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Different node deployments in a square area grid of wireless sensor network and optimal number of relays

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Abstract

Wireless sensor networks deployment is an important issue to be considered when trying to cover an area with sensors, our work focuses on the deployment of a grid network for larger number of sensor nodes from 36 nodes up to 100 nodes. We study different cases of distances between source an destination, the result showed the diagonal path is the best path where least energy consumption are consumed. The diagonal path use number of intermediate nodes (relays) along it. Our result show the best number of relay nodes and different distances between source node and destination node according to some threshold distances.

Keywords

Node deployment, relay nodes, power consumption.

1. Introduction

A wireless sensor network is a collection of sensor nodes which are consist of sensing unit, processing unit, transceiver unit, and power unit [1]. The sensor nodes collect the data from its environment and send the collected data to the single hop neighboring nodes which in turn send this data to the sink node [2]. Sensor nodes deployment is an important issue in terms of coverage, connectivity, cost and lifetime [3]. In [4-7] the deployment issue with ensuring network connectivity and system lifetime maximization where very well investigated. In [8] the authors discussed the optimal power consumption in cooperative WSNs where nodes are deployed in grid manner for 2x2 network (4 nodes) up to 5x5 grid network (25 node). Power consumption is a very important issue that should be taken into account when deploying nodes in a field. In this paper we discuss the power consumption with different cases of node deployment in grid of network of 6x6 up to 10x10 network. The rest of this paper is organized as follows: In section 2, energy analysis of wireless transmission and network model are presented, in the next section, the experimental results are analyzed, and discussion and conclusion are given in section 4.

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2. Energy analysis of wireless transmission and network model

To transmit a data from the source node to the destination node, number of relay nodes can be used to reduce the power consumption required for the transmission. These relay nodes will act as a router which receive the data, amplify the data signal and forward it to next neighbor. Receiving, amplifying, and forwarding data can be expressed by the following models [9, 11]:

$$ETx(k, d) = ETx\_elec \times K + \varepsilon amp \times K \times d^2 \quad (1)$$

$$ERx(K) = ERx\_elec \quad (2)$$

Where:

$ETx(k, d)$: Power consumption in transmission of *K* bits for distance *d*

$ERx(K)$: Power consumption in reception of *K* bits

ERx_elec : Power consumption in the sensor node receiver circuit to process 1 bit

ETx_elec : Power consumption in the sensor node transmitter circuit to process 1 bit

$\varepsilon\ amp$: Power consumption by amplifier

K : Data size in bits

d: Distance between the two nodes

We use static nodes that are equally spaced from each other in 2-d grid network [10]. The following parameters are used:

N: The total number of nodes in the network (36, 49, 64, 81 and 100) node.

d_{row}: The distance from the first node to the last node in the same row/column (in meters).

K: 1-bit.

3. Experimental results

For all cases (6x6 ,7x7, 8x8, 9x9 and 10x10), we use *Єamp* = 100 pJ/bit/m2, *ERX_elec* = 50 nJ/bit, *ETX_elec* = 50 nJ/bit as in [8,12] for calculating the power consumption represented by (1) and (2). Also we assume the source node and the destination node are the two farthest nodes in the grid that sends and receives data along the diagonal path.

3.1 Analysis and experimental result of 6x6 network:

We assume source node 1 sends data to destination node 36 as in figure1.

Case 1: direct path from node 1 to node 36 without any relay, noting that the distance from node 1 to node 36 is $\sqrt{2}\ d_{row}$:

$$E6x6 - direct = 2 \text{ X } 0.1\, drow^2 + 100 \quad (3)$$

Case2: By using relay nodes:

For one relay case:

- Node 8 = node 29 because each of them has one short transmission and four long transmission blocks. So the total power consumption after applying (1) and (2) is:

$$E6x6 = \frac{3.4}{25} drow^2 + 200 \qquad (4)$$

- Node 15 = node 22:

