A cluster based approach for delay minimization in data collection process for ieee 802.11s WMN

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Agenda

- Introduction
- Existing Model
- Problem statement
- Mathematical Model
- Illustrative Example
- Conclusion and Furture work

Introduction:

- This work focuses on minimizing delay in the process of data collection that occurs in a Wireless Mesh Network (WMN).
- As WMN are battery powered devices, consumption of energy is a major problem.
- In order to increase the lifetime of network, data collection efficiency is compromised.
- A cluster based approach is used to minimize the delay between the transmissions.
- Base station is static and rest of the nodes are dynamic.

Introduction:

- Each cluster contains a cluster head (CH) which collects data from the respective nodes in the cluster.
- Data is collected from the nodes by the CH in a single-hop manner.
- Slot allocation and scheduling are done based on remaining energy calculation and link duration respectively.
- Firstly data is collected from nodes and then from cluster head recursively.

Existing model:

- The existing model deals with the minimization of energy consumption by the nodes in WMN and in-turn minimizing the delay during the data transmission.
- This is done by clustering the nodes and a cluster head (CH) is selected.
- The CH collects the data from the Cluster members and fuses the data, then sends the data to the destination.
- Each node is assigned with the rank and the cluster head has the highest rank.
- This model is for multi-hop fixed topology, the nodes are static.

- Each node with rank k will have k-1 child nodes. The node with rank k needs k-1 time slot and extra 1 time slot to aggregate data to send that to the higher node.

- Thus the number of time slots increases as the aggregation of data increases.

- Thereby increasing the energy consumption, delay and decrease in QOS.

Problem statement:

- To minimize delay, increase data collection efficiency, increase throughput, decrease network overhead in WMN by modifying the existing LEACH protocol.
- The proposed model selects the cluster head based on maximum number of links, available energy and link duration.
- The nodes requesting the CH for data collection process is prioritized based on the duration of link between node and CH.
- Data is collected eventually by the cluster head and sent to the base station.

Proposed model:

- The proposed model is a single - hop wireless sensor network where base station (BS) remains static and nodes are dynamic within the cluster.

- The model consists of four major modules to minimize delay in data collection they are: cluster head selection, slot allocation, slot scheduling and data collection.

- The nodes are randomly distributed and are bounded by some region and if the node tries to cross the boundary of the cluster then the it is re-bounded by some angle theta.

- The link is established between two nodes only when the transmission range of both the nodes overlap.
- A cluster head is selected based on the number of links, maximum link duration, maximum energy and a decision parameter is used by the base station for CH selection.
- The link duration must be maximum in-order to avoid link breakages and re-transmission which thereby reduces the delay.

Proposed model:

- In the process of slot allocation the number of slots required for the node is calculated.
- We have considered five frames and in each frame there are eight slots.
- The slots for the nodes are given only if the remaining energy in the cluster head is greater than the requested energy from the node.
- These are scheduled based on link duration. The node which has maximum link duration with the CH will be given low priority and vice-versa.
- Further all the CHs which has fused data collected from all its nodes, will be allocated and scheduled in the same way and thus the data is collected at the base station.
- Since we consider the survivability of the node in data collection, delay and re- transmission rate is reduced.

Mathematical Model:

The equation which determines whether there is a link between two nodes is given based on the distance during which the link is connected,

$$d_{ij} = 2r_i cos\beta_{ij} \quad (1)$$

Existance of link is given by

$$l(i,j) = \begin{cases} 1, & \text{if } d_{ij} > 0 \text{ i.e link established.} \\ 0, & \text{no link present.} \end{cases} \quad (2)$$

Link duration between the cluster head and base station is given by,

$$ld_{ij} = \frac{d_{ij}}{v_i} \quad (3)$$

Number of links of each node in the cluster is given by,

$$nl_i = \sum_{j=1}^{N_c^i} l_{i,j} \quad (4)$$

Cluster head will be the node with maximum link duration, number of links and available energy as shown in the Equation 5.

