GROUP BASED ALGORITHM TO MANAGE ACCESS TECHNIQUE IN THE VEHICULAR NETWORKING TO REDUCE PREAMBLE ID COLLISION AND IMPROVE RACH ALLOCATION IN ITS

[1]Ramprasad Subramanian, [2]Shouman Barua, [3]Sinh Cong Lam, [4]Pantha Ghosal, [5]Kumbesan Sandrasegaran

[1,2,3,4,5]Centre for Real-time Information Networks,
School of Computing and Communications, Faculty of Engineering and Information Technology, University of Technology Sydney, Sydney, Australia

ABSTRACT

Intelligent transportation system (ITS) is an application which provides intelligence to the transportation and traffic management systems. Although the word ITS applies to all systems in the transportation but as per the European union directive it is the application of Information and communication technology in the field of transportation is defined as ITS. The communication technology has evolved greatly today from 2G/3G to long term evolution (LTE). In this paper we focus on the LTE and its application in the ITS. Since LTE offers excellent QoS, wide area coverage and high availability it is a preferred choice for vehicle to infrastructure (V2I) service. At the same time the LTE customer base is increasing day by day which results in congestion and accessing the network to send or request resources becomes difficult. In this paper we have proposed a group based node selection algorithm to reduce the preamble ID collision otherwise this uncoordinated preamble ID transmission by vehicle node (VN) will eventually clog the network and there will be a massive congestion and re-transmissions attempts by VNs to obtain the random access channel (RACH).

KEYWORDS

Intelligent transportation system (ITS), Long term evolution (LTE), Mobile ad hoc network (MANET), Vehicle ad hoc network (VANET), Vehicle to infrastructure (V2I), Vehicle to vehicle (V2V), Random access channel (RACH).

1. INTRODUCTION

Intelligent transportation system (ITS) refers to the application of modern telecommunication technology in the control of the transportation system. The time spent by the people in the cars and in other transportation has increased [1] and many people prefer driving themselves in the long weekend rather than taking up the public transportation. So the modern ITS should encompass of automated highways, automated toll collection system, vehicle tracking system, intelligent transportation and logistics, in-vehicle GPS and mapping systems, automated enforcement of traffic lights and speed laws, smart control devices[2]. But the key to make the transportation systems intelligent is made possible with the application of telecommunication technology in the transportation domain. The word transportation systems became intelligent transportation system with the application of telecommunication technology. The long term goal of the ITS is to make the transportation system more and more autonomous with the help of the

DOI : 10.5121/ijwmn.2014.6501

telecommunication technology[2]. This long term goal also provides a huge challenge to the telecommunication technology to further grow in the areas of robust technology, high data rates, with adequate coverage etc. But this long term goal should be ably supported by lot of short term goals which can be realised with the current advancement in the telecommunications. These short term goals include making the roads more and more efficient and safer to travel by fulfilling the growth in the following areas:

a. Blind spot detection.
b. Collision avoidance.
c. Intelligent navigation using traffic light updates.
d. Intelligent traffic control using real time traffic information.

The medium term goals and opportunities leads to autonomous driving:

a. Provision of the telecommunication infrastructure support for the autonomous driving.
b. The telecommunication is the fulcrum of the autonomous driving and without that, achieving the autonomous driving in a large scale is not feasible.
c. Traffic control and navigation in a large dynamic environment is not feasible without the communication technology support.

The long term goals include:

a. In car office as indicated.
b. In car entertainment and many more.

Telecommunication is the key to make ITS happen and ITS provides tremendous opportunity for the growth in the telecom sector. There is a sort of serendipitical relationship exists between the telecommunication and ITS. For example in developing countries such as India where lot of people travel in their cars to reach the office because but the problem is heavy traffic congestion and as a result of this the quality man hours is wasted in the traffic and the productivity is affected. So in order to overcome this problem telecommunication can be effectively used to control the traffic and to provide all the latest infrastructure of the office environment inside the car as long term goal of the ITS. This will enable the people to start the work immediately once when they get into the car and the quality man hours can be fully utilized.

In the interaction between the ITS and telecommunications, the later should come up with the customized solution to meet the ITS requirement. At the same time the information delivered by the telecommunication systems to the ITS system must be handled properly and with some strategy. Otherwise, even with the information there will not be any improvement in the system.

2. COMMUNICATION NETWORK DESIGN FOR ITS

Several network designs and several protocols have been proposed by various researchers in the telecommunications over past few years to enable ITS and its application happen. But still there is no solution for all the needs. So an important question may arise at this juncture why we need so many forms of communication systems for the ITS[3]. The answer is simple to this question. The applications of ITS is not just in one area to provide one full proof system to cater the need[2],[3]. The applications of ITS are numerous so based on the intended applications the telecommunication systems can be remodelled. Likewise for vehicular networking there exists two methods of communication setup and they are vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). For the communication links between V2V numerous algorithms have been developed and specified by various researchers. Apart from this IEEE has standardised the

VANET with IEEE 802.11p1 standards which communicates between the vehicles[4],[5]. VANET is particularly designed for the short range communications between the vehicles. Since there is no infrastructure support for the VANET the communication range cannot be extended beyond certain limits. This technology offers a tremendous networking capacity between the vehicles but when it comes to long range communication needs then instead of VANET, LTE would be an appropriate choice. The focus of this paper is LTE in V2I.

