Secure, Reliable and an Energy Efficient Protocol for Wireless Body Sensor Network in Medical Applications

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ABSTRACT
In this paper, Wireless Sensor Networks (WSN) are currently utilized in several applications together with military, environmental, healthcare applications, home automation and control. Wireless healthcare application offers several challenges like reliable data transmission, node mobility support and quick event detection, timely delivery of data, power management and node computation. This project focuses on wireless protocols concerned in medical application. Being capable of sensing, process and communication one or a lot of very important signs, these nodes is seamlessly integrated into wireless body area networks for health monitoring. In our proposed work, a new protocol is generated by combining privacy preserving scalar product for computation protocol (PPSPC) and cascading information retrieval by controlling access with distributed slot assignment protocol (CICADA) for enabling security, reliability and energy efficiency in wireless body sensor network(WBSN).

General Terms
Methodology for Information Transmission in Wireless Body Sensor Network.

Keywords
Wireless network, wireless protocols, body sensor network, biosensor, ultra wideband, personal health information.

1. INTRODUCTION
A Wireless Network is a communication between two devices without cables. It uses radio waves. The transmission is carried out by the electromagnetic waves. Wireless networks are comparatively difficult to set up, maintain, and troubleshoot. The same connection may be shared by multiple users. It has lower transmission speed.

Wireless sensor network consist of spatially distributed autonomous sensors to monitor physical (or) environmental conditions such as temperature, sound, vibration, pressure, motion (or) pollutants and to cooperatively pass their data through the network to a main location. The Parameters involved in Wireless Sensor Network are,

- Number of nodes
- Batteries
- Redundancy
- Data rate

Most of the sensors used by the personal health monitor are battery-operated and use wireless communication; such applications require networking protocols that are Efficient, Reliable, Scalable, and Secure. This paper proposes the design of a new protocol is generated by combining privacy preserving scalar product for computation protocol (PPSPC) and cascading information retrieval by controlling access with distributed slot assignment protocol (CICADA) for enabling security, reliability and energy efficiency in wireless body sensor network(WBSN).

The rest of this paper is organized as follows. Section 2 discusses related works for the wireless body sensor network and section 3 depicts the overall proposed system architecture. Section 4 shows the way of implementing constructing proposed system model and results obtained respectively Section 5 derives the conclusion and references.

2. RELATED WORK
Daojing He et al [3] proposed a system to identify the unique features of Medical Sensor Networks (MSNs) and introduce the relevant node behaviors such as transmission rate, leaving time, into trust evaluation to detect malicious nodes. Daojing He et al [2] presented a Body Sensor Network (BSN) is a wireless network of biosensors and a local processing unit, which is commonly referred to as the personal wireless hub (PWH). Tam Vu Ngoc [17] proposed a wireless technology not only improving the quality of life of patients and doctor-patient efficiency, and also wireless technology enables clinicians to monitor patients remotely and give them timely health information.

Hooi Been Lim et al [9] discuss the model aims to investigate the effects of the numerical models structure complexity. Measurements of ultra wideband (UWB) signal propagation along a human are performed and compared to the simulation results obtained with numerical arm models of different complexity levels. Francesco Chiti et al [6] proposed a wireless pervasive communication system to support advance healthcare applications. In order to improve the appropriateness of gathered data, information related to the context need to be extracted and correlated with the on body sensing. Tomohiro Kuroda et al [18] developed two prototypes, the ubiquitous echo graph and the networked digital camera and to embed the medical devices into Hospital Information System [HIS].

Masafumi Fujii et al [12] proposed a finite-difference time-domain (FDTD) model is computationally efficient. FDTD model for a whole human body based on accurate 2-pole Debye dispersion dielectric tissue properties. Hande Alemdar et al [7] proposed pervasive healthcare systems provide rich contextual information and alerting mechanisms against odd conditions with continuous monitoring. Enan A.Khalil et al

[5] presented the main challenges in designing and planning the operations of wireless sensor networks (WSNs) is to optimize energy consumption and prolong network life time. Zahoor A. Khan et al [20] proposed a system for body area networks (BANs) focused on making its communication more reliable, energy efficient, secure, and to better utilize system resources.

