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Performance Evaluation of Leach, Ileach & Da_Leach For Homogeneous Wsns

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Abstract: Energy consumption have found to be vital issue in WSNs. Data aggregation techniques have become a major part of WSNs to overcome the problem energy consumption by reducing the flooding at the base station. Also, data aggregation techniques reduce the communication cost of WSNs because it reduces the redundant data by aggregation. However, certain improvements have been proposed for the cluster head selection optimization as well to enhance the lifetime further. The overall objective of this paper is to evaluate the performance of the LEACH, iLEACH and DA_LEACH. The experimental results shown that the DA_LEACH outperforms over the available techniques with respect to stability period and network lifetime.

Keywords: LEACH, iLEACH, DA_LEACH, Wireless sensor networks, Network lifetime, Data aggregation, Energy minimization

I. INTRODUCTION

Wireless sensor networks (WSNs) are unique category ad-hoc network having facility to sense, processing and wireless connectivity. WSNs include hundreds or thousands of sensor nodes have the capability to communicate with each other, have limited energy source, energy constrain and bandwidth. The sensors bring together with themselves to form a communication network such as a single multi-hop network or a hierarchical organization with a number of clusters and cluster heads to collect the data to sink node in the WSN. Because of limited compute resources of the sensors present major challenges for routing protocols and algorithms. Large techniques are required to make them energy-efficient to increase the life-time of a WSN. Figure 1 shows the WSN structure. More energy to convey data above long distances so that an improved technique is to contain fewer nodes sends data to the base station. These nodes called aggregator nodes and processes called data aggregation in WSNs.

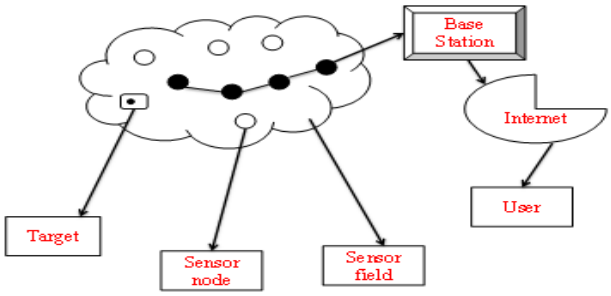

Figure.1 A wireless sensor network structure

The central purpose of the data aggregation (DA) is to diminish the power consumption by minimize the number of data transmissions. Data aggregation is defined as the process of aggregate the data from multiple sensors to eliminate redundant transmission and provide merged information to the base station. All the aggregation nodes bring together data from their children nodes and compute the aggregation value. Then only the aggregated values are forward towards the data sink. The sensors occasionally sense the data, process it and transmit it to the base station.

Data aggregation is classified as Cluster-based, Tree-based and Hybrid-based structure. In a cluster-based structure, the network is partition into subgroups. Each subgroup is called cluster. In every cluster, there are several sensor nodes in which a node is assign as a "cluster head" (CH). The CHs are elected to send their cluster nodes data to the sink. A CH is generally the master and the sensor nodes are slaves, this master/slave method allow tight traffic control since no node is allowed to transmit outside the cluster, and no communication is allowable among slaves excepting through the master.

In a tree-based structure, the sensor nodes are planned into a tree like structure and data aggregation is performing at intermediate nodes alongside the tree. In this, aggregation is achieve by construct an aggregation tree which may possibly be a minimum spanning tree, rooted at sink and source nodes are consider as leaves. Each node has a parent node to promote its data. Flow of data starts from leaves nodes up to

the sink and there in the aggregation finished by parent nodes. In hybrid-based structure, the cluster-based and tree-based structure has been used together in an efficient way. Also, structure can be attuned according to explicit network condition.

LEACH stands for Low-Energy Adaptive Clustering Hierarchy. LEACH is a self-organizing, adaptive clustering protocol that uses randomization to distribute the energy load consistently with the sensors in the network. Sensor nodes organize themselves into clusters in LEACH routing protocol. In each cluster one of the sensor node acts as cluster-head and residual sensor nodes as member nodes of that cluster. Only cluster-head can directly commune to sink and member nodes use cluster-head as intermediate router in case of communication to sink. Cluster-head collect the data from all the nodes, combined the data and route all significant compress information to Sink.

