Avant-Grade framework Routing Optimization Based on Established Network Lifetime and Energy Management in WSN

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Research Article

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Avant-Grade framework Routing Optimization Based on Established Network Lifetime and Energy Management in WSN

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Abstract

Wireless Sensor Network (WSN) is known to be a highly resource constrained class of network where energy consumption is one of the prime concerns. The existing system of LTDC has more drawbacks in network routing optimization lifetime and energy level improvement needed. In this research, a cross layer design methodology was adopted to design an energy efficient routing protocol entitled Avant-Grade framework Routing Optimization [AGFRO]. AGFRO is designed to minimize energy consumed in each node by reducing the amount of time in which a sensor node is in an idle listening state and reducing the average communication distance over the network. The performance of the proposed system has been critically evaluated in the context of network lifetime, throughput, and energy consumption of the network per individual basis and per data packet basis. The research results were analyzed and benchmarked against the well-known AGFRO protocols. The outcomes show a significant improvement in the WSN in terms of energy efficiency and the overall performance of WSN.

Keywords: Avant-Grade framework Routing Optimization [AGFRO], Energy Management, Network Lifetime.

1. INTRODUCTION

Wireless sensor technology is playing a vital role in many of the commercialized industrial automation processes and various other real life applications. It is particularly suitable for harsh environment applications where deploying of other network infrastructure is difficult and/or almost impossible such as in battlefield, in hazardous chemical plant, and in high thermal environment. It is not uncommon to see that most of the crucial surveillance and security applications also rely on sensor based applications. Sensors which are tiny in size and cheap in cost have the capabilities to be deployed in a range of applications as explained. Essentially all sensor networks comprise some forms of sensing mechanism to collect data from an intended physical environment either by a time driven approach or by event triggering approach or one of the cluster-based routing protocols. Being very small in size, sensor nodes are built with limited computational capacity, small storage memory, and finite battery power capacity.

The structure of a typical WSN node consists of four main components: a sensing element, normally used for sensing a physically measureable parameter; an Analog-to-Digital Converter (ADC), used for converting analog signals to some digital formats; a processing unit, providing simple/basic data processing and computation capabilities; and a power unit, responsible for sensor node's operation life span. It is a known fact that WSN is a resource constrained network in which energy efficiency is always the main issue since the operation of WSN depends heavily on the life span of the sensor nodes' battery. The most energy consuming operation in WSN is the data packet routing activity. The characteristics of the WSN are different from the conventional networks. These unique characteristics are often taken into account for addressing the issues and challenges related to network coverage, runtime topologies management, node distribution, node administration, node mobility energy efficiency/consumption, network deployment, application areas/environment, and so forth

Figure.1 defines the synchronous node terminals in the short term which the amount of information and congestion may occur at this time. Left a large number of congested data packets has drop causes data transfer reliability. Meanwhile, networks reduce pocket rate, unnecessary energy consumption, recycling, and fuel consumption. Some measures are routinely used to reduce upstream node data congestion to control the investment data rate. It is difficult to control downstream flow.

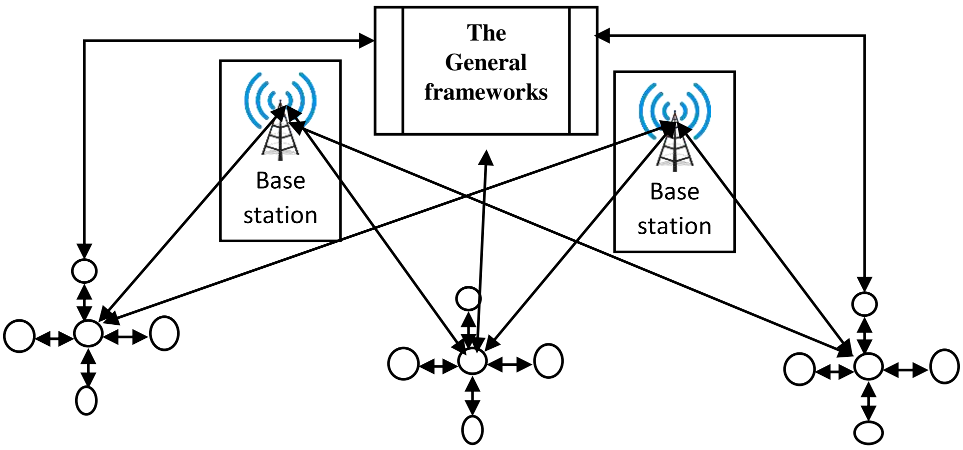

Figure.1. the General Architecture of frameworks based route optimization

Data has been transferred from the target node to target as quickly as possible. However, even in anti-power sensor networks, large amounts of data can be easily transferred from the node in a "multi-one" manner, resulting in serious bandwidth loss rates and power issues. As a result, the nodes' power consumption around the synchronization node is much faster than others, resulting in power imbalance and shorter network life. Data has been transmitted to BS from various sources using the energy-efficient routing method. The rest of the sheet is handled as follows.

2. RELATED WORKS

Quality of service (QoS) and security issues. To extended network lifetime, many applications require QoS, security guarantees and a traditional approach. Sensor protection [1] is the interface between the network QoS. Wireless Sensor Networks (WSN) can be used as part of a network display to determine the relationship. Therefore, WSN [2] is one of the most important performance standards.

. Security of Industrial Wireless Sensor Networks (IWSNs) is important. Therefore, in this article, we will explore how multipath can increase safety, life and coverage issues [3]. A novel cross-Layer Optimization Control protocol has been proposed to reduce many bad performance damage industrial control systems. The clock sensor is a multihop mesh and is [4] designed as a common wireless sensor in a multihop network.

Data Upload Time the Wireless sensor networks generate a large number of mobile data collections [5]. Location Optical Wireless Sensor Networks have Different sensor optical wireless sensor networks to implement effective geo-routing methods for measuring with underwater locations and support interfacial connections [6].

The Independent Duty Cycle for Opportunistic Routing on Wireless Sensor Networks (WSNs), until determined to set as a relay based on dynamic real-time network conditions [7]. Recent advances in environmental power generation technology include conventional sensor networks. Due to the dynamics of ambient energy resources' secular profiles, most studies focus on designing and optimizing energy management schemes within a single sensor node [8].

In wireless sensor networks, sensor nodes typically deliver multihop mode, auto-integrated and centrally synchronized data. Clinical analysis of the performance improvement [9] with each pocket navigator device in a routing network whose terminals extend the sensor network's life through initial power allocation. We hope that our previous work [10] has shown similar results for the specific matched battery model and general battery dynamics.

The goal is to increase the lifespan of a network with a sensor network. Previous works on fixed-topographic networks have complex. Here, a new definition of network lifetime [11] is needed to add source node dynamics. Most sensors accept network distribution and dynamic routing protocols. Flexibility is the most powerful heat of the network that can select the best forward from different candidates for best routing performance [12] at each node. Calculating the structural diagram of one of the most crucial nodes' focal points is a measuring challenge. The concept of social network analysis is an important focal point. Therefore, a wireless sensor network (WSN) has been used to define such a network's significance, such as a terminal. Wireless sensor networks [13] another important feature of the optimization way.

