A Time based Mobility Management Method for Leo Satellite Networks

Debabrata Sarddar
Department of E.T.C.E.
Jadavpur University

Soumya Das
Department of E.T.C.E
Bengal Institute of Tech.
W.B.U.T

Dipsikha Ganguly
Department of E.T.C.E.
B.P. Poddar I.M.T. W.B.U.T

Suman Kumar Sikder
M. Tech in C.S.E
Jadavpur University

Sougata Chakraborty
M. Tech in C.S.E
Jadavpur University

Kunal Hui
M. Tech in C.S.E
Haldia Institute of Technology

Shabnam Bandyopadhyay
Department of C.S.E
Jadavpur University

Kalyan Kumar Das
M. Tech in C.S.E
Jadavpur University

Mrinal Kanti Naskar
Department of E.T.C.E
Jadavpur University

ABSTRACT
Low Earth Orbit (LEO) satellite networks will work as an important role in future global communications as it can provide wireless connectivity to any part of the world. It has some distinct characteristics such as low propagation delay, low power requirements and more efficient spectrum allocation due to frequency reuse between satellite and spotbeams. But the higher relative speed than terrestrial mobile networks is the main disadvantage of LEO satellites. As a result, the frequency of handover is more which decreases the quality of service. To overcome this problem, many solutions are given by scientists. Here we have proposed a Time Based Mobility Management (TBMM) method in which we have divided the total 24 hours into two phrases: active phrase and idle phrase and apply precise location management and loose location management simultaneously. Through mathematical analysis simulation results shows that this method is better than the standard mobility management methods.

Keywords
Satellite Networks, Handover, Global Communication, Frequency Reuse. Time Based Mobility Management

1. INTRODUCTION
Satellite communication networks are utilized to co-exist with terrestrial networks in order to provide global coverage to a heterogeneously distributed over population. A LEO satellite takes about 100 minutes to orbit the earth, which means that a single satellite is in view of ground equipment for only a few minutes [1]. As a consequence, a LEO satellite system must hand over between satellites to complete the transmission if a transmission takes more than the short time period that any one satellite is in view,. In general, this can be accomplished by constantly relaying signals between the satellite and various ground stations, or by communicating between the satellites themselves using "inter-satellite links" (ISLs) [1], [2].In addition, LEO systems are designed to have more than one satellite in view from any spot on Earth at any given time, minimizing the possibility that the network will lose the transmission. Because of the fast-flying satellites, LEO systems must incorporate sophisticated tracking and switching equipment to maintain consistent service coverage. The need for complex tracking schemes is minimized, but not obviated, in LEO systems designed to handle only short-burst transmissions [3].

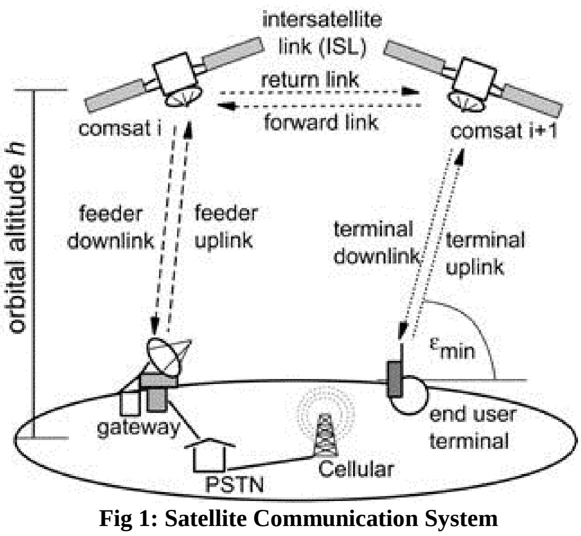

Fig 1: Satellite Communication System

Handover:
In the term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another. In satellite communications it is the process of transferring satellite control responsibility from one earth station to another without loss or interruption of service. Handovers may degrade the system performance as an unsuccessful handover results call blocking and forced call termination. Forced call termination is less desirable than a new call blocking though both affect the performance of the system. A number of handover techniques have been proposed to solve this problem. IP/LEO satellite networks are used to provide a wide

variety of IP-based applications, such as teleconferencing and tele-education. Being totally independent of terrestrial networks, LEO satellite networks have a unique ability of supporting certain emergency communication systems, such as I Am Alive (IAA) System [4]. To provide such applications, scalable mobility management and IP communication between end nodes are required. Conventional IP mobility management protocols, typified by Mobile IP [5] and LIN6 (Location Independent Network architecture for IPv6) [7], require mobile nodes to send binding update requests to the Location Directory every time a handover occurs. Given the high-mobility of satellite networks, usage of these approaches will result in a large number of binding update requests and consequently affect the scalability of the mobility management schemes.
Now we will try to find an equation of rate of handover occurrence form the boundary crossing model.