Because of these extra responsibilities cluster-head dissipate more energy and if it remains cluster-head permanently it will die rapidly as happen in case of static clustering. LEACH tackles this difficulty by randomized rotation of cluster-head to save the battery of individual node. In this way, LEACH maximizes life time of network nodes and also reduces the energy dissipation by compress the date before transmitting to cluster-head. LEACH routing protocol operation based on rounds, wherever each round usually consists of two phases.

First is setup phase and second is steady state phase. In setup phase, cluster-head and cluster are created. Whole network nodes are divided into many clusters. A few nodes choose themselves as a cluster-head autonomously from other nodes. These nodes choose themselves on behalf Suggested percentage P and its earlier record as cluster-head. Nodes which were not cluster-head in earlier 1/p rounds generate a number between 0 to 1 and if it is less then threshold T(n) then nodes become cluster-head. Threshold value is set throughout this formula.

$$T_n = \begin{cases} \dfrac{P}{1 - P \times \left(r \bmod \frac{1}{p}\right)}, & n \in G \\ 0, & Otherwise \end{cases}$$

Where G is set of nodes that have not been cluster-head in previous 1/p rounds, P is the suggested percentage of cluster-head, r is the current round. The node become cluster-head in current round, it will be cluster-head after next 1/p rounds. This indicates that every node will serve as a cluster-head evenly and energy dissipation will be uniform throughout the network. Chosen cluster-head broadcast its status using CSMA MAC protocol. Non-cluster-head node will select its cluster-head compare RSSI of several cluster-head from where node received advertisement. Cluster-head will create TDMA schedule for its connected members in the cluster.

In Steady state phase starts when clusters have been created. In this phase, nodes commune to cluster-head through allocated time slots otherwise nodes keep sleeping. Due to this attribute, LEACH minimizes energy dissipation and extends battery life of all individual nodes. When data from all nodes of cluster have been received to cluster-head.it will aggregate, compress and transmit to sink. The steady state phase is longer than setup phase.

The improved LEACH (iLEACH) protocol is based on the initial energy and number of neighbors of the nodes. This protocol is more appropriate than any type that assumes a protocol in which each node know the total energy of the network and then adapts its election probability of becoming a cluster head according to its remaining energy.

$$T_n = \begin{cases} \dfrac{p}{1-p\left(r \bmod \left(\frac{1}{p}\right)\right)} \times \dfrac{E_{cur}}{E_{avg}} \times \dfrac{Nbr_n}{Nbr_{avg}} \times \dfrac{dtobs_{avg}}{dtobs_n} S \in G \end{cases}$$

Where E_{cur} is the current sensor node power; E_{avg} is the average energy of the network in the current round; Nbr_n is the number of neighbors for *n*; Nbr_{avg} is the average number of neighboring nodes in the network; $dtobs_{avg}$ is the average distance of the network sensor nodes to the BS; $dtobs_n$ is the distance of sensor nodes from the BS. The more is the distance of the sensor node far from the BS, the more is the amount of energy spent on sending data to the BS.

II. RELATED WORKS

An arrangement and general organization of published clustering schemes has been presented. It review different clustering algorithms for WSNs significance their objectives, features, complexity, etc. Also evaluate these clustering algorithms based on metrics such as convergence rate, cluster stability, cluster overlapping, and location awareness and maintain for node mobility [1]. Major focus of this study has how these extensive routing protocols work in order to increase the life time and how quality routing protocol has improved for the wireless sensor network. It also highlights some of the issue faced by LEACH and explains how these issues are tackle by extensive version of LEACH [2]. Controlled mobility has effectual in prolong lifetime up to 6 times than while the sink does not move [3].

An energy efficient routing algorithm has been proposed which saves an important section of inner network communications energy [4]. A new private data aggregation method has been proposed in order to assemble sensitive data from WSNs. Thus, it can protect the tendency of private data of a sensor node from being known by its neighboring nodes and data aggregators in a WSN [5]. A formal classification of sensor networks has presented and introduces a new network protocol, TEEN for reactive networks. TEEN have suitable for time critical applications

and have reasonably efficient in conditions of energy consumption and response time [6]. Mobility-based communication can extend the lifetime of WSNs and increase the connectivity of sensor nodes and clusters. It also introduces a new approach to work out the mobile device trajectory in sparse WSNs where data generation rates of sensors are well-known [7]. It proposes a new improved algorithm of LEACH protocol (LEACH-TLCH) which has intentional to stability the energy consumption of the whole network and expand the life of the network [8].

