THE INTERNATIONAL JOURNAL OF
SCIENCE & TECHNOLEDGE

An Efficient Achieving Optimal Throughput Utility and Low Delay with CSMA-Like Algorithms: A Virtual Multichannel Approach

G. Preetha Deva Kumari
M.E., Department of ECE,
Pavendar Bharathidasan College of Engineering and Technology, Tiruchirapalli, Tamil Nadu, India
S. Sumithra
HOD, Department of ECE,
Pavendar Bharathidasan College of Engineering and Technology, Tiruchirapalli, Tamil Nadu, India

Abstract:
A new CSMA-like algorithm, called Virtual-Multi-Channel CSMA (VMC-CSMA), is an algorithm that can provably achieve high throughput utility and low delay with low complexity. The key idea of VMC-CSMA to avoid the starvation problem is to use multiple virtual channels (which emulate a multichannel system) and compute a good set of feasible schedules simultaneously (without constantly switching / recomputing schedules). However Accuracy is very low in this network. While transmission of data the message may loss. Reliability is also comparatively low in this method. In order to save resources and energy, data must be aggregated. The objective of data aggregation is to eliminate redundant data transmission and to enhance the life time of energy in wireless network. Efficient clustering schemes are beneficial for data aggregation process. Thus, in this paper we propose new schemes for clustering with respect cluster head selection to attain energy efficiency and to extend the lifetime. To increase the privacy in the network HMAC algorithm is added. And we also process the Clustering concept to increase the efficiency of the network

Keywords: *Starvation problem, data aggregation, cluster head selection*

1. Introduction

CSMA algorithms suffer the starvation problem and incur large delay that may grow exponentially with the network size. The starvation problem occurs whenever the available capacity is divided into two schedules namely odd and even schedule. During the transmission of data to the any one of the scheduled nodes then nodes of another schedule will be starved. In order to develop a new algorithm that can provably achieve high throughput utility and low delay with low complexity new CSMA-like algorithm, called Virtual-MultiChannel CSMA(VMC-CSMA), is introduced that can dramatically reduce delay. The key idea of VMC-CSMA to avoid the starvation problem is to use multiple virtual channels which emulate a multichannel system and compute a good set of feasible schedules simultaneously without constantly switching/recomputing schedules. Under the protocol interference model and a single-hop utility-maximization setting,VMC-CSMA can approach arbitrarily close-to-optimal systemutility with both the number of virtual channels and the computation complexity increasing logarithmically with the network size. Furthermore, once VMC-CSMA converges to the steady state, we can show that under certain assumptions on the utility functions and the topology, both the expected packet delay and the tail distribution of the head-of-line (HOL) waiting time at each link can be bounded independently of the network size. Simulation results confirm that VMC-CSMA algorithms indeed achieve both high throughput utility and low delay with low-complexity

Through various observations, it is stated that localized algorithms are more scalable and robust than centralized algorithms. However Accuracy is very low in this network. While transmission of data the message may lose. Reliability is also comparatively low in this method. The lifetime of WSN is limited because each sensor node is tightly power-constrained and. Hence there is a need to develop or to design energy efficient protocols for prolonging lifetime of a network. Efficient arrangement of sensor nodes within clusters is beneficial in reducing energy consumption. Hence we can say clustering is an important technique to govern energy and topology as well as mobility and scalability of WSNs. There are clusters of sensor nodes in a clustered network. Every cluster has a cluster head (CH), cluster member nodes (CM). Considering various clustering structure, several energy-efficient routing protocols are designed. These clustering protocols smooth the load balancing and upturn the network lifetime.

For example, if the energy of a cluster head (CH) becomes to be despised, another node is selected as a CH considering some threshold. In such a way, nodes in the network play a part in communication and networking responsibility by being CHs at different times. Hence, clustering enhances the network lifetime.

