Probabilistic Polling System Approach for IoT Secure Routing

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ABSTRACT

The Internet of things (IoT) affects on humans life deeply. There are traditional cyber threats and also new threats. There is no guard and immunity for systems against the innumerable variance of attack and exploitation. In this paper, an approach base on Polling System is presented for secure routing IoT devices. We use polling system with probabilistic routing, so there is a probability to move from one queue to another. Probabilistic polling system allows us to perform priority of stakeholders' votes.

Keywords- *Internet of Things; Secure Routing; Polling System*

I. Introduction

The Internet of things (IoT) affects on humans life deeply [9]. Although the new IoT functionality of smart devices causes to the better life for the human, there are traditional cyber threats and also new threats. However there were many works on the IoT security, most of them were not Use-Centric. In against of the previous works, the proposed approach is base on the interaction with users, so it is User-Centric completely. In a broad view, we divide IoT networks into two categories: 1- consumer and 2- industrial. While we use IoT devices in a smart home, we emphasize on the smart point of the IoT devices. In other words, the ideal point of IoT devices is communicated and adjusting to other physical devices in the home. While a set of smart home devices has a particular behavior or need for special decision making, we called them as user-centric IoT (UCIoT) [10].

There is no guard and immunity for systems against the innumerable variance of attack and exploitation. Thus security mechanism has fought to keep with IoT. Intelligence is successful to detect the intruder. IoT has the challenge to bridge physical with the cyber world [11]. Previous security mechanisms must be adapted in order to maintain defensive expectation.

In this paper, an approach base on Polling System is presented for secure routing IoT devices. In the classical view, Polling System is a set of one server and multiple queues. Clients are arrived and set into queues and then get server according to a particular policy. (figure 1)

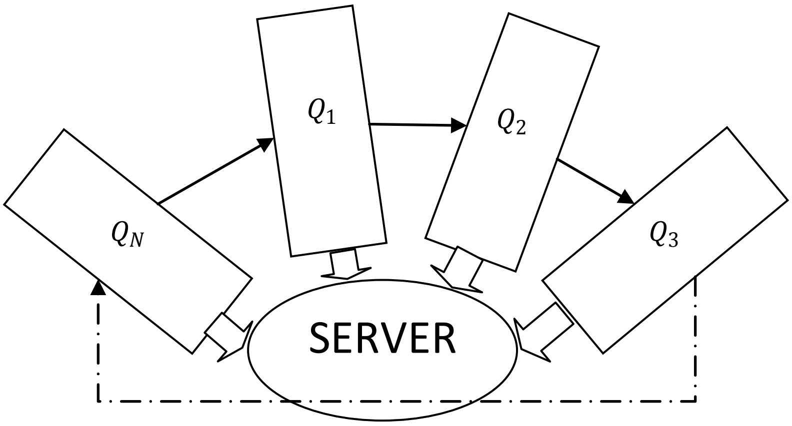

Fig. 1. Classical Polling System

The number of queues and also the capacity of queues are predefined. In the beginning, Polling System is used for the time-sharing computer system, but now it is used to model wide variety applications (computer communications, robotics, traffic and transportation, manufacturing, production, mail distribution, etc.) [12, 13, 14]. In the time-sharing polling system, there are N terminals that are connected to a central computer. The central computer visit terminals in turn and cyclic order. The size of queues is finite and the arrival process is independent Poisson Process with parameter λ_i.

Several service policies are examined on the basic model of Polling System such as exhaustive, gated, and limited-l policies. The server policy determines association server to clients. The basic Polling model can be applied in different applications: Token Ring Networks; Robotic Systems; Various Non-Generic Computers; Communication Systems. The common scheme for Polling System is a server resource shared by multiple queues. The basic model of Polling System is cyclic polling model. In the next step, the fixed polling order is replaced with random polling order. The important measure of the performance of Polling System is Response Time [15, 16]. In the Polling System with probabilistic routing, when the client in queue i is serviced, it is routed to queue j with probability$p_{i,j}$.

In this paper, we use polling system with probabilistic routing. Polling system provides a platform for security voting of all stakeholders. In the other side, probabilistic routing establishes priority approach. Therefore the presented approach can be used in the organization with employees by different priority.

This paper is organized as follow: section 2 is the study of related works; section 3 explains proposal algorithm, finally, section 4 is the conclusion.

II. Related Works

Akatyev et. Al. assume heterogeneous IoT devices. they use data flow diagram to represent the dependencies between users and information [1, 20]. In [2, 21, 22], In this survey, authors categorize IoT security issues into three groups: 1- low-level security issues; 2- intermediate-level security issues and high-level security issues and then study about security mechanism for each of them. Coulter et. al. research in current intrusion detection approaches from an intelligence perspective.

Levy et. al.define different types of polling systems [4, 23, 24]. Time-sharing polling system, there are N terminals that are connected to a central computer. The central computer visit terminals in turn and cyclic order. The size of queues is finite and the arrival process is independent Poisson Process with parameter λ_i. In [5], Authors use a $M/M/1$ queue to model the traffic of the network. Yang et. al. propose an approach to estimate the mean queue length, mean cycle time and throughout for two-class priority-based polling system. Tags energy conservation is the top priority in RFID systems.In a typical RFID, which has one or multiple readers and numerous tags, each tag (carrier identifier) is communicated directly to readers. Tags, base on battery consumption, are divided into two groups: 1- active and 2- passive. Passive tags do not have an internal battery and instead of it, they are used radio waves. While there are many warehouse products whit own tags, passive tags cause to interference and sophisticated communication. Active tags against passive tags have own battery-powered and can be used in mobile status. [7] presents an approach to design an efficient protocol for active tags. Cyber-Physical Systems (CPS) are set of different devices include computational, networked, communicational and sensor devices [8, 18, 19]. CPS can be used for monitor, control and in general wireless communication. CPS architecture has three layers: 1- Cyber layer, 2- physical layer and 3- Networking layer.

