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Signalling for a Wireless Mobile Broadband System Demonstrator

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Abstract

This contribution gives an overview of the concept for the signalling information flow and the interfaces of the wireless mobile broadband system trial platform for the ACTS project SAMBA (System for Advanced Mobile Broadband Applications).
Besides the architecture and protocol stack of the system this document describes message sequence charts for a number of basic functions within the SAMBA trial platfrom, i.e. login of the MTA (mobile terminal adapter) to establish basic signalling, call setup toward the MTA, call setup originated from the MTA, connection release and basic signalling connection release.

1 Introduction

The main objective of the SAMBA project is to promote the development of a broadband radio extension to the IBC (Integrated Broadband Communication), thus allowing the use of broadband multimedia services by mobile users.

Keeping this objective in mind, besides the support of reliable wireless ATM transmission, the integration of the radio access system into the B-ISDN is the major task. In that respect, additional functions are required to support mobile users.

The reference architecture of the SAMBA trial platform is shown in Figure 1. The trial platform supports wireless terminals operating in two different modes. In the first operation mode (Mode 1) the wireless mobile terminal adapter (MTA) supports the user network interface as known from regular ATM networks. Therefore the ATM Terminal is a conventional user terminal which runs the user network signalling and the user application. A second operation mode (Mode 2) is supported which allows direct connection of user equipment without user signalling support. In this case permanent virtual connections (PVCs) are used.