Recently, unscrewed aerial vehicles (UAVs) have been widely adopted to utilize network resources such as the Internet (population), sensor networks and three-dimensional (3D) wireless networks [14]. The entire network of wireless sensor networks (WSNs) sends messages about the node, an important and simple operation. WSNs have been designed to awaken a growing symmetry responsibility for the reliability and methods of posting new challenges in effective protocols [15].

3. PROPOSED METHODOLOGY

Routing optimization has been introduced using AGFRO protocol to minimize power losses during transmission and extend network life. Step-by-step confidence groups are specified using the AGFRO protocol. Figure 1 shows that the optimal power level rings based on network lifetime are selected using the proposed AGFRO protocol based on the target function.

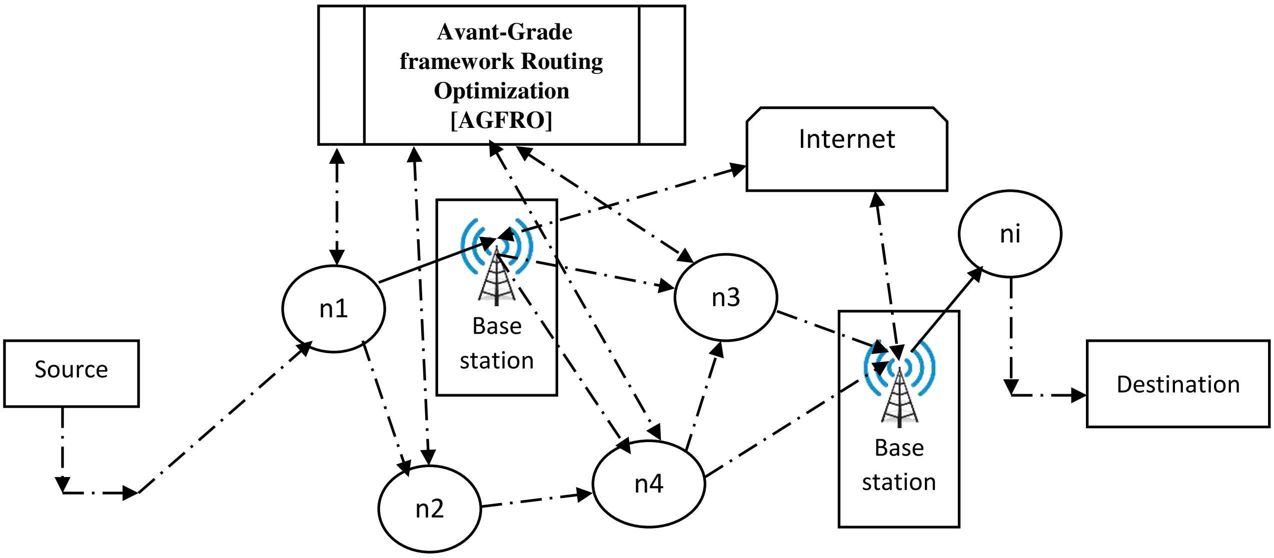

Figure.2 Proposed Architecture

The random walk model was adopted to optimize the logistics network. To make the analogy, the possibility to select next routing node can be viewed as the transition probability between the two nodes of the random walk process. Then, a transition probability matrix of two adjacent node sets can be generated. Assume that a random path could be selected in the network nodes; the model will gradually converge to its stable distribution, indicating the possibility that a route is chosen.

3.1 Avant-Grade framework Routing Optimization [AGFRO]

In AGFRO protocol, assuming each node has the same initial energy of the network, it appears different generally. Every time slot has data communication. Usually, the nodes have a higher probability to be selected as a Cluster Head (CH) which has more residual energy. In addition, it reduces the possibility that the nodes will stop working due to energy consumption.

The energy of CHs is mainly consumed in three aspects: data in receiving, merging, and sending to the BS from member nodes. Because most cluster heads are far from the BS, which mostly protocols use multiple paths attenuation channel model. The energy consumption of the CH function is given follow:

AGFRO still needs to solve the following two problems. Firstly, mathematical formulae are needed to represent the constraints, such as data transmission time constraints, node coverage constraint, data transmission constraints, energy constraint, and grid selection constraint. Optimization model is required. Secondly, each individual needs to meet all constraints. Genetic algorithm is required to be improved; then optimal solution is obtained.

3.2 Data Transmission Delay Constraints

Data transmission delay should not be too long; therefore, the sum of waiting time of sink node moving along the path once should not be longer than defined maximum data transmission delay.

$$\sum_{p} t_p < t_{delay}{}_{---(1)}$$

Where t_p represents sojourn time of sink node at sojourn grid center p; represents defined maximum data transmission delay. Mobile data collection process of sink node consists of static data collection processes when sink node stays at several sojourn grid centers for a period of time; therefore, sojourn time of sink node at grid center P should not be less than the delay performance time of sink node moving between adjacent grid centers.

$$t_p > \frac{d_p}{V}, \forall P --- (2)$$

Where represents the distance from grid center to next sojourn neighbor grid center.

3.3 Constraint Analysis

WSN considering data transmission delay, data transmission hops, storage capacity, node energy, and movement speed of sink node are limited, data transmission delay constraints, node coverage constraint, data transmission constraints, energy constraint, and grid selection constraint are, respectively, extracted out.

3.4 Node Coverage Constraint

It collects data of sensor nodes whose transmission hops to sink node are not more than defined threshold. Bad movement path of sink node may lead some sensor nodes not to communicate with sink node. Those nodes are called isolated nodes. Therefore, it is necessary to analyze node coverage constraint and eliminate isolated nodes. (Px_i, Py_i) Represents location coordinates of sensor node. (gx_i, gy_i) Represents sojourn location coordinates of current sink node. Represents the distance from sensor node to sojourn location of sink node. d_{ij} represents the distance from sensor node to neighbor sensor node j. The calculation formulae of and d_{ij} are as follows:

$$dg_i^p = \sqrt[2]{(Px_i - gy_p)^2 + (Px_i - gy_p)^2} \quad j\in N_i \text{----- (3)}$$

Where $\boldsymbol{N_i}$ represents the set of all neighbor sensor nodes which are in the single-hop throughput range of sensor node. When sink node stays at grid center *p*, data transmission hops between each sensor node and sink node are

$$h_i^p = \begin{cases} l & dg_i^p < d_{max} \\ min_{j\epsilon N_i}(h_i^p) dg_i^p \geq d_{max} \end{cases} \text{--- (4)}$$

Where h_i^p represents minimum transmission hops from sensor node to sink node. i represents maximum throughput of node.

$$h_{ij}^p = \begin{cases} l & dg_i^p < d_{max} \\ \infty \, dg_i^p \geq d_{max} \end{cases} \text{--- (5)}$$

In the data collection process, all sensor nodes are required to communicate with sink node and send data to sink node. There is no isolated node; therefore, node maximum throughput constraint is

$$\sum_p C_i^p \geq l, \forall i - - - - (6)$$

3.4 Data Transmission Constraints

In an actual system of WSNs, sensor nodes keep sensing data from time to time. If a sensor node is not in the data collection range of sink node, the sensed data should be put into memory. When the needed stored data exceeds maximum storage capacity, the latest data replaces the oldest data. Therefore, when sink node stays at grid center, data transmission constraint of sensor node

$$0 \leq C_i^p g_i^p + b_i^{p-1} + t_p, s_p ----(7)$$

Where $\boldsymbol{g_i^p}$ represents maximum amount of transmission data of sensor node i when sink node stays as grid center P. S represents sensing rate of sensor node P.

$$b_i^p = \sum_p C_i^p \geq l, \forall i ----(8)$$

Where b_i^p represents maximum storage capacity of sensor nodes.