$$E6x6 = \frac{2.6}{25} drow^2 + 200 \qquad (5)$$

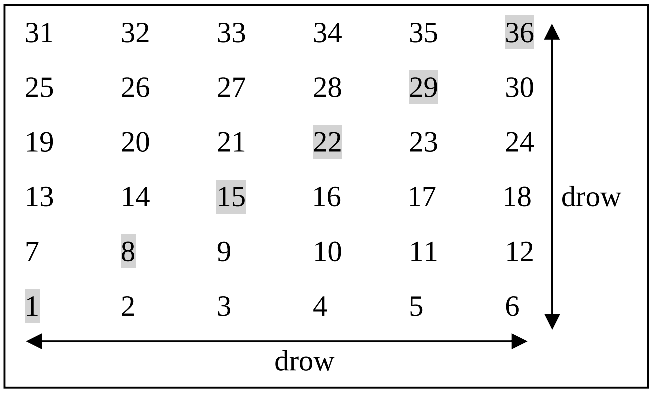

Figure1: wireless sensor nodes in 6x6 deployment

For two relays case:

- Nodes (8,15) = (8,29) = (22,29):

$$E6x6 = \frac{2.2}{25} drow^2 + 300 \qquad (6)$$

- Nodes (8,22) =(15,22)=(15,29):

$$E6x6 = \frac{1.8}{25} drow^2 + 300 \qquad (7)$$

For three relays case:

- Nodes (8,15,22) = (8,15,29) = (8,22,29) = (15,22,29):

$$E6x6 = \frac{1.4}{25} drow^2 + 400 \qquad (8)$$

For four relays case:

- Nodes (8,15,22,29):

$$E6x6 = \frac{1}{25} drow^2 + 500 \qquad (9)$$

For the case of 6x6 we will have the following four lemmas:

Lemma 1:

Threshold distance between the optimal power consumption using direct path and using one relay (in the middle either node15 or 22) in 6x6 grid is 32.27 m.

Proof:

Set (3) and (5) together to get:

$$2 \text{ X } 0.1\, drow^2 + 100 = \frac{2.6}{25} drow^2 + 200$$

Implies: drow= 32.27 m.

Lemma 2:

Threshold distance between the optimal power consumption using one relay path (middle) and using two relays (node 15 and 22) in 6x6 grid is 56 m.

Proof:

Set (5) and (7) together to get:

$$\frac{2.6}{25} drow^2 + 200 = \frac{1.8}{25} drow^2 + 300$$

Implies: drow □ 56m

Lemma 3:

Threshold distance between the optimal power consumption using two and three relays in 6x6 grid is 79 m.

Proof:

Set (7) and (8) together to get:

$$\frac{1.8}{25} drow^2 + 300 = \frac{1.4}{25} drow^2 + 400$$

Implies: drow □ 79m

Lemma 4:

Threshold distance between the optimal power consumption using three and four relays in 6x6 grid is 79 m.

Proof:

Set (8) and (9) together to get:

$$\frac{1.4}{25} drow^2 + 400 = \frac{1}{25} drow^2 + 500$$

Implies: drow□ 79 m.

In 6x6 grid network, we notice that direct path is best up to 32.27 m, then using one relay would give better power consumption for up to distance 56 m, and then four relays would be the choice for distance longer than 79 m.

1.2 Analysis and experimental results of 7x7 deployment:

We assume source node 1 sends data to destination node 49 as in figure2:

Case 1: direct path from node 1 to node 49 without any relay:

$$E7x7 - direct = 2 \times 0.1\, drow^2 + 100 \qquad (10)$$

Case2: As in 6x6 deployment, number of relay nodes exist, but the most optimal relay nodes that consume less transmission blocks are:

For one relay case:

- Node 25:

$$E7x7 = \frac{3.6}{36} drow^2 + 200 \qquad (11)$$

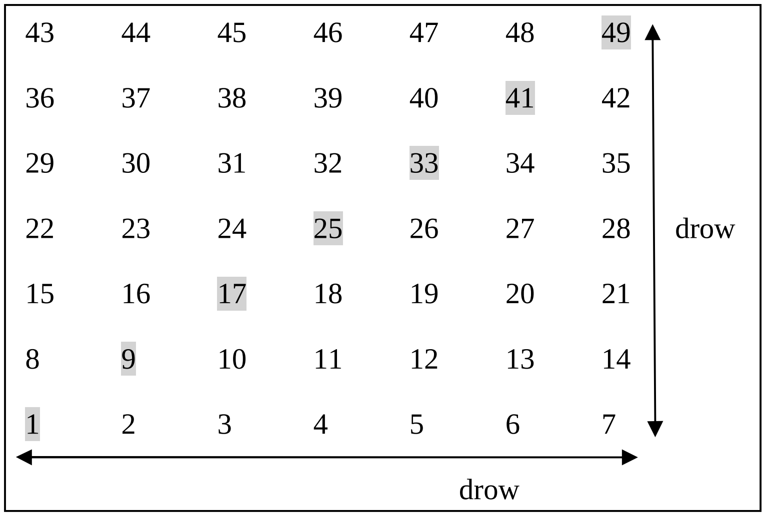

Figure2: wireless sensor nodes in 7x7 deployment

For two relays case:

- Nodes (17,33):

$$E7x7 = \frac{2.4}{36} drow^2 + 300 \quad (12)$$

For three relays case:

- Nodes(9,17,33)=(9,25,33)=(9,25,41)=(17,25,33)=(17,25,41)=(17,33,41):

$$E7x7 = \frac{2}{36} drow^2 + 400 \quad (13)$$

For four relays case:

- Nodes (9,17,25,33)=(9,17,25,41)=(9,17,33,41)=(9,25,33,41)=(17,25,33,41):

$$E7x7 = \frac{1.6}{36} drow^2 + 500 \quad (14)$$

For five relays case:

- Nodes (9,17,25,33,41):

$$E7x7 = \frac{1.2}{36} drow^2 + 600 \quad (15)$$

For the case of 7x7 we will have the following five lemmas:

Lemma 5:

Threshold distance between the optimal power consumption using direct path and using one relay in 7x7 grid is 31.62 m.

Proof:

Set (10) and (11) together to get:

$$2 \text{ X } 0.1\, drow^2 + 100 = \frac{3.6}{36} drow^2 + 200$$

Implies: drow = 31.62 m.

Lemma 6:

Threshold distance between the optimal power consumption using one and two relays in 7x7 grid is 54.77 m.

Proof:

Set (11) and (12) together to get:

$$\frac{3.6}{36}\text{drow}^2 + 200 = \frac{2.4}{36}\text{drow}^2 + 400$$

Implies: drow= 54.77 m.

Lemma 7:

Threshold distance between the optimal power consumption using two relays and three relays in 7x7 grid is 94.86 m.

Proof:

Set (12) and (13) together to get:

$$\frac{2.4}{36}\text{drow}^2 + 300 = \frac{2}{36}\text{drow}^2 + 400$$

Implies: drow = 94.86 m.

Lemma 8:

Threshold distance between the optimal power consumption using three relays and using four relays in 7x7 grid is 94.86 m.

Proof:

Set (13) and (14) together to get:

$$\frac{2}{36}\text{drow}^2 + 400 = \frac{1.6}{36}\text{drow}^2 + 500$$

Implies: drow= 94.86 m.

Lemma 9:

Threshold distance between the optimal power consumption using four and five relays in 7x7 grid is 94.86 m.

Proof:

Set (14) and (15) together to get:

$$\frac{1.6}{36}\text{drow}^2 + 500 = \frac{1.2}{36}\text{drow}^2 + 600$$

Implies: drow= 94.86 m.

In 7x7 grid network, we notice that direct transmission is best up to 31.62 m, after that one relay would give better power consumption up to distance 54.77 m, and then five relays would be the choice for distances longer than 94.86 m.

3.2 Analysis and experimental results of 8x8 deployment:

We assume source node 1 sends data to destination node 64 as in figure3:

57	58	59	60	61	62	63	64	
49	50	51	52	53	54	55	56	
41	42	43	44	45	46	47	48	
33	34	35	36	37	38	39	40	
25	26	27	28	29	30	31	32	drow
17	18	19	20	21	22	23	24	
9	10	11	12	13	14	15	16	
1	2	3	4	5	6	7	8	
			drow					

Figure 3: wireless sensor nodes in 8x8 deployment

Case 1: direct path from node 1 to node 64 without any relay:

$$E8x8 - direct = 2 \times 0.1\, drow^2 + 100 \qquad (16)$$

Case2: By using relay nodes:

For one relay:

- Node 28 = node 37:

$$E8x8 = \frac{5}{49} drow^2 + 200 \qquad (17)$$

For two relays case:

- Nodes (19,37)=(19,46)=(28,46):

$$E8x8 = \frac{3.4}{49} drow^2 + 300 \qquad (18)$$

For three relays case:

- Nodes (10,28,46) = (19,28,46) = (19,37,46) = (19,37,55):

$$E8x8 = \frac{2.6}{49} drow^2 + 400 \qquad (19)$$

For four relays case:

- Node (10,19,28,46) = (10,19,37,55) = (10,28,37,46) = (10,28,46,55) = (10,28,37,55) = (19,28,37,46) = (19,28,37,55) = (19,37,46,55) = (19,28,46,55):

$$E8x8 = \frac{2.2}{49} drow^2 + 500 \qquad (20)$$

For five relays case:

- Nodes (10,19,28,37,46) = (10,19,28,37,55) = (10,19,28,46,55) = (10,19,37,46,55) = (10,28,37,46,55) = (19,28,37,46,55):

$$E8x8 = \frac{1.8}{49} drow^2 + 600 \tag{21}$$

For six relays case:

- Nodes (10,19,28,37,46,55):

$$E8x8 = \frac{1.4}{49} drow^2 + 700 \tag{22}$$

For the case of 8x8 we will have the following six lemmas:

Lemma 10:

Threshold distance between the optimal power consumption using direct path and using one relay in 8x8 grid is 33.33 m.

Proof:

Set (16) and (17) together to get:

$$2 \text{ X } 0.1\, drow^2 + 100 = \frac{5}{49} drow^2 + 200$$

Implies: drow = 33.33 m.

Lemma 11:

Threshold distance between the optimal power consumption using one and relays in 8x8 grid is 55.33 m.

Proof:

Set (17) and (18) together to get:

$$\frac{5}{49} drow^2 + 200 = \frac{3.4}{49} drow^2 + 300$$

Implies: drow= 55.33 m.

Lemma 12:

Threshold distance between the optimal power consumption using two and three relays in 8x8 grid is 78.26 m.

Proof:

Set (18) and (19) together to get:

$$\frac{3.4}{49} drow^2 + 300 = \frac{2.6}{49} drow^2 + 400$$

Implies: drow = 78.26m.

Lemma 13:

Threshold distance between the optimal power consumption using three and four relays in 8x8 grid is 110.67 m.

Proof:

Set (19) and (20) together to get:

$$\frac{2.6}{49} drow^2 + 400 = \frac{2.2}{49} drow^2 + 500$$

Implies: drow= 110.67 m.

Lemma 14:

Threshold distance between the optimal power consumption using four and five relays in 8x8 grid is 110.67 m.

Proof:

Set (20) and (21) together to get:

$\frac{2.2}{49}drow^2 + 500 = \frac{1.8}{49}drow^2 + 600$

Implies: drow= 110.67 m.

Lemma 15:

Threshold distance between the optimal power consumption using five and six relays in 8x8 grid is 110.67 m.

Proof:

Set (21) and (22) together to get:

$\frac{1.8}{49}drow^2 + 600 = \frac{1.4}{49}drow^2 + 700$

Implies: drow=110.67 m.

In 8x8 grid network, we notice that direct transmission is good up to 33.33 m , then one relay is better for distances up to 55.33, two relays would be the choice for distance up to 78.26 m , and then six relays would give best power consumption for distances longer than 110.67 m.

3.3 Analysis and experimental results of 9x9 deployment:

We assume source node 1 sends data to destination node 81 as in figure4:

Case 1: direct path from node 1 to node 81 without any relay:

$$E9x9 - direct = 2 X 0.1\, drow^2 + 100 \quad (23)$$

Case2: By using relay nodes:

For one relay case:

- Node 41

$$E9x9 = \frac{6.4}{64}drow^2 + 200 \quad (24)$$

For two relays case:

- Nodes (11,41)=(31,41)=(31,71)=(41,51)=(41,71)=(11,51):

$$E9x9 = \frac{5.2}{64}drow^2 + 300 \quad (25)$$

For three relays case: 8

- Nodes(11,21,51) = (11,41,51) = (11,41,71) = (31,41,51) = (31,41,71) = (31,61,71):

