

# Analysis of an Efficient Energy Optimized Routing Mechanism using ITAEO Protocol and Compared with TAE0 Protocol in WBAN

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## Abstract

**Aim :** The aim of the study is to minimise the energy consumption in sensors in wireless body area networks by using Improved Thermal aware and Energy Optimized routing protocol (ITAEO) protocol compared with Thermal aware and Energy Optimized routing protocol (TAE0) protocol. **Materials and Methods:** In this research clustering approach based routing in ITAEO is proposed to minimise energy consumption in TAE0 by efficient selection of cluster head (CH). The sample size of each group is 20 (N=20) collected by varying the number of rounds and it was calculated by calculator.net with pre- test power of 80% (G- power). **Results:** Simulation results show that ITAEO protocol has performed better than TAE0 protocol in terms of Throughput and energy consumption. The proposed ITAEO Protocol achieved (3.2%) higher throughput and (5.6%) lower energy consumption with TAE0 Protocol. The sample t-test shows that there is a significant difference in ITAEO and TAE0 values in terms of information throughput and energy consumption ( $p < 0.05$ ). **Conclusion:** Depending on the experimental results and independent statistical t-test shows that proposed ITAEO protocol has achieved higher performance when compared to TAE0 protocol.

**Keywords:** Wireless Body Area Network, Healthcare monitoring, Routing, Energy, Power consumption, End-to-end delay, Energy consumption, Innovative node reception cou

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## INTRODUCTION

Recent developments in sensor nodes with compact size and low power consumption, as well as low cost, have made it possible to create an effective routing protocol in WBAN (Aftab et al. 2020) and (Javed et al. 2019). It is about the energy consumption and remote health care monitoring system in wireless body area networks. It is important nowadays because temperature raises harmful effects on the significance of technology and it has numerous applications for both medical and non-medical purposes like in defence activities by physicians for remote health monitoring. The TAE0 routing protocol is proposed that not deals with thermal aspects and hotspot problems also extremes the stability of the network. (National Research Council et al. 2013) illustrated that the forwarded node selection depends on the distance parameter. WBAN is used for various applications such as remote monitoring (Kopparapu 2015) and (Wüest, Zawadzki, and Schmid 2001).

Mostly 25 articles were published in IEEE access and 15 articles in google scholar related to the aware routing protocol for WBAN remote health care application (Fox et al. 2021; Almagati and Kran 2021; Johns et al. 2021) and (Institute of Medicine and Board on Health Care Services 2012). In this scheme the clusters are formed and the cluster heads are selected using distance parameters. (Rigelsford 2002) in this scheme the clustering and cluster head is selected using residual energy of the wireless body area networks sensor nodes. (Wang, n.d.; Kumar et al. 2021). A transceiver in a sensor device is responsible for the communication of data through electromagnetic waves this scheme is illustrated by (Wang, n.d.) Our team has extensive knowledge and research experience that has translate into high quality publications (Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021).

From this literature review, the clusters are formed and the CH selection depends on the distance and residual energy parameter, but these parameters are not able to select the efficient CH, hence there is need for energy efficient cluster based routing with efficient CH. In this scheme the CH selection depends on various parameters such as Innovative node reception count, node distance and residual energy. Therefore the ITAEO protocol is proposed and compared with the TAE0 protocol.

## Materials and Methods

The research was carried out in the Department of Biomedical Engineering at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Science, Saveetha University, Tamil Nadu, India. Two groups are required for This Study. Group one consists of the ITAEO Protocol and group Two represents the TAE0 Protocol. The Sample Size Calculated by using a sample size calculator finding the mean and standard deviation. The sample size was 20 per group 80% of the pre-test (G-power). A PC with Ubuntu OS by VMWare workstation and NS2 simulator software was used for execution of the project. The NS run command was given to execute the code in TCL script.

### ITAEO Protocol

All the sensor nodes are placed in the human body and form the clusters. The cluster members need a leader node to send the data to the sink. The header node is selected using following parameters such as Innovative node reception count, node distance and nore residual energy.

The various steps involved in the (CH) selection process are described below.

**STEP 1** :All the Sensor nodes are deployed in a human body and clusters are formed

**STEP 2** :All the sensor nodes calculates their values using CH selection parameters such as Innovative node reception count, node distance

**STEP 3** :The mode which contains the highest rank the node becomes the CH

**STEP 4** :The coordinate node aggregates the information from the sensor nodes and route the information to the sink.

**STEP 5** :The sink gathers all the information from the various CHs and send it to the application unit.

### TAE0 Protocol

Temperature aware and energy optimized ( TAE0) routing protocol is proposed that not only deals with the thermal aspects and hot spot problems, but also extends the stability and lifetime of a network. WBAN has the potential to solve social problems, like efficient use of limits. The CH selection parameters are distance and residual energy of the node (Aftab et al. 2020).

