Time-Lay and RSA Technique for Efficient Data Transmission in Internet of Things

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Abstract— *Internet of Things (IoT) is a network which is much vulnerable to security attacks due to its decentralized nature. It is a system that connects physical objects which can be accessed through the Internet. These physical objects have large capability to collect and transmit the data over the Internet. For gathering the data from different sources, clocks are needed to be synchronized and security must also be ensured in the network. The modified time lay technique is proposed in this paper which will synchronize the clocks of the IoT devices. The RSA algorithm is implemented which increase security of IoT. The simulation of modified time-lay technique is performed in NS2 and it is observed that the modified time-lay performs well in terms of energy consumption, throughput and delay.*

Keywords— IoT, Secure Channel, Time-lay, RSA.

I. INTRODUCTION

In the early 1960s a term "Internet" was invented, also known as network of networks. The main purpose of this network was to connect a wide variety of computers through the Internet and provide the data sharing amongst them. The major issue of sharing resources was resolved using the Internet and it also provided the effective results in the research area [1]. The Internet since then has emerged as a widely used technology and is the biggest source of communication through which large number of users can communicate and share their resources. It is coined as a major invention since then and its usage is beyond limits, since near and far communication is possible through this means. It has become a highway where the global world can get connected to each other and provide an effective means to the networking devices and distributing services [2]. In the modern world, size, complexity, and the role an Internet plays have exceeded the initial expectations. Many heterogeneous devices such as wired/ wireless, actuators, sensors and smart home appliances are required to get connected to each other. Various applications are used nowadays to create a smart world where different objects work together to create a context-based application or service. For the physical devices the ever-growing network is the Internet of Things (IoT) [3]. It is a technology that allows users to achieve deep analysis, integration and automation within the system. This technology provides its extension to those devices which require the Internet connectivity for their functions in the system. The embedded technology of Internet has been utilized by many devices in order to communicate with the external environment [4]. It becomes a major concern as well as an opportunity as there is an increase in the data volume and number of connections between various devices. When the IoT services are increased then the large number of devices are designed [5]. In the type of services, security is the major concern of the network. Many levels of configuration and application-level proprietary algorithms are required for the secure communication in IoT type systems. Due to this security, sometimes user dejects to implement this protection and sometimes provide priority to the functionality over security [6]. This technology is more prone to attacks and thefts due to the unavailability of secured links. Security within these systems is always a

major concern as there are numerous systems which are involved in the communication. Thus, the data involved within these systems is to be made secure. As compared to traditional networks, there is much vulnerability in this network like intrinsic characteristics of the IoT, integration of the IoT and the Internet. There are many adversaries that come in the path of IoT network in order to attack an IoT system. Hence, proper evaluation is necessary to overcome such issues in accordance with potential adversarial and information flows in order to avoid those attacks.

The clock synchronization is the real problem because of which it becomes difficult to implement the IoT in a real time system. The efficient communication in the network is done when devices are properly synchronized, which ensures end to end delivery of data without any delay in the network. There are few methods which can be used to get accurate clock synchronization. In Network Time Protocol (NTP) [7], with the use of GPS (Global Positioning System) a proper synchronized time can be attained. The biggest advantage of using NTP system is that it provides high level of accuracy and reliability in terms of clock synchronization. Precision Time Control (PTP) [7] is a protocol which is used to synchronize a clock throughout a computer network. On a local area network, it can achieve time and clock accuracy in a sub-microsecond range which makes it a good match for measurement and control systems [8]. It is basically designed for those applications which cannot afford a GPS tracker at each node.

The introduction of the Internet of things is presented in first section. The related work is presented in the second section which describes technique of clock synchronization and security. In the next section problem statement is highlighted which is resolved in this paper. The research methodology is discussed in the next section in which time-lay technique and RSA algorithm is described in detail. In the last section the result analysis is presented by using time-lay and RSA algorithm in IoT.

