An Adaptive VCT based Handoff Scheme for Mobile Base Station in Wireless ATM Network *

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Abstract

As broadband multimedia services and wireless services become popular, it is believed that ATM is widely accepted as a backbone network. In a small cell radius structure, handover occurs more frequently as the mobile base station moves. Therefore, it is necessary to have high-speed handover control.

To support network mobility, we introduce a new optimum handover scheme using the overlayered tree structure based on the virtual connection tree (VCT) for the handover involving several call connections. Then the handover delay could be reduced, we describe ATM signaling capabilities supporting this scheme and present UNI/NNI protocol extensions.

According to simulation results of static and proposed adaptive VCT schemes in the circumstance of mobile network, proposed scheme has smaller handover delay compared with conventional schemes.

1 Introduction

As broadband multimedia services and wireless services become popular, it is believed that ATM is widely accepted as a backbone network. To support user's mobility, fixed ATM protocol has been augmented with mobility management capabilities such as location management and handoff [1].

In order to solve the problem rerouting user connection in WATM handoff, many re-routing algorithms have been proposed. Schemes to support wireless ATM handoff could be classified into 3 categories [2]: connection re-establishment, connection modification, and handoff anticipation. In previous works, the performance of these schemes was compared. The handoff anticipation scheme has the best handoff latency at the expense of lower bandwidth efficiency of fixed network [3].

Based on the handoff anticipation scheme, we propose an adaptive virtual connection tree (VCT) handoff algorithm. Considering both mobile BS's moving speed and the number of active connections in mobile BS, mobile BS will choose the proper size of tree. In shared switch structure, one sub layer's switch is connected with two higher layer's switches. By adopting the shared switch structure, inter VCT handoff delay could be reduced.

The paper is organized as follows. Section 2 describes mobile ATM network model and our network model. Section 3 presents the proposed handover algorithm and signaling protocol. The comparison of our scheme with the conventional scheme is given in section 4. This section also describes handover latency, complexity and bandwidth requirements.

Finally, concluding remarks are given in section 5.

2 Network architecture

2.1 Mobile ATM network

ATM Forum defines the Wireless ATM reference

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configurations to support various mobility scenarios [4]. Figure 1 shows the scenario that the segments of the ATM network are in motion with respect to the fixed portion of the network. Here, we assume that the end-user terminals are not in motion relative to the platform. We introduce the mobile base station which is the small mobile network that has not switch in it. Mobile BS has one access point (AP). AP in mobile BS relays end user's signaling messages to AP in fixed network.

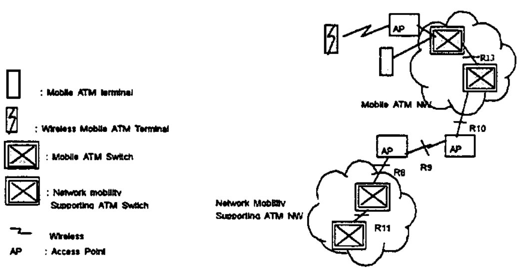


Figure 1. Mobile ATM network

Mobile BS has different characteristics from mobile end user. It has very high travel speed and has to support multiple independent calls simultaneously. Typical examples of mobile platforms include airplanes, trains, and ships.

2.2 Network Model

In other to provide seamless handover, we introduce shared switch structure by the EMAS. We will show that the shared switch structure can solve the inter tree handover delay problem.

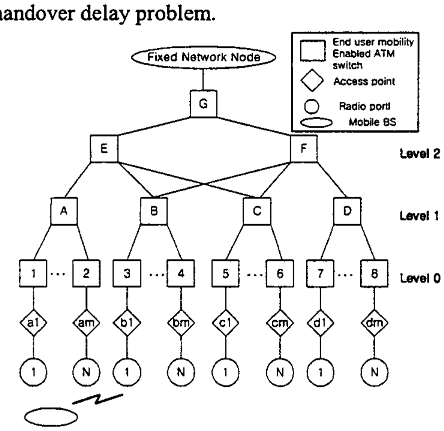


Figure 2. Network architecture

We assume a hierarchical and symmetrical network [3]. The network architecture takes the form shown in Figure 2. Above the AP, there are 3 levels in the network hierarchy and the level is characterized with the indices level 0, level 1 and level 2.

3 Proposed handover scheme

3.1 Handover requirements

Up to now most of previous handoff re-routing schemes do not support multiple connections and only consider mobility of mobile end user. To support the handoff involving multiple connections, the current routing schemes have to be modified. If multiple connections are processed sequentially, the handoff delay is the sum of rerouting delay for each connection. Tight delay constraints due to high travel speed will be more severe problem in mobile BS environment [5]. To provide network's segment's mobility a new handover scheme is needed and must be provided fast handoff rerouting algorithm. In this case, wired resource overhead could be relatively negligible problem.