A Hashed Message Authentication Code (HMAC) is a message authentication function for Internet communications described in RFC 2104 of the Network Working Group of the Internet Engineering Task Force (IETF). HMAC uses standard message digest functions, such as MD5 and SHA-1. In general, HMAC MD5 provides better performance for secure communications, while HMAC SHA-1 provides stronger cryptographic security. MAC is widely used by Internet security technologies, such as the TLS and IPSec protocols, to verify the integrity of transmitted data during secure communications. HMAC generates a message digest for each block of transmitted data and uses a random secret symmetric key to encrypt the message digests. The secret key is securely shared between the parties involved in the secure communications. When data is received, the secret key is necessary to decrypt the message digest and perform the data integrity check.

2. System Model

Consider a wireless network with nodes and links, Here each node represents communication device, and each link corresponds to a pair of transmitting node and receiving node. We assume the so-called protocol interference model, i.e., two links interfere with each other if they can not transmit data at the same time.1 Let be the set of links that interfere with link . We assume that the link interference relationship is bilateral, i.e., if , then . Two links and are
called neighbors if and interfere with each other. We consider a time-slotted system, where each slot has unit length. Assume that the wireless network has only one physical channel. The capacity of each link is assumed to be 1, i.e., each link can transmit at most one unit-sized packet in one time-slot. To represent a schedule, we will use an -dimension vector such that The basic idea of CSMA has been extended to more general interference models, e.g., those based on signal-to-interference-plus-noise ratio (SINR) although the algorithms there are likely to suffer similar starvation problem and large delay. Thus, we expect that the key insights of our work can also be extended to reduce delay under these more general interference models. Element is 1 if link is included in the schedule, and 0otherwise.Associated with each link is a one-hop flow, i.e., packets of the flow will immediately leave the network after it traverses the link. We assume that each flow is infinitely backlogged, i.e., at the transport layer it always has packets to send. Furthermore, Each flow at link has a utility function associated with it. If the long-term average rate of link is, then, represents the satisfactory level of the corresponding flow .We assume that each utility function is positive, non decreasing, strictly concave, and twice differentiable. Furthermore, we assume that it is bounded on the domain. Let denote the capacity region of the wireless network, which is given by the set of all rate vectors such that there exists a control policy that can support the long term average rate at each link .As we have, we are interested in both high throughput utility and low delay. For high throughput utility, we aim to solve the following optimization problem. Let be the optimal solution of problem. That problem is a cross-layer control problem because it involves two control mechanisms. First, the transport layer of the flow at each link does congestion control and determines how packets can be injected at the long-term average rate. Second, at the MAC layer, the system determines how to schedule the link transmissions to support the long-term average
rate at all links. Under infinite-backlog setting, the delay of a packet is defined as the difference between the time when the transport layer injects
the packet into the buffer and the time when this packet is served by the link. Although this definition seems to be a natural definition of delay, it unfortunately does not fully capture
the effect of the possible starvation problem . For example, consider a queue with a single buffer. A new packet is added to the buffer immediately after the old packet is served. Suppose that for every 1000 packets, it takes only one time-slot to serve each of the first 999 packets. However, the 1000th packet suffers
starvation for 1000 time-slots. In this case, the expected packet delay (average over all packets) is 1.99. Thus, the effect of the starvation problem is not obvious. Due to this reason, we introduce another notion of delay. Specifically, at each time-slot, we study the time that the HOL packet has waited in the system. In the above example, the expected HOL waiting time across time-slots would be around 250. Hence, the negative impact of the starvation problem is more obvious. In this paper, by "low delay," we mean that both the packet delay and the HOL waiting time should be small. Thus, the goal is to develop low-complexity and distributed algorithms that can provably achieve both high throughput utility and low delay.

3. Cluster Head Selection

3.1. Node Deployment

The Random node deployment algorithm is carried out in this method. The sub modules for the module 1 is Network formation, Region Division, Number of node calculation, Number of dead node calculation, Coverage area calculation, Probability calculations for regions.

