CONTRIBUTION TO MODELING IOT

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ABSTRACT

This article is about a mathematical model based on the probability of IoT. The Internet of Things (IoT) is mainly concerned with the Internet. This technology makes it possible to connect the world to the world, a process that was not possible before. The availability as well as the access frequency of these physical objects are random vis-à-vis the Internet network. In this paper we try to model the access of these objects by following a random process and a model that will be compared to the number of objects wishing to connect to the internet. As is a model, our contribution is therefore limited in a small scale if it refers to the size of the internet. .

Keyword*:* *IoT, M2M, internet, poisson law*

1. INTRODUCTION

Over time, we have integrated the computer in different objects of our daily life. These objects can connect and communicate with each other. With this emergence of the network, Internet-related machines are designed to execute and then think, and today they learn to perceive, feel and react. It is in this context that we begin our research on the behavior of these objects vis-à-vis the Internet, known nowadays as "Internet of Things» (IoT).

Indeed, because of its applications, and especially the use of smartphones, the IoT has attracted a lot of attention in both academia and industry. In our research work, we want to make a contribution to model the access of these objects to the internet by proposing a formalization of all these objects.

2. IOT TECHNOLOGY

The IoT or the Internet of Things is a collection of connected objects and devices (on the Internet) and technologies (mostly networks and software) related to them, and by extension the universality of anything that can be connected via the Internet to receive and / or transmit data. The IoT is considered Web 3.0, or the spread of the Internet and its uses connected using the global networks technology.

The openness of the Internet and the accessibility of the network make it possible to connect a multitude of objects for a multitude of uses, allowing the whole to communicate. The ITU (International Telecommunication Union) says nothing else by defining the Internet of Things as "a global infrastructure for the information society, which allows for advanced services by interconnecting objects (physical or virtual) through existing or evolving interoperable information and communication technologies ".

Any object that can connect to an open network on the Internet is potentially a connected object. It is in its uses that it finds its utility, uses defined by the embedded programs, the algorithms, or by remote solutions on servers (in the cloud) which receive information coming from the objects, sensors for example, the store, analyze, process, and optionally automate actions that are returned to the objects .

If the uses 'public' begin to be known, smartphone, watch or household equipment connected, home automation, e-health, it is especially in its industrial dimension that the IoT offers extraordinary potentialities, the simplest in the sensors and measurement, to the most complex, robotics, numerical controls, remote control, etc.

3. RANDOM EVENT

It is appropriate to represent a random experiment E, that is to say an experiment whose outcome is randomly submitted, by the set Ω of all the possible results for this experiment. This set is called universe ,space of possibilities or even state space . A possible result of the experiment E is classically noted φ.
A random event A linked to the experiment E is a subset of Ω which we can say from the experience if it is realized or not.