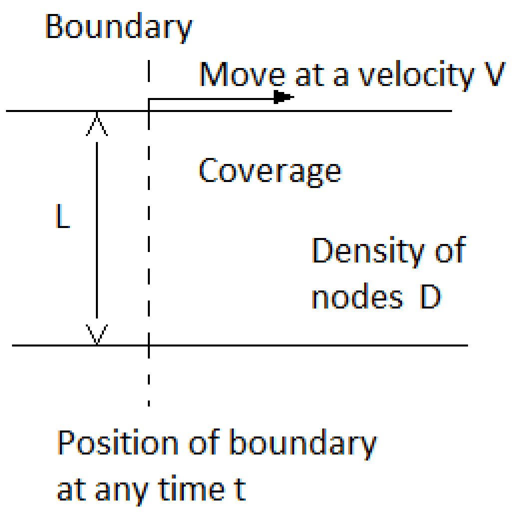

Fig: 2 Boundary crossing model

In the above figure, a coverage boundary of length L moves with velocity V from left to right during a period of time Δt. The nodes that belong to the area with surface L.V will be required to perform handover during time Δt. Denoting the area density of nodes as D, the rate of boundary crossing event, R, can be expressed as:

$$R=V.L.D \qquad (1)$$

Considering the fact that handovers are mainly due to satellites movement, V can be approximated to the ground speed of satellites. Let $D_L(V_{sat}.t)$ denote the linear density of nodes on the coverage boundary at time t. The rate of handover occurrence, $R_{HO}(t)$, is:

$$R_{HO}(t)=V_{sat}.L_{sat}\int_{Vsat(t-t\Delta)}^{Vsat.t} DL(Vsat.t)dt. \qquad (2)$$

Where, V_{sat} and L_{sat} denote the ground speed of satellite and the coverage boundary length, respectively.Since satellites are assumed to cover wide areas and move fast, V_{sat} and L_{sat} are large. From Eq.2, it becomes evident that $R_{HO}(t)$ takes large values even for small values of Δt. Furthermore, this rate of handovers is likely to become even larger in a very populated area (large values of $D_L(V_{sat} \cdot t)$).
In this paper we have proposed a new mobility management method named Time Base Mobility Management (TBMM) in the basis of time.
The rest of the paper is organised as follow: in the second section we have described the related mobility management methods available. In the third section we have described the details of TBMM method. In the forth section we have compared the handover management cost of standard IP protocols our proposed work. The simulation results of related mobility management methods and TBMM method based on handover cost is evaluated in section five. In the next section we conclude the whole paper and finally a future work is mention regarding this paper in section seven.

2.RELATED WORK

2.1. Mobility Management in Terrestrial Mobile Networks and LEO Satellite Networks:

2.1.1. *Outline of General Mobility Management:*
In recent years the main concern in IP/LEO networks is the mobility management. The purpose of it is to locate MNs in the network and to guarantee a seamless data transmission upon change in node position. Mobility management mainly deals with two operations, namely binding update and data delivery [8].

- *Binding Update:* This operation aims to associate Reachability Identity (Reach.ID) and Routing Identity (Route.ID) of each node.
- *Reach.ID:* It indicates a unique name of the node and not subjected to change.
- *Route.ID:* It specifies position of the node in the network and changes in response to node movement. When a MN changes its position, the Route.ID changes as well as the old binding update is no longer valid. To update the binding, MNs are requested to send their new Route.ID to the Location Directory (LD) [10].The main disadvantage of this procedure is when LD is geographically too far from the MNs. As a result, the cost of binding update becomes very expensive especially a high mobility environment such as satellite networks [9]. We all know that a handover is a local process which involves only the MN, the old AR, and the new AR where as binding update is a global process that may affect other network elements in addition to the three adjacent entities. We have two types of Location Management namely Precise Location Management and Loose Location Management.
- *Precise Location Management*: When Route.ID indicates the position of the MN, so data transmission can be done seamlessly with no further operations. This is called Precise Location Management. In this case the MN requires frequent update of MNs registration even upon a slight movement of nodes. Thus the required update cost can be very huge [11]
- *Loose Location Management*: When Route.ID is used to indicate the location of MN roughly, an additional operation called paging is done to find the position of MN. But in wide paging areas, the paging cost can be very high which the main disadvantage of it is.

