Integrated Mobility Concepts for Wireless LANs

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Abstract
The focus of this paper is on the integrated IP mobility support within micro cellular systems as an extension to global mobility environments. Since macro mobility, mainly realized with the help of Mobile IP, is not able to support highly dynamic scenarios, novel concepts have to be developed. Different solutions are proposed within this paper, e.g. for fast handover in WLANs, which are connected to an IP-based infrastructure. For expedited handover execution a new concept for backbone signaling is proposed. It explores the interface between the link and network layer, which will be described, too, and which has been specified in detail for HIPERLAN/2. With the approaches described in this paper it can be expected that HO can be supported in an efficient way not sacrificing the rare radio resource.

1. INTRODUCTION

In order to satisfy the mobile user's demand for high data rates with Quality of Service (QoS) support, innovative concepts need to be introduced. Current 3G cellular systems only partly cover the required needs. Therefore, one promising approach, which is also followed within the Information Society Technologies (IST) project MIND (Mobile IP based Network Developments) [1] aims at integrating Wireless LAN technology as an access network, complementary to 3G cellular systems together with their wired, mainly IP-based fixed backbone connections. Next to high data rates, which are provided by WLANs, fast and seamless handover (HO) support is of essential interest if users move while a connection is established. This becomes a great challenge since the coverage of WLANs is restricted due to the high frequencies they operate at (usually at several GHz).

Current research activities within European projects and respective working groups of the IETF focus on enhanced mobility support (e.g. WINE GLASS, MobyDick, IETF mobileIP,...). Since most of the existing access networks already have their own support to handle mobility between Access Points (APs), projects like WINE GLASS [2] employ an architecture that relies on the existing mobility mechanisms provided by the access networks to provide micro-mobility. Other projects like MobyDick [3] handle mobility at IP-level or above [4].
However, none of the approaches incorporates different micro mobility support schemes in order to integrate them into an overall concept. By means of combining the advantageous aspects of each proposed concept, a more sophisticated and efficient HO support can be achieved. E.g. information gathered while applying one HO scheme can be used to speed up another HO scheme. In such a way a complementary overall concept is achieved, which will be presented in this paper.

Structure of the Paper

To describe our approaches for the HO HIPERLAN/2 (H/2) [5][6][7] is used as example system. It provides high data rates, means for QoS support and it is assumed as complementary wireless access technology of UMTS by ETSI/BRAN and 3GPP [8]. After introducing the mobility control of H/2 in Section 2, a brief overview is provided of the interface between the link layer and network layer in Section 3. This interface has been specified in detail for H/2 and provides all relevant primitives to support efficient HO concepts. In Section 4 two concepts are presented how the HO and thus the mobility support can be realized. The main idea is to shift the information transfer of connection related data, which needs to be present at the new AP, from the air interface to the wired backbone. However, a minimum amount of signaling via the air interface always needs to be done. Consequently, the difference between the two herein described HO strategies lies in the amount of data that needs to be transmitted via the air interface. The advantages of each approach are pointed out and a way of combining both methods in order to achieve best possible HO support is presented. In Section 5 we describe a way of efficiently building up a database, which is necessary to support fast HO. This database also demonstrates the complement character of our concepts, since it is set up with the help of the one HO type and used by the other one. In Section 6 we present simulation results that will show the effectiveness of our proposal. As already mentioned above, H/2 is chosen as WLAN reference standard for demonstrating the key points of the concept. However, the described method is not limited to H/2 and can be applied to mobility support within WLAN standards in general.

2. MOBILITY CONTROL

The current H/2 specification deals with three types of HO: sector, radio and network HO. While the first two ones can be completely served within one H/2 access point, the latter one requires the support of the access network. The procedures for the sector and the radio HO are specified in [7]. Within this paper only a short overview will be given. The main objective is to describe the procedures, which are necessary to provide a network HO. Since the Mobile Terminal (MT) leaves the serving area of a Radio Link Control (RLC) instance, a network HO involves also higher layers, which are connected to the H/2 Data Link Layer (DLC) by an appropriate convergence layer (CL). This CL is important for the interconnection of a specific higher layer protocol like e.g. Ethernet, IEEE 1394 or IP with the DLC. The task of the CL thereby is to adapt the service requirements of the respective higher layer to bearer services offered by H/2. This includes both, logical QoS mapping as well as adjustment of potential variable higher layer packet sizes to the fixed packet lengths of H/2. In the notation of the CL, a prefix is added depending on the higher layer the CL is connected to: E.g. to maintain association and connection parameters, specific signaling via the IP backbone may be needed. This requires interworking with the IP layer by means of an IP convergence layer (IP-CL). A more detailed description of the IP-CL will be given in Section 3.