$$CH = \max_{i \in N_c^i} (ld_{ij}, nl_i, AE_i) \quad (5)$$

Draining rate of a node is an important parameter to be considered in selecting the cluster head and it is given by,

$$DR_i = \frac{E_I - E_C}{T_1 - T_2} \qquad (12)$$

Survivability of nodes can be defined as the time during which the node can survive with its remaining energy calculated using Equation 12,

$$surv_i = \frac{RE_i}{DR_i} \qquad (13)$$

Decision parameter used by the base station to select the CH is given below,

$$Dp[i] = |ld_i - surv_i| \qquad (14)$$

where ld i is the link duration which can be calculated using Equation 3 and surv i can be determined using Equation 13

Cluster head will be the node with minimum dp value.

$$CH = min(Dp[i]) \qquad (15)$$

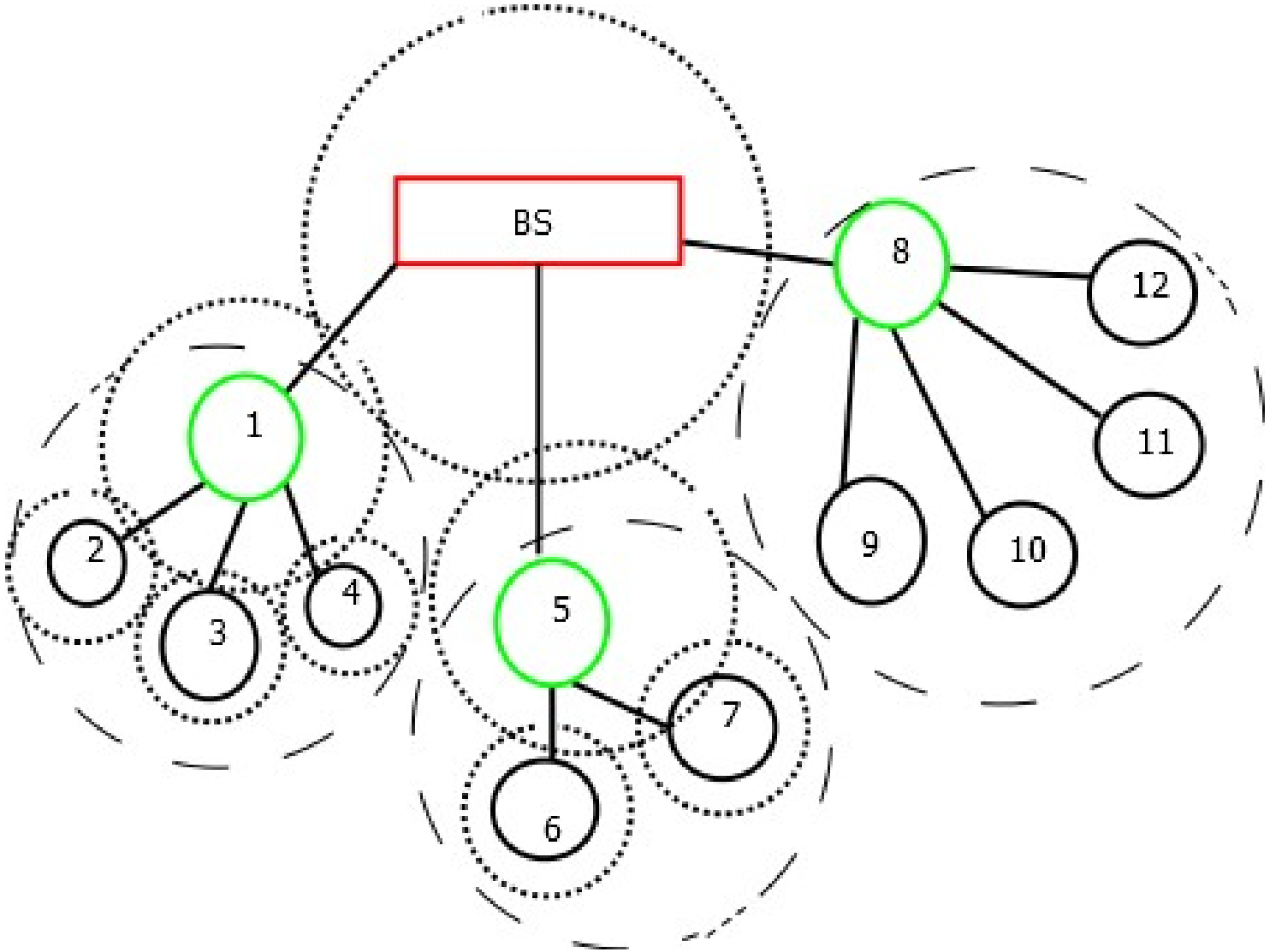
The priorities are assigned using:

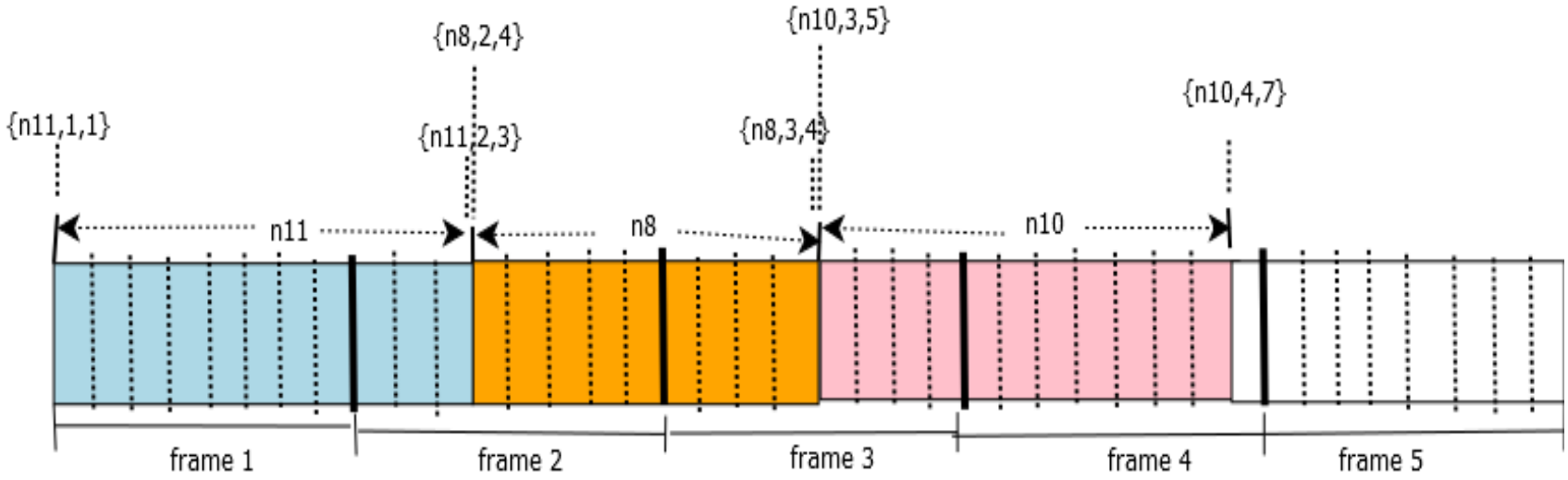
$$priority\{min\,(ld_{k,CH}, ld_{j,CH})\}\forall k, j \in N \qquad (22)$$

Where, $priority\{min\,(ld_{k,CH}, ld_{j,CH})\}$

$$= \begin{cases} Pr\,(k) + 1, & \text{if } ld_{k,CH} < ld_{j,CH}. \\ Pr\,(j) + 1, & \text{Otherwise.} \end{cases} \qquad (23)$$

Illustrative example:

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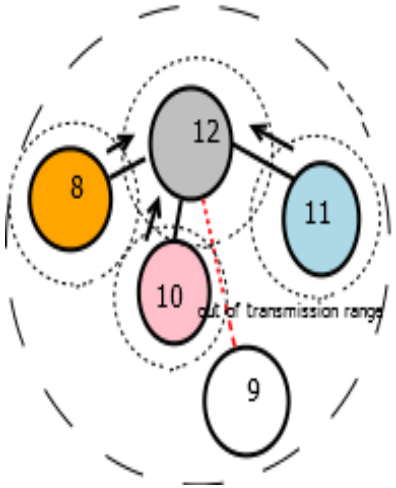
{n8,2,4}
{n11,2,3}
{n10,3,5}
{n8,3,4}
{n10,4,7}
n11
n8
n10
frame 1
frame 2
frame 3
frame 4
frame 5


