Quality of Service through Path Selecting Algorithm in Pervasive and IoT Computing

Padmanabhan P
School of Computing Science and Engineering, Galgotias University
Greater Noida, Uttar Pradesh, India
padmanabhan5312@gmail.com

Sampath Kumar K
School of Computing Science and Engineering, Galgotias University
Greater Noida, Uttar Pradesh, India
ksampathkumara@gmail.com

John A
School of Computing Science and Engineering, Galgotias University
Greater Noida, Uttar Pradesh, India
johnmtech@gmail.com

Abstract

The pervasive and IoT connectivity is facing different issues in the communication in dynamic environments. Because the availability of the connecting resources is changing dynamically in each situation. So, in the pervasive and IoT connectivity quality of the service plays an important role in continuous communication. Different parameters of Quality of Services are used to measure continuous connectives of devices. Throughput, network size, connecting devices, energies are some of the main parameters used to manage the quality of services. The present paper has analyzed and achieved the quality of services using continuous connecting devices in the dynamic environments and selection of path of devices. The proposed work consists of communication components for continuous signal sending, routing approach and selection of path in the dynamic environments. The communication components are used to connect various devices in the dynamic situations. The main connecting components are IoT model, IoT node, Road side unit, and Communication model. The routing approach is used to connect the long-distance using ant colony-based routing algorithm. Using this routing algorithm, one can extent the connectivity from one source to the destination of moving objects. The path selection is used to segment the moving devices using Euclidean distance and MDI techniques. Using this selection moving devices are connected segment wise. With the use of above mentioned three things the moving devices are connected continuously and quality of the services also improved. The Quality of the services is achieved using throughput, network size, energy and availability of resources. The IoT sensor and road side units are available in segment wise. Hence availability and quality of services are improved. The implementation is performed using OMNeT++ to provide the better solutions in throughput and energy.

***Keywords*: Pervasive and IoT Computing, Quality of Service, Path Selection Algorithm, Routing in Dynamic Devices.**

1. Introduction

The resource management, routing, resource virtualization and quality of services (QoS) are the important research area in Internet of Things (IoT) and pervasive computing. The QoS is an important concept to guarantee the delivery of various activities in the computing environments. Some of the dominating QoS activities in IoT and pervasive computing are usability, availability, connectivity, portability, compatibility and performance efficiency etc. Different types of QoS specified by ISO/IEC 25010 are shown in Figure 1. Different research activities are introduced in these IoT and pervasive computing. In the IoT and pervasive computing research, different platforms are used to check the quality of service. In this manuscript the dynamic road network related quality of service are provided in the path connectivity and resource sharing. The fundamental properties of IoT and pervasive related applications are making the ability to combine and select the services as per the end user's requirements. The services, selection, combining connectivity and availability of resources are important in all the types of service providing. Selecting the appropriate function in the dynamic environment is different based on the end users. The appropriate function providing is also comes under the QoS.