3. INTERLAYER COMMUNICATION

Classical WLAN systems do not specify higher layer functionalities. Since their focus is to serve as radio access network, those functionalities, e.g. routing or address resolution, need to be overtaken by a respective Intelligent Network (IN), which is also connected to or part of a fixed backbone architecture. In order to provide required services to the upper layers, the information transfer between the lower layers of the WLAN system and the higher layer of the IN needs to be organized.
Within the IST project BRAIN [9], a generic interface IP_2W [10] was specified that is able to overtake this task, see Figure 1.

The generic design of the IP_2W interface allows the interworking of various WLANs with respective INs. In order to facilitate this interworking, the respective WLAN system only needs to incorporate a specific CL that is able to understand the IP_2W directives.

The CL itself is divided into a Common Part Convergence Sublayer (CPCS) and a Service Specific Convergence Sublayer (SSCS). The current H/2 specifications already provide a CPCS [18] as well as IEEE1394 and Ethernet SSCS [19][20] whereas BRAIN/MIND focuses on the

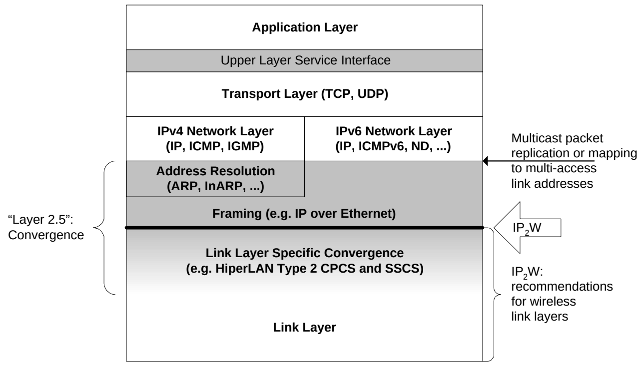

Figure 1: Interlayer communication and IP_2W interface

specification of an innovative SSCS dedicated to the direct support of IP traffic in a mobile environment [21]. This will allow providing the requested IP_2W service to the network layer on each side of the air interface.

Within the proposed concepts for mobility support, the H/2 IP-CL will be employed and slightly enhanced in order to connect H/2 to the IN and to enable information exchange between old and new AP in case of a HO. Though H/2 is chosen as an exemplary WLAN, the concepts are not focused on this standard, since the employment of the generic IP_2W interface allows a mapping to other WLAN standards, e.g. IEEE 802.11, too.

4. INTERWORKING WITH IP MOBILITY

WLAN standards like H/2 shall support end devices' mobility within and outside of active communication phases. A terminal that is associated to an AP resides in the active phase, regardless whether it is transmitting user data or not. During the association procedure, the MT registers within the local access network with the help of the AP. In the first case, when the MT registers within a foreign network and has no active communication yet, the home network needs to be informed. For this purpose, the Mobile IP-protocol [13] can be used.
The following approach integrates H/2- and IP-mobility. We therefore select a hierarchical mobility model and distinguish between global and local mobility. Within this network model, a Mobile IP capable network provides wide (global) area mobility, whereas local wireless access networks as considered in MIND, handle local mobility. Within the local area, the Mobile IP protocol is not capable to be used since it is optimized for slowly moving MTs and becomes inefficient in the case of frequent migrations [12]. For that reason, more recent approaches have tried to take into account the local character of mobility to avoid time-consuming re-routing

over the home agent. Examples are Cellular IP [14], HAWAII [15] or Hierarchical Mobile IP [16].

The efficient support of local mobility between different APs demands for a close integration of H/2-mobility protocols and the IP-protocol. Different approaches for local mobility protocols assume the transmission of route-update packets via an active radio connection between the MT and the AP. Therefore, in the case of an H/2 HO firstly the DLC-procedures for association and connection establishment need to be run through. Thus, an update of the routing path within the access network can only be done afterwards. This time-consuming, sequential run off can be avoided, if the new AP triggers the IP mobility procedure as soon as the MT has registered. User data to be transmitted to the MT will be buffered by the new AP until the DLC-connections are established.

Another important advantage of this solution that distinguishes this approach from previous proposals is, that the protocols for local mobility support need not to be implemented in the MTs. Thus, the different local networks may even employ different mobility protocols whereas the implementation within the MTs is not affected.
This close integration of the mobility protocols is the task of the IP-CL. The network HO procedure of the RLC-protocol therefore conveys different possibilities, depending on the supported services within the access networks.

The following section describes two possible variants: Network HO with and without signaling over the backbone network.

4.1 Network handover without signaling over the backbone

If a MT initiates a HO while an active connection is established, the information about the current transmission status needs to be reported to the new AP. If the access network does not support the transfer of the information, they need to be re-negotiated between MT and the new AP. Figure 2 shows the schematic sequence of the network HO. Since the connection related data is transmitted via the air interface, the respective sub-procedures for call establishment need to be run through.

