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QoS Methodology on Variable User Services using Soft Computing Algorithm over IoT Networks

K. Manojkumar*[1], Dr. S. Devi[2]
*[1]Assistant Professor, Computer Science and Engineering, Government College of Engineering, Thanjavur, Tamil Nadu, India
[2]Professor, Electronics and Communication Engineering, PRIST deemed to be University, Thanjavur, Tamil Nadu, India

ABSTRACT

The provision of deterministic QoS over variable services based on user applications over the IoT network is a requirement among the research community. IoT finds various applications in real-time use cases, beginning with the implementation of effective decision-making to allow business intelligence, agriculture, smart home, office, forestry that supports streaming services. The QoS framework and successful session management of multiple query exchanges between IoT nodes increase the risk of traffic or flooding over the network. The need to help the optimization of resource usage in the provisioning of QoS with an adaptive route discovery using Firefly swarm intelligence is a key discussion of this work. FSIN, the proposed work aims at the design of an optimization route approach using firefly to evaluate the route direction as well as variable resource allocation over heterogeneous IoT devices for dynamic services. This method tests the threshold behaviour of the desired QoS on demand and demonstrates that the goals of the FSIN meet the longevity of the QoS system session, the minimum delay to achieve and the optimum quality of service based on the packet delivery rate.

Keywords: Firefly, IoT, Adaptive QoS, Throughput, Packet delivery rate, Delay

I. INTRODUCTION

Recent research survey[7] on ad hoc heterogeneous networks shows that IoT networks are found to be inconsistent in bandwidth, resource usage and redundant network queries that are vulnerable to irregular network traffic. Research in the field of QoS provisioning among variable user services is highly suggested between research and the industrial community. Although IoT finds numerous applications in real-time use cases such as agriculture, smart home, workplace, forestry that support streaming services, the need for research QoS metrics is discussed in depth. IoT-based Smart devices involved in data acquisition may be used to communicate with several IoT devices across the network in order to optimise energy usage, service quality metrics, resource assignment, channel assignment needed to support the required amount of sensor readings in order to conduct a data acquisition process with support for establishing the application quality threshold. The proposed research work FSIN focuses on aspects of QoS deliverables[11] with support for QoS management requirements and addressing the resource limitations of IoT mobility devices with sensing and activation.

A group of heterogeneous IoT devices, whose inter-cooperation constitutes and represents a network, operates in synchronous communication using the

HTTP request/reply model for a session setup over variable services, generating different patterns of traffic dictated by the quality of the service (QoS). Analysis of traffic patterns over IoT nodes shows that flooding redundant data packets often contributes to QoS latency as per research strategy. This method of QoS provisioning and successful session management of multiple query exchanges between IoT nodes increase the risk of flooding over the network. The need to help the optimization of resource usage in the provisioning of QoS with an adaptive route discovery using Firefly swarm intelligence is a major topic of this work. Swarm intelligence survey indicates that optimization help is the primary objective that mocks the actions of animals/birds that can be applied in the design and prediction of the optimal adaptive route of QoS management. Firefly approach[12] is adopted in this work due to the behaviour of Firefly's food foraging behaviour to predict the optimal food source and the choice of pathways to meet its prey. The proposed research work FSIN aims to design an optimization approach using firefly to assign variable resources to heterogeneous IoT devices.

Services such as smart city or building and determining the threshold actions of the appropriate QoS. Discussions show that FSIN goals fulfil durability, minimum servicing, maximum service efficiency and faster deployment of QoS systems.

This paper is structured as follows: Section 1 addresses the introduction to the Internet of Things, focusing on QoS over the provision of an adaptive session focused on service management. Detailed IoT survey on aspects of QoS provisioning over highly competitive mobile yet wireless interconnected IoT networks is discussed in Section 2. Section 3 presents Firefly swarm intelligence approach and its architecture aspects over the IoT network, while Section 4 focuses on FSIN algorithmics and its implementation via route discovery and QoS session management. The experimental aspects of the proposed FSIN method are discussed in Section 5. Section 6 concludes the need for more study

II. Firefly Approach for FSIN

Study on Firefly algorithm [3] [8] shows that it is easy to understand and implement. This swarm-based algorithm shows that it is well prone to early convergence as well as suggest on relaxation of maximizing its effort using constant parameters. Firefly behaviour is based on the flashing patterns and behavior of fireflies whose characteristic is predicted by animating the characteristic behavior of nodes.