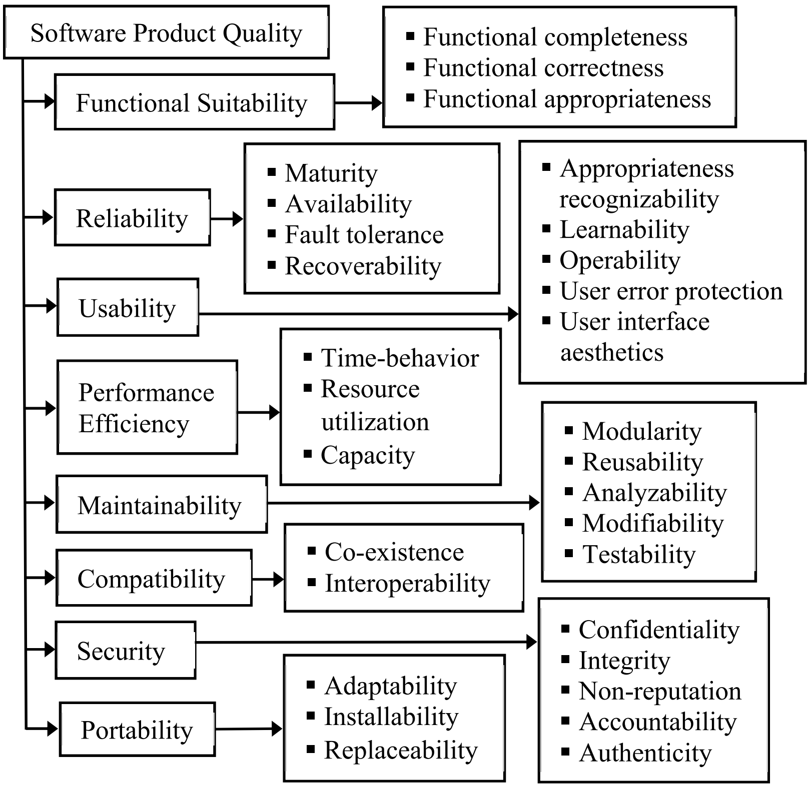

Fig. 1. Types of Quality of Service for computation

The quality of service providing is comes under the non-functional services. In this work, the non-functional QoS is achieved using connectivity and availability of resources in the dynamic environments. The service connectivity and availability of resources are more challenging task because the requirement of connectivity is ever changing in the environments. The different algorithms are developed by different researchers in static and dynamic environments. The cluster head, shortest path selection, flow based and physical services are some of the models introduced by different researchers [1-3]. All of these works are constantly supportive to the static environment and the efficiency of QoS is also good. But in the dynamic environment the objects are changing every second. So, the connectivity and availability of the environments is also changing dynamically. The main problem in the dynamic environment, the resources are disconnected, due to unavailability or resources. So, the reliability of services and availability of services are automatically decreases. This paper addresses the problem of dynamic path resource connectivity and resource availability of dynamic end users. The main contribution proposed are i. Provide continuous connectivity in the dynamic environments ii. Provide continuous resource availability for continuous connectivity using routing algorithm and path selection algorithm. iii. Improve the Quality of service in terms of connectivity and availability.

2. Related Work

The related work of quality of services is based on two things such as connectivity architecture and metrics of communication in pervasive and IoT. The different authors presented various works related to the connectivity.

Properties	IoT/Pervasive	WSNs	MANETs
Topology	Dynamic	Dynamic/Static	Dynamic
Buffer Size	Varies	Varies	Varies
Mobility	Dynamic	Based on connectivity	Dynamic
Medium Contention	Based on availability resources	Not varies	Based on availability resources
Communication Range	Varies based on available device	Not varies	Varies based on available device
Typical Density	Dynamic	Static	Dynamic

Table 1. Enabling and communication properties in various communication.

e-ISSN : 0976-5166
p-ISSN : 2231-3850

Nowadays, we are surrounded with different types of network connectivity and streaming. For Connectivity and streaming different technologies are used in the network environments. Pervasive computing and IoT are different devices that connected in the surrounding connecting devices.

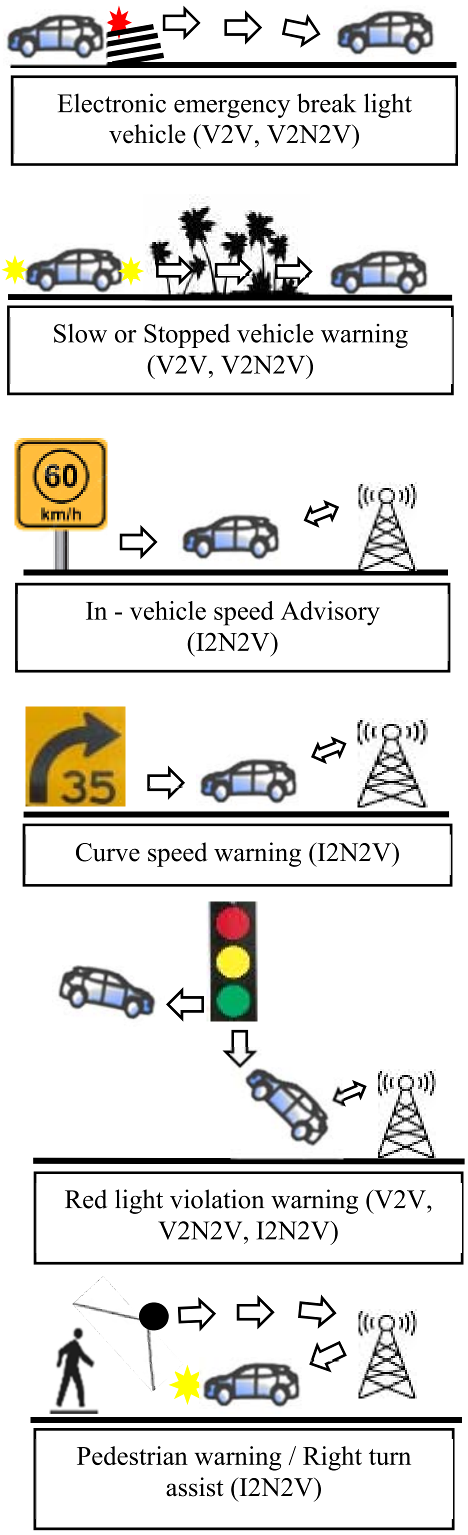

Fig. 2. Connecting devices in moving devices (Source: www.istockphoto.com/)

Those connecting devices changes the position simultaneously, consequently next available connectivity station and devices are changing the positions. Due to these reasons, the availability of devices and making the path for next available devices are very difficult in the pervasive and IoT environments.