The following steps are executed in chronological order:

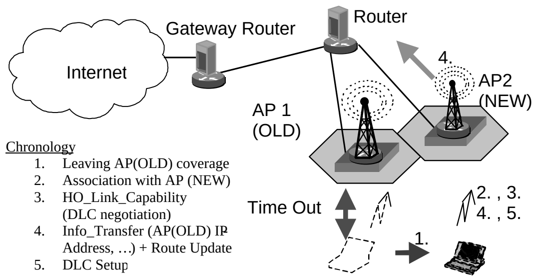

Figure 2: Handover without signaling over the backbone

1. Leaving of the coverage of the old AP (AP1(OLD)).
2. Association of the MT at the target AP (AP2 (NEW)). Thereby the MT transmits its old MAC_ID (MAC_ID1), which was used in the ongoing connection with AP1 (OLD). Additionally, the DLC address of AP1 (OLD), the so-called Access Point Identifier (AP-ID1) is transmitted, too. As a response, AP2 (NEW) assigns a new, local MAC_ID (MAC_ID2) to the MT.
3. Afterwards, the HO_Link_Capability-sub-procedure is called to negotiate the DLC configuration parameters between MT and AP2 (NEW). Besides this, AP2 (NEW) determines which other sub-procedures might need to be called.
4. The Info_Transfer-sub-procedure is used by the MT to convey information about its own addresses, like the Logical Link Address (LLA) e.g. in EUI-64-format and the IP-address. Where required, the AP1 (OLD) IP-address can also be conveyed. AP2 (NEW) hereafter confirms the information transfer with its own IP-address. Having all relevant information, the IP-CL of AP2 (NEW) will convey this information to the IP-layer, which then can initiate the route-update packet of the IP mobility protocol. Such, the internal routing tables of the router are updated.
5. Almost in parallel to the route-update signal, the DLC connections via the air interface are established afterwards. The MT's IP-CL reports the new connections to its IP layer.
6. Termination of the HO procedure.

The above described procedure does not explicitly inform AP1 (OLD) about the ongoing HO. Therefore, it keeps the association with the MT until a time out comes up and forces the AP1 (OLD) to start the disassociation process. User data, which arrives at the AP1 (OLD) within this period cannot be forwarded and gets lost.
This is also indicated within Figure 3, which illustrates the involvement of the IP-CL within this HO type: The old AP is not informed about the change of association of the MT and thus does not know, whether the MT has left its coverage area, was switched off or suffers from an insufficient radio link quality. Therefore, it will receive a time out signal and release resources, which were allocated for the MT's connection.

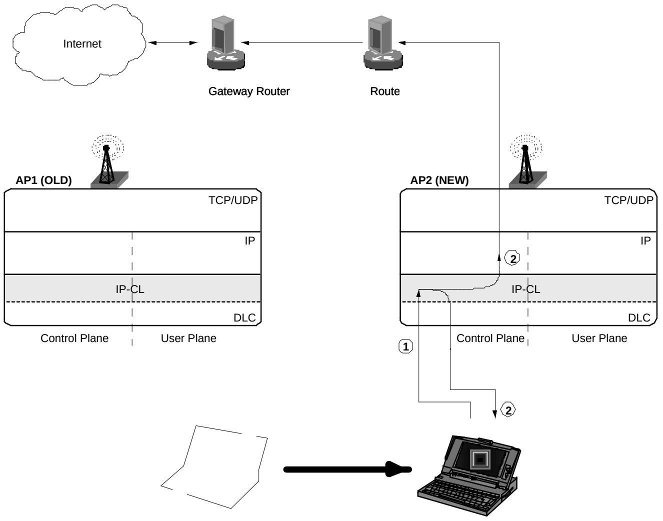

Figure 3: IP-CL within handover process: No signaling over the backbone

Since the new point of attachment is not known, no tunneling of misrouted data packets is possible. Within this HO, only the IP-CLs of the MT and the new AP are involved. The aforementioned actions are performed within the control plane of the MT and AP2 (NEW). The subsequent data transfer via the user plane is not included in the figures.

The IP-CL within this type of HO mainly restricts on forwarding the received information to the upper layers. Thus, no additional challenges need to be fulfilled.

4.2 Network handover with signaling over the backbone

The re-negotiation of the connection related parameters via the air interface during a HO results in an appreciable interruption of data transmission. Thus, in the following, it is assumed that this information is transferred to the target AP (AP2 (NEW)) via the fixed wire line access network, cf. Figure 4. For this purpose, the integration of a control protocol, located within the IP-CL of each AP, is necessary. We thereby assume that data transfer via the fixed network is much faster and more reliable than via the air interface. In the following we therefore also refer to the two HO types as "slow" and "fast" HO, since it is very likely that the HO type with signaling over the network is faster, because the data to be transmitted is less probably corrupted (no interferences), neither the time consuming access procedures need to be run through. Simulation results in Section 6 support this statement.