Devendra Gurjar et al [4] presented a model for strong need to collect physiological data and sensor networking in healthcare to focus on health-related applications of wireless sensor networks. Matiar M.R.Howlader et al [11] developed an emerging biomedical application using intelligent sensors for remote patient monitoring and systems for rehabilitation comparing surface vs. implanted sensors are considered. Moshaddique Al Ameen et al [13] proposed a wireless body area network using wearable and non-wearable sensor devices humans can be tracked and monitored. Phond Phunchongharn et al [14] developed a system using wireless communications in a healthcare environment raises two critical issues. First, the RF transmission can cause electromagnetic interface (EMI) to biomedical devices, which could critically malfunction. Second, the different types of electronic health (e-health) applications require different quality of service (QoS).

3. ARCHITECTURE FOR PROPOSED SYSTEM

The ultimate goal of this proposed system is to develop a wireless protocols involved in medical applications. Wireless Healthcare application offers many challenges such as reliable data transmission, node mobility support timely delivery of data and power management. Privacy Preserving Scalar Product for Computation Protocol (PPSPC) provides a security. Cascading Information Retrieval by Controlling Access with Distributed Slot Assignment Protocol (CICADA) provides reliability and energy efficiency. In our proposed work, a new protocol is generated by combining PPSPC & CICADA protocol for enabling security, reliability and energy efficiency in Wireless Body Sensor Network (WBSN).

3.1 Phases involved in the Proposed System

The system involves the process of network formation, implementation of ppspc with cicada algorithm, protocol generation, energy optimization, performance analysis. The development of the system is divided into the following phases:

- Network Formation
- Implementation of PPSPC with CICADA Algorithm
- Protocol Generation
- Energy Optimization
- Performance Analysis

The first module mainly deals with the process of network formation. In network formation, whole network is divided into several clusters. And the network model is consisting of set of sensor nodes. Their functions are simple, specific and usually operated. They sense the medium, collect raw data and forward it to the next neighbor nodes. The next module deals with Algorithm Implementation, PPSPC protocol provides security and to perform key generation algorithm where as CICADA protocol offers reliability & energy efficiency and to perform Distributed slot scheduling algorithm. The third module deals with Protocol Generation, record information from the sensor nodes and operations performed on a given set of data to extract the required information in an appropriate form such as diagram, report, tables. The fourth module deals with Energy Optimization, reducing energy consumption while maintaining health and safety. Reducing the amount of power consumed during data between the sensor nodes. Finally do the performance analysis. The final module explores the performance analysis, reduce average end to end delay and increase throughput & packet delivery ratio. The Figure 1 shows the proposed system. This work is implemented by using Network-Simulator 2 software.

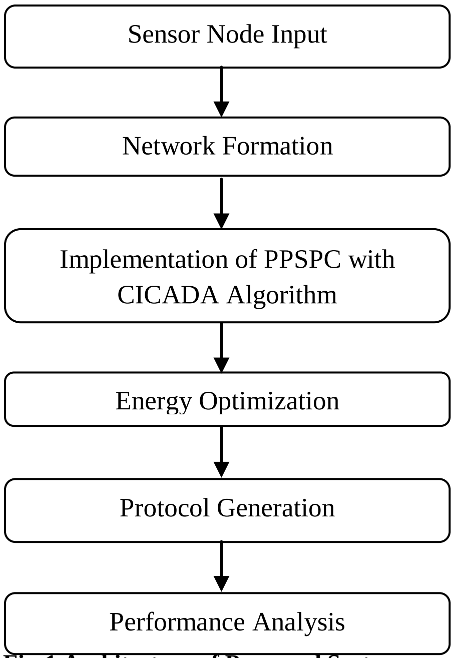

Fig-1 Architecture of Proposed System

3.1.1 Phase 1 - Network Formation

In Network Formation 100 nodes are randomly distributed within the network field of size 1500m * 1500m. Then vary the node speed from 5m/s to 30m/s. Each Node configured into Sensor Node. They sense the medium collect the raw data forward into next hop neighbor nodes. The Sender Node transmits packet information into Receiver Node. Based on the Relay Node only to send packet information from Sender to Receiver. Packet losses during data transmission consider the Sinkhole Attack. In Sinkhole Attack, routing information supplied by a node difficult to verify and a compromised node attracts all the traffic from its neighbors by telling its neighbor that it has shortest route to reach. So these kinds of purpose choose the Sinkhole Attack.