So from this discussion we can conclude that Route.ID plays a very important role on the mobility management cost. More attention should be thus paid to the choice of Route.ID type that suites best mobility management in the underlying network.
2.1.2. *Mobility management in Terrestrial IP network:*
The main drawback of mobility management in terrestrial IP networks is the fact that IP addresses that are originally designed for Route.ID's are also used as Reach.ID's in higher layers. As a result, a MN cannot be identified in the higher layers if its IP address changes at handover occurrence time.
The most useful protocol among existing mobility management is Mobile IP (MIP) which was proposed to

tackle this problem. It uses two different IP addresses for two different identities of MN. First one is referred as Home address and acts as a Reach.ID and second one is Care of Address and serves as Route.ID. Home Agent plays the role of LD in MIP. In this case, locations of MNs are precisely managed by binding update for every handover occurrence.

Another mobility management protocol is LIN6 where LIN6 address are used to refer to the Route.ID of mobile nodes. LIN6 addresses are decided according to the AR that mobile nodes are connected to which is similar to CoA of MIP.

MIP and LIN6 uses a precise location management which necessitates a binding update whenever MN changes its position which is devoid of the condition that the MN is communicating or not. So it is better to use a precise location management to the active nodes. But for the inactive nodes a loose location management is sufficient where the no of binding update frequency can be reduced.

The most dominant loose location mobility management protocols are Paging in Mobile IP (P-MIP) [12] and Cellular IP [13]. Paging is a procedure that allows a wireless system to search for an idle mobile host when there is a message destined to it, such that the mobile user do not need to register its precise location to the system whenever it moves.

In P-MIP each paging area is consists of a certain number of ARs in the network. Whenever a packet data is destined to an idle node reaches at one of the AR in a paging area, that AR broadcasts a paging request to all the other ARs that subsequently send paging messages within own coverage areas. When an idle MN receives a paging request, it becomes active. But that MN is not required to perform binding update within its own paging area. The MN should only update its binding whenever it crosses the paging area boundary. Thus the frequency of binding update can be reduced.

2.1.3. *Mobility Management in LEO satellite networks:*

The most widely used protocol for mobility management over satellite networks is again Mobile IP (MIP) which is proposed by the Internet Engineering Task Force (IETF) to handle mobility of internet hosts for mobile data communications. It is based on the concept of Home Agent (HA) and Foreign Agent (FA) for routing of packets from one point of attachment to other. It is basically completed by four steps.

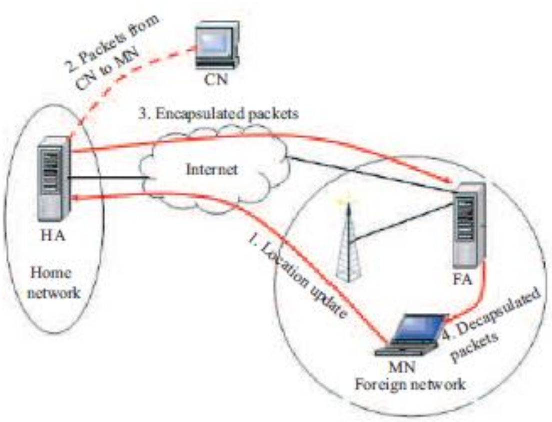

Fig 3 Handover Flow in Mobile IP

i) When handover begins MN registers itself in FA and waits for allocation of channels in FA and updates its location in HA directory.

ii) The packets are sent to HA and HA encapsulate it.

iii) Encapsulated packets are sent to The FA.

iv) FA decapsulate those packets and sent it to MN.

Applying MIP to LEO satellite networks will result in a precise location management of MNs and consequently an invocation of binding update upon each handover occurrence [14]. As discussed earlier, the number of binding update request will be huge in a single burst. To process all the requests, a massive amount of network bandwidth and computational load are required. This is a serious issue for scalability of mobility management in LEO satellite networks.

To reduce the binding update two loose location management schemes have been introduced; P-MIP and Handover Independent IP Mobility Management [16]. The design of P-MIP encompass, Paging area construction, Movement Detection, Registration, Paging, Data Handling

However since paging areas are formed from the coverage areas of a certain number of satellites which are constantly moving, so the ceaseless motion of the satellites makes the paging areas to keep changing. Meanwhile, bursting binding updates might occur as well when LEO satellites cross paging area boundary. So this loose location management method is not suitable for LEO satellite networks.

Another loose location management method is Handover Independent IP Mobility Management which uses the IP addressing on the basis of geographical location and is independent of logical locations.

In this method, the earth's surface is divided into a number of cells, and MN's Route.ID's are associated with the cell where MNs reside in. MNs are assumed to be equipped with GPS (Global Positioning System) receiver for finding their locations. A Route.ID changes and the corresponding binding update occurs only when a MN moves to neighbour cell.