The proposed Inter-AP protocol only consists of a few messages and employs a standard transport protocol, such as e.g. UDP [11]. The advantage of UDP in contrast to TCP is a shorter signaling period, but no error protection is provided.

Figure 4 shows the shortened HO procedure at the air interface and the communication of the two APs via the fixed wire line access network. The following steps are executed in chronological order:

1. Leaving of the coverage of the old AP (AP1 (OLD)).
2. During the HO Association the MT provides its original MAC_ID1 and the DLC address of AP1 (OLD) (AP-ID1) to the new AP2 (NEW). It thereafter receives its new MAC_ID2 from the new AP2(NEW). In the following HO_Link_Capability sub-procedure, AP2 (NEW) indicates the shortened HO procedure.
3. Based on the AP-ID1, AP2 (NEW) determines the IP-address of AP1 (OLD). For this purpose it is assumed that AP2 (NEW) holds a lookup table, within which incorporated AP-IDs are mapped to their respective IP-address. This lookup table can either be managed within the IP-CL or within the IP-layer. Generation and update of this table is the task of address resolution protocols. An example is described in Section 5. Afterwards, AP2 (NEW) informs AP1 (OLD) about the ongoing HO by sending a message via the fixed network, using a higher layer transport protocol (e.g. UDP). The message should contain the parameters AP-ID1 and MAC_ID1 as well as the AP-ID2 and the AP2 IP-address.
4. AP1 (OLD) replies with a message, which besides the MT addresses (EUI-64 and IP) includes information about the existing DLC User Connections (DUCs). The describing parameters DUC-descr , e.g. DLCC-IDs or CL-CONN-ATR (data related to the CL which is transmitted transparently to RLC) are identical to those of the RLC protocol [7]. User data, still misrouted from the router to AP1 (OLD) can then be forwarded to the new AP2 (NEW) by means of IP tunneling.
5. On having received all the necessary DUC-descr, the setup of the DLC connection can be completed.
6. The IP-CL of AP2 (NEW) subsequently informs about the new connections. AP2 (NEW) generates with the help of the received information from AP1 (OLD) a route-update packet (not shown in Figure 4) and reports the new point of attachment of the MT to the router.
7. Termination of the HO procedure.

Figure 5 illustrates the task of the IP-CL within this HO type. It can be seen, that the AP2 (NEW) now retrieves information related to the ongoing connection of the MT via the wire line connection.

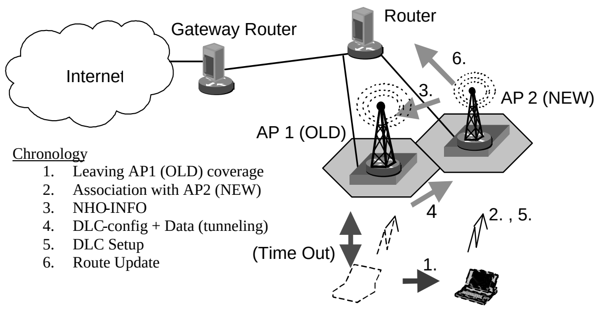

Figure 4: Handover with signaling over the backbone

Therefore, it firstly needs information about the old AP (AP-ID old) and the mobile identifier at this old AP (MAC_ID). This minimum amount of information always needs to be transmitted by the MT via the air interface during the HO_Link_Capability sub-procedure. Having this information, AP2 (NEW) now is able to contact AP1(OLD). For this purpose a second, independent instance (HO-INFO instance, AP2b) is initiated within AP2 (NEW). In such a way, all relevant information that is present in one of the instances of AP2 (NEW) may be accessed by the other instance, too. The distinction AP2a/b herein is introduced as a logical separation to indicate that there are two protocols running (which are handled by two instances at AP2(NEW)), one of them serving the communication between AP2(NEW)-MT and the other one serving the communication between AP2(NEW)-AP1(OLD).

The IP-CL of the HO-INFO instance (AP2b) reports the received information to the upper layers and demands for provision of the missing information about the old layer 2 connection from the old AP. Here upon, AP2b establishes a higher layer connection (e.g. UDP) with AP1 (OLD) and transmits the parameters transparently to AP1 (OLD). In AP1 (OLD) the required information is gathered from the IP-CL (see 4,5 in Figure 5) and sent back to AP2b. AP2b finally provides the requested information to the IP-CL where it can be accessed by its calling instance (AP2a). AP2a then is able to continue with the DLC setup procedure (8). At the same time, the AP2a IP-CL informs the upper IP layer about the newly arrived and associated MT. The IP layer then sends the route-update information to the router. A detailed description of the primitives, which are used within the information exchange procedure, together with their attributes can be found in [10]and [17].