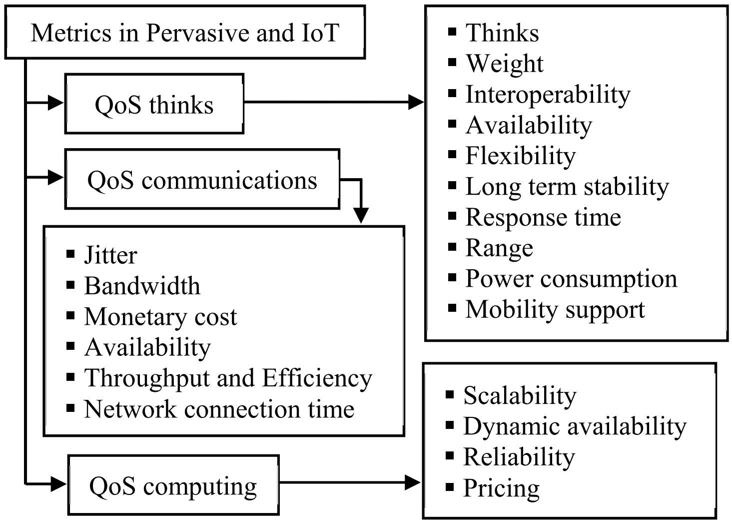

Fig. 3. Metrics in pervasive and IoT

In this related work, two parts of works are supported to the quality of services in the dynamic connecting environments. One is architecture of the model and second one is quality of metrics for communication. The basic enabling and communication properties [4] of the architecture and quality of the metrics are shown in Table 1. The different researchers introduced various architecture or models for communication. The authors of [4] proposed ARA model introduced IoT communications between different nodes in the heterogeneous dynamic environments. These heterogeneous environments change the ownership dynamically because in the dynamic environments the positions of connecting resources are ever changing. The authors of [5] presented multi-path selection node for transmitting multi-media data. In this work PBMR algorithm is used to select the path in the dynamic environments. The authors of [6] multipath routing worked to reduce the energy in sensors networks. Using this work, routing path energy and the routing mitigates in sensor network can be increased. The authors of [7] proposed a QoS protocol for end-to-end connectivity efficiently in a routing protocol for guaranteed connectivity and delivery. The author of [8] proposed efficient ant colony optimization of link quality control for efficient path. The authors of [9] proposed QoS routing and analysis with different protocols using various parameters such as scalability, energy and location awareness. The authors of [10] proposed a mathematical model for optimal path to a wide range of QoS to provide appropriate path. This model provides the adaptive QoS in hop by hope. The authors of [11] proposed a distributed cooperative routing protocol for WMSN. Using this method the QoS in balanced routing, energy consumption, reliability and delay can be performed. The authors of [12] summarized various intelligence based efficient protocol for QoS assurance. The authors of [13] investigated multi-path energy co-operation using NOMA. The proposed multi-hope method having two phases such as information transmission and communication protocol. NOMA will schedule the connectivity as per the optimal performance. The authors of [14] proposed a Quality of WMSN with the help of reinforcement learning with the guarantee to sensing of IOV. The authors of [15] proposed an industrial real time protocol for routing the feasible multi-path. Another main related work is connectivity of various devices in connecting environments. The main connecting devices of dynamic road network environments are shown in the Figure 2. Another side the Quality of metrics consist of three metrics such as QoS Communication, QoS thinks and QoS computing metrics. The Quality of metrics consists of different metrics and the summaries of those metrics are shown in the Figure 3. Another main related work is connectivity of different devices. The main connecting devices of dynamic road network environments are shown in the Figure 2.

3. Proposed Modelling

In the proposed quality service path selection is achieved using dynamic topologies in the homogeneous and heterogeneous moving objects devices. The proposed quality of service achieved using communication components, routing approach, path sensing and tracking. The structure of the communication in the heterogeneous network is shown in the Figure 4.

3.1. *Communication component*

The communication components are used to communicate from one moving objects to another moving objects. The communication environments are consisted of IoT model, IoT node, Road side unit (RSU) and Communication model.