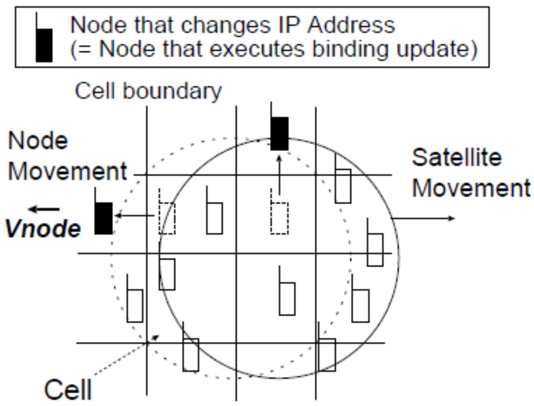

Fig 4 Handover Independent Mobility Management

This method has three steps.

1) Geographical Location mapping to Route.ID
2) Cell distribution in a satellite coverage
3) Connection setup and maintenance

The main disadvantages of this method are

- As the LEO satellites have high speed so it crosses the boundaries of the cells frequently which leads to less mitigation of the frequency of IP binding update
- This method needs centralised binding management, which causes huge location directory database and long distance transmission path for IP, address binding updates. This places a heavy burden on communication and storage resources in satellites.

3. PROPOSED WORK

Here we have proposed a new mobility management method named Time Based Mobility Management (TBMM) Method in IP satellite networks using the concept of precise location management and loose location management simultaneously during different time periods in a day. The key idea of this paper is based on the following facts.

A. From the previous studies [20] we know that every MN has a mobility pattern during a specific period of time. If we use the IP addressing scheme on the basis of ground station real time coverage area then maximum MN spends the maximum period in a day in any particular cell. For example maximum people spend at home during sleeping hours.

B. We know those mobile users are idle most of the time in a day. But if we investigate the database of the call lists of any MN in a week we can see that every MN have a specific time in a day when it is busy and when it is idle. For example during sleeping hours the no of calls are less than the office hours.

From these two points here the total 24hours is divided into two phrases based on the mobility of MN and the no of calls appeared in the MN.

1. *Active Phrase*: It is selected according to the following criterion

A. When the MN is active most of the time i.e. maximum number of call approximately 80% of total no of calls and total call duration appeared in between this time. In default it is 10am to 10 pm.

B. When the MN is out of its Home cell (discussed later). As in average in a MN maximum calls appeared when it is out if its Home cell, so these two times in above mentioned points generally overlaps.

2. *Idle phrase*: When the MN is idle most of the time i.e. the total no of calls and the total call duration is 20% or less. This phrase is mainly the sleeping hours. So the mobility of MN and the number of calls appeared and call duration are very less.

Here we have divided the mobility management in two phrases.

1. *Precise Location Management*: In active phrase the mobility of MN is precisely managed as the MN is busy most of the time and also its changes its home cell or home sub cells very frequently in this time.

2. *Loose Location Management*: In the Idle phrase as the mobility of MN is less and also the no of calls appeared is less so we can use loose location management.

TBMM method Design

The design of TBMM method encompasses Database Formation, Timing Area Construction, Movement detection, Registration and Connection Set Up.

Database Formation:

A database for each MN has to be formed which has the following properties

a. It will be a weekly database i.e.it will update itself weekly basis.

b. In each day in a week it will contain the starting and ending time of each call and corresponding sub cell ID.

c. After each day it will calculate the total no of calls and total call duration.

d. Each time a MN changes its cell, the cell ID with corresponding time has been saved in the database. A suitable timing table must be maintained to handle these data.

This database can be saved in Location Directory or Billboard Manager (BM) [22] which was mentioned in our previous work.

Timing area construction:

In TBMM method, the timing area can be constructed by dividing the earth's surface in to a number of cells and each cell is further divided in a number of sub cells. The main cell is situated at centre of each sub cell. Each main cell has a unique Timing Area ID (TAI). Each sub cell also has a TAI. Though the TAI of different sub cells of different cells are same as each sub cell TAI includes their corresponding cell TAI. This is done to avoid a huge number of TAI. Now the Timing area can be constructed in two ways; Fixed Time Area (FTA) and Dynamic Time Area (DTA)

A. *Fixed Time area*: In fixed time area based contraction, once we have divided the earth's surface, it is same for all MN. From the database, each MN is assigned to a specific cell under which it spends the most of the time in a week which is called Home Cell. A specific sub cell is also assigned to it under which it spends most of the time in a day which is called Home Sub Cell. The other sub cells within the home cell are called Foreign Sub cells. The other cells are called Foreign Cell. Here main sub cell and home sub cell may or may not be same for a MN.

B. *Dynamic Time area*: In dynamic time area based construction, each cell is constructed according to the database of each MN such that main sub cell and home sub cell are same for each MN. This type of timing area construction is difficult as for each MN there is a new cell and corresponding sub cell. Here we will use only fixed time area construction type TBMM.