### Statistical Analysis

The statistical analysis was carried out using the SPSS Tool. The significance is calculated using an independent t-test . It was performed for the two dependent variables such as energy consumption, throughput. The independent number of clusters, battery power. Using the SPSS software the Standard deviation, standard error of means were also calculated.

## Results

Table 1 shows experimental results of data analysis of the ITAEO protocol under varying number of rounds and throughput with reference to energy consumption. Experimental results of ITAEO protocol under varying number of rounds (0 to 12000) in terms of throughput (achieved highest value 5.00 when the number of rounds is 12000 and achieved lowest value 1.00 when the number of rounds is 600). Table 2 shows the experimental results of the TAE0 protocol under varying number of rounds and energy with reference to the throughput. Experimental results of TAE0 protocol under varying number of rounds (0 to 12000) in terms of energy consumption (achieved highest value 0.90 when the number of rounds is 600 and achieved lowest value 0.35 when the number of rounds is 12000). Table 3 shows the Group statistical analysis of ITAEO protocol and TAE0 protocol. Throughput Mean value is 0.33208 in ITAEO and the energy is 0.31401. The standard deviation value of energy consumption is 1.40431 and throughput value in the standard deviation value is 0.26518. Table 4 shows the independent sample T-test calculation of proposed ITAEO protocol and comparison of TAE0 protocol. The energy consumption and throughput are statistically significant ( $p < 0.05$ ). Figure 1 shows a comparison of throughput in ITAEO with TAE0 protocol under varying number of rounds and the throughput is increased by 3.2%. Figure 2 represents comparison of energy consumption of sensor nodes battery power in ITAEO with TAE0 protocol under varying numbers of rounds the energy consumption is minimized by 5.6% due to the position of the node. Figure 3 shows the bar chart representing the comparison of ITAEO protocol and TAE0 protocol in terms of throughput. X Axis: ITAEO protocol vs TAE0 protocol

protocol, Y Axis: Mean throughput of detection  $\pm 1$  SD. Figure 4 illustrates the bar chart representing the comparison of ITAEO protocol and TAE0 protocol in terms of energy consumption when compared with the previous protocol of TAE0 X Axis: ITAEO protocol vs TAE0 protocol.

## Discussion

Comparison of energy consumption of ITAEO protocol and TAE0 protocol is studied. The numbers of rounds of the proposed protocol is varied from 600 to 1200. The energy consumption is reduced by 5.6% and the throughput is increased by 3.2% in ITAEO protocol compared with TAE0 protocol under varying numbers of rounds. The energy consumption, throughput are statistically significant ( $p < 0.05$ ) using SPSS software independent sample t-test calculation. According to simulation data, the ITAEO protocol output performs the TAE0 in terms of efficient routing.

Modification made in this research is that the CH node selection depends on multiple parameters such as Innovative node reception count, node distance and residual energy. (Kopparapu 2015; Institute of Medicine and Board on Health Care Services 2012)(Maddocks 2019) These papers are similar routing protocols in order to improve the performance of CH nodes in sensors in the WBAN (Javed et al. 2019)(Institute of Medicine and Board on Health Care Services 2012).

The Main limitation of this work is the ITAEO is if the size of the network increases the number of clusters increases which causes more packet drop ratio in the network. In future the security of the routing protocol needs to be improved.

## Conclusion

The cluster based routing protocols are used to minimise the energy consumption and maximise the throughput in the network. The ITAEO protocol has better simulated outputs when compared to the TAE0 protocol in terms of energy consumption minimised by 5.6% and throughput increased by 3.2 %

## Declaration

**Conflict of Interests** No conflict of interest in this manuscript.

### Author Contribution

Author NM was involved in Methodology creation, simulation, data collection, data analysis, Manuscript writing. Author CS was involved in conceptualization, guidelines and critical review of manuscript.

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## TABLES AND FIGURES

**Table 1.** shows experimental result data analysis of the ITAEO protocol under varying numbers of rounds (600 to 1200) in terms of throughput (achieved highest value 5.90 when the number of rounds is 1200 and achieved lowest value 1.00 when the number of rounds is 600).