Fig. 4. Heterogeneous communication structure

3.1.1. IoT model

The connectivity of various devices in the heterogeneous pervasive computing are performed in two ways. One is node of the moving objects, which are closely connected without other devices such as RSU and routing. In this connecting the nearest devices or sensors connected with each other for communication in short time intervals. The second connectivity is without any nearest devices, the moving objects are connected using RSU and routing devices in the heterogeneous network. In this situation the devices are connected for long time in the heterogeneous and homogeneous IoT environments.

3.1.2. IoT node

The different devices are connected simultaneously in the IoT and pervasive computing. Each node is relaying and performing connecting, processing and communicating tasks. In these situations, the different nodes are used to communicate and connect each other's. Some of the main connecting devices are mobile devices, WSN sink, RFID, PDAs and sensors well recognized larger pooling devices in the heterogeneous network. If these nodes are connected continuously without delay, further no routing devices is required. The important task in this node is measuring the capacity of each node and distance of connecting each other's. If the connectivity is not performed well in the environments buffer capacity and residential errors are used.
IoT environments.

3.1.3. Road side unit

The different devices are connected simultaneously in the IoT and pervasive computing. Each node is relaying and performing connecting, processing and communicating tasks. In these situations, the different nodes are used to communicate and connect each other's. Some of the main connecting devices are mobile devices, WSN sink, RFID, PDAs and sensors well recognized larger pooling devices in the heterogeneous network. If these nodes are connected continuously without delay, further no routing devices is required. The important task in this node is measuring the capacity of each node and distance of connecting each other's. If the connectivity is not performed well in the environments buffer capacity and residential errors are used. The RSU unit is used to collect the data in the dynamic environments with static property. This unit is used to gather the information using various connecting devices and intelligence vehicles. The devices like phone, RFID reader, sensors and routers are connected and communicated simultaneously in the heterogeneous network. If the connectivity of the dynamic devices are missing, automatically this RSU will take of the communication and connectivity. The structure of the RSU connectivity with moving objects is (Car) shown in the Figure 5 [21].

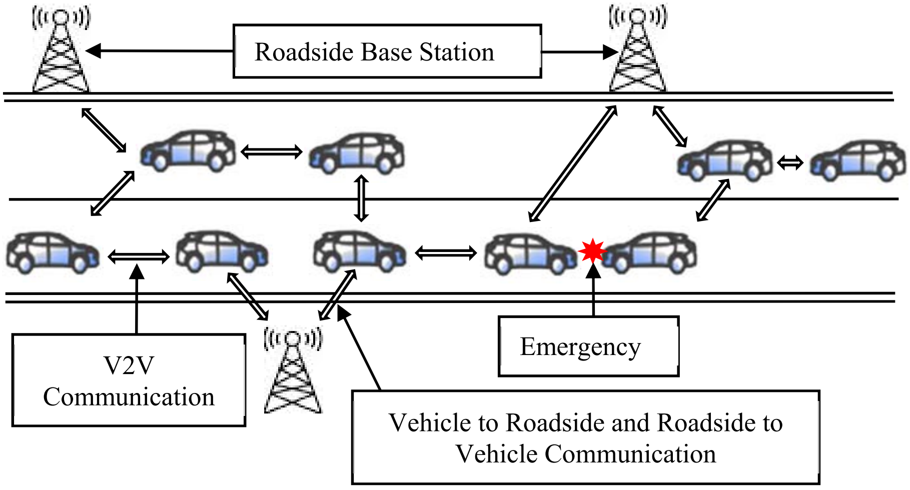

Fig. 5. Connectivity structure using RSU

3.1.4. Communication model

Connecting all devices, signal transmission, receiving and connectivity are depended on surrounding heterogeneous and homogeneous data. The variations of connecting and routing is performed using the routing and path selection model. The continuous connectivity in the short distance is performed using phones, sensor and etc. But long-distance connectivity is performed using the router and path selection algorithms. In this long distance and continuous connectivity, router and path selection plays an important role to improve the quality of measurements.