Movement Detection:

Here we have assumed that MNs are equipped with GPS receiver for finding their location in a cell. The movement detection can be in two ways for two different phrases

- ❖ <u>For active phrase</u>: As in active phrase we have used precise location management, so every time a MN changes its position i.e. it moves to a different cell or sub cell it registers itself through binding update. In this phrase the position of MN is identified from its IP address as it contains its home cell and sub home cell information.
- ❖ <u>For idle phrase</u>: In idle phrase we have used loose location management so we can use an algorithm which is similar to paging. As whenever a MN changes its home sub cell within its home cell it does not have to register. But when it changes its home cell it has to register. As in idle phrase the movement of MN is very rare so the no of binding update is very less. A MN is identified in this phrase by GPS. Whenever a message is destined to it, its geographical position is identified from GPS. Then from database the cell ID and sub cell ID is also known. So the message is destined to that MN.

Registration:

The registration procedure also has two types. For active phrase whenever a MN changes its home sub cell or home cell, it registers. For idle phrase, whenever a MN changes its home cell it registers.

Connection Set Up

In the proposed TBMM method the location of MN is managed in the basis of 'Time'. As we have used precise location management and loose location management simultaneously, so we need careful handling of connection whenever a handover takes place in an ongoing call as well as whenever it changes its sub cells or cells. Another important thing is that whenever a new connection is about to set up, we must find the MN and set up a communication path. The following TBMM algorithm has to be performed to establish a connection and to perform handover seamlessly.

TBMM Algorithm:

When a new connection starts, in default the active phrase timing is set to 10am to 10 pm. After checking the database of 1st week, the new active phrase timing is set up and updated weekly. TBMM algorithm is shown in figure 5

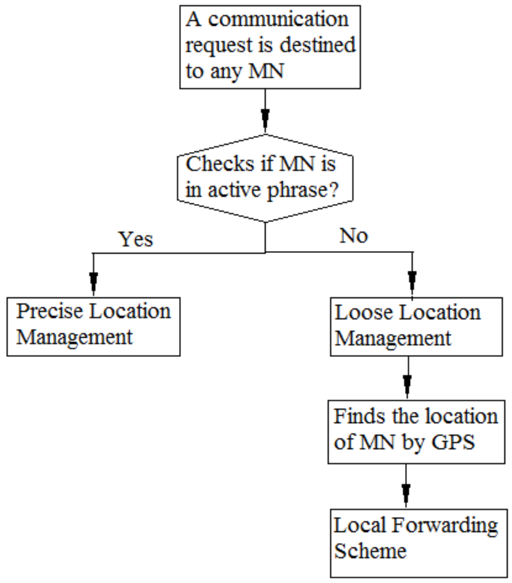

Fig 5: TBMM Algorithm

Step 1: Whenever a communication request is destined to a MN, the algorithm first checks the database and finds the phrase of the MN i.e. whether it is in active phrase or in idle phrase.
Step 2: If the MN is in active phrase mode then it goes to step 3 which describes the precise location management, otherwise it goes to step 5 which describes loose location management.
Step 3: As the MN is now in precise location management so its position can easily be found by its IP address. So a new connection can easily be made by setting a link with the MN.
Step 4: When it receives a handover request, the path between the two communication MN changes resulting in a possible disconnection of the nodes. To maintain the connection seamlessly certain modification are required. A number of handover schemes have been proposed to solve this problem. As here the positions of MNs are precisely managed so we can use a simple routing mechanism which is used for Mobile IP which has been discussed earlier. This is same as MIP
Step 5: As the location of MN is now loosely managed so its position can be found by using GPS. After finding this algorithm uses the database to find the actual position i.e. in which cell and in which sub cell the MN resides. Now the communication can be easily made as mentioned earlier.
Step 6: When the MN receives a handover request it goes to Local forwarding Scheme which is as follows
Local Forwarding Scheme: Whenever a handover occurs, an active MN notifies its new AR of its old AR at the handover occurrence time. After receiving this notification, the new AR informs the old AR that the MN has indeed performed a handover. In responds to that, the old AR forwards the packets that are destined for the node to the new AR. As this forwarding mechanism only involves generation of some control messages among the MN, the new AR and the old AR.

ADVANTAGES

TBMM method has following advantages

1. The main advantage of this scheme is that it uses the advantages of both precise location management and loose location management. By using both mobility management schemes simultaneously it removes the disadvantages of using a single mobility management method as discussed earlier in related work.
2. By dividing the total time period into active and idle phrase according to is activity. So as not all MN is active in a specific period of time. So no of binding update cost reduces.
3. As the number of night workers in office increase as a result of rapid fast growing IT sectors, so many MN has the active period in night. So the total binding update management is speared into 24 hours. So the generation of huge no of binding update in a single burst is reduced.