The simulation consists of N-number of base station each consist of their own nodes. Nodes have their own biosensors which may be an implanted or non implanted devices and for different channels to communicate each others. 2-fixed nodes that periodically send beacon messages in the network. These 2-nodes send their periodic beacon messages simultaneously. To calculate distance between sensor node and two fixed nodes preferably by TOA (Time of Arrival) or TDOA (Time Difference of Arrival) methods. To calculate the neighbor node distance as follows,

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

For above equation x_1, x_2, y_1, y_2 are the coordinates of the node. They are randomly selected and assigned to every node.

3.1.2 Phase 2 - Implementation of PPSPC with CICADA Algorithm

In the proposal, the information both a node's residual energy and the distance from it to the next hop node are considered with different equilibrium weight factors. That cross layer algorithm applied over a collection protocol improves the performance for different application requirements and shows that energy resources are conserved through dynamic parameter tuning.

Privacy Preserving Scalar Product for Computation (PPSPC) protocol provides a security. In this proposed work, PPSPC algorithm is implemented. Key generation is performed using PPSPC algorithm. PPSPC protocol algorithm involves,

- Input : U_0's binary vector $a=(a_1,a_2,\ldots a_n)$ and U_j's binary vector $b=(b_1,b_2,\ldots b_n)$
- Output : the scalar product of vector

$$a.b = \sum_{i=0}^{n} a_i \,.\, b_i$$

Steps:

1. U_0 expected threshold for the number of common symptoms character.
2. Vector $a.b \geq th$. U_0 assigns the current session key to U_j.
3. U_0 can decrypt and process the raw PHI data send from U_0.

Cascading Information Retrieval by Controlling Access with Distributed Slot Assignment protocol (CICADA) protocol provides a reliability and energy efficiency. Distributed slot scheduling algorithm is used. This protocol offers low delay and good resilience to mobility. Distributed Slot Scheduling algorithm involves, scheduling algorithm determines which links transmit at each time instant. A schedule is a collection of links that can be activated simultaneously. Divide each time slot into a control slot and a data transmission slot.

Steps:

1. In control slot t, select a "decision schedule" m (t): a set of links that may decide to change their state from the previous slot. Other links cannot change their state.
2. For any link I in m(t) do
3. If no links in its conflict set N (i) were active in the previous data slot link I will decide to become,
   - Active with probability $(p_i) = x_i(t)=1$
   - Inactive with probability $(1-p_i) = x_i(t)=0$
   - Else, link I will be inactive $= x_i(t)=0$

Combining two different protocols by using OLSR (Optimized Link State Routing Protocol). To configure OLSR protocol using frontend as OTCL language and backend as C++ language. Based on Link state Algorithm use this OLSR protocol. The set of selected neighbor nodes are called multipoint relays. MPR nodes are randomly selected as intermediate nodes in the path between a source and a destination.

3.1.3 Phase 3 - Protocol Generation

Based on comparison analysis of all protocols related to wireless body sensor network, PPSPC & CICADA protocol are combined for providing three protocols like together security, reliability and energy efficiency. And data gathering wireless sensor network under different communication organizations. The design of practical protocols for large-scale data gathering wireless sensor networks. In Protocol generation AOMDV (Adhoc On demand Multipath Distance Vector routing Protocol) is used. In AOMDV protocol all the nodes in the network have equal number of interfaces.

3.1.4 Phase 4 – Energy Optimization

Reducing energy consumption while maintaining health and safety. Reducing the amount of power consumed during data transmission between the sensor nodes. Aggregation reduces the amount of traffic which helps to reduce energy consumption on sensor nodes. Calculate each and every nodes energy value; first we set initial energy level, transmitting energy level, receiving energy level Then update energy of all nodes in every RRT. Initial Energy is given in Joules.

$$\text{Energy} = \text{power} * \text{time}$$

3.1.5 Phase 5 – Performance Analysis

The performance analysis carried out on AODV, Mod-AOMDV protocols using NS2 Simulator. The Average End-to-End Delay, Throughput and Packet delivery ratio are the 3-common measure used for the comparison of the performance of above protocols. It will reduce Average end to end delay, and increase Throughput and Packet delivery ratio. Throughput is defined as how many data packets received by receiver with in data transmission time or successful data transmission performed within a time period. Throughput is represented in bits/bytes per second. Packet delivery ratio is defined as the ratio of the data packets delivered to the destinations to those generated by the sources. Sometimes it is known as Packet Delivery Fraction (PDF). End-to-End Delay can be defined as the average time between packets sent and receive.

