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Energy Efficient AODV Protocol for Internet of Things

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Abstract— (**IOT) Internet of Things meant to be the network interconnection of everyday objects. It is generally viewed as a self-configuring wireless network of sensors whose idea would be to interconnect all things. The Internet of Things is a rather new concept in IT field. However, the research of routing protocols of Internet of Things is still a blank, while route designing is an essential part in the research of Internet of Things. The more improvement is required for the use in internet of things, for every single character which is connecting to the internet. For improving the routing of AODV for Internet of Things we are working on the implementation of the algorithm through optimizing the protocol, such as routing table and internet connecting table will combine into one. The objective of this paper is Simulation study of AODV routing protocol for the Internet of things.Performance evaluation of AODV and AODV with internet of things using ns2 simulator.**

Index Terms— **Thing's Information as Object, Smart business, Utilities, 3-layer architecture of lOT**

I. INTRODUCTION

Internet of Things (IOT) involve to the networked interconnection of everyday objects. It is generally viewed as a self-configuring wireless network of sensors whose function would be to interconnect all things [1]. There are physical objects one wants to be able to track, to monitor and to relate with. Examples include inanimate objects like pallets, boxes containing consumer goods, cars, machines, fridges – and perhaps even the well known milk brand carton or cup of yoghurt – as well as animate things such as animals and humans. These are the effects of the Internet of Things – or to use a clearer term, the entities of interest [2].Many experts are optimistic about the future of Internet of Things, while several of them contemplate on the usage of IOT. All them like the central parts of IOT. The routing method designing is still a blank [1].The relationship among all these terms is schematically summarized in Figure. 1.A thing of interest is monitored by a device in the environment, or it can also have a device attached [2] Figure 1: Relationship among things, devices, resources and services [2]

1.2.2. Thing's Information as Object:

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Things including substances and products are the base of human living. Following are the two main characters: large quantity of diverse types; relative fixed material entity. The former demands an effective management to the thing's information, the lastly defines that the object's information can be shown in relative fixed form, so it can be recorded on some material medium, and adhered to the thing's entity. The things information and the thing's entity are combined into one [5].

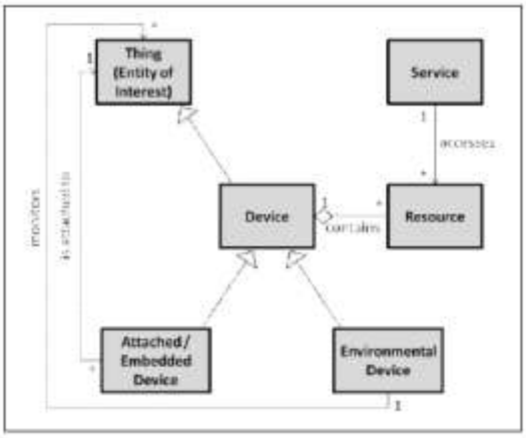

Figure 1 Relationship among things, devices, resources and services

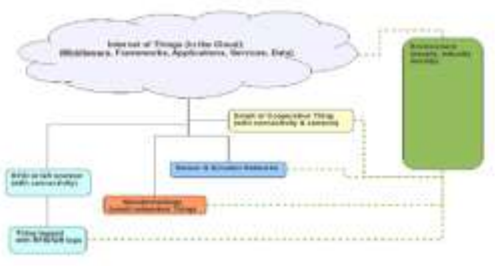

Figure 2: Components in the Internet of Things

The IOT vision enhances connectivity from any-time, any-place for anybo*dy* into **any-time, anywhere**" used for "**some*what***". While these effects are located into the network, more and more smart processes and services are probable which can support our economies, environment and health. Figure 2 provides a view of the IOT ecosystem. In addition, physical objects are progressively fitted with tags (e.g. radio-frequency identification (RFID) or Quick Response codes (QR-codes)) which could be sensed or scanned by devices (e.g. the new generation smart phones containing embedded (GPS)global positioning system and/or RFID scanners or QR-code readers). This combination links the physical world to cyberspace during the smart device,

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thus increasing the Internet into what has now been coined the Internet of Things" [3]

There are **recurrent application** domains which will be compressed by the emergence of internet of things. The application can be classified into the diverse network availability, scale, coverage and repeatability of use involvement as shown in figure.3.