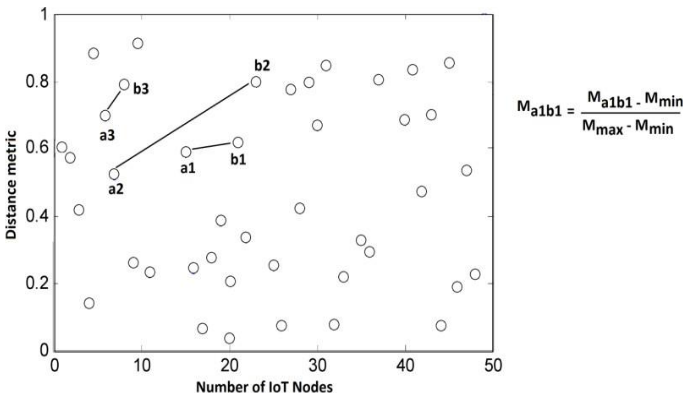

Figure 1. Design of Firefly as IoT Nodes over Variable Distance

Figure 1 shows the design of distance metric over IoT nodes which depict the behaviour of fire flies, where Mmin shows the minimum distance between IoT nodes and Mmax as maximum distance for reaching the target IoT node, while Ma1b1 are the ideal manhattan distance between any IoT nodes.

A linear function λ(t) covers the maximum rate of M(t); ρ(t) represents the minimum service rate of M*(t) which are defined as follows:

$$\lambda(t) = \begin{cases} a.t + r, t > 0 \\ 0 \quad otherwise \end{cases} \quad (1)$$

$$\rho(t) = \begin{cases} M(t - Pt), t > Pt \\ 0 \quad otherwise \end{cases} \quad (2)$$

Here ‘a’ defines arrival rate of packet in a session as sustainable factor, ‘r’ denotes observed packet rate of burstiness, M is the minimum service rate, and Pt is the maximum processing latency (millisecs). In theoretical aspects, M should be greater than ‘a’ which ensures that there is no packet dropping during session of data transfer.

Distance between any firefly ‘a’ and ‘b’ can be calculated using Manhattan distance Mab which is the observed distance between firefly Xa and Xb, (Xai, Ybi) represents the coordinates firefly ‘a’ mapping over task ‘k’. Here, (Xai, Ybi) represents the coordinates of the mapping scheme of firefly ‘b’ in task k, and ‘n’ is the total number of tasks.

$$Mab^n = \sum_{k=0}^{n} \left(|Xia - Xib| + |Yia + Yib| \right) \quad (3)$$

To analyse delay d(t) over route session Si , which suggests on QoS on demand over a session based on mapping of λ over ρ, and observed packet arrival curve λ(t), and its service call ρ(t) in use.

$$d(t).Si = Pt + r / M(t) \quad (4)$$

Equation (3) explains the distance required for a node ‘a’ to transfer data to node ‘b’, and equation (4) analyses on the observed delay time taken for a session ‘Si’ to be established and resource allocation over service call. Satisfying the QoS requirement demands assign the session within a call and completion of call effectively.

Figure 2 shows the analysis of FSIN_Q over nodes during session maintenance and provisioning. At any time ‘t’, location of firefly is predicted and any change in location of firefly (mobility of IoT node), suggests on change in distance from ‘ith’ location to neighbourhood ‘jth’ location of another firefly.