4. SIMULATION ENVIRONMENT

Table 1. Simulation Parameters

Parameter Name	**Value**
Simulator	NS-2.34
Number of Nodes	100
Simulation Time	200 Seconds
Initial Energy	20J/node
Packet Size	1000 bits
Sensing Area	1500m*1500m
Traffic type	CBR
Data Payload	512 bytes/packet

Mobility Model	Random Way Point Algorithm
Routing Protocol	OLSR, AOMDV

In Table 1. Shows the simulation parameter. For the implementation of the proposed work simulator NS-2.34 is used. Number of nodes 100 is randomly deployed in 1500m*1500m area. Initial energy of each node is set to 20 J/node.

The simulation environment is composed of a Base Station and some sensor nodes. The Base Station is fixed and located far from the sensor nodes. The location of each sensor node is randomly distributed in the sensing area. All sensor nodes are stationary and the initial energy is the same for each sensor node. A round is defined as the receiving data from all sensor nodes to the Base Station. Nodes have their own biosensors which may be an implanted or non implanted devices and for different channels to communicate each others. 2-fixed nodes that periodically send beacon messages in the network. These 2-nodes send their periodic beacon messages simultaneously. They are some mobile nodes in the network. To calculate distance between mobile node and two fixed nodes preferably by TOA (Time of Arrival) or TDOA (Time Difference of Arrival) methods. In Figure.2. Shows the comparison of wireless protocols involved in medical applications.

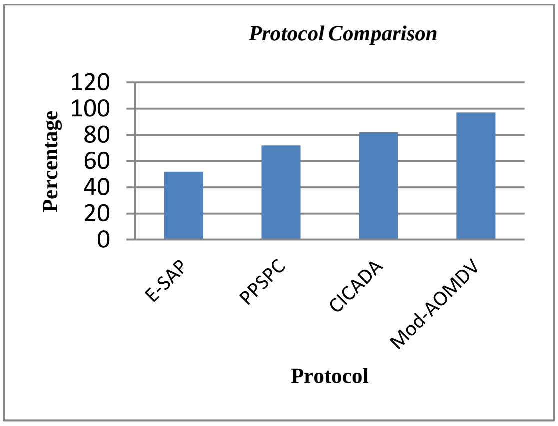

Fig-2. Comparison of Wireless Protocols

5. IMPLEMENTATION RESULTS

The implementation results contain network formation, neighbor node distance calculation, OLSR protocol configuration, AOMDV protocol generation and energy calculation, performance analysis. The results are shown as follows:

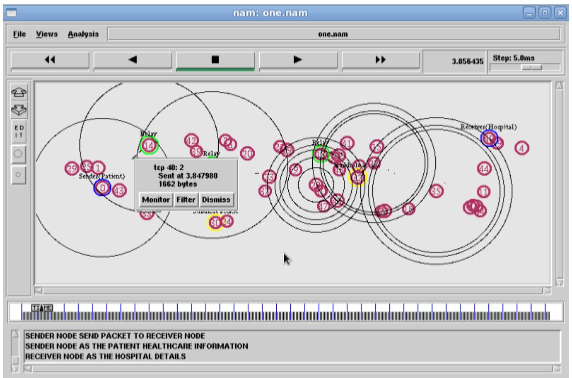

Fig - 3. Network Formation

In Fig-3. Shows Network Formation. In Network Formation, 100 nodes are randomly distributed in the network field of size 1500m*1500m. Network model consist of set of sensor nodes. Their functions are simple, specific and usually operated. They are used to sense the medium, collect the raw data and forward into the next hop neighbor nodes. To transmit a packet from sender to receiver. To send a information between 2 nodes like Sender and Receiver at a particular time period.