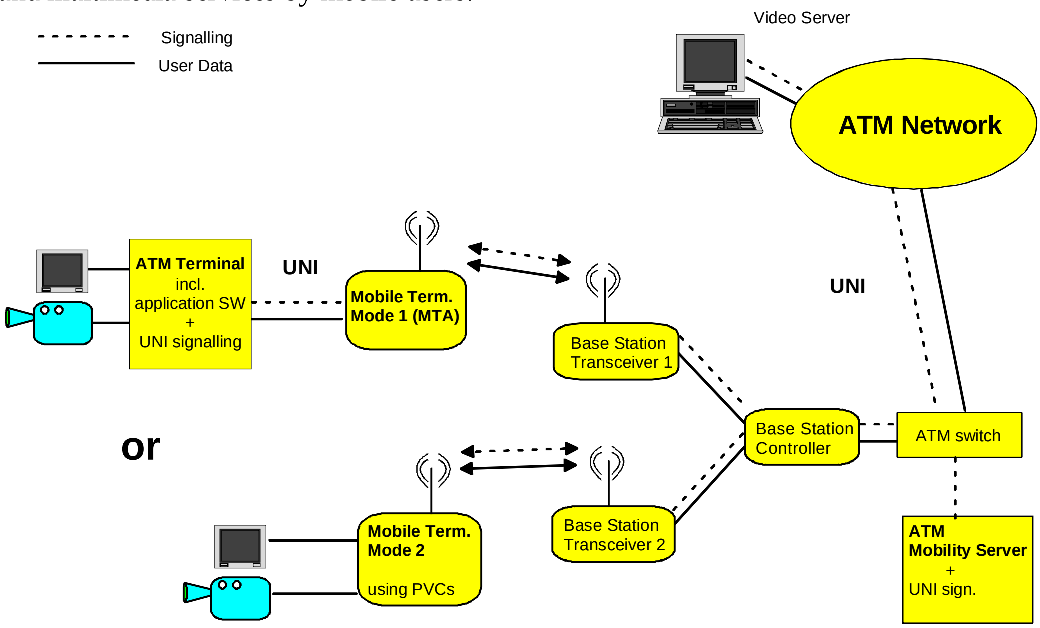

Figure 1 : SAMBA System Trial Architecture

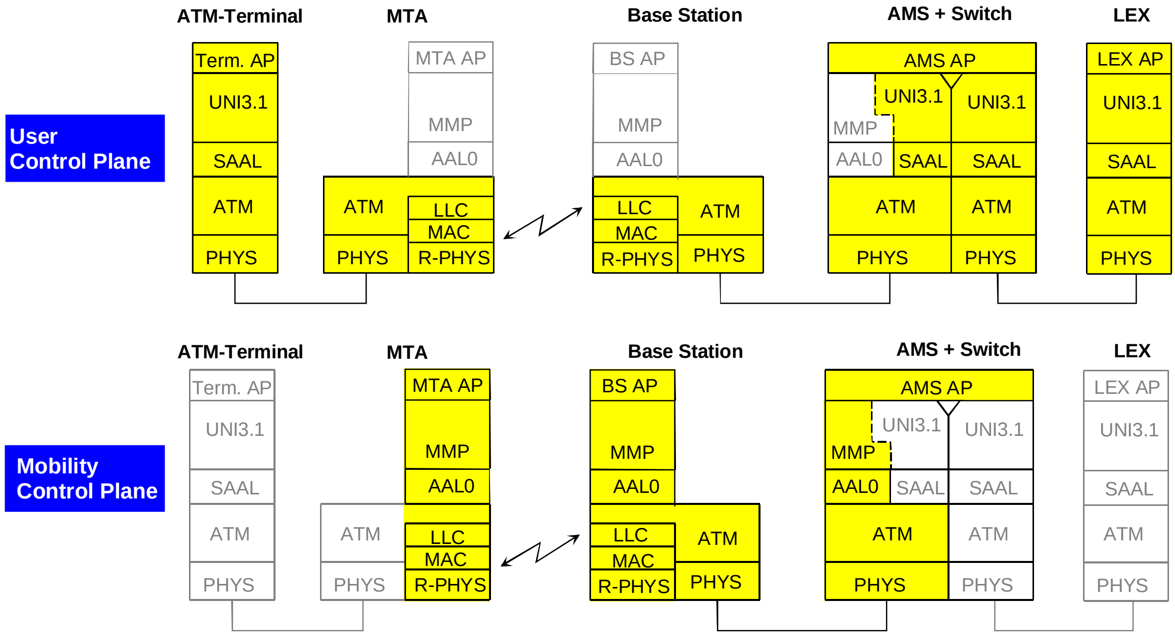

Figure 2: Protocol Stack of Control Planes

The terminals are connected via the air interface to a Base Station Transceiver (BST) for each cell of the system. The transceivers are connected to the Base Station Controller (BSC) which controls the radio connection to the mobile terminals. This also includes handover and random access of the mobile terminals. In the following only the BSC is considered. The BST is not involved in the signalling, thus the term BS (Base Station) is used for the radio access system.

The ATM switch supports routing of ATM cells and connects the radio access system to a local exchange of the public ATM network. The necessary control of the switch and the signalling to the user as to the network is terminated in the ATM Mobility Server (AMS). This server also provides the mobility functions of the higher layers and the network resource management. Besides the user data flow the signalling flow of the system is shown in the figure.

2 Protocol Stack

The protocol stack of the ATM control plane distinguishes between the User Control Plane and the Mobility Control Plane (Figure 2, active functions depicted in grey). The User Control Plane serves the UNI signalling of a standard ATM terminal. The AMS is the peer entity of the (mobile) ATM terminal and handles the communication with the local exchange (LEX) of the ATM network.

Mobility and radio resource management is supported by the Mobility Control Plane. This plane provides the functions to assign radio resources and to establish transparent radio connections for signalling (UNI) as well as for data of a mobile user.

On top of Figure 2 the User Control Plane is depicted. The ATM Local Exchange (ATM-LEX) has a standard ATM configuration. The Call Application Layer is supported by the UNI 3.1 signalling layer which provides the user to network interface procedures for call setup and maintenance. As in a regular ATM network UNI 3.1 relies on the SAAL service which is located above the ATM Layer. The ATM Layer provides the access to the Physical Layer.

To the network the AMS uses standard UNI 3.1 ATM signalling. Therefore the same protocol stack as in the LEX is used in the AMS. Logically the Mobile Terminal operates only as a terminal adapter. The ATM Terminal is also able to use the standard ATM signalling protocol which is terminated in the AMS. The transport of ATM cells (user data and ATM signalling) over the air interface is controlled by the Media Access Control and Logical Link Control Layer (MAC/LLC)[2]. This layer support an error protected transport of ATM cells and multiplexes several mobile connections over the air interface.

As already mentioned, besides standard ATM signalling, specific signalling for mobile broadband systems is employed in the Mobility Control Plane. This special signalling is necessary to control the entities added to a standard ATM system for support of the radio access and mobility. It incorporates procedures (Mobility Management Protocol, MMP) to locate mobile users and to maintain radio connections during handover. These MMP functions served only in the mobile terminal adapter (MTA) and in the base station are controlled by the AMS. Hence, the standard ATM terminal is not involved in the mobility relevant protocols and needs no modification.