3.2 Handover algorithm

Proposed handover algorithm is based on virtual connection tree (VCT) for the mobile BS involving several connections. A VCT consists of base station and wired network switching nodes and links [6]. At call admission time, root switch reserves the virtual connection number (VCN) between the root of the VCT and each base station of the corresponding tree. When mobile BS moves in the same neighboring mobile access region, there is no intervention of the network admission controller. Mobile BS simply transmits the ATM cells with appropriate VCN, so handover latency is the minimum.

We define two kinds of VCT type. First kind is layer 1 tree which has the level one switch as root. Second kind layer 2 VCT's root is the level two switch. A switch at a level one has the connections with two switches at level two. In proposed overlayerd tree architecture, a layer 1 tree is shared with two different layer 2 trees.

To decrease the inter VCT handover probability, layer 2 VCT is allocated to fast moving user. But increasing the size of VCT causes the larger inter VCT handover delay.

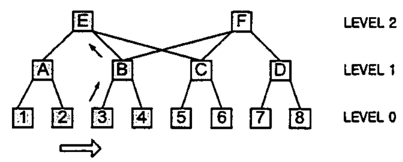
In this paper we adopt layered tree architecture to reduce the inter VCT handover delay.

Step 1: When mobile BS moves form switch 2 to switch 3, mobile BS experiences the intra VCT handover, if the layer 2 tree is allocated to mobile BS.

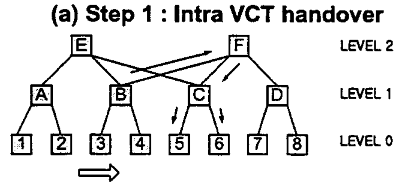
Step 2: Another level 2 switch F which has connection with level 1 switch B begins the tree reestablishment procedure

Step 3: Now new layer 2 VCT whose root is switch F is established.

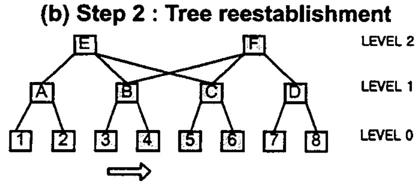
Proposed handover scheme separates call handover and VCT reservation procedure in wired network. Therefore mobile BS using layer 2 tree never experiences inter VCT handover.



(a) Step 1 : Intra VCT handover



(b) Step 2 : Tree reestablishment



(c) Step 3: Handover procedure completion

Figure 3. Handover procedure

3.3 Signaling protocol

The each call connection in the mobile BS has a different destination and call routing procedure has to be performed individually. But all active connections in the same mobile BS have the same mobility characteristic and experience the same handover. The cross over switch is correspondent to VCT's root switch. In proposed handover scheme, handover is performed with mobile BS level not with each end user level. So each end user's handover request and handover confirm messages can be aggregated into one mobile BS's handover message. As a result, handover delay decreases and air interference can be reduced.

To support new mobile BS's signaling protocol existing WATM signaling messages have to be modified. Further studies need to be carried out to specify the signaling protocol supporting mobile BS.

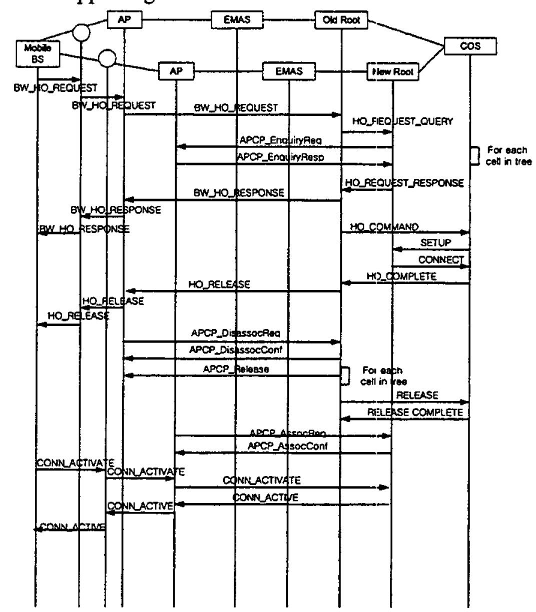
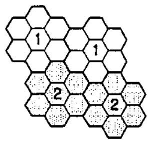


Figure 4. Inter VCT handover Signaling message for Layer1 scheme

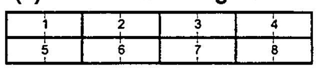
4 Simulation environments and results analysis

4.1 Simulation environments

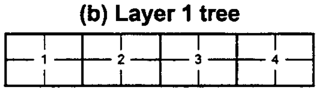
We assume that there are 7 radio cells in a switch. And there are two switches under the layer 1 tree's root switch. In this simulation, we have considered 16 switches in the network. Small VCT has two level 1 switches as shown in Figure 5 (b) and big VCT has 4 level 1 switches as shown in Figure 5 (C).



