ALOHA Protocol For Packet Data Transfer In Wireless Networks: A Survey

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Abstract- *ALOHA has long remained one of the most important protocols for data transfer in wireless networks or wireless sensor networks. One of the fundamental drawbacks that pure ALOHA faces is the large rate of collision among data packets and frame delays. The drawbacks are somewhat overcome in slotted LAOHA in which data is transferred after polling the channel. Although slotted ALHOHA finds a remedy for the problems faced by pure ALOHA, still the throughput and frame delay suffer at times of redundant transmission and frame delays. The present work proposes a mechanism for slotted ALOHA where non-persistent polling of the channel for lesser chances of packet collision. It also proposes a channel sensing mechanism and interleaving to avoid burst errors. Specifically, interleaving is beneficial to avoid information loss in case of burst errors in the channel.*

Keywords- ALOHA, Slotted ALOHA, Throughput, Interleaving, Burst Errors

I. INTRODUCTION

ALOHA, was a pioneering computer networking system developed at the University of Hawaii. ALOHAnet became operational in June, 1971, providing the first public demonstration of a wireless packet data network. ALOHA originally stood for Additive Links On-line Hawaii Area.[5]
The ALOHAnet used a new method of medium access (ALOHA random access) and experimental ultra high frequency (UHF) for its operation, since frequency assignments for communications to and from a computer were not available for commercial applications in the 1970s. But even before such frequencies were assigned there were two other media available for the application of an ALOHA channel – cables and satellites. In the 1970s ALOHA random access was employed in the nascent Ethernet cable based network and then in the Marisat (now Inmarsat) satellite network.

In the early 1980s frequencies for mobile networks became available, and in 1985 frequencies suitable for what became known as Wi-Fi were allocated in the US.These regulatory developments made it possible to use the ALOHA random-access techniques in both Wi-Fi and in mobile telephone networks.

ALOHA channels were used in a limited way in the 1980s in 1G mobile phones for signaling and control purposes.In the late 1980s, the European standardization group GSM who worked on the Pan-European Digital mobile communication system GSM greatly expanded the use of ALOHA channels for access to radio channels in mobile telephony. In addition SMS message texting was implemented in 2G mobile phones. In the early 2000s additional ALOHA channels were added to 2.5G and 3G mobile phones with the widespread introduction of GPRS, using a slotted-ALOHA random-access channel combined with a version of the Reservation ALOHA scheme first analyzed by a group at BBN

Aloha protocol was designed as part of a project at the University of Hawaii. It provided data transmission between computers on several of the Hawaiian Islands using radio transmissions.

Communications was typically between remote stations and a central sited named Menehune or vice versa.All messages to the Menehune were sent using the same frequency. When it received a message intact, the Menehune would broadcast an ack on a distinct outgoing frequency.The outgoing frequency was also used for messages from the central site to remote computers.All stations listened for message on this second frequency.

II. LITERATURE SURVEY

Claire Gousaud et al. explained and studied about Random Unslotted Time-Frequency ALOHA: Theory and Application to IoT UNB Networks. Internet of Things (IoT) is a new concept gaining more and more interest from researchers and industries. The objective is to provide connectivity to a very large number of heterogeneous devices such as RFID tags, actuators, and sensors. The collected data can then be exploited in several application areas, such as smart cities, home automation, industrial applications, among others. The main common feature between these devices is that, contrary to human-driven communications, object-driven communications usually require low transmission rates. Indeed these objects occasionally send and/or receive a small amount of data. The ALOHA protocol is regaining interest in the context of the Internet of Things (IoT), especially for Ultra Narrow Band (UNB) signals. In this case, the classical assumption of channelization is not verified anymore, modifying the ALOHA performances. Indeed, UNB signals suffer from a lack of precision on the actual transmission carrier frequency, leading to a behavior similar to a frequency unslotted random access.