Besides standard ATM procedures the AMS Application Part (AMS AP) supports the control of the BS and mobility functions necessary for a wireless system. From the AMS to the BS the AMS AP communicates to the BS Application Part (BS AP) via AAL0 and supporting protocols. The MTA on the other side is controlled by the BS and the MTA AP communicates to the BS AP using AAL0 and supporting protocols. Note once again that the ATM Layer relies on the MAC/LLC Layer when using the air interface.

3 Signalling Procedures

In this section the signalling flows are depicted. To give a brief overview of the signalling flow in whole the most relevant messages with their parameters are shown regardless of the protocol layer they belong to. This gives a good overview of the time behaviour of the system signalling. These signalling procedures are shown for an MTA in Mode 1. For Mode 2 permanent virtual connection between MTA and AMS/switch are used.

3.1 Establishing Basic Signalling Link for Mobility Management

In Figure 3 the login of the MTA (Mobile Terminal Adapter) is depicted. This procedure is invoked by the MTA when being switched on or when getting in contact with the network.

Going through the signalling flow the MTA first sends the MM_Assign_Req via the Random Access Channel, as this is the first contact to the network. The MTA is identified by a MobileId. The BS sends the request for the Basic Signalling Link to the AMS which assigns a Signalling VPI/VCI for the MobileId.

The VPI/VCI used for signalling is then reported to the BS, which has already established the necessary LLC and MAC instances for this signalling connection. These

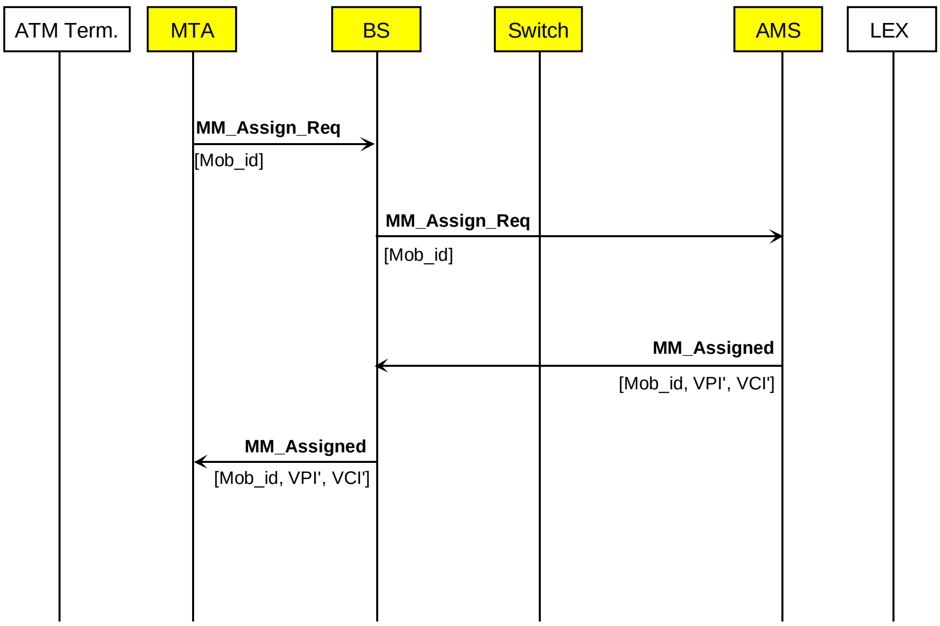

Figure 3 : Signalling Flow for Basic Signalling Link Establishment

connection characteristics are then broadcast to the MTA using the MM_Assigned.

The signalling connection is now ready to be used for signalling traffic from the BS to the MTA and vice versa.

3.2 Establishing UNI Signalling Connection

As the air interface works like an ATM multiplexer for transparent connections it routes all user and signalling ATM cells according their addresses, i.e. VCI and VPI, included in the ATM cell header. In the SAMBA trial platform transparent connections via the air interface are used to support user signalling. This leads to a problem as the standardised version of UNI ([3], [4]) uses the same ATM addresses (VPI=0, VCI=5) for all signalling virtual channels (SVC). Due to this situation the problem which occurs is depicted in Figure 4. User signalling cells in the downlink direction from the AMS to the mobile ATM terminal can not be delivered by the base station as all terminals would use the same ATM addressing.

To overcome this problem switched signalling virtual channels will be used in SAMBA. When assigning resources for terminal signalling each ATM terminal will get its unique SVC address. Inside the MTA this unique SVC address has to be converted to the standard SVC address (VPI=0, VCI=5) and vice versa.