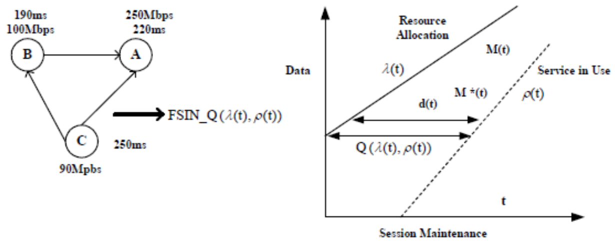

Figure 2. Analysis of FSIN_Q over Nodes during Session Maintenance and Provisioning

As per swarm intelligence theory, change on firefly on mobility towards another brighter fireflies can be denoted as ‘ρi’ movement, where ith movement of firefly indicates possibility of any increase in delay to detect a route path. Movement of any firefly is random by detection but its behaviour suggests that mobility of a firefly is to suggest on an improved route map or session to be established. Determination of a random movement may be an optimal or primal in route discovery based on resource availability or energy of node in use.

$$X_i(t+1)=X_i t+(1-\beta)^r.\rho i - (X_j t - X_i t)+\sigma.random(t) \quad (5)$$

Here, β denotes attractiveness of firefly ‘a’ at the distance r = 0, and σ indicates the random mobility of firefly at an instant ‘t’. Change in node selection also indicates refreshment of route path ‘r’ with adaptive QoS and resource allocation for service in use (Eqn. 5)

A. FSIN – Support for Adaptive QoS

FSIN adopts dynamic run time process to provide consistent support on device plug and play and service configuration changes. FSIN adopts run time procedures to support on regular procedures of IoT node querying, node discovery, source initiation, route change, route adaptation and management process. Node's consistent querying approach at runtime provides an effective monitoring and support handling service applications. Understanding the node behaviour and gathering intensive knowledge of service based behaviour, provides better run-time adaptation during runtime of route setup accordingly. The process of querying is the responsibility of agent objects to probe into object's identity, identify their parameters and change in value. Change in status of a communication device or sudden changes of traffic intensity of IoT may contribute to changes in routing path of network or sharing of resource objects among other media applications or frequent user changes.

III. PROPOSED MODEL - FSIN - DESIGN ASPECTS

Numerous media service application adopts different application configurations affixed over IoT devices. Such device based configuration consists of numerous groups of application components to be designated as objects, specific functionalities and hence represented by its configuration over directional communication over IoT nodes under consistent mobility and session refresh to maintain its liveliness. Any IoT node may change its property or status during stage of run-time instantiation, which is based on its resource availability and user demand based service in use. The proposed work FSIN assists on service to adapt to any change in configuration or state of nature, which includes change of resource availability or user requirements. FSIN need to adapt towards adaptation at run time towards service adapting to any change in network mobility and service setup. To define multiple route selection, consistent support is demanded in terms of data rate, bit error rate and definition of stability index of channel in use. Figure 2 shows IoT nodes in communication and consistently establishing session over multiple nodes on task completion.

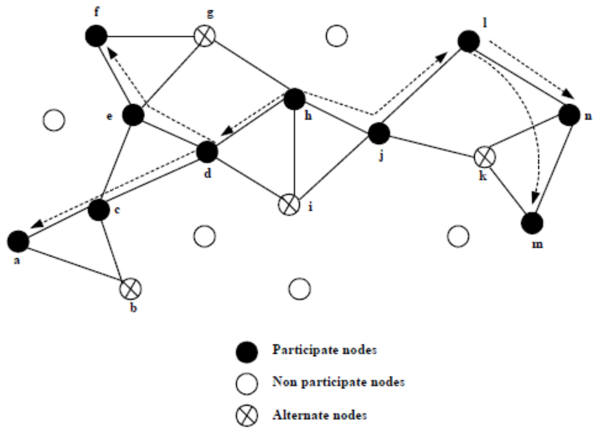

Figure 3. Adaptive Route Selection and Node Organization

Figure 3 shows the approach on ideal route selection for data transfer and session management using Firefly swarm intelligence approach. Discovery of route selection involves multiple nodes to forward data using push/pull approaches. Selection of forwarding nodes involves resources with specific QoS to be provided with service demandable time. Any node which participates in route selection process a route refresh, maintain its consistent QoS until session is completed, based on alternate forwarding nodes identified as per user demand FSIN algorithm assigns on determining all possible adaptable route inputs between any nodes in session establishment and activity. The phenomenon of route establishment based on positive interference among nodes suggests on instances to move away services. Algorithm takes the nodes traffic intensity 'Ts' as input gathered at each interval of time and measures on observed event 'Eo'. 'Si' suggests on service category whose positive and negative instances of service decides on the adaptive QoS in demand whose metric depends on 'λ', resource utilization frequency,'ρ' aspects of resources in use with regard to 'σ', node mobility ratio, which together contributes to delay 'Dw' towards suggesting on negative instances and aspects of service.