$$E9x9 = \frac{4}{64}drow^2 + 400 \quad (26)$$

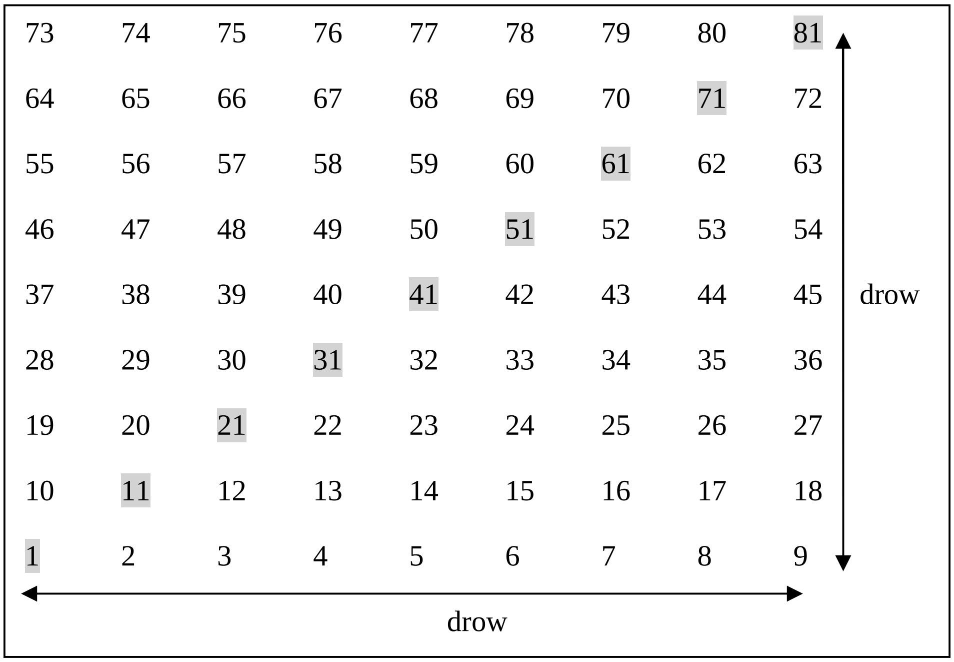

Figure4: wireless sensor nodes in 9x9 deployment

For four relays case:

- Nodes (11,21,31,51) = (11,21,31,61) = (11,21,41,51) = (11,21,41,71) = (11,21,51,61) = (11,21,51,71) = (11,31,41,51) = (11,31,41,71) = (11,41,51,61) = (11,4151,71) = (11,41,61,71) = (21,31,41,51) = (21,31,41,71) = (21,51,61,71) = (31,41,51,61) = (31,41,51,71) = (31,41,61,71) = (31,51,61,71) = (11,31,61,71):

$$E9x9 = \frac{3.2}{64} drow^2 + 500 \tag{27}$$

For five relays case:

- Nodes (11,21,31,41,61) = (11,21,31,51,61) = (11,21,3151,71) = (11,21,41,51,61) = (11,21,41,51,71) = (11,21,41,61,71) = (11,31,41,51,61) = (11,31,41,51,71) = (11,31,51,61,71) = (21,31,41,51,61) = (21,31,41,51,71) = (21,31,41,61,71) = (21,31,51,61,71) = (21,41,51,61,71):

$$E9x9 = \frac{2.4}{64} drow^2 + 600 \tag{28}$$

For six relay nodes case:

- Nodes (11,21,31,41,51,61) = (11,21,31,41,51,71) = (11,21,31,51,61,71) = (11,21,41,51,61,71) = (11,31,41,51,61,71) = (21,31,41,51,61,71):

$$E9x9 = \frac{2}{64} drow^2 + 700 \tag{29}$$

For seven relay nodes: (11,21,31,41,51,61,71)**:**

$$E9x9 = \frac{1.6}{64} drow^2 + 800 \tag{30}$$

For the case of 9x9 we will have the following seven lemmas:

Lemma 16:

Threshold distance between the optimal power consumption using direct transmission and one relay in 9x9 grid is 31.62 m.

Proof:

Set (23) and (24) together to get:

$$2 \text{ X } 0.1\, drow^2 + 100 = \frac{6.4}{64} drow^2 + 200$$

Implies: drow=31.62 m.

Lemma 17:

Threshold distance between the optimal power consumption using one and two relays in 9x9 grid is 73m.

Proof:

Set (24) and (25) together to get:

$$\frac{6.4}{64} drow^2 + 200 = \frac{5.2}{64} drow^2 + 300$$

Implies: drow= 73 m.

Lemma 18:

Threshold distance between the optimal power consumption using two and three relays in 9x9 grid is 73m.