B.Energy Model Calculations:

For a first order module, the overall energy for a transmitter to send a B-bit message over a distance d, energy is given by:

$$E_{Tx}(B,d)= B * E_{con} + B* \varepsilon_{sf} * d^2 \quad \text{if } d \le d_0 \qquad (1)$$

Where E_{con} is the energy consumed per bit to run the transmitter or the receiver circuit. ε_{sf} and ε_{pm} depend on the transmitter amplifier model, and d is the distance between the transmitter and the receiver. By equating the two expressions at d= d_0. To receive an B-bit message the radio expends $E_{Rx} = B * E_{con}$

Now, let there is an area A over which n nodes are evenly distributed. The sink is situated in the centre of the field, and that the distance of any node to the BS its cluster head is $\le d_0$. Therefore, the energy consumed by the cluster head node during a round is given by the following formula:

$E_{CH} = (n/k-1) * B * E_{con} + n/k * B * E_{process} + B *$
$E_{con} + B* \varepsilon_{sf} * d^2_{avgBS}$ (2)
Where k is the number of clusters, $E_{process}$ is the processing cost of a bit report to the BS, and d_{avgBS} is the average distance between a cluster head and the BS. The energy used in a non-cluster-head node is equal to:
$E_{CM}=B*E_{con}+B*\varepsilon_{sf}*d^2_{avgCH}$ (3)
Where d_{avgCH} is the average distance between a cluster member and its cluster head.Hence, total energy consumed in the network is equal to:
$E_{tcon}= B*(2n8* E_{con} + n* E_{process}(k* d^2_{avgBS} + n*$
$d^2_{avgCH}))$ (4)
If the distance of a significant percentage of nodes to the BS is greater than d_0 then:
$K_{optimum}= \sqrt{n/2\pi}\ \sqrt{\varepsilon sf/\varepsilon pm}\ *Area/d^2_{avgBS}$ (5)
Hence optimal probability of a node to become a cluster head, $P_{optimum}$, can be computed as follows:
$P_{optimum}=K_{optimum}/n$ (6)

3.2. Cluster Head selection

Most of the methodical results of prior research are gained assuming that the nodes of the sensor network are armed with the identical amount of energy. But this is not the case, thus in this paper, influence of heterogeneity in terms of node energy is introduced. Let develop a model for a WSN with nodes heterogeneous in types of nodes in the sensor field with unlike energy (node_type1, node_type2, node_type3). Let node_type1, node_type2 are having α and β times more energy than node_type3. And P_1 and P_2 are the percentage of node_type1 and node_type2 in the nodes set. Spontaneously, node_type1 and node_type2 have to become cluster heads more frequently than node_type3. Obviously new heterogeneous setting has improved the total initial energy of the network. Assume, IE_1 IE_2 and IE_3 are an initial energy of node_type1, node_type2, node_type3 resp. It can be given by:
$IE_1= IE_3(1+ \alpha)$
$IE_2= IE_3(1+ \beta)$
Therefore, the total initial energy of the new heterogeneous network is equal to:
$E_{tot} = n(l -P_1-P_2)IE_3 + n\ P_1IE_1 + n\ P_2IE_2$
Substituting values of IE_1 and IE_2 and assuming $Q = P_1 \alpha + P_2 \beta$ in above equation,
$E_{tot}=nIE_3(1+Q)$ (7)
Thus the equation for cluster head selection in heterogeneous network is given by:
$New=(1+Q)/P_{optimum}$
The steady region of the sensor network is improved by (l+Q) times. That is, (1) each node_type3 node becomes a cluster head once every (l+Q)/ $P_{optimum}$ rounds per CH; (2) each node_type1 node becomes a cluster head exactly (l+ α) times every (l+Q)/ $P_{optimum}$ rounds per CH; (3) each node_type2 node becomes a cluster head exactly (1 + β) times every (1 +Q)/ $P_{optimum}$ rounds per CH. Thus, the optimal selection percentage of every node is:
$P_{n1}= P_{optimum} / (l+Q) * (l+ \alpha)$
$P_{n2}= P_{optimum} / (l+Q) * (l+ \beta)$
$P_{n3}= P_{optimum} / (l+Q)$
Similarly each node type is having some talk time(T) with respect to every current round.
It can also be stated as threshold. So talk time can be given as,
$T(n) = P_{ch} / 1- P_{ch}(r \bmod 1/ P_{ch})$ if n=G
0 Otherwise (8)
Where, P_{ch} is the desired cluster-head probability, *r* is the number of the current round and *G* is the set of nodes that have not been cluster-heads in the last 1/ P_{ch} rounds

