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A Review on Iot and its Challenges in Routing

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Abstract:
Internet has connected everything and made all the thing alive. This has led to the new rule of future. The future refers to the IoT (Internet of things). IoT integrates physical things with the internet which will create smart environment that will be having plethora of applications in the near future. In IoT devices communicate with each other and gather and shares information. Therefore, connectivity is the major building block of IoT. As an enormous amount of data is generated and processed the control over the various physical things is of much importance. Also, the communication between the things should be accurate which corresponds to the various factors such as energy efficiency, time delay and overhead. In this paper IOT as a technology oriented and its various challenges like low cost system and scalability is to be discussed.

Keywords: IOT (internet of things), PSO (particle swarm optimization), ACO (ant colony optimization), GWO (grey wolf optimization), routing.

1. INTRODUCTION

The internet is a way to interconnect various systems which helps devices to communicate globally with each other using a set of standard protocols. It helps in connecting various heterogeneous networks that are used for the purpose of academics, business and governments, etc. Earlier internet was only a medium for static websites and email communications. But nowadays internet implementation can be seen everywhere and in many aspects of our life helping us to achieve various services and applications. It helps users to meet their needs at any time and place. Internet technology has become the main demand of the users nowadays and it reflects the demand of the user in one way or another which has led to the world become smaller and closer to the users than ever. It has become an important aspect to remain connected to the world each second. Therefore, connectivity between the devices is increasing each year and become challenging also. This requires an autonomous device communication to be created. A promising solution for this problem is IOT (Internet of Things). IOT is an informational network that allows the lookup of information about real world objects interact directly with each other by means of a unique identifier [1]. The IOT is the network of interconnected things. The network is based on the IP (internet Protocol) network and the things are the devices which are connected to the networks. The devices like sensors and actuators which are equipped with the telecommunication interface, storage and processing units. This particular communication paradigm allows seamless integration of an object into the internet which helps us to allow different form of interaction between the human beings and the devices and devices to devices which is commonly called as machine to machine communication (M2M). IOT wants to build the globe where all the devices around the globe should be interconnected and will communicate with each other. As an important part the "communication" has to be considered and also the collaboration between all of those different devices through the Internet and based on the advances of wireless access technologies, formed by machine to machine (M2M) communication [2]. The result of such kind of M2M communication is information, which on one hand is related to the people and, on the other hand, is produced by them. Furthermore, the data ownership is a key aspect, thus, the establishing of secured communication, accessing the resources, and the user identification and authentication are crucial and play an important role because the "actual users" are humans [3]. IOT can be considered as the major footstep in the maturity of the internet. The main aim of IOT is to develop an enhanced surrounding for mankind, which is intended to automatically fulfill the requirements of human beings. IOT has applications in domestic fields as well as in the industry field. Therefore there are many challenges related to IoT that are scalability, finite resources and small physical size.

2. IOT ARCHITECTURE

Earlier decades the three layered architecture was introduced. It has layers called perception layer, network layer and application layer. Physically data was taken with the help of sensors and therefore it is called the physical layer[4]. Connection of devices with the servers and transmitting of the information is done with the help of network layer. Application layers handles the application specific services of the user. Six layered architecture is mostly used nowadays. For better understanding of the IOT functionality more layers are added to the architecture. It consists of coding layer, perception layer, network, middleware layer, application, and the business layer[5].

a) Coding Layer

Coding layer is the base of IOT. It provides the identity to the objects. A specific or unique ID is provided to each object which help in the identification of each and every object

b) Perception layer

Perception layer helps in the physical recognition of each object. It consists of various sensors and RFID tags which could sense

the physical factors like humidity temperature, location etc. of the objects. It collects the information from these sensors and convert into the useful information into the digital form so that it can be processed further into the next layer.