3.2. *Routing approach*

The long-distance connectivity is performed with the help of routing algorithms. In this work the traditional Ant-Colony-Based Routing Algorithm (ARA) [23] is used for connectivity in the dynamic environments. The main properties of the ARA are locality, multi pathing and sleep node. The requirement satisfaction of ARA are distributed environments, loop-free, demand and sleep period operations. If the continuous and short- term connectivity is not available in the environments, automatically the routing approach will act immediately. In the heterogeneous IoT moving objects demanding the long distance, the routing properties will initiate the operations immediately. The nearest available resources (RSU) are connected immediately using this routing approaches. The data and signals forwarded to the nearest destinations or RSU. The ARA divided into two stages as backward and forward. The forward stage, forwarded the data and signals to the nearest nodes or RSU. The nearest RSU or nodes updates the received signals and messages continuous up to the normal connectivity. All the received messages will have route information and pass moving objects information. The backward stages used to provide the acknowledgement between connected nodes to corresponding nearest RSU. The ARA routing approach has used two algorithms for collecting the data from source to destinations. The Algorithm 1 shows the source node connectivity to the router from RSU.

Algorithms 1: Source Node Connectivity
Terms: S – Source, D – Destination, ACK, RT – Routing Table

1. Initiate the connectivity
2. If S no connectivity and route to research D
3. Then forward the nearest RSU and setup the routing message
4. Initialize the RT
5. Acknowledgement (ACK) the demand for request to connectivity
6. Check the local connectivity
7. If the local connectivity is not available, will increase the distance
8. Exchange the information in time interval
9. Update the RT tables
10. Still further continuous connectivity.

In the Algorithm 1, the initial stage source devices are connected using the accessing the moving objects. If the continuous connectivity is missing the source node, automatically it start to connect with the nearest routing devices. The destination of the connectivity is shown in the Algorithm 2.

Algorithm 2: Destination Node Connectivity
Terms: S – Source, D – Destination, ACK, RT – Routing Table

1. D receive the routing setup
2. If the device is available to find short distance connectivity path, then remove the short distance connectivity path.
3. Increase the long distance of connectivity
4. Remove the short path from S and D
5. Select the best path for multiple connectivity
6. Find the best path and notifications
7. If no path for connectivity, to send RT setup Message
8. Select multiple path
9. Store the available resources
10. Then Select available path in connectivity
11. If RSU connectivity expired, then to select another path for connectivity.

Using the destination node algorithm for all the intermediate available nodes and path connected using multiple moving objects. If the objects are not available, RSU connectivity will be available immediately to be connected to the routing.

3.3. *Path selecting and tracking*

The path selecting and tracking place an important role to select objects to connectivity in the dynamic environments. The moving objects in the dynamic environments are connected using multiple segments. The moving objects in the environments are grouped using the partitions of dynamic environment and performed using Euclidean distance; distance calculated MDI. The diagrammatic representation of segments and grouping of objects in the pervasive computing environment is shown in Figure 6. Based on each segment (S) objects are grouped together and communicated each other with the help of clustering methods. The density-based clustering is used to group the moving objects. In each clustering the objects are grouped and communicated with each other using distance and path of each segment. In moving environments, all the paths are selected using Nearest Neighborhood (NN) property. Using the NN path selection, entire routes are assigned and check the passible paths for connectivity. The step-by-step process for path selection and tracking are shown in the Algorithm 3.

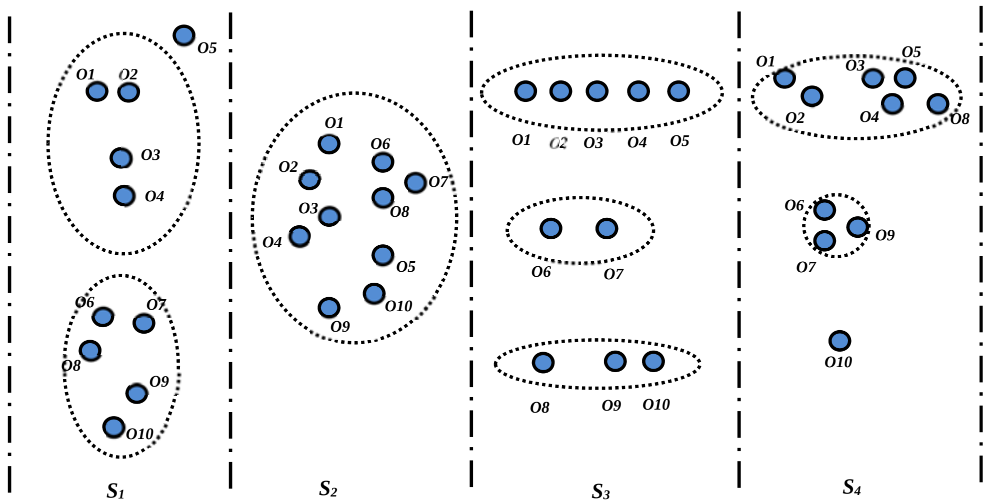

Fig. 6. Partitions segments in moving objects network.

