Minimization of time Delay Using Concurrent Data Collection for IOT

Project report submitted in partial fulfillment of the requirement for the degree of Bachelor of Technology
in

Computer Science & Engineering
By

151416 Avinash Thakur

Under the supervision of

Mr. Arvind Kumar

To

Department of Computer Science & Engineering and Information Technology
Jaypee University of Information Technology, Waknaghat, Solan-173234, Himachal Pradesh

CERTIFICATE

This is to certify that this project report authorized as ***Minimization of time delay using Concurrent Data Collection for IOT based Applications*** submitted to ***Jaypee University of Information Technology***, is a bonafided record of work done by

151416 Avinash Thakur

underneath my supervision from ***January, 2019*** to ***May, 2019*** in partial fulfillment of the requirements for the honor of the degree of ***Bachelor of Technology*** *in* ***Computer Science &Engineering***.

The matter personified in the report has not been submitted for the honor of any other degree or diploma.

Mr. Arvind Kumar
Assistant Professor
Department of Computer Science & Engineering and IT

Dated:

ACKNOWLEDGEMENT

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(Avinash Thakur)

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LIST OF ABBREVIATIONS

IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
WSN	Wireless Sensor Network
CH	Cluster Head
CM	Cluster Member
DADCNS	Delay-Aware Data Collection Network Structure
CTP	Collection Tree Protocol
SC	Single Chain
ETX	Expected Transmissions
MST	Minimum Spanning Tree
SCH	Sub Cluster Head
IVP	Invitation Packet
RP	Rejecting Packet
CR	Connection Request
MAC	Media Access Control
CDMA	Code Division Multiple Access
DCT	Data Collection Time
MANET	Mobile Adhoc Network
N2N	Node to Node
N2BS	Node to Base Station
N2N	Node to Node
MCU	Microcontroller Unit
TCR	Transceiver Unit

SB	Sensor Board
|N|	Total Number of Nodes
Min(a,b)	Minimum of a and b

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ABSTRACT

IoT system have a massive amount of smart devices which leads to maximization of massive amount of data. So to improve the performance of the IoT system our main task is to minimize the time delay. In Normal wireless network delay is defined as the time taken for the amount of data to transfer from sender end to the receiver end. So in this a delay minimization technique is described for the wireless sensor network –concurrent data collection tree. In concurrent data collection tree the time taken to send data to destination is efficient but the uses the number of β-rings in less number of times which we can improve by generating another algorithm which uses the basics of the concurrent data gathering tree with the advancement of maximizing the α-ring and β-ring as well. As β-ring take less time to transfer the data so the maximization of β-ring will lead to minimization of delay.

Chapter 1

INTRODUCTION

IoT systems are becoming Popular and in demand and have a promising future applications. Many usr will own and proportion the IoT schemes, an association of sensors and middleware. numerous inquiries could be prepare through customers and even IoT devices inside the interim, which starts special parallel facts streams in same machine. To support urbanization, IoT plays a significant role and main task where attention is needed is the minimization of delay and efficient collection of concurrent coming data. IoT is a improved key among these newest technology. To transmit data Sensor nodes are used where sensor nodes are series powers devices so Energy minimization is also an issue regarding the transmission of data. Energy saving is related to lifetime of a sensor network. So the amount of energy inspired in a broadcast is directly depends on the analogous announcement distance. So, long distance communication between the sensor nodes and base station are usually not assumed to be not much. The consumption of energy by the sensor nodes can be minimized by supporting the clustering algorithm, which says that a group of clusters are formed and every cluster has their own sub-cluster head to which the data is going to send. The clustering is made by those nodes which are interrelated to each other so that there is minimum distance between the transmission of data. These sub-clusters heads are connected to the cluster head which controls all downward nodes and lastly transfer data to the BS. We have used a technique to minimize the energy which is obtainable by Cheng et. al. in "A Delay-Aware Network Structure for Wireless Sensor Networks with In-Network Data Fusion" and the network structure we have used in this project is presented by Chi-Tsun Cheng in "Concurrent Data Collection Trees for IoT Applications".

There are various kinds of networks round for the wi-fi sensors but seeing Cheng's et. Parallel facts series wood, can develop data collection performance as they use parallel statistics streams for statistics verbal exchange. but power reduction becomes important to the element of battery energy-driven gadgets. In IoT networks there are massive variety of gadgets working collectively, inter-related to every other so it desires a huge quantity of energy even as strolling. consequently, a network needs to be constructed in this sort of way that it uses much less power. at the same time as at the same time have a minimized put off in transmitting records. So the Concurrent records collection wooden gives this opportunity with the aid of manner of the usage of parallel statistics streams for powerful records collection and Clustering set of rules to restriction the power. previous community structures that communicated in parallel did now not don't forget both of the above variables/factors. sturdy adaptability, comprehensive sensing coverage, and excessive fault tolerance are some of the unique blessings of wi-fi sensor networks. wireless sensor networks consist of massive quantities of wi-fi sensor nodes, which might be compact, mild-weighted, and battery-powered gadgets that can be used in absolutely any surroundings. due to these unique characteristics, sensor nodes are generally deployed close to the goals of hobby on the way to do near-variety sensing. The records accrued will go through in-community approaches and then go back to the person who is normally placed in a remote web page. most of the time, cord-much less sensor nodes are placed in extreme environments, where are too adversarial for preservation. Sensor nodes should preserve their scarce strength by using all method and stay active so that it will preserve the desired sensing coverage of the environment.

So to achieve a network which minimize the factor delay and energy different methods are needed to be considered. As we have also seen in paper "A Delay-Aware Network Structure for WSN with in Network data Fusion. N-network facts fusion and clustering were proven as two powerful strategies in reducing electricity intake in WSNs. In a normal clustering algorithm, more than a few of nodes in a network will be decided on because the cluster heads (CHs). The closing nodes will be appeared as cluster contributors which are known to be cluster member (CMs) and some act as the connections which collects the data and do fusion and these are called as the cluster heads (CHs). As CH will collect facts from its CMs. If the facts obtained from the CMs are fusible, a CH can carry out facts fusion on the incoming information and decrease the dimensions of its outgoing information. The fused records will be transmitted to a fusion middle which are called fusion center (FC), if you want to method the fused information in addition by means of reducing the general communication distance and the transmitted facts size, the energy ate up in communications is significantly decreased. Even we also introduce an extra element in decreasing the energy factor by which the consumption of the energy in transmitting the data can be decreased which is doing clustering by which distance between the connected nodes is decreased and hence energy consumption decreases.

And now talking about the delay minimization to achieve a delay minimization the first thing that needed to select is the network topology. So to achieve the minimization of time delay we use the topology which is ring topology. As in ring topology all the nodes are connected in the shape of the ring and all the nodes present in there can communicate with each other at any time. The time needed to communicate with the nodes is considered here as one-time slot which we are going to minimize. So we can use the ring topology for minimization of time delay. Now come to the fact of methodology used to arrange the nodes to be connected such that they will support the fact of concurrent collection of data. So we use the tree Data structure where some nodes are acting as root node and some are acting as their child. These nodes are attached such that the task of child is to collect data and send the collected data to the parent and the task of parent is to fuse the upcoming data with its own data and use different nodes as concurrent node. Now about the algorithm of using the tree data structure with all nodes an algorithm is designed which work with the topology called the ring topology and will make a perfect use of concurrent data collection. This algorithm is designed and implemented in this project and result are concluded and the result we get would minimize the time delay.

Consequently, in this idea we have described an successful methodology for minimization of Delay in concurrent statistics series trees alongside numerous other cases that may correctly refurbish the networks to its everyday running in a well-timed way. Aside from the set of rules we've mentioned various ways in which our algorithm can be improved as to which network structure is higher and the extraordinary opportunities of its recuperation at exclusive time slots and one of a kind time streams associated with it. Our, outcomes were established using various graphs which are made using excel carried out using the code advanced in C++.

PROJECT OBJECTIVE:

"To design an algorithm for Minimizing the Delay for Concurrent Data Collection "

Chapter 2

LITERATURE (1)

"Concurrent Data Collection Trees for IoT Applications"

Abstract

In IoT arrange a great deal of gadgets cooperate. They create huge measures of information. Consequently, information gathering process turns into a central worry in extensive systems. Information gathering forms must use least measure of time while gathering information. In this paper a ring type network structure is used where the nodes are arranged in the form such that data is collected by the nodes and then send to the base station. A ring network topology is further represented in the form of a tree where root is the base station and other nodes are the part of the tree. The ring structure is divided in to two parts α-Ring and β-ring. In this paper they use the number of alpha rings more and it causes increase in delay. To solve this problem, we are trying to design an approach which is proposed as an algorithm in this project.

Concurrent Data Collection tree:

It is the tree structure used to collect data from various places. It consists of node and base station. Each node can communicate with the another node at any time and the time taken to communicate is to be considered zero for the calculation of delay.

Let us consider a network structure N which have n number of nodes and A base station B which are of b number of time.

$$N= \{n_1, n_2, n_3, \ldots\ldots\ldots\ldots\ldots\ldots n_N \text{ times}\}$$

$$B = \{b_1, b_2, b_3, \ldots\ldots\ldots\ldots\ldots\ldots b_s \text{ times}\}$$

In this structure the data is collected using ring topology where the nodes are collected in the shape of ring and each node is going to collect the data and send that data to the base station. the Data is collected in the form of streams and these streams were fuse using the nodes and after fusing data it is sent in to base station. Each data is fused before forwarding that data in to its parent.

Let us suppose that single part of stream takes one-unit time-slot and the time taken to fuse the data is negligible. The data is aggregated using base station and each stream has its own base station for the aggregation of data.

