An Evolutionary Location Update Model in Mobile Cellular Communication Network Sample

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Abstract *— In the this scheme, we will propose a model, where we will use fixed time based scheme and an adaptive scheme using increasing velocity of the mobile node. Here the mobile station will continuously monitor the velocity, and threshold level of the velocity will be maintained here. And at the base station, there will be two schemes fixed time based and an adaptive scheme which is MN's velocity based. Now at the mobile station, when MN's velocity increases, then according to the MN's velocity, the schemes at the base station will be switched as described later. The near and far distance will be measured according to the near and far position from the location area boundary. We have shown the positive and negative direction of mobile node here. Fuzzification here helped to get the scheme with the higher probability of taking place. Then the simulation results show the reduction in the number of location update in the proposed model.*

Keywords— *Put your keywords here, keywords are separated by comma.*

I. INTRODUCTION

(Size 10 & Normal) A GSM network is the network made by the individual cells. Each cell has its own base station. Now, each base station covers a small geographical area. Then by integrating the coverage of some base stations, we can be able to get an area called the Location area (LA). It can be a much wider area.

In the following, there is a figure of the location area, which is used for the general purpose analysis (GPA). From the given figure, we can easily differentiate the location areas separated by the different borders. There lies the three different location areas and there we have also shown the cell area:

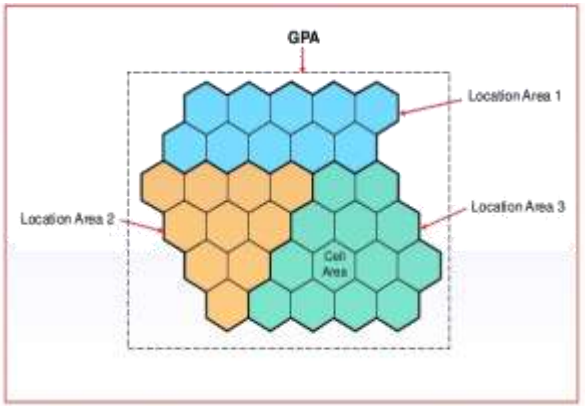


Fig.1 Location area and cell area[16]

When a mobile device moves from one location area to another location area, then it will inform the network about the new location area. While moving to a new location area, the mobile device will find a new location area code. When the device will find that the location area code is different from the previous location area code, then the device will send a location updation request to the network, with the previous location and the temporary mobile subscriber identity (TMSI).

The location update procedure is divided into two categories:

1. Static location update.
2. Dynamic location update.

1. Static location update:

A location update procedure is static, if there is a pre-determined set of cells in which the location update will be occurs by the mobile station, no matter about its mobility.

2. Dynamic location update scheme:

A location update scheme is dynamic in nature, if the location update can be generated by the mobile station depending on its mobility.

A comparison here is given bellow between the static and the dynamic location update scheme:

II.TABLE I

COMPARISON OF STATIC AND DYNAMIC:

Static	Dynamic
Offers a lower level of cost reduction, with the reduced computational complexity.	It adjusts the location updation frequency per user, and it can be able to achieve the better result. It will require the high computational overhead.

TYPES OF STATIC UPDATE SCHEMES:

Here the different type of static scheme is described:

Always update vs. never update:

The always update strategy is the simplest location update scheme, which performs the location update when the movement is done by the user to the new cell. Here, the network takes always the full idea about the location of the user. It requires no paging for the identification of the location of the user when an incoming call arrival is done. This scheme works good for the users which has low mobility, and its performance is not good for the users with higher mobility.

The users with high mobility require many location update and a large amount of use of the resource.

Now, the never update scheme is the logical counterpart to the always update scheme. It never requires that the mobile device will update its location with the network. This scheme has no location update overhead, but it may result excessive paging for the big network.

So, from the above two paragraph, we can say that, always update minimizes the paging cost and never update minimizes the location update cost.

Location area topology:

The location area topology is used to control the frequency of location updates. Network here will be partitioned into a group of cells, which turns into a Meta cell which is longer, or location areas. Location updation occurs, when they leave their location area in which they are currently situated.