COST ANALYSIS

In this section we will evaluate the cost of TBMM method and compares it to that Mobile IP, P-MIP and Handover Independent Mobile IP.

MOBILITY MANAGEMENT COST ELEMENTS

As discussed earlier, the mobility management cost mainly consists of the binding update cost and data delivery cost. In precise location management method, the binding update cost is large as a large number of binding update request is generated. In loose location management, this cost is reduced but some additional cost such as local forwarding cost and paging cost are generated. So the overall cost rises.

MOBILITY MANAGEMENT COST DEFINITION

In [12] the mobility management cost is evaluated as the product of generated control message size, M and the number of hopes, H, required to deliver the message. If we apply such definition into the paging cost, it will be proportional with the number of receivers. Taking into account the broadcasting capabilities of satellites, however, the cost is also simply a product of the message size and the number of travelled hops.

$$\text{Cost}=M.H \tag{3}$$

COSTS OF DIFFERENT MOBILITY MANAGEMENT EVENTS

The following defines the cost required for each mobility management event; binding update, local forwarding, paging and GPS finding.

For each case, the Control messages generated are assumed to be equally sized (M) in all the four events. The number of control messages that are generated upon a handover occurrence between mobile nodes and the corresponding ARs, is assumed to be same for MIP, P-MIP, handover Independent Mobile IP and our proposed method. Thus we can neglect the number of control message in the cost evaluation.

1. *Binding Update Cost:* Let $H_{MN,LD}$ denote the number of hops between a mobile node and the Location Directory. The cost for binding update procedure can be expressed as:

$$M.H_{MN,LD}$$

2. *Local Forwarding Cost:* Denoting the number of hops between two adjacent satellites as $H_{AR,AR}$ the local forwarding cost is shown as follows:

$$M \cdot H_{AR,AR}$$

3. *Paging Cost:* The paging cost as mentioned in [16] is

$$M.H_{AR,AR}.(S-1) + M.1.S$$

Where *S* denotes the number of single-beam satellites that cover a single paging area.

4. *GPS Finding Cost:* The cost to find a MN by GPS method is G.

MANAGEMENT COST OF MIP, P-MIP, HANDOVER INDEPENDENT MOBILE IP AND OUR PROPOSED METHOD

The costs of Mobile IP, P-MIP, Handover Independent Mobile IP and our proposed method are as follows

A. Mobile IP: The cost of MIP is the product of binding update cost and rate of handover occurrence. The local forwarding, paging and GPS are not used here. So the MIP management cost, $C_{MIP}(t)$ can be expressed as

$$C_{MIP}(t)= M.H_{MN,LD}.R_{HO}(t) \quad (4)$$

B. Paging in Mobile IP: In P-MIP the active MN update their binding upon handover occurrence. The idle nodes perform their binding update only when they cross the paging area boundary. So using equation 1 the rate at which boundary nodes cross the paging area boundary at time t, $R_{p\_area}(t)$ is

$$R_{p\_area}(t)=V_{sat}.L_{p\_area}.\int_{Vsat.(t-t\Delta)}^{Vsat.t} DL(Vsat.t)dt \quad (5)$$

Where L_{p_area} denotes the boundary length of paging area.

So the P-MIP cost $C_{P\text{-}MIP}(t)$ is

$$C_{P\text{-}MIP}(t)=M.H_{MN,LD}.R_{p\_area}(t)+ M.H_{MN,LD}.\{R_{HO}(t)-R_{p\_area}(t)\}.\alpha + \{M.H_{AR,AR}.(S-1) + M.S\}.n(t).(1-\alpha).\lambda \quad (6)$$

Where $n(t)$ and α denote the total number of nodes per a coverage area at time *t* and the ratio of active mobile nodes to the total number of nodes, respectively. The rate of newly coming connections to a mobile node is denoted as λ. The first and second terms indicate the binding update cost, whereas the third one refers to the paging cost. Observe that $n(t)\cdot(1-\alpha)\cdot\lambda$ indicates paging the occurrence rate.

C. Handover Independent Mobility Management Cost: In this method, the local forwarding and paging scheme occurs as some additional cost. So the total cost $C_{HI}(t)$ is

$$C_{HI}(t)= M.H_{MN,LD}.R_{cc}(t))+ M._{HARAR}.R_{HO}(t).\alpha + \{M.H_{AR,AR}.(S-1) + M.S\}.n(t).(1-\alpha).\lambda \quad (7)$$

Where $R_{CC}(t)$ can be expressed as

$$R_{CC}(t)=C.V_{node}.L_{cell}.\int_{Vnode(t-\Delta t)}^{Vsat.t} Dn(Vsat.t)dt \quad (8)$$

Where C is the no of cells, V_{node} and L_{cell} denotes the velocity of nodes and the cell boundary length respectively.