Suppose there are s data streams. These data streams are arranged in such manner so that every stream starts at same time-slot and ends at same time-slot. As data is collected parallel so the number of nodes used by each data stream is same and maximum so that there is no inconsistency in collection of data as well as less time delay in data collection. To select the maximum number of nodes if Total number of nodes present are |N| and the streams are s than the maximum nodes utilize by each data stream is

$$m_{max} = \lfloor (\frac{|N|}{s}) \rfloor$$

where in floor(x) ($\lfloor$ x $\rfloor$) is the characteristic that takes as enter an actual quantity x and gives an output which returns the integer value less than or equal to x.

There are two type of connection one is node to node and other is node to base station. This is decided by m_i where m_i is the number of nodes utilized in i^{th} time-slot by the data streams. And it is defined as

$$m_i = \min(m_{max} , |N|-\sum_{j=1}^{i-1} m\hat{}j])$$

Where

$$m\hat{}_j = \lceil (\frac{mj}{2}) \rceil$$

Where ceiling(x) ($\lceil$ x $\rceil$) is the function where the input is a real number x and the output is the smallest integer value greater than or equal to x.

Delay calculation is given by

$$T = t_1 + t_2$$

t_1 = in this time-slot m_{max} node are utilized

$$t_1 = \begin{cases} \lfloor 2(|N| - m_{max})(m_{max}+1) + 1 \rfloor & \text{, if } m_{max} \text{ is odd,} \\ \lfloor 2(|N| - m_{max})\, m_{max} + 1 \rfloor & \text{, if } m_{max} \text{ even.} \end{cases}$$

t_2 = in this all the remaining data gathering process of the current data stream by using DADCN

$$t_2 = \begin{cases} \lfloor \log_2(|N| - t_1 \frac{m\,max+1}{2}) \rfloor + 1 & , \quad |N| - t_1\, m_{max} + 1/2 > 0 \text{ and } m_{max} \text{ is odd} \\ \lfloor \log_2(|N| - t_1 \frac{m\,max}{2}) \rfloor + 1 & , \quad |N| - t_1\, m_{max} + 1/2 > 0 \text{ and } m_{max} \text{ is odd} \\ 0 & \text{otherwise} \end{cases}$$

α-Ring:

it is the type of ring structure which is formed when the following condition satisfies:

$|N_\alpha| \geq 2s$

Where $|N_\alpha|$ is the total number of nodes and s is the number of data streams.

In α-ring the t_1 is the time taken by the nodes to collect data from $|N_\alpha|$-1 node in to a single node. Such node takes 1 time-slot to aggregate data to the base station.

Let us consider there are $|N_\alpha|$ node give as $\{n_1,n_2,n_3,\ldots\ldots\ldots,n_N\alpha\}$. In the interval where $T<t_1$ node n_{c1} in the s^{th} data collection process data to node n_{c2} and the n_{c2} will fuse the data with its own and this will form a ring structure and this structure is called α-ring structure. where c_1,c_2 are define below

$$c_1 = (1 + \text{mod}\ (2*(s-1) + T - 1, |N\alpha|)),$$

$$c_2 = (1 + \text{mod}\ (2*(s-1) + T, |N\alpha|)).$$

At time-slot $t = t_1 + 1$, there are $|N_\alpha| - t_1$ nodes in an α-ring waiting to transmit their data and data from these $|N\alpha| - t_1$ nodes will then be collected using the DADCNS, which will take total t_2 time-slots.

Consider an example of α-ring is as shown below

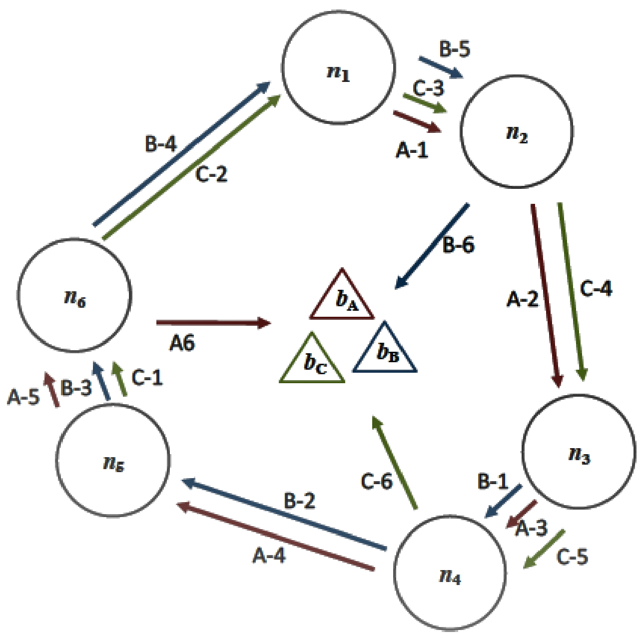

Fig.2.1 *α-ring* when the value of |N| = 6 and streams s = 3

In this total number of nodes $|N_\alpha|$ = 6 and number of data stream (s) = 3. Therefore, m_{max}=2. This shows that for t_1 time-slot maximum nodes used by data stream are 2.

Let us assume that the name of streams are {A, B, C} and these streams are divided in to six parts.

For 1st time-slot A_1 uses node n_1 and n_2 whereas B_1 use node n_3 and n_4 and C_1 uses n_5 and n_6. In the same manner for 2nd time-slot A_2 uses node n_2 and n_3 whereas B_2 use node n_4 and n_5 and C_2 uses n_6 and n_1. This node-to node connection is there for five-time slot and finally at the sixth time-slot the data is finalized then be composed together using the DADCNS, which will remain for t_2 time-slots and aggregated at the base-station at the end.

$T = t_1 + t_2 = 5 + 1 = 6$

Data collection tree for α-ring :