This procedure is derived from the Meta Signalling procedure specified in [5].

The MTA starts to establish this signalling connection by sending a UNI_Assign_Req message towards the BS via the basic signalling link for mobility management. The BS directs this request to the AMS where the relevant VCI/VPI pair is determined. The connection for this VPI/VCI pair is established using an Est_Conn message towards the API (Application Programming Interface) of the switch. After the setup of the connection in the switch, the switch acknowledges that the connections are switched trough now. The VCI/VPI used for the UNI signalling connection within the system is sent to the BS using the UNI_Assigned message. The same message is used towards the MTA to transfer the VCI/VPI pair.

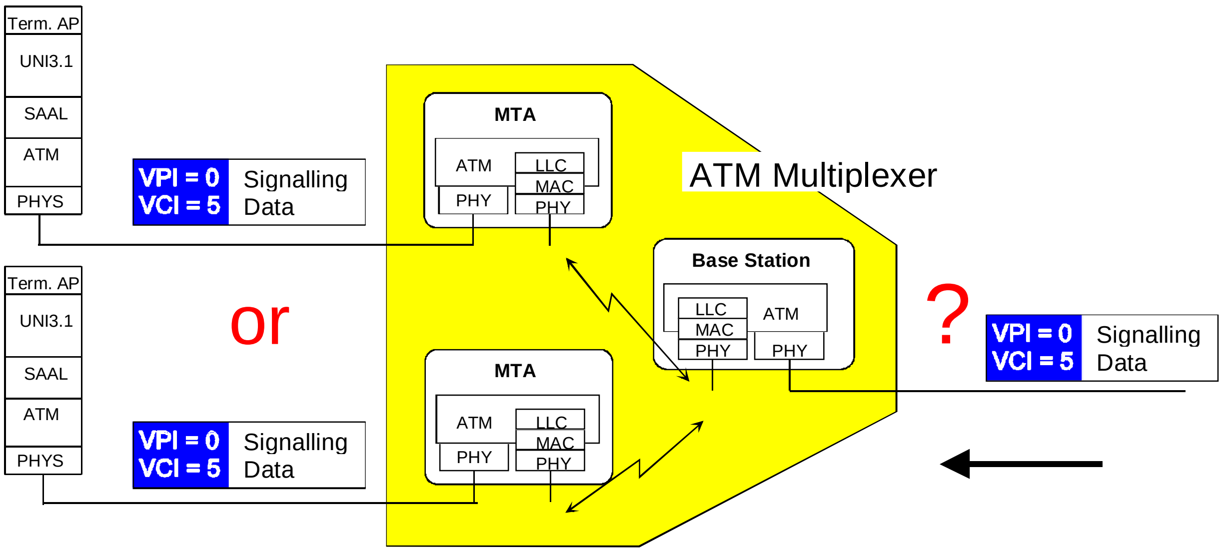

Figure 4: Multiplexing of Signalling Virtual Channels

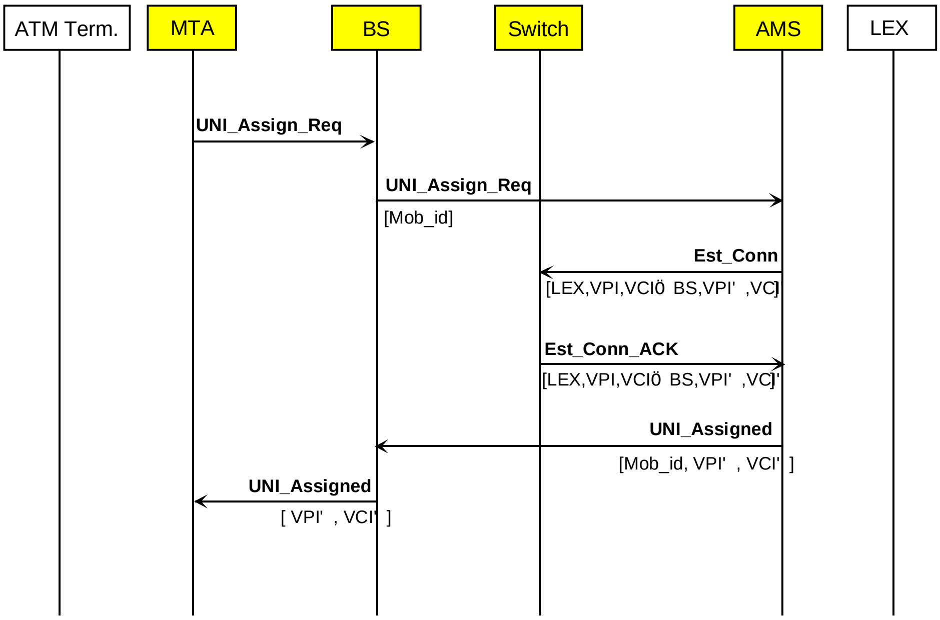

Figure 5: Signalling Flow for UNI Signalling Link Establishment

3.3 Mobile Terminating Connection Setup

The basic signalling flow for a user connection setup towards the mobile terminal is shown in Figure 6.

After having received a SETUP from the LEX (local exchange) the AMS derives the MobileId using the Called Party Number (CdP) from the SETUP. The AMS generates traffic description information which is necessary for the BS. At the same time a VPI'/VCI' pair for the mobile terminal and a VPI/VCI pair for the Local Exchange is reserved.