II. Literature Review

T. Inzerilli et al. [9] proposed a location-based approach with the help of which the wireless systems can handle the soft mobile-controlled vertical handover. There is a detailed analysis of the dual-model terminal that includes UMTS and IEEE 802.11 network interface cards. The goodput is optimized and the ping-pong effect is controlled within this novel approach. Depending upon the location of mobile node, the initiation of preliminary handover initiation phase is done. A goodput estimation phase that is provided by a transient of casting at the time of soft handovers is followed to perform handover. For attaining handover decisions, the utilization of location information is assessed as per the experimental results.

R. Giuliano et al. [10] focuses on the security aspects of IoT capillary networks. There are both unidirectional as well as bidirectional IP and non-IP devices present within the network. These all are present within the capillary networks and needed a secure access within them. The duration of the validity of the time window is assessed within this paper. Results are examined in terms of the time required for transmission within the realistic scenario along with the indication for setting time limit for the validity of the window. At the end, the benchmark analysis is provided for assessing the effectiveness of the proposed method in terms of security when various attacks were present in the scenario.

R. Giuliano et al. [11] presented as analysis which highlight various security guidelines of the IoT capillary network. The algorithm is proposed in this paper which provides security to uni-directional and bi-directional devices. The technique of NTP is implemented in this paper for the clock synchronization. The secure channel which is established using Diffie-Hellman to provide security will be renewed after certain amount of time. The effectiveness of proposed technique is assessed along with the analysis of security by providing the analysis of benchmark through the comparisons against existing techniques.

Iqbaljeet et al. [12] stated that Wireless Sensor Network has no central controller, due to which energy consumption is a major issue. By using Bully algorithm, greater probability of becoming Cluster Head is given to node with higher energy for better distribution of energy and more reliable message transmission. In this paper, author had used the diffusion based and time-lay technique to synchronize cluster head clock. As per the simulation results, it is analyzed that proposed algorithm increase efficiency of the network in terms of energy, packet loss and delay.

A. Tekeoglu et al. [13] proposed a testbed for examining the security and privacy of IoT devices. Here, layer 2 and layer 3 packets are captured within this testbed. The security and privacy related issues within various IoT devices are investigated. Various vulnerability related scans, identification of insecure protocol versions, firmware updates, and various other issues related to authentication and privacy are performed within the testbed. It is seen that the proposed system provides better performance in terms of security parameters like authenticity and privacy.

I. Nasr et al. [14] proposed a clock synchronization algorithm which is based on the non-coherent timing detection. The coherent timing detectors work on the Rayleigh fading channel technique for the clock synchronization in the IoT. The Rayleigh fading channel technique is very light weight due to which the complexity of the system reduced to greater extent. The proposed technique performs well than the NDA (Non Data Aided) coherent technique for clock synchronization in term of mean square error.

III. RESEARCH GAPS

On the basis of the Literature review done, we have come up with few inferences which would be useful for us in our work. The inferences drawn have been mentioned below:

1. The NTP protocol uses the GPS system for the clock synchronization and due to use of GPS system, the energy consumption is increased which reduces the network lifetime.
2. The NTP protocol is based on synchronizing clocks of IoT devices and use external control messages which increase routing overhead and delay in the network.
3. Time-lay technique is one of the clock synchronization technique used in WSN. In this all the nodes of the network set their clock according to the third party clock.
4. The time-lay technique does not use the external message or device for clock synchronization which reduces delay and routing overhead for clock synchronization.
5. The IoT is the decentralized network due to which mobile devices keep on joining the network and in this technique one of the nodes take initiative for the clock synchronization which is energy efficient approach.
6. It is analyzed that the Diffie- Hellman algorithm [15] is much vulnerable towards security attacks whereas, RSA algorithm is more secure and less number of security attacks are possible in this algorithm.

The internet of things has the decentralized architecture due which clock synchronization and security are the major issues.

In the previous research work, technique of NTP is used for the clock synchronization. The NTP technique use GPS system for the clock synchronization. Due to use of GPS, energy consumption of the network is quite high. The technique needs to be designed which consume least energy and synchronize clocks of the sensor nodes efficiently. In the previous research, Diffie- Hellman algorithm is used for the secure channel establishment and it is analyzed that Diffie-Hellman is much vulnerable [15] towards security attacks. The security technique is required in which less number of security attacks are possible.

