# Dynamic Connectivity Establishment and Cooperative Scheduling for Qos Aware Wireless Body Area Networks

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***Abstract***

*In a IoT environment, the total number of Wireless Body Area Network (WBAN) equipped patients requesting ubiquitous healthcare services in an area increases significantly. Therefore, increased traffic load and group-based mobility of WBANs degrades the performance of each WBAN significantly, concerning service delay and network throughput. In addition, the mobility of WBANs affects connectivity between a WBAN and an Access Point (AP) dynamically, which affects the variation in link quality significantly. To address the connectivity problem and provide Quality of Services (QoS) in the network, we propose a dynamic connectivity establishment and cooperative scheduling scheme, which minimizes the packet delivery delay and maximizes the network throughput. First, to secure the reliable connectivity among WBANs and APs dynamically and study the performance of the proposed approach holistically based on different network parameters.*

**Keywords** - Wireless Body Area Network, Biomedical monitoring, Smart Health, QoS, Cooperative Packet Scheduling, Dynamic Connectivity Establishment.

## I. INTRODUCTION

WBANs are useful for remote monitoring of physiological conditions of patients. In a typical WBAN architecture, several on-body sensors sense the physiological parameters of patients and transmit the sensed data to Local Processing Units (LPUs). Thereafter, LPUs send the aggregated data to the Access Points (APs) for further processing. In a hospital environment, several WBANs may coexist in the presence of multiple APs. Therefore, in such a scenario, multiple WBANs attempt to send their data to the APs. Further, as WBANs are inherently mobile in nature, a WBAN architecture inherits the traits of a group-based model in which each WBAN is composed of several heterogeneous body sensors.

Group-based mobility and changes in the body posture of WBANs have serious Implications on the performance of WBAN communication, especially connectivity between a WBAN and an AP. WBAN-based applications, the patient equipped with body sensor nodes moves from one location to another to fulfill their medical requirements. However, due to Movement of WBANs, the connectivity among WBANs and LPUs gets affected, which inherently increases the service delay.

Additionally, in a particular location, there can exist multiple WBANs in order to get the adequate connectivity from an AP. All WBANs may not get the adequate connectivity with an AP. Thus, the QoS requirements of WBANs gets affected, which necessitates a dynamic connectivity establishment algorithm for WBANs in order to minimize the service delay of the network and also to maximize the QoS requirements of WBANs.

This paper contain section1.Literature survey 2:architecture diagram 3: methodology 4: experimental result and its analysis 5: conclusion and future work.

## II. LITERATURE SURVEY

**J. Yick, et.al.,[1]**Fault Tolerance is an important factor in Wireless Sensor Network (WSN) as an emerging research field. Nodes in WSN get easily depleted due to battery limitation in battlefield and unattended environment. Fault causes severe damage in a network, to reduce the effect of this fault, fault tolerance becomes very essential method. To track the network node failure, Negative code Answering (NCA) Algorithm is proposed in wireless sensor network with the assist of Mobile Agent (MA) techniques. MA is lightweight process and this paper used MA as Collecting Agent (CA) and Monitoring Agent (MNA). Agents provide fault tolerance in a network. **S. Borasia & V. Raisinghani, [2]**Wireless sensor network (WSN) plays an important role in many application areas like in military surveillance, health care etc. A WSN is deployed with a large number of sensor nodes in a wide geographical area. These nodes collect information depending on type of the application and transmit the data towards the sink node. **A. Rezaei and M.K. Rafsanjani[3]**The performance of wireless sensor networks (WSN) is affected by the lossy communication medium, application diversity, dense deployment, limited processing power and storage capacity, frequent topology change. All these limitations provide significant and unique design challenges to data transport control in wireless sensor networks. An effective transport protocol should consider reliable message delivery, energy-efficiency, quality of service and congestion control. **G. Li et.al.,[9]**In wireless sensor networks, congestion not only leads to packet loss, but also increases delays and lowers network throughput with a lot of energy wastage due to retransmissions. Therefore an effective solution should be proposed to mitigate congestion to increase energy efficiency and prolong the lifetime of network. Traditional solutions work in an open-loop fashion. In this paper, we propose a novel decentralized and weighted fairness guaranteed congestion control protocol (WFCC). **M.A. Kafi et.al[10]** The recent wireless sensor network applications are resource greedy in terms of throughput and network reliability. However, the wireless shared medium leads to links interferences in addition to wireless losses due to the harsh environment. The effect of these two points translates on differences in links bandwidth capacities, lack of reliability and throughput degradation. In this study, we tackle the problem of throughput maximization by proposing an efficient congestion control-based schedule algorithm, dubbed REFIACC (Reliable, Efficient, Fair and Interference-Aware Congestion Control) protocol. REFIACC prevents the interferences and ensures a high fairness of bandwidth utilization among sensor nodes by scheduling the communications.