After reservation the AMS sends a Setup_RC to the BS via the AMS-BS control channel. The BS establishes a connection to the MTA and informs the MTA about the parameters for this connection. BS and MTA are preparing the lower layer instances to support the connection. The completion of this action is reported to the AMS using the Setup_RC_ACK message.

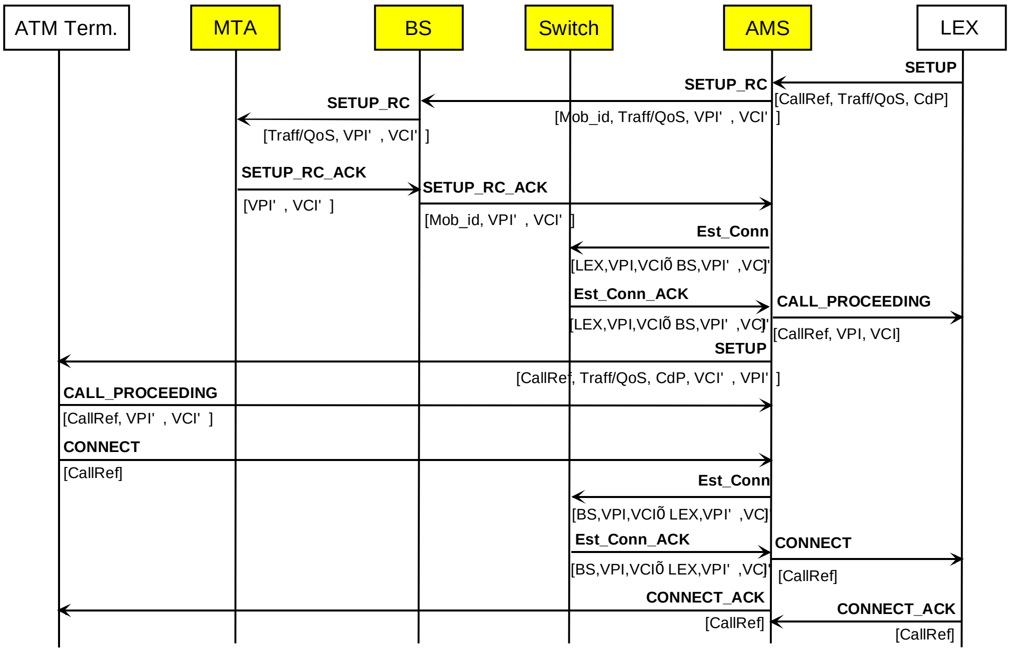

Figure 6 : Signalling Flow for Mobile Terminating Connection Setup

The AMS will establish the forward connection in the switch with the acknowledged message Est_Conn. Having established a connection from the LEX to the MTA the AMS sends a CALL PROCEEDING back to the LEX.

In forward direction a SETUP is sent to the M-ATM Terminal via the existing signalling link (cf. UNI signalling establishment). After receiving a CALL PROCEEDING the AMS waits for the CONNECT message.

When the M-ATM Terminal User answers the connection a CONNECT is sent to the AMS. Upon this message the AMS will through connect the user connection (Est_Conn), send a CONNECT to the LEX and a CONNECT_ACK to the M-ATM Terminal. After the LEX has sent a CONNECT_ACK to the AMS the signalling for a connection setup to a mobile terminal is finished.