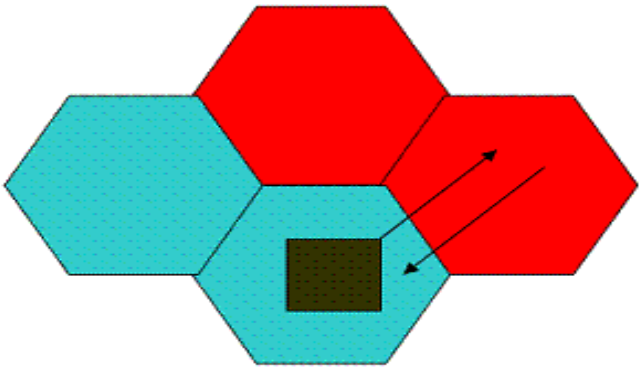


Fig.2 Ping pong effect

The above figure shows the partitioning of the network in the location areas. In this figure, we can discuss about an effect called ping pong effect. This effect is a big drawback of the location area scheme. Here, the user moves very frequently between the two location areas. It results a high location update rate with comparatively low mobility.

Now, to solve this problem, a number of proposals have been done, such as Two Location Area (TLA) and Three Location Area (TrLA) mechanism. This mechanism involves multiple location areas to a mobile device. Location update occurs when one of these Two or Three location areas have been covered.

Types of dynamic location update scheme:

1. Threshold based
2. Profile based

Threshold based:

In this method, mobile device maintains a particular parameter, and updates its location when the parameter increases beyond a certain threshold.

The most common threshold based schemes are:

a. Time based
b. Movement based
c. Distance based

a. Time based:

In the time based scheme, the user will maintain a certain time threshold ‘T’ and it updates its location after the expiration of this time threshold ‘T’.

b. Movement based:

In the movement based strategy, the location updation occurs after a certain no of boundary crossing to the other cell in the network. Here a boundary crossing threshold will be maintained.

c. Distance based:

In the Distance based scheme, a certain distance is maintained here as a threshold, and the mobile device updates its location when it crosses this certain distance maintained as a threshold.

Profile based approach:

Under this scheme, based on the information about the users previous movement and list of the cells a user resides and the cells in which the user intended to move, a profile is made for each user. This profile can be called a complex location area. The network sends this list to the mobile device, and location updation occurs only when the user enters in a cell not contained in the list.

Now, after the complete observation of static and dynamic location update schemes, there are various types of location update and location management phenomena based on these schemes.

PAGING PROCEDURE:

It is the procedure to locate the recipient of calls as quickly as possible.

Sequential paging: In this, paging is done to the cells nearest to the cell of most recent location.

Now in our proposed scheme, we update, and then continued outward if user is not immediately found.

Simultaneous paging: In this paging method, every cell is paged at the same time to find the users.

The location management mechanism, together consider the location update and as well as the paging function.

have worked only with the location update phenomena. We will take these two schemes together in the proposed model. Here the two schemes will be optional according to the mobile the velocity will be called the lower velocity and above this limit, the velocity will be called the higher velocity. The base nodes velocity. We have set a threshold velocity here bellow which station will continuously monitor the velocity of the mobile node, When the velocity comes lower, then the selected scheme will be switched to fixed time based scheme at the base station. But if the velocity is at the threshold (medium) or above (high), then the selected scheme will be switched to the adaptive scheme of increasing velocity based.

The bellow diagram wills help us to have an outline of the proposed model:

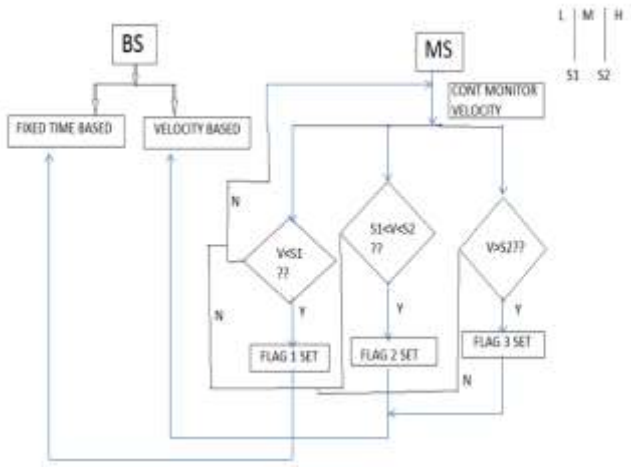


Fig.3 Block diagram of proposed idea

Where, V=Velocity and S1 and S2= Threshold levels of velocity

When flag 1 is set ⇒ It is low velocity (L) and base station will switch to the fixed time based scheme.

