Wireless ATM – Routing And Real Time Delivery

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Abstract *. This paper discusses the potentials of Wireless ATM in the present Scenarios. It includes the description of the various issues in the field of Wireless ATM, particularly the rerouting issues in detail and the potential future works which need proper considerations. Wireless ATM technology is becoming a dominant one in the present days as it has the capabilities of supporting a range of services, ranging from time –sensitive, Real time to Bursty traffic. This Paper sketches a brief overview of the Wireless ATM, the issues in the Wireless ATM technology and concentrates particularly on the Routing and the Real time data Delivery.*

1. Introduction

The need to support more demanding applications , like the multimedia, voice conversation in parallel to the normal bursty traffic , has taken the attention of many researchers . Some of the recent topics in the field of Wireless ATM are Connection rerouting schemes, Route Optimizations, Lossless Handovers, Mobile Multicasting in the Wireless ATM, Quality of service over wireless ATM, Buffering techniques for lossless Handover in Wireless ATM, develop an efficient protocol that will run on the wireless medium without much of the delay and error. Till now no standard protocol has been made by the ATM Forum or the ITU-T as they are trying to get the High speed networks work without error and with a higher speed. The Wireless networks of the ATM-type are certainly going to play a very important role in the broadband communications network of the future. [1]

1.1 ATM Overview

An ATM network consists of fast packet switching systems linked via point to point links to each other and to their terminal nodes. An ATM packet is a 53 byte packet with the 48 bytes of data and 5 bytes of the control information. There is a point-to-point connection setup between the two hosts before any data is exchanged between them.

It is during this initial connection setup that the desired level of service between the hosts is put forth to the ATM network and if the network is able to support the desired service only then a reliable, guaranteed, point to point network is set up between the two hosts. An ATM network on a wired network has been till date guaranting all these features, but when we look at the Wireless ATM, the procedure for the initial connection setup is the same, But what happens when there is a Mobile Host and after the initial connection setup he changes the position? , How is the rerouting of the Connection taken care off smoothly? These are some of the issues which we would be exploring in this paper .

Wireless ATM, as opposed to the traditional Ethernet is different in that in the Traditional Ethernet the sharing of the medium is random, whereas in the Wireless ATM the sharing of the medium is at the discretion of the switch .The switch requires information about the needs of the End terminals in order to allow a particular connection to setup. The switch will give access to the medium only if it finds that the new connection will not degrade the already setup connections. The finite buffers in the switches do drop the packets sometimes, but this is concealed by the ATM Adaptation layer (AAL) because of its capabilities to retransmit and reconstruct the packets. Some of the other functions of the AAL is to re-assemble the received frames and to segment the frames into cells. The different flavours of the Adaptation layer that are now popularly used are the AAL0 , AAL1 , AAL2 , AAL3/4 , AAL5. These differ in terms of the type of service which they provide/support. One of the examples which uses a combination of the AALs is a video conferencing application, where the transfer of voice uses the AAL1, the transfer of video uses the AAL2 layer and the data transfer uses the AAL5.

1.2 Wireless ATM

Wireless ATM is an extension to the Wired ATM, with the aided concepts of Mobility and the already existing features of reliability and the capability, to provide on demand support to many different traffic types with different quality of service aspects. Also Wireless ATM systems are typically based on cellular network layout with very small cells (micro or pico). Hence due to the small cell size, handover between the radio cells will be very frequent [3]. The mobility aspect forces a decoupling of the normal mapping of node and switch port. Instead, a wireless access point "connects" the set of wireless nodes, it services, on a single port of the ATM switch [2]. [3]
Two dominant approaches can be identified for the integration of wireless ATM to support a fixed ATM network. At one extreme, wireless ATM is viewed as an overlay to the fixed infrastucture.In such an approach , mobility support is mostly implemented using separate network elements specific to the mobility. The other approach is to view Wireless ATM as an integral part of an ATM network.In this case , the ATM switches are enhanced with mobile specific features. The resulting switch can support both mobile and fixed users and no special types of switches are required to support mobility.In this case, the fixed ATM network becomes a shared switching and transmission infrastructure for both fixed and mobile users. The access point is connected to an ATM switch over an ATM UNI interface. The switch in turn is shared between fixed and mobile users. In addition to the connection control functions located with in the switch , some mobility related functions like the location management and the terminal authentication , etc, are required.For interaction with the Mobile terminal , the switch uses an enhanced version of the ATM UNI signaling protocol for connection control and handover. In addition to this, an additional protocol called as the Access Point Control Protocol (APCP) is used. The APCP allows the switch to interact with the access point duration connection set-up and handover.

