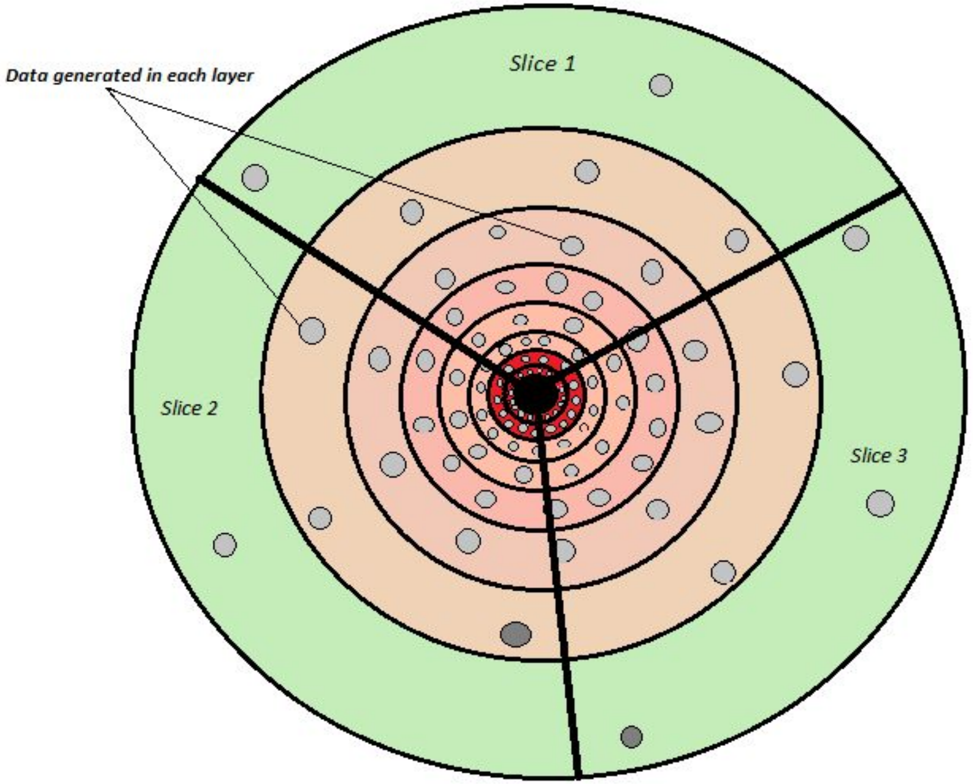
Enhanced Balanced Energy Model for WSN



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Wireless Sensor Network (WSN)

Wireless sensor network is a set of small and intelligent entities which are responsible for their organization, and working in order to provide sensing services assigned to them. The services provided by a sensor network belong to broad spectrum of real time applications. **Surveillance in battlefields and buildings for stopping possible intrusion and theft and monitoring vehicular traffic.**

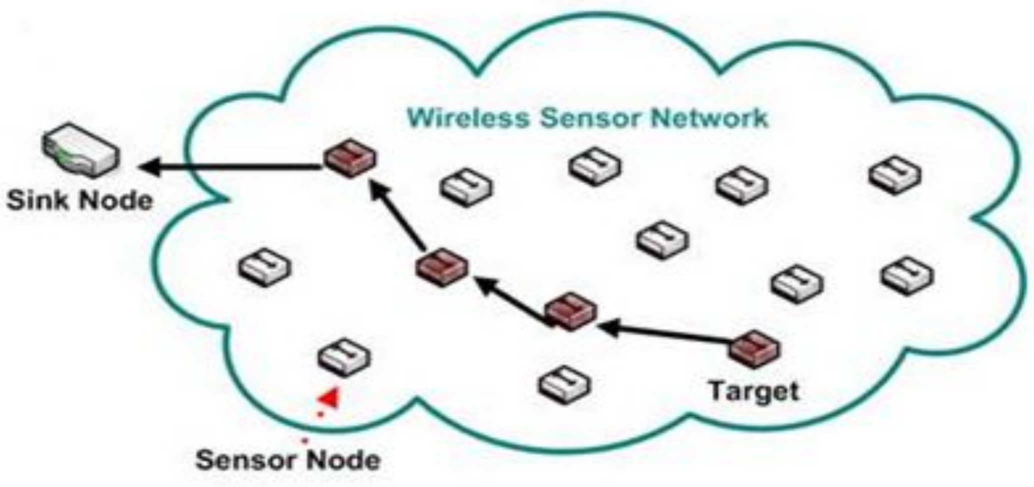


Fig. Source : Wikipedia

Wireless Sensor Network (cont.)

A Wireless Sensor Network is supposed to be made up of a **large number of sensors and at least one base station**. The sensors are self-governing small devices with several constraints like the battery power, computational capacity, range of communication and memory. They also are equipped with transceivers to collect information from its environment and pass it on up to a certain base station, where the measured parameters can be queued and available for further analysis to the end user.

Wireless sensor networks (WSNs) are a collection of sensors used to observe physical or environmental phenomenon such as heat, humidity, vibration, light, and pressure. A WSN consists of sensor nodes, which are equipped with sensing capabilities, wireless communication interfaces, and limited processing and energy resources. One or more powerful base stations (BS) serve as the final destination of the sensed data.

