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Simple Mobile ATM

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Abstract
We show how an existing private ATM network can be simply transformed into a network with basic user mobility support by using the standard Simple Network Management Protocol (SNMP). This new application of SNMP allows mobility without changes in the signalling protocols of either the user or network side. Initial results of implementing the new technique on a home location server are presented.

I. INTRODUCTION

Narrowband mobile telecommunication has already penetrated everyday life, e.g. mobile telephony, and with the movement towards mobile broadband systems for supplying mobile multimedia services, new network architectures are already being discussed within the framework of IMT-2000/UMTS [1]. Consequently the upgrading of ATM to support mobility is currently undergoing serious discussion [2]. There are two types of mobility. The first, supported in this paper, we may call weak mobility and allows connection anywhere in the mobile enhanced network from a stationary position. The second type, full mobility, also includes handover while moving within an area covered by a wireless enhanced mobile network. End-user mobility with handover, in a fixed ATM network, may be achieved in the future by mobile enhanced ATM switches together with signalling extension (UNI and PNNI) or partitioned address space [2]. However, until this happens a simple solution for existing ATM networks is required and weak mobility may adequately satisfy many broadband End System (ES) users.

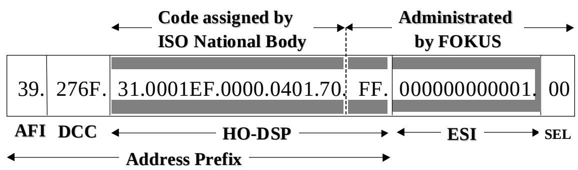
We implemented end-user mobility in our existing ATM network by allowing the ES to access the network at different locations and automatically invoke registration over an implemented Home-Location Server (H-LS). The proposed mobility is scalable/extendable to larger ATM networks as user/network signalling extensions are not necessary and the ATM application and ATM switch are unaware of the mobility. Moreover, SNMP is used for the mobility management, leading to minimum overhead within an ATM network using this method. In general we believe it may help network administrators to simplify ES movement to new access points, even in the case of fixed to fixed access movement. In this paper we are mainly interested in mobile registration and location update; handover will be addressed in future implementations.

This paper is organised as follows. Section II describes the implemented mobility using partitioned addressing, a similar scheme to that used by GSM, and the SNMP based H-LS. Section III demonstrates a mobile scenario in the private ATM network at FOKUS [3] including measurement results of the maximum speed of mobility management.

II. THE MOBILITY MANAGEMENT

A. The addressing format used for the mobile ES

Figure 1 shows the 20 byte OSI-Network Service Access Point (NSAP) mobile ATM-ES address format used. This format uses a 13 byte prefix based on the Data Country Code (DCC), a six byte End System Identifier (ESI) and a one byte SELector (SEL) allowing differentiation between multiple addresses at the same interface.



AFI: Authority and Format Identifier
SEL: SELector (not used for routing)

Figure 1 The 20 byte DCC-AES OSI-NSAP numbering format as used for the mobile demonstrator (MT 1, see Figure 2) in the private ATM network at FOKUS [3].

The High-Order Domain Specific Part (HO-DSP) assigned by ISO to national address registration authorities allows not only a variable level of hierarchy at any bit position [4], but also maintains the possibility for a private numbering plan which is organisationally based. For the FOKUS network [3], the globally assigned HO-DSP (indicated in Figure 1) are the first 9 bytes. The remaining byte is internally managed and the hexadecimal code FF is used to indicate the mobile user address space. The address partition in the address prefix includes the following:

- Within the private network this address can belong to any switch.
- Address aggregation. As it is fixed to FF a highest common peer group ID for all the mobiles is possible. This is important for the scalability of networks.

The switches within a hierarchical level have in general a complete view of the peer group by using PNNI Topology State Elements (PTSE), and are flooded between the switches. In general each switch may then have the complete NSAP addresses table. PNNI routing only operates on the first 19 bytes of the address and uses longest prefix matching to determine the route. Between the two peers as shown in Figure 2, the PNNI hierarchy level bit value could be set to 96.