## III. ARCHITECTURE DIAGRAM

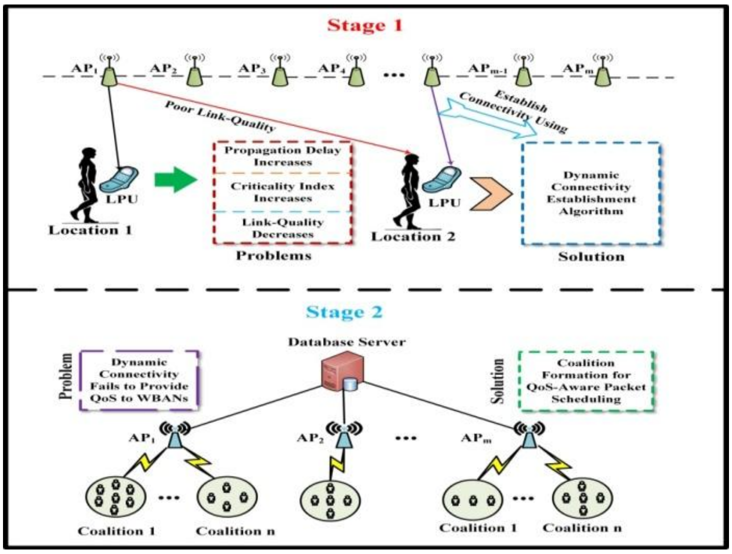



**Figure 2.1 System architecture**

The system model of WBAN architecture showing coalitions connected to multiple AP. Let us assume that a critical WBAN $B_i$ sends packets to the destination or shares the time t of another WBAN $B_k$ in the same coalition, which is in the normal condition and does not have packets to send. To share the cooperative time slot t, the critical WBAN $B_i$ pays the price $c^t$ per packet for sending its packet. The cost of data transmission and time slot sharing by the APs are assumed to be zero. In this scenario, a rational WBAN can form coalition under a particular AP and the selection of the AP among multiple APs is done dynamically. WBANs help one another to send the packets of the critical WBANs using cooperative packet scheduling.

## III. METHODOLOGY

The modules involved in the project are as follows

- Node Formation.
- Create Connection Between WBAN and AP.
- Dynamic connectivity establishment algorithm.
- Quality Of Service.

### *A. Node formation*

Sensor nodes which are specially designed in such a typical way that they have a microcontroller which controls the monitoring, a radio transceiver for generating radio waves, different type of wireless communicating devices and also equipped with an energy source such as battery.

**Create event scheduler:**

set ns [new Simulator]

**Schedule events:**

$ns at <time> <event>

<event>: any legitimate ns/tcl commands

$ns at 5.0 “finish”

**Start scheduler:**

$ns run

### *B. Create connection between wban and ap.*

Dynamic connectivity establishment for WBANs to manage transient connectivity between them and the APs, caused by factors such as body shadowing and mobility of WBANs. The proposed scheme opts for dynamic connectivity with an AP, in the presence of multiple WBANs in a critical emergency situation, in hospital environments. After addressing the dynamic connectivity problem, we propose to form coalition game to minimize the service delay and schedule the packets of different WBANs cooperatively. We prove the existence of Nash Equilibrium for the proposed coalition game to obtain a stable formation for the WBANs through cooperative packet scheduling. Further, a Markov model is used to analyze the stable coalition formation. We also propose a dynamic cooperative packet scheduling algorithm for use among WBANs, to minimize the service delay and increase the network throughput.