NUMBER OF ROUNDS	IEOCER PROTOCOL	EOCER PROTOCOL
600	1.00	0.05
1200	1.20	0.05
1800	1.50	0.31
2400	1.90	0.36
3000	2.00	0.42
3600	2.30	0.55
4200	2.50	0.57
4800	2.90	0.61
6300	3.00	0.63
5400	3.30	0.67
6000	3.70	0.69
6600	3.90	0.71
7200	4.00	0.75
7800	4.20	0.79
8400	4.40	0.80
9600	4.90	0.82
10200	5.00	0.85
10800	5.20	0.89
11400	5.50	0.90
12000	5.90	0.90

**Table 2.** shows the experimental results of the ITAEO protocol under varying number rounds (600 to 1200) in terms of energy consumption ( achieved highest value 0.90 when the number of rounds is 600 and achieved lowest value 0.31 when the rounds is 12000 )

NUMBER OF ROUNDS	IEOCER PROTOCOL	EOCER PROTOCOL
600	0.90	4.9
1200	0.88	4.2
1800	0.85	3.8
2400	0.81	3.5

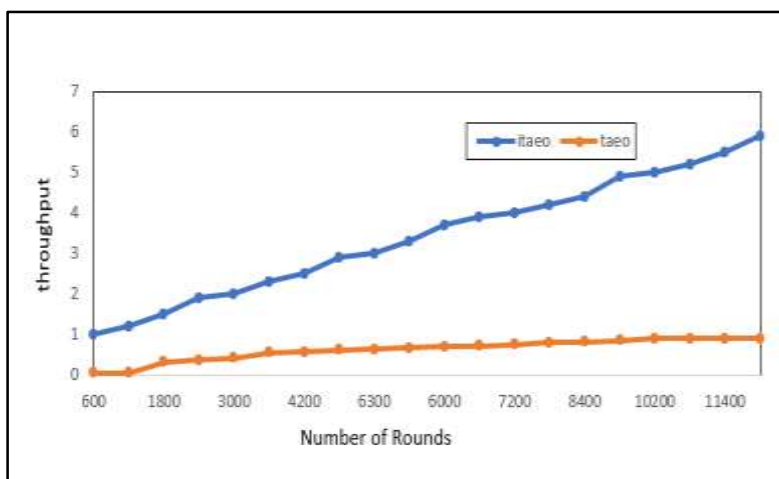
3000	0.77	3.2
3600	0.74	2.9
4200	0.71	2.8
4800	0.68	2.5
6300	0.65	2.1
5400	0.61	1.8
6000	0.59	1.5
6600	0.57	1.2
7200	0.51	1.2
7800	0.48	1.2
8400	0.45	1.2
9600	0.42	0.8
10200	0.38	0.5
10800	0.35	0.4
11400	0.32	0.2
12000	0.31	0.2

**Table 3.** Group statistical analysis of ITAEO Protocol and TAEO protocol. throughput Mean value is 33208 in ITAEO protocol and the energy is . The standard Deviation value of Energy consumption is i.e..19425 and throughput value in the standard deviation value is 1.48511

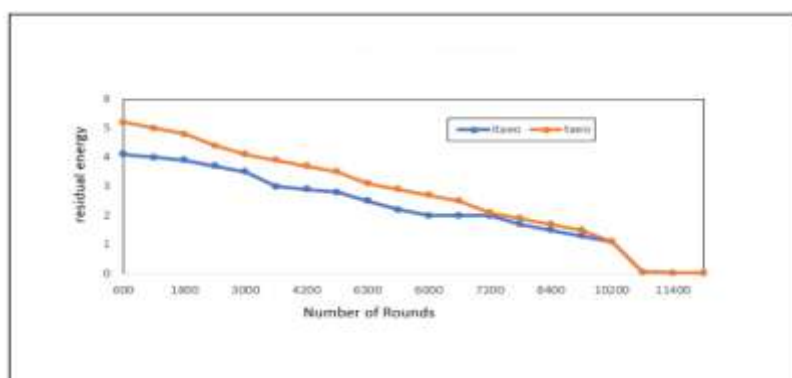
	GROUP	N	MEAN	STD.DEVIATION	STD.ERROR MEAN
Throughput	ITAEO	20	3.4150	1.48511	.33208
	TAEO	20	6135	26518	05930
Energy	ITAEO	20	.5990	.19425	.04281
	TAEO	20	2.0050	1.40431	.31401

**Table 4.** Shows the independent sample T-test Calculation of proposed ITAEO protocol and Comparison of TAO protocol. The energy consumption,end-to-end delay are statistically significant ( $p < 0.05$ ).