As the focus of this paper is on the routing issues, we shall concentrate more on that.
We shall study the issues in routing in section 2 and the various rerouting schemes in the section 3, with a deeper study of the two of the schemes and in section 4 the simulation results of the two schemes are discussed, followed by the conclusion.

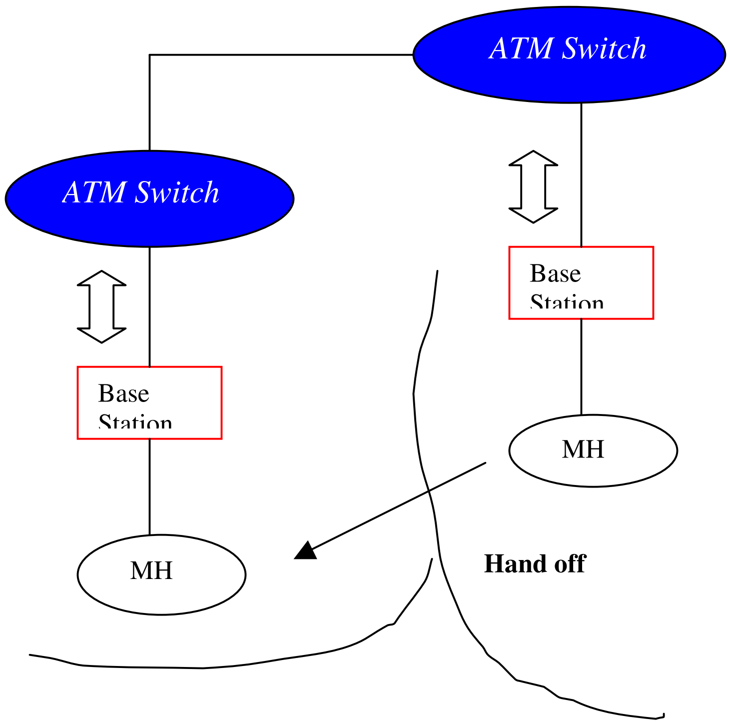

Fig 1
Basic Scenario in the Wireless ATM

2. Issues in routing

ATM, being a connection -oriented means of transferring the data, requires that a connection d be setup before any kind of transfers. As the mobile user moves, The ATM connection needs to be modified (or rerouted) to support seamless communication. [4]. Some of the important issues during this connection rerouting are, the new path which is selected for rerouting has to be Optimal and it should not lead to triangular routing or any kind of looping, the lossless handoff issue, which deals mainly with the reduction in the number of packets lost due to handoff, the handoff delay (the time interval between moving to the new location and start receiving ATM cells) [4]. Some of the other issues which we need to take care while developing any kind of the rerouting scheme is whether the ATM cell sequencing is maintained by a rerouting scheme or not, the rerouting scheme that can be supported by the network configuration (infrastructure or ad-hoc or both).

3. Connection Rerouting Schemes

Some of the major connection rerouting schemes are mainly based on: (a) Connection re-establishment [5]– the new connection that is established after the mobile user has moved. (b) Connection extension [6] – extending the connection to the new location where the mobile user has moved. (c) Anchor switch routing [7] – keeping the part of the route unchanged to the switch and then modifying the path from the switch to the new location. (d) Dynamic rerouting [8]- rerouting the connection while the mobile host is on the move. (e) Hybrid schemes [9]- Combining of the two or the more routing schemes. (f) Setting paths in advance for communications in the wireless network [10].

Most of the research in rerouting or handoff management involves the use of connection extension, dynamic rerouting, connection tree or hybrid schemes [4].