Components of WSNs

- **Sensor :-** A sensor is an object whose purpose is to detect events or changes in its environment and sends the information to the computer which then tells the actuator (output devices) to provide the corresponding output. A sensor is a device that converts real world data (Analog) into data that a computer can understand using ADC (Analog to Digital converter)

- **Agent :-** An agent is the embedded device with sensor and used to sense physical phenomena i.e. temperature, humidity, pressure, heat etc.

- **Base Station (Sinknode) :-** A Base station is station where all information or data is collected from sensors

Underlying Model and Assumptions

- Base Station is located at the center of sensors network.
- Base Station is immobile.
- Base Station is not energy constrained.
- All Sensor nodes in the network are homogeneous and energy constrained.
- Symmetric propagation channel is employed.
- Nodes have location information with respective energy levels.
- Sensor nodes are immobile.

Radio Energy Model

- The energy consumption for transmitting one bit message over a distance d is

$$E_{Tx} = E_{elec} \times b + E_{Fs} \times b \times b \times d^2, \qquad d < d_{0,}$$

$$E_{Tx} = E_{elec} \times b + E_{mp} \times b \times d^4, \qquad d \geq d_0$$

Where E_{elec} is the energy to operate the transceiver circuit. ;
E_{fs} and E_{mp} are the energy expenditures for transmitting one-bit of data

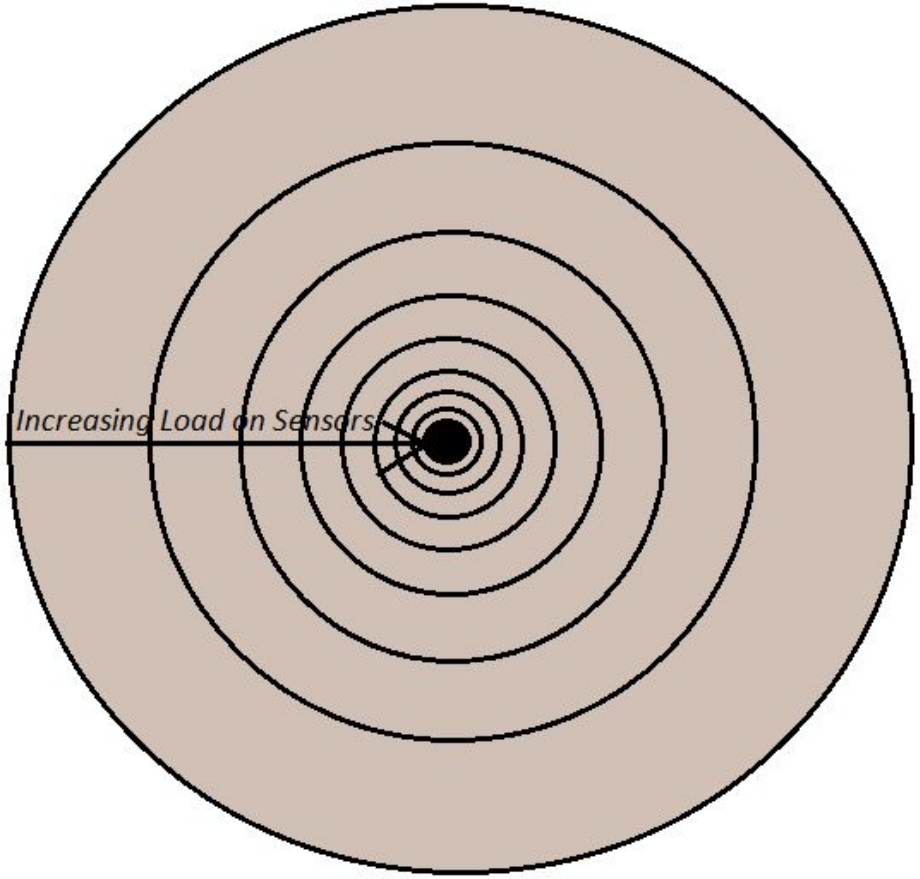
- For receiving this message, the energy consumption is