In this paper, the success probability and throughput of ALOHA is generalized to further describe frequency-unslotted systems such as UNB. The main contribution of this paper is the derivation of a generalized expression of the throughput for the random time-frequency ALOHA systems. Besides, this study permits to highlight the duality of ALOHA in time and frequency domain. In this paper, is has been evaluated the extension of the ALOHA scheme to the case of time-frequency random access, as experienced for example with UNB transmissions in IoT networks. The authors have derived and validated the theoretical expression of the success probability for all the configurations (time slotted or unslotted, and frequency slotted or unslotted). They have exploited the theoretical expression to derive the throughput.

Enrico Paolini et al. explored the concept of Coded Slotted ALOHA: A Graph-Based Method for Uncoordinated Multiple Access . In this paper, a random access scheme is introduced, which relies on the combination of packet erasure correcting codes and successive interference cancellation (SIC). The scheme is named coded slotted ALOHA. A bipartite graph representation of the SIC process, resembling iterative decoding of generalized low-density parity-check codes over the erasure channel, is exploited to optimize the selection probabilities of the component erasure correcting codes through a density evolution analysis.

The capacity (in packets per slot) of the scheme is then analyzed in the context of the collision channel without feedback. Moreover, a capacity bound is developed, and component code distributions tightly approaching the bound are derived. In this paper, a coding approach relying on iterative interference subtraction for the collision channel without feedback has been proposed and analyzed. The scheme, dubbed CSA, can be seen as an extension of the IRSA scheme, where the extension consists of splitting packets into segments and encoding the segments via randomly picked local component codes.

A bridge between erasure decoding for graph-based codes and the iterative interference cancellation process of CSA has been established, allowing an elegant analysis of the access scheme performance. Exploiting this graphical representation, density evolution equations for CSA on the collision channel have been obtained and used to analyze the iterative interference subtraction process. The “capacity” of the CSA scheme without retransmissions has been defined and, in the process, it has been shown that the scheme is asymptotically reliable even if retransmissions are forbidden.

A throughput as high as 1[packets/slot] has been shown to be tightly approachable when sufficiently low coding rates are employed for the component codes. Furthermore, a technique to design CSA schemes with arbitrarily high coding rates has been developed which allows approaching the capacity bound over the whole range of rates. Numerical results have been presented to validate the proposed analytical framework.

F. V´azquez-Gallego et al. demonstrated the Performance Evaluation of Frame Slotted-ALOHA with Succesive Interference Cancellation in Machine-to-Machine Networks . Machine-to-Machine (M2M) area networks connect a gateway with a huge number of energy-constrained end-devices.

Therefore, energy efficiency is essential to prolong the lifetime ofM2M networks. In this paper, they consider an M2M area network composed of hundreds or thousands of end-devices that periodically transmit data upon request from a gateway. They have proposed a Medium Access Control (MAC) protocol based on Frame Slotted- ALOHA (FSA) with Successive Interference Cancellation (SIC), also referred to as SIC-FSA, for data collection applications. By means of comprehensive computer-based simulations, they have evaluated the delay and the energy consumed by the gateway and the end devices using SIC-FSA. They have compared the delay and energy performance provided by SIC-FSA with that of conventional FSA and diversity-FSA (D-FSA).Results show that SIC-FSA can reduce the delay and energy consumption of the gateway in more than 50%, and the energy consumed by an end-device in more than 10%, with respect to FSA in dense M2M networks equipped with radio-transceivers in compliance with the IEEE 802.11 physical layer.Results show that in SIC-FSA there is an optimal number of packet replicas and slots per frame, which minimize delay and energy consumption, and must be optimized as a function of the number of end-devices. The delay and the energy consumption increase exponentially when the number of replicas increases above its optimal value. In addition, similarly to FSA, the delay and the energy consumption using SIC-FSA increase linearly with the number of end-devices when we use the optimal number of replicas and slots. SICFSA provides delay reductions and energy savings of more than 50% in the energy consumption of the coordinator with respect to FSA, and of more than 10% in the energy consumed per end-device. Therefore, the use of SIC-FSA can improve considerably the energy efficiency of M2M networks when the number of devices is huge.