The first term in Eq. 7 indicates the binding update cost. The second and third terms represent the local forwarding and paging cost, respectively.

D. Proposed Method: In our proposed method, its total cost can be divided in two parts. For active phrase the cost is C_{active} and for idle phrase its cost is C_{idle}. So the total cost C_{tot} is

$$C_{tot} = \{C_{active}.h+ C_{idle}.(24-h)\}/24 \quad (9)$$

Where h is the no of hours that a MN is in active phrase.

Now as previously mentioned, in active phrase the location of MN is precisely managed. So its cost will be the same of MIP. Hence

$$C_{active} = M.H_{MN,LD}.R_{HO}(t) \quad (10)$$

Now in idle phrase, the location of MN is loosely managed. Dividing a satellite coverage area into C cells, the total rate of binding update occurrence, denoted as $R_{TM}(t)$, can be approximated to the sum of the rate of cell crossing event of C cells. On the other hand, for each cell, the rate of cell crossing event form Eq. 1 can written as

$$R_{TM}(t)=C.V_{node}.L_{cell}\int_{Vnode(t-\Delta t)}^{Vsat.t} Dn(Vsat.t)dt \quad \text{...} (11)$$

Where V_{node} and L_{cell} denotes the velocity of nodes and the cell boundary length, respectively. $D_n(V_{sat}.t)$ denotes the linear density of nodes in a boundary at a time t. So

$$C_{idle}= M.H_{MN,LD}.R_{TM}(t))+M._{HARAR}.R_{HO}(t).\alpha + G \quad \text{...........} (12)$$

The first term, in above equation 12 indicates the binding update cost where as the second and third term denotes the local forwarding cost and GPS cost. Now if we put the values of eq. 10 and eq. 12 in eq. 9 we can have the total handover cost. So C_{tot} is

$$C_{tot} = \{ M.H_{MN,LD}.R_{HO}(t).h+ M.H_{MN,LD}.R_{TM}(t))+ M._{HARAR}.R_{HO}(t).\alpha + G.(24-h)\}/24 \quad (13)$$

4. SIMULATION RESULTS

In order to evaluate the performance of TBMM method we compare it to MIP, P-MIP and Handover Independent Mobile IP. Each method is evaluated by handover costs. The simulation results were run on MATLAB 7.8 in a designed virtual environment.

The virtual environment is created by setting the following parameters

Satellite coverage area radius	700[km]
Satellite ground Speed	7[km/sec]
7[km/sec]	17[km/sec](60km/hr)
Active Phrase duration	12hr
α	15%
λ	0.0009
Number of nodes reside in the coverage area	10^6
Δt	1sec
$H_{MN,LD}$	2
$H_{AR,AR}$	1
S	5

We assume the satellite coverage area to be square shaped and their surfaces are equal to that of a circle with a radius 700[km]. Nodes density is calculated as the ratio of the total number of nodes to the coverage area surface. For the sake of simplicity, effects of cell shapes on the management cost are ignored and cells are assumed to be square shaped.

In Paging Mobile IP, a paging area is constructed by the coverage areas of five satellites that are a certain satellite and its four neighbouring satellites (i.e. $S = 5$). Each neighbouring satellite is in the same orbit and both adjacent orbits. On the other hands, in the proposed method, *S* depends on a cell size. In figure we have shown the simulation results. It shows that the cost of our proposed method is better than MIP, P-MIP and Handover independent MIP. The management cost is higher for the smaller values of square-shaped cell length. This is because the frequent binding update that caused when large number of mobile nodes that crosses the cell boundary.

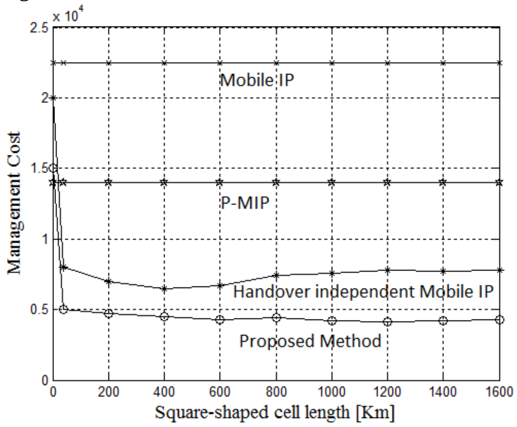

Fig 6 Management Cost evaluation

5. CONCLUSION

In this paper we have proposed TBMM method where we have reduced the handover cost.We first described what satellite communication is and the advantages of satellite communication. Then we introduce the term 'handover' and the problems of handover on satellite communication. Then we described various IP protocol management methods such as MIP, P-MIP and Handover independent MIP. After that we have described our proposed work and mentioned its advantages. The cost analysis of different mobility management methods with comparison with our proposed work is given in the next part of this paper. Based on the cost analysis, a simulation result of these mobility management methods with our proposed works is also given. It shows that the TBMM method is better than other IP protocols. So we can use it in our IP networks as a mode of future satellite communications.