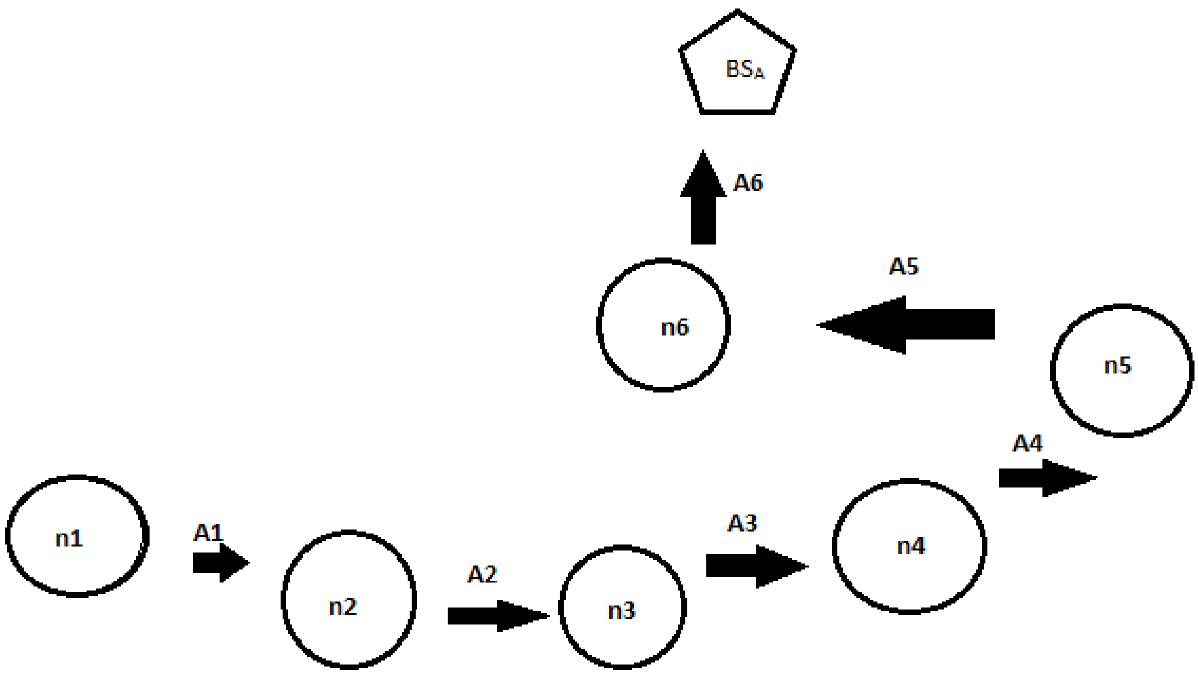

Fig 2.2.1 Data collection tree for Stream A

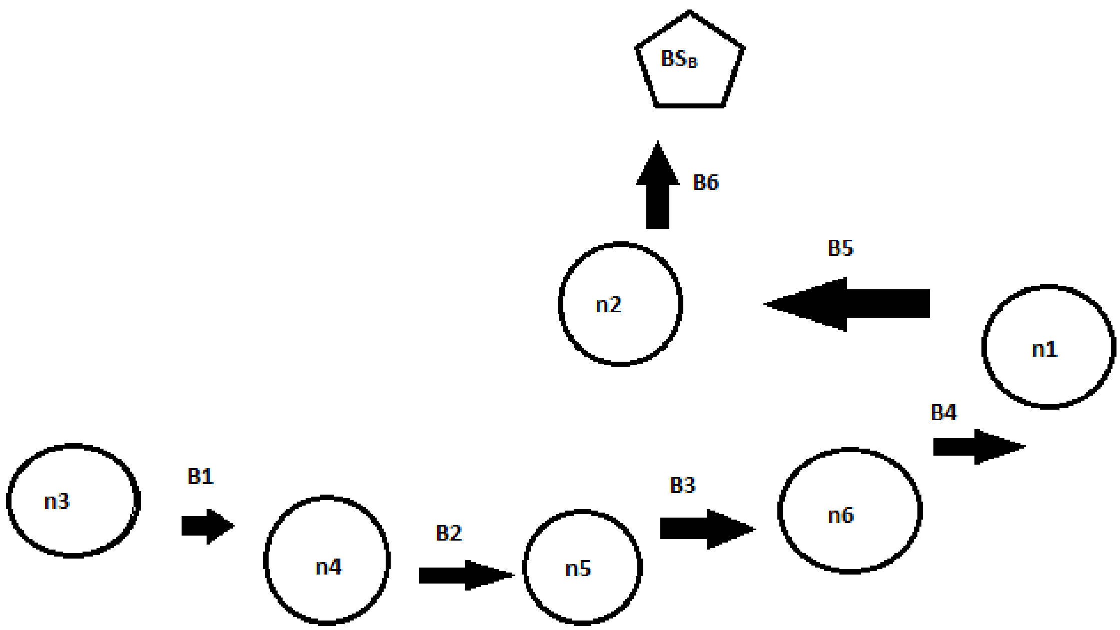

Fig. 2.2.2 Data collection tree for stream B

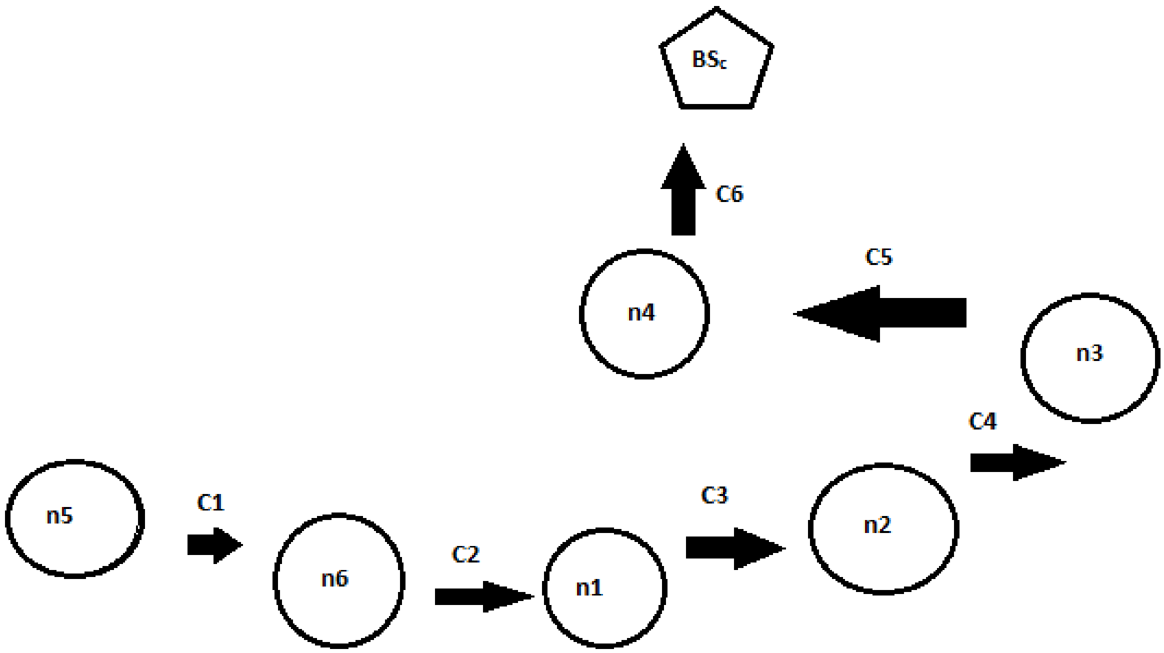

Fig 2.2.3 Data collection Tree for Stream C

***β-ring*:**

it is the type of ring structure which is formed when the following condition satisfies:

$$|N_\beta| \geq 3s$$

Where |N| is the total number of nodes and s is the number of data streams. In this the communication is N2N and N2base-station.

Let us consider there are $|N_\beta|$ node give as $\{n_1, n_2, n_3, \ldots\ldots\ldots, n_{N\beta}\}$. In the interval where $T<t_1$ node n_{c3} in the s^{th} data gathering process data send to node n_{c4} and the n_{c5} will involve in node to base station communication and this will form a ring structure and this structure is called *β-ring* structure. Where c_1, c_2, c_3 are define below

$$c_3 = (1 + \mathrm{mod}\ (3(s-1) + 2*(T-1), |N_\beta|)),$$

$$c_4 = (1 + \mathrm{mod}\ (3(s-1) + 2*(T-1)+1, |N_\beta|)),$$

$$c_5 = (1 + \mathrm{mod}\ (3(s-1) + 2*(T-1) + 2; |N_\beta|));$$

Example of β-ring is as shown :

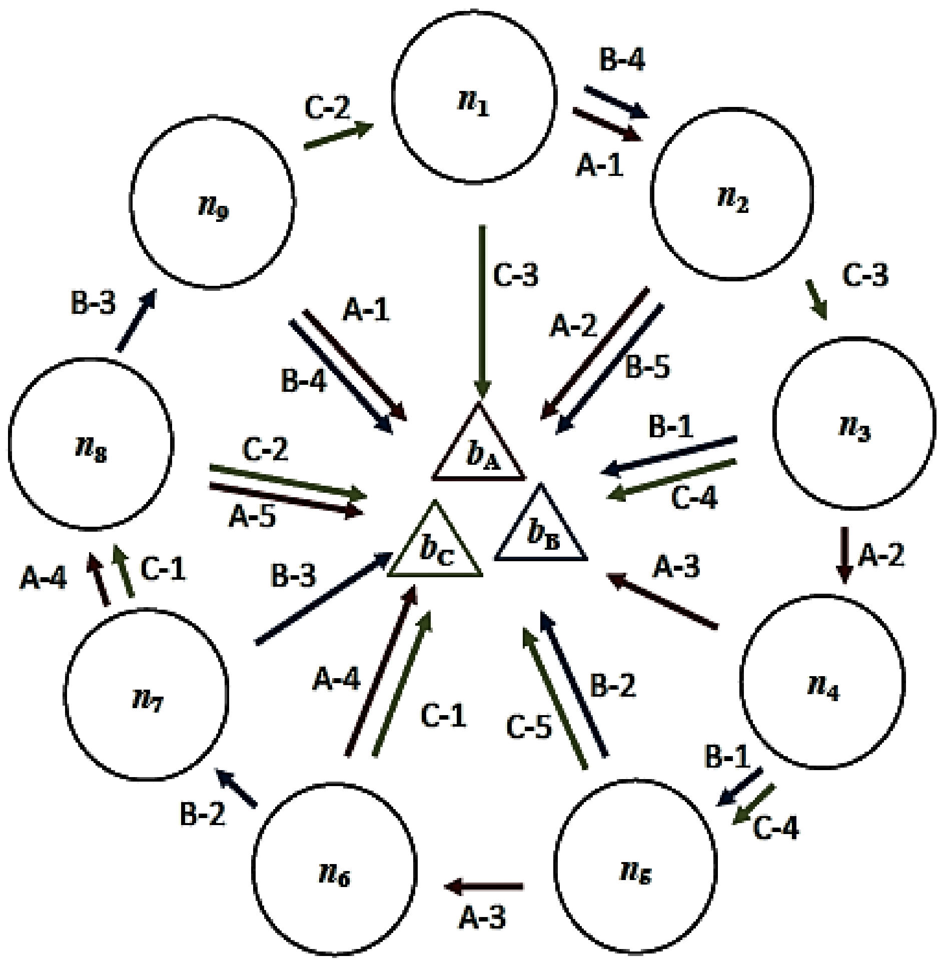

Fig 2.3 *β-ring* when |N|=9 and the streams s = 3

Consider an example of β-ring is as shown in fig where total number of nodes $|N_{\beta}|$ = 9 and number of data stream (s) = 3. Therefore, m_{max}=3. This shows that for t_1 time-slot maximum nodes used by data stream are 3.

Let us assume that the name of streams is {A, B, C} and these streams are divided in to 5 parts.

for 1st time-slot A_1 uses node n_1 and n_2 which is node to node communication and n_9 is sending data to base station which is node to base station communication similarly B_1 use node n_4 and n_5 for node to node communication and n_3 to base station and C_1 uses n_7 and n_8 for node to node communication and n_6 for node to base station communication. In the same manner for 2nd time-slot A_2 uses node n_3 and n_4 for node to node and n_2 for node to base station whereas B_2 use node n_6, n_7 and n_5 and C_2 uses $n_{9,}$ n_1 and n_8. This node-to node and node to base station communication is there for four-time slot and finally at the fifth time-slot there is only node to base communication where data is to be processed using the DADCNS and it will last for t_2 time-slots and aggregated at the base-station at the end.

$$T = t_1 + t_2 = 4 + 1 = 5$$

Data collection tree for *β*-ring :