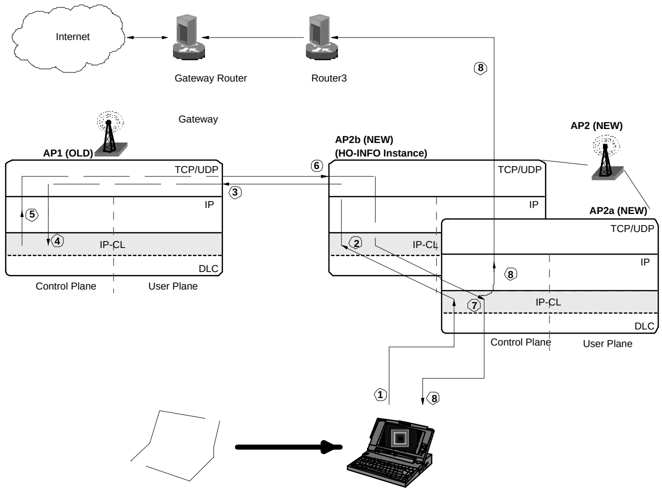

Figure 5: IP-CL within the handover process: Signaling over the backbone

The IP-CL within this type of HO differs in its complexity compared to the one in the previous section. For the wire line supported signaling, the IP-CL needs to fulfill additional tasks like management and update of the database presented in the next section. One further difference is the point of time at which the IP-CL informs the IP about the new connection (and thus triggers the IP layer to send the route-update packet to the router). In the first HO type, this is done as soon as possible, which means even before the complete DLC connection is established. In other words: HOs on layer 2 and layer 3 are executed in parallel. This is necessary to avoid the loss of misrouted IP-packets. In the second type of HO, the IP-CL firstly waits until the complete DLC connection is established and then reports the new connection to the IP-layer. The layer 2 HO has completely finished before the layer 3 HO is executed. It is not necessary to execute them in parallel, since misrouted packets are re-send by means of tunneling and stored in AP2, thus no packets get lost.

5. DYNAMIC COMPOSITION OF A TOPOLOGY DATABASE

The above introduced procedure for a presumed faster HO execution with signaling via the fixed network needs to be aware of the IP addresses of neighboring APs to apply the Inter-AP protocol. Each AP administers a simplified topology database with the IP addresses of its HO partners, the precedent serving AP of a MT. This database is structured like a lookup table, wherein a mapping from IP-addresses to DLC-addresses and vice versa is performed. The database can either be managed within the IP-CL or in the IP layer. One argument for the latter surely is, that IP addresses are layer 3 specific and thus should be administered there. How-

ever, it is proposed to locate it in the IP-CL, since this means that the decision about the type of HO to be chosen does not need an intervention of layer 3 anymore. Additionally, it was stated that AP2a and AP2b share the same IP-CL space. Since the information about the IP address of AP1 (OLD) needs to be transferred to the IP layer of AP2b, it is favorable if the database is in the commonly shared IP-CL.
The following method describes a way to dynamically set up and update such a database:

1. The MT registers at the new AP while conveying the AP-ID of the precedent AP.
2. The target AP decides which kind of HO procedure is applied, this means either the “slow” one without fixed network support, or the presumed faster one with fixed network support. If the new AP is not able to perform a mapping between the AP-ID and the respective IP address, it will decide to carry out the slow HO execution, which means all data including the IP-address of the precedent AP is re-transmitted via the air interface, thus the internal database can be updated (see right branch in Figure 6).
3. If the AP-ID is in the database, the AP may decide to use the HO with signaling over the wire line access network. However, if the present database needs to be updated, the AP can decide to use the other type of HO nevertheless.
4. Within the slow HO procedure, the AP receives information to update/set up its personal topology database and stores the respective couple of AP-ID and IP-address therein.

If MTs from the same precedent AP enter the coverage area of an AP, all the relevant address information is available and the “fast” HO procedure can be executed. For the purpose of updating the database, the slow procedure can be demanded periodically, see Figure 6.

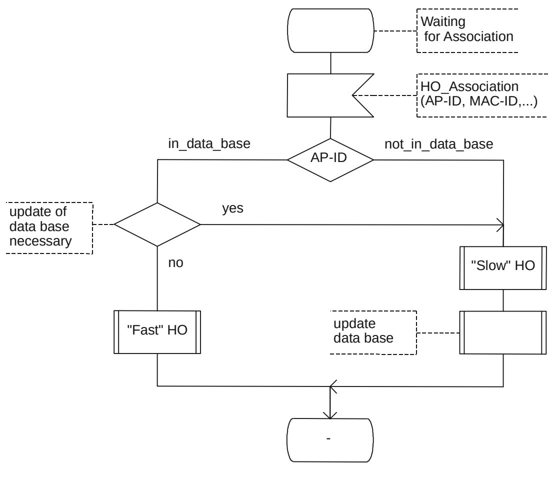

Figure 6: Dynamic composition of a topology database

6. ANALYSIS

In the following section we investigate the influence of the different HO procedures on the packet delay. The aforementioned concepts have been modeled and implemented and will be evaluated by means of computer simulations.