When flag 2 is set ⇒ It is medium velocity (M) and base station will understand that updating is needed, and switched to increasing velocity based adaptive scheme.

When flag 3 is set ⇒ It is high velocity (H) and base station will switch to velocity based scheme.

Now, when a situation will come, where after increasing, the velocity will remain constant, then also at the base station, the scheme will again switched to the fixed time based scheme.

III. Introduction To The Proposed Model Scenerio:

Now, according to the model shown below, we will do some calculation according to the characteristics of the fixed time based and increasing velocity based adaptive phenomena.

In my model, I have taken the location area = 3km.

Mobile node velocity threshold = 40km/hr.

And the time threshold= 4.5min.

Here we will work on the 4 scenarios shown in the following:

IV. TABLE 2:

VELOCITY	DISTANCE	DIRECTION	LOCATION UPDATE	SCHEME
HIGH	FAR FROM LOCATION AREA BOUNDARY	-V TO +V	NO	INCREASING VELOCITY BASED ADAPTIVE SCHEME
LOW	NEAR TO LOCATION AREA BOUNDARY	+V TO -V	YES	TIME BASED SCHEME
HIGH	NEAR TO LOCATION AREA BOUNDARY	-V TO +V	NO	INCREASING VELOCITY BASED ADAPTIVE SCHEME
LOW	FAR FROM LOCATION AREA BOUNDARY	+V TO -V	YES	TIME BASED SCHEME

We will see the network model next.

Now, according to the first scenario,

Let us take, velocity = 60km/hr. and distance=2.8 km far from the location area boundary, then here increasing velocity based adaptive scheme will take place. It will then set its own location area which is surely greater than 3km. Suppose it sets the threshold area=4km, so there will be no location update between 3km.

Now, according to the second scenario,

Suppose, before reaching 4km, at the boundary of 3km, its velocity decreases to 20km/hr. And it is 200metre near to the location area boundary, then here time based scheme will take place with time threshold 4.5min.

Within this time limit with this decreased velocity, it will travel 1.5km. Hence one time location will be updated in this case.

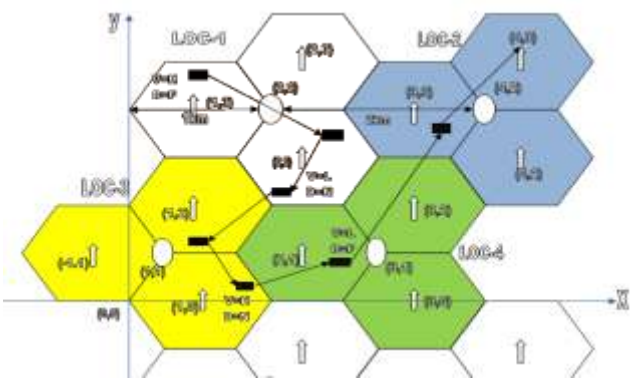


Fig.4 Network model

Now, according to the third scenario,

Suppose after it, suddenly its velocity again increased to 70km/hr. and it is near to the location area boundary of 200 meter, then again here increasing velocity based adaptive scheme will come with larger threshold area (such as- 4.5km). Then here also will be no location update.

Now, according to the fourth scenario,

Suppose after crossing fourth location area, the velocity decreased to 30km/hr and the distance is 1.5 km far from location area boundary, again the time based scheme with the threshold of 4.5 min will be applied.

And with this velocity in this time span it will cover 2.5 km, and thus here one location update will occur.

In this system, we have taken 13 km in concern. Now, if we take only time based scheme, then following the above methodology, the four location update will occurs. Whereas by using this two way location update scheme, the number of location updation will be two. So location updation is reduced here and thus reducing the cost.

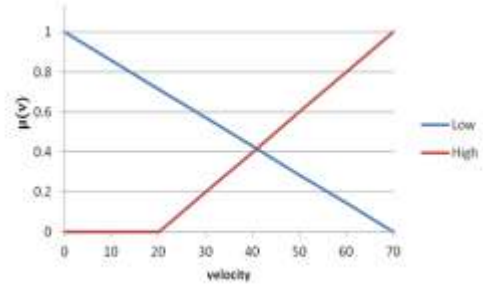
Here, the above calculation is done by assumption, and now according to the taken values in this model, we will do the fuzzification and then we will do the de-fuzzification to get the result. This result will show that which scheme has the greater probability to take place in the proposed model, and after getting the result, we can come to a conclusion about the fact that the number of location update will be reduced or not.

