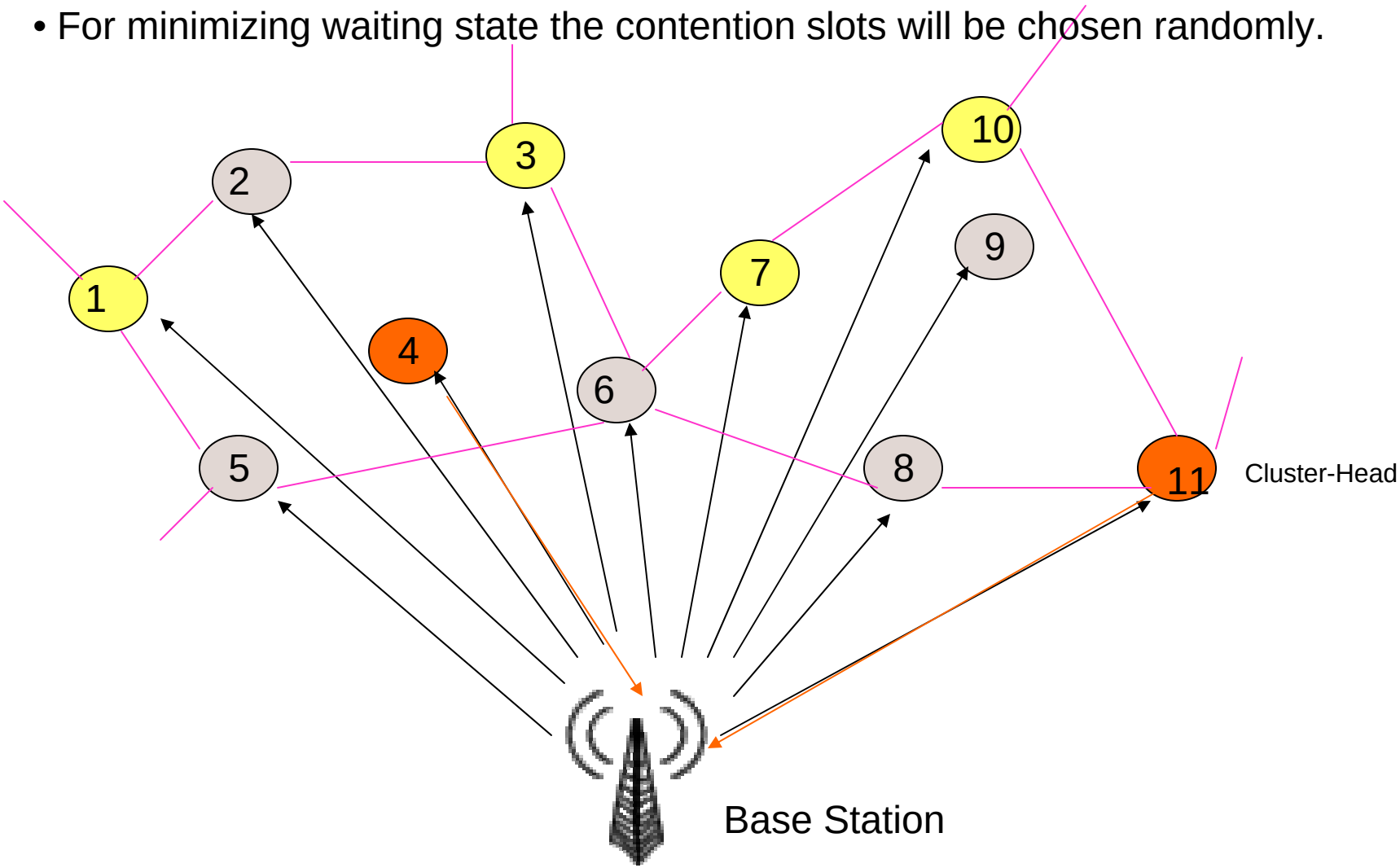
A-sLEACH Continued…

- Data Gathering in The Cluster-Head Using The Proposed Enhanced FIFO Priority Scheme.
- The Aggregated Data Possesses Nodes' Position, Energy Status, Cluster-Head ID etc.



A-sLEACH Continued…

- The Aggregated Data in Cluster-Head is Sent to the Base Station Using a Fixed Spreading Code with CSMA.
- For minimizing waiting state the contention slots will be chosen randomly.

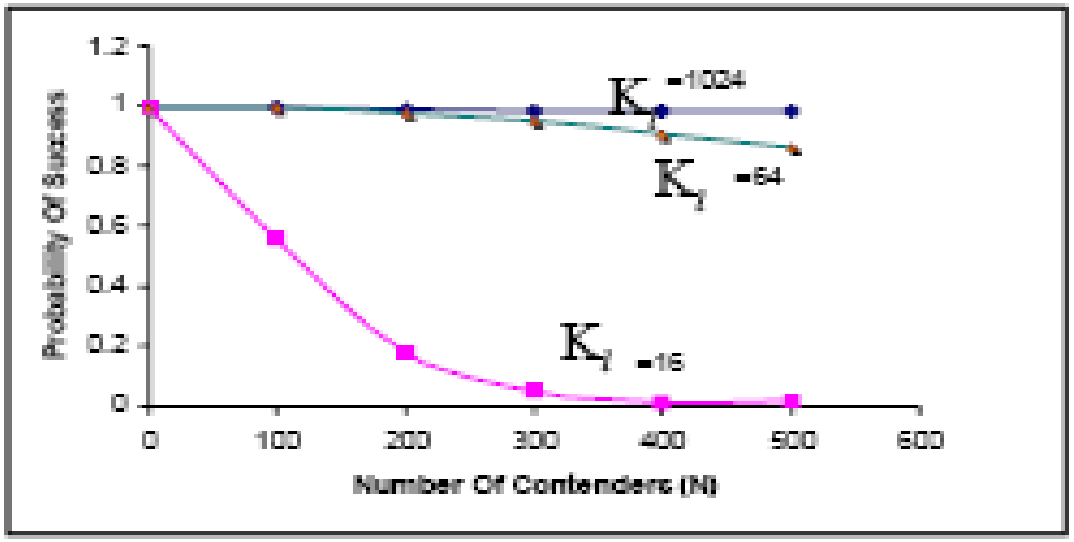


Let $\pi_p(N)$ be the probability of success when N nodes select a contention slot using probability distribution *p.* Then the probability of success is the sum of the probabilities of success in each slot before slot K_l .

$$\pi_p(N) = N p_1 (1- p_1)^{N-1} + N p_2 (1-p_1-p_2)^{N-1} + \ldots$$

$$\ldots\ldots\ldots + N p_{K_l-1} (1-p_1 \quad -\ldots\ldots \quad - \quad p_{K_l-1})^{N-1}$$

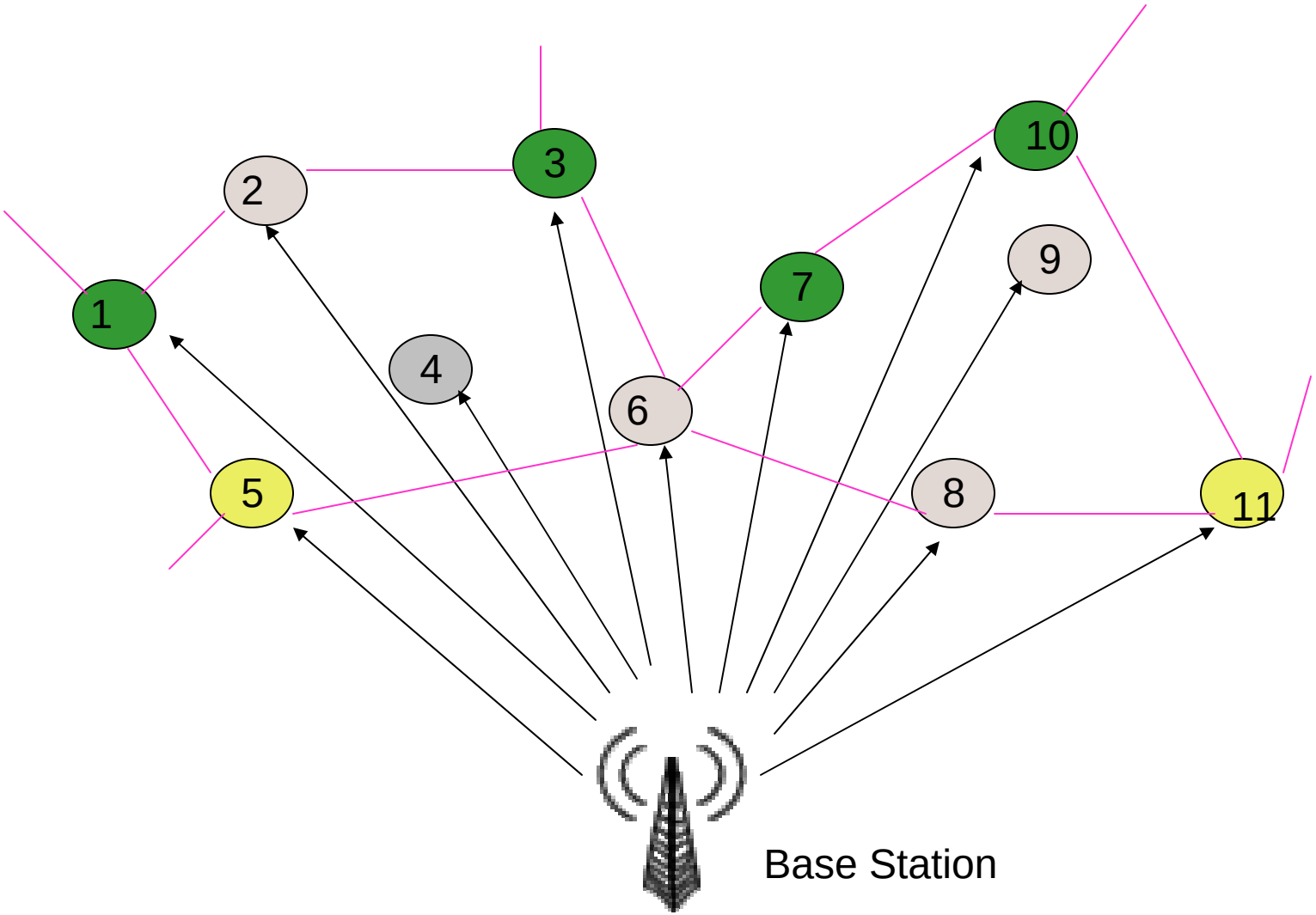
$$= N \sum_{S=1}^{K_l-1} p_S \left(1 - \sum_{p_1=1}^{S} p_{p_1}\right)^{N-1} .$$



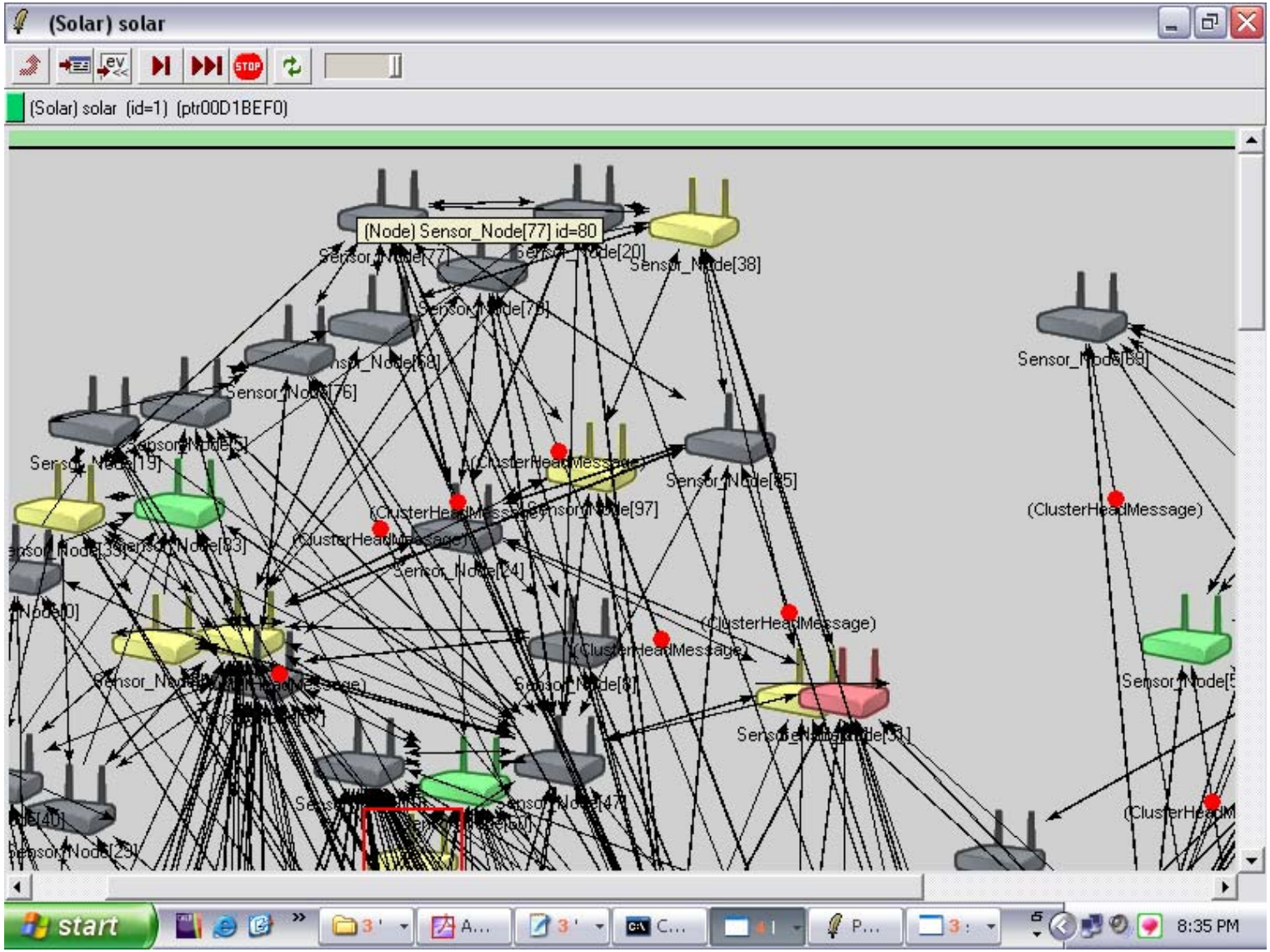
The maximum probability of success $\pi_p(N)$ becomes flat as N increases.

A-sLEACH Continued…

- The Nodes 1,3 & 7,10 are selected as Best Nodes for Becoming the Cluster-Head in the Next Round.



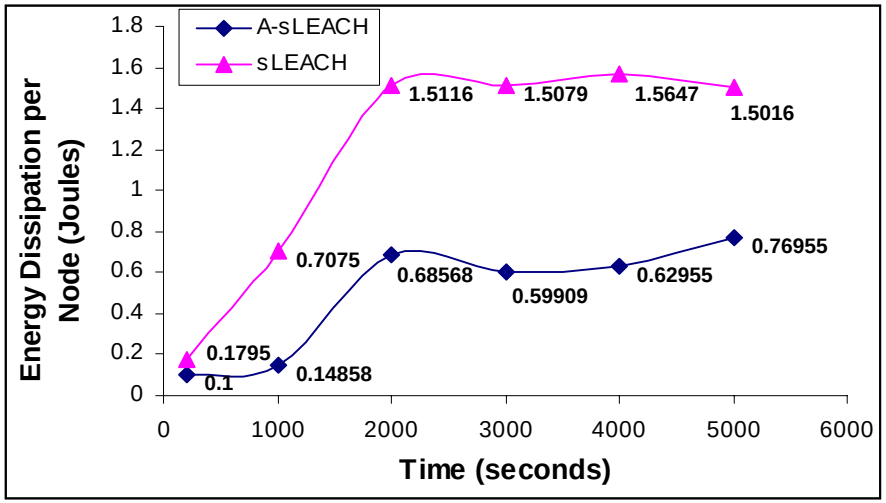
A-sLEACH Continued…



Simulation View in OMNET++ after 3000 seconds.

Evaluation

❖ We have implemented our proposed protocol algorithm **A-sLEACH** in the discrete event simulator **OMNET++** and **MATLAB**.Using our proposed cluster forming scheme and selection of solar-powered nodes as cluster-head saves energy about 57.78% per node and keeps the total remaining energy comparatively more about 14.31%. For example, with 25 **sunNodes** ,96.56% of all cluster-heads are solar-powered where with 15 **sunNodes** only 85% of the cluster-heads are solar-powered. Our proposed scheme has 19.58% more lifetime than sLEACH.



Energy Dissipation per Node vs Time when, N =100, $|T_{\lambda_X} \times T_{\lambda_Y}|$ = 1000m × 1000m.

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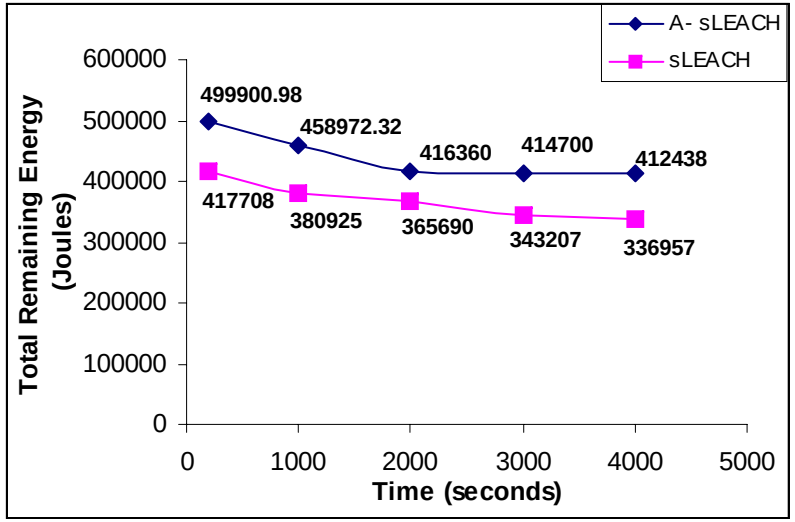

Total Remaining Energy vs Time when, N =100, $\left| T_{\lambda_X} \times T_{\lambda_Y} \right|$ =1000m× 1000m, ξ_{bsw} =500000 Joules.

Evaluation

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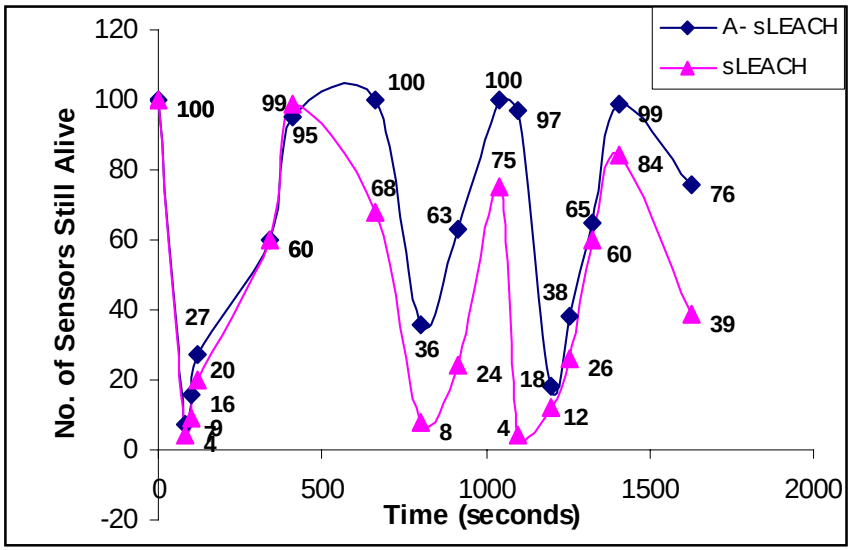
Energy (J/node)	Protocol	Rounds First Node Alive	Rounds Last Node Alive
0.25	MTE	5	221
	sLEACH	482.65	814.62
	A-sLEACH	559.71	944.69
0.5	MTE	8	429
	sLEACH	1141.7	1607.2
	A-sLEACH	1323.99	1863.69
1	MTE	15	843
	sLEACH	2263.8	3194.8
	A-sLEACH	2625.08	3704.66



Number of Sensors Still Alive over Time when, N =100, $|T_{\lambda_X} \times T_{\lambda_Y}|$ = 1000m× 1000m.


Thanks….