IV. PROPOSED WORK

This work is based on clock synchronization and secure channel establishment for communication in IoT. For this, firstly we deploy the sensor network with finite sensor nodes. In WSN, time-lay technique is used to synchronize the clocks by taking base station as the initiator. Now to introduce the clock synchronization in IoT, we are taking cluster head as the initiator due to its decentralized and ever expanding nature. The sensor nodes in the network are clustered and cluster heads are selected in each cluster. The cluster head exchange their clocks with each other and calculate average time. The cluster heads will set their times according to calculated average time. The average time is also shared with the nodes which are in the cluster. This whole process leads to clock synchronization of the sensor nodes.

It works in two phases: The *level discovery phase*, followed by the *synchronization phase*. The pseudo code is explained as follow:

Level discovery phase: The level discovery phase is based on constrained flooding. The root node is assigned level 0; this node initiates this phase by broadcasting a level-discovery packet that contains the identity and the level of the sender. The immediate neighbors that receive this packet assign themselves a level that is one greater than the level in the packet received (i.e., level 1 in this case). After this step, these neighbors broadcast a new level-discovery packet with their own level. This process is continued until each node has a level.

Synchronization phase: Consider a message exchange between two nodes A and B. T1 and T4 represent the time measured by A's local clock. Similarly, T2 and T3 represent the time measured by B's local clock. We assume that A's level is greater than B's by one.

1. At time T1, A sends a synchronization-pulse message to B. The synchronization-pulse message contains the level number of A and the value of T1. Node B receives this packet at T2, where T2 = T1 + d and d represents the clock offset between the two nodes.
2. At time T3, B sends an acknowledgement packet to A. This packet contains the level number of B and the values of T1, T2, and T3. With this information, node A calculates the clock offset as follows:

   d= ((T2-T1) - (T4-T3)) / 2
3. Node A corrects its clock to synchronize with node B, based on the computed offset.

RSA Algorithm

An asymmetric encryption algorithm which was proposed in 1978 and was mostly accepted and implemented within the public applications, is known as the RSA algorithm. This type of algorithm can be utilized for both data encryption as well as digital signature.

1. The RSA algorithm uses the asymmetric cryptosystem which is more secured as compared to symmetric cryptosystems.
2. The algorithm is secure as it reduces the chances of the man-in-middle attack.

Pseudo code for Modified Time-lay technique

Cluster Head:

broadcast (Sync_start, level=0)

if receive (Sync_req) then

send (Sync_ack , T1, T2, T3)

Neighbour cluster nodes :

receive (Sync_start , level)

```
if ( level = null) then
{
level++;
wait a short random time ;
send ( Sync_req, level, T1) ;
receive(Sync_ack);
{
record ( T1, T2, T3, T4);
d = ( (T2 -T1) - (T4 -T3) ) / 2;
calculate (d, )
Sync( d, )
}
Broadcast(Sync_start,node=0)
If node(reciver Sync)
{Sensor node send(ping)
{
If(Node receive Ping)
{
 Send(Ack)
{
Wait for random time
{
Node record(d and d1)
{
IF(d1==d)
{
Node adjust its clock to d
{
Else
{
Reply with Ok message
}
```

V.USING THE TEMPLATE

After the text edit has been completed, the paper is ready

V. RESULTS & DISCUSSION

The Internet of things is different from the wireless sensor networks. Due to difference between architecture of WSN and IoT, routing protocols are different. In the wireless sensor networks LEACH is used as the routing protocol and in IoT RPL [5] is used as the routing protocol. In this work, the directed communication takes place in the network using RPL based AODV. The performance of proposed modified time-lay and RSA algorithm is compared with the existing scenario as mentioned in [11], in which NTP is used for clock synchronization and Diffie-Hellman for secure channel between IoT devices. The performance of proposed and existing work is also compared with the scenario where no clock synchronization and security algorithm is implemented. The work is implemented in

NS 2.35 simulator with parameters stated in Table 1, and results are analyzed in terms of delay, throughput and energy consumption.