The V2I architecture is the communication link between the vehicle and infrastructure. In this the vehicle can communicate with the content server located with the service provider's network to fetch the required information. For example if a person from country A is going to country B and happens to drive a car. The geography of the new place will be alien to him. So in order to reach the destination properly he or she can request the route information to the content server from the vehicle and the trip planner can guide him properly to reach the planned destination. This cannot be achieved by using V2V architecture and instead V2I will be useful. Apart from this if an accident happens in a bridge the message of the accident has to be informed to the intended users of the bridge and propose an alternative route to them in order to control the traffic jams because of the accident so that the commuters can take the alternative route to reach the destination. This type of network controlled operations can be performed using V2I architecture and the same is not possible with V2V architecture.

V2I architecture can be effectively used by the emergency service providers for example in a situation where a person is travelling in a motorway and if somebody is experiencing an emergency and needs immediate attention or help, then the person can propagate the appropriate request message to the emergency handling centre. Not only in the emergency condition V2I is also very useful in lot of other circumstances like in a situation where a guidance is required from the expert, requesting information from the ITS service provider data base etc. There is some drawback in this V2I architecture apart from the advantages specified previously. In this architecture each time a person A propagates the information to person B even if person B is geographically located close to person A the information has to take a long route of going through the central server from the vehicle. So this will result in some delay for the information to reach the destination.

2.1. LTE for V2I architecture in ITS

LTE is a evolution of 3G UMTS. The main improvement of the LTE from its predecessors is the removal of base station controller (BSC) or radio network controller (RNC). The intelligence of the base stations in 2G and 3G is limited and they are mainly controlled by BSC and RNC. These controllers play a major role in radio resource management, call assignment procedure and control of base station nodes. Apart from this the controllers are controlled by circuit switched network (CS core). The 2G network has very minimum data capacity. The 3G system which got evolved from 2G offered a better data capacity compared to 2G. But the LTE/LTE-A which got evolved from 3G offers a excellent data rate capacity of 1Gbits/s in peak download and 500 Mbits/s in upload.

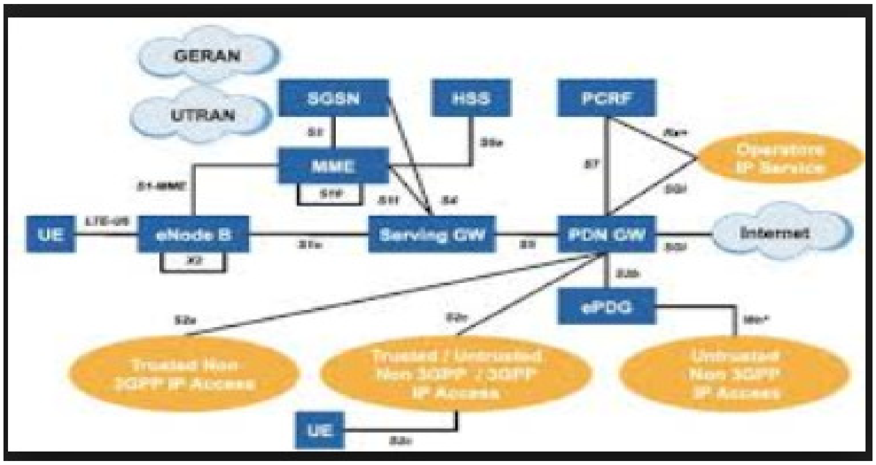

Figure 1. LTE architecture (Alcatel-lucent)

The network architecture of LTE doesn't have any similarities with 2G or 3G. In LTE there is no concept of BSC or RNC. The nodeB's (NB) from 3G got evolved into eNodeB (eNB). The eNB are connected to mobility management entity (MME). MME is an evolved packet core (EPC) element. The MME resides in the EPC control plane and manages mobility management activities like session states, authentication, paging, mobility with 2G and 3G nodes, roaming, and other bearer management functions. The EPC differs from the CS core and packet switched core (PS core) in many aspects. The EPC routes the packets through internet protocols (IP). It supports both IPv4 and IPv6. The EPC always maintains the IP connection between the mobile and the outside world by setting up a basic IP connection. This feature of LTE differs with 2G and 3G. The connections are made when it is requested and after the session is closed the connection to the outside world is disconnected.

The EPC behaves as a data pipe between the external world and to the mobile. It just transports the information to and from the external world to the mobile and vice versa. This operation of the EPC is similar to that of the normal internet connection. EPC does not care about the content of the packets. It just transmits all the information inside the pipe. In EPC the voice application is not the part of the system. It is handled separately by IP multimedia system (IMS). This operation of EPC varies with the traditional telecommunication networks in which voice forms an integral part of the network. The EPC simply transports the packets which contains voice packets similar to other data packets. The EPC has the mechanism to control and specify the data rate, error rate and delay to travel across the EPC. There is no timing requirement for the data packet to travel across the EPC in user plane but the specifications suggests that 10 milliseconds for the normal mobile and 50 milliseconds for the roaming mobile. The EPC should also support the handovers between the 2G and 3G systems.