Algorithm 3: Path Selection and Tracing of Connectivity
Input: Moving objects (M), Segmentation (S), d-distance, S, D, RT

1. Initialize the heterogeneous environments
2. Initialize the Os

3. Find the d between the O1 to on in the S
4. Os are communicated within the Os
5. Continuously collect the distance between two objects
6. Apply the NN
7. If the objects are away from the NN, Initiate the RT
8. Find the S and D of moving objects
9. If nearest objects are not found, initializing the process of path selection.
10. Trace the connectivity continuously using S and D.

Using this path selection continuously moving objects are connected and traced the availability of resources to connect. So different metrics are easily achieved using with the help of connectivity and availability. For example, different communication metrics and IoT metrics are achieved using routing and path selection of moving objects.

4. Implementation

The simulation of the proposed work performed using OMNeT++. The basic simulation setup of the proposed work and virtual objects setup are presented in Table 2. The simulation analysis requirements server shows the growing network size. Because the size of the moving node count to gateway count is in increasing order.

Parameters	IoT devices/Values/Ranges
Node Counts	900-250 dynamic Devices
Segments	20 to 30
Application Layers	IoT Application Layers
Packet Rate	200 - 1000 P/Sec
Protocols	TCP/IP and UDP
Environments	IEEE802.11
Areas Size	10000m * 1000m
Communication Range	Min: 100m - 2000m and Max: 100m - 10000m
Mobility type	Dynamic
Memory Range	128 KB to 32 GB
Simulation time	50 sec
Metrics	Communication metrics

Table 2. Experimental parameters

As per the virtual objects and moving managements the IoT environments are created and virtualized using device management applications. The output of ARA-PS is performed in the different iterations and corresponding metrics are shown in the Figure 7 and 8. Basically, in the communication throughput, energy level and trust function are plotted in the graphs. The output of the proposed work is compared with previous standard homogeneous routing methods such as minimum spanning tree, Steiner tree, Dynamic routing approach and LinGo. The predicted output compared with different comparison metrics such as throughput, delay, energy, price, ideal time and etc. The Figure 7 shows the throughput graph in terms of network size. If the network size increased, automatically the throughput will decrease, but in the proposed work the throughput constantly increases and constraint delivery time will maintain in the ARA-PS algorithm.

Another main important comparison parameter is throughput in available energy. The network size automatically increases the throughput and energy level will increase in the homogeneous and heterogeneous networks. In this proposed work network is extended using RSU, RFID readers and etc. So automatically connecting points are always available in the dynamic environments. If the connecting points are increased, the energy usage will also increase automatically.