(a) Radio cell configuration



(b) Layer 1 tree



(c) Layer 2 tree

Figure 5. Network configuration

Also we assume that a mobile BS choose any one of the adjacent cells in the VCT and 30 percents of mobile BS moves fast. Fast moving mobile BS's average cell dwell time is about 0.5 to 4 minutes. Mobile BS with low mobility has cell dwell time more than 4 minutes. Average call holding time is 3 minutes, call arrival rate has poisson distribution with average value 1 to 10 call(s)/min and each mobile BS has 10 end users in it.

4.2 Processing time of signaling message flow

Before calculating handover delay, the signaling message flow processing times must be evaluated. In this section we will present flow processing times of signaling messages for the inter VCT handover [3].

Table 1. The number of signaling messages

Handover type	Number of signals	Delay[ms]
Layer 1 intra tree handover	16×N	93.9× N
Layer 1 inter tree handover	(50+5×C) × N	(278.15+187.7 × C) × N
Layer 2 tree handover	(34+9×C) × N	120.1× N

Table 1 shows the number of signaling messages during handover procedure in the consideration the new VCT reservation procedure. N is the number of active calls in mobile BS and C is the number of radio ports under the root switch.

4.3 Results and discussion

We consider the elapsed time from the handover invocation until handover completion as a measure of the handover algorithm performance. And for the measure of complexity, the number of signaling messages needed to perform a handover is considered.

Figure 6 shows the handover delay plotted against mobile BS's average handover rate and Figure 7 shows the number of signaling messages for handover. Proposed overlayered switch based adaptive VCT allocation algorithm has smaller handover delay compared with conventional scheme because our scheme prevents the inter VCT handover. But due to more frequent tree reestablishment, the number of signaling messages required is greater compared with the conventional VCT handover procedure. As mobile BS's speed is increased, a larger number of mobile BSs uses layer 2 tree. The layer 2 tree allocated mobile BS's ratio is increased and the average handover delay decreases.

Figure 8 depicts the measured time for handover operation according to the number of active user connection. Handover delay increases linearly with the number of active calls in mobile BS. Similar to previous simulation results, handover delay is reduced and the number of signaling messages needed to perform handover increases.

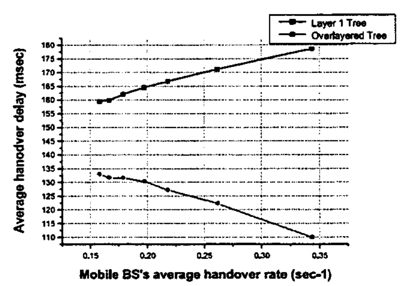


Figure 6. Average handover delay vs. Mobile BS's average handover rate

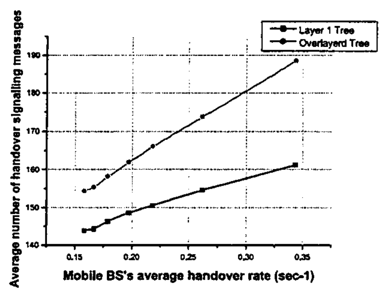


Figure 7. Average number of signaling messages vs. Mobile BS's average handover rate

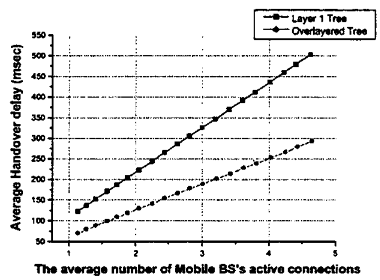


Figure 8. Average handover delay vs. Average number of mobile BS's active connections

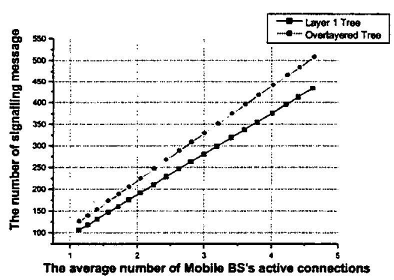


Figure 9. Average number of signaling messages vs. Average number of mobile BS's active connections

5 Conclusions

In this paper we designed the new optimum handoff scheme to support network mobility. For efficient group handover of mobile BS involving several connections, the end user's handoff requests in mobile BS platform are forwarded to fixed network's BS. For the communication between mobile BS and AP in fixed network, signaling protocols must be modified. In this work, we describe ATM signaling capabilities required for supporting proposed scheme and present UNI/NNI protocol extensions.

Considering both mobile BS's moving speed and the number of active connections in mobile BS, mobile BS would choose the proper size of tree. In shared switch structure, one switch is connected with two high level switches. According to the simulation results of static and proposed adaptive VCT schemes in the circumstance of mobile network, proposed scheme has the smaller handoff delay. As the number of connections in mobile platform increases, and the moving speed of mobile platform becomes higher, our scheme has better performance.

6 References

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