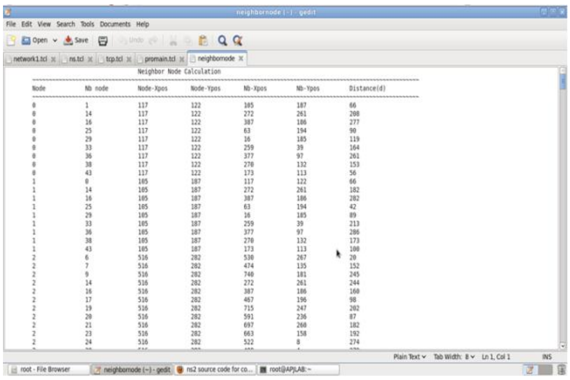

Fig - 4. Neighbor Node Distance Calculation

In Fig-4. Shows Neighbor Node Distance Calculation. In these cases Nearest Neighbor Algorithm is used.

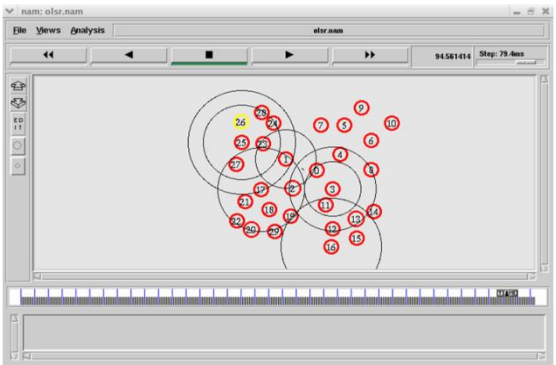

Fig - 5. OLSR Protocol Configuration

In Fig-5. Shows OLSR Protocol Configuration. The set of selected neighbor nodes are called multipoint relays. MPR nodes are randomly selected as intermediate nodes in the path between a source and a destination. The above diagram yellow color node as the MPR node. For combining 2-different protocol into a single one use OLSR protocol.

Fig - 6. AOMDV Protocol Generation

In Fig-6. Shows AOMDV Protocol Generation. The design of practical protocols for large-scale data gathering wireless sensor networks. In Protocol generation AOMDV (Adhoc On demand Multipath Distance Vector routing Protocol) is used. In AOMDV protocol all the nodes in the network have equal number of interfaces

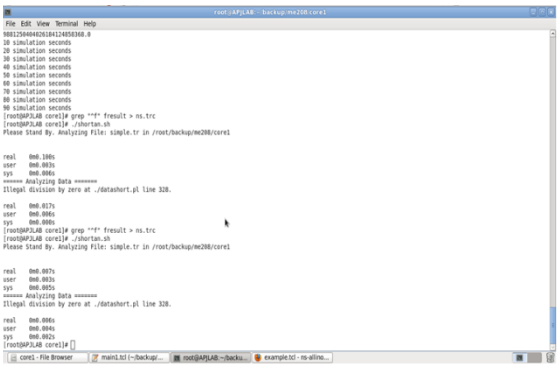

Fig - 7. Energy Calculation

In Fig-7. Shows Energy Calculation. Reducing energy consumption while maintaining health and safety. Reducing the amount of power consumed during data transmission between the sensor nodes.

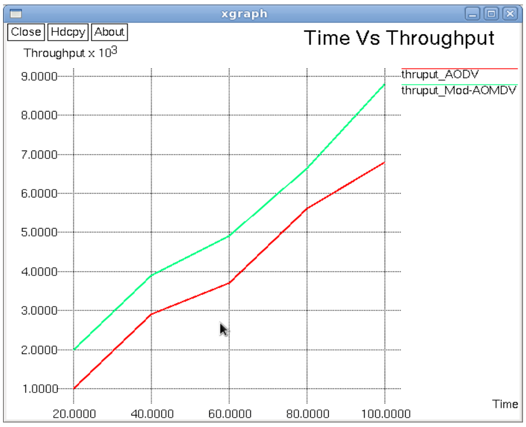

Fig - 8. Performance Analysis of Throughput

In Fig-8. Shows Performance Analysis of Throughput. Throughput is defined as how many data packets received by receiver with in data transmission time or successful data transmission performed within a time period. Throughput is represented in bits/bytes per second.