Now, we will try to do the phenomena with the fuzzy method. And here we will do the fuzzification and get the result:

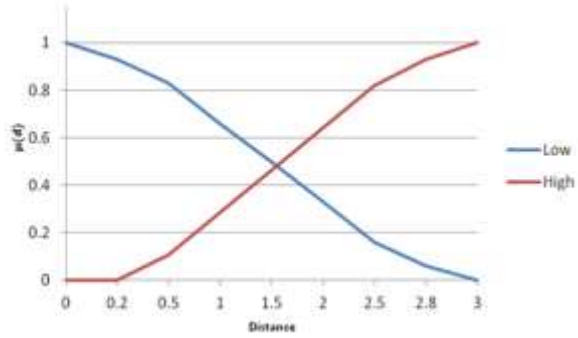
Now, to do it, we will define some **Linguistic variables** → velocity (high, low), distance from location area boundary (near, far), location update (yes, no), schemes (time based, increasing velocity based adaptive scheme).

The next step is to construct the **Membership function**:

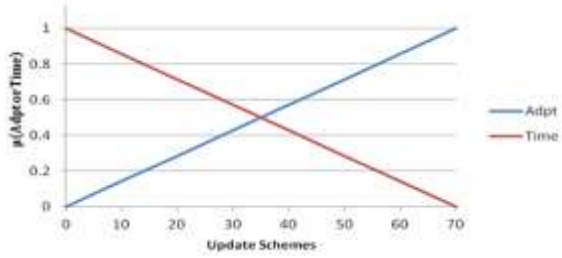
The membership function for the velocity is shown below-



Now we will define the membership function of distance:



Now the membership functions of location update:



Here below we have given the complete fuzzy rules, formulas, and the resulting table of four scenarios:

IV. Fuzzy To Binary Rule Generation:

Now we will construct the **fuzzy rules** as shown below:

i. IF velocity is high AND distance is far, THEN the command is increasing velocity based adaptive scheme.

ii. IF velocity is low AND distance is near, THEN the command is time based scheme.

iii. IF velocity is high AND distance is near, THEN the command is increasing velocity based adaptive scheme.

iv. IF velocity is low AND distance is far, THEN the command is time based scheme.

Now we will write the formula in terms of velocity and distance:

1. $\mu_{sch}(ad) = \{\mu v(H)+\mu d(H)\}$
2. $\mu_{sch}(ad)=\{\mu v(H)+\mu d(L)\}$
3. $\mu_{sch}(time)=\{\mu v(L)+\mu d(L)\}$
4. $\mu_{sch}(time)=\{\mu v(L)+\mu d(H)\}$

Now, after accumulation:

1. $\mu_{sch}(ad)=[\mu v(H)*\{\mu d(H)+\mu d(L)\}]$
2. $\mu_{sch}(time)=[\mu v(L)*\{\mu d(H)+\mu d(L)\}]$

Some Scenarios Of The Application Of The Model:

Now we will get the values as shown in the table:

VELOCITY (km/hr)	μv(H)	μv(L)	DISTANCE (km)	μd(H)	μd(L)	μsch(Ad)	μsch(time)
60	0.8	0.142	2.8	0.928	0.06	0.79	0.140
20	0	0.714	0.2	0	0.93	0	0.7
70	1	0	0.2	0	0.93	0.9	0
30	0.2	0.57	1.5	0.464	0.5	0.19	0.54

Now, from the above table values, we are now setting a **threshold as 0.5**, bellow which the schemes will not be considerable.

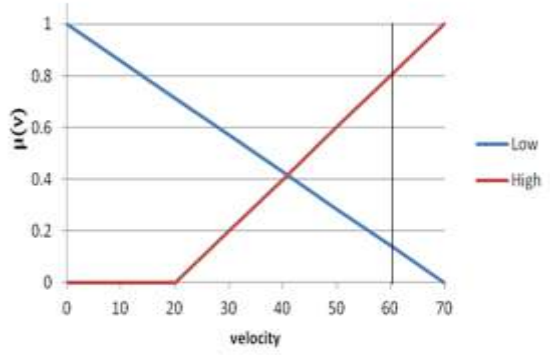
So, here from the table we are able to say that the increasing velocity based adaptive scheme has the more tendency of taking place in this model.