Table 1: Simulation Parameters

Parameter	**Value**
No. of nodes	80
Topography Area	1500m ×1200m
Channel type	Wireless
Antenna Type	Omni-directional
Queue Type	Priority Queue
Queue Size	100 packets
Link Type	LL
MAC Layer	IEEE 802.11g
Routing Protocol	AODV
Transmission Range	140 m
Traffic Type	Constant Bit Rate (CBR)
Simulation Time	100 seconds
Simulation Tool	NS 2.35

In the implementation, the NTP and time-lay are the techniques for the clock synchronization. The techniques of NTP and time-lay are implemented on the data link layer. The technique of Diffie- Hellman and RSA are used to improve security of the network. The Diffie- Hellman and RSA techniques are implemented on the network layer. The technique which is proposed in this work is cross layer approach for the security and clock synchronization.

Following are the parameters used for evaluating the proposed work:

1. Energy Consumption: The energy is performance analysis parameter which measure energy consumption of the network. The energy consumption of the network is measure with the number of packets multiplied with per unit energy. The network is efficient when it has least energy consumption

Energy consumption= number of packets transmitted x per unit energy

2. Throughput: The amount of data being transmitted in a given period of time from one region to the other is calculated by throughput.

Throughput= (number of packets received / number of packets sent) × time

3. Delay: The delay is the parameter which count delay in the data transmission. It calculates the number of packets which are delayed.

In the graphs three scenarios are compared which are “without any” which shows the scenario in which no technique of clock synchronization and no technique of security is implemented in the network. In the “existing” scenario the NTP technique is implemented for the clock synchronization and technique of Diffie- Hellman is implemented for the security. In the “proposed”, technique of time-lay is implemented for the clock synchronization and RSA is used for the security.

It is observed from figure 1, that the time-lay offers a superior throughput rate than NTP and other case in which no technique is applied. It is noticed that the throughput mainly increases after 40 seconds because till that the base station floods the control messages in the network for topology discovery.

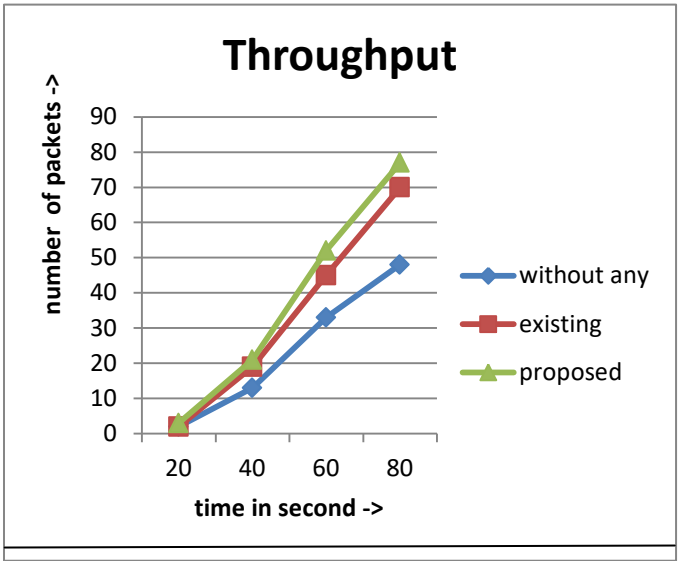

Figure 1: Throughput Comparison

GPS system uses Internet to synchronize the clocks, due to which energy consumption is more in NTP. Whereas in time-lay number of messages exchanged are more but even then the energy consumption is less due to which there is slight variation in their energy consumption graph lines as shown in figure 2. Whereas the energy consumption comparison graph for all the three cases is shown in figure 3.