3.3. Cluster Setup

Every non-cluster-head node that is a cluster member (CM) defines to which cluster it belongs by selecting the cluster head with the maximum residual energy, and that needs the least communication energy, based on the received signal strength of the advertisement from each cluster head. Initially all cluster members compute the approximate distance d between the sender nodes and itself based on the received signal strength.
Now consider a assistant parameter C_{assis}. It can be calculated as:
$C_{assis} = \sigma * E_{residual} + (1 - \sigma) * (1 – Unitary (d)* 2/ \pi)$ (10)
where $E_{residual}$ is the residual energy of the cluster head candidate.

- Every node decides to which cluster it belongs by the maximum Cassis. Afterwards the node notifies the cluster head node that it will be a member of the cluster. Each node transmits an assist request message back to the elected cluster head. This The cluster heads deed as local control centers to assist the data transmissions in their cluster.
- The CH node establishes a TDMA schedule and transmits this schedule to the nodes in the cluster.
- This confirms that there are no collisions among data messages.

- The entire data transmission time is distributed equally into m TDMA slots. In each TDMA slot, No. 1, No.2, . . . ,No. (x+l) node will collect aggregate information and transmit data to Base Station sequentially.
- The approach of using the association of cluster head and subordinate CH nodes improves energy efficiency and lengthens the system lifetime.

Message is a little message, consisting of the node's ID and the cluster head's ID. Because the cluster head nodes consume their energy faster than other nodes, we must elect some subordinate cluster head (subordinate -CH) nodes to assist the cluster head's work.

In every round, every cluster head node broadcasts to other in its cluster, and these cluster member nodes will send back their confirmation message to the CH.The confirmation message contains the residual energy $E_{residual}$ of this CM node. Every cluster head node sorts downward by $E_{residual}$ and elects the top y stronger nodes as the subordinate -CH nodes. These subordinate -CH nodes assist the cluster head to collect, aggregate the information and allot tasks to other nodes. The flow is as follows:

- The cluster head node is numbered No. 1 CH node, other y stronger subordinate-CH are numbered No. 2, . . . , No.(x+ 1) nodes in incline order by $E_{residual}$.

4. HMAC Algorithm

Algorithm Description:

A Hashed Message Authentication Code (HMAC) is a message authentication function for Internet communications described in RFC 2104 of the Network Working Group of the Internet Engineering Task Force (IETF). HMAC uses standard message digest functions, such as MD5 and SHA-1. In general, HMAC MD5 provides better performance for secure communications, while HMAC SHA-1 provides stronger cryptographic security.HMAC is widely used by Internet security technologies, such as the TLS and IPSec protocols, to verify the integrity of transmitted data during secure communications. HMAC generates a message digest for each block of transmitted data and uses a random secret symmetric key to encrypt the message digests. The secret key is securely shared between the parties involved in the secure communications. (Secure secret key exchange is done with key exchange algorithms, which are described later in this chapter.) When data is received, the secret key is necessary to decrypt the message digest and perform the data integrity check.The cryptographic strength of the HMAC depends on the underlying strength of the message digest used and how securely the secret key is exchanged. An intruder does not know the secret key and cannot tamper with the data en route or counterfeit the message digest. HMAC provides data integrity and protection against tampering in a manner similar to digital signatures, but it does not require communicating parties to have public and private keys. HMACs also provide better performance for bulk online communications than public key digital signing technology.

5. Simulation Result

We evaluate the VMC-CSMA algorithm in two topologies with our Network simulator. Specifically, we simulate the improved scheduling algorithm and a random backoff-based decision-schedule algorithm discussed in Section. For both topologies, there is a one-hop flow associated with each link, and its utility function is given by .Furthermore, the simulation time is 15 000 slots. In Fig (1) the average delay is reduced in this method as compare with the proposed method. Though the no of connection has increased the use of cluster head selection can decrease the average delay in dramatical way. The objective of the paper is to reduce the Energy consumption with respect to simulation time. The use of clustering scheme and data aggragation causes the significant improvement in Energy saving. The reduction in energy consumption is shown in fig (2). the use of HMAC algorithm to provide security based on encryption will provide the considerable increase in Packet Delivery Ratio is shown in fig (3). The considerable reduction in loss will causes the better performance by increase the remaining energy which can be shown in fig (4).