-> Smart business:

RFID technologies are used in various sectors such as inventory management, supply and delivery chain. This relies on the capability of RFID to identify and support for tracking goods and assets.

->Utilities:

The information from the network in this application sphere is almost for service operation and optimization of consumer for customer. Utilities have several extra expenses about the reading and analyzing the consumer and management because monitoring is the strength and competent resource of management [5].

Figure 3.Application in IOT [5]

1.4 3-layer architecture of lOT:

Poles apart from its definition unclear, the architecture of lOT are generally accepted. The well-known 3-layer architecture consists of the Perception Layer, the Network Layer and the Application layer, as shown in Figure 4.

The Internet business environment hierarchical model based on Web is shown in figure 5[10].

1. The Perception Layer:

The Perception Layer is similar to the facial skin and the five sense organs of IOT, which helps mainly in identifying objects and gathering information. The Perception Layer consists 2-D bar code labels and readers, RFID tags and reader-writers, terminals, camera, GPS, sensors, and sensor network. Its main task is to identify the object, gathering information.

2. The network layer:

The network layer is like the neural network and brain of lOT, its main function is to transmit and process the information. The network layer includes a convergence network of communication and Internet network, in sequence center, network management center, and intelligent processing center, etc. The network layer will transmit and process the information produced from perception layer.

3. The Application Layer:

The Application Layer is a combination of lOT's social division and industry demand, to realize the extensive intellectualization. The Application Layer is the deep convergence of lOT and business technology, combined with industry needs to realize the intellectualized industry, which is related to person's social division of labor, eventually form human society [6].

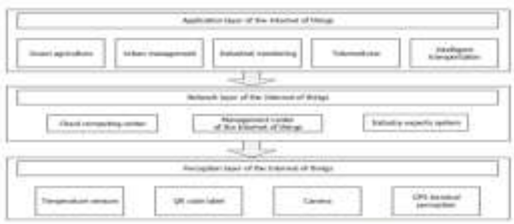

Figure4. 3-layer architecture of the Internet of Things[10]

II. RELATED WORK

The research work performed in this area by different researchers *is* presented as follows:

Yicong Tianet et al. [1] designed a routing method that can take function as routing destination not just nodes. The Internet of Things is a rather new concept in IT field. However, the research of routing protocols of Internet of Things is still a empty, while route designing is an important part in the research of Internet of Things. In this method, the development is suitable for use in internet of things. Interrelate with AOMDV in the internet of things, simulation results show that AOMDV-IOT achieves improved performance in average end-to-end delay, packet loss and discovery frequency.

Stephan Haller et al. [2] studied the things in the Internet of Things. The Internet of Things is a hyped word and many definitions for it exist. Worse still, it comes with a lot of related terminology that is not used regularly either, hindering scientific discourse. This paper tries to bring clarity by describing the most significant terms like things, devices, entities of interest, resources, addressing, and identity and, more importantly, the relationships between them.

Yinghui Huang et al. [3] presented descriptive models for Internet of Things. From a semantic analysis for *Internet of things*, a conclusion is drawn that the word *thing* here indicates essentially the *thing's information* and the *Internet* here is actually the *Internet application*. Internet of Things is a new kind of Internet application which makes the thing's information be common on a global scale. Internet of Things has two attributes: being an Internet application and dealing with thing's information, and four discrepancy features: only for thing's information, coded by UID or EPC, stored in RFID electronic tag, uploaded by non-contact analysis with RFID reader. The descriptive models for Internet of Things are introduced based on the vital attributes and the differential features. The graphical model of Internet of Things shows that the two key tasks of constructing Internet of Things are the preprocessing of thing's information before uploaded into Internet and the building of a RFID system. The rest expression model of Internet of Things stresses the common character that all Internet applications have, (explicitly an Internet application is essentially a set of information), so the improvement processes and the technical methods of other Internet applications could be referenced and reused for building Internet of Things.