Scenario Description

We assume a simple scenario with one MT moving from one AP (AP 1) to another AP (AP2), as shown within Figure 2 and Figure 4. Since our focus is based on the protocol caused delay times, we presume a perfect link without any disruption or loss of packets on the air interface. Data packets only get lost in case of being misrouted during the HO process and its subsequent association procedure. Since no Automatic Repeat Request (ARQ) is applied, those packets will not be retransmitted. For all simulations we consider the MT to maintain an active bi-directional connection with symmetric DUCs loaded by 64kbit/s, respectively 2Mbit/s-Poisson sources. Only packets that reach the receiver will be evaluated, thus packets that get lost do not contribute to the delay evaluation.

Handover without network support (slow HO)

We start by examining the protocol caused delay times within the non-backbone supported scenario. As said in Section 4.1, all data related to DLC association and connection needs to be re-transmitted via the air interface.
Figure 7 points up the messages and PDUs that need to be exchanged.

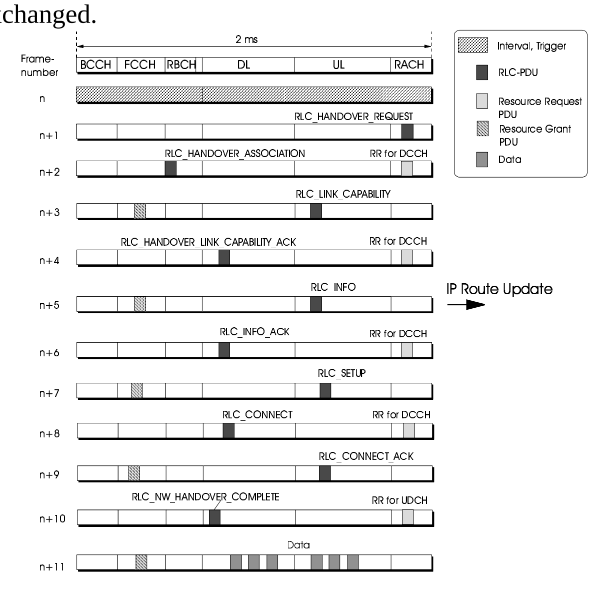

Figure 7: RLC-messages for HO without backbone support

Figure 8 shows the complementary distribution function (CDF) of the simulated delay times for this HO type, regarding up- and downlink separately.

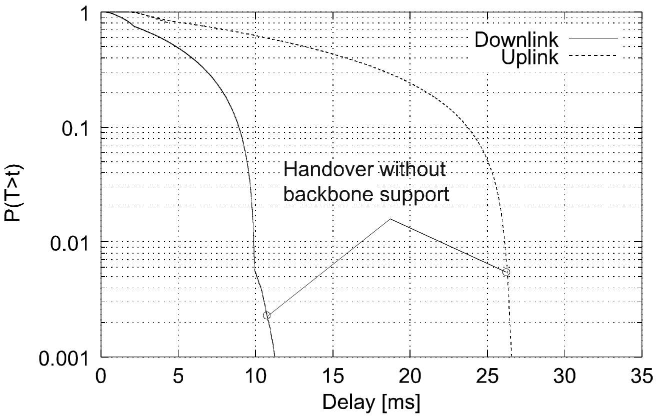

Figure 8: Packet Delay for connections with load of 64 kbit/s, resp. 2 Mbit/s (Phy-mode: 36 Mbit/s), slow HO

For the simulations in Figure 8 we took Poisson sources generating traffic of 64 kbit/s resp. 2 Mbit/s. Since the CDFs of the delay times of both traffic loads are the same, only two curves can be seen here. The reason for this congruence lies in the chosen Phy-mode 16QAM3/4 with its nominal data rate of 36 Mbit/s that is even able to serve the load of 2 Mbit/s without causing additional delay.

The discrepancy in the delay times for UL and DL is due to the loss of DL packets during the HO, thus they are not considered within the evaluation. Both curves show an asymptotic behavior towards 11ms (Downlink) and 27 ms (Uplink). This can be explained with the help of Figure 7. As said in the previous section, DL packets get lost during the HO procedure. This happens as long as the IP route-update packet (see Figure 2 and 7) has not been sent. Concerning to Figure 7, at least another 5 MAC frames (5x2ms =10 ms) are needed, before earliest user data may be transmitted again. For the uplink, whereas no packets get lost the packets have to be cached by the MT and cannot be sent before the whole association procedure is run through. As indicated by Figure 7, this lasts at least 10 MAC frames (10x2ms=20ms < 27ms). Here we note another effect that causes extra delay: Due to the long queue in the MT, all buffered data cannot be sent within one MAC frame, but additional frames are needed. For the DL this effect does not appear, since the misrouted packets are not buffered but lost.