The performance measure observed for 150 IoT nodes during activity is discussed in Figure 4 as packet delivery rate among the proposed FSIN approach, over ANN [7] and GA approach [1]. Packet delivery ratio refers to the total number of packets delivered over a session in task

Proposed FSIN shows higher delivery rate in comparison to Artificial Neural networks [9] and Genetic Algorithm as traditional approaches. Performance of FSIN is improved as 18.43% of packet delivery rate in comparison to ANN whose performance is 38.73%, GA shows 48.30%, while FSIN delivers at 53.28% at an improved PDR during completion of session. The observed delay over variable 150 nodes is shown in Figure 5, where proposed approach FSIN shows reduced delay in comparison to ANN and Genetic Algorithms.

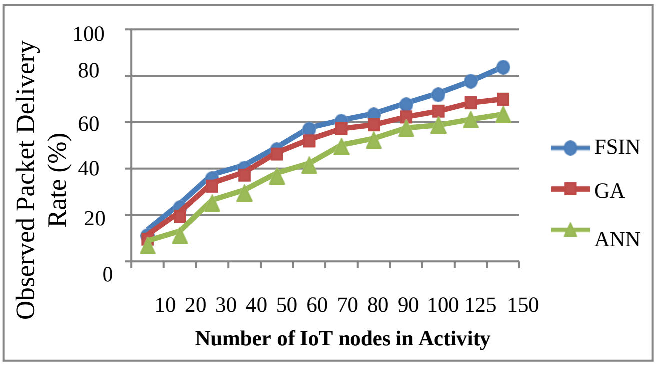

Figure 4. Observed Packet Delivery Rate

FSIN performs with an average of 49msecs while GA shows 62 msecs and ANN takes an average of 74 msecs for execution of sensor data over MQTT protocol. This delay attributes primarily over an average of 100 IoT nodes in execution and delay increases as number of nodes are increased.

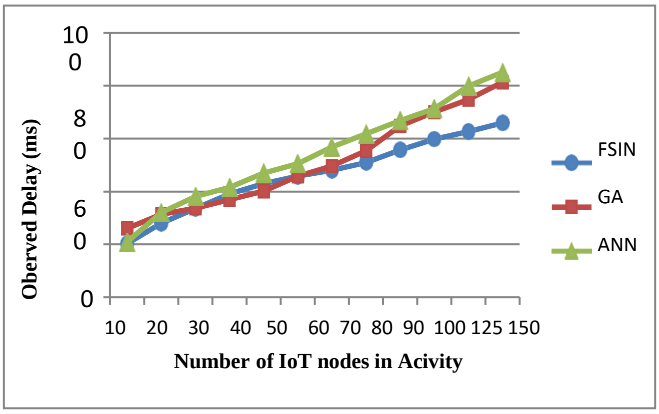

Figure 5. Observed Delay over IoT nodes

IV. CONCLUSION AND FUTURE WORK

The suggested approach focuses on improving the QoS network parameters towards throughput and analyzes on network contention over delay metrics. FSIN proposes prediction of optimal route mapping approaches directly. Section 5, which discusses on experimental results, shows the route mapping approaches determined by Firefly flash approach is improved than Genetic Algorithm and Fuzzy mapping schemes. Research survey and analysis shows that Firefly approaches to local optimal in minimal time, as well as on evaluation FSIN suggests on optimal prediction of expected node behaviour whose desired QoS supports on demand. Performance shows that objectives of FSIN satisfy on QoS over device utilization, minimal delay to achieve and packet delivery rate found to be improved than other approaches such as ANN and GA. The work can be extended into machine learning models to be incorporated in future.

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