Louis Coetzee et al. [4] in this paper study is given about the Internet of Things. The Internet is a living entity, always altering and evolving. New applications and businesses are formed continuously. In addition to an evolving Internet, technology is also altering the landscape. Broadband connectivity is becoming cheap and ubiquitous; devices are becoming more powerful and smaller with a range of on-board sensors. The proliferation of more devices becoming connected is foremost to a new standard: the Internet of Things. The Internet of Things is driven by an expansion of the Internet through the inclusion of physical objects united with an ability to provide smarter services to the environment as more data becomes available. Diverse application domains ranging from Green-IT and energy efficiency to logistics are already starting to profit from Internet of Things concepts. There are challenges associated with the Internet of Things, most explicitly in areas of trust and safety, standardization and governance required to ensure a fair and trustworthy open Internet of Things which supplies value to all of society.

Nan LIN et al. [5] With the deepening of the research and development of embedded devices and the Internet of things technology widespread application, intelligent objects and types, increasing the number of the Internet of things devices constantly gained popularity in the People's Daily life. The development of digital and network technology build the controller node, sensor node, radio frequency identification, and home appliances such as TV, air conditioning equipment can make use of the Internet protocol, wireless communication protocol to attain information transmission and exchange. The Internet of things technology triggered a new wave of information industry, and with infinite commercial value. Internet of things based on Web application architecture and key technology research is of great practical significance.

Miao Wu et al. [6] studied the architecture of Internet of Things. The Internet of Things is a technological revolution that represents the future of computing and connections. It is not the simple extension of the Internet or the Telecommunications Network. It has the features of two, the Internet and the Telecommunications Network, and also has it shown distinguishing feature. Through analyzing the present accepted three-layer structure of the Internet of things, author suggests that the three-layer structure can't express the entire features and connotation of the Internet of Things. After reanalyzing the technical structure of the Internet and the Logical Layered Architecture of the Telecommunication Management Network, author establishes new five-layer construction of the Internet of Things. Author believes this architecture is more helpful to comprehend the essence of the Internet of Things.

Lu Tan et al. [7] designed architecture of the Internet of Things and then designed a specific the Internet of Things application model which can relate to automatic facilities management in the smart campus. Now a day, the main communication form on the Internet is human-human. But it is foreseeable that in a close soon that any object will have a unique way of identification and can be addressed so that every object can be linked. The Internet will become to the Internet of Things. The communicate forms will develop from human-human to human-human, human-thing and thing-thing (also calledM2M). This will bring a new ubiquitous computing and communication age and change people's life extremely. Radio Frequency Identification techniques (RFID) and related recognition technologies will be the corner stones of the upcoming Internet of Things (IOT).This paper target to show a skeleton of the Internet of Things and try to address some essential issues of the Internet of Things like its construction and the interoperability, etc.

Arjun P.Athreyaet al. [8] presented a survey of related work in the area of self-organization and discusses prospect research opportunities and challenges for self-organization in the Internet of Things. The Internet of Things is a paradigm that permits the interaction of ubiquitous devices through a network to achieve common goals. This standard like any man-made infrastructure is subject to disasters, outages and other adversarial conditions. Under these situations provisioned transmission fail, render the paradigm with little or no use. Hence, network self-organization with these devices is needed to allow for communication resilience. Author studied the system perspective of the Internet of Things. Author then identify and describe the key components of self-organization in the Internet of Things and confer enabling technologies.

III. PROPOSED WORK

Problem Formulation

For improving the routing of AODV for Internet of Things we are working on the implementation of the algorithm through optimizing the protocol, such as routing table and internet connecting table, that will combine into one. Additionally, the improvement protocol not only can used in internet of things, but find applications in other fields also. Now we can use our advanced protocol to search the function, and the algorithm will find appropriate node for us. It is modified AODV to adapt with the usage in internet of things. Our principal objective is to find and create the connection between nodes and internet efficiently. If a node need to create a link to the internet, it should initial ensure its internet connecting table, if the information there is valid, the node will choose the node whose hops count is lowest, or start the route finding process. Then it will take the discovered node as destination node to send message. Compared with AODV in the internet of things, simulation results show that AODV-IOT achieves better performance in packet delivery ratio, average end-to-end delay, through-put and energy consumption.