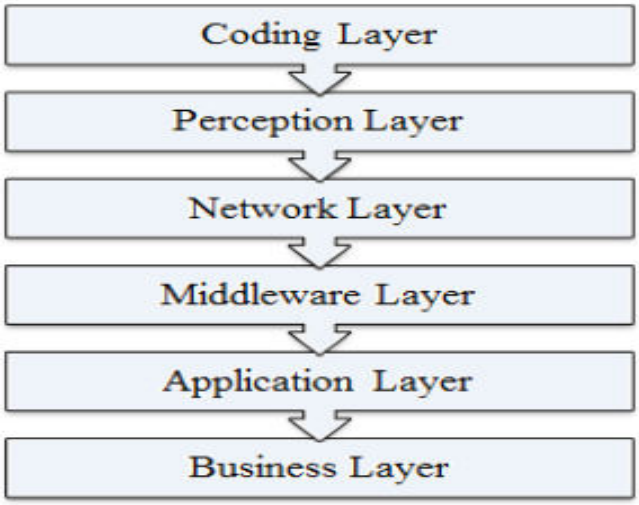

Figure.1. Architecture of IoT

c) Network Layer
It receives the information in digitally form and transfer the information to the middleware layer through the processing systems. The transmission medium in network layer can be WiFi, Bluetooth and Zigbee etc. The various protocols used in the layer are IPv6, IPv4, DDTetc.

d) Middleware Layer
The data received from the sensor devices are processed in this layer. The technologies like cloud computing helps in the access to the database and helps in storing all the important information. The processing over the information is done with the help of some intelligent processing and further actions are taken on the results that are processed.

e) Application Layer
Application layer is very important in case of large scale development of the IoT network. As application is a fundamental part of the IoT development. There are many applications of IoT and are still to be discovered which includes smart home, smart world etc.

f) Business Layer
This particular layer helps in generating different models related to business for building the effective strategies of business. It manages the services and application of IoT.

3. IOT COMMUNICATION

The number of people in earth is overtaken by the number of devices that are interconnected. IoT's network structure is horizontal and it gives same priority to each node. The different type of communication that is possible in this area is machine to machine (M2M), machine to human and human to machine. The communication process is only achieved only if the process supports the transfer of information between the heterogeneous networks [6]. Therefore the intermediate nodes must be encouraged so that they can participate in the relaying messages by integrating rewards for example monetary gain to the devices that are relaying.

4. IOT ROUTING

IoT is helping and is going to help humans by offering a large number of applications that will improve human lives. The main objective in case of routing is to reduce the unprecedented amount of storage, security, cost effectiveness and efficiency in terms of data supply and energy. Routing issues have become more challenging in case of lossy radio links and low power networks. A smart routing protocol can unleash the intrinsic power of any dynamic and heterogeneous network that can be characterized by various factors i.e changing topology and flow. Also there was a misconception earlier that any protocol that are designed earlier can function well for the IoT but this is not the case. Multiple issues arise due to the routing protocol as earlier one cannot intercommunicate with each other. Therefore protocols were designed particularly for the Iot so as to meet the requirements of the particular network. Therefore for the effective working of the IoT intelligent protocols are needed so as to achieve D2D communication in IoT. Also, scalable and efficient protocols that can adopt different network size and variations and also are capable to find optimal routes are required.

5. OPTIMIZATION TECHNIQUES IN IOT

The optimization technique in routing is selected according to the requirement of the network. There are various factors according to which the technique is chosen. The factors are energy efficient routing, data redundancy elimination and delay minimization.

a) Energy efficient routing
This kind of technique basically optimizes the energy requirements which help in selecting the path that can lead to the increase in the lifetime of the particular networks[7]. The data is routed towards the destination through those nodes which have sufficient energy to transfer the data and can avoid the nodes which are insufficient of transferring the data due to the low energy.

b) Delay Minimization
The IoT consists of various heterogeneous devices and data is transferred from the nodes to the destination. Data is expired after some time. So as it is required to send the data within a fixed time span is essential.

c) Eliminating Data Redundancy
Due to the energy requirement of each node it is advised to use only the important information that should be sent across the nodes. Eliminating the redundant data will help in reducing the energy requirement which will lead to the efficient transfer of data. Therefore data fusion technique is used so as to remove data redundancy.