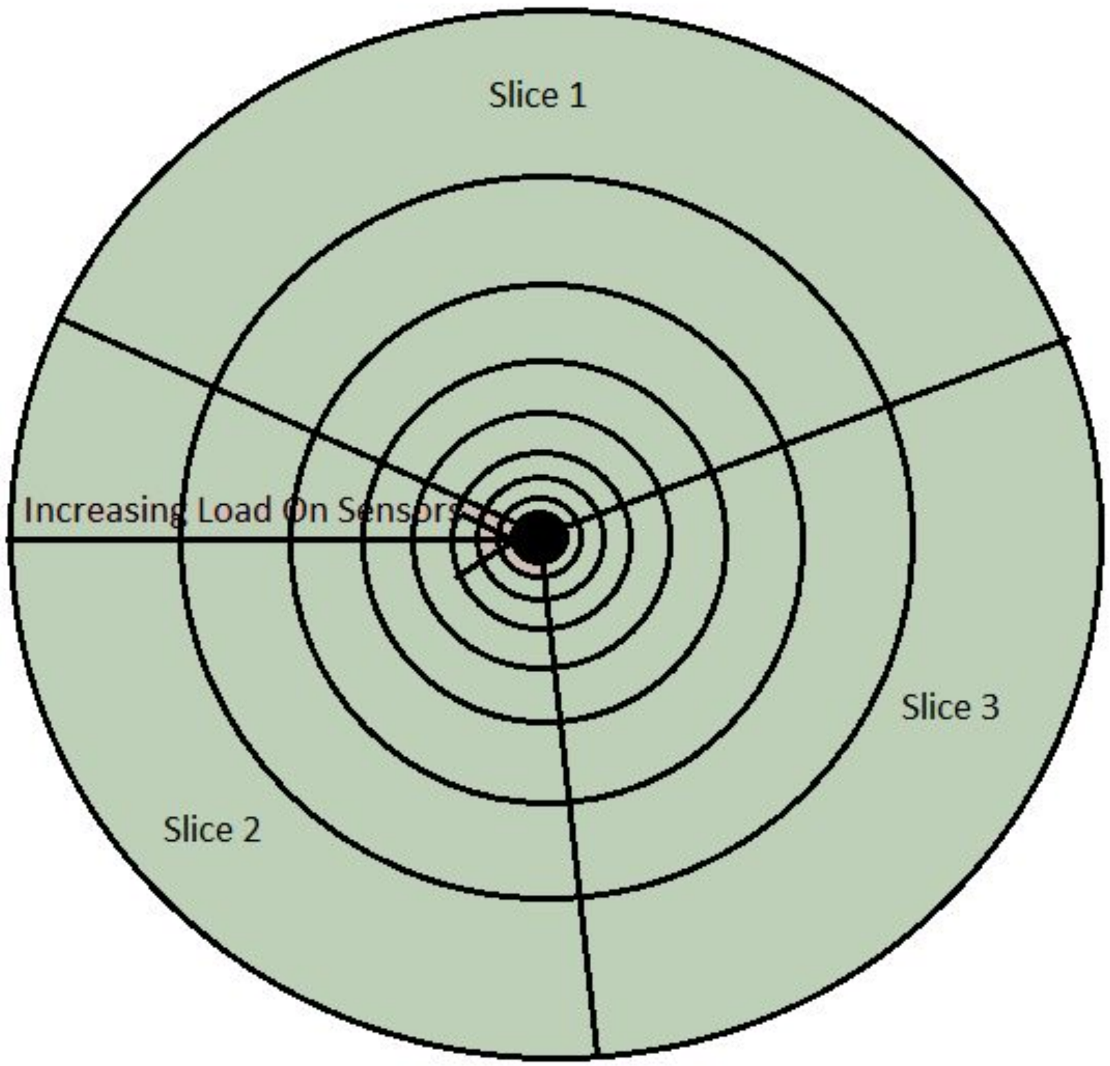
$$E_{Rx} = E_{elec} \times b,$$

- d is the threshold transmission distance

$$d_o = \sqrt{\left(\sqrt{\frac{E_{Fs}}{E_{mp}}}\right)}$$

Problem Description:




Slice 1
Increasing Load On Sensors
Slice 3
Slice 2

$$\int_{R_8}^{R}\left(\frac{1}{\sqrt{2\pi\,\sigma}}\,e^{-(x-\mu)^2\,/\,2\sigma^2}\right)dx = k\,/\,N$$

Annulus Formation Algorithm

1. $W = 0$ / var*iable to store previous waiting time* * /
2. $W_i =$ *time for which sensors has to wait before sending a hello packet*
3. $h_i =$ *current hop count of a sensor*
4. *begin*
5. *ith sensor receives a Hello Packet*
6. *ith sensor receives the hop count value h*
7. $if\,(h < h_i)$
8. $h_i = h$