3.5 Optimization Model Establishment

The mobile data collection process of sink node can be divided into several static data collection processes at waiting time. Therefore, based on the analysis of the constraints and the hypothesis of routing optimization problem of network lifetime with limited data transmission delay and hops can be transformed to the network model. According to energy consumption of sensor node i, lifetime of sensor node is

$$T_i = \frac{E_{in}}{\sum_p C_i^p \geq l, \forall i} \text{ --- } (9)$$

Network lifetime is

$$T = \min(T_i) ----(10)$$

Optimization model of network lifetime with limited data transmission delay

4. RESULT AND DISCUSSION

In sensor nodes of actual WSNs, the energy consumption of data process and calculation and control package communication such as information query package, routing information package, and transmission data query package are relatively small; therefore only energy consumption of data sensing and communication is considered during simulation process. Energy consumption model which is adopted in the current academic field is used for all nodes.

$$E_f = g_{ij}E_{elec} + g_{ij}E_{fs}$$

$$E_j = g_{ij}E_{elec} \quad \text{- - - } (11)$$

where $\boldsymbol{E_f}$ represents energy consumption of node data transmission, $\boldsymbol{E_j}$ represents energy consumption of node data reception, represents the amount of data which sensor node needs to send to neighbor sensor node j, E_{elec} represents energy consumption parameter of communication circuit, and represents energy consumption parameter of signal amplification.

Due to various factors, this method has not yet confirmed its performance. The proposed system was introduced AGFRO Routing Optimization system that has been compared to various methods, namely Life Time Delay Clustering (LTDC), Digital Signature Random Number Generators (SMDSRNFGs), Stochastic Data Scheduling Mechanism (SDSM), and Stableand Load-Balanced Routing (SLBR) and methods in this developed system.

Table 1 Simulation parameters of the proposed method

Parameters	**Value**
Tool	NS2
Language	TCL
Number of nodes	100
Traffic Model	CBR (Constant Bit Rate)
Simulation time	10mis
Network topology	Hybrid network

Simulation parameters are based on the different analog levels, where the proposed method's several factors assess its performance as shown in Table 1. The simulation results are as follows.

Simulation result

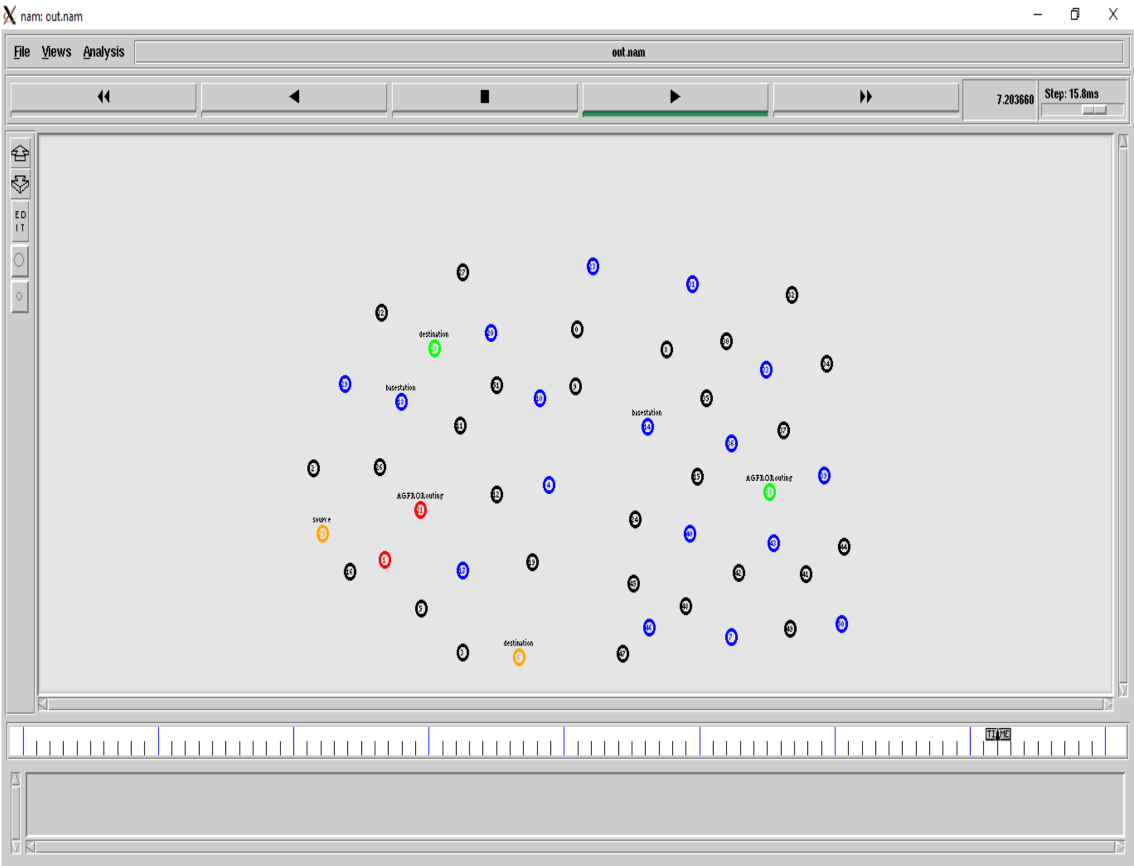

Figure. 5 AGFRO protocol based routing optimization

Figure.5 results show that the network routing optimization on the wsn network. The AGDRO routing protocol support for increased routing lifetime and increased the route optimization

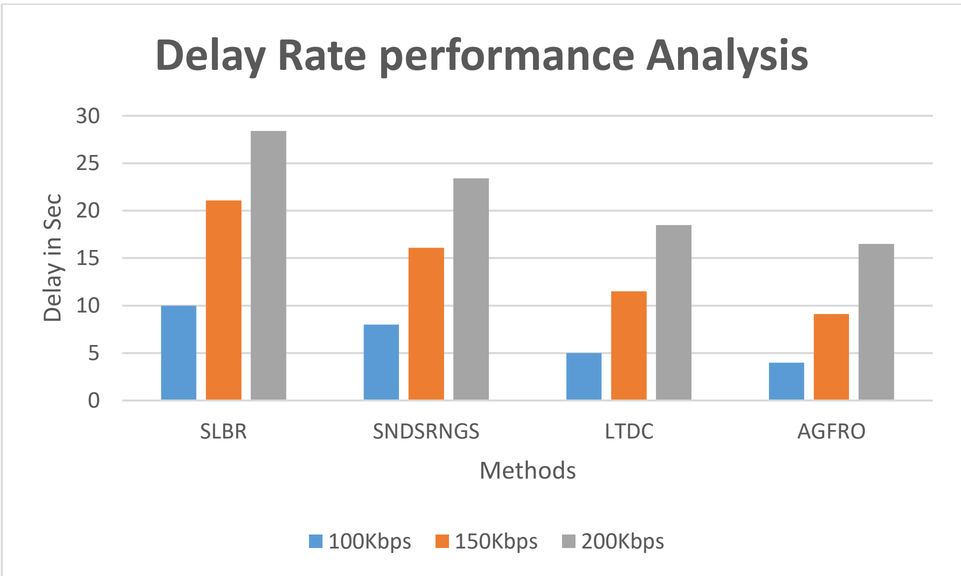

Figure. 6 Network Delay performance analysis

Figure.6 defines the wireless sensor networks that have analysis packet delay time compared to various protocols. The SLBR protocol has delay time speeds up to 28.4 /sec for

200kbps taken, and the SMDSRNGS protocol has delay time speeds up to 23.4 /sec 200kbps taken, and The LTDC protocol has delay time speeds of 18.5/sec 200kbps taken, and The AGFRO protocol has delay time speeds of 16.5/sec 200kbps taken.