Cˇ edomirStefanovic´ et al. concentrate on ALOHA Random Access that Operates as a Rateless Code. Various applications of wireless Machine-to- Machine (M2M) communications have rekindled the research interest in random access protocols, suitable to support a large number of connected devices. Slotted ALOHA and its derivatives represent a simple solution for distributed random access in wireless networks. Recently, a framed version of slotted ALOHA gained renewed interest due to the incorporation of successive interference cancellation (SIC) in the scheme, which resulted in substantially higher throughputs. Based on similar principles and inspired by the rateless coding paradigm, a frameless approach for distributed random access in the slotted ALOHA framework is described in this paper. The proposed approach shares an operational analogy with rateless coding, expressed both through the user access strategy and the adaptive length of the contention period, with the objective to end the contention when the instantaneous throughput is maximized. The paper presents the related analysis, providing heuristic criteria for terminating the contention period and showing that very high throughputs can be achieved, even for a low number for contending users. The demonstrated results potentially have more direct practical implications compared to the approaches for coded random access that lead to high throughputs only asymptotically.

This paper has introduced the random access scheme termed frameless ALOHA, in which the contention period is adaptively terminated in order to maximize the throughput. Although based on rather simple principles, the proposed scheme provides considerably high throughputs, in fact the highest reported so far for low to moderate number of users.

CedomirStefanovi´c et al. studied the Frameless ALOHA Protocol for Wireless Networks. They propose a novel distributed random access scheme for wireless networks based on slotted ALOHA, motivated by the analogies between successive interference cancellation and iterative belief-propagation decoding on erasure channels. The proposed scheme assumes that each user independently accesses the wireless link in each slot with a predefined probability, resulting in a distribution of user transmissions over slots. The operation bears analogy with rateless codes, both in terms of probability distributions as well as to the fact that the ALOHA frame becomes fluid and adapted to the current contention process. The aim is to optimize the slot access probability in order to achieve rateless-like distributions, focusing both on the maximization of the resolution probability of user transmissions and the throughput of the scheme.

Gianluigi Liva et al. studied Graph-Based Analysis and Optimization of Contention Resolution Diversity Slotted ALOHA. Contention resolution diversity slotted ALOHA (CRDSA) is a simple but effective improvement of slotted ALOHA. CRDSA relies on MAC bursts repetition and on interference cancellation (IC), achieving a peak throughput $T\simeq$ 0.55, whereas for slotted ALOHA $T\simeq$ 0.37. In this paper they show that the IC process of CRDSA can be conveniently described by a bipartite graph, establishing a bridge between the IC process and the iterative erasure decoding of graph-based codes. Exploiting this analogy, we show how a high throughput can be achieved by selecting variable burst repetition rates according to given probability distributions, leading to irregular graphs. A framework for the probability distribution optimization is provided. Based on that, we propose a novel scheme, named irregular repetition slotted ALOHA, that can achieve a throughput $T\simeq$ 0.97 for large frames and near to $T\simeq$ 0.8 in practical implementations, resulting in a gain of $\sim$ 45% w.r.t. CRDSA. An analysis of the normalized efficiency is introduced, allowing performance comparisons under the constraint of equal average transmission power. Simulation results, including an IC mechanism described in the paper, substantiate the validity of the analysis and confirm the high efficiency of the proposed approach down to a signalto- noise ratio as a low as $Eb/N0$ = 2 dB.

Jun-Bong Eom et al. proposed the concept of Accurate Tag Estimation for Dynamic Framed-Slotted ALOHA in RFID Systems. Dynamic Framed-Slotted ALOHA (DFSA) is one of the most popular algorithms to resolve tag collision in RFID systems. In DFSA, it is widely known that the optimal performance is achieved when the frame size is equal to the number of tags. So, a reader dynamically adjusts the next frame size according to the current number of tags. Thus it is important to estimate the number of tags accurately. In this paper, they propose a novel tag estimation method for DFSA. We compare the performance of the proposed method with those of other existing methods. And, simulation results show that our scheme improves the accuracy of tag estimation and the speed of tag identification.