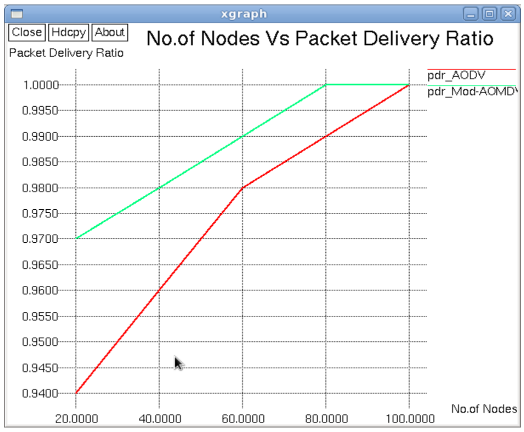

Fig - 9. Performance Analysis of Packet delivery ratio

In Fig-9. Shows Performance Analysis of Packet delivery ratio. Packet delivery ratio is defined as the ratio of the data packets delivered to the destinations to those generated by the sources. Sometimes it is known as Packet Delivery Fraction (PDF). Packet delivery ratio is represented as percentage (%).

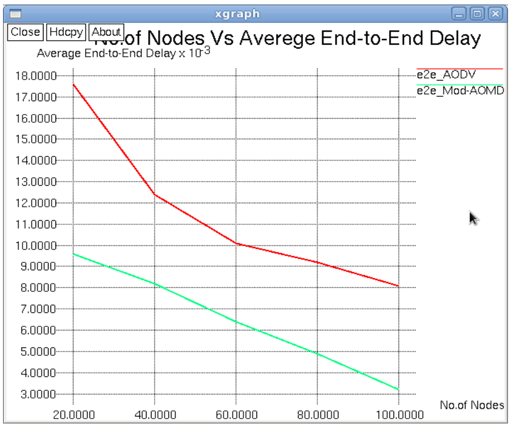

Fig - 10. Performance Analysis of Average End-to-End Delay

In Fig-10. Shows Performance Analysis of Average End-to-End Delay. End-to-End Delay can be defined as the average time between packets sent and receive.

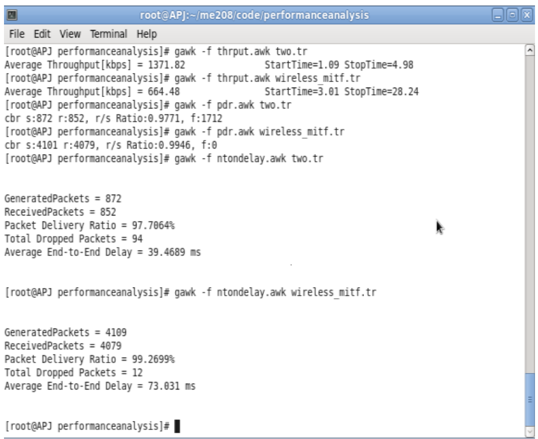

Fig - 11. Comparison of AODV and Mod-AOMDV Protocol

In Fig-11. Shows Comparison of AODV and Mod-AOMDV protocol. In these cases to analyze the trace file with this script Packet delivery ratio and Average End-to-End Delay. Run this script using awk file. Awk script is used to filter the information and by filter we can get the information that we require.

6. CONCLUSION

Many researchers have contributed good number of algorithms for efficient and reliable protocol for sensitive applications. Wireless Body Sensor Networks (WBSN) used for sensing, processing, communication and storage, are emerging as a solution to the challenges of monitoring physiological and activity information of people anywhere and at anytime in human centric applications. The wireless healthcare applications require security, reliability and energy efficiency in wireless body sensor network. The existing PPSPC protocol does not offer reliability and energy efficiency where as CICADA protocol does not provide security. In our proposed work OLSR protocol combines the characteristics of PPSPC & CICADA protocol for enabling security, reliability and an energy efficiency in wireless body sensor network (WBSN). After that AOMDV Protocol Generation and Energy Calculation is completed. Finally the performance is analyzed based on Throughput, Packet delivery ratio and Average End-to-End Delay.

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