The table below shows the different features and the associated network elements in LTE and UMTS and suggests the difference between them.

Table 1. UMTS and LTE network elements details

Feature	UMTS	LTE
Radio access network components	NodeB, RNC	eNB
RRC protocol states	CELL_DCH, CELL_FACH, CELLPCH, URA_PCH, RRC_IDLE	RRC_CONNECTED, RRC_IDLE
Handovers	Soft and hard handovers	Hard
Neighbour lists	Always required	Not required

The LTE/LTE-A is designed to handle 1Gbits/s in download and 500 Mbits/s in the upload. This tremendous capacity lured the ITS and its application to adopt this technology as the technology for backbone communication in V2I infrastructure service. The data rate capacity of LTE is attracting more and more people to migrate to LTE from other traditional technologies like 2G and 3G. As a result of this there is a huge increase in the customer base and in turn congestion in the network.

Many developed countries across the world are slowly introducing ITS and its applications in the traffic management. Apart from the government agencies the vehicle manufacturers like Toyota, BMW, GM etc are introducing lot of ITS features in the vehicles. Apart from supporting ITS the operators are introducing new features and they are supporting lot of machine to machine (M2M) services in order to increase the revenue to compensate for the increase in opex. As per the ETSI survey [6] around 50 billion machine to machine devices are expected to occupy the market in 2020. But this comes with the price of increased congestion in the random access channel (RACH). But in our paper we will restrict our discussion to the VNs. These VNs will be in the idle mode when they don't have anything to transmit and become to active mode when it is transmitting any information. To become active, the VNs have to request for RACH by sending a preamble ID. But as per the analysis as the number of VNs increase the collision percentage of the preamble ID also increases. So as a result the VNs will go for retransmissions and it will finally end up in clogging the network.

The data that has been presented in Figure 2 is the result of collection of RACH counters to analyse the RACH failures for past three months from an operator LTE network and in which more than a billion of RACH attempts where studied and from that RACH failure percentage has been calculated. The results below shows only the RACH failures in the network. From this below Figure 2 we can attribute that 30% of the RACH attempts in the networks is failing and only 70% of the RACH attempts are successful. Through this analysis we want to confirm that LTE network is already getting clogged up without much of the usages in the ITS applications or other M2M services as of today and the situation will get worse if we start supporting these service. At the same time a proper random access technique should be addressed to improve the situation as the current techniques has many shortcomings.