In this paper, to achieve the optimal performance of DFSAmin RFID systems, we have proposed an efficient tag estimation method. The proposed method estimates the number of unread tags by multiplying the number of collided time slots by a well-defined factor, which is found by analysis based on the number of successful and collided time slots. When the number of tags is not given, which is usual in practice, it can achieve accurate estimation performance. The simulation results show that our scheme indeed improves the accuracy of tag estimation and consumes less time slots than others.

Radha Krishna Ganti et al. studied about Spatial and Temporal Correlation of the Interference in ALOHA Ad Hoc Networks. Interference is a main limiting factor of the performance of a wireless ad hoc network. The temporal and the spatial correlation of the interference makes the outages correlated temporally (important for retransmissions) and spatially correlated (important for routing). In this they quantify the temporal and spatial correlation of the interference in a wireless ad hoc network whose nodes are distributed as a Poisson point process on the plane when ALOHA is used as the multiple-access scheme. Interference is a main limiting factor of the performance of a wireless ad hoc network. The temporal and the spatial correlation of the interference makes the outages correlated temporally (important for retransmissions) and spatially correlated (important for routing). In this they have quantified the temporal and spatial correlation of the interference in a wireless ad hoc network whose nodes are distributed as a Poisson point process on the plane when ALOHA is used as the multiple-access scheme.

M. SarperGokturk et al. researched on Throughput Analysis of ALOHA with Cooperative Diversity. Cooperative transmissions emulate multi-antenna systems and can improve the quality of signal reception. In this paper, they proposed and analyzed a cross layer random acces scheme, C-ALOHA, that enables cooperative transmissions in the context of ALOHA system. Our analysis shows that over a fading channel C-ALOHA can improve the throughput by 30%, as compared to standard ALOHA protocol.

Mariam Kaynia et al. studied about unslotted ALOHA and CSMA are analyzed in spatially distributed wireless networks. Users/packets arrive randomly in space and time according to a Poisson process, and are thereby transmitted to their intended destinations using a fully-distributed MAC protocol (either ALOHA or CSMA). An SINR-based model is considered, and a packet transmission is successful if the received SINR is above a threshold value for the duration of the packet. Accurate bounds to the probability of outage, which is a function of the density of transmissions, are developed for both MAC protocols. These bounds are used to evaluate the performances of ALOHA and CSMA, and to gain insight into the design of general MAC protocols for ad hoc networks. Moreover, CSMA with receiver sensing is proposed to improve the performance of CSMA.

III. ALOHA

PURE ALOHA

Pure Aloha is an unslotted, fully-decentralized protocol. It is extremely simple and trivial to implement. The ground rule is - "when you want to talk, just talk!". So, a node which wants to transmits, will go ahead and send the packet on its broadcast channel, with no consideration whatsoever as to anybody else is transmitting or not.

The first version of the protocol (now called "Pure ALOHA", and the one implemented in ALOHAnet) was quite simple:

If you have data to send, send the data If, while you are transmitting data, you receive any data from another station, there has been a message collision. All transmitting stations will need to try resending "later".

Note that the first step implies that Pure ALOHA does not check whether the channel is busy before transmitting. Since collisions can occur and data may have to be sent again, ALOHA cannot use 100% of the capacity of the communications channel. How long a station waits until it transmits, and the likelihood a collision occurs are interrelated, and both affect how efficiently the channel can be used. This means that the concept of "transmit later" is a critical aspect: the quality of the backoff scheme chosen significantly influences the efficiency of the protocol, the ultimate channel capacity, and the predictability of its behavior.

One serious drawback here is that, you dont know whether what you are sending has been received properly or not (so as to say, "whether you've been heard and understood?"). To resolve this, in Pure Aloha, when one node finishes speaking, it expects an acknowledgement in a finite amount of time - otherwise it simply retransmits the data. This scheme works well in small networks where the load is not high. But in large, load intensive networks where many nodes may want to transmit at the same time, this scheme fails miserably. This led to the development of Slotted Aloha.