And as we described earlier while proposing the model, with the increasing velocity based adaptive scheme, the location updation no is reduced and hence reduced the cost. So, this model is more efficient than the model based on only time based scheme.

Example Scenario 1:

Let us take the first scenario, where velocity high and distance far:

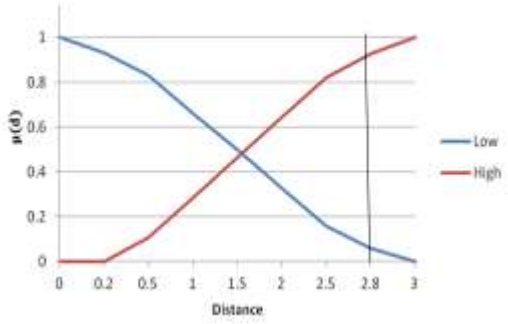
The first scenario membership values of velocity is shown:



$$\mu_{low}(v) = 0.142, \quad \mu_{high}(v) = 0.8$$

So the velocity is high.

Now we take the first scenario membership value of distance:



membership values are:

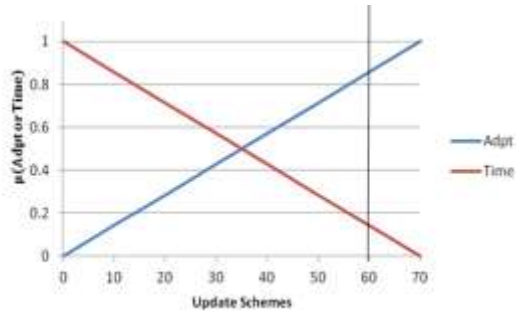
Here, $\mu_{low}(d) = 0.06$ $\mu_{high}(d) = 0.928$

So, the distance is near to the location area boundary here.

Here the used fuzzy rule will be:

IF velocity is high AND distance is far, THEN the command is increasing velocity based adaptive scheme.

The first scenario membership value of schemes:



Membership value of scheme will be:

$\mu_{sch}(adpt) = 0.82$

$\mu_{sch}(time) = 0.140$

So, increasing velocity based adaptive scheme will take place here.

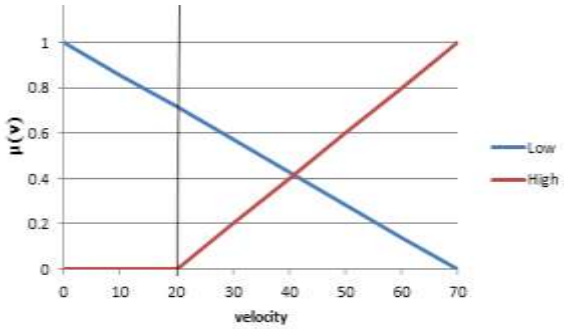
And applied formula will be:

$\mu_{sch}(ad) = [\mu v(H) * \{\mu d(H) + \mu d(L)\}]$

Example Scenario 2:

Now let us take the second scenario:

Here, Velocity is low, and distance near. The second scenario velocity membership:



Here, for the point 20, the membership function will be:

$\mu_{low}(v) = 0.714, \mu_{high}(v) = 0$

So the velocity is low here.

Now for second scenario membership value of distance will be:

Here at 0.2 the membership values are,

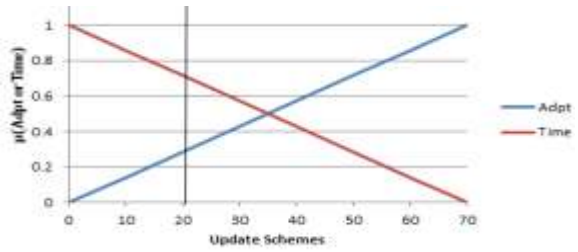
μ_{low} (d)= 0.93; μ_{high} (d)=0

So the distance is near to the location area boundery here.

So the applied fuzzy rule will be:

IF velocity is low AND distance is near, THEN the command is time based scheme.

The second scenario membership value of scheme:



The membership value of scheme will be:

μ_{sch}(time)=0.7;μ_{sch}(adpt)=0.3

So time based scheme will take place here.