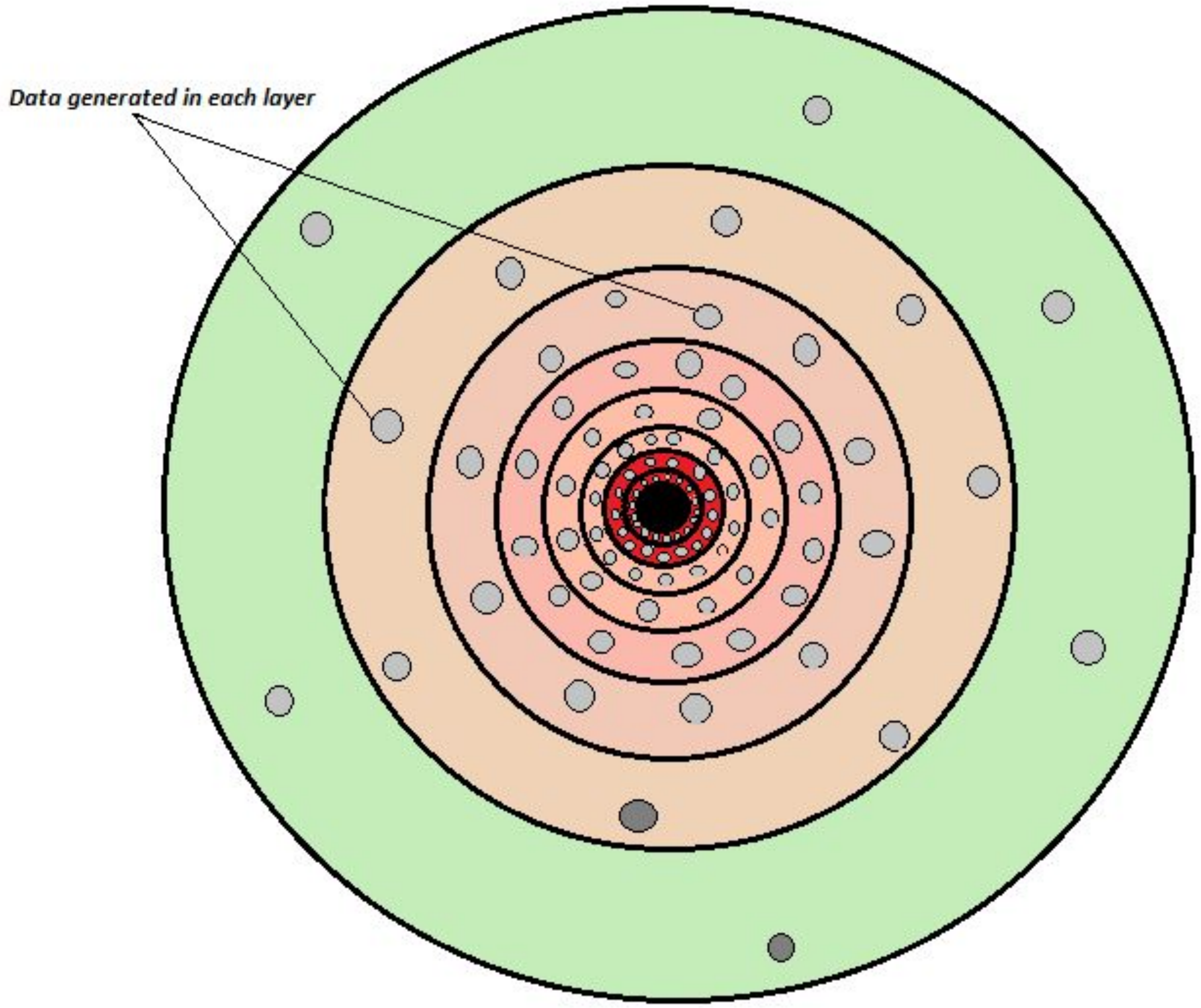
   *Annulus number is derived u*sin*g equation*

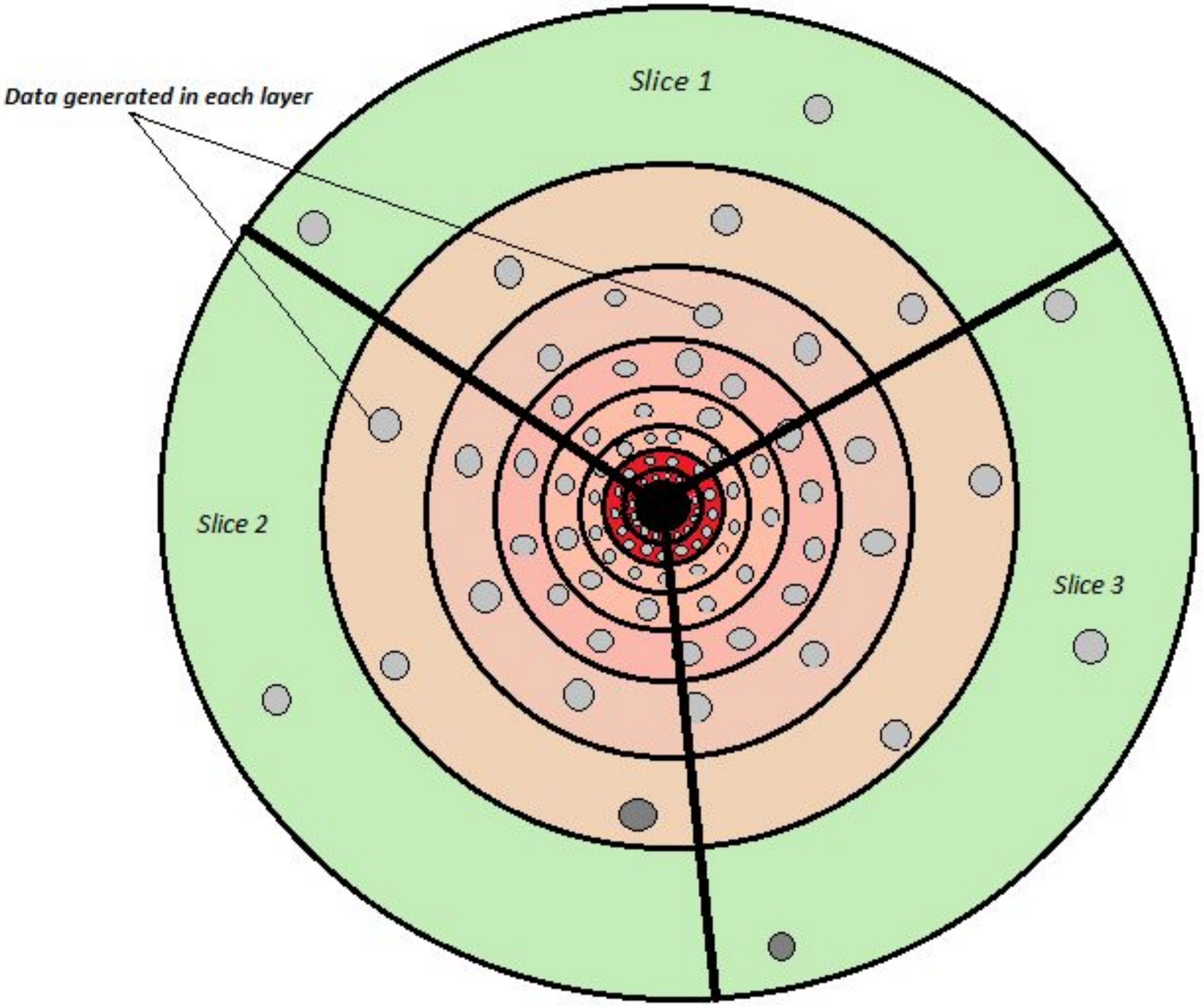
$$A_i = \begin{cases} \dfrac{h_i}{2} \Rightarrow\Rightarrow \text{ if } h_i \text{ is even} \\ \hline \dfrac{h_i - 1}{2} \Rightarrow\Rightarrow \text{ if } h_i \text{ is odd} \end{cases}$$