In the connection extension mechanism a novel Homing algorithm has been proposed, in which, as the mobile user moves from its current location to a new location, the initial routing of the packets to a destination node is done through the old base station (which was also the Initial Home base station) and also slowly the current base station is updated so as to make it the Home base station of the Mobile user and there after all the cells are directly send from the new Home station to the destination and the same is applicable to the Destination Home base station. This scheme also preserves the sequence of the ATM cell without any kind of a central sequencer or without any kind of re-sequencing at the destination. The base station should have some kind of mechanism to decide upon an optimized path before the extension of the path. [4]

In the dynamic rerouting scheme [8] a common switch is found between the path from the source to the old base station and the new base station, this is a cross over switch, this helps in making less changes in the new path, but also leads to some delay, in order to determine the new crossover switch (COS) and make changes in the COS for the new connection. This is one of the most popular schemes and a lot of work has been done in this. In [8] the authors have proposed a hierarchical rerouting (HRR) scheme for the handoff .In this scheme the Crossover scheme is determined in an hierarchical manner. In this the discovery of the crossover switch, one needs to have a proper understanding of the PNNI (private network to network interface) standards. The hierarchical scheme as opposed to the flat scheme decreases the handoff latency. The discovery of the crossover switch also depends a lot on the network configuration. [4]

The Virtual tree based scheme [15] consists of a Root switch (RS), which is the root of the virtual tree, the other switches connected to it are branches, as in a tree structure, to these switches a base control switch is connected, which supports a collection of base stations which in turn support the mobile hosts. Each base station controller has a radio access system (RAS). In this kind of a scheme if the mobile host does a handoff from one base station to another base station with in the same radio radio access system then the procedure for the new connection is very simple as whenThe handoff is between the two RS (inter RS handoff).

If the mobile user movers to another base station with in the same RAS, after the initial permissions to connect into the virtual tree, it sends a Virtual Branch number (VBN), which sets up a path between the RS and the base station and the mobile user receives all its data on this

Virtual Branch, now if the mobile user changes to another base station all it has to send is a new Virtual branch number, as opposed to this if the mobile user moves to another RAS the connection admission control function will have to be called and all the resources with in the RAS will have to be investigated to see if the RAS can support the new users resource demands and hence the work involved is more. [4] In brief this is more like an advance path setup scheme in which the ATM connections are setup before a mobile host moves into a new location .It mainly involves the setting up of a complete tree of paths covering several neighboring cells and then the rerouting is performed by the host selecting a different branch of the tree by using a different connection number.

There are routing schemes that are prediction based, in which the algorithm sets up the new path in advance, based on the moving pattern of the mobile user. Such schemes however show efficiency only if there is efficiency in the prediction [4, 12].