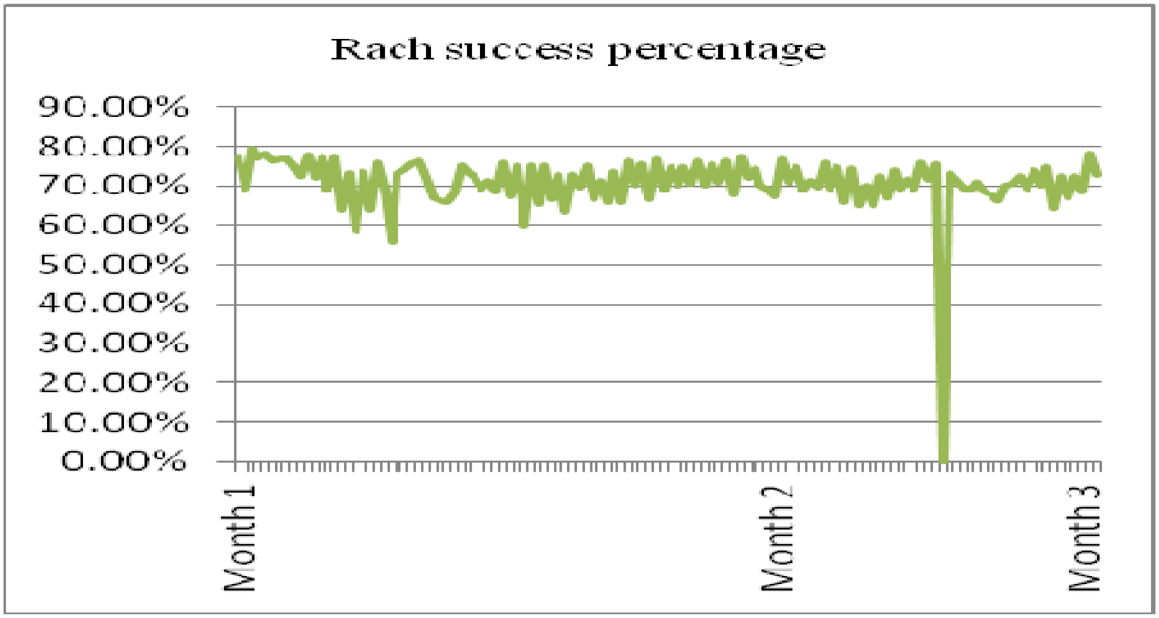

Figure 2. RACH KPI counter from live network

3. RELATED WORK

Many algorithms has been proposed earlier to overcome the RACH congestion. These algorithms can be classified as Delay focused, Non-hierarchical, success rate, non-hierarchical and energy based. [7] proposes cluster based approach to manage access control of massive kind. Jitter is considered as the main QoS criteria. In [8] proposes access management technique based on the events. This article proposes fast adaptive SALOHA scheme for this. [9] proposes collaborative access class barring approach. In this technique if M2M device service area covers more than one BSs, then access class barring scheme for the BSs will be modified based on the congestion of the BS. Radio access network (RAN) control method for synchronised M2M traffic is proposed in [10] because synchronized traffic is exerts more load in the network than asynchronous traffic. [11] proposed the random scheme based on the network congestion level access class barring scheme is implemented. Here M2M traffic is subdivided into five major classes and priorities are assigned accordingly. In [12] a new scheme has been proposed that does not have influence on H2H services. The M2M device remembers successful contention information to achieve contention free RACH. All this algorithms proposed are for static M2M devices. Even though vehicular nodes are classified among this M2M devices but they are highly dynamic nodes. Hence the proposed algorithms have limitations when it comes to the dynamic M2M devices. Hence a group based algorithm to manage access technique in vehicular networking to reduce preamble ID collision has been proposed.

4. PROPOSED ALGORITHM

As seen in the Figure 3 the vehicle devices will communicate with each other using IEEE 802.11 P1. Each device will try to behave as a group leader thinking that the LTE signal received by the VN is the strongest. The received signal strength of the network is constantly exchanged between the VNs using IEEE 802.11 p1 signal. During the exchange if one of the VN identifies that the received signal from the neighbour node is greater than that of the recipient node then the recipient node becomes a member of the group headed by the transmitter node. The node with highest signal strength (signal from LTE cell) becomes the group leader and other nodes who join the group becomes the group members. The groups created are amorphous in nature and the group leader can change swiftly due to the highly dynamic nature of the RF environment and also due to highly dynamic nature of the vehicles. If the leader is changed then the group collapses and new leader creates new group with his members. There is no limiting capacity to number of members who can join in a group. Since there is every chance that group leader will change soon the number of node limitations in the group is not required. The group leader monitors the weighted values of its members and if the weighted values falls below certain level the node will be released from the group by the group leader.

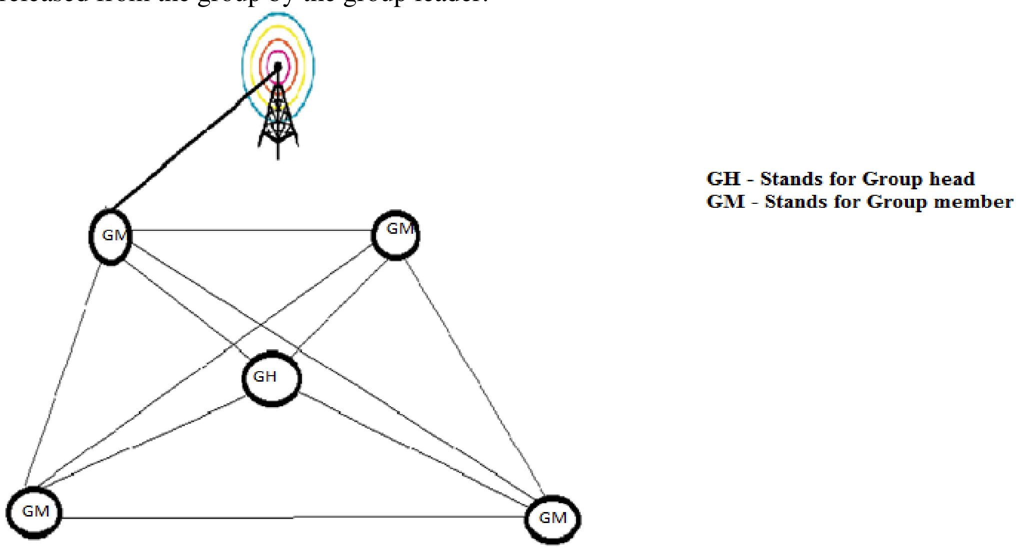

Figure 3. Schema of the proposed algorithm

Figure 4. Simulation of the grouping proposed in the algorithm

Apart from the signal strength, the other factors such as direction of arrival (DoA), position and the velocity of the group members are calculated and based on this weighted values are allocated for each group members and the member will be arranged in the descending order and will be allocated with a time slot to transmit the same preamble ID used by the group head earlier. Once the group head successfully transmits its preamble ID without any collision then same preamble ID will be used by the group members to as reach the eNB.

In our algorithm we assume that both the group members and the group leader are in motion and the data we receive from the members are not homogeneous. In an environment in which the fading characteristics are rapidly changing more instantly, estimating the correlation matrix is computationally intensive to user other DoA methods such as ESPRIT, MUSIC etc. So that's why the non-statistical or direct data domain (D3) technique known as Matrix Pencil algorithm to estimate the DoA of the signal has been chosen. In our Algorithm we assume that all the VNs are transmitting at the constant power level. So based on the received signal strength and based on the DoA of the signal the position estimation can be derived. But this is just an approximate position estimation and some tradeoffs can be allowed in this calculation. Since the position estimation carries less weightage as compared to signal strength from LTE cell and DoA. The exact coordinates of the vehicles obtained in vehicle navigation systems from GPS will not be used to maintain the privacy of the individual. The group leader will poll its members at a regular intervals and the difference in the position between the first poll and second poll will be used to calculate the velocity of the member. Each VN will transmit its LTE signal strength information to other VN and each node will be receiving this information from other nodes. The vehicle nodes uses triangulation technique to find out its position and this will be relative to geographic north. This self position info calculated by the node will be used if that node become the leader and form its own group.