Proposed MG-LEACH has using similar redundant nodes here in the system to locate in the similar region for enhancing life time of the whole network [9]. ILEACH uses a data aggregation tree to send data. The method can avoid that the cluster heads directly communicate with sink, therefore, it reduce the energy consumption enhanced [10]. It proposes a hybrid protocol for improving data aggregation effectiveness in target tracking applications of WSNs [11]. An energy-efficient and high-accuracy (EEHA) method for secure data aggregation has been proposed. The main idea of this method has to precise data aggregation have achieved not including private sensor reading and with no introduce important overhead on the battery-limited sensors [12].

It proposes a new improved method called LEACH-N based on LEACH. These approaches can assurance the rationality through select head nodes. Furthermore, the network robustness can be improved and the life cycle for the network can be extended [13]. An ant colony algorithm for data aggregation in WSNs has been proposed. Each ant will explore various paths from source node to sink node. The data aggregation tree will be constructing by the accumulate pheromone [14]. The energy consumption of cluster head and the energy consumption of multi-hop route have considered [15]. Bandwidth Efficient Heterogeneity aware Cluster based Data Aggregation (BHCDA) algorithm present the result for the effectual data gathering with in-network aggregation [16].

The data aggregations are one of the significant techniques for enhancing the life time of the network. And security issues have data integrity among the help of integrity to diminish the compromised sensor source nodes or aggregator nodes from considerably altering the concluding aggregation value [17]. The most constructive algorithm for the efficient cluster head selection have proposed in which no need to choose cluster head occasionally due to which lots of energy have saved in the WSN [18]. The methods to ease this problem and to attain a more balanced energy consume to use mobile sinks [19]. It provides efficient data aggregation technique which considers both energy and reliability [20].

III. EXPERIMENTAL SETUP

The performance of special homogeneous protocols has been evaluate in MATLAB. The simulation has been peformed in the network of 100 nodes and the base station(fixed and mobile). The nodes are positioned at random in the network and the field dimension is 100m x100m. Evaluate the performance of LEACH, iLEACH and DA_LEACH. Now, use unusual metrics to examine and evaluate the performance of the protocols which are first dead evaluation, last dead evaluation, average energy consumed and number of alive nodes in two different scenario as:

- Fixed Sink
- Mobile Sink

Table 1Value of Parameters

Parameter	Values
Area (x, y)	100,100
Base station (x, y)	50,150 or mobile
Nodes (n)	100
Probability (p)	0.1
Initial Energy	0.5
transmitter energy	$50*10^{-9}$
receiver energy	$50*10^{-9}$
Free space(amplifier)	$10* 10^{-13}$
Multipath(amplifier)	$0.0013*10^{-13}$
Effective Data aggregation	$5*10^{-9}$
Maximum lifetime	2000

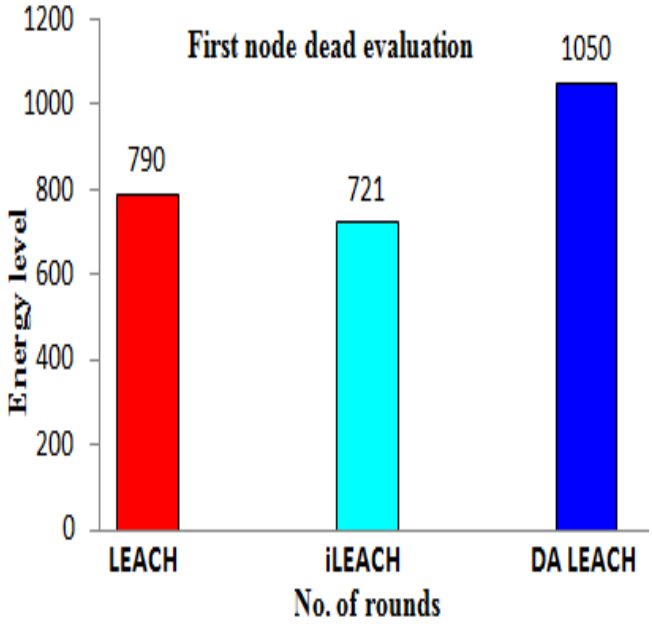

Figure.2 First node dead evaluation

Figure 2 shows the first dead node evaluation. In LEACH, the first node dies at round 790 while in iLEACH node dies at round 721 while in DA_LEACH node dies at round 1050. Therefore, the performance of LEACH is better than that of iLEACH whereas DA_LEACH is better than LEACH. So, the simulation shows that the performance of DA_LEACH is better than LEACH and iLEACH.