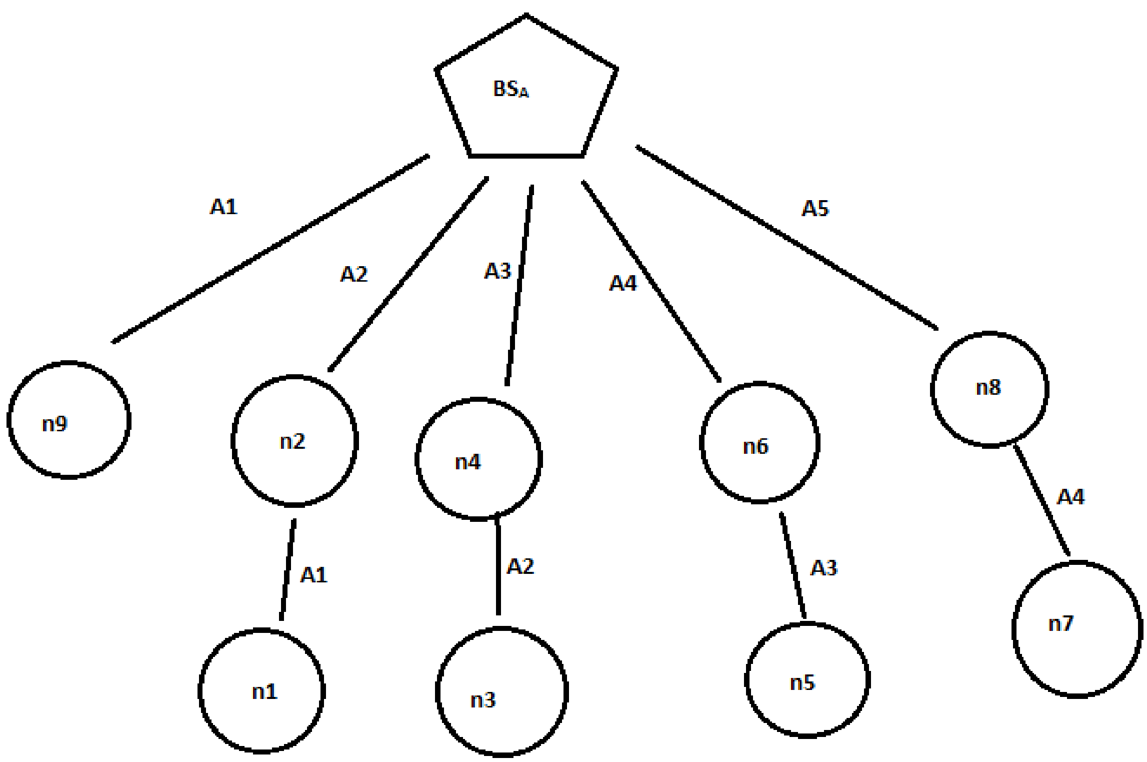

Fig 2.4.1 Data collection tree for stream A

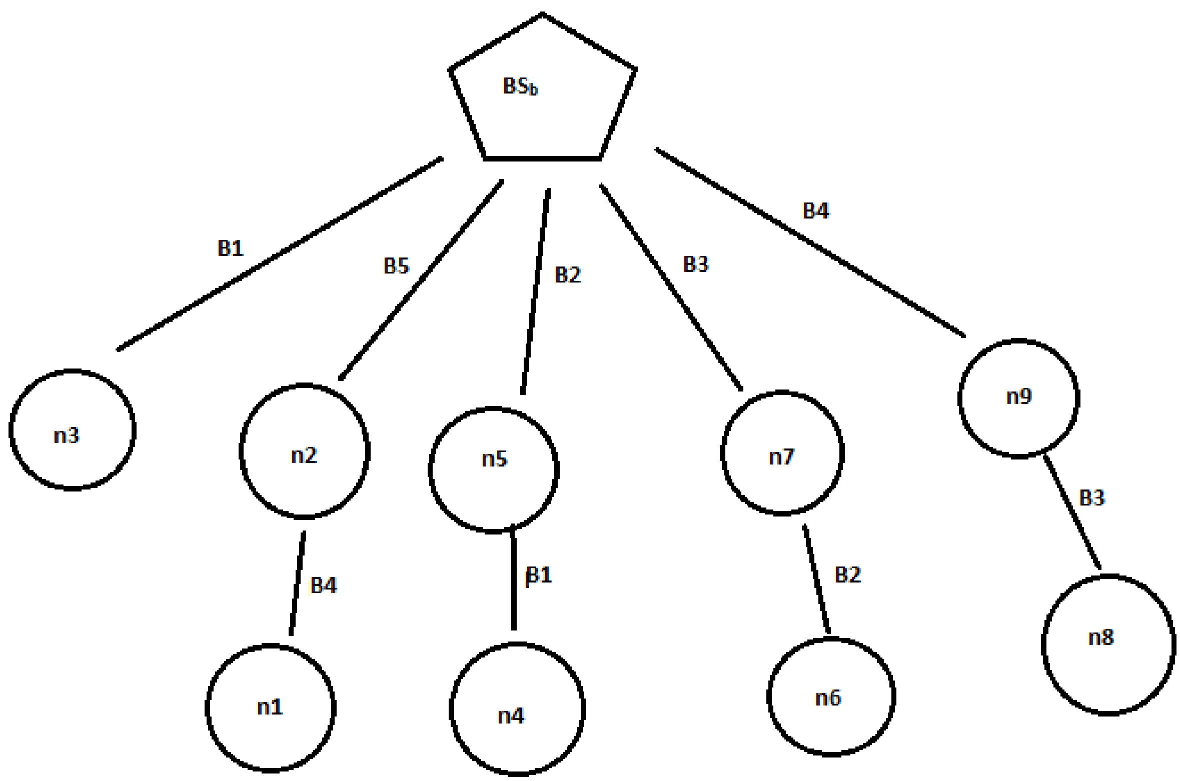

Fig 2.4.2 Data collection tree for stream B

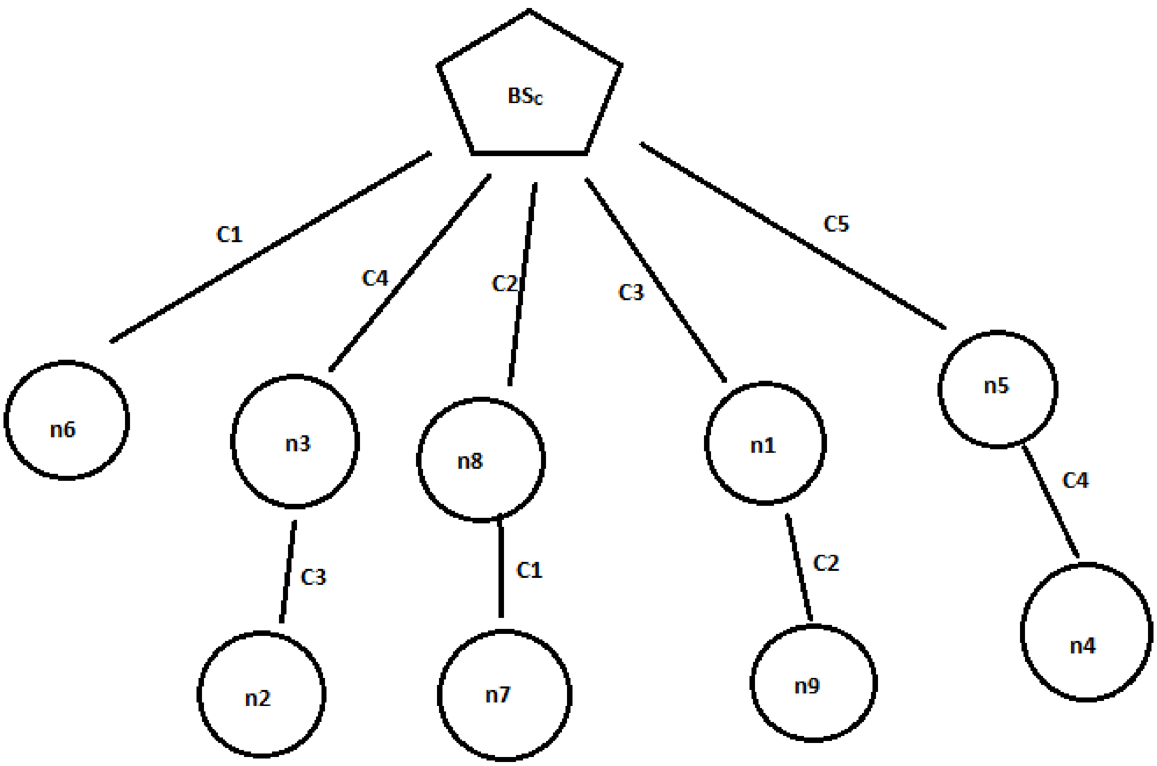

Fig 2.4.3 Data collection tree for stream C

MULTIPLE RINGS:

For cases with $m_{max} > 3$, different sized multiple α and β rings are needed.

Case 1- m_{max} is even and >= 4:

$$n_\alpha = m_{max}/2$$

no. of 'α' rings are produced. Every *α*- ring will be first allocated with 2*s no. of* nodes. Remaining | N | - n_α (2s) nodes are then allotted to the n_α rings sequentially. Difference in α-ring size will be less than 1 between two arbitrary rings. Two nodes are used by the data stream of every α-ring. At time $T_1 + 1$ remaining nodes will be ready to submit the information. Data is retrieved easily among these nodes using T_2 time slots.

Case 2 – m_{max} is odd and >= 5:

In this one β ring and $n'_\alpha = (m_{max} - 3)/2$ no. of α-rings are produced. At the beginning 2s nodes are allocated for each α ring whereas 3k nodes are allocated for every β ring.

The remaining $| N | - 3s_{BS} - n'_\alpha (2s_{BS})$ nodes are allotted to the β ring until $| N_\beta | = 2t_1 + 1$. The remaining nodes are allocated to the α ring sequentially. β rings are filled up before the α rings because β rings reduces the data collection time for same no. of nodes as it takes lesser time. Furthermore, all of its Node-to-Node communications are accomplished in the 1^{st} t1 time-slots, as the highest β ring size is restricted to $2t_1 + 1$.

For $| N_\beta | = 2t_1 + 1$, the network m_{max} nodes in first T1 slots, while remaining nodes will take T2 time-slots.

Result & Analysis:

The period of records series collection procedure T (universal variety of time areas required with the aid of the use of base stations of one-of-a-kind data parts) is used as a normal overall presentation pointer. The reference form used for universal performance evaluation is DADCN. DADCN is sued in shape of a unmarried cluster. the general overall performance parameter of concurrent facts anthology tree community structure is pretty low in assessment to DADCN.

- As value of m is going to increases then the value of T also rises linearly in DADCN while in this concurrent data gathering tree structure if the value of |N| rises, then the value of m_{max} which is the main performance measurure also increases but it does not diverge linearly. consequently, with raise in value of |N| & k the presentation gap flanked by two network topology also broadens.