4. SIMULATION

First we do this simulation with packet tracer

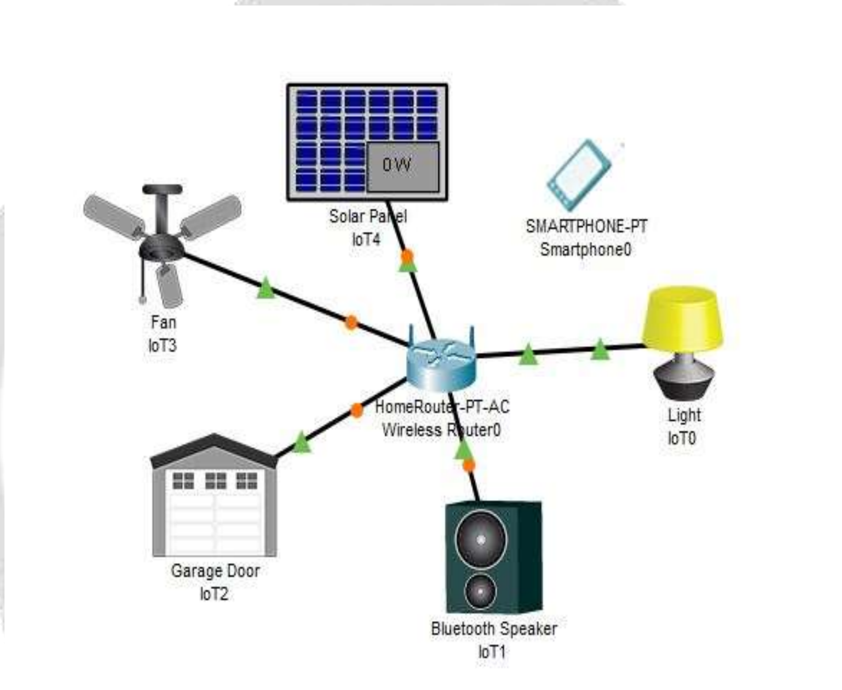


Fig -2: Simulation architecture

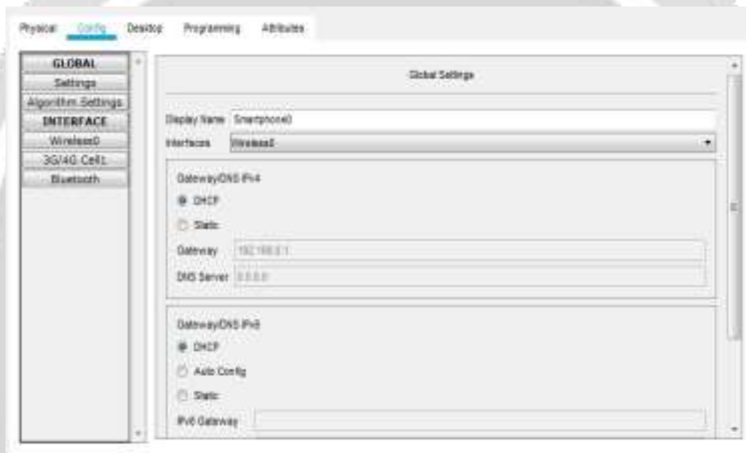
We connect an object on the internet and we look at the round-trip time of the packets

- for a connected object the round trip time is 3ms
- then we add another object and it becomes 13ms
- we add a third object it becomes 10ms
- we add a fourth object it becomes 9ms
- and at the end of the simulation we add a fifth object and the time to go back becomes 10ms

➢ The result of these simulations shows us that regardless of the number of objects, internet accessibility does not depend on numbers, but on the object itself.

what we presented at the top (formula)
thus the accessibility of an object to the internet is a random phenomenon where each object presents a probability to be defined in our case we limit our search on round-trip time, but by continuing our search we can define other test criteria as used other protocol (http, udp, ftp, ...) or varied the bandwidths of the internet.