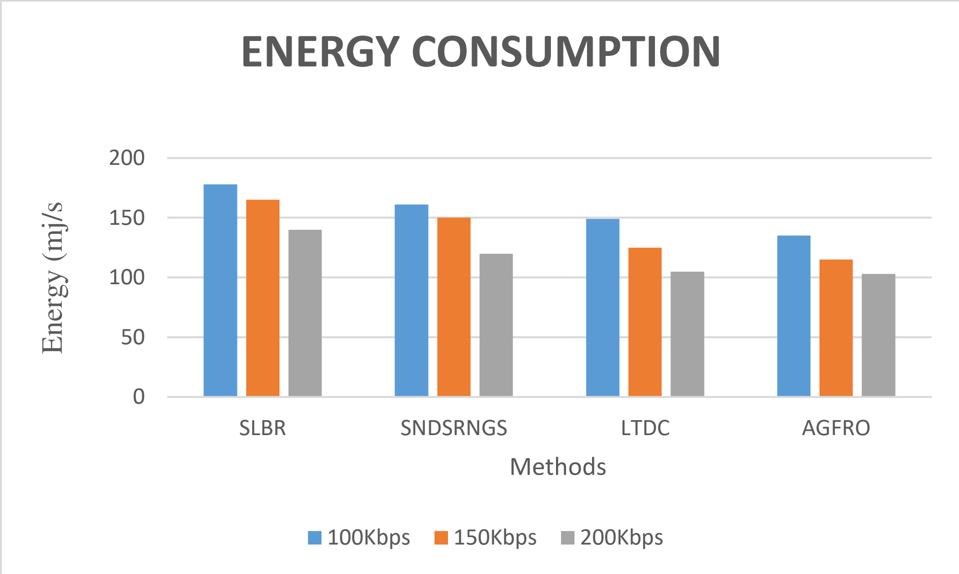

Figure.7 Energy consumption rate analysis

Figure.7 defines the wireless sensor network. Energy consumption rate analysis has compared to various protocols. The SLBR protocol has an Energy consumption rate of 140 m/sec for 200kbps taken. The SNDSRNGs protocol has an Energy consumption rate of 120 m/sec for 200kbps taken, and the LTDC protocol has an Energy consumption rate of 105 m/sec for 200kbps taken, and the AGFRO protocol has an Energy consumption rate of 103 m/sec for 200kbps taken.

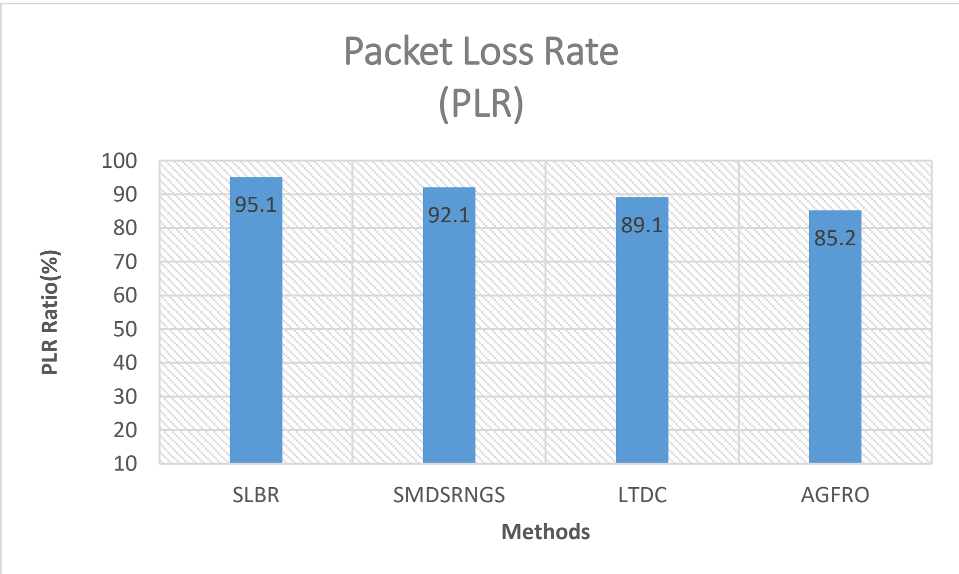

Figure 8 Packet Loss rate analysis

Figure.8 defines the wireless sensor network Packet Loss rate analysis has compared to various protocols. The SLBR protocol has a Packet Loss rate of 95.1 %. The SMDSRNGs protocol has a Packet Loss rate of 92.1%, and the LTDC protocol has a Packet Loss rate of 89.1 %, the AGFRO protocol has a Packet Loss rate of 85.2 %.

Table 2 Routing performance analysis

Time in Sec	Routing Performance in (%)			
	SLBR	SMDSRNGs	LTDC	AGFRO
120	18	23	26	32
140	25	29	32	43
160	47	52	58	68
180	79	82	88	91
200	92	94	96	97.2

Table 2 and figure 8 show the routing performance of the proposed method AGFRO has been compared to existing methods like SLBR, SMDSRNGs, LTDC.

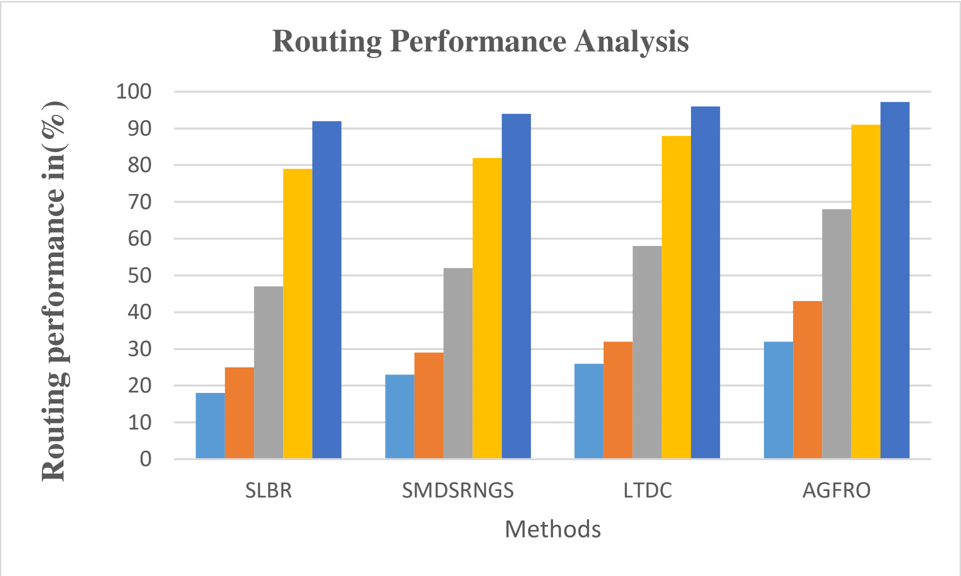

Figure 9 analysis of routing performance

Figure.9 show that the SLBR protocol has taken 200 m/sec of Routing Performance average, which is 92%. The SMDSRNGs protocol has taken 200 m/sec of Routing Performance average, which is 94 %. The LTDC protocol has taken 200 m/sec of Routing Performance average, which is 96%. The AGFRO protocol has taken 200 m/sec of Routing Performance average, which is 96%.