SLOTTED ALOHA

This is quite similar to Pure Aloha, differing only in the way transmissions take place. Instead of transmitting right at demand time, the sender waits for some time. This delay is specified as follows - the timeline is divided into equal slots and then it is required that transmission should take place only at slot boundaries. To be more precise, the slotted-Aloha makes the following assumptions:

All frames consist of exactly L bits.

Time is divided into slots of size L/R seconds (i.e., a slot equals the time to transmit one frame).

Nodes start to transmit frames only at the beginnings of slots.

The nodes are synchronized so that each node knows when the slots begin.

If two or more frames collide in a slot, then all the nodes detect the collision event before the slot ends.

An improvement to the original ALOHA protocol was "Slotted ALOHA", which introduced discrete timeslots and increased the maximum throughput. A station can start a transmission only at the beginning of a timeslot, and thus collisions are reduced. In this case, only transmission-attempts within 1 frame-time and not 2 consecutive frame-times need to be considered, since collisions can only occur during each timeslot. Thus, the probability of there being zero transmission-attempts by other stations in a single timeslot is:

〚PROB〛_SLOTTED=e^(-G)

The probability of a transmission requiring exactly k attempts is (k-1 collisions and 1 success):

〚PROB〛_SLOTTED k=e^(-G) (1-e^(-G))^(k-1)

The throughput is:

S_SLOTTED=Ge^(-G)

The maximum throughput is 1/e frames per frame-time (reached when G = 1), which is approximately 0.368 frames per frame-time, or 36.8%.

Slotted ALOHA is used in low-data-rate tactical satellite communications networks by military forces, in subscriber-based satellite communications networks, mobile telephony call setup, set-top box communications and in the contactless RFID technologies.

Internet Of Things

Internet of Things (IoT) is a new concept gaining more and more interest from researchers and industries. The objective is to provide connectivity to a very large number of heterogeneous devices such as RFID tags, actuators, and sensors. The collected data can then be exploited in several application areas, such as smart cities, home automation, industrial applications, among others. The main common feature between these devices is that, contrary to human-driven communications, object-driven communications usually require low transmission rates. Indeed these objects occasionally send and/or receive a small amount of data.

For the communication point of view, the main challenge is not the individual rate, but rather having a very low energy consumption. With contemporary transmission schemes such as LTE [3], the nodes' emission power can be reduced by using small cells, but this leads to a high number of base stations with small load, but high infrastructure costs. Another option is to consider other transmission schemes that provide sufficient coverage for limited emission power.

During the last decade, 4 dedicated transmission schemes have emerged for the uplink of such Low PowerWide Area Networks (LPWAN). They are based on new radio technologies: LoRa (Long Range), Weightless, RPMA (Random Phase Multiple Access) and UNB-based (Ultra Narrow Band). LoRa and RPMA use spread spectrum techniques, UNB occupies a very narrow band (typically 100 Hz), while Weigthless proposes either UNB or spread spectrum techniques depending on the targeted application.

The main advantage of UNB transmissions is that it does not rely on access protocols to handle multiple access , while limited signaling is an important issue for IoT networks . Indeed, the hand-shake protocol overheads Internet of Things (IoT) is a new concept gaining moreand more interest from researchers and industries.

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Carrier Sense Multiple Access Protocols

In both slotted and pure ALOHA, a node's decision to transmit is made independently of the activity of the other nodes attached to the broadcast channel. In particular, a node neither pays attention to whether another node happens to be transmitting when it begins to transmit, nor stops transmitting if another node begins to interfere with its transmission. As humans, we have human protocols that allow allows us to not only behave with more civility, but also to decrease the amount of time spent "colliding" with each other in conversation and consequently increasing the amount of data we exchange in our conversations. Specifically, there are two important rules for polite human conversation:

Listen before speaking: If someone else is speaking, wait until they are done. In the networking world, this is termed carrier sensing - a node listens to the channel before transmitting. If a frame from another node is currently being transmitted into the channel, a node then waits ("backs off") a random amount of time and then again senses the channel. If the channel is sensed to be idle, the node then begins frame transmission. Otherwise, the node waits another random amount of time and repeats this process.