### C. Dynamic connectivity establishment algorithm.

In medical emergency situations, to get connected to a dynamic AP with minimum delay, we propose an algorithm, that named Establishment of Dynamic Connectivity (EDC), increases the data packet delivery ratio among different WBANs in the communication range of a dynamic AP. Dynamically choosing connectivity is not sufficient to provide effective medical service to the critical WBANs, as realistically, in the proximity of a particular AP, several WBANs also attempt access at the same time. But due to channel and residual bandwidth constraints, it is not possible for an AP to secure solution all WBANs at a particular instant of time in a particular time-period.

### D. Quality Of Service

The manage connectivity, we proposed the Dynamic Connectivity Establishment (DCE) algorithm, which is based on a price-based approach. Finally, critical WBANs in the proximity of an AP form coalitions to ensure QoS between them. In each coalition, the WBANs participate in cooperative packet scheduling to provide services to the critical WBANs. For handling cooperation between WBANs, we proposed another algorithm Optimal Cooperative Packet Scheduling.

- Dynamic connectivity establishment for WBANs to manage transient connectivity between them and the APs, caused by factors such as body shadowing and mobility of WBANs.
- The proposed scheme opts for dynamic connectivity with an AP, in the presence of multiple WBANs in a critical emergency situation, in hospital environments.

## V. EXPERIMENTAL ANALYSIS AND RESULTS

The selection of an AP dynamically among multiple APs in a hospital environment in the presence of multiple WBANs. Also, we prove the requirement of dynamic selection of AP in medical emergency situations. A dynamic AP is chosen based upon different selection parameters — available bandwidth, received signal strength, residual energy, and criticality of the WBANs.

### A. Introduction to ns-2 simulation

- Ns-2 implements a variety of network components and protocols.
- It is an open-source event-driven simulator designed specifically for research in computer communication networks.

#### 1. Starting NS

NS starts with the command ns (assuming that we are in the directory with the ns executable, or that were path points to that directory), where is the name of a Tcl script file which defines the simulation scenario (i.e. the topology and the events). We could also just start ns without any arguments and enter the Tcl commands in the Tcl shell, but that is definitely less comfortable. Everything else depends on the Tcl script. The script might create some output, it might write a trace file or it might start nam to visualize the simulation.

#### 2. Starting Nam

We can either start nam with the command 'nam<nam-file>'

where '<nam-file>' is the name of a nam trace file that was generated by ns, or we can execute it directly out of the Tcl simulation script for the simulation which we want to visualize.

- Nam is a Tcl/Tk based animation tool that is used to visualize the ns simulations and real world packet trace data.
- The first step to use nam is to produce a nam trace file.
- The nam trace file should contain topology information like nodes, links, queues, node connectivity etc as well as packet trace information.

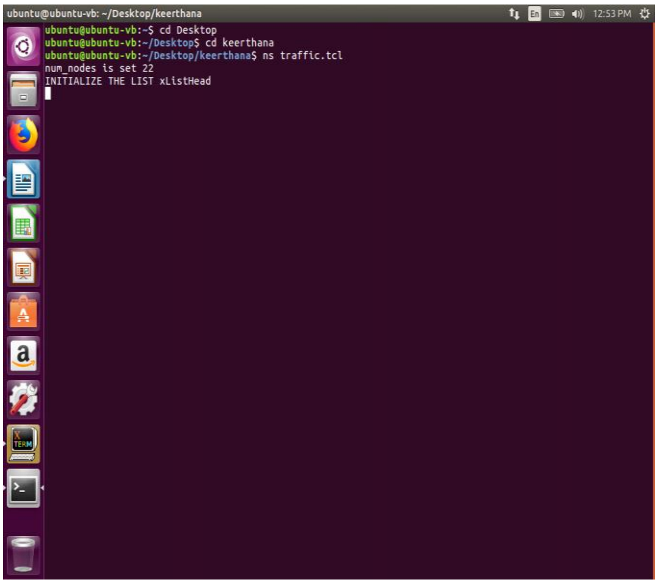
#### 3. Characteristics Of NS2

- To evaluate that performance of existing network protocols
- To evaluate new network protocols before use
- To run large scale experiments not possible in real experiments
- To simulate a variety of ip networks.