The users on both sides are now able to use the user connection as requested.

3.4 Mobile Originating Connection Setup

The signalling flow for a connection setup originated in the M-ATM Terminal is very similar to the setup originated in the fixed network. The signalling flow is show in Figure 7.

Instead of the local exchange the M-ATM Terminal sends the SETUP message to the AMS. The AMS then starts the same procedure to setup a connection path to the M-ATM Terminal, moreover the BS does not know if a connection is originated in the fixed or mobile part of the connection to be setup.

When the connection from the terminal to the switch connected to the AMS is setup a CALL PROCEEDING is sent to the terminal and a SETUP is sent to the fixed network. The AMS will trough connect the communication path in forward direction after having received the CALL PROCEEDING from the fixed network. This message confirms the VPI'/VCI' to be used for the data connection from the AMS to the fixed network.

Having received the CONNECT from the fixed network the AMS will through connect the backward direction of the user communication path and send a CONNECT to the terminal to indicate that the connection is now ready for user data transfer. Towards the fixed network the received CONNECT message is acknowledged with a CONNECT_ACK. The same message is used from the terminal to acknowledge the CONNECT sent by the AMS.

At this state of the connection setup data communication via VPI'/VCI' to and from the

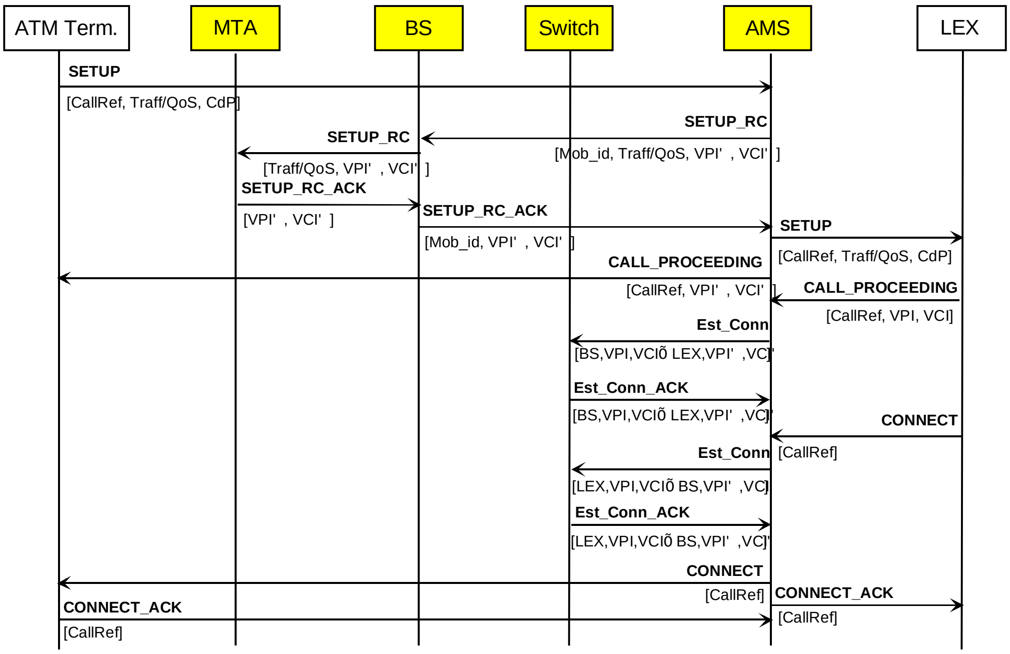

Figure 7 : Signalling Flow for Mobile Originating Connection Setup

fixed network and via VPI/VCI from and to the terminal is possible.

3.5 Connection Clearing

In this section the release of a connection path is described as depicted in Figure 8.

When the AMS receives a RELEASE from the fixed network the AMS will transfer the RELEASE to the terminal transparently and send a Release_RC to the BS in order to advise the BS to release the radio resources.

The BS then clears the connection to the MTA using the Release_RC towards the MTA which is acknowledged by the MTA with an Release_RC_ACK. Having released the radio communication the BS acknowledges this state to the AMS with a Release_RC_ACK.

Note that this release of a connection only refers to the user communication path identified by VPI' /VCI' . The signalling connection still remains.

After the BS has acknowledged the clearing of the communication path the AMS releases the connection in the switch using Rel_Conn. When the switch acknowledges the deletion of the connection the AMS is able to send a RELEASE COMPLETE to the fixed network to indicate that the AMS has released all his connection resources which belong to the connection that shall be released. The terminal will indicate to the AMS using a RELEASE COMPLETE that it has also released all connection resources.