Proof:

Set (25) and (26) together to get:

$$\frac{5.2}{64} drow^2 + 300 = \frac{4}{64} drow^2 + 400$$

Implies: drow= 73m.

Lemma 19:

Threshold distance between the optimal power consumption using three and four relays in 9x9 grid is 89.44 m.

Proof:

Set (26) and (27) together to get:

$$\frac{4}{64} drow^2 + 400 = \frac{3.2}{64} drow^2 + 500$$

Implies: drow = 89.44 m

Lemma 20:

Threshold distance between the optimal power consumption using four and five relays in 9x9 grid is 89.44 m.

Proof:

Set (27) and (28) together to get:

$\frac{3.2}{64}$drow² + 500 = $\frac{2.4}{64}$drow² + 600

Implies: drow = 89.44 m.

Lemma 21:

Threshold distance between the optimal power consumption using five and six relays in 9x9 grid is 126.5 m.

Proof:

Set (28) and (29) together to get:

$\frac{2.4}{64}$drow² + 600 = $\frac{2}{64}$drow² + 700

Implies:

drow = 126.5 m.

Lemma 22:

Threshold distance between the optimal power consumption using six and seven relays in 9x9 grid is 126.5 m.

Proof:

Set (29) and (30) together to get:

$\frac{2}{64}$drow² + 700 = $\frac{1.6}{64}$drow² + 800

Implies: drow = 126.5 m.

In 9x9 grid network, we notice that direct transmission is best up to 31.62 m, then three relays is better for distance up to 73 m, five relays would be the choice for up to distance 89.44 m. seven relays would give the optimal power consumption for distances longer than 126.5 m.

3.4 Analysis and experimental results of 10x10 deployment:

We assume source node 1 sends data to destination node 100 as in figure 5:

Case 1: direct path from node 1 to node 100 without any relay:

$$E10x10 - direct = 2 \times 0.1\, drow^2 + 100 \quad (31)$$

Case2: By using relay nodes:

For one relay case:

- Node 45=56:

$$E10x10 = \frac{8.2}{81} drow^2 + 200 \quad (32)$$

For two relays case:

- Nodes (34,67):

$$E10x10 = \frac{5.4}{81} drow^2 + 300 \quad (33)$$

91	92	93	94	95	96	97	98	99	100
81	82	83	84	85	86	87	88	89	90
71	72	73	74	75	76	77	78	79	80
61	62	63	64	65	67	67	68	69	70
51	52	53	54	55	56	57	58	59	60
41	42	43	44	45	46	47	48	49	50
31	32	33	34	35	36	37	38	39	40
21	22	23	24	25	26	27	28	29	30
11	12	13	14	15	16	17	18	19	20
1	2	3	4	5	6	7	8	9	10

drow

drow

Figure5: wireless sensor nodes in 10x10 deployment

For three relays case:

- Nodes(34,56,78)=(23,56,78)=(23,45,78)=(23,45,67):

$$E10x10 = \frac{4.2}{81} drow^2 + 400 \qquad (34)$$

For four relays case:

- Nodes (12,34,56,78)=(23,34,56,78)=(23,45,56,78)=(23,45,67,78)=(23,45,67,89)=(23,56,67,78) =(23,56,67,89):

$$E10x10 = \frac{3.4}{81} drow^2 + 500 \qquad (35)$$

For five relays case:

- Nodes (12,23,34,56,78) = (12,23,45,56,89) = (12,23,45,67,78) = (12,23,45,67,89) = (12,34,45,67,78) = (12,34,45,67,89) = (12,34,56,67,78) = (12,34,56,67,89) = (12,34,56,78,89) = (23,34,45,56,78) = (23,34,45,67,78) = (23,34,56,67,78) = (23,34,56,67,89) = (23,34,56,78,89) = (23,45,56,67,78) = (23,45,56,67,89) = (23,45,67,78,89):

$$E10x10 = \frac{3}{81} drow^2 + 600 \qquad (36)$$

For six relay nodes case:

- Nodes (12,23,34,45,56,78) = (12,23,34,45,56,78) = (12,23,34,45,67,89) = (12,23,34,56,67,78) = (12,23,34,56,67,89)= (12,23,34,56,78,89 = (12,23,34,67,78,89) =