The algorithm is represented in the form of a flow chart in the figure below.

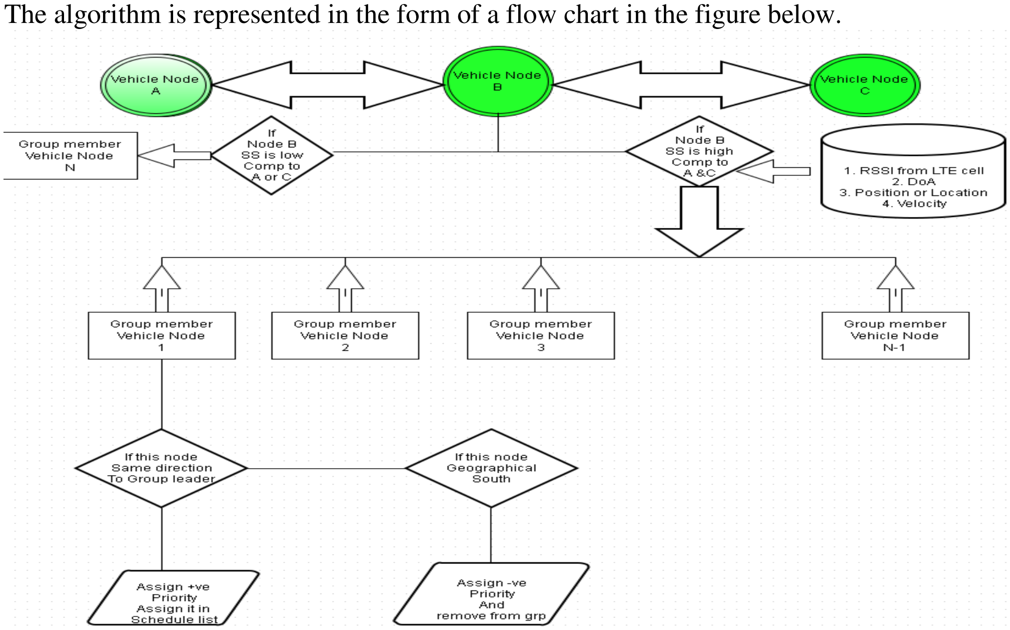

Figure 5. Flow chart of the proposed algorithm

4.1. Algorithm design

4.1.1. Calculation of directional of arrival using matrix pencil theorem

The algorithm like MLE, MUSIC and ESPRIT calculates the DoA based on the correlation matrix R. To construct a correlation matrix these algorithms consumes considerable amount of computational load because of the correlation and this makes it more complex to use the and especially in a environment which is highly dynamic. To estimate the correlation matrix we need at least K samples from the data x where $K > 2N$. The K samples of the data can obtained from the K snapshot from the target under the consideration. But with the prime assumption that all the K samples follow the same statistics i.e., the data is homogenous. In an environment in which the fading characteristics are rapidly changing and waiting for K samples of data and then calculating the matrix to estimate the DoA may not time consuming and computationally intensive. The proposed algorithm works in a highly dynamic environment and hence decided to choose matrix pencil theorem which works in the non-statistical way and computes the DoA with the data it receives unlike the other algorithms which waits for the K samples of data to estimate the DoA. Matrix Pencil was originally developed for the estimation of the poles of a system. However, it can be applied as well to DOA estimation. In the original Matrix Pencil the received data at time index n is given by

$$x_n = \sum_{m=1}^{M} A_m z_m^n + n_n \tag{1}$$

where $z_m = e^{j\, kd \cos \varphi_m \Delta t}$ represent the poles of the system, n_n represents the AWGN. The goal is to estimate z_m given x_n, $n = 0, \ldots N-1$.

To improve the position accuracy of the group members calculation we have assumed that VNs uses multiple antenna terminals. So in our case, the data is received at the group head terminals of N antenna elements from the group member, otherwise the formulation is exactly the same. Hence, the original Matrix Pencil algorithm is applicable to DoA estimation. The matrix Pencil algorithm which we have chosen here has many similarities to the other DoA estimation techniques such as ESPRIT, but without estimating a correlation matrix. We begin by defining two $(N-L)\times L$ matrices X_0 and X_1 as

$$\mathbf{X}_0 = \begin{bmatrix} x_0 & x_1 & \cdots & x_{L-1} \\ x_1 & x_2 & \cdots & x_L \\ \vdots & \vdots & \ddots & \vdots \\ x_{N-L-1} & x_{N-L} & \cdots & x_{N-2} \end{bmatrix}, \quad \mathbf{X}_1 = \begin{bmatrix} x_1 & x_2 & \cdots & x_L \\ x_2 & x_3 & \cdots & x_{L+1} \\ \vdots & \vdots & \ddots & \vdots \\ x_{N-L} & x_{N-L+1} & \cdots & x_{N-1} \end{bmatrix}, \tag{2}$$