If someone else begins talking at the same time, stop talking. In the networking world, this is termed collision detection - a transmitting node listens to the channel while it is transmitting. If it detects that another node is transmitting an interfering frame, it stops transmitting and uses some protocol to determine when it should next attempt to transmit.

It is evident that the end-to-end channel propagation delay of a broadcast channel - the time it takes for a signal to propagate from one of the the channel to another - will play a crucial role in determining its performance.

CSMA- Carrier Sense Multiple Access

This is the simplest version CSMA protocol as described above. It does not specify any collision detection or handling. So collisions might and WILL occur and clearly then, this is not a very good protocol for large, load intensive networks.

So, we need an improvement over CSMA - this led to the development of CSMA/CD.

CSMA/CD- CSMA with Collision Detection

In this protocol, while transmitting the data, the sender simultaneously tries to receive it. So, as soon as it detects a collission (it doesn't receive its own data) it stops transmitting. Thereafter, the node waits for some time interval before attempting to transmit again. Simply put, "listen while you talk". But, how long should one wait for the carrier to be freed? There are three schemes to handle this:

1-Persistent: In this scheme, transmission proceeds immediately if the carrier is idle. However, if the carrier is busy, then sender continues to sense the carrier until it becomes idle. The main problem here is that, if more than one transmitters are ready to send, a collision is GUARANTEED!!

Non-Persistent: In this scheme, the broadcast channel is not monitored continuously. The sender polls it at random time intervals and transmits whenever the carrier is idle. This decreases the probability of collisions. But, it is not efficient in a low load situation, where number of collisions are anyway small. The problems it entails are:

If back-off time is too long, the idle time of carrier is wasted in some sense

It may result in long access delays

p-Persistent: Even if a sender finds the carrier to be idle, it uses a probabilistic distribution to determine whether to transmit or not. Put simply, "toss a coin to decide". If the carrier is idle, then transmission takes place with a probability p and the sender waits with a probability 1-p. This scheme is a good trade off between the Non-persistent and 1-persistent schemes. So, for low load situations, p is high (example: 1-persistent); and for high load situations, p may be lower. Clearly, the value of p plays an important role in determining the performance of this protocol. Also the same p is likely to provide different performance at different loads.

CSMA/CD doesn't work in some wireless scenarios called "hidden node" problems. Consider a situation, where there are 3 nodes - A, B and C communicating with each other using a wireless protocol. Morover, B can communicate with both A and C, but A and C lie outside each other's range and hence can't communicate directly with each other.

Now, suppose both A and C want to communicate with B simultaneously. They both will sense the carrier to be idle and hence will begin transmission, and even if there is a collision, neither A nor C will ever detect it. B on the other hand will receive 2 packets at the same time and might not be able to understand either of them. To get around this problem, a better version called CSMA/CA was developed, specially for wireless applications.

Throughput Analysis in Different Network Configurations

Cooperative transmissions emulate multi-antenna systems and can improve the quality of signal reception. A cross layer random access scheme, C-ALOHA,that enables cooperative transmissions in the context of ALOHA system. Our analysis shows that over a fading channel C-ALOHA can improve the throughput by 30%, as compared to standard ALOHA protocol. In a wireless network, transmission errors occur either due to packet collisions or due to channel fading/noise. Recently in, a practical technique is presented for differentiating collisions and channel errors. In this work, we exploit the collision/error differentiation capability presented in and propose an ALOHA based random access scheme, Cooperative ALOHA (C-ALOHA), which enables cooperative transmissions in case of erroneous packet receptions to provide robustness to channel errors and improve the packet success probability. In C-ALOHA, initial transmission of a packet is carried out as in the ALOHA system.

To express the throughput of the ALOHA random access scheme, it is often assumed that message transmission attempts occur according to a Poisson process with rate G attempts per slot. For channels in which a transmission is successful if and and only if in that slot only a single packet transmission is present, the throughput of successful messages is equal to

The probability of having just one message: $S = G \exp\{-G\}$,

or equivalently,

The attempted traffic G multiplied by the probability $\exp\{-G\}$ that no interfering message is present

Both arguments yield the well-known result for the throughput of slotted ALOHA:

$$S = G \exp\{-G\}$$

For unslotted ALOHA without capture, a test packet is destroyed by any overlapping transmission starting in the time window thatstarts one packet time before the transmission of the test packet andcloses at the end of the transmission of the test packet.