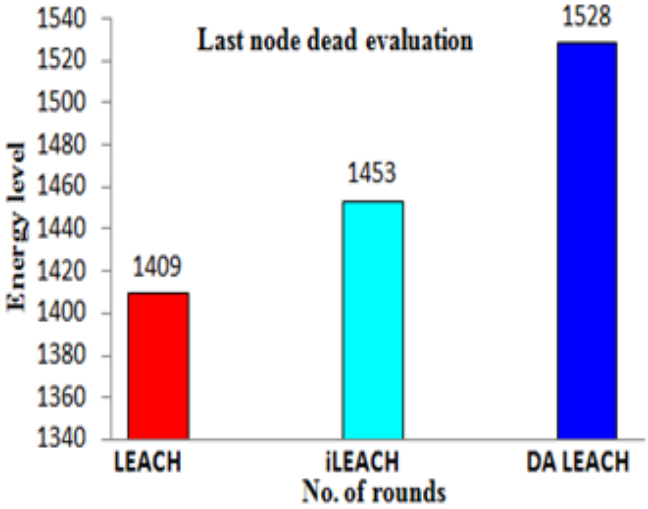

Figure.3 Last node dead evaluation

Figure 3 shows the last dead node evaluation. In LEACH, the last node dies at round 1409 while in iLEACH node dies at round 1453 while in DA_LEACH node dies at round 1528. Therefore, the performance of iLEACH is better than that of LEACH whereas DA_LEACH is better than iLEACH. So, the simulation shows that the performance of DA_LEACH is better than LEACH and iLEACH.

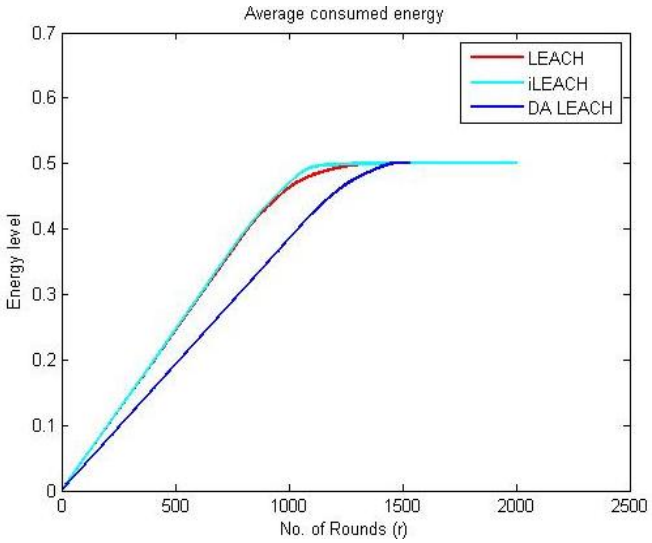

Figure.4 Average energy consumed during rounds

Figure 4 shows that the average energy consumption in the network is optimally managed. The energy consumption in iLEACH has been reduced compared with LEACH, as well as energy consumption in DA_LEACH has been reduced than LEACH. In this, average energy consumed in LEACH and iLEACH has been overlapped due to the trade-off factor. The performance of DA_LEACH is better than both.