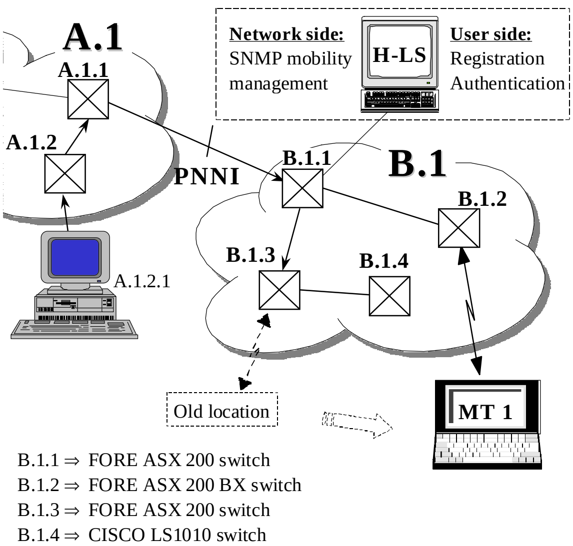


Figure 2 Mobile end-system changing access point within the private ATM network at FOKUS.

For fixed ESs, address registration is started automatically using the Interim Link Management Interface (ILMI) protocol [4], where the ESI is often the corresponding Media Access Control (MAC) address of the ES. However, to obtain mobility in a private network the mobile address registration and setting is managed by the H-LS which uses SNMP like ILMI.

The setting of an address immediately triggers a corresponding PTSE update if since the last update the minimum interval default value has expired. Although the ATM Forum specifies a minimum update interval of 0.1 to 1 second [4], the PTSE update speed in the whole network depends on many factors such as node processing, link speed, network topology, etc.

B. The tasks of the home location server

The H-LS as shown in Figure 2 currently supports the following:

- Mobile Terminal (MT) registration
- Authentication
- Location update

whilst further work will examine the implementation of handover and the possibility for foreign MTs to register with location update within their home network.

The H-LS provides the interface between the user side, which has to do with the MT registration and authentication, and the network side which is allowed by using SNMP to set and delete addresses within the network on all its ATM switches. SNMP in general can run over ATM or Ethernet and in our network the H-LS has used the existing Ethernet connection to the switches.

III EXPERIMENTAL RESULTS

A. Mobile ATM scenario

If an MT gets connected to an ATM switch, the SAAL is established and ILMI will supply the mobile terminal with a temporary ATM address to establish a connection to the H-LS, as indicated in Figure 3. At the moment the H-LS address must be configured manually at the MT until UNI 4.0 ANYCAST is implemented.

Also shown is the signalling and data exchange between the MT and the H-LS. After a connection has been established, the MT sends its temporary ILMI address together with its global/local mobile address and authentication key to the H-LS. The H-LS then verifies its home location register to see if the mobile address is known and whether authentication is correct. At this point the H-LS would, if the MT is from a foreign network, send an authentication and location request to the foreign network and wait for the reply. If authentication is verified, the H-LS will set the mobile address on the switch via SNMP. The address table is usually located in the enterprise subtree of the Management Information Base (MIB) and therefore may differ from switch to switch. Finally the H-LS can inform the MT that its request has been permitted and it can be now reached under its mobile address at the new location. With the address set in this way the routing to the MT will always be via the optimal path.

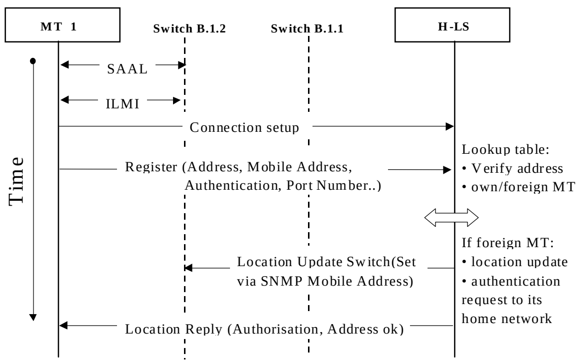


Figure 3 The signalling necessary for MT location update and registration.

Figure 4 shows the temporary ILMI address and NSAP static route address of the MT on the switch B.1.3 and B.1.2 before and after its relocation respectively. In the case of a foreign MT, the H-LS in the foreign network has to route incoming calls to the mobiles current network as the address HO-DSP will be different.

There are now two ways to perform mobile de-registration:

- The MT de-registers itself by sending a message to the H-LS.
- When the MT gets disconnected from the switch the H-LS gets a release for the data connection.

If handover is required, a short term solution would be to set the MT's mobile address as an additional address on the port of the H-LS. Information is then sent (tunnelled) to the MT's current address. This allows handover as the H-LS keeps control over where to send/tunnel the data, but if there are many MTs with handover requests the H-LS capacity may not be sufficient.