Hence, packets transmitted over an unslotted ALOHA channel see on average twice as many interfering packets as in slotted ALOHA. In fact

$$S = G \exp\{-2 G\}$$

Both unslotted and slotted ALOHA exhibit the typical behaviour thatat low traffic (small G), S is approximately equal to G at high traffic loads (large G), S decreases to zero. Almost all packets are lost in collisions.one throughput value S corresponds to two values of G. The curves misleading suggest that one G would be stable while the other is unstable. For systems without capture it turns out, however, that the ALOHA system with a fixed retransmission procedure, independent of the history of the network, is always unstable.

ALOHA in Mobile Radio Nets

In a radio channel, packets may be received successfully despite interference from competing terminals. This is called `receiver capture'. The larger the differences in received signal power, the more likely it is that one signal is sufficiently strong to capture the receiver

The throughput becomes G times the probability that a particular (a priori chosen) packet is sufficiently stronger than the sum of all interfering packets.

IV. CONCLUSION

It can be concluded from the previous discussions that ALOHA is an efficient protocol for packet data transfer in wireless networks. Slotted ALOHA is seen as a replacement for simple ALOHA. The main aim though in ALOHA based systems is the increase in throughput. For this, collision among data packets needs to be reduced. It is expected that this paper would pave a way for further research on throughput enhancement for ALOHA systems

REFRENCES

[1] Claire Goursaud and Yuqi Mo, “Random Unslotted Time-Frequency ALOHA: Theory and Application to IoT UNB Networks”, 2016 23rd International Conference on Telecommunications (ICT).

[2] Enrico Plaini, Gianluigi Liva Marco Chiani “Slotted Aloha:A Graph Based Method for UnCoordinated Multiple Access”, IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 61, NO. 12, DECEMBER 2015

[3] F. V´azquez-Gallego et al., “Performance Evaluation of Frame Slotted-ALOHA with Successive Interfrence Cancellation in Machine-to-Machine Networks”, European Wireless 2014.

[4] Cˇ edomirStefanovic´, Peter Popovski, “A Random Access that Opertates as a Rateless Code IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 61, NO. 11, NOVEMBER 2013.

[5] CedomirStefanovi´c, et al., Frameless ALOHA Protocol for Wireless Networks”, IEEE COMMUNICATIONS LETTERS, VOL. 16, NO. 12, DECEMBER 2012.

[6] Gianluigi Liva, “Graph Based Analysis and Optimization of Contention Resolution Diversity Slotted ALOHA”, IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. 59, NO. 2, FEBRUARY 2011.

[7] Jun-Bong Eom et al., “Accurate Tag Estimation for Dynamic Framed-Slotted ALOHA in RFID Systems, IEEE COMMUNICATIONS LETTERS, VOL. 14, NO. 1, JANUARY 2010.

[8] Radha Krishna Ganti et al., “Spatial and Temporal Correlation of the Interference in ALOHA Ad Hoc Networks”, IEEE COMMUNICATIONS LETTERS, VOL. 13, NO. 9, SEPTEMBER 2009.

[9] M. SarperGokturk, OzgurErcetin, OzgurGurbuz, “Throughput Analysis of ALOHA with Cooperative Diversity”, IEEE COMMUNICATIONS LETTERS, VOL. 12, NO. 6, JUNE 2008.

[10] Mariam Kaynia and Nihar Jindal, “Performance of ALOHA and CSMA in Spatially Distributed Wireless Networks”, in: IEEE 2008.

[11] N. Abramson "The Throughput of Packet Broadcasting Channels", IEEE Transactions on Communications, Vol 25 No 1, pp117–128, January 1977.

[12] R. Binder, ALOHAnet Protocols, ALOHA System Technical Report, College of Engineering, The University of Hawaii, September, 1974