2
Related Work

This chapter briefly presents some background and related work that propose handover mechanisms on each of the TCP/IP architecture layers to provide a seamless mobility. Considerations that justifies the use of the L3 (Layer 3) handover by the GMA are also discussed.

2.1 Application Layer Handover

Application layer handover mechanisms provide a seamless mobility to applications by means of a user-level interface. This technique usually interposes a library between client application code and the operating system that redirect socket API calls. Common implementations of this technique are MSOCKS [17] and RSOCKS [18]. All of these wrap the traditional socket API of the operational system in order to avoid changes to the application code.

MSOCKS [17] is a proxy-based system that enables a client application process to establish a mobile connection with an ordinary server. The proxy uses a technique called *TCP Splice* (supported by its transport layer) that allows the client, as it moves, to close its end of the connection and establish a new one without affecting the server. The goal of the TCP Splice is to make it appear to the endpoints of two separate TCP connections that those two connections are, in fact, one. From the point-of-view of the endpoints, it should appear that they are directly connected by a single TCP connection with all the end-to-end properties of a normal TCP connection.

RSOCKS [18] (Reliable Sockets) are implemented as a user-level library interposed between the application process and the kernel at both ends of a TCP connection. The control sockets periodically exchange *heartbeat probes* in order to detect a connection failure