After this procedure the AMS may use the released VCI/VPI pairs and all other resources for a new connection.

If the terminal starts to release a connection the same procedure applies, except that the terminal starts sending the RELEASE which is transferred by the AMS to the fixed network. The AMS will use the identical procedures to release its resources and acknowledges this to the terminal while waiting for an acknowledgement from the fixed network.

3.6 Clearing UNI Signalling Connection

This section and Figure 9 show the clearing of the UNI signalling connection for an MTA. The procedure is initiated by the MTA sending a UNI_Release_Req. The BS then forwards this

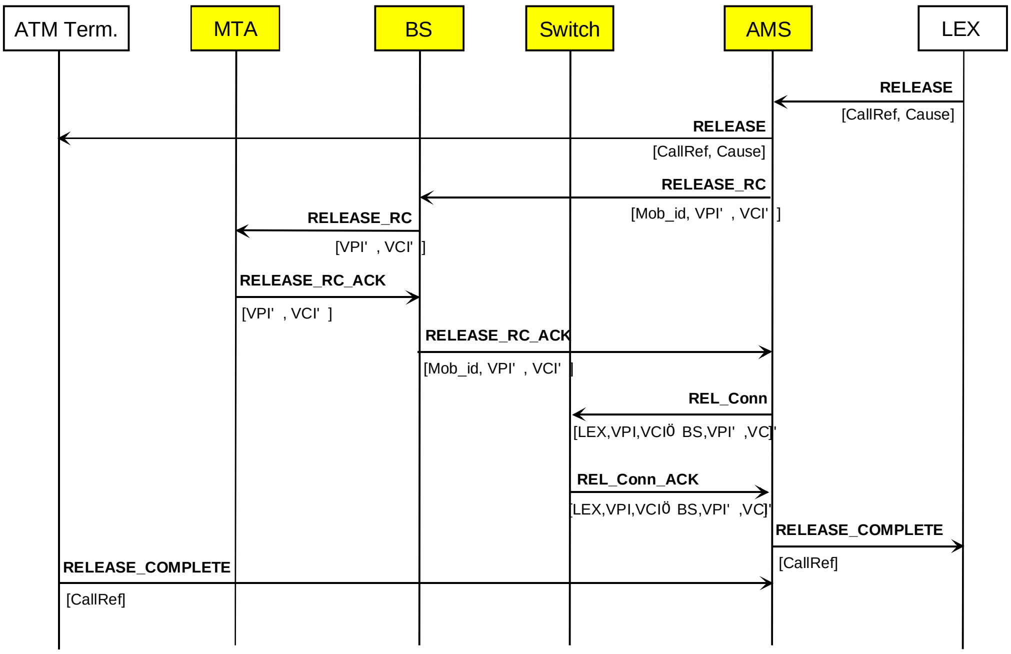

Figure 8 : Signalling Flow for Connection Clearing

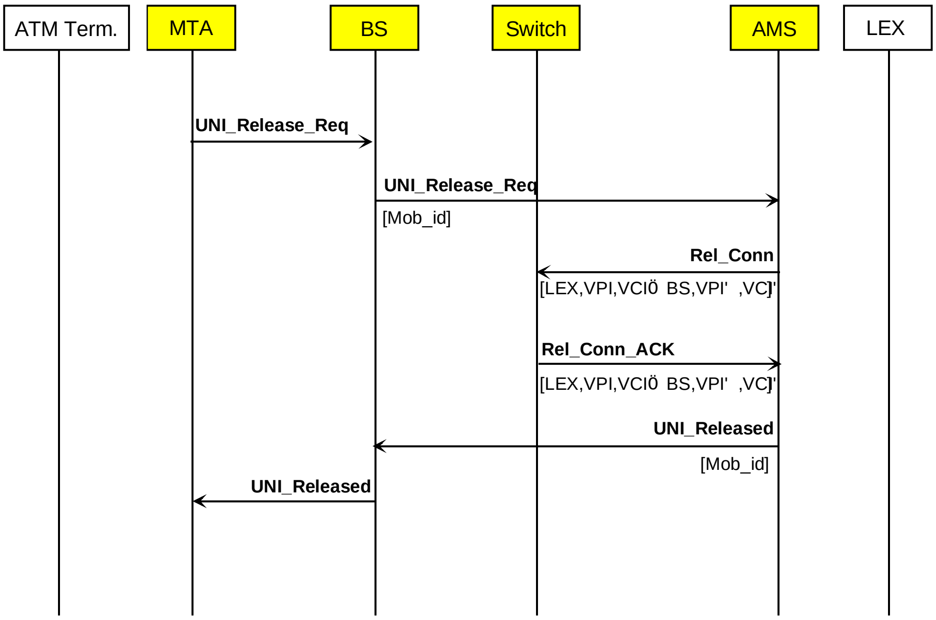

Figure 9 : Signalling Flow for Clearing UNI Signalling Connection

request to the AMS adding the MobileId of the MTA it got the request from.

The AMS clears the signalling connection path in the switch using Rel_Conn and acknowledges this to the BS which releases its resources bound to the UNI signalling connection for this MTA. After having released the resources this is reported to the MTA and the UNI basic signalling connection is cleared.

3.7 Clearing Basic Signalling Link for Mobility Management

Having terminated the UNI signalling connection the MTA can also release the basic signalling link connection. This is done sending an MM_Release_Req to the BS (cf. Figure 10). This entity directs this request to the AMS adding the MobileId to the request. The AMS releases its resources bound to the MTA. After having released the resources this is reported to the BS with the message MM_Released. The BS will then direct this message to the MTA.