5. CONCLUSION

According to limited data transmission delay and hops in m WSNs, and data formulas are used to represent constraints and optimization model. Next, AGFRO routing method is selected to calculate node energy consumption when sink node stays at waiting time grid centers. Performances among SLBR, SMDSRNGs, LTDC, and AGFRO are compared and analyzed. Simulation results show that, in the monitoring area, when sensor nodes obey random uniform distribution in whole area, random uniform distribution in part area, and random Poisson distribution in part area, according to node location and other information, AGFRO can find an optimal movement path of sink node and sojourn times. Therefore, network lifetime is improved. Sensor nodes are fully covered, and average node energy consumption and average amount of node discarded data are reduced, AGFRO were increased complexity of life time.

Declarations

Funding

Not applicable

Conflicts of interest/Competing interests (include appropriate disclosures)

Enclosed separate disclosure

Availability of data and material (data transparency)

Not applicable

***Code availability (software application or custom code)**

Not applicable

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Authors biography

Dr.V.Kumar has completed Bachelor’s Degree in Computer Science and Engineering in December 1998 at KSR College of Technology, Tiruchengode and a Master's Degree in Computer Science and Engineering in April 2003 at Dr. M.G.R Engineering College, Chennai. He has completed his Ph.D. degree in Computer Networks in 2011. He has around 4 years of Industrial and 17 years of Teaching Experience. Presently he is serving as a Professor and Head in the Department of Computer Science and Engineering at Knowledge Institute of Technology, Salem, Tamil Nadu, India.

He had received Distinguished HOD Award from CSI TechNext India in 2017. He had received Academic Game Changer Award from EMC Corporation in 2015. He has published more than 10 papers in International Journals. His field of interest includes Wireless Networks. He has organized several AICTE sponsored STTP / workshops. He is an active member of IEEE, CSI and Life Member of ISTE.

Jayapandian N is currently working as Assistant Professor in the Department of Computer Science & Engineering at Christ University, Bangalore. He has received his PhD from Anna University, Chennai. He has completed M.E.(CSE) from Kongu Engineering College, Erode, Tamilnadu at 2009. He has completed his B.Tech.(IT) from Institute of Road and Transport Technology, Erode, Tamilnadu at 2006. He is active life Member of ISTE. He is currently doing his research in Cloud Computing in Anna University, Chennai. In his 10 years of teaching experience and one year of Industry Experience. His research interests are Grid Computing and Cloud Computing. He has published in 4 book chapters, 25 International Journal articles, 60 international and National Conferences.

Dr.P.Balasubramanie is currently working as a Professor in the Department of Computer Science and Engineering, Kongu Engineering College, Tamilnadu, India. He is one of the approved Supervisor of Anna University, Chennai and guided 29 Ph.D. Scholars. Currently, he is Guiding 9 scholars. He has published 238 articles in International/National journals. He has authored/co-authored 11 books with the reputed publishers. Three of the books published are used as text/reference books by many of the leading Universities in India. He has completed one AICTE RPS and one UGC MRP as a Principal investigator. He has received Rs. 13 Lakhs of a grant from various funding agencies like AICTE, CSIR, NBHM, DRDO, INSA and so on and organized 21 STTP/SDP/Seminar/Workshops for the benefit of Faculty members and Research scholars. He has received 17 awards so far from various agencies. His area of interest includes Data mining, Networking, cloud computing and Optimization algorithms.