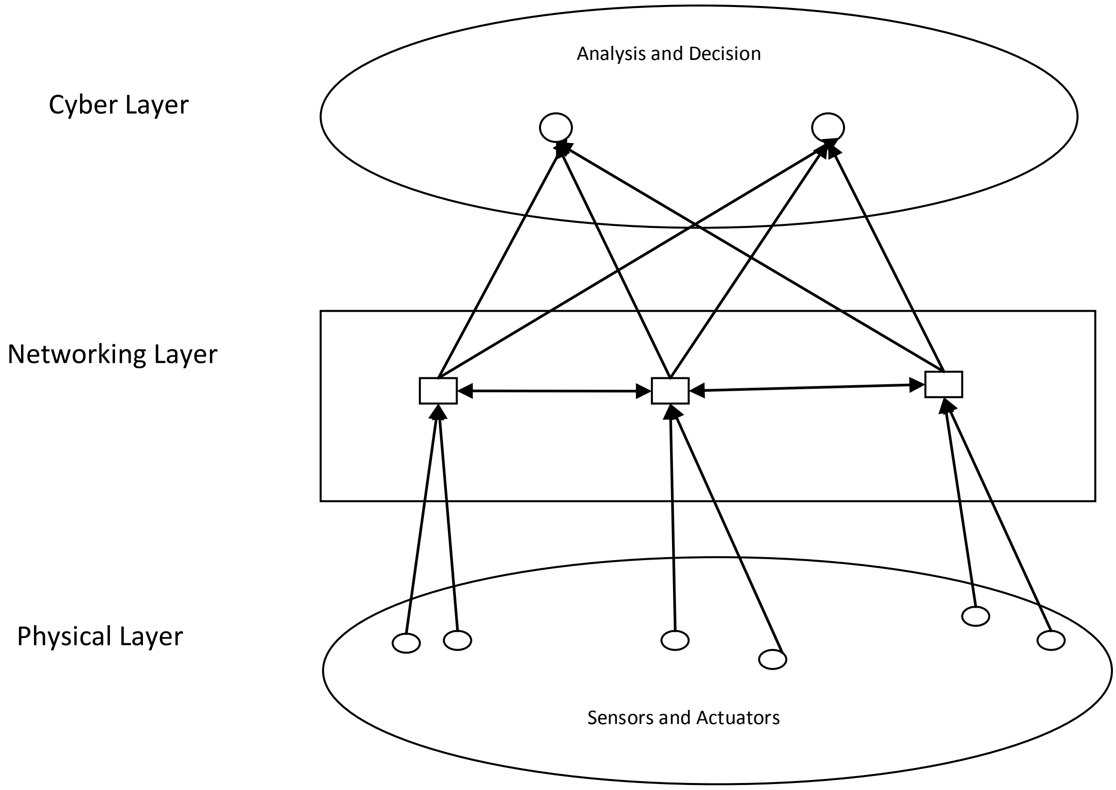

Fig. 2. Security Levels

Since inefficient utilization of bandwidth, deterministic Multi-Access Control (MAC) protocols are not adapted to the requirements of CPS. In a polling MAC protocol, request to transmit data packets are done base on the density of in polling list. Zheng et. al. design a polling MAC protocol to meet the requirements of CPS applications. In that protocol, authors use Orthogonal Frequency Division Multiplexing (OFDM), which is the contention of IEEE 802.11 [8, 16].

Previous works specified two points: 1-using polling system to gather different opinions and 2-apply priority in polling system to different users.

III. 3 Proposed Algorithm

The data packets need to route while they are transferred via the network. There are different parameters to select a suitable path. In the other side, there are different stakeholders that have opinions to transfer a data packet. In the simplest situation, there is SERVER on the one side and there is CLIENT on the other side. The most route approaches concern some special formulas. Although their approach is common and usable, the users' opinions are ignored. Proposed algorithm concerns users' opinions, indeed it considers the priority of stakeholders. Actually, all stakeholders do not have same expertise, so there must be a difference between stakeholders.

In this paper, users decide about a suitable path. The users take their opinions about the feasible paths (as votes) and then the suitable path is decided base on votes. In the proposed algorithm, there is a queue for voting users. Users can give their vote in this queue, and also their position can rise to the next queue according to the following probability:

$$p = a_n/(a_1 + \cdots + a_m)$$
(1

While $a_1 + \cdots + a_m$ are coefficients of queues and set as default. a means coefficient of nth queue. Coefficients are sorted ascend to descend, so the probability to raise positions of stakeholders reduces in each epoch of algorithm.

Above probability is used just when there is no pre-knowledge of stakeholders, but if there is pre-knowledge for priority of stakeholders, it can be applied without probability. When all stakeholders are assigned in queues, the final vote is calculated by adding votes in different queues multiply their coefficients.

Let assign coefficients as follow:

$$a = [8\ 6\ 5\ 4]$$
(2

There are 20 stakeholders in the system and four queues, so the probability of queues are as:

$$p_1 = 0.34, p_2 = 0.26, p_3 = 0.21\ p_4 = 0.21$$
(3

IV. 4 Conclusion

In this paper, an approach base on Polling System is presented for secure routing IoT devices. Polling System is used because one important parameter for secure routing is stakeholders' opinions. Since there is a difference between the positions of stakeholders, we use probabilistic polling system. In presented system, clients in queues are visited (voting policy) according to a probability. Actually, we can change the voting policy or set some clients as constant in some queues. There is need to pre-knowledge to set the constant position of clients, but there is an opportunity for this job in the paper.

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