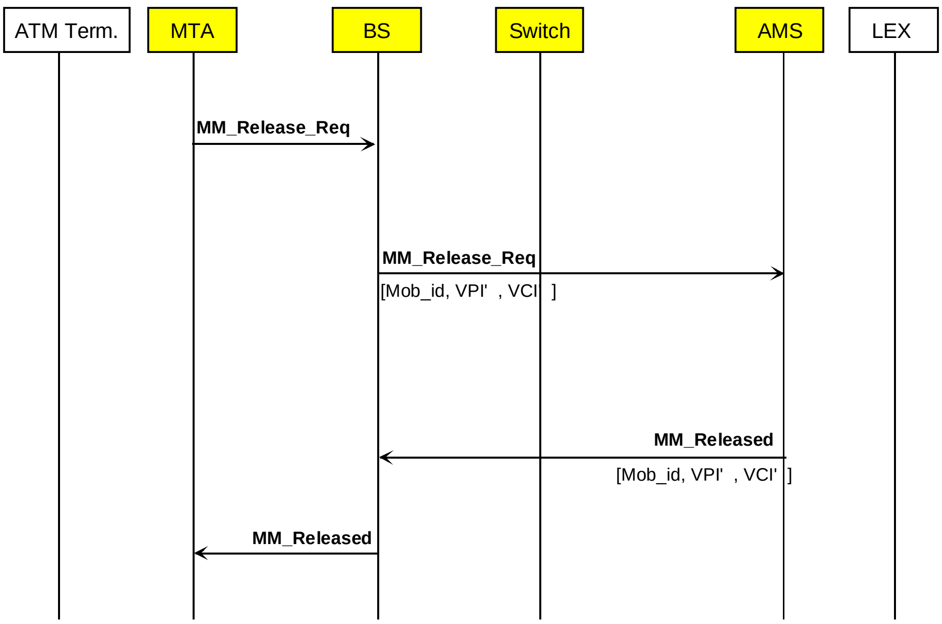

Figure 10: Signalling Flow for Clearing Basic Signalling Link for Mobility Management

In this state the MTA is able to release its internal resources for the basic signalling link and the MTA is no longer logged in. Thus only the MTA is able to get in to contact with the network again.

4 Conclusion

This contribution describes the concept of signalling used in the cellular wireless mobile broadband system trial of the ACTS project SAMBA (System for Advanced Mobile Broadband Applications). Having gone through the architecture of the SAMBA system trial platform the protocol stack was shown. The procedures and signalling flows for call establishment were then discussed in section 3. Besides the standard ATM Signalling specific signalling for a wireless mobile broadband system is employed. This signalling provides the control of the system components and the mobility functions of the trial platform. Standard ATM signalling and interfaces are provided to the network and to the user. The problem of ambiguity of identifiers for the basic UNI3.1 signalling connections to different MTAs has been solved with an identifier translation in the MTA.

5 Acknowledgement

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6 References

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[5] ITU-T Recommendation Q.2120: B-ISDN Meta Signalling, 1995