12
8
11
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out of transmission range
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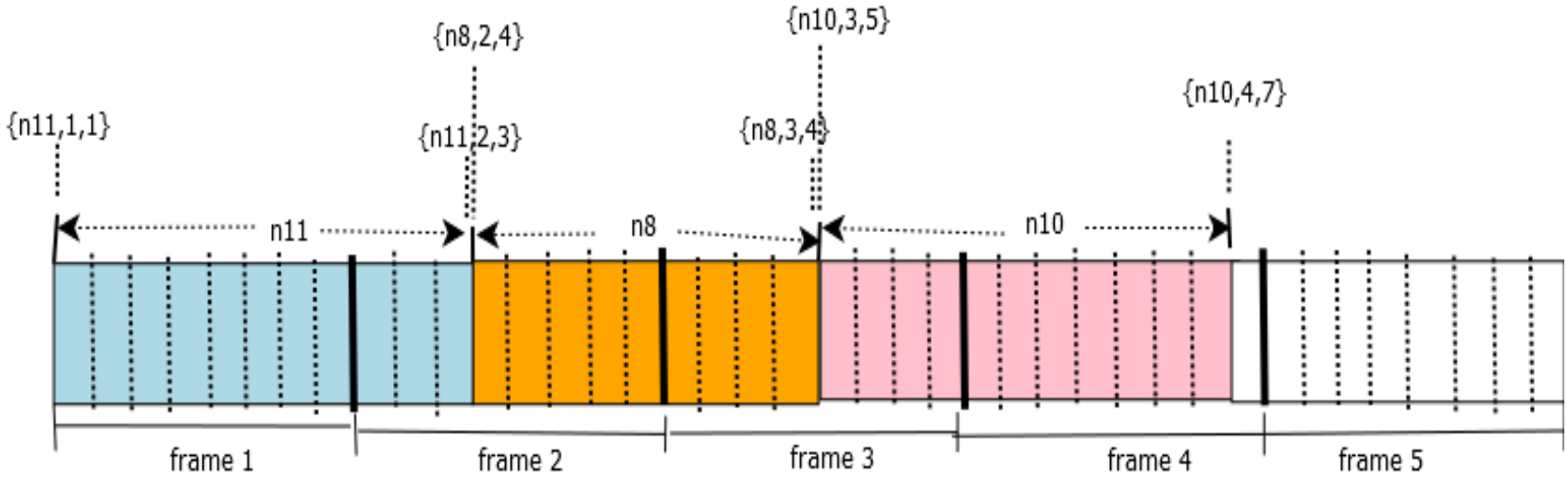
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frame 4
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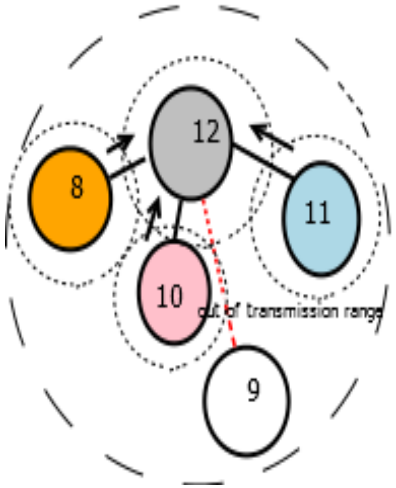
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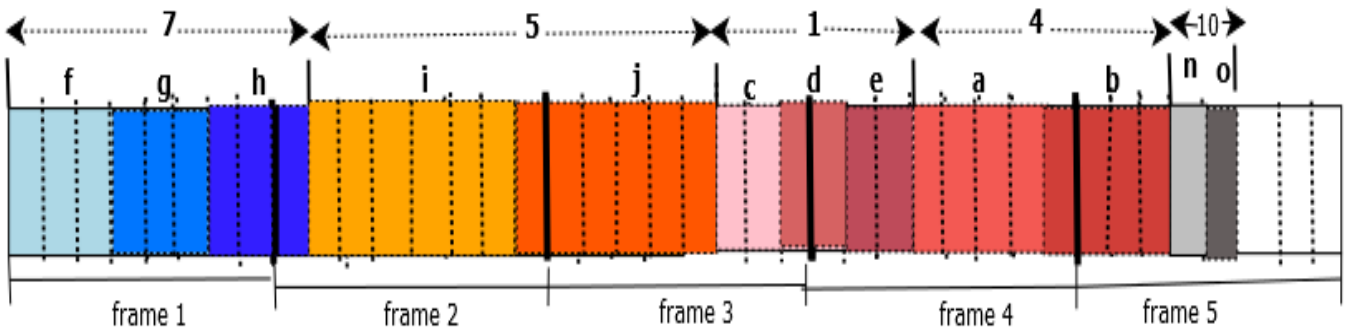