The hybrid scheme uses the advantages of more than one scheme, by using a combination of schemes. For example, the Rearrange ATM Connection (RAC) and extend ATM connection scheme (EAC)[4, 13, 14] is based on connection rearrangement and extension, kind of a Hybrid scheme. This scheme introduces an entity called as Network Call Processor (NCP), which handles the re-routing requests. The NCP works in collaboration with the Base stations, i.e. if the NCP is experiencing load due to the already existing connections or due to the unavailability of the resources to guarantee the quality of service for the new connection, or the already queued requests, then it broadcasts a message to the base station to take care of the rerouting by means of the connection extension scheme. In this scheme the NCP broadcasts the information or its state periodically, so that the base station will know when it has to use the connection extension scheme in order to handle the recent re-routing request. In this scheme the NCP first looks at its load factor and if it is able to support a particular request, an RAC algorithm is run. As soon as the Mobile host moves into the domain of a new base station, and sends a request to the NCP, the NCP runs the RAC algorithm and divides the ATM switches into four sets, namely the YN (were there but not needed anymore), YYc (were there and still needed with change), YYn (were there and still needed with no change), NY (were not there but needed now). The NCP then fills in the information of these sets with respect to the present reroute request and then REARRANGES the routing table information for the switches which need to change and now point to the new location. There are various criteria by means of which the NCP will take decisions while forming the new route for the Mobile host; these are mainly in terms of the number of messages that can be exchanged, or the number of switches along the route. Now, if the NCP is not able to accept the request then the base station will implement the EAC algorithm to run and fulfill the request requirements. In this the current base station will request the new base station to extend the ATM connection and in return also asks for a list of all the base stations that are previously connected to the new base station. Whenever there is an extension of the connection through the base stations there is always a possibility of the looping and the triangular routing problems. A general algorithm proposed [4] takes care of that and makes the routing more efficient .In this algorithm the new base station checks if it would be able to provide the requested quality of service and also checks for any kind of loop formations and triangular routings and then runs the part of the algorithm that takes care of the looping, as soon as the looping is experienced the new base station stops forwarding the ATM cells and then sends a marker cell followed by an EXTEND-CONNECTION message, to the current base station and then after recovering the ATM and the marker cells, the new base station sends the LOOP-CLEARING message to the current Base station . In order to take care of the triangular routing problem the new base station sends the REQUEST-REROUTE to the neighboring base station and if the neighboring base station can provide the quality of support that is required, the neighboring base station stops forwarding the ATM cells to the new base station and then sends a marker cell and then the new base station sends an EXTEND-CONNECTION message to the current Base station and after recovering the ATM cells and the marker cells the new base station sends an REROUTE message to the current base station. But if the quality of service cannot be provided by the neighboring base station the new base station sends an EXTEND-CONNECTION to the current base station.

Two schemes for Route Optimization are proposed in [12], in which a route optimization algorithm for the ATM networks based on the PNNI (Private Network-to-Network Interface, provides a solution to the Handoff management problem. The first scheme is a one-phase scheme in which the rerouting procedure is integrated into the handoff procedure. A second solution is the two-phase method, in which the fast handoff are taken care by a sub optimal routing and then optimization to this route is done The new proposed procedure for route optimization scheme is for the connection oriented networks and requires that a connection be set up between a Cross over switch (COS) and one of the ends of the connection in order to reroute a connection and to transfer the user data into the new switching from the old path, without the loss of ATM sequence.

The route Optimization algorithm involves four steps in order to solve the base rerouting problem (a) to determine the crossover node (b) to establish a new connection between the new base station and the COS (c) Switch the user data from the old segment to the new one (d) and finally release the old connection between the COS and the old base station. [12] Out of these the determination of the crossover node is an important one .In this an Optimal cross over node is chosen and as much overlap as it is possible between the old and the new paths is achieved .Two aspects of the PNNI based networks that are fundamental to this procedure are: (a) every node only has summarized information regarding the topology of the network with in the peer group (nodes outside of a peer group do not have information regarding the internal structure of that peer group) and (b) connections are routed using hierarchical routing.

In order to find an optimal crossover node, the nodes need to have an exact picture of the relationships at the ancestors-are-siblings level in the PNNI hierarchy, and hence three scenarios are considered by the algorithm to calculate an optimal cross over node. (a) A case in which the new base station is close (closeness in terms of the levels in the hierarchy) to the old base station when compared its distance from the far end to itself, in this case an optimal crossover node will be the ingress border node of the ancestor–are-siblings peer group. This is because of the fact that in a PNNI network, nodes have information about the members of only their group and do not have information about the nodes outside their group and thus an exact location of the nodes that are reachable from their peer group cannot be determined. (b) A case when the old base station is closer to the far-end, when compared to distance between itself and the new base station, in this there is no portion of the old connection that will remain the same for the new connection and the far end itself is considered as an optimal crossover node, and hence the new connection is established all over from the far end to the new base station. (c) A case where the new base station is closer to the far-end or the new and the old base stations are equidistant to the far-end station, in this situation there is no segment that would be common to both of them and hence once again the far-end station is considered as the new crossover node.

After the determination of an optimal crossover node the setting of the connection between the optimal crossover node and the new base station takes place, now the identity of the optimal crossover node is obtained by examining the detailed path of the existing connection and if the process of route optimization was started by the new base station then a connection is setup between the new base station and the optimal cross over node, if this process was initiated by the old base station, then the old segment is tracked back till the optimal crossover node is reached and then a new connection is set up from that cross over node to the new base station.