Figures

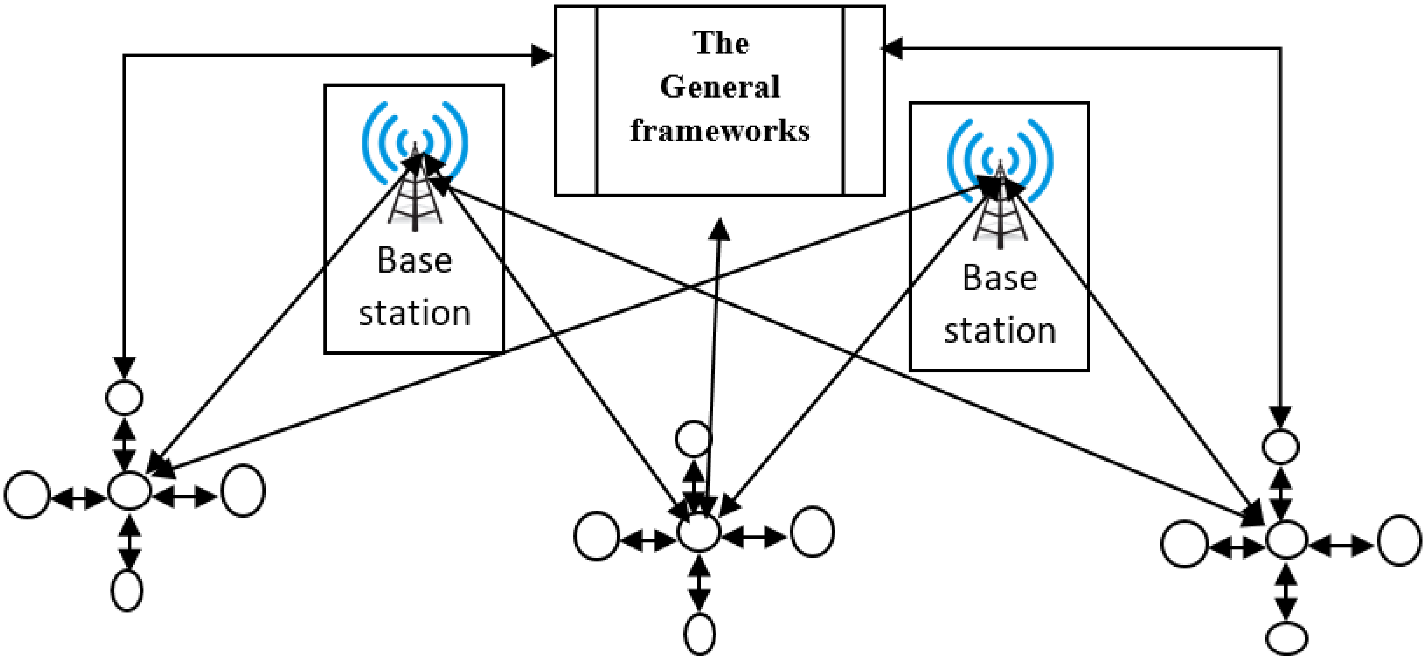

Figure 1

the General Architecture of frameworks based route optimization

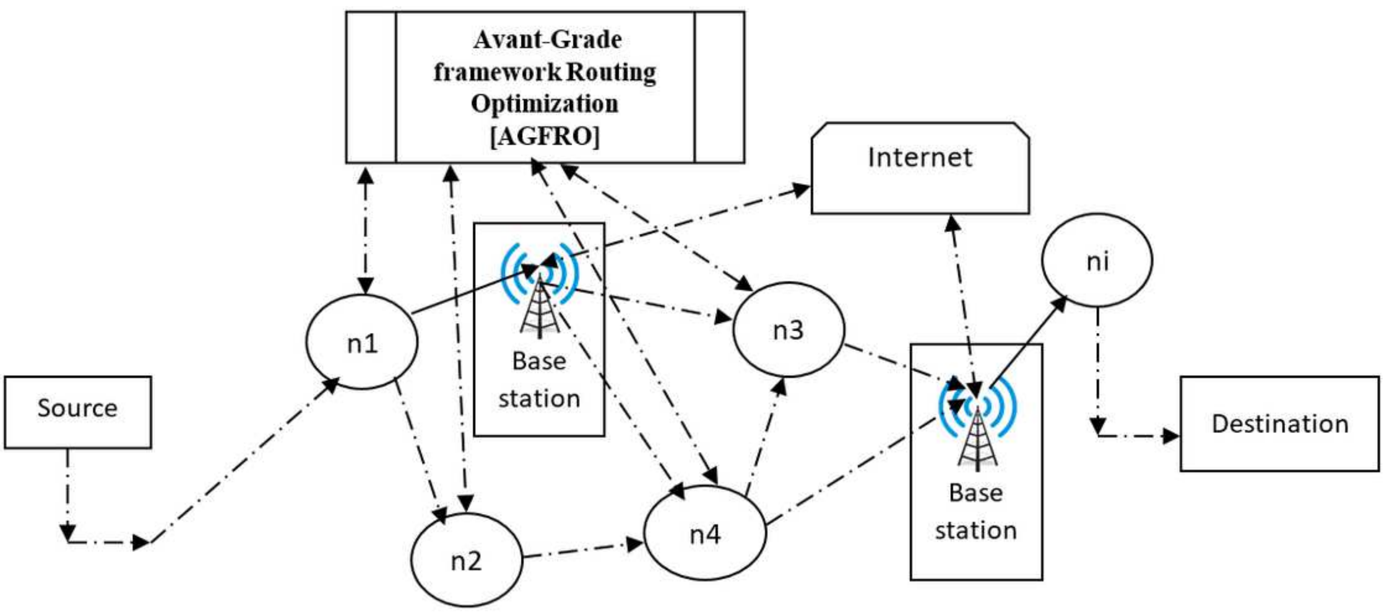

Figure 2

Proposed Architecture

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Figure 3

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Figure 4

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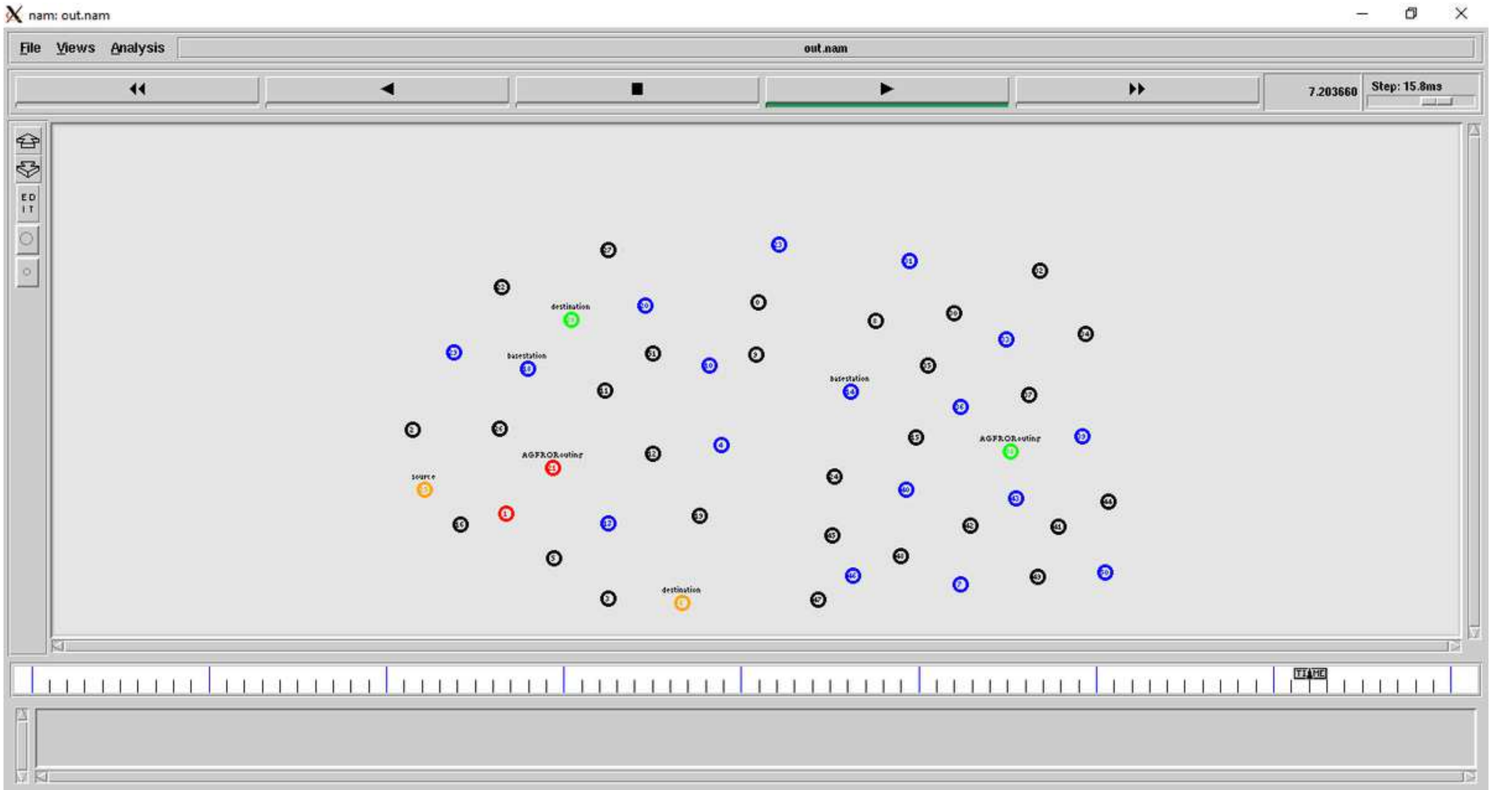