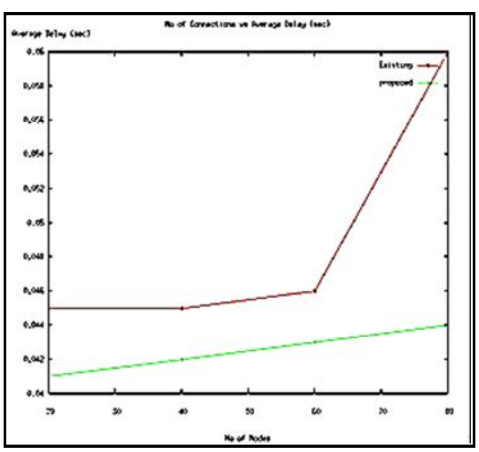

Figure 1: Average delay vs Number of connection

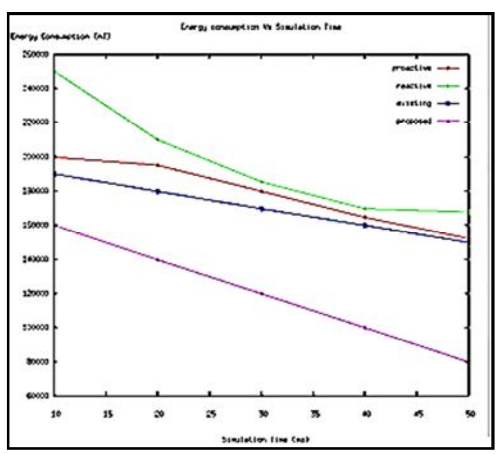

Figure 2: Energy consumption vs simulation time

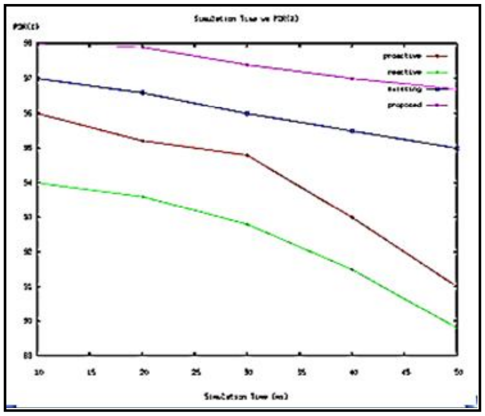

Figure 3: Packet delivery ratio vs simulation time

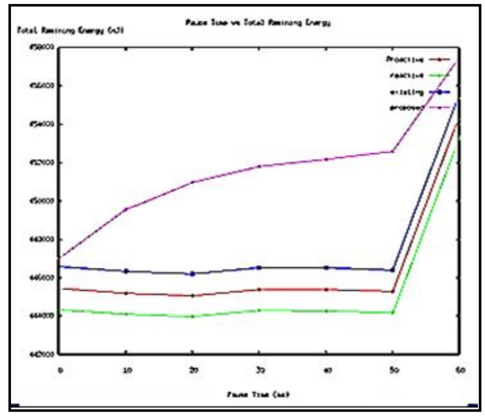

Figure 4: Remaining Energy Vs simulation time

The simulation results for a random network with 100 nodes and 100 links.

6. Conclusion

In WSN sensor nodes are deployed to sense the data but these sensor nodes have limited resourses and that is why WSN is a resource constraint network. In order to save resources and energy, data must be aggregated, and avoid amounts of traffic in the network. The objective of data aggregation is to eliminate redundant data transmission and to enhance the life time of energy in wireless sensor network. Efficient clustering schemes are beneficial for data aggregation process. Thus, in this paper we propose new schemes for clustering with respect cluster head selection to attain energy efficiency and to extend the lifetime of WSN. To further increase the energy efficiency in the network, introduce the protocols like LEACH, HEED, ASEEP, PEGASIS, APTEEN. By the use of these protocols the energy consumption of the network is reduced when we increase the quality of service parameters in the better way.