- When value of k or |N| is amplified, value of m_{max} also show some variations. These variations in the value of m_{max} would primes to the alteration in the total quantity of α and β rings that are going to be formed. Consequently, it has been perceived that if value of k or |N| growths the resultant value of T does not grow monotonically.

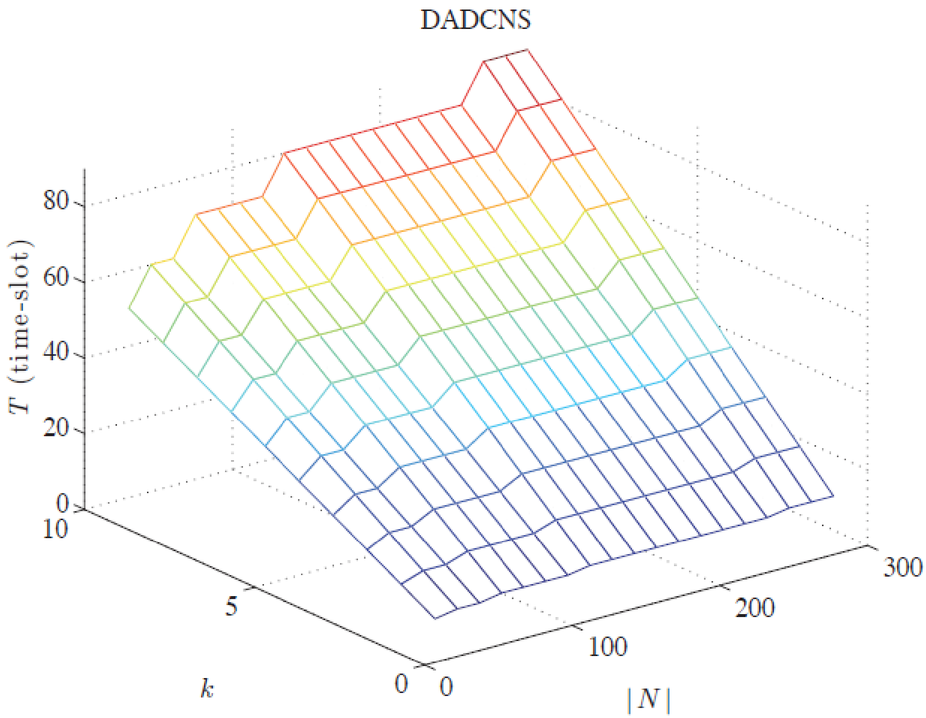

Fig. Variation of |N|, s, T according to the DADCN

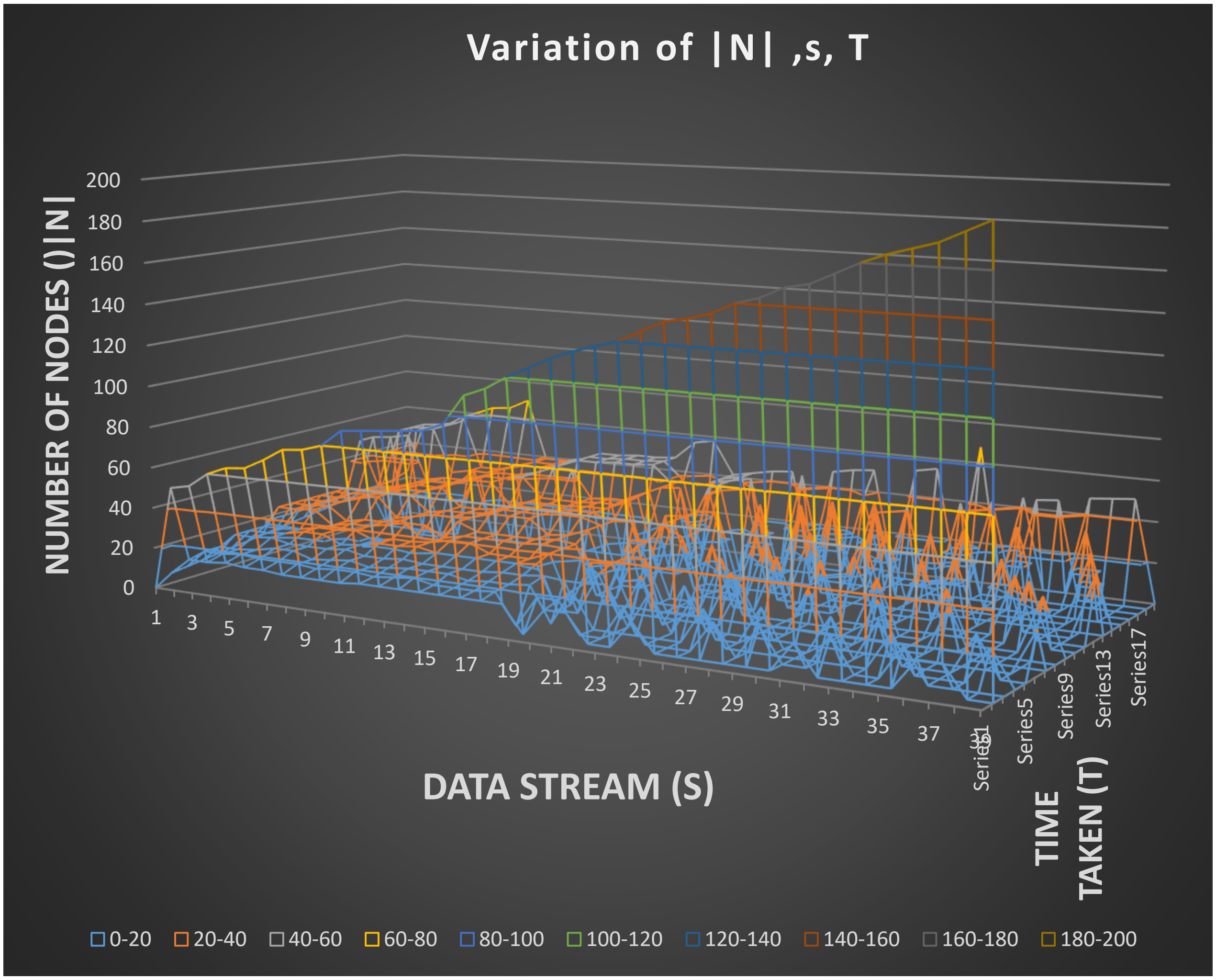

Fig 2.5 Variation of |N|, s, T according to the Data Collection tree

Chapter 3

METHODOLOGY

then the topology used is α-Ring. it is the type of ring structure which is formed when the following condition satisfies:

$$|N_\alpha| \geq 2s$$

Where $|N_\alpha|$ is the total number of nodes and s is the number of data streams.

In α-ring the t_1 is the time taken by the nodes to collect data from $|N_\alpha|$-1 node in to a single node. Such node takes 1 time-slot to aggregate data to the base station.

Let us consider there are $|N_\alpha|$ node give as $\{n_1,n_2,n_3,\ldots\ldots\ldots,n_N\alpha\}$. In the interval where $T<t_1$ node n_{c1} in the s^{th} data collection process data to node n_{c2} and the n_{c2} will fuse the data with its own and this will form a ring structure and this structure is called α-ring structure. where c_1,c_2 are define below

$$C_1 = (1 + \mathrm{mod}\ (2(s - 1) + T - 1, |N\alpha|)),$$

$$C_2 = (1 + \mathrm{mod}\ (2(s - 1) + T, |N\alpha|)).$$

At time-slot $t = t_1 + 1$, there are $|N_\alpha| - t_1$ nodes in an α-ring waiting to transmit their data and data from these $|N\alpha| - t_1$ nodes will then be collected using the DADCNS, which will take total t_2 time-slots.