5.1 Various optimization Techniques

5.1.1 Ant Colony Optimization

Ant colony optimization is based upon the basic behavior of ants. A particular chemical is produces by the ants that help in the

communication between the ants. This particular chemical compound is called as the pheromone. The algorithm follows start from the parameter initialization and pheromone networks. The first ant forms a path and leaves the chemical which is followed up by the rest of the ants.[8][9] The path is made towards the destination according to the local search. The network is updated with the pheromone chemical.

Basic algorithm for ACO
Set parameter and initialize pheromone trails
While (termination condition not met) do
Construct ant solutions
Apply local search
Update pheromones
end
end

5.1.2 Particle Swarm Optimization

Particle swarm optimization (PSO) [10] is a nature inspired swarm intelligence based algorithm, modelled after observing the choreography of a flock of birds, i.e., how they can explore and exploit the multi-dimensional search space for food and shelter. PSO consists of a predefined number of particles say N_P, called a swarm. Each particle provides a potential solution. A particle P_i, $1 \leq i \leq N_p$, has position $X_{i,d}$ and velocity $V_{i,d}$, $1 \leq d \leq D$ in the dth dimension of the search space. The dimension Dis same for all particles. A fitness function is used to evaluate each particle for verifying the quality of the solution. The objective of PSO is to find the particle's positions that result best evaluation of the given fitness function [8]. In the initialization process of PSO, each particle is assigned with a random position and velocity to move in the search space. During each iteration (generation), each particle finds its own best, i.e., personal best called Pbest and also the global best called Gbest. Toreach the global best solution, it uses its personal and global best to update the velocity Vi,d and position Xi,d using the following equations global best called Gbest. To reach the global best solution, it uses its personal and global best to update the velocity Vi,d and position Xi,d using the following equations

$v_{i,d} = \omega \times v_{i,d}(t) + c_1 \times x_1 \times \left(X_{Pbest\ i,d} - X_{i,d}\right) + c_2 \times x_2 \times (X_{Gbest} - X_{i,d})$

$$X_{i,d}(t+1) = X_{i,d}(t) + V_{i,d}(t+1)$$

where ω, $0 < \omega < 1$, is the inertia weight, C_1, C_2 where $0 \leq C_1, C_2 \leq 2$ are the acceleration coefficients and x_1, x_2 where $0 \leq x_1, x_2 \leq 1$ are the randomly generated values. The updating process is repeated until it is reached to an acceptable value of Gbest. After getting new updated position, the particle evaluates the fitness function and updates Pbesti as well as Gbest for the minimization problem as follow

$$\text{Pbesti} = \begin{cases} Pi & if (fitness(Pi) < fitness(Pbesti) \\ Pbest & otherwise \end{cases}$$

$$\text{Gbesti} = \begin{cases} Pi & if \quad (fitness(Pi) < fitness(Gbest)) \\ Gbest & otherwise \end{cases}$$

The particle explores in the multi-dimensional search space to achieve a global best solution. It is clear that initially a particle Pi, occupies the position $X_{i,d}$ with velocity Vi, d at a point of time and it is moving in some direction. Later the particle changes the direction and moves to another position using its memory. It then again changes its direction by the influence of the swarm and occupies a new position $X_{i,d}(t+k)$ with velocity $V_{i,d}(t+k)$ and finally reaches the global best position $X_{i,d}(s)$, where $t+k < s$ and the variables s, t and k are defined on a particular period of time.

5.1.3 Grey Wolf Optimization

This technique mimics the leadership hierarchy of grey wolves. In grey wolves the main and females are dominant members of the pact. The hunting process is guided by the males in case males are not available the female become the dominant one. All the other wolves follow the three wolves which are dominant and are referred by α,β,δ,γ[11].