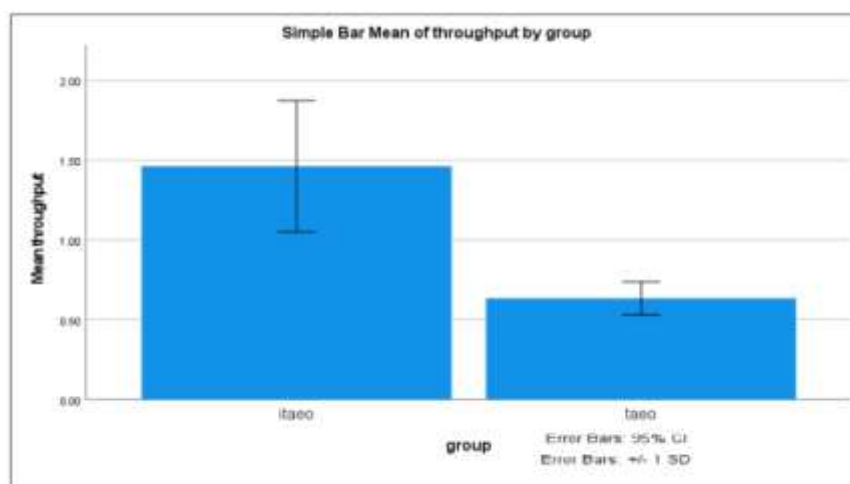
		Levene's Test for Equality of variances		T-test for Equality of Means						
		F	Sig	t	df	Sig.(2-tailed)	Mean Difference	std.Error Difference	Lower	Upper
Throughput	Equal variances assumed	36.48	<.001	0.305	<.001	<.001	2.80150	3.3733	2.1186	3.48439
	Equal variances not assumed			0.305	20.21	<.001	2.80150	3.3733	2.0983	3.5047
Energy	Equal variances assumed	41.81	<.001	-4.43	38	<.001	1.40600	.31692	-2.047	-.7644
	Equal variances not assumed			-4.43	19.70	<.001	-1.40600	.31692	-2.067	-.7442



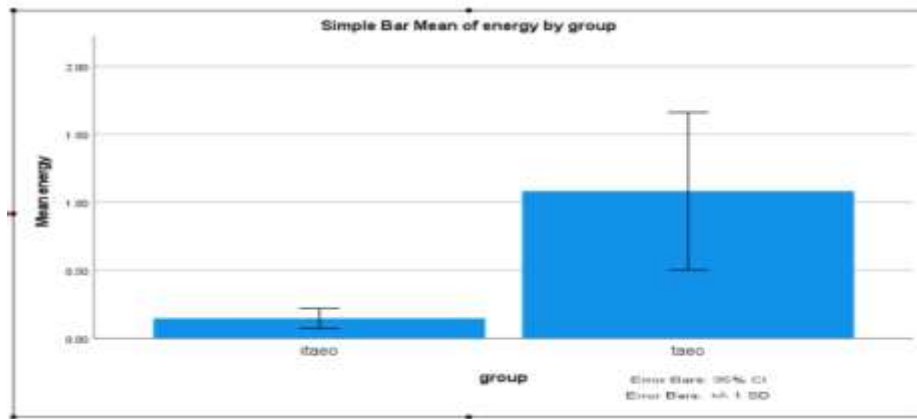
**Fig. 1.** Comparison of end-to-end delay in ITAEO with TAE0 protocol under varying number of rounds and the end-to-end delay is decreased by 3.2% .



**Fig. 2.** compared the energy consumption of sensor nodes battery power in ITAEO with TAE0 protocol.under varying number of rounds the energy consumption is minimized by 5.6%.



**Fig. 3.** Bar chart representing the comparison of ITAEO and TAE0 protocol in terms of Throughput and achieved 3.2% higher throughput when compared with TAE0 protocol.X axis ITAEO protocol vs TAE0 protocol,Y axis : Mean throughput of detection  $\pm$  1 SD.



**Fig. 4.** Bar chart representing the comparison of ITAEO protocol and TAE0 protocol in terms of 5.6% lower energy consumption when compared with the previous protocol of TAE0 X Axis : ITAEO protocol vs TAE0 protocol ,Y axis : Mean energy consumption of detection  $\pm$  1 SD.