Consider an example of α-ring is as shown below

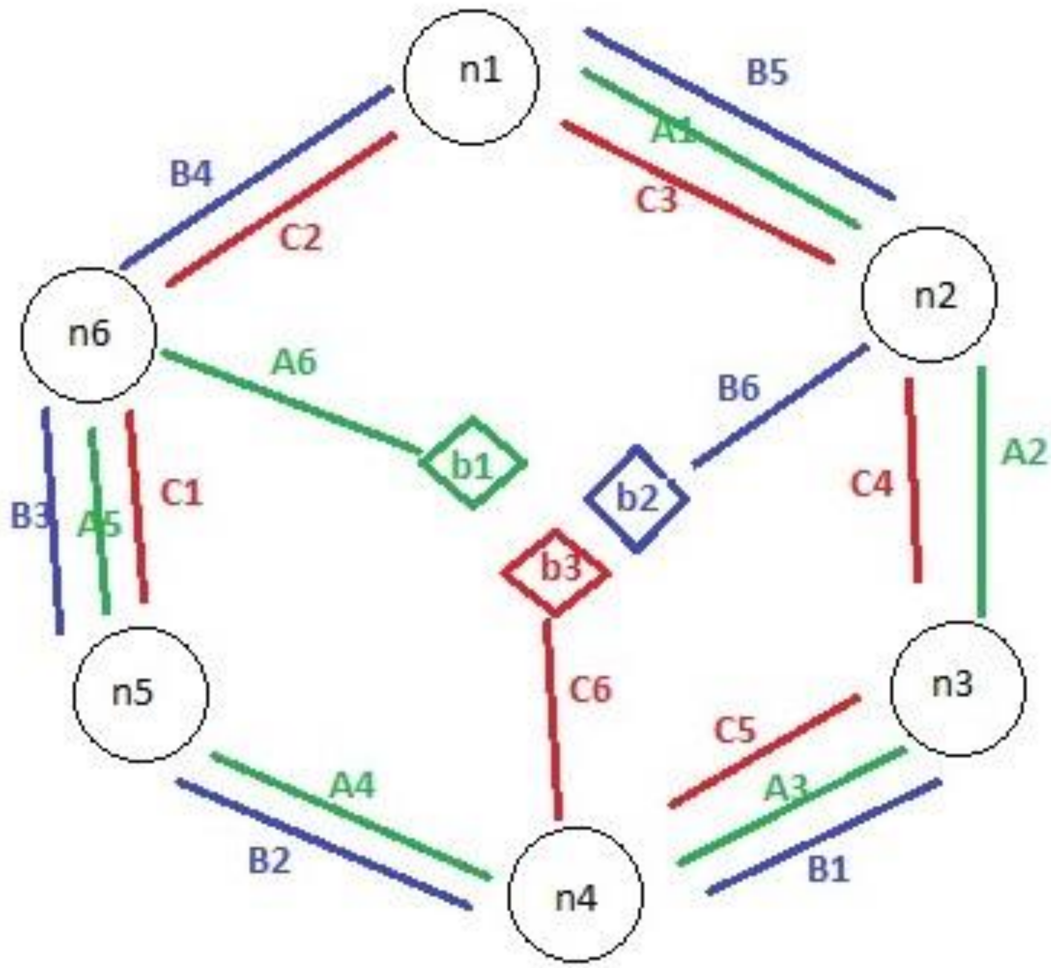

Fig.3.1 *α-ring* when the value of |N| = 6 and streams s = 3

In this total number of nodes $|N_{\alpha}| = 6$ and number of data stream (s) = 3. Therefore, $m_{max}=2$. This shows that for t_1 time-slot maximum nodes used by data stream are 2.

CASE 2: $m_{max} = 3$

The topology used is the β-ring. It is the type of ring structure which is formed when the following condition satisfies:

$$|N_\beta| \geq 3s$$

Where |N| is the total number of nodes and s is the number of data streams. In this the communication is node to node and node to base-station.

Let us consider there are $|N_\beta|$ node give as $\{n_1,n_2,n_3,\ldots\ldots\ldots,n_{N\beta}\}$. In the interval where $T<t_1$ node n_{c3} in the s^{th} data gathering process data send to node n_{c4} and the n_{c5} will involve in node to base station communication and this will form a ring structure and this structure is called *β-ring* structure. Where c_1,c_2,c_3 are define below

$$c_3 = (1 + \text{mod } (3(s-1) + 2(T-1), |N_\beta|)),$$

$$c_4 = (1 + \text{mod } (3(s-1) + 2(T-1)+1, |N_\beta|)),$$

$$c_5 = (1 + \text{mod } (3(s-1) + 2(T-1) + 2; |N_\beta|));$$

Example of β-ring is as shown :

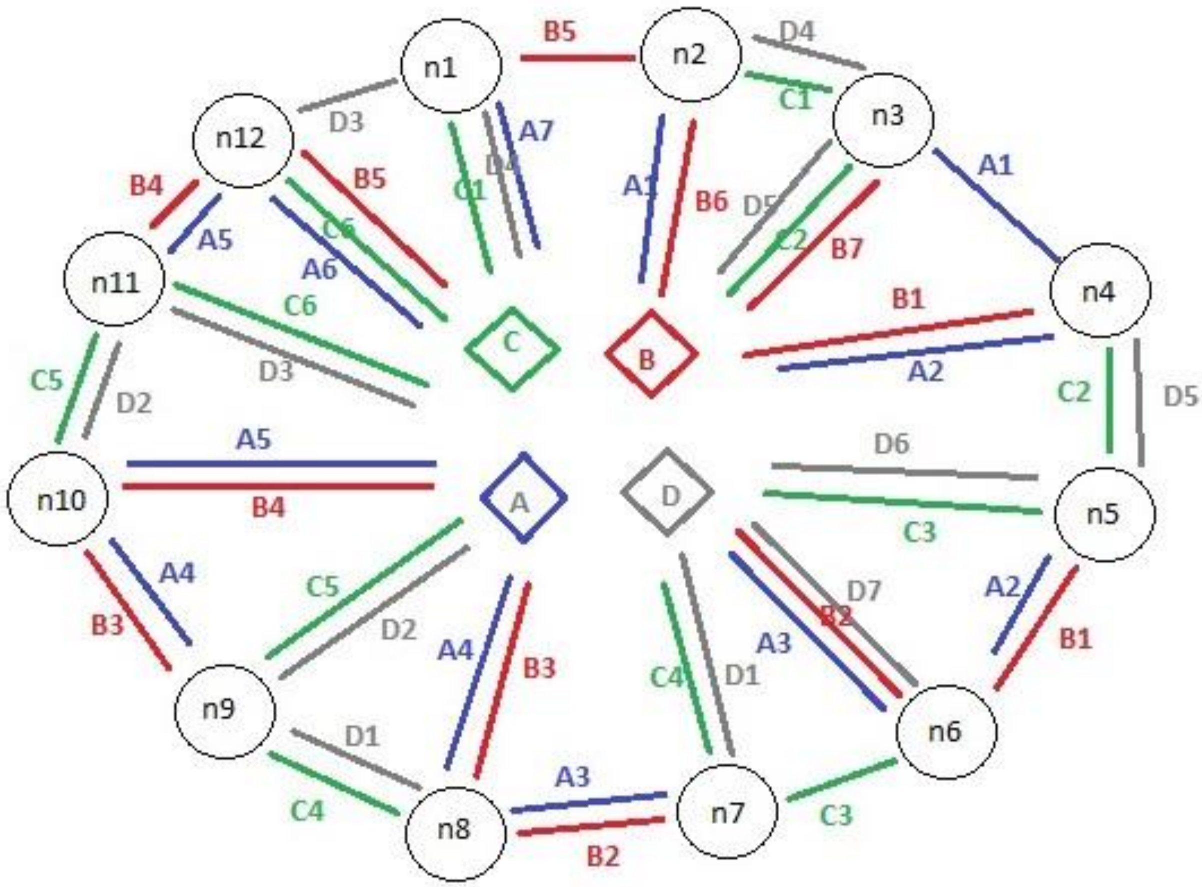

Fig. 3.2 *β-ring* when |N|=12 and the streams s = 4

Consider an example of β-ring is as shown in fig where total number of nodes $|N_\beta|$ = 12 and number of data stream (s) = 4. Therefore, m_{max}=3. This shows that for t_1 time-slot maximum nodes used by data stream are 3 as shown in fig

CASE 3: If $m_{max} \geq 4$

In this case the topology which is going to be used is a mixture of both the α-ring and the β-ring. To achieve the mixture of both the ring we used a technique which is that we start first allocating the β-ring and then α-ring and this sequence goes on until $2n_{\alpha}+3n_{\beta} = m_{max}$. After allocating the α-rings and the β-ring the number of nodes left are used to send the data in to the base station. For achieving the above result there are different cases that arises which are describes below.

- Case I: During allocation of rings if last ring allocated is alpha ring and value of m_{max} is equal to one then rather than allocating the last ring as α-rings allocate it as β-ring.

  - ➢ For example: if value of Number of nodes |N| = 48 and the number of streams (s) is equal to s= 3 then the value of m_{max}=16 so the distribution will be β, α, β, α, β, α, but in this case last ring allocated is α and the value of m_{max} is 1 so the last ring will be change with the β ring so the actual distribution will be β, α, β, α, β, β.

- CASE II: During allocation of rings if last ring allocated is alpha ring and value of m_{max} is equal to two then rather than allocating the last ring as β -rings allocate it as α-ring.

  - ➢ For example: if value of Number of nodes |N| = 51 and the number of streams (s) is equal to s= 3 then the value of m_{max}=17 so the distribution will be β, α, β, α, β, α, but in this case last ring allocated is α and the value of m_{max} is 2 so the last ring will be change with the ring α so the actual distribution will be β, α, β, α, β, α, α.

- CASE III: During allocation rings if last ring allocated is β ring and value of m_{max} is equal to 1 then rather than allocating the last ring as α -rings we allocate 2 α-rings and the previous β-ring is deallocated.
  - ➢ For example: if value of Number of nodes |N| = 42 and the number of streams (s) is equal to s= 3 then the value of m_{max}=14 so the distribution will be β, α, β, α, β but in this case last ring allocated is β and the value of m_{max} is 1 so the last ring will be allocated with the ring

α and the previous is also changes to α. So the actual distribution will be β, α, β, α, α, α.

Chapter 4

Methodology Design:

As a single facts circulate within the proposed statistics series tree will utilize m_{max} nodes in the first t_1 time-slots consecutively, wherein t1 is expressed as following with different cases

- Case 1: if $m_{max} = 2$
  - $t_1 = \lfloor(2(|N|-m_{max})/ m_{max})+ 1\rfloor$
- Case 2: if $m_{max} = 3$
  - $t_1 = \lfloor[2(|N|-m_{max})/ (m_{max}+1)] + 1\rfloor$
- Case 3: $m_{max} > 3$
  - Case 1 : if $|N| \% s = 0$ and s is odd
    - $t_1 = [3(s+1)/2] – 2$
  - Case 2 : $|N| \% s = 0$ and s is even
    - $t_1 = [3*s/2]-1$
  - Case 3: $N \% s != 0$
    - t_1 = {time for (|N| - |N| % s) nodes + (nodes left for(N – N % s)+N % s)/($3n_\beta +2n_\alpha$)}
- Case 4: If $n_\alpha >0$ and $n_\beta = 1$ and $m_{max} >=4$
  - Case 1: if m_{max} is odd
    - $T_{1 =} \lfloor(2(|N|-m_{max})/ m_{max}) + 1\rfloor$
  - Case 2: if m_{max} is even
    - $T_1 = \lfloor[2(|N|-m_{max})/ (m_{max}+1)] + 1\rfloor$