Random number of wolves: Random number of wolves expressed by 2-D array of nodes selection possibilities

$$W = \begin{bmatrix} G_1^i G_2^i G_3^i \dots\dots\dots\dots . G_{A-1}^i G_A^i \\ G_1^{i+1} G_2^{i+2} G_3^{i+3} \dots\dots\dots\dots . G_{A-1}^{i+1} G_A^i \\ \dots\dots\dots\dots\dots\dots \\ \dots\dots\dots\dots\dots\dots \\ G_P G_P G_P \dots\dots\dots\dots . G_P G_P \\ G_1 G_2 G_3 \dots\dots\dots\dots . G_{A-1} G_P \end{bmatrix}$$

$G_J^i = initial\ value\ of\ ith\ pack\ of\ Jth\ volves.$

The given matrix presented above shows the pack of wolves on the basis of levels α, β, δ.

(c) Fitness Function

$\vec{F} = |C.G_P(t) - G(t)|$ ..... (1)
$\vec{G}(t+1) = G_1(t) - \vec{A}.\vec{D}$ ..... (2)

Here, the behavior of prey is encircled during hunting process. Here,'t' represents the current iterations A and C, which acts as coefficient vectors of the prey. $\vec{G}$ is the position vector of the grey wolf.

Identify the best Hunt

$\overrightarrow{D_\alpha} = \left|\overrightarrow{C}.\overrightarrow{G_\alpha} - \vec{G}\right|$ ..... (3)
$\overrightarrow{D_\beta} = \left|\overrightarrow{C}.\overrightarrow{G_\beta} - \vec{G}\right|$ ..... (4)
$\overrightarrow{D_\delta} = \left|\overrightarrow{C}.\overrightarrow{G_\delta} - \vec{G}\right|$ ..... (5)
$\overrightarrow{G_1} = G_\alpha - \vec{A}.(\overrightarrow{D_\alpha})$ ..... (6)
$\overrightarrow{G_2} = G_\beta - \vec{A}.(\overrightarrow{D_\beta})$ ..... (7)
$\overrightarrow{G_3} = G_\delta - \vec{A}.(\overrightarrow{D_\delta})$ ..... (8)

In this process, identify the best hunt among all hunts that are guided by alpha, beta and delta participating occasionally.

(d) Updated Value: Here is the updated value of alpha.

$$G(t+1) = \frac{\overrightarrow{G_1} + \overrightarrow{G_2} + \overrightarrow{G_3}}{3}$$

6. FUTURE RESEARCH AND CHALLENGES

There are some real challenges due to the network that are made up of heterogeneous networks. There are various parameters that affect the routing process. Some of them are as follows.

a)Scalability

The networks that are used in the IoT are mobile as well as stationary. So while using the mobile network the user can leave the network which leads to the reduction and expansion of the

size of the network. So, scalability of the network affects the routing process.

b) Heterogeneity
In Iot different technologies and devices are brought under one roof. Due to various devices and networks heterogeneity adds complexity in routing process. So the routing protocols should be built according to the network that can accommodate heterogeneity in it.

c) Context awareness
It is very essential for smart routing to collect the context from the environment and analyze it for generating knowledge. This particular knowledge is useful for taking the decisions in routing. There are various parameters by which routing decision are taken that depends on the energy of nodes, cost effectiveness and delay minimization.

d) Latency
It is necessary to deliver the data from source to destination in time as the data expires after some time. Therefore it is essential to maintain the service quality of the network by maintaining the latency in the routing protocols.

e) Death of nodes
There are nodes in the network that are energy constrained nodes. Overuse of nodes and unnecessary use of nodes results in the death of nodes. As it is not possible to replace the nodes. Energy holes may get created due to dead nodes which may create the interruption in the process of routing.

7. CONCLUSIONS

Due to the advancement in the technology all objects around the world can be connected. Communication between these devices are possible due to the IoT which has led to build a smart environment. Sensor data routing is one of the main challenges of the IoT. We have reviewed the most important aspects of routing in IoT and the challenges that are faced by the IoT in the routing process. These particular issues are needed to be addressed in the near future. In the next few years such issues will be the commanding force for research in routing in academics as well as in industries.

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