Figure 5

AGFRO protocol based routing optimization

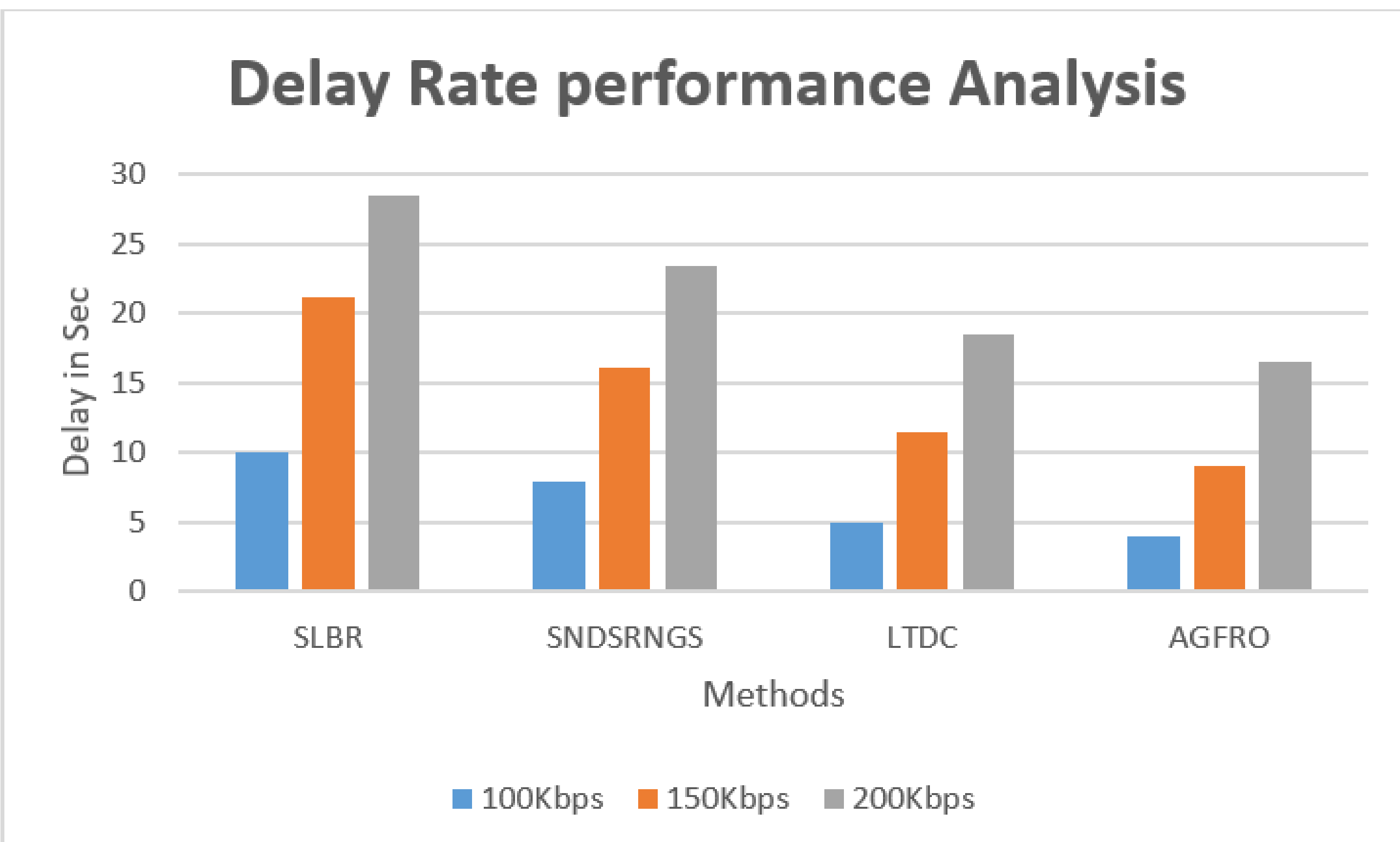

Figure 6

Network Delay performance analysis

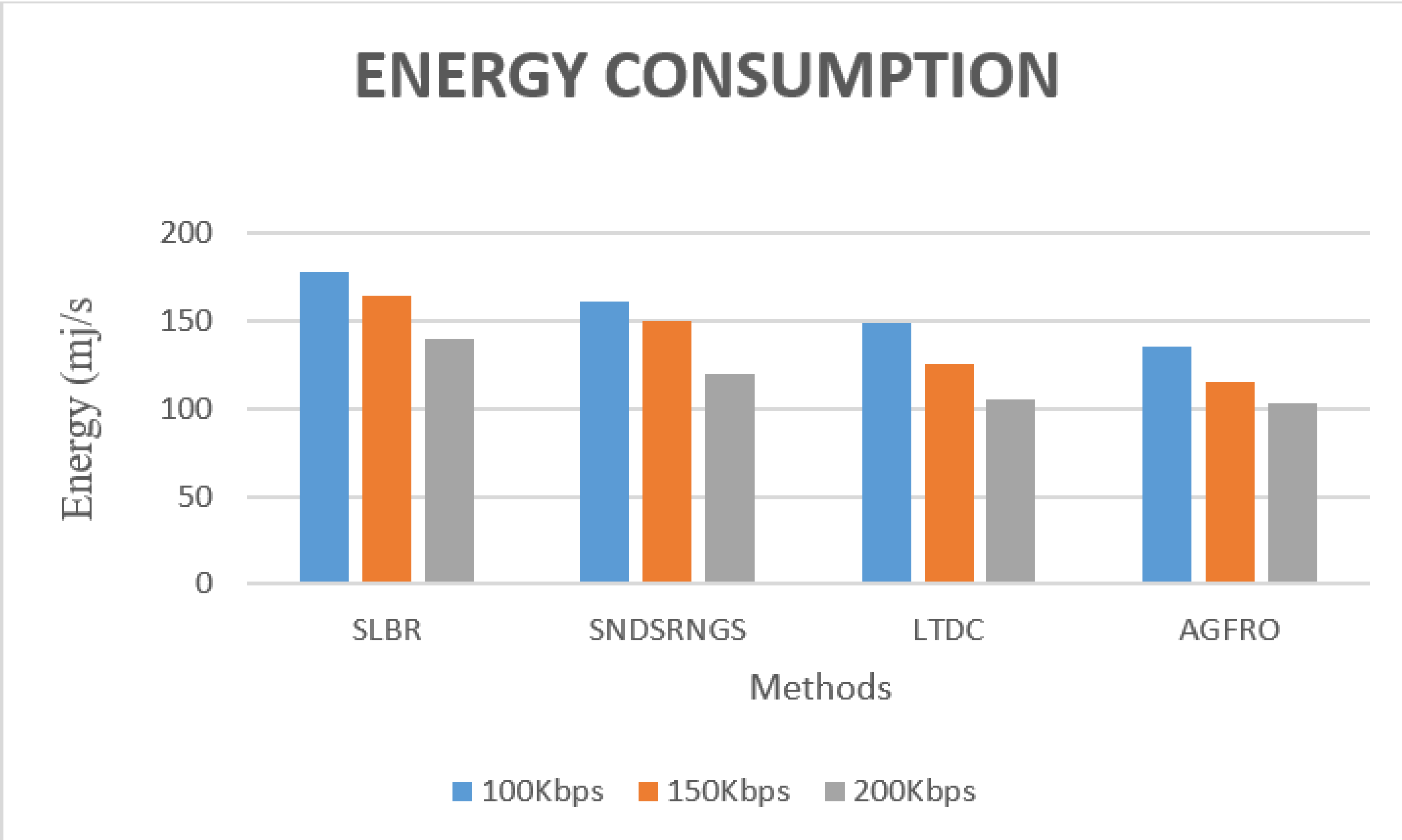

Figure 7