There will be $|N| - t_1(n_\alpha+2n_\beta)$ nodes coming up for communication at the $(t_1+1)^{th}$ time-slot. These nodes will income t_2 time-slots to finish the residual data gathering process of the current data stream by using DADCNS discussed in paper called A Delay-Aware Network Structure for WSN which uses the fact -Network Data Union which says that the poised data which is sent to base station is done using clustering of those nodes which deal with the same node. Therefore, t_2 of the planned data collection tree is expressed as

$$t_2 = \begin{cases} [\log_2(|N|-t_1(n_\alpha + 2n_\beta)) +1] & |N|-t_1(n_\alpha + 2n_\beta) > 0 \\ 0 & \text{otherwise} \end{cases}$$

Thus, the overall period of *s* concurrent data collection processes in a network *N* is spoken as

$$T = t_1 + t_2$$

Example 1*:* Consider a network N with $|N| = 43$ nodes and $s = 3$ concurrent data streams. The supreme likely number of nodes that can be used by a single data stream is give by $m_{max} = \lceil 43/3 \rceil = 14$. So the distribution of rings will be β, α, β, α, α, α. Consequently, the overall length of the 3 concurrent data gathering processes in the network is uttered as

$T = t_1 + t_2$

As s is odd and |N| % s != 0 therefore t_1 is given as follow

t_1 = time for (42) nodes + (nodes left using (42) nodes +1)/(3*2+2*4)

Time for (42) nodes = [3(s+1)/2] – 2 = [3(3+1)/2]-2 = 4

Nodes left using (42) nodes = $|N| - t_1(n_\alpha+2n_\beta) = 43 - 4(4+2*2) = 11$

$t_1 = 4$

For t_2 DADCN is employed, therefore t_2 is given as follow

$t_2 = [\log(|N|-t_1(n_\alpha + 2n_\beta)) +1] = (\log_2(11)+1)=3$

$T = t_1 + t_2 = 4+3 = 7$

If old algorithm is used than the time taken is given by

$t_1 = \lfloor 2(|N|-\mu_{max}) / \mu_{max} + 1 \rfloor$

$t_1 = \{ 2*(43-14)/14\}+1 = 5$

$t_2 = \lfloor \log2(|N| - t_1 * \lceil m_{max} / 2 \rceil) \rfloor + 1 = 3$

Therefore, $T = t_1 + t_2 = 5 +3 = 8$ which is larger than the algorithm proposed in this project.

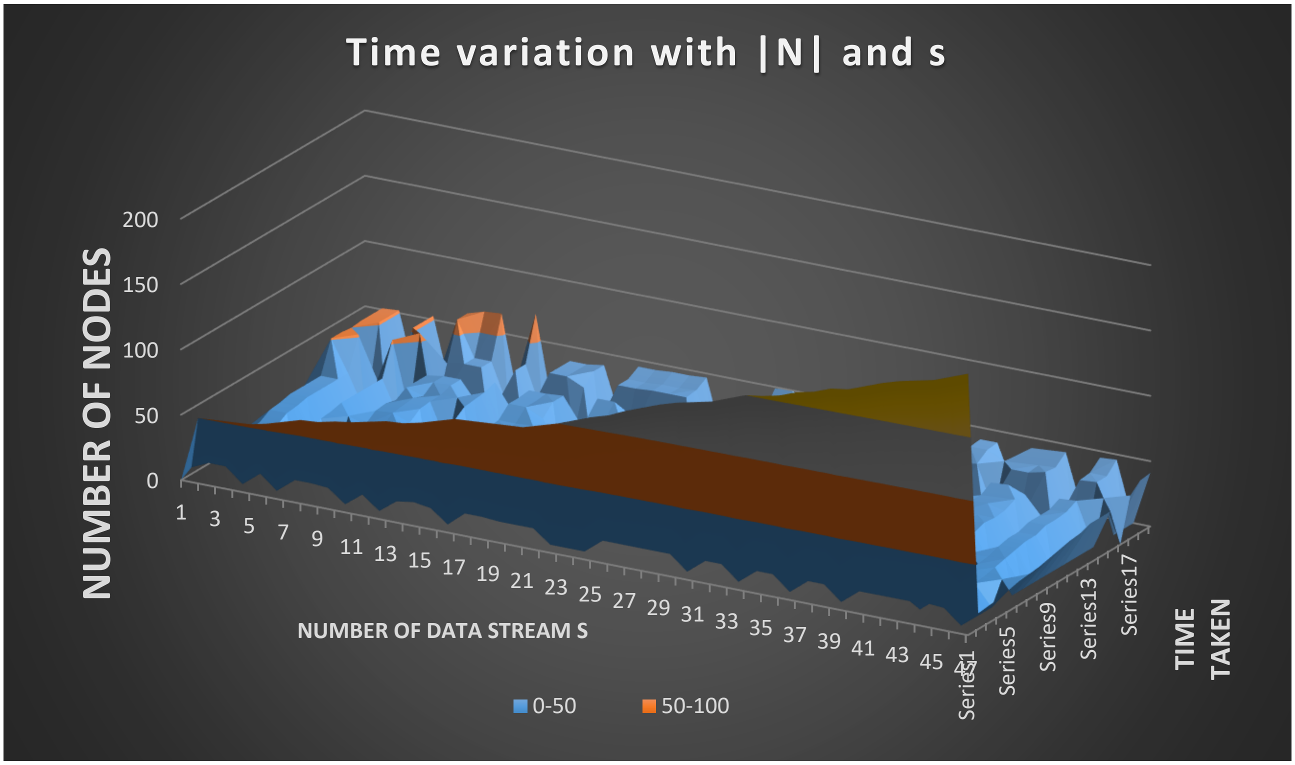

Fig 4.1 Variation of |N|, s and T

Chapter 5

Result:

As the fig shows that with increase in the Number of Node |N| the value of the time taken to transmit the data stream from sender end to receiver end also goes on increase. It is also shown in graph that the Time dependency on the Number of nodes and the data stream does not vary linearly as it varies with a curve and the curve height of the proposed algorithm is less which shows that the time taken to transmit data from one end to another end is less as compare to the time taken using data collection tree which is shown in fig b.

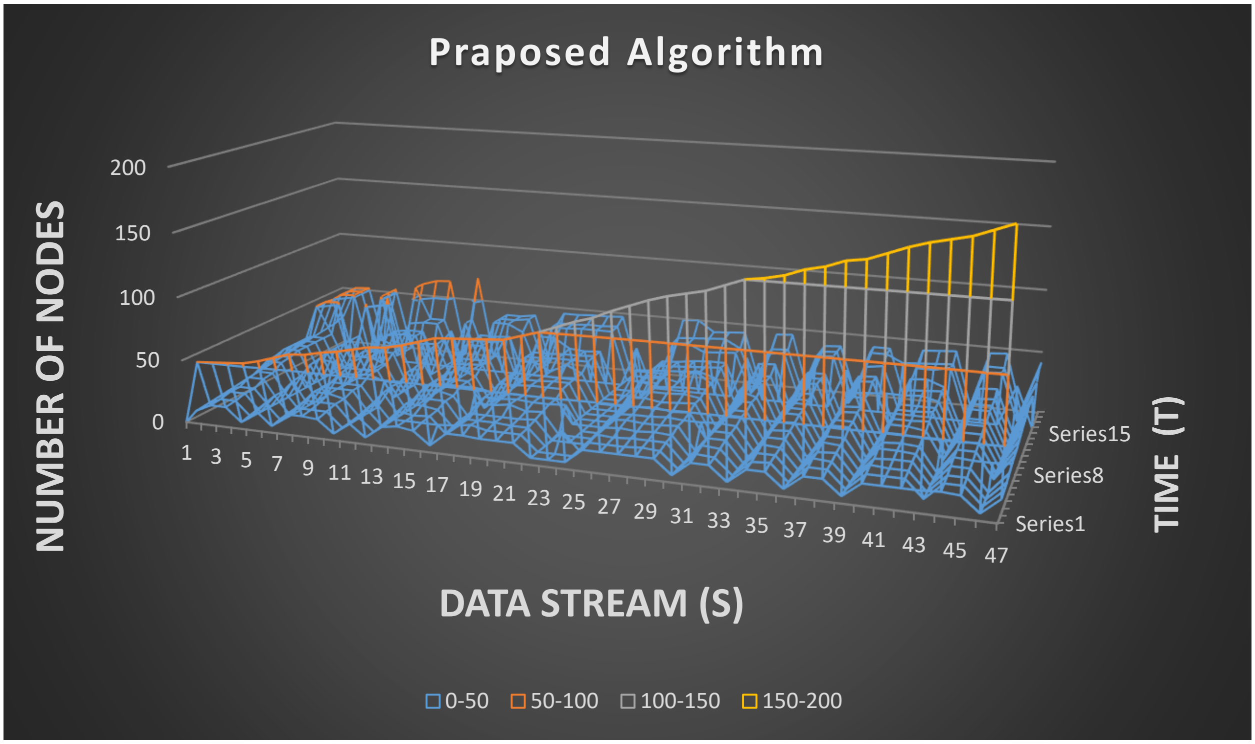

Fig 5.1.1 Variation of T with |N|, s (proposed algorithm)