4.1Configuration of IoT connected



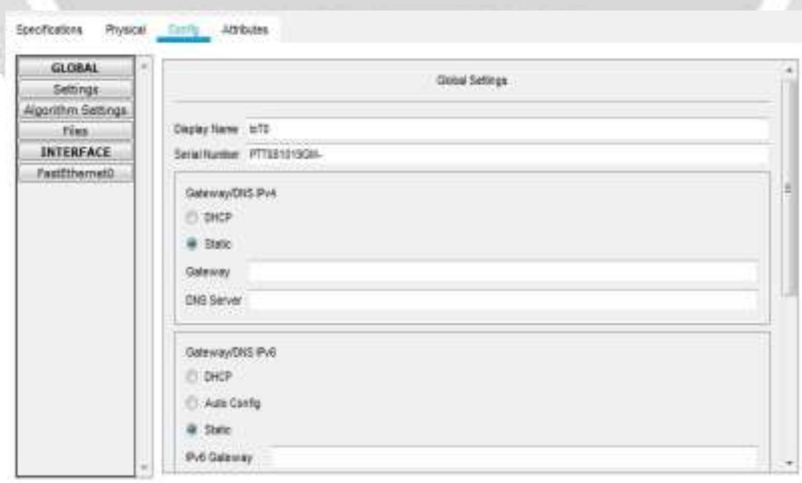


Fig -2: IoT configuration in packet tracer

4.1.1 Result

Table 1: Response time according to the number of IoT

Object IoT	Timeslot
1	18
2	12
3	11
4	7
5	6
6	6
7	4
8	4
9	4
10	3
20	3

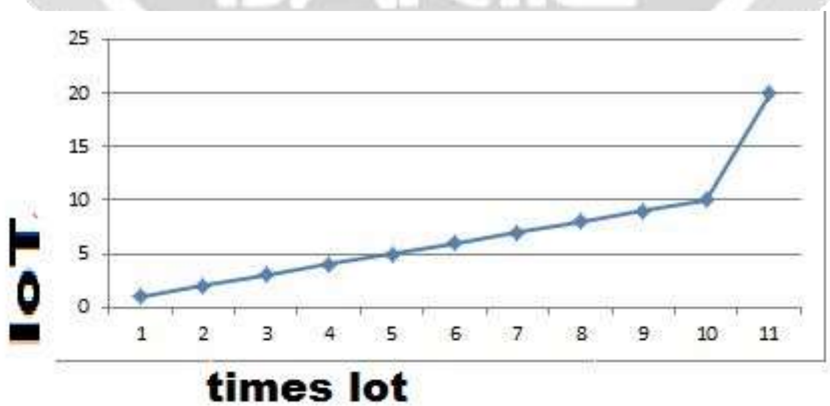


Fig -2: IoT configuration in packet tracer

From the figure above, we can see that the response time decreases with the number of IoT connected to the networks.

This is due to the effect of traffic congestion and network saturation,

Our simulation also shows us that whatever the open session on the internet (PC, tablet, smartphone, object, ...) the behavior of the internet remains the same, ie the bandwidth allocated to each terminal is based on the number of these connection.

Thus the behavior of IoT on the internet and the number of connected objects connection has as main parameter the width of the bandwidth.

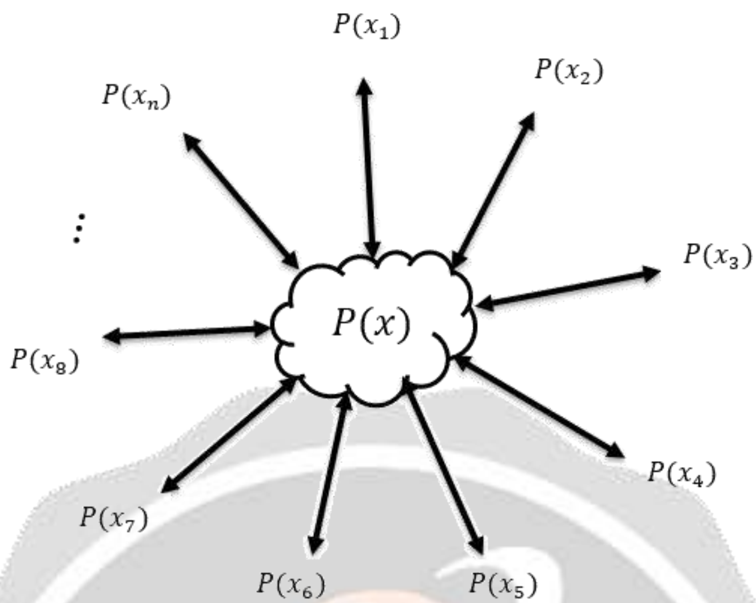
4.1.2 Mathematical modeling of IoT

- In our case the random events being sets $X = \{x_1, x_2, ..., x_n\}$, set of object accesses in the internet network. The access to the network is thus defined by the realization or not of the event.

The $x_1, x_2 \ldots x_n$ represents the objects that want connected to the internet

Fig -3: IoT architecture

From Fig-3 we can say that : $P(x) = f(P(x_1, \ldots . x_m))$



$$P(x_1) = \frac{1}{N}(x_1)$$

N = number of arrivals on the network

$$P(X) = \frac{1}{N}(x_1 + x_2 + \cdots + x_n) \qquad (1)$$

$x \in \mathbb{N}$

We can introduce a parameter in this random variable as the network throughput.

But the law of fish demonstrated below brings us back to apply it in our case as the accesses are accidental and unpredictable.