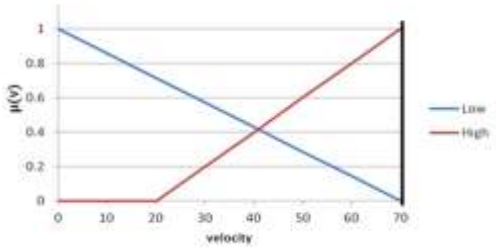
And the applied formula will be:

μ_{sch}(time)=[μv(L)*{μd(H)+μd(L)}]

Example Scenario 3:

Now according to the 3rd scenario, where the velocity is high and the distance near:

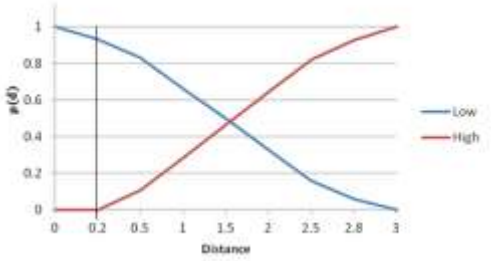
Third scenario membership value of velocity:



Here at point 70 the membership values are, μ_{low} (v)=0;μ_{high} (v)=1

So the velocity is high here.

Now for third scenario membership value of distance:



Now, for the point 0.2, the membership function will be:

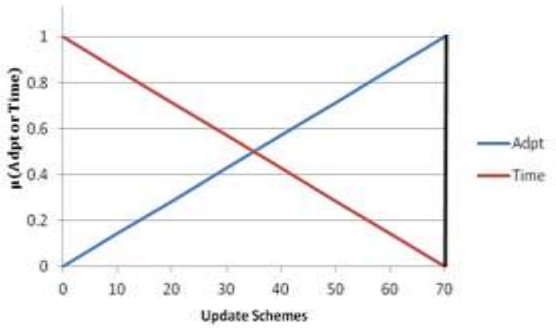
μ_{low} (d)=0.93;μ_{high} (d)=0

So, the distance is near to the location area boundary.

Here, the applied fuzzy rule will be:

IF velocity is high AND distance is near, THEN the command is increasing velocity based adaptive scheme.

Third scenario membership value of scheme:



The membership values of schemes will be:

μ_{sch}(adpt)=0.9;μ_{sch}(time)=0

So increasing velocity based adaptive scheme will take place here.

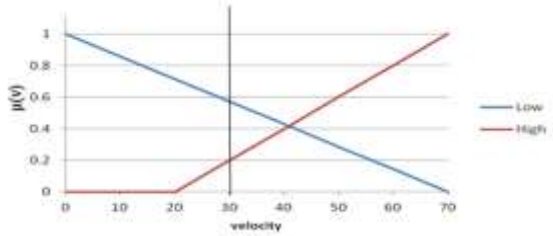
And applied formula will be:

μ_{sch}(adpt)=[μv(H)*{μd(H)+μd(L)}]

Example Scenario 4:

Now, according to the fourth scenario, the velocity is low and the distance is far from the location area boundary:

The 4th scenario membership value of velocity:



Here, for the point 30, the membership value will be:

$\mu_{low}(v) = 0.571; \mu_{high}(v) = 0.2$

So the velocity is low here.

Fourth scenario membership value of distance:

At the point 1.5, the membership function will be:

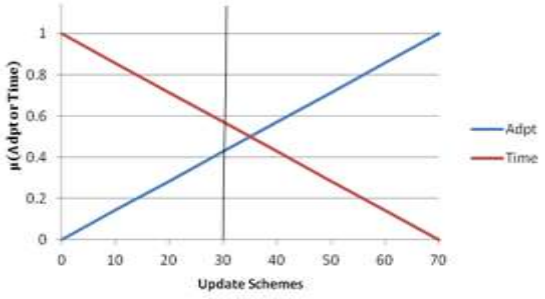
$\mu_{low}(d) = 0.464; \mu_{high}(d) = 0.5$

So, the distance is far from the location area boundary here.

Here, the applied rule will be:

IF velocity is low AND distance is far, THEN the command is time based scheme.