where L is a pencil parameter that must satisfy

$$M \le L \le N - L \quad N \text{ even} \tag{3}$$

$$M \le L \le N - L + 1 \quad N \text{ odd.} \tag{4}$$

The basis of Matrix Pencil is that, based on the data model, we can write these matrices as

$$X_0 = Z_1 A Z_2, \qquad (5)$$

$$X_1 = Z_1 A \Phi Z_2, \qquad (6)$$

where Φ is the same as in ESPRIT, the diagonal matrix that we want to estimate. The four matrices are given by

$$\mathbf{Z}_1 = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ z_1 & z_2 & \cdots & z_M \\ \vdots & \vdots & \ddots & \vdots \\ z_1^{(N-L-1)} & z_2^{(N-L-1)} & \cdots & z_M^{(N\_L-1)} \end{bmatrix}_{(N-L)\times M}$$

$$\mathbf{Z}_2 = \begin{bmatrix} 1 & z_1 & \cdots & z_1^{L-1} \\ 1 & z_2 & \cdots & z_2^{L-1} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & z_M & \cdots & z_M^{L-1} \end{bmatrix}_{M\times L}$$

$$\mathbf{\Phi} = \begin{bmatrix} z_1 & 0 & \cdots & 0 \\ 0 & z_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & z_M \end{bmatrix}_{M\times M}$$

$$\mathbf{A} = \begin{bmatrix} \alpha_1 & 0 & \cdots & 0 \\ 0 & \alpha_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \alpha_M \end{bmatrix}_{M\times M}$$

Without noise, for the choice of pencil parameter L that satisfies the constrains in eqn. (4), the matrices X0 and X1 have rank M. Consider the matrix pencil $X_1 - \lambda X_0 = Z_1 A\,[\phi - \lambda I] Z_2$. For arbitrary λ, this matrix difference also has rank M. However, if λ is one of the z_m, i.e $\lambda = z_m$, for some $m \epsilon [1, M]$, the rank of the matrix differences reduces by one to M -1. This implies that we can find poles (z_m) as the generalized eigen values of the matrix pair $[X_{0,} X_1]$, i.e.,

$$X_1 q - \lambda X_0 q$$

Note that q, the generalized eigenvector, has no relationship to the eigen vectors of the correlation matrix. The M generalised eigen values of this matrix pair form the estimates of the z_m and the DoA may be obtained as

$$\phi_m = cos^{-1}[\frac{[\xi \ln(z_m)]}{kd}], m = 1, \ldots \ldots M \qquad (7)$$

The steps of Matrix pencil are therefore

1. Given N and M, choose L
2. Form matrices X and X
3. Find z_m as the generalized eigen values of the matrix pair $[X_{0,} X_1]$.
4. Find the DoA as specified as 10.

Note that finding the generalized eigenvalues of the matrix pair $[X_{0,} X_1]$ is equivalent to finding the eigenvalues of $[X_0^H X_0]^{-1} X_0^H X_1$.

Now after seeing the above theorem the similarities between matrix pencil and ESPRIT estimation techniques are clear. Both these algorithms estimates the diagonal matrix whose entries are poles of the system (what we call z_m). But apart from this similarlity, the major difference between this two techniques is that ESPRIT works with the signal subsplace as defined by the correlation matrix, but the matrix pencil works with the data directly. This represents a savings in terms of computation load.

The below Figure 6 shows the simulation analysis to estimate the accuracy of the DoA in the chosen matrix pencil theorem. The simulation was done using NS-3 simulator. In this DoA accuracy estimation simulation we have taken 5 snapshots and estimated in 7x7 correlation matrix. Since we have to locate only one signal effectively from the group member we have chosen the above criterion and the other signals which is emanated from the group member through multipath etc can be suppressed due to spreading gain. The assumption of 5 snapshot is adequate to estimate the signal subspace. In matrix pencil theorem the algorithm should have the knowledge about the data that is transmitted and also about the coherent detector. Since in our case the signal model is same and the type of the data which will be received will also be same and by this the signal to noise ratio is improved by averaging the received data. Another advantage of using the matrix pencil theorem is the computational loads are less and it is twice as fast as the other DoA estimation techniques.