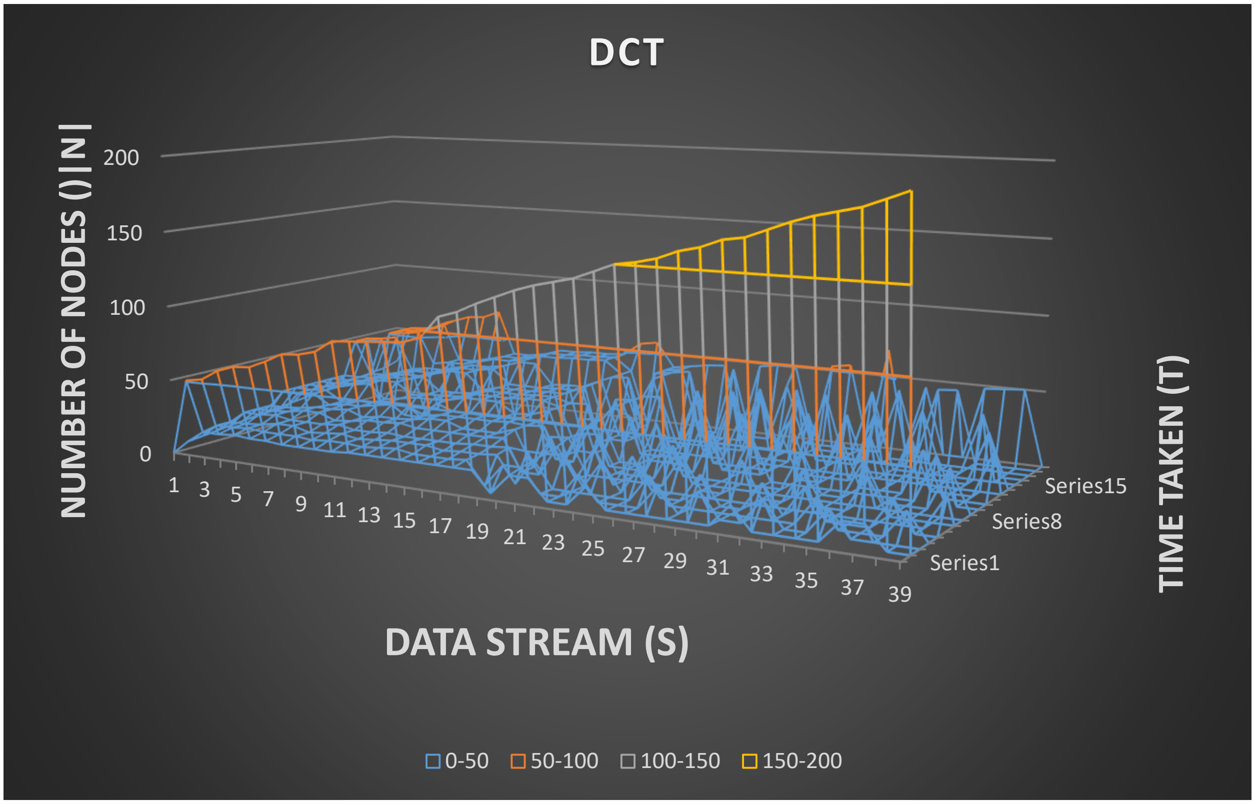

Fig 5.1.2 Variation of |N|, s, T according to the Data Collection tree

CONCLUSION

With increasing call for of IoT gadgets it will become difficult to keep a network that have a minimal delay. So on this task we've got successfully designed an algorithm for concurrent records collection using a concurrent records collection bushes that decrease the information series time with minimal put off. We have implemented the ring network topology with two aspects one is *α-ring* and other is the *β-ring*. In this project we have designed an algorithm that maximize the use of both *α-ring* and *β-ring.* Doing this we have concluded that using the algorithm explain in this project the time taken to send concurrent data from one end to another end can be minimized and is less than the time taken using the Concurrent Data collection tree. The comparison of the time is as shown in the fig 5.3.1 and fig 5.3.2

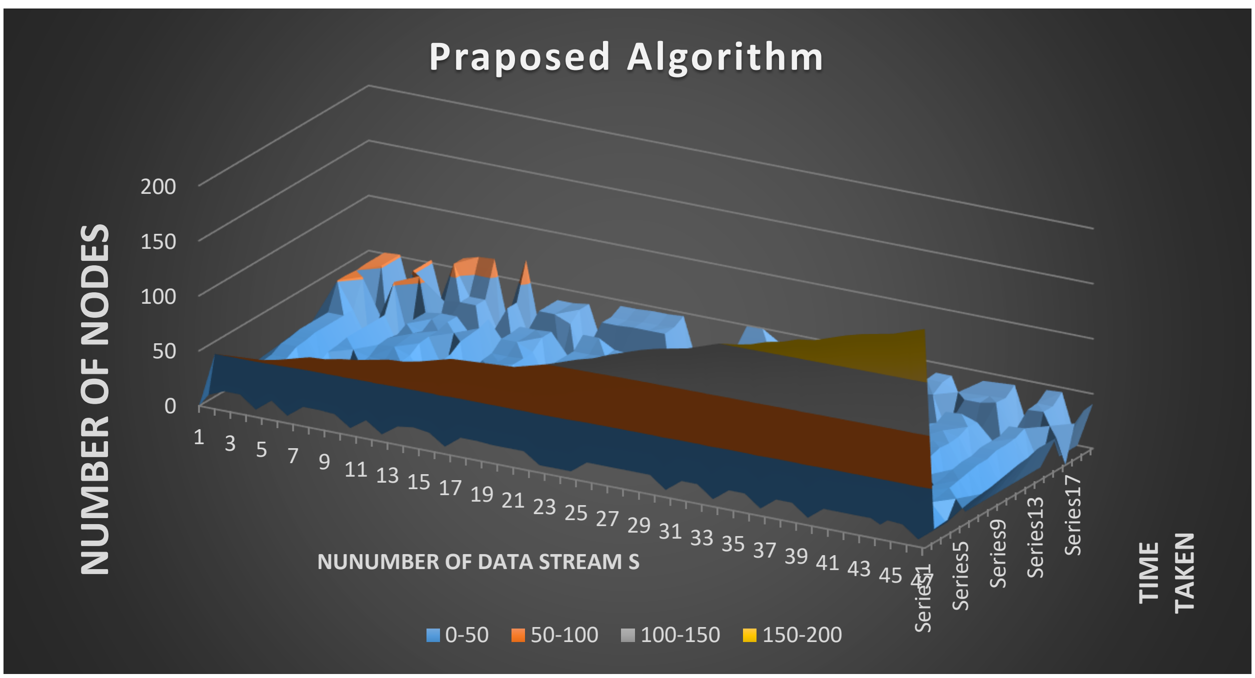

Fig 5.2.1 Variation of T with |N|,s (proposed algorithm)

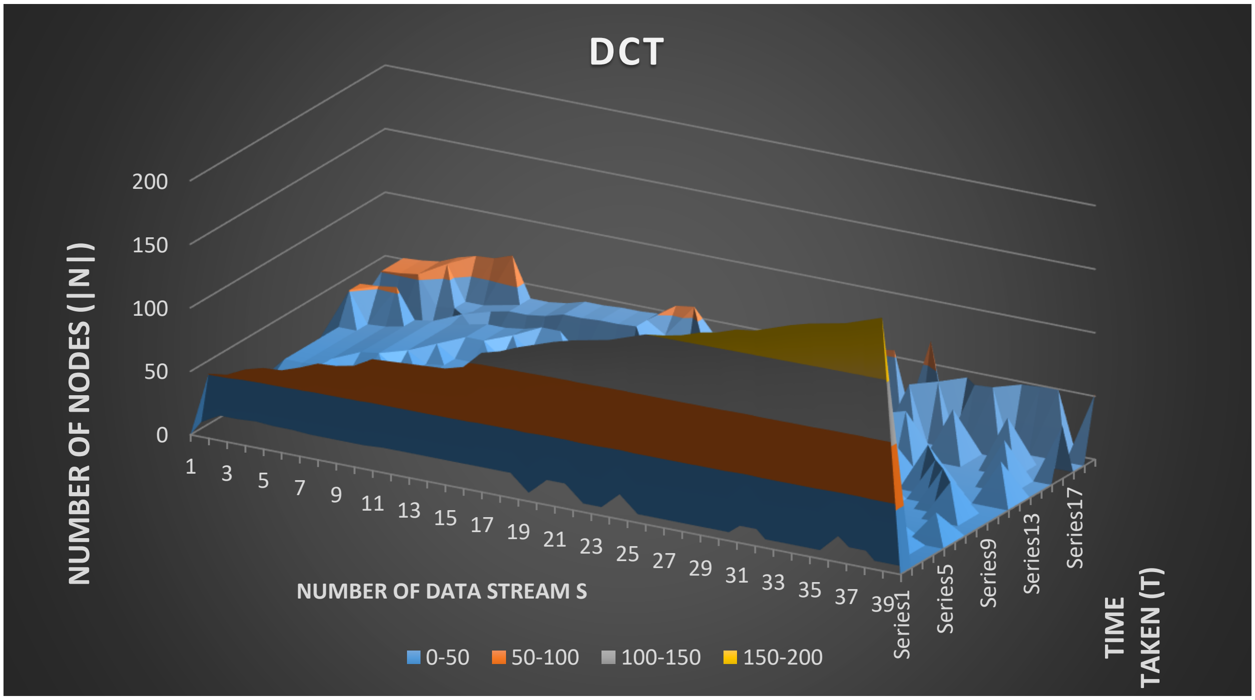

Fig 5.2.2 Variation of T with |N|, s (Data Collection Tree)

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APPENDIX A

Sudo code:

The alogorithm for the allocation of α-ring and the β-ring is as shown below.

```
alpha_ring = 0
beta_ring = 0
c= 0
N=m_max
while(N is not equal to zero)
      case 1:  if(alpha_flag == true && N==1)
              alpha_ring --;  beta_ring ++;  N=0;
       case 2: else if(alpha_flag == true && N==2)
                alpha_ring++;         N=0;
        case 3 :  else if(alpha_flag == false && N==1)
                beta_ring --;   alpha_ring = alpha_ring +2;     N=0;
        case 4: if(c==0)
            beta_ring ++;  alpha_flag = false;  N=N-3;
              c=1;
          case 5: else
                    alpha ring ++; alpha flag = true; N=N-2; c=0;
End while
```

It includes all the cases we have discussed.