9. $W_i = \varepsilon\, e^{-\varepsilon_i t}$
10. $W_i = W_i - W$
11. $R_i = \dfrac{L_{i-1} R_{i-1}}{L_i}$
12. $Wait\,(W_i)$

    broadcast the Hello Packet

13. *else*
14. *discard the packet* /* *delayed packet* * /
15. *end if*
16. *end begin*


Data generated in each layer

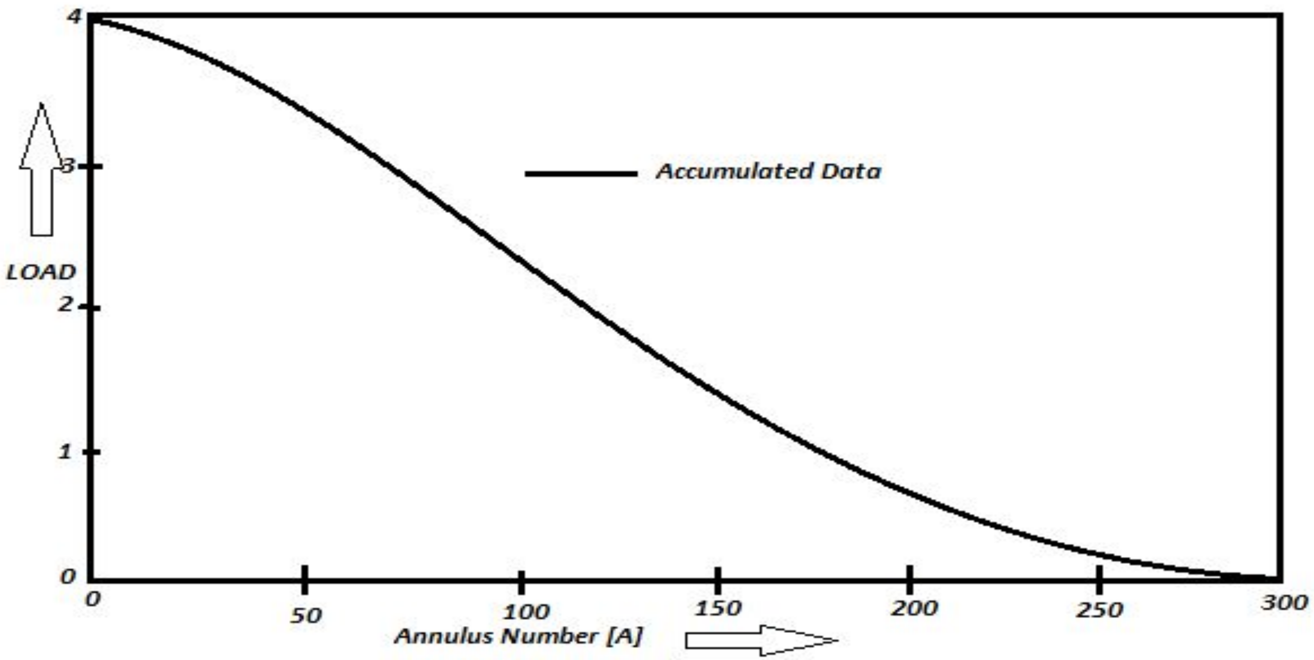

Data generated in each layer
Slice 1
Slice 2
Slice 3

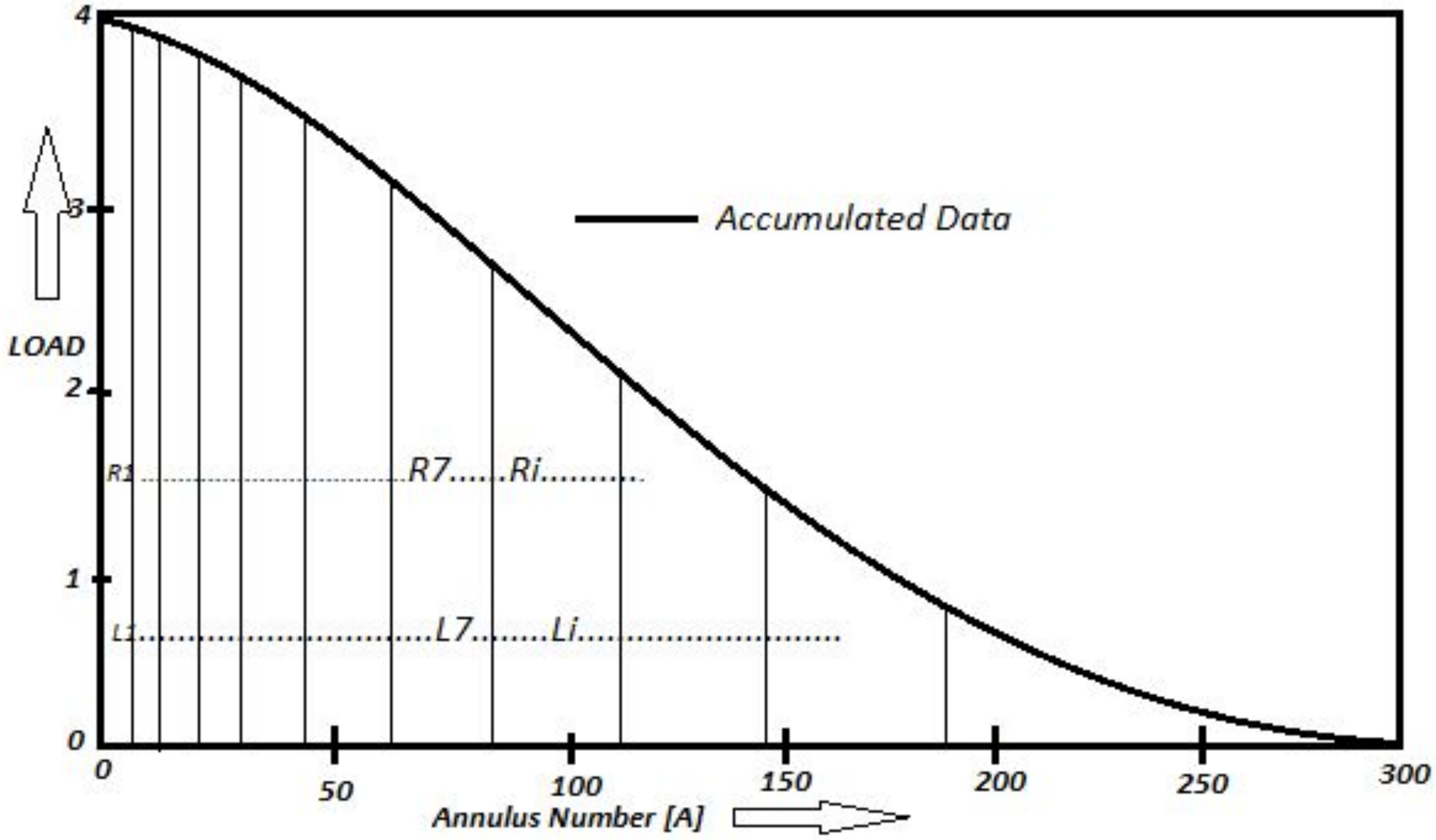
Routing Algorithm

p_{id} : *packet identity assigned to the packet*
s_{id} : *sender identity*
r_{id} : *received dentity*
begin
A packet is genrated or received at ith sensor
If (data is generated by itself)
/ select a next hop sensor to forward the packet */*
if (sensor is lower annulus is available in the Hello List)
choose one with highest residual energy.
else
choose a sensor from its own annulus with highest residual energy
end if
s_{id} = *identity of a sensor which is genrating packet*
r_{id} = *identity of a next hop sensor*
transmit packet with transmission range R_i
end if
end begin.

Load Equalization

- $$\text{Load} = \frac{Amount\ of\ data\ in\ the\ annulus}{Area\ of\ the\ annulus}$$





4
3
2
1
0
LOAD
Accumulated Data
R1
R7......Ri..........
L1
L7.......Li
0
50
100
150
200
250
300
Annulus Number [A]

Implementation

For this implementation

- Number of cluster are 9 (3 concentric slice and 3 radial lines)
- Each concentric slice is further equally divided by radial lines and are equal.
- Concentric circle radius increases in exponential rate.
- No. of sensor in each cluster are unequal.
- Sensor node are placed uniformly.
- Sensor are energy constrained and are in non harvesting state.