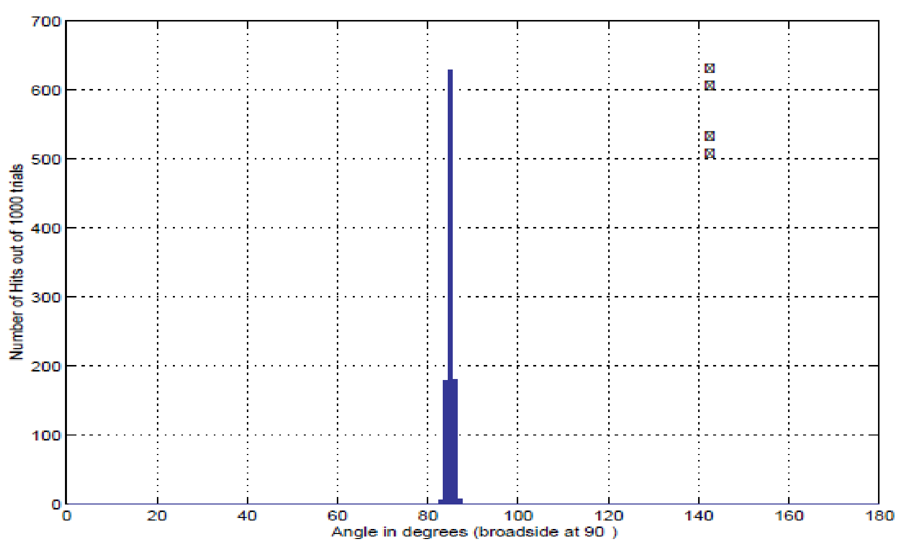

Figure 6. Accuracy estimation simulation for Matrix pencil theorem

4.1.2. Signal model and calculation of signal strength

For mathematical consideration we will assume that the signals experiences flat fading Assuming it as flat fading is a trade-off. Usually in the city condition the fading characteristics will change very quickly but at the same time we have to consider the ping pong effect in the city condition. As a result of this ping pong effect the group leader can change very fast and the group members also changes accordingly. So to incorporate this fast changing nature of group leader we would assume that the signals experiences flat fading. In an environment in which the fading characteristics are rapidly changing, this may not be valid. More importantly, estimating the correlation matrix is computationally intensive. So that's why we recommend to use Matrix pencil theorem to calculate the DoA. The signal model can be represented as below eqn (8).

$$X_i(t) = \sum_{k=1}^{dn-1} a(\theta_k) S_k(t - \tau_{ik}) + n_i(t) \quad (8)$$

$a(\theta_k)$ is the gain pattern of the receiver at the angle.

$n_i(t)$ is the additive noise.

d_{n-1} time delay that source k takes to travel from one mobile to another mobile.

τ_{ik} Is the number of mobiles transmitting signal to each other.

And the modulating signal can be represented as eqn (9)

$$S_k(t) = g_k(t)\cos(w_0 t + \infty_k(t)) \quad (9)$$

$$\mathbf{Z}_1 = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ z_1 & z_2 & \cdots & z_M \\ \vdots & \vdots & \ddots & \vdots \\ z_1^{(N-L-1)} & z_2^{(N-L-1)} & \cdots & z_M^{(N-L-1)} \end{bmatrix}_{(N-L)\times M}$$

g order. The group leader calculates
LTE cell. The calculation is based on
from the LTE as 100th percentile. All
based on this each VNs will perform
d. Whichever VNs has the highest
l on the below equation (10).

$$\mathbf{Z}_2 = \begin{bmatrix} 1 & z_1 & \cdots & z_1^{L-1} \\ 1 & z_2 & \cdots & z_2^{L-1} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & z_M & \cdots & z_M^{L-1} \end{bmatrix}_{M\times L}$$

$$P_{dbm} = \left(\frac{(N_m - M_{dbm})}{N_m}\right) X\ 100 \quad (10)$$

$$\mathbf{\Phi} = \begin{bmatrix} z_1 & 0 & \cdots & 0 \\ 0 & z_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & z_M \end{bmatrix}_{M\times M}$$

of the vehicle by the following

$$\mathbf{A} = \begin{bmatrix} \alpha_1 & 0 & \cdots & 0 \\ 0 & \alpha_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \alpha_M \end{bmatrix}_{M\times M}$$

$$\left[\frac{P_{pollIteration}(t) * \left(\frac{(N_M - M_{dbm})}{N_M}\right) X100 - D_M}{(d_1 - d_2)}\right] = V_M \quad (11)$$

$P_{pollIteration}(t)$ Denotes the number polling done the system at a constant interval of time.

N_M Denotes the total number of members present in the group

M_{dbm} Denotes the signal strength received by the member from the LTE cell

$d_1 - d_2$ Denotes the distance travelled by the member from point D1 to D2.

V_M Denotes the velocity in the member node travels

5. SIMULATION RESULTS

The below simulations shows the comparison between the collision percentage and re-transmission attempts for different number of subscribers before and after applying the proposed algorithm. The simulations was carried using NS-3 simulator[7]. The results shows that definitely there is a marked difference in the collision percentage and re-transmission attempts after applying the proposed algorithm. Figure 7 and 8 shows the simulations for preamble ID collision percentage and successful preamble ID throughout condition. Before applying the algorithm the collision percentage for 10 subscribers accessing the RACH resource at the same time in a cell is around 20% but after applying the group based algorithm the preamble ID collision percentage for 10 subscribers is almost 11%. The algorithm has improved situation by reducing almost 9% of preamble ID collision. The advantage of this algorithm is more visible when the number subscribers increases. When 200 subscribers are attempting for the RACH the same time the preamble ID collision is around 75% but for the same number of subscribers after implementing the algorithm is around 60% which is 15 % less. Simulations in Figure 9 and 10 shows between the max-retransmission attempts while the collision percentage increases before and after applying the algorithm. Before applying the algorithm for the collision percentage of 20% the re-transmission attempt is 3. But after applying the algorithm for the same collision percentage of 13 % the re-transmission attempt is 1. So this shows that the number of re-transmission attempts and the collision percentage of the preamble ID has improved the situation after applying the proposed algorithm.