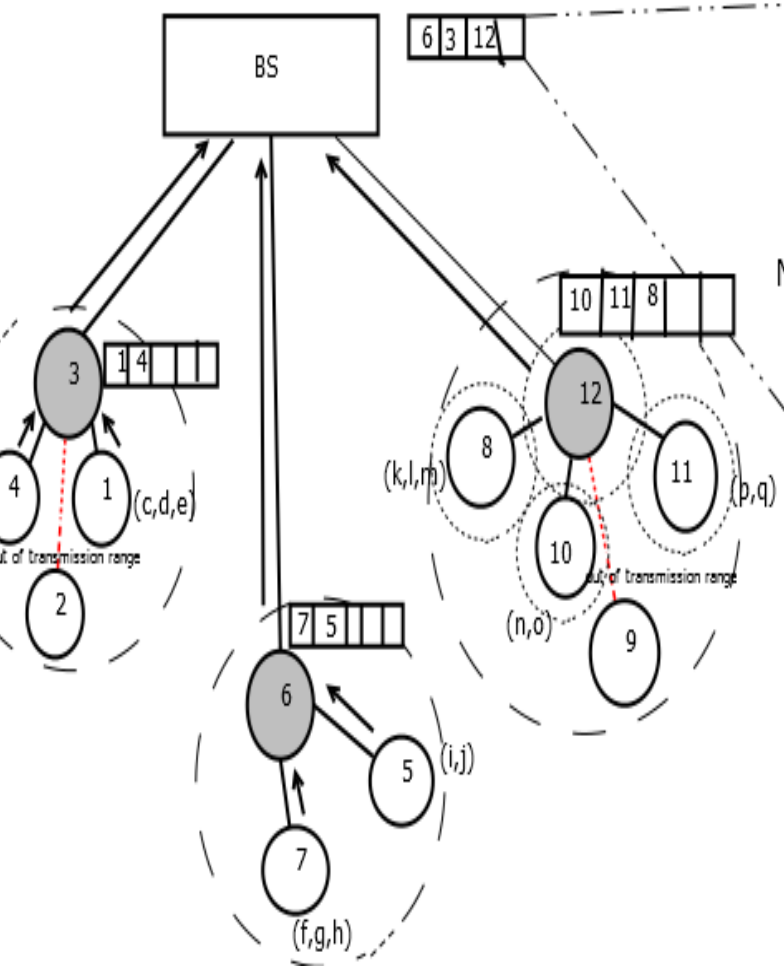

CH no.	6		3		12		
Node no.	7	5	1	4	10	11	8
Data	(f,g,h)	(i,j)	(c,d,e)	(a,b)	(n,o)	(p,q)	(k,l,m)
No. of time slots	(3,3,3)	(6,6)	(2,2,2)	(4,4)	(1,1)	w	w
Time	f {1,2,3} g {4,5,6} h {7,8,9}	i {10,11,12, 13,14,15} j {16,17,18, 19,20,21}	c { 22,23} d {24,25} e {26,27}	a {28,29,30,31} b {32,33,34,35}	n {36} o {37}	p q	k l m

Conclusion and Future Work

- In this work, we have considered a delay minimization technique for wireless mesh networks with consecutive data collection processes.
- This is achieved due to clustering of nodes which is done based on the location of nodes.
- Nodes are connected to the CH in a non-cyclic manner. Base station is static and nodes are considered to be dynamic in nature.
- The node within the cluster having maximum number of links, highlink duration and maximum available energy is selected as cluster head.
- Slot is allocated based on the remaining energy of node. Scheduling of nodes takes place based on the link duration. The proposed technique shows that more data can be collected in less time with minimum delay, without loss of data thereby increases the performance.
- Implementation of proposed model with dynamic clustering in the field of wireless mesh network will be our future work.

Thank You