Important Functions

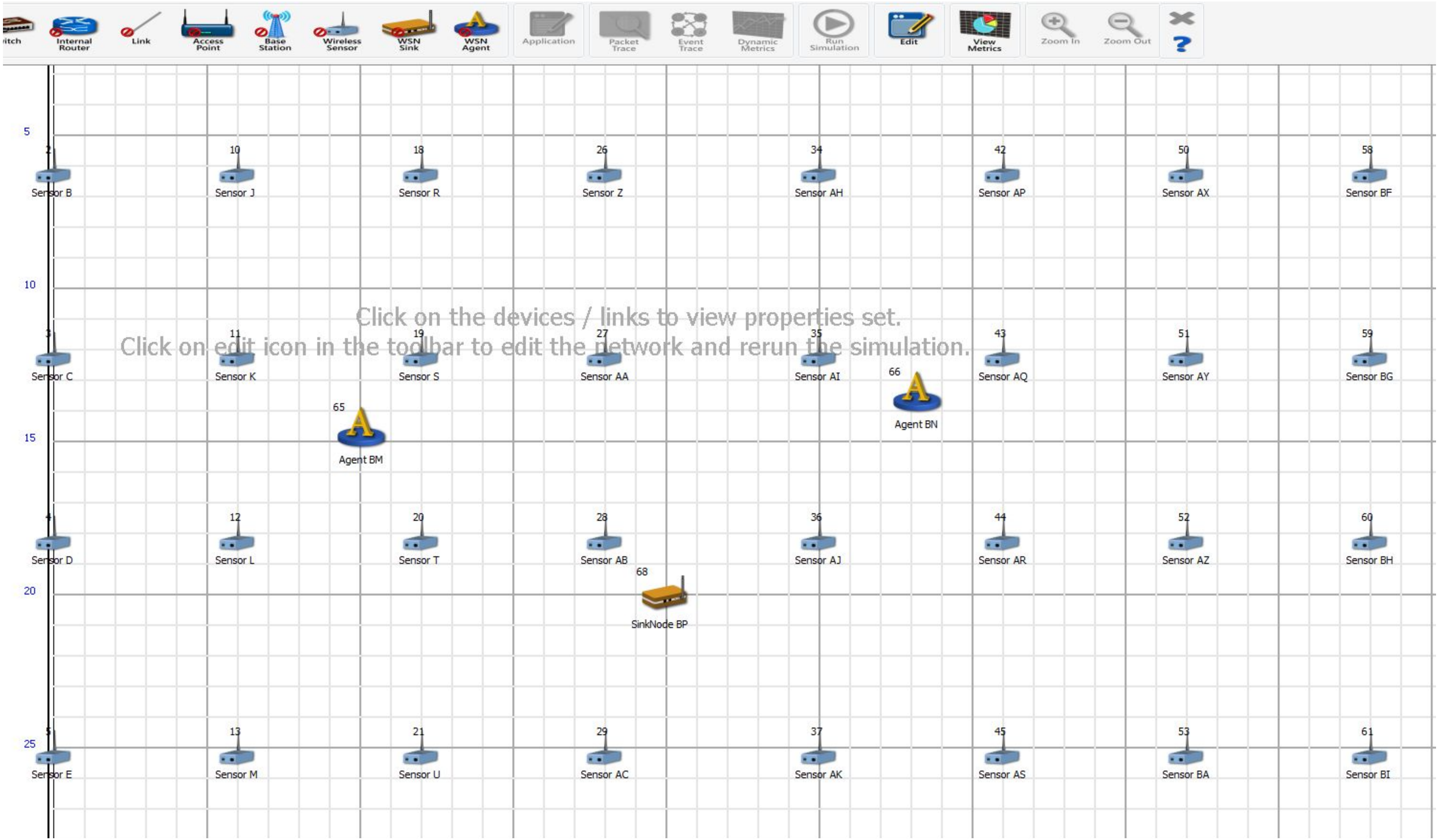
CheckDestination() This function is used to check whether the current device is the destination (i.e) the sinknode or not. Else the packet will be forwarded to the next hop.

GetNextHop() This function is used to identify the next hop in cases where the current device is either a sensor within the inside cluster or the side cluster. Static routes are defined in this function. It returns the Device ID of the next hop.

ClusterAssign () This function is used to assign cluster to each of the sensor node by determining sensor location with respect to sinknode.

ClusterAssign()

```
for(SensorID = 1; SensorID <=NUMBEROFSENSOR;SensorID++){
lb:
        Sensor_X = DEVICE_POSITION(SensorID)->X - SinkNode_X;
        Sensor_Y = SinkNode_Y - DEVICE_POSITION(SensorID)->Y;
        Sensor_Sinknode_distance = fn_NetSim_Utilities_CalculateDistance(DEVICE_POSITION(NUMBEROFSENSOR + 1),
                                DEVICE_POSITION(SensorID));
            for(i=0;i<NUMBEROFCONCENTRICCIRCLE+1;i++){
                  if(Sensor_Sinknode_distance <= CONCENTRIC_DISTANCE[i]){
                Sensor_Angle = (180 * atan2(Sensor_Y,Sensor_X)) / PI;
                for(j=0;j< NUMBEROFSENSOR;j++){
                        if(CLUSTER_DATA[i][(int)(Sensor_Angle/angle)][j] == 0){
                                CLUSTER_DATA[i][(int)(Sensor_Angle/angle)][j] = SensorID;
                                SensorID++;
                                goto lb;
                        }
                }
                  }
}
```