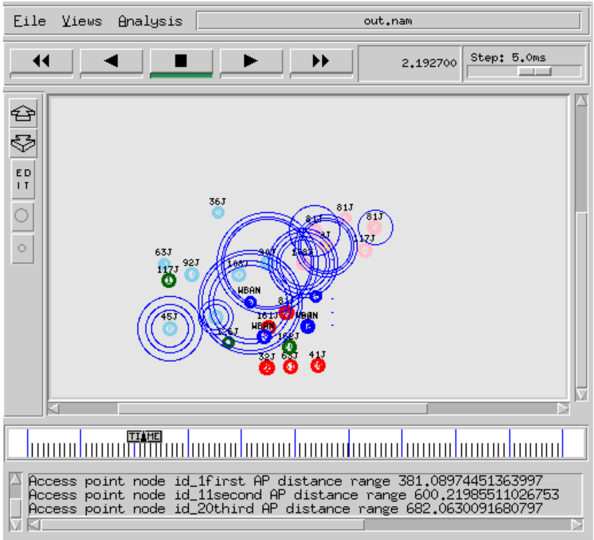
#### 4. Results

TERMINAL

CREATING A NODES

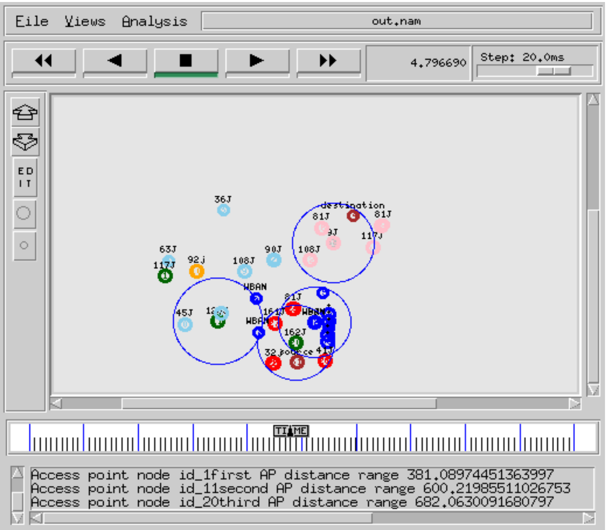


Network is initialised with the wireless node with their specified location. In this number of nodes created has been 48.



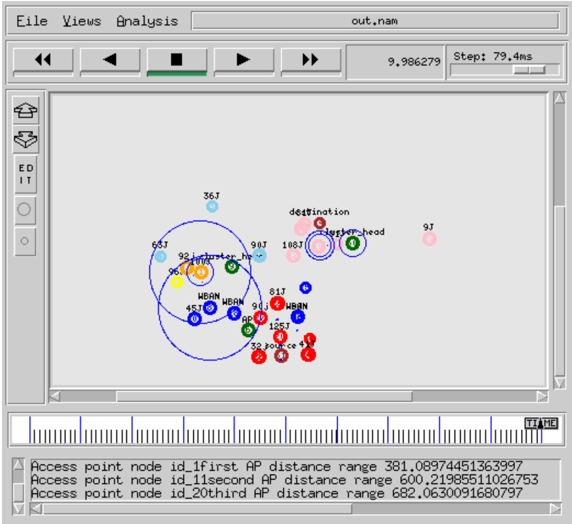

### B. Sender, receiver and cluster head allocation

Initially packets select random nodes, after which Pheromone value will get updated by all the packets as it reaches the destination. After the particular process, all packets move in the resulted shortest path. Sender and receiver in which the data or packets can transmitted between the nodes.