7. References

i. P.-K. Huang and X. Lin, "Improving the delay performance of CSMA algorithms: A virtual multi-channel approach," in Proc. IEEE IN- FOCOM, 2013, pp. 2598–2606.
ii. L. Tassiulas and A. Ephremides, "Stability properties of constrained queueing systems and scheduling policies for maximum throughput in multihop radio networks," IEEE Trans. Autom. Control, vol. 37, no. 12, pp. 1936–1948, Dec. 1992.
iii. X. Lin, N. B. Shroff, and R. Srikant, "A tutorial on cross-layer opti- mization in wireless networks," IEEE J. Sel. Areas Commun., vol. 24, no. 8, pp. 1452–1463, Aug. 2006.
iv. L. Georgiadis, M. J. Neely, and L. Tassiulas, "Resource allocation and cross-layer control in wireless networks," Found. TrendsNetw., vol. 1, no. 1, pp. 1–144, 2006.
v. L. Jiang and J. Walrand, "A distributed CSMA algorithm for throughput and utility maximization in wireless networks," IEEE/ACM Trans. Netw., vol. 18, no. 3, pp. 960–972, Jun. 2010.
vi. J. Ni, B. Tan, and R. Srikant, "Q-CSMA: Queue-length based CSMA/CA algorithms for achieving maximum throughput and low delay in wireless networks," IEEE/ACM Trans. Netw., vol. 20, no. 3, pp. 825–836, Jun. 2012.
vii. C.Borgs, J.T. Chayes, A. Frieze, J.H.Kim, P. Tetali, E.Vigoda, and V. H. Vu, "Torpid mixing of some Monte Carlo Markov chain algorithms in statistical physics," in Proc. IEEE FOCS, 1999, pp. 218–229.
viii. M. Lotfinezhad and P. Marbach, "Through put-optimal random access with order-optimal delay," in Proc. IEEE INFOCOM, 2011, pp. 2867–2875.
ix. D.Shah, D. N. Tse, and J. N. T sitsiklis, "Hardness of low delay network scheduling," IEEE Trans. Inf. Theory, vol. 57, no. 12, pp. 7810–7817, Dec. 2011.
x. S. Sarkar and S. Ray, "Arbitrary throughput versus complexity tradeoffs in wireless networks using graph partitioning," IEEE Trans. Autom. Control, vol. 53, no. 10, pp. 2307–2323, Oct. 2008.
xi. D. Shah and J. Shin, "Delay optimal queue-based CSMA," Perform. Eval. Rev., vol. 38, no. 1, pp. 373–374, 2010.
xii. L. Jiang, M. Leconte, J. Ni, R. Srikant, and J. Walrand, "Fast mixing of parallel Glauberdynamicsandlow-delay CSMAscheduling,"IEEE Trans. Inf. Theory, vol. 58, no. 10, pp. 6541–6555, Oct. 2012.
xiii. V. G. Subramanian and M. Alanyali, "Delay performance of CSMA in networks with bounded degree conflict graphs," in Proc. IEEE ISIT, 2011, pp. 2373–2377.
xiv. B. Li and A. Eryilmaz, "Optimal distributed scheduling under time- varying conditions: A fast-CSMA algorithm with applications," IEEE Trans. Wireless Commun.,vol. 12, no. 7, pp. 3278–3288, Jul. 2013.
xv. C.-H. Lee, D. Y. Eun, S.-Y. Yun, and Y. Yi, "From Glauber dynamics to metropolis algorithm: Smaller delay in optimal CSMA," in Proc. IEEE ISIT, 2012, pp. 2681–2685.
xvi. K.-K. Lam, C.-K. Chau, M. Chen, and S.-C. Liew, "Mixing time and temporal starvation of general CSMA networks with multiple frequency agility," in Proc. IEEE ISIT, 2012, pp. 2676–2680.
xvii. D. Xue and E. Ekici, "On reducing delay and temporal starvation of queue-length-based CSMA algorithms," in Proc. 50th Annu. Allerton Conf. Commun., Control, Comput., 2012, pp. 754–761.