6. FUTURE WORK

In our future work we will try to find how these precise location management and loose location management can be used dynamically for every MN individually to reduce the handover cost further.

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AUTHORS PROFILE

Debabrata Sarddar is currently pursuing his PhD at Jadavpur University. He completed his M.Tech in Computer Science & Engineering from DAVV, Indore in 2006, and his B.Tech in Computer Science & Engineering from Regional Engineering College, Durgapur in 2001. His research interest includes wireless and mobile communication. Email: dsarddar@rediffmail.com

Soumya Das, son of Mr. Subrata Das and Mrs. Swapna Das, currently pursuing his B.Tech in Electronics & Communication Engg. at Bengal Institute of Technology under West Bengal University of Technology. His research interest includes mobile communication & satellite communication.
Email: Soumya06.das@gmail.com

Dipsikha Ganguly, currently pursuing B.Tech in Electronics & Communication engineering at B.P.Poddar Institute of Management & Technology under West Bengal University of Technology. Her research interest includes wireless communication & satellite communication. Email: Dips.ganguly@gmail.com

Suman Kumar Sikder completed his B.Tech in CSE from Murshidabad College of Engineering & Technology and M.Tech in Computer Science & Engineering from Jadavpur University in 2011. His research interest includes wireless sensor networks and wireless communication systems.
Email: sikdersuman@gmail.com

Sougata Chakraborty is presently an employee of IBM (Kolkata). He has completed his B.Tech in IT from Murshidabad College of Engineering and Technology and M.Tech in Computer Science & Engineering from Jadavpur University in 2011. His research interest includes wireless sensor networks and wireless communication systems.
Email: me.sougata.chakraborty@gmail.com

Kunal Hui is presently an employee of Cognizant (Kolkata). He has completed his B.Tech in Computer Science & Engineering from Murshidabad College of Engineering and Technology (2004-2008) and M.Tech in Computer Science & Engineering from Haldia Institute of Technology (2009-2011). His research interest includes wireless sensor networks and wireless communication systems. Email: kunalhui@gmail.com

Shabnam Bandyopadhyay is presently an employee of Cognizant (Kolkata). She has completed her B.Tech in Electronics and Communication Engineering from Meghnad Saha Institute of Technology and pursuing M.Tech degree in Computer Science & Engineering at Jadavpur University Her research interest includes wireless sensor networks and wireless communication systems. Email: shabnam.msit@gmail.com

Kalyan Kumar Das completed his BE degree in Computer Science and Engineering from REC (NIT), Durgapur in 2002 and M.Tech. in Computer Technology from Jadavpur University in 2011. His research interest includes wireless sensor networks and wireless communication systems. Email: kalyan.biltu@gmail.com

Mrinal Kanti Naskar received his B.Tech. (Hons) and M.Tech degrees from E&ECE Department, IIT Kharagpur, India in 1987 and 1989 respectively and Ph.D. from Jadavpur University, India in 2006.. He served as a faculty member in NIT, Jamshedpur and NIT, Durgapur during 1991-1996 and 1996-1999 respectively. Currently, he is a professor in the Department of Electronics and Tele-Communication Engineering, Jadavpur University, Kolkata, India where he is in charge of the Advanced Digital and Embedded Systems Lab. His research interests include ad-hoc networks, optical networks, wireless sensor networks, wireless and mobile networks and embedded systems. He is an author/co-author of the several published/accepted articles in WDM optical networking field that include "Adaptive Dynamic Wavelength Routing for WDM Optical Networks" [WOCN,2006], "A Heuristic Solution to SADM minimization for Static Traffic Grooming in WDM uni-directional Ring Networks" [Photonic Network Communication, 2006], "Genetic Evolutionary Approach for Static Traffic Grooming to SONET over WDM Optical Networks" [Computer Communication, Elsevier, 2007], and "Genetic Evolutionary Algorithm for Optimal Allocation of Wavelength Converters in WDM Optical Networks" [Photonic Network Communications,2008]. Fast Handoff Implementation by using Curve Fitting Equation With Help of GPS.
Email: mrinalnaskar@yahoo.co.in