Let us consider a case when there are frequent handoffs, that is a mobile host changes its cells frequently, this is called the second phase route optimization, in this scheme the route optimization is done only after a couple of handoff have been done. In the two-phase scheme, the first phase determines a sub optimal route to the new connection and if there are more handoffs, a new sub optimal route is selected and then after a couple of such handoffs the route optimization routine is run. The Optimization is the second phase and consists of four steps (a) the determination of the connection segment, to reroute and the corresponding target node or the new base station is selected. (b) The determination of the crossover node and the setting up of the connection between the crossover node and the new base station. (c) Switching of the old data path to the new path. (d) Releasing the connection between the old base station and the crossover node is done.

Another aspect for rerouting, which is mentioned in [12] is dynamically determining the crossover node and determination of an optimal route while setting up new connections to the new base station. This is called as the one phase dynamic Crossover switch search handoff scheme. This scheme also has the four steps of determining the crossover node, setting up the connection between the crossover node and the new base station, then directing all the data to the new base station and the releasing the old connection by some way of signaling. The process of determining the crossover node is already discussed; let us have a look at some of the aspects of switching the user data from the old to the new path and the releasing of the old connection. This procedure depends on the type of the desired handoff, if the desired handoff is of lossless, (that is there should be no loss of the cells) type and the sequence of the cells be maintained, then a different approach is taken, were in the "Tail " signals and buffering is used to switch the user data from the old path to the new base station .Now depending on the type of the hand off, whether the handoff is soft (where in data can be send to and received from both the old and the new base stations)or hard(data cannot be send or received from the old base station) the routines are run. The soft handoff is same as the case in the two phase scheme except that in the one phase scheme the mobile node is the source node that participates in the switch over as opposed to which in a two-phase scheme the mobile node is the new base station. During the hard hand off a "Tail" signal is sent from the cross over switch to the old base station and all the cells that are buffered into the old base station are sent to the crossover switch, as soon as the crossover switch receives the buffered cells from the old base station, it immediately forwards them to the new base station and for all the subsequent cells which are buffered at the crossover switch itself, a "Tail2" signal from the old base station is awaited for, and only after the reception of the "Tail2" signal the cells that are buffered at the crossover switch are then forwarded to the new base station.

4. Summaries and Conclusions:

In this paper I have discussed the various routing schemes that are currently developed, in order to have an Optimized route in the Wireless ATM when ever there is a hand off. I have Summarized (Fig 2) the advantages and the disadvantages of two [4][12] schemes.

After looking at the various schemes for rerouting in wireless ATM, I suggest that the hybrid scheme could be a good solution, taking into consideration the advantages of more than one scheme and coming up with an efficient route.

Routing Scheme	Advantages	Disadvantages
[4] RAC + EAC	1. Optimal Routes 2. NCP – Simple to implement 3.NCP–bandwidth efficiency	NCP - More Processing intensive. EAC - Inefficiencies during the routing. EAC - complex base stations will be required.
[12] Hierarchical routing	1.More scalable	Processing time is more in order to calculate the crossover switch

Fig 2
Summary

5. Future work

With the increasing popularity and the power of the portable computers and wireless LAN applications, particularly the multimedia being an integral component of all the evolving new applications, ATM based wireless access applications are becoming highly desirable.

The most important issues in the design of wireless ATM systems are the issues to be dealt at the physical layer, the issues at the data link layer, the multiple channel access issues and of course the mobility management issues.

The problem of the mobility management depends upon a number of factors, like the network configuration, the structure of the network, the demands of the applications which are to be served by the network, the quality of service requirements, the mobility pattern of the mobile user, the quality of the radio signal strength, the internetworking of the networks and so.

With such a large variation in the demands from the different types of applications and the a variety of the Local area networks, Some of the possible issues which can be considered for future works are, the joining of the networks different types of routing schemes and forming an internetwork, the reduction in the processing delay while selecting an optimal route, the reduction in the handoff delay, the QoS issues in the Wireless ATM, the recovery mechanisms, in case there is a failure in the switches, base station , or the mobile users.

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