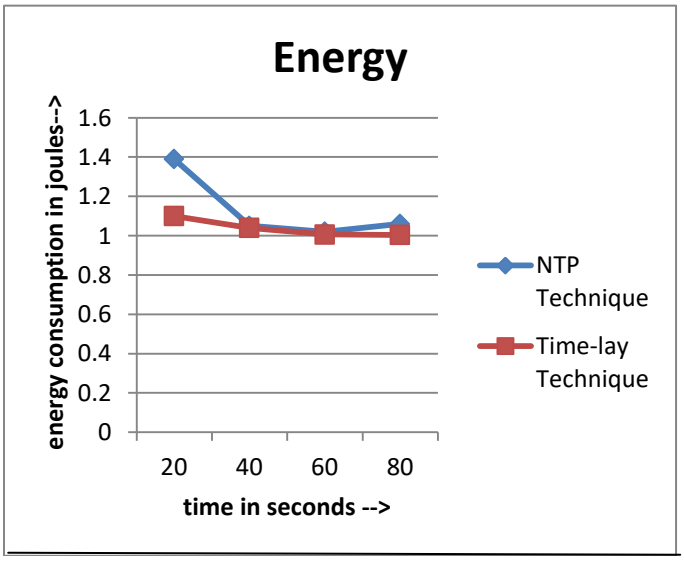

Figure 2: Energy Comparison between NTP and Time-lay

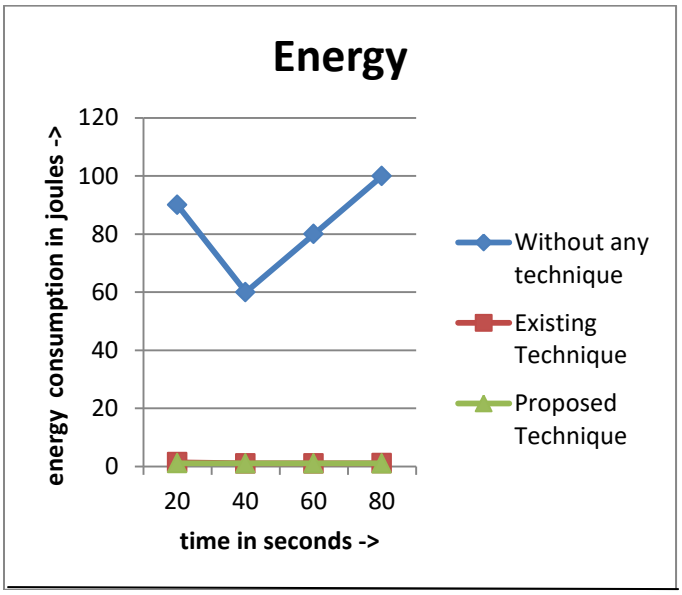

Figure 3: Energy Comparison

It is observed from figure 4, that the time-lay offers least delay than NTP and other case in which no technique is applied. It is noticed that the delay mainly decreases after 40 seconds because till that time, the base station floods the control messages in the network for topology discovery.

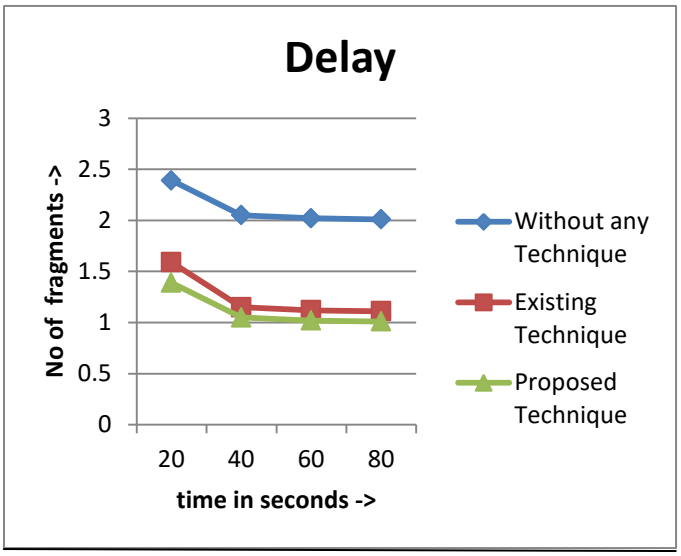

Figure 3: Delay Comparison

VI. CONCLUSION

In this paper, it has been concluded that Internet of Things is a type of network in which information which is accessed from the sensors are passed to the base station. To efficiently collect the data from the sensors, clocks of nodes are needed to be synchronized. In this work, a modified time-lay technique is applied which is used to synchronize the clocks of the devices. The RSA algorithm is used which can encrypt and decrypt the information which is transmitted over the channel. It is seen through the simulations that the modified time-lay technique performs well in terms of energy, delay and throughput.

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