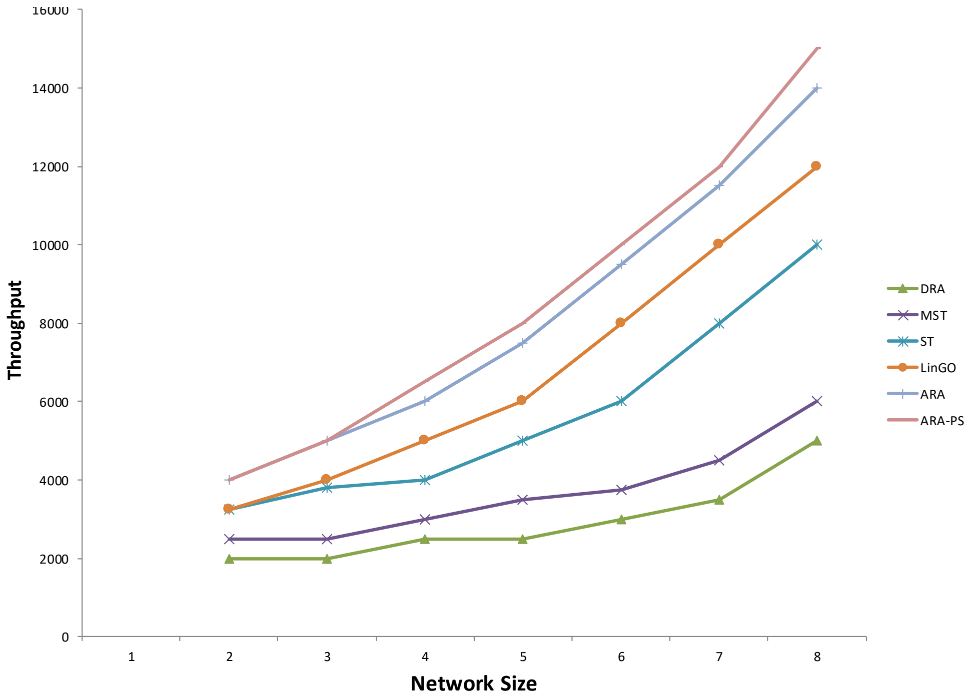

Fig. 7. Throughput vs. the network size

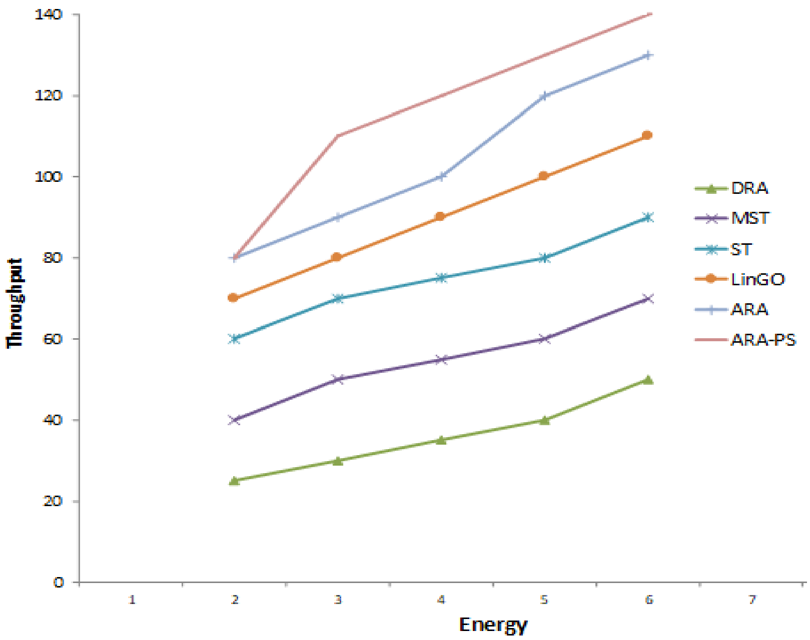

Fig. 8. Throughput vs. the available energy

Another important quality of services in pervasive and IoT computing is quality functions. The quality of the proposed methods are achieved using energy, throughput, connecting time and availability of resources in the dynamic networks. The quality of measure is monitored continuously in the communication networks. Based on the availability of connectivity, all the nodes are connected simultaneously in the dynamic environments.

5. Conclusion

The pervasive and IoT connectivity is facing different issues in the communication in dynamic environments. Because the availability of the connecting resources is changing dynamically in each situation. So, in the pervasive and IoT connectivity quality of the service, plays an important role in continuous communication. The different Quality of Service parameters are used to measure continuous connectives of devices. The throughput, network size, connecting devices, energies are some of the main parameters used to manage the quality of services. This paper has achieved the quality of services using continuous connecting devices in the dynamic environments and selection of path of devices. The proposed work consists of communication components for continuous signal sending, routing approach and selection of path in the dynamic environments. The communication components are used to connect various devices in the dynamic situations. The main connecting components are IoT model, IoT node, Road side unit, and Communication model. The routing approach is used to connect the long-distance using ant colony-based routing algorithm. Using this routing algorithm, can extent the connectivity in the one source to destination of moving objects. The path selection is used to segment the moving devices path using Euclidean distance and MDI techniques. Using this segment wise moving devices are connected. Using these three things the moving devices are connected continuously and quality of the services is also improved. The Quality of Services is achieved using throughput, network size, energy, and availability of resources.