4.2 Poisson Law

The law of fish generally applies to accidental phenomena where the probability p is very low, or phenomena without memory (machine breakdowns, aircraft accidents, mistakes in a text, access to the internet, etc.). Under certain conditions, it can also be defined as the limit of a binomial distribution (especially when $n \geq 50$ and $np \leq 5$: Let $n \in N^*$, $k \in \{0, \ldots, n\}$ and $p \in [0, 1]$. Calculations with a binomial law quickly become complicated as soon as n is very big and p very small. We then look for an approximation P (X = k) by something more simple. The question is then: by putting $\lambda = np$ (constant), is the quantity $P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$ does it have a limit when $n \to \infty$

$$= \binom{n}{k} p^k (1-p)^{n-k} = \binom{n}{k}\left(\frac{\lambda}{n}\right)^k \left(1 - \frac{\lambda}{n}\right)^{n-k}$$
$$\binom{n}{k}\frac{\lambda^k}{n^k}\exp\left((n-k)\ln\left(1 - \frac{\lambda}{n}\right)\right)$$

$$= \frac{n(n-1)...(n(k-1))}{n^k} \frac{\lambda^k}{k!} \exp\left(-\frac{(n-k)\lambda}{n} + 0\left(\frac{1}{n}\right)\right)$$

$$= 1\Big(\underbrace{1-\frac{1}{n}}_{\xrightarrow[n\to\infty]{}1}\Big)\Big(\underbrace{1-\frac{2}{n}}_{\xrightarrow[n\to\infty]{}1}\Big)\cdots\Big(\underbrace{1-\frac{k-1}{n}}_{\xrightarrow[n\to\infty]{}1}\Big)\frac{\lambda^k}{k!}\exp\Big(\underbrace{-\frac{(n-k)\lambda}{n}}_{\xrightarrow[n\to\infty]{}-\lambda}+o\Big(\frac{1}{n}\Big)\Big). \quad (2)$$

By continuity of the exponential function, we deduce that:

$$= \frac{n(n-1)...(n(k-1))}{n^k} \frac{\lambda^k}{k!} \exp\left(-\frac{(n-k)\lambda}{n} + 0\left(\frac{1}{n}\right)\right) \quad (3)$$

In probability if the average number of occurrences in a fixed time interval is λ, then the probability that it exists exactly k occurrences (k being a natural whole , k = 0, 1, 2 ...) is

$$p(k) = P(X = k) = \frac{\lambda^k}{k!} e^{-\lambda}$$

or :

- e is the basis of the exponential (e ≈2.718) ;
- k! is the factorial of k ;
- λ is a real number strictly positive .

It is said that X follows the Poisson's law of parameter λ

If we take as parameter the flow we have :

$$P(x) = \frac{a^x}{x!} e^{-a} \quad (5\ )$$

a : is the flow

3.4 Proposed model

By deduction :

$$P(X) = \frac{a^X}{X!} e^{-a} \quad (6)$$

We can find the limit of access to the IoT :

$\lim_{X\to\mathbb{N}} P(X) = \lim_{X\to\mathbb{N}} \frac{1}{N} \sum_1^n (x_1 + x_2 + \cdots + x_n$ In reality $\mathbb{N} < \infty$ hence the limit $P(X)$ depends on the parameter a

$P(x)$ and the average

Access to the Internet by connected objects is a random event

Thus we can deduce that after this model, the determination of the different possible limits of access to the IOT in space and time can be projected, as well as the maximums of the objects that can access the network and the minimum required for the bandwidths.

5. CONCLUSIONS

Considering the limitations of the current transmission of Internet protocols for various device and traffic characteristics, we proposed a model that is scalable by changing the parameter " at "Which provides better access between the user application and the transport layer to manage network features throughout. Since the fundamental principle of IoT is the machine to machine architecture, the increase in the number of machines may inflate the flow. The introduction of new parameters such as distance or SNRs may affect the accuracy of our model. While offering a significant performance improvement the throughput of the application. The end goal is to offer a set of new features for the mobility of connected objects in an indefinite time.

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