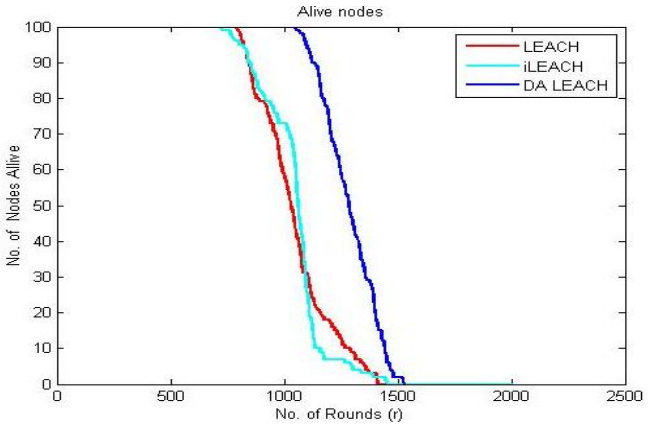

Figure.5 Alive nodes during rounds

Figure 5 shows network life time of all routing protocols when the sink is fixed. By comparing LEACH, iLEACH and DA_LEACH the stability period of LEACH is shorter than iLEACH and DA_LEACH. DA_LEACH performs better results than LEACH and iLEACH. The network lifetime of DA_LEACH is better than other.

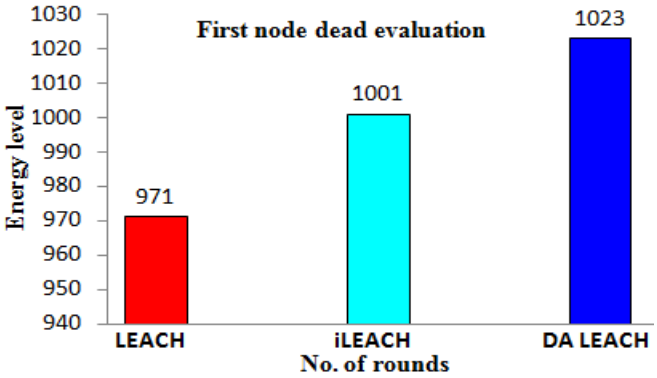

Figure.6 First node dead evaluation

Figure 6 shows the first dead node evaluation. In LEACH, the first node dies at round 971 while in iLEACH node dies at round 1001 while in DA_LEACH node dies at round 1023. Therefore, the performance of iLEACH is better than that of LEACH whereas DA_LEACH is better than iLEACH. So, the simulation shows that the performance of DA_LEACH is better than LEACH and iLEACH.

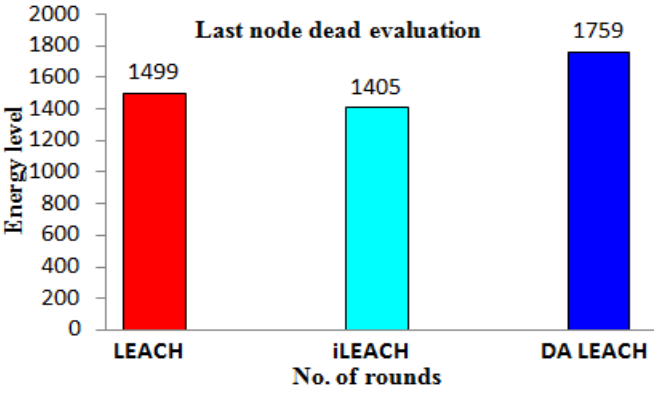

Figure.7 Last node dead evaluation

Figure 7 shows the last dead node evaluation. In LEACH, the first node dies at round 1499 while in iLEACH node dies at round 1405 while in DA_LEACH node dies at round 759. Therefore, the performance of LEACH is better than that of iLEACH whereas DA_LEACH is better than LEACH. So, the simulation shows that the performance of DA_LEACH is better than LEACH and iLEACH.

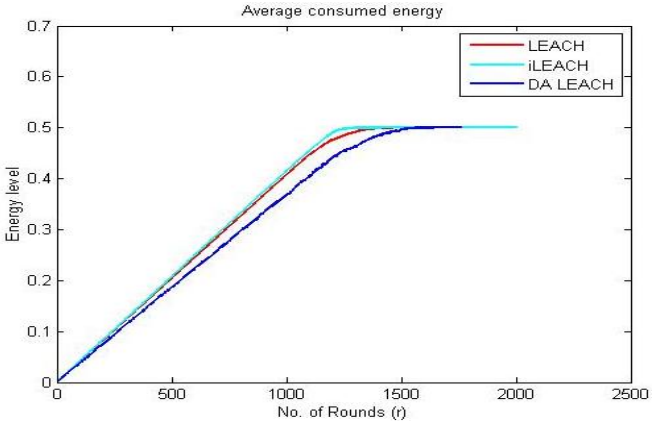

Figure.8 Average energy consumed during rounds

Figure 8 shows that the average energy consumption in the network is optimally managed. The energy consumption in iLEACH has been reduced compared with LEACH, as well as energy consumption in DA_LEACH has been reduced than iEACH. In this, average energy consumed in LEACH and iLEACH has been overlapped due to the trade-off factor. The performance of DA_LEACH is better than both.