Fourth scenario membership value of scheme:



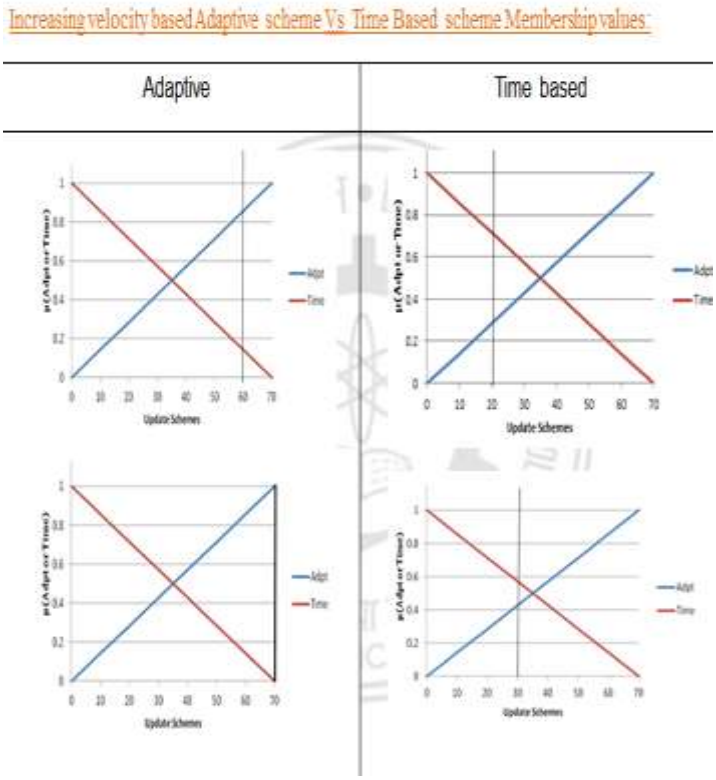
Here the membership values will be:

μsch(time)=0.5;μsch(adpt)=0.42

So, time based scheme will take place here.

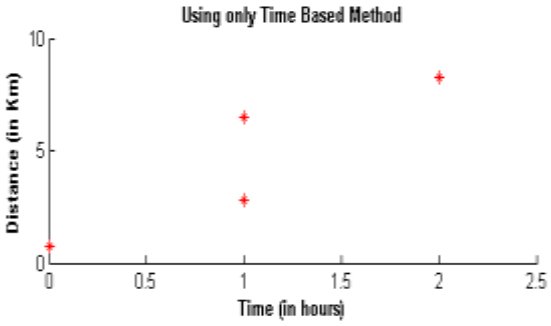
Here the applied formula will be:

μsch(time)=[μv(L)*{μd(H)+μd(L)}]

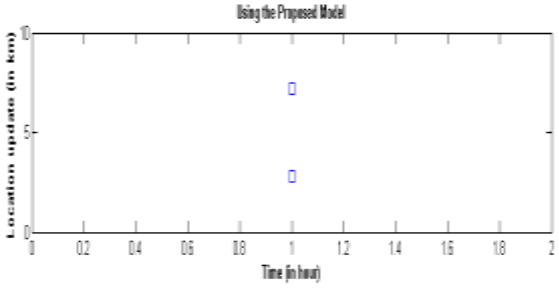


So, here we have got the four results. By compering these results we can say that the first and the 3rd scenario has the greater values than second and fourth scenario.

V. Simulation And Result:



Here the star points indicate the updates.



Here the square points indicates the updates.

Here by comparing the two graphs we can say that the number of location update is reduced in the proposed model where we have used the two schemes simultaneously, the fixed time based scheme and the increasing velocity based adaptive scheme.

As the location update is reduced here, the cost function is then also will be reduced. So, the proposed model is more efficient in nature than the model which is based only on the fixed time based scheme.

VI. CONCLUSION:

Here we have proposed a model with the two schemes, fixed time based and the increasing velocity based adaptive scheme. We have here done the fuzzification and de fuzzification to have the result. This result of fuzzification indicates the scheme with the greater probability to take place, then we have done the simulation based on two schemes, only fixed time based scheme and together the fixed time based scheme and increasing velocity based adaptive scheme, to indicate in which model the number of location update will be reduced. After getting the results, here we are able to propose a more efficient model here.

VII. FUTURE WORK:

In this paper, we have worked with the location update topology and its cost function. The future work will be to work with the paging topology and the cost function of paging. Then with both of the cost function we can be able to propose a more realistic model in future with more efficiency.

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