Proposed Work

In this dissertation we have proposed a protocol based on AODV to improve the routing of AODV for Internet of things. It is modified AODV to adapt with the usage in internet of things. Our principal objective is to find and create the connection between nodes and internet efficiently. The routing protocol will find the most appropriate link automatically, and record other links as back up. If a node

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need to create a link to the internet, it ought to first check its internet connecting table, if the information there is valid, the node will choose the node which hops count is the lowest, or start the routing finding process. Then it will take the discovered node as destination node to send message.

IV. RESULTS AND ANALYSIS

In this dissertation AODV routing protocol is improved for the Internet of things**.** In order to improve the algorithm the protocol is optimized such that routing table and internet connecting table will combine into one. The results are shown below.

Here we compare the results of AODV and AODV-IOT. The comparison is done for 10, 20 and 30 nodes. The outcome of AODV and AOMDV-IOT for 10 nodes are shown in figure 4.1 and 4.2

```
Performance Metrics

Total Packets Sent              :      9993
Total Packets Received          :      9990
Total Packets Dropped           :      9
Packet Delivery Ratio           :      99.97%
Throughput of the network(KBps) :      4.9950
Average End to End Delay        :0.002337363 ms
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    17.6627
```

Figure 4.1 Result of default AODV for node (n) = 10

```
Performance Metrics

Total Packets Sent              :      9993
Total Packets Received          :      9993
Total Packets Dropped           :      0
Packet Delivery Ratio           :      100.00%
Throughput of the network(KBps) :      4.9965
Average End to End Delay        :0.001381506 ms
Metric values are correct
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    13.7335
```

Figure 4.2 Result of AODV-IOT for node (n) = 10

The comparison of performance metrics for AODV and AOMV-IOT for 10 nodes is shown in table 4.1

Table 4.1 Performance metrics for nodes n = (10)

PDR%	Throughput(Kbps)	Average EndToEnd Delay	Consumed Energy
99.97	4.995	0.00233	17.66
100	4.996	0.00138	13.73

The results of AODV and AOMDV-IOT for 20 nodes are specified in figure 4.3 and 4.4

```
Performance Metrics

Total Packets Sent              :      6800
Total Packets Received          :      6795
Total Packets Dropped           :      37
Packet Delivery Ratio           :      99.93%
Throughput of the network(KBps) :      3.3975
Average End to End Delay        :0.004611616 ms
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    30.6128
```

Figure 4.3Result of default AODV for node (n) = 20

```
Performance Metrics

Total Packets Sent              :      6800
Total Packets Received          :      6798
Total Packets Dropped           :      2
Packet Delivery Ratio           :      99.97%
Throughput of the network(KBps) :      3.3990
Average End to End Delay        :0.001513502 ms
Metric values are correct
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    21.5003
```

Figure 4.4 Result of AODV-IOT for node (n) = 20

Table 4.2 Performance Metrics for nodes (n)= 20

PDR%	Throughput(Kbps)	Average EndToEnd Delay	Consumed Energy
99.93	3.397	0.00461	30.61
99.97	3.399	0.00151	21.5

The results of AODV and AOMDV-IOT for 30 nodes are shown in figure 4.5 and 4.6

```
Performance Metrics

Total Packets Sent              :      5414
Total Packets Received          :      5363
Total Packets Dropped           :      89
Packet Delivery Ratio           :      99.06%
Throughput of the network(KBps) :      2.6815
Average End to End Delay        :0.055567833 ms
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    46.3129
```

Figure 4.Outcome of default AODV for node (n) = 30

```
Performance Metrics

Total Packets Sent              :      5414
Total Packets Received          :      5413
Total Packets Dropped           :      1
Packet Delivery Ratio           :      99.98%
Throughput of the network(KBps) :      2.7065
Average End to End Delay        :0.001736343 ms
Metric values are correct
neha@neha-laptop:~/anamika$ awk -f energy.awk trace.tr
Total Energy Consumption    30.7779
```

Figure 4.6 Result of AODV-IOT for node (n) = 30

Table 4.3 Performance Metrics for nodes (n)= 30

PDR%	Throughput(Kbps)	Average EndToEnd Delay	Consumed Energy
99.06	2.681	0.0555	46.31
99.98	2.706	0.0017	30.77