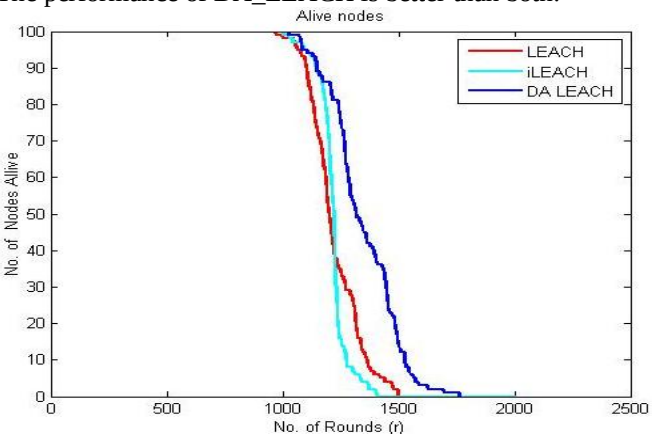

Figure.9 Alive nodes during rounds

Figure 9 shows network life time of all routing protocols when the sink is not fixed. By comparing LEACH, ILEACH and DA_LEACH the stability period of LEACH and iLEACH are shorter as well same than DA_LEACH. DA_LEACH performs better results than LEACH and iLEACH. The network lifetime of DA_LEACH is better than other.

Table 2 and 3 shows the protocols with and without fixed BS. These protocols are LEACH, iLEACH and DA_LEACH.

Table 2 Fixed sink or BS

Protocols	First node dead	Last node dead
LEACH	790	1409
iLEACH	721	1453
DA_LEACH	1050	1528

Table 2 shows that base station is fixed. In this, protocols LEACH, iLEACH, DA_LEACH has been used that depend on parameters such as first node dead and last node dead. First node dead node appears at 790 rounds in LEACH, 741 rounds in iLEACH and 1093 rounds in DA_LEACH. Last dead node appears at 1409 rounds in LEACH, 1453 rounds in iLEACH and 1528 rounds in DA_LEACH. DA_LEACH shows better results for evaluating first and last node than other protocols.

Table 3 Mobile sink or BS

Protocols	First node dead	Last node dead
LEACH	971	1499
iLEACH	741	1405
DA_LEACH	1093	1759

Table 3 shows that base station is not fixed. In this, protocols LEACH, iLEACH, DA_LEACH has been used that depend on parameters such as first node dead and last node dead. First node dead node appears at 971 rounds in LEACH, 741 rounds in iLEACH and 1093 rounds in DA_LEACH. Last dead node appears at 1499 rounds in LEACH, 1405 rounds in iLEACH and 1759 rounds in DA_LEACH. DA_LEACH shows better results for evaluating first and last node than other protocols.

IV. CONCLUSION AND FUTURE SCOPE

The energy and bandwidth of the sensors are valued resources along with important to consume proficiently. Data aggregation at the base station by individual nodes causes flooding of the data which consequences in most power consumption. To moderate this problem, numerous data aggregation techniques have been proposed so far. It has been found that the majority of the clustering base protocol has focused on intra-cluster data aggregation. This paper has evaluated the performance of the LEACH, iLEACH and DA_LEACH by using the MATLAB tool.

It has been found the DA_LEACH outperforms over the LEACH and iLEACH in both cases either stability period or network lifetime. But between LEACH and iLEACH, there exists trade-off in terms of stability period and the lifetime. If stability period considered then LEACH is better or if the network lifetime is requirement then the iLEACH is better alternative. Thus the DA_LEACH is quite better and found to be best choice amongst LEACH, iLEACH and DA_LEACH.

In near future, a new hybrid data aggregation based clustering protocol will be proposed to enhance the outcome of clustering protocol further. Moreover, the use of data compression technique at CHs will also be done to lessen the data packets size to exploit the network bandwidth accurately.

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