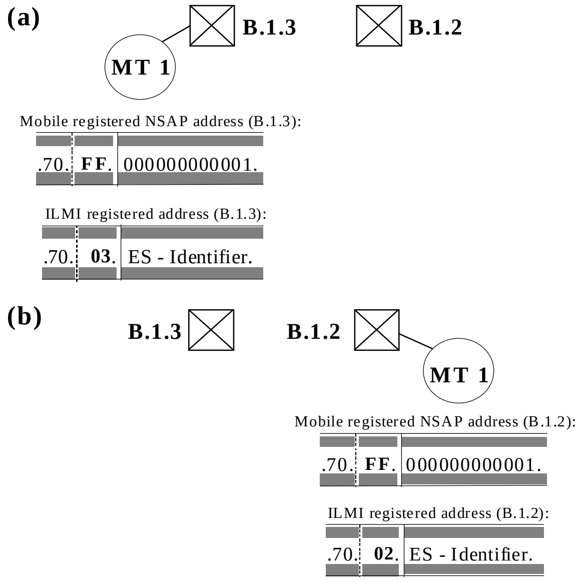


Figure 4 NSAP static route address and ILMI registered addressed in (a) before movement of the MT and in (b) afterwards.

B. The mobile registration time

Figure 5 shows the maximum time needed for the MT until it is again reachable at its new location under its mobile address. Also shown are the individual times needed for ILMI registration and the SNMP address manipulation. The switches used were manufactured by Fore and Cisco, see Figure 2, and the time difference in MT registration/location update between these was negligible. The time needed for the PTSE flooding to all the switches depends in general very much on the network topology, switch processing time, etc, and may vary from a few milliseconds up to one second in the worst case. Since our mobile network uses partitioned address space the PTSE address update is only necessary within the local peer.

For the current implementation the ILMI registration and SNMP setting of the mobile address is the most time consuming, assuming PTSE flooding occurs fast, whereas the setup and data transfer between the MT and H-LS occurs in a few milliseconds and can be neglected. This may not be the case for an MT from a foreign network where the processing and data transfer time may increase. The total time, worst case, of about 4.5 seconds has been acceptable in our scenario as the focus has been on the reachability of mobile ESs at different locations within the mobile enhanced network. This time will be reduced in future implementations by triggering the ILMI update as soon as the SAAL is established and by eliminating the use of a general purpose SNMP tool, thus eliminating the parsing of the textual MIB.

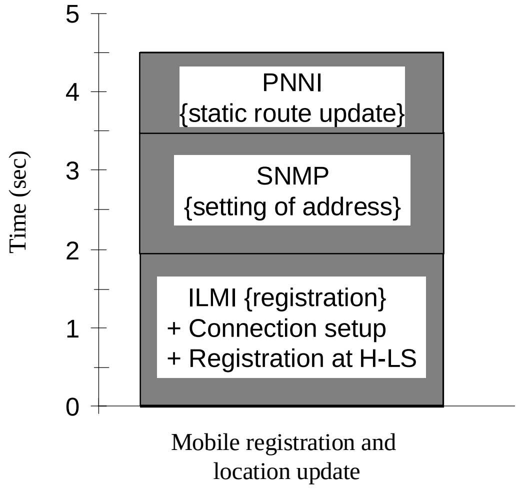


Figure 5 Worst case time for MT location update. Also shown are the individual times needed for ILMI registration and the SNMP address manipulation, whereas for the PNNI update interval the worst case of one second is shown.

IV CONCLUSIONS

We have shown that through the use of an SNMP based H-LS, mobility in existing ATM networks can be achieved by simple means. This may not only help network managers to allow people to connect their ES at different locations any time, but may also be useful as a basis to study more advanced mobility concepts, e.g. hierarchy level of location update or handover, and their feasibility as currently discussed in the ATM Forum [4]. We have:

- Shown mobile ES scenarios in a real ATM network with no mobility support, where standard ATM signalling UNI and PNNI does not need to be changed.
- Measured the speed of mobile registration, where ILMI and SNMP were shown to be the bottleneck in the current implementation

We believe the basic mobility features, as discussed above, within a local network may satisfy mobility requirements of many ES users. A further advantage of the described mobility management is that there is no large management overhead. Moreover, routing to the MT, within the peer, will always be via the optimal path.

Further work will examine:

- The support of handover in a private network.
- Allowance of MTs from foreign networks to register by implementing a foreign location service.

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