Figure 9 shows the number of lost PDUs for both traffic loads. For the 64 kbit/s load we register a mean loss of 3 PDUs, whereas the mean loss for the 2 Mbit/s load is 79 PDUs.

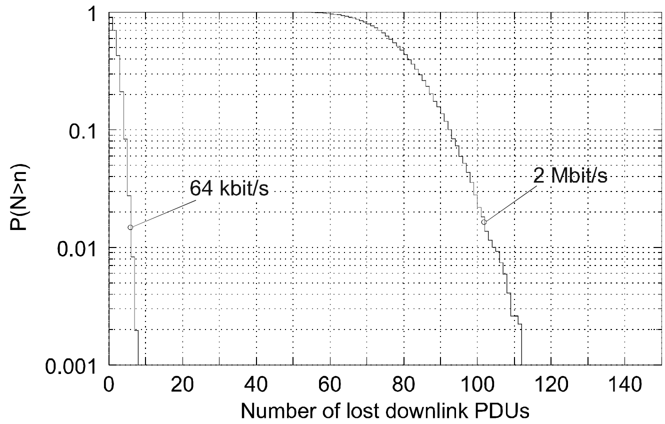

Figure 9: Lost downlink PDUs during slow HO

In order to highlight the previously described effect for the UL delay times, a lower Phy-mode, BPSK1/2, with a nominal data rate of only 6 Mbit/s was chosen, whereas the source with 2 Mbit/s was kept.

Figure 10 shows the result of this simulation. The delay for both connections increases, due to additional time needed to empty the buffer.

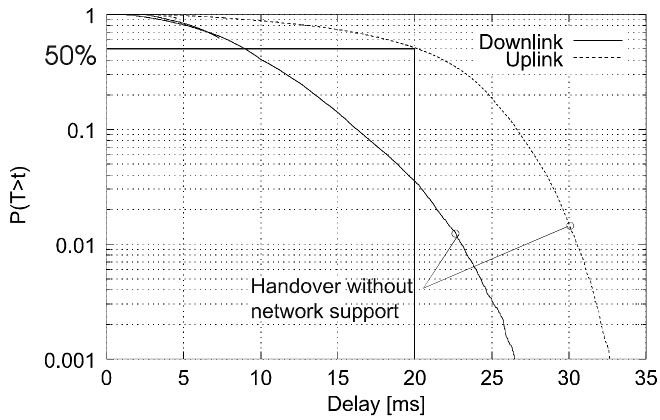

Figure 10: Packet Delay for a connection with load of 2 Mbit/s (Phy-mode: 6 Mbit/s), slow HO

Handover with network support (fast HO)

In the following we focus on the backbone supported HO, presented in Section 4.2. Now, most of the association and connection related data is transmitted via the wired backbone from the old AP1 to the new AP2, cp. Figures 4 and 5. Only little information needs to be provided by the MT and transmitted via the air interface.

Figure 11 shows the messages and PDUs that need to be transferred for this HO.

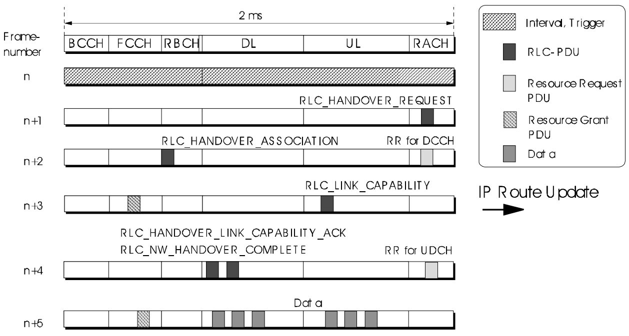

Figure 11: RLC-messages for HO with backbone support, fast HO

The message RLC_HANDOVER_REQUEST contains the DLC-ID of the old AP1 the mobile was connected to before. The new AP2 determines the respective IP-address with the help of the database described in Section 5 and acquires all DLC related information from AP1. Comparing Figure 11 and Figure 7 we can see, that the HO now is executed significantly faster. Also the route-update message can be sent earlier.