(12,23,45,56,67,78) = (12,23,45,56,67,89) = (12,23,45,56,78,89) = (12,23,45,67,78,89) = (23,34,45,56,67,78) = (23,34,45,56,67,89) = (23,34,45,56,78,89) = (23,34,45,67,78,89) = (23,34,56,67,78,89) = (23,45,56,67,78,89):

$$E10x10 = \frac{2.6}{81} drow^2 + 700 \quad (37)$$

for seven relay nodes case:

- Nodes (12,23,34,45,56,67,78) = (12,23,34,45,56,67,89) = (12,23,34,45,56,78,89) = (12,23,34,45,67,78,89) = (12,23,34,56,67,78,89) = (12,23,45,56,67,78,89) = (12,34,45,56,67,78,89) =(23,34,45,56,67,78,89):

$$E10x10 = \frac{2.2}{81} drow^2 + 800 \quad (38)$$

For eight relay nodes:

- Nodes (12,23,34,45,56,67,78,89):

$$E10x10 = \frac{1.8}{81} drow^2 + 900 \quad (39)$$

For 10x10 grid deployment we will have the following eight lemmas:

Lemma 23:

Threshold distance between the optimal power consumption using direct transmission and one relay in10x10 grid is 33.33 m.

Proof:

Set (31) and (32) together to get:

$$2 \text{ X } 0.1\, drow^2 + 100 = \frac{8.2}{81} drow^2 + 200$$

Implies: drow = 33.33 m.

Lemma 24:

Threshold distance between the optimal power consumption using one and two relays in 10x10 grid is 53.78 m.

Proof:

Set (32) and (33) together to get:

$$\frac{8.2}{81} drow^2 + 200 = \frac{5.4}{81} drow^2 + 300$$

Implies: drow = 53.78 m.

Lemma 25:

Threshold distance between the optimal power consumption using two and three relays in10x10 grid is 82.15 m.

Proof:

Set (33) and (34) together to get:

$$\frac{5.4}{81} drow^2 + 300 = \frac{4.2}{81} drow^2 + 400$$

Implies: drow = 82.15 m.

Lemma 26:

Threshold distance between the optimal power consumption using three and four relays in10x10 grid is 100.62 m.

Proof:

Set (34) and (35) together to get:

$\frac{4.2}{81}\text{drow}^2 + 400 = \frac{3.4}{81}\text{drow}^2 + 500$

Implies: drow = 100.62 m.

Lemma 27:

Threshold distance between the optimal power consumption using four and five relays in10x10 grid is 142 m.

Proof:

Set (35) and (36) together to get:

$\frac{3.4}{81}\text{drow}^2 + 500 = \frac{3}{81}\text{drow}^2 + 600$

Implies: drow = 142 m.

Lemma 28:

Threshold distance between the optimal power consumption using five and six relays in 10x10 grid is 142 m.

Proof:

Set (36) and (37) together to get:

$\frac{3}{81}\text{drow}^2 + 600 = \frac{2.6}{81}\text{drow}^2 + 700$

Implies: drow = 142 m.

Lemma 29:

Threshold distance between the optimal power consumption using six and seven relays in 10x10 grid is 142 m.

Proof:

Set (37) and (38) together to get:

$\frac{2.6}{81}\text{drow}^2 + 700 = \frac{2.2}{81}\text{drow}^2 + 800$

Implies: drow = 142 m.

Lemma 30:

Threshold distance between the optimal power consumption using seven relays and eight relays in 10x10 grid is 142 m.

Proof:

Set (38) and (39) together to get:

$$\frac{2.2}{81}\text{drow}^2 + 800 = \frac{1.8}{81}\text{drow}^2 + 900$$

Implies: drow = 142 m.

In 10x10 grid network, we notice that direct transmission is best up to distance 33.33 m, then one relay node can be used up to distance 53.78 m, then two relays is better for distance 82.15 m, for up to 100.62 m three relays would be the choice , and finally for distance longer than 142 m, seven relays is the best.

4. Discussion and conclusion :

The direct transmission consumes much energy than using relays [8], so it is preferable to use efficient number of relays when transmitting from source to destination in order to reduce energy consumption to minimum. We studied the different cases of node deployment form 6x6 to 10x10 grid networks. The result shows that there are number of paths that the data can follow to be received by the destination, each of our selected paths to be as an optimal path consumes less energy than other paths.We explained what these paths are and which one is the best depending on the shortest transmission block.

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