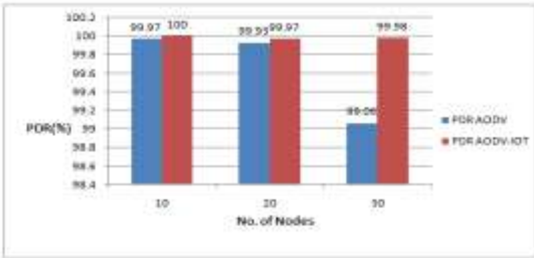

Figure 4.7 Packet Delivery Ratio by AODV and AODV-IOT

Figure 4.7 shows that Packet delivery ratio by AODV – 99.97% and Packet delivery ratio by AODV-IOT – 100.00% for 10 nodes, Packet delivery ratio by AODV – 99.93% and Packet delivery ratio by AODV-IOT – 99.97% for 20 nodes and Packet delivery ratio by AODV – 99.06% and Packet delivery ratio by AODV-IOT – 99.98% for 30 nodes.

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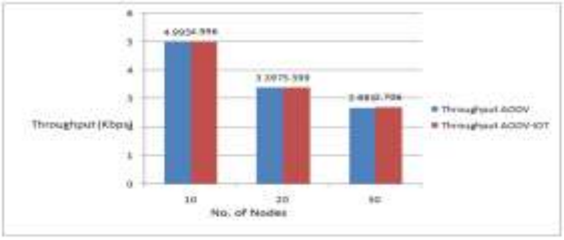
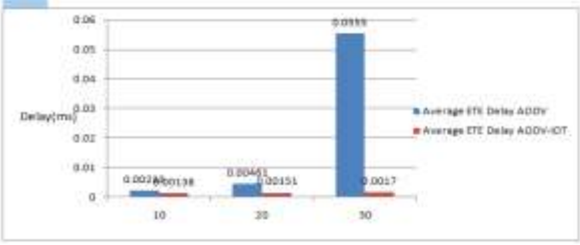


Figure 4.8 Throughput of Network AODV and AODV-IOT

Figure 4.8 shows that Throughput of network by AODV – 4.995 and Throughput of network by AODV-IOT – 4.996 for



10 nodes, Throughput of network by AODV – 3.397 and Throughput of network by AODV IOT – 3.399 for 20 nodes and Throughput of network by AODV – 2.681 and Throughput of network by AODV-IOT – 2.706 for 30 nodes.

Comment

Figure 4.9 Average End To End Delay by AODV and AODV-IOT

Figure 4.9 shows that average end to end delay by AODV – 0.00233 ms and average end to end delay by AODV-IOT – 0.00138 ms for 10 nodes, average end to end delay by AODV – 0.00461 ms and average end to end delay by AODV-IOT – 0.00151 ms for 20 nodes and average end to end delay by AODV – 0.0555 ms and average end to end delay by AOD- IOT – 0.0017 ms for 30 nodes.

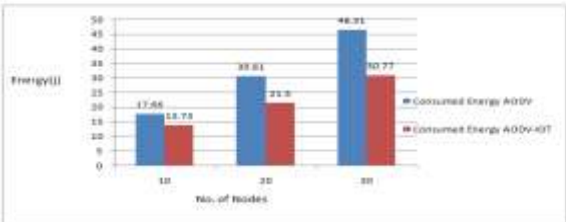


Figure 4.10 Energy Consumed by AODV and AODV-IOT

Figure 4.10 shows that energy consumed by AODV – 17.66 j and energy consumed by AODV-IOT – 13.73 j for 10 nodes, energy consumed by AODV – 30.61 and energy consumed by AODV-IOT – 21.5 j for 20 nodes and energy consumed by AODV – 46.31 j and energy consumed by AOD-IOT – 30.77 j for 30 nodes.

V. CONCLUSION AND FUTURE SCOPE

Internet of Things has the widespread future with providing applications with many aids to users. Internet of Things has prominent potential of benefits over the worldwide. As every new technology has some challenges, Internet of Things has also some challenges .The presented paper discussed AODV routing protocol for Internet of Things. Here we improved the algorithm through optimizing the protocol, such as routing table and internet connecting table are combined into one and optimizing the energy consumption in AODV-IOT. Proposed AODV-IOT gives better performance in terms of Packet Delivery Ratio, Throughput, Average Delay and Consumed Energy.

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