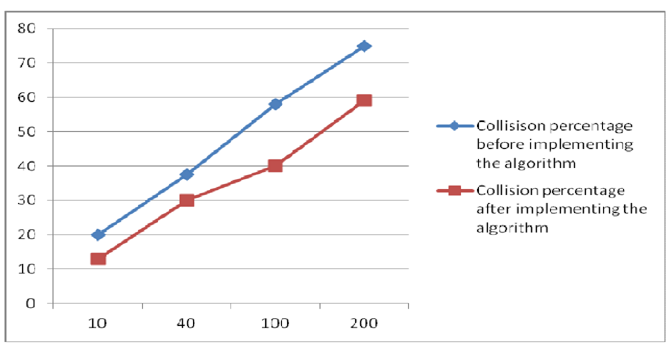

Figure 7. Preamble ID collision simulation results before and after applying algorithm

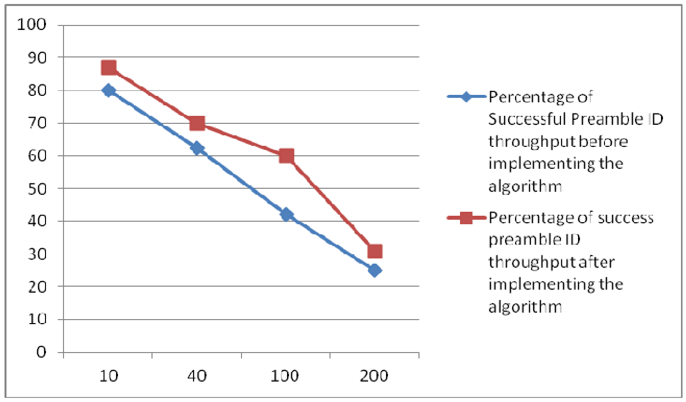

Figure 8. Preamble ID through before and after applying the algorithm

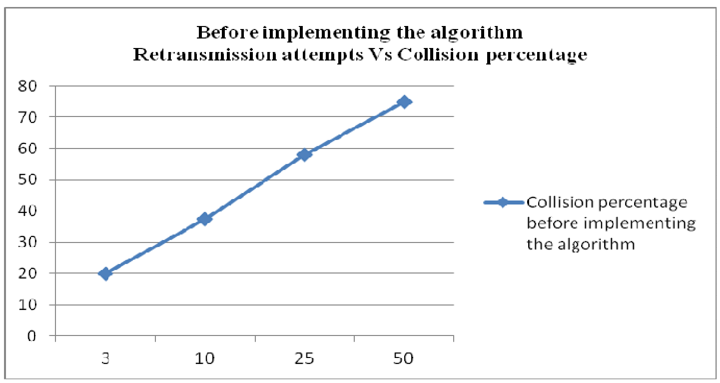

Figure 9. Retransmission attempts and collision percentage before applying the algorithm

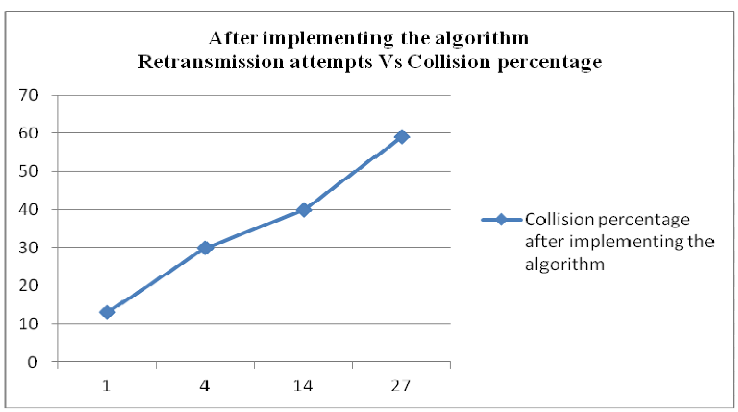

Figure 10. Retransmission attempts and collision percentage after applying the algorithm

6. CONCLUSION

The simulation is performed to analyze the preamble ID collision. During the contention based random access if VNs transmits same random preamble ID in different resource blocks there will not be any collision of preamble IDs but the collision occurs if VNs transmits the same preamble ID in the same resource blocks and this results in re-transmission of preamble ID automatically until the maximum re-transmission attempts is reached. As such the networks are busy because of the increasing customer base in LTE and as projected by ETSI many more machine to machine devices like smart meters, VNs, smart grids application devices etc are going to join the LTE bandwagon in the future. Hence an attempt has been made to improve the RACH congestion by the proposed algorithm and the results of the simulation of this algorithm is also encouraging in this regard. The strategy behind the proposed algorithm is to organise the access management mechanism of the machine to machine communication devices. Instead of allowing the VN devices to access the LTE base station at free will a group based access management techniques is introduced in the proposed algorithm. This not only organizes the access request sent by the VNs it will also avoid congestion in RACH and the impact of increasing VNs in the over H2H services can be reduced.

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