Energy consumption rate analysis

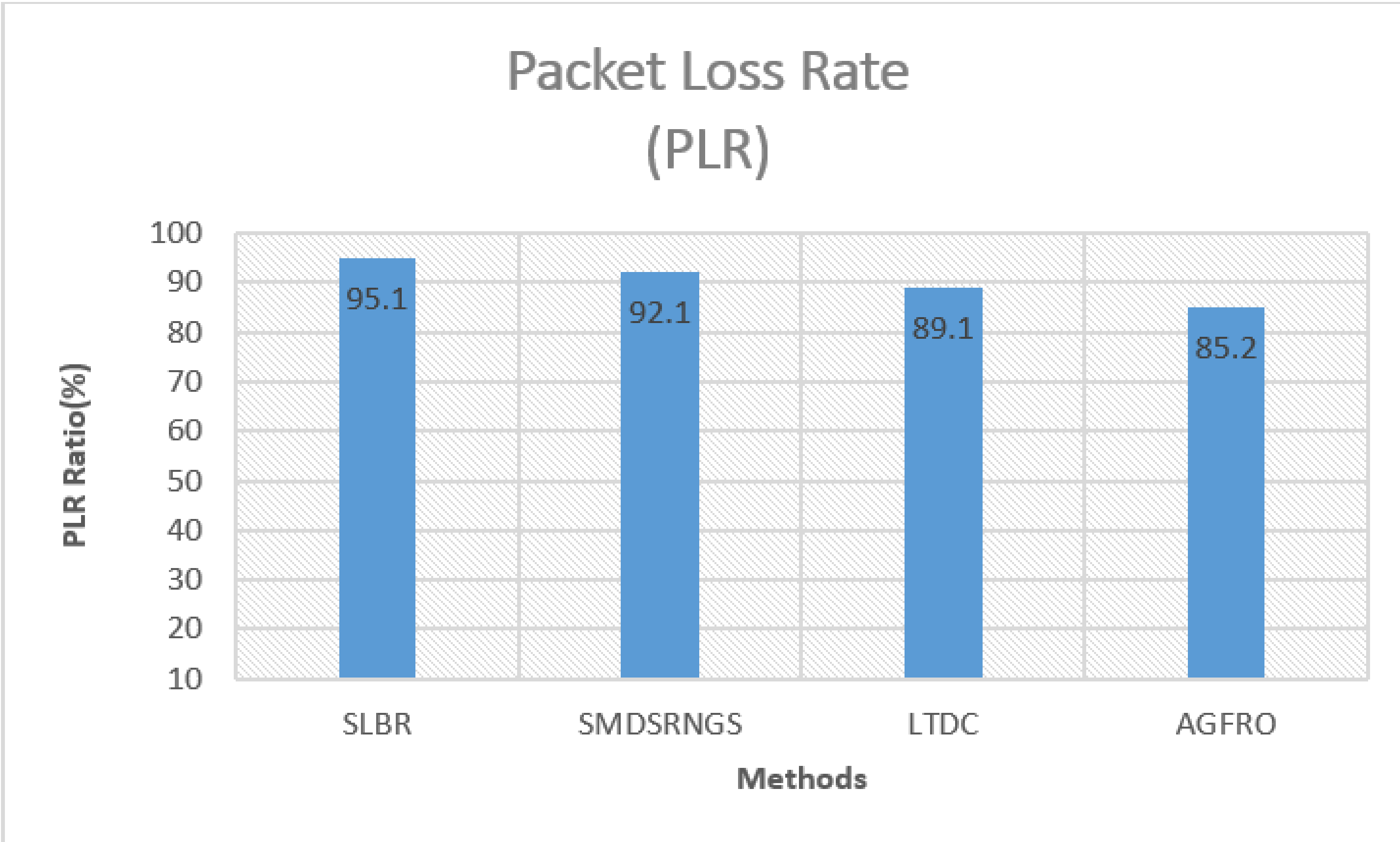

Figure 8

Packet Loss rate analysis

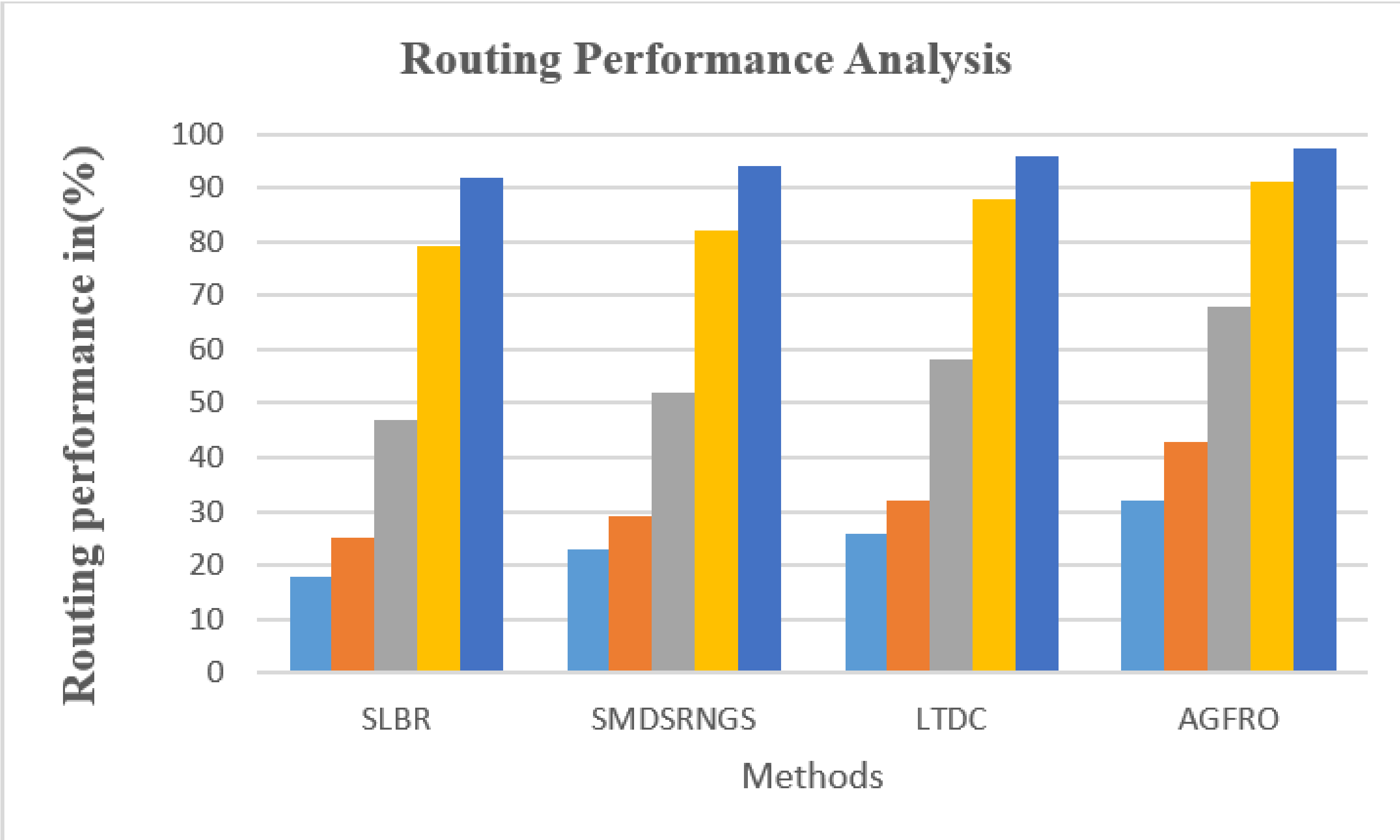

Figure 9

analysis of routing performance