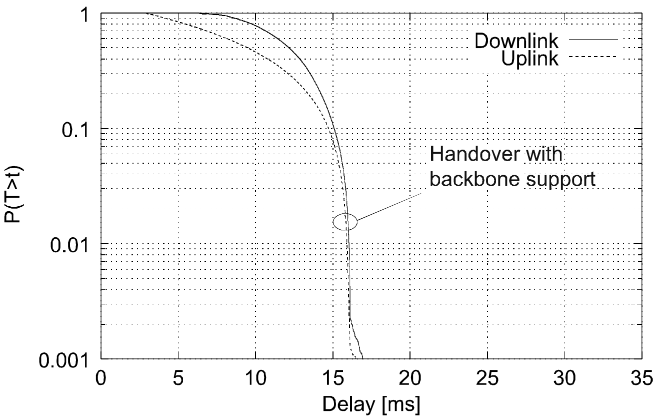

Figure 12: Packet Delay for connections with load of 64 kbit/s, resp. 2 Mbit/s (Phy-mode: 36 Mbit/s), fast HO

Figure 12 shows the simulation results for the same 64 kbit/s, 2 Mbit/s traffic sources as for the previous simulations. Again, we apply first the highest Phy-mode 16QAM3/4 with the nominal data rate of 36 Mbit/s. For the simulations we assumed that the data transfer via the wired backbone is sufficiently short and is executed in parallel to the DLC setup. As we can see, there is almost no discrepancy anymore between the CDFs of UL and DL, since this type of HO allows tunneling of misrouted packets from AP1 to AP2, thus no (DL) packets get lost and now contribute to the evaluation. This is also the reason, why the total amount of time for DL packages seams to deteriorate (compare DL curves of Figure 8 and 12). However, comparing the uplink curves of both Figures discloses the real gain.

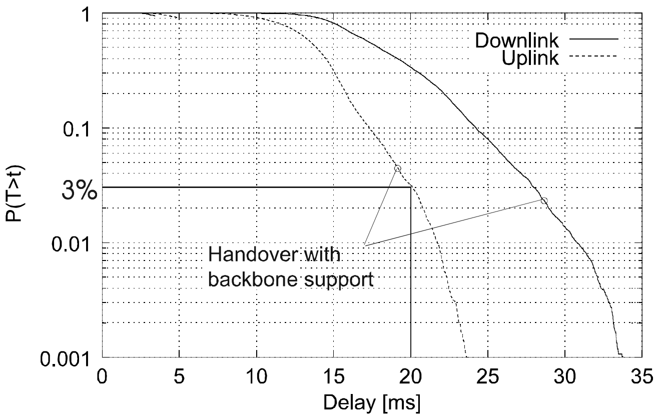

Figure 13: Packet Delay for a connection with load of 2 Mbit/s (Phy-mode: 6 Mbit/s), fast HO

The same is valid if we regard also the heavily loaded scenario (load: 2 Mbit/s, Phy-mode: 6 Mbit/s) of Figure 13. Again, we compare the *uplink* curves of the respective figures 13 and 10, since they are not affected by misrouted packets. While for the first HO type without backbone support the probability for a packet to suffer from a delay of e.g. more than 20ms is 50% (see Figure 10), the respective probability for a packet served by the other HO type is only 3%.

7. CONCLUSION

In this paper, a concept for efficient and seamless movement between different network environments with as little intervention from the user as possible is targeted. For that purpose a generic IP_2W interface has been developed within the BRAIN project to connect different kind of link layers and the IP layer and to serve the IP layer with appropriate triggers for mobility support. The applicability of this generic concept to H/2 results in an appropriate IP-CL, which supports the HO between different AP controllers. This horizontal network HO involves interaction with the IP mobility protocols and signaling between the link layer and IP layer through the IP-CL. Whereas for macro-mobility common approaches can be applied, for the micro-mobility within the access network different concepts are discussed. Especially, for fast HO procedures with reduced signaling over the air interface a new approach has been described in this paper. A detailed description of the functionality and procedures involved are exemplarily provided for H/2.

To avoid time and resource consuming authentication and registration procedures when a mobile changes the point of attachment, a novel expedited signaling scheme over the backbone network is proposed. By means of discovery procedures and caching each AP is aware of the neighboring APs and allows to exchange user and connection relevant data from the old to the new AP instead of signaling over the air. A prerequisite is the knowledge of routes to the neighboring APs. The respective protocols needed to dynamically build up such a topology database in each AP controller have been described in this paper, too. By means of simulations we thereafter investigated the effects of backbone signaling on the packet delay. Obviously, the accelerated HO procedure will be the basis for a possible seamless HO. However, we have shown that the fast HO is not a standalone solution, since its accuracy depends on a database, which is maintained up to date only due to the deployment of the slow HO type. In such a way both concepts complement each other.

With this new concept of signaling over the backbone and building up topology databases a seamless HO becomes possible, which explores the scare radio resource in an efficient way at the same time.
Since the basic concept behind the new proposed HO scheme for horizontal HO as described in this paper is independent of the access technology, it is expected that for the vertical HO this concept may also play a fundamental role for efficient and seamless mobility

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