References

[1] Abinaya S, Akshaya G, Dhivya J. *Minimizing energy consumption using internet of things.* Int. J. Recent Innov. Trends Comput. Commun., no. March 2017:67–70.
[2] Alanazi A, Elleithy K, (2015). *Real-time QoS routing protocols in wireless multimedia sensor networks: study and analysis.* Sensors 15(9):22209–22233.
[3] Alsaryrah O, Mashal I, Chung T. *Bi-objective optimization for energy aware internet of things service composition.* IEEE Access 2018;6:26809–19.
[4] A. R. and X. Su, *"Mobility handling in MAC for wireless ad hoc networks,"* Wirel. Commun. Mob. Comput., vol. 9, no. 3, pp. 303–311, 2009.
[5] Eiza MH, Owens T, Ni Q (2016). *Secure and robust multiconstrained QoS aware routing algorithm for VANETs.* IEEE Trans Depend Sec Comput 13(1):32–45
[6] F. Al-Turjman, *Price-based data delivery framework for dynamic and pervasive IoT, Pervasive and Mobile Computing (2017),* http://dx.doi.org/10.1016/j.pmcj.2017.05.001
[7] Gunes, Mesut, Udo Sorges, and Imed Bouazizi. *"ARA-the ant-colony based routing algorithm for MANETs."* Proceedings. International Conference on Parallel Processing Workshop. IEEE, 2002.
[8] https://5gaa.org/wp-content/uploads/2019/05/06.Virtual_RSU_Architecture.pdf
[9] https://www.capgemini.com/us-en/resources/the-road-to-the-5g-connected-vehicle/
[10] Hasan, Mohammed Zaki, Fadi Al-Turjman, and Hussain Al-Rizzo. *"Optimized multi-constrained quality-of-service multipath routing approach for multimedia sensor networks."* IEEE sensors journal 17.7 (2017): 2298-2309.
[11] Incebacak D, Tavli B, Bicakci K, Altın-Kayhan A (2013) *Optimal number of routing paths in multi-path routing to minimize energy consumption in wireless sensor networks.* EURASIP J Wireless Commun Netw 1:252–261.
[12] Kaur, Tarunpreet, and Dilip Kumar. *"Computational intelligence-based energy efficient routing protocols with QoS assurance for wireless sensor networks: a survey."* International Journal of Wireless and Mobile Computing 16.2 (2019): 172-193.
[13] Kim, Beom-Su, et al. *"Adaptive real-time routing protocol for (M, k)-firm in industrial wireless multimedia sensor networks."* Sensors 20.6 (2020): 1633.
[14] Kiran, P. Sai, B. Thirumala Rao, and L. S. S. Reddy. *"Architectural Crises in Vehicular Ad-Hoc Networks."* Global Journal of Computer Science and Technology (2010).
[15] R. Buyya and A. V. Dastjerdi, Internet of Things: Principles and Paradigms. 2016.
[16] Reddy MPK, Babu MR. Energy efficient cluster head selection for internet of things energy efficient cluster head selection for internet of things. New Rev Inf Netw 2017; 22(1):54–70.
[17] Singh, Manisha, and Gaurav Baranwal. *"Quality of service (qos) in internet of things."* 2018 3rd International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU). IEEE, 2018.
[18] So-In, Chakchai, Duc-Dung Tran, and Hung Tran. *"Optimal system performance in multihop energy harvesting WSNs using cooperative NOMA and friendly jammers."* IEEE Access 7 (2019): 125494-125510.
[19] Suseela, S., et al. *"QoS optimization through PBMR algorithm in multipath wireless multimedia sensor networks."* Peer-to-Peer Networking and Applications 13.4 (2020): 1248-1259.
[20] Wang, Denghui, et al. *"An energy-efficient distributed adaptive cooperative routing based on reinforcement learning in wireless multimedia sensor networks."* Computer Networks 178 (2020): 107313.
[21] Wang, Denghui, et al. *"A novel QoS-awared grid routing protocol in the sensing layer of Internet of vehicles based on reinforcement learning."* IEEE Access 7 (2019): 185730-185739.

Authors Profile

Padmanabhan P is working as an Assistant Professor in the School of Computing Science and Engineering, Galgotias University (GU), Greater Noida, Uttar Pradesh, India. He has completed his BSc, MSc and M.Tech from reputed institutions. His research thrust is mainly focused on Wireless Sensor Networks, Cloud Technologies and Internet of Things (IoT).

Dr. K Sampath Kumar is working as a Professor and PhD Coordinator in the School of Computing Science and Engineering, Galgotias University, Greater Noida, UP, NCR-Delhi, India. He has completed his Ph.D. in Big Data Mining from Anna University, Chennai and obtained his ME from Sathyabama University, Chennai. He has more than 21 years of experience in the field of teaching. He has published more than 60 research articles in the International Journals and Conferences also published more than 13 patents. He is expertise in Big Data, Cloud, IOT and Artificial Intelligence.

Dr. A. John is working as an Associate Professor in the School of Computing Science and Engineering, Galgotias University, Greater Noida, India. He received his Ph.D. in Computer Science and Engineering from Manonmaniam Sundaranar University, Tirunelveli, India and Master's degree in Computer Science and Engineering from Pondicherry University, Puducherry, India. And Bachelor's degree in Computer Science, from Puducherry, India. He has presented and published papers in various National and International Conferences and Journals. His fields of interest are Spatial and temporal data, Machine Learning, Data Analysis and Prediction, Resource Management in WSN and Society technology Interface etc.