### C. Data transmission between the nodes

In this data transmission has been occurred between the different types of sender and receiver. While sending the data occurrence of nodes may be happened.

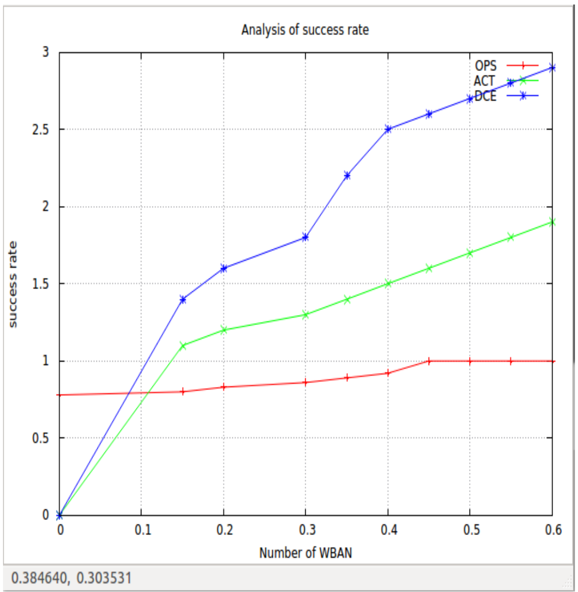



### D. Graph

In the graph green colour line indicates the existing method and red colour line indicates the proposed method.

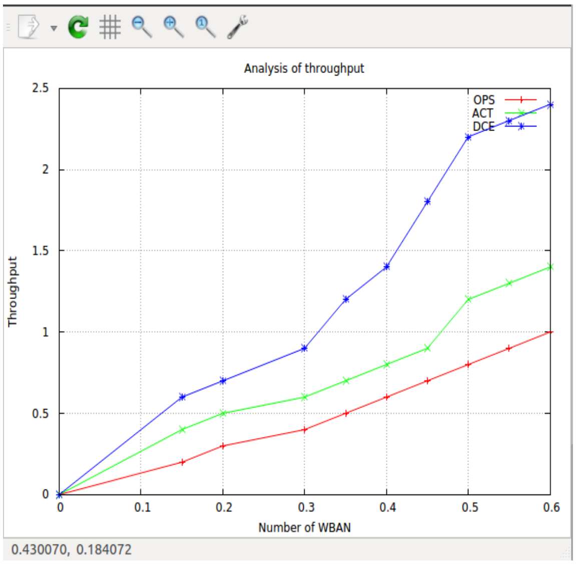
### E. Success rate

Network Lifetime shows that how much redundant data has been transmitted with failure




### F. Throughput

It is seen from our simulations that normal routing protocol outperforms in terms of throughput without being under the influence of worm whole attack. At varying speeds network when being under attack and also when prevented from attack by Intrusion detection, gives almost same throughput




## V. CONCLUSION AND FUTURE WORKS

In this work, we presented a scheme for dynamic connectivity establishment and cooperative scheduling for QoS-aware WBANs. First, we dynamically choose a dynamic AP for the critical WBANs, so as to deal with the transient connectivity problem between WBANs and APs. To manage connectivity, we proposed the Dynamic Connectivity Establishment (DCE) algorithm, which is based on a price-based approach. Finally, critical WBANs in the proximity of an AP form coalitions to ensure QoS between them. In each coalition, the WBANs participate in cooperative packet scheduling to provide services to the critical WBANs. For handling cooperation between WBANs, we proposed another algorithm Optimal Cooperative Packet Scheduling. We compared our proposed schemes with the existing schemes, based on which we show that the former our approach outperform the later.

## FUTURE WORK

Future extension of this work includes studying and characterizing the dynamic behavior of link quality between WBANs and APs for the connectivity problem. Another extension of the work is to observe the performance of the proposed solutions in real-life setting for mobile edge computing applications. Consequently, in the presence of transient connectivity, the data rate adaption technique can be implemented to increase the overall performance of WBANs. On the other hand, we intend to address the security and privacy issues of cooperative packet scheduling among WBANs in critical emergency situations.

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