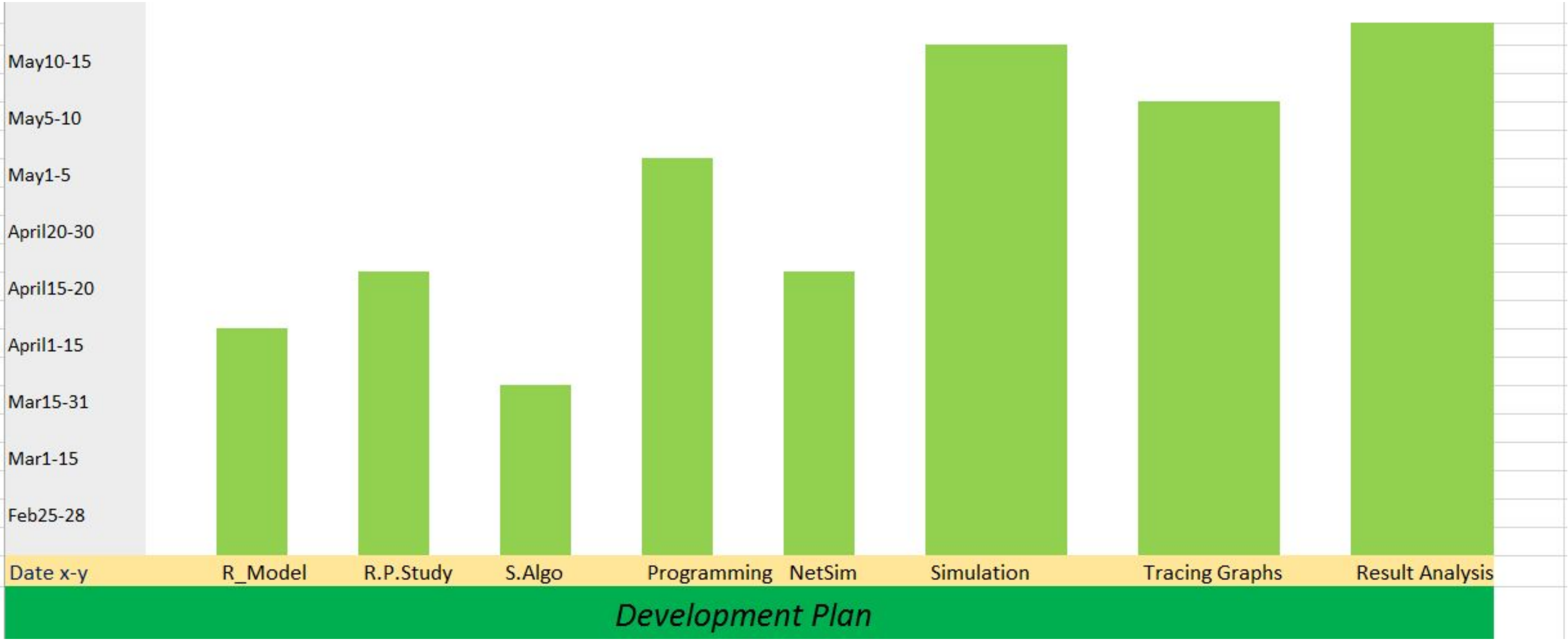


itch
Internal Router
Link
Access Point
Base Station
Wireless Sensor
WSN Sink
WSN Agent
Application
Packet Trace
Event Trace
Dynamic Metrics
Run Simulation
Edit
View Metrics
Zoom In
Zoom Out
5
10
15
20
25
Click on the devices / links to view properties set.
Click on edit icon in the toolbar to edit the network and rerun the simulation.
2 Sensor B
10 Sensor J
18 Sensor R
26 Sensor Z
34 Sensor AH
42 Sensor AP
50 Sensor AX
58 Sensor BF
3 Sensor C
11 Sensor K
19 Sensor S
27 Sensor AA
35 Sensor AI
43 Sensor AQ
51 Sensor AY
59 Sensor BG
65 Agent BM
66 Agent BN
4 Sensor D
12 Sensor L
20 Sensor T
28 Sensor AB
36 Sensor AJ
44 Sensor AR
52 Sensor AZ
60 Sensor BH
68 SinkNode BP
5 Sensor E
13 Sensor M
21 Sensor U
29 Sensor AC
37 Sensor AK
45 Sensor AS
53 Sensor BA
61 Sensor BI

Cluster Log

```
CLUSTER (0, 0)  [  ]

CLUSTER (0, 1)  [  28  ]

CLUSTER (0, 2)  [  ]

CLUSTER (0, 3)  [  29  ]


CLUSTER (1, 0)  [  36  37  ]

CLUSTER (1, 1)  [  20  27  ]

CLUSTER (1, 2)  [  ]

CLUSTER (1, 3)  [  5  6  7  13  14  15  16  21  22  23  24  30  31  32  ]


CLUSTER (2, 0)  [  33  34  35  38  39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  58  59  60  61  62  ]

CLUSTER (2, 1)  [  2  3  4  9  10  11  12  17  18  19  25  26  ]

CLUSTER (2, 2)  [  ]

CLUSTER (2, 3)  [  ]
```

Development Plan



Conclusion

The enhanced energy model for wireless sensor network presented, the significance of energy rationalization for **providing satisfactory coverage and enhancing lifetime of the network.**

As of now static routing needs to be done so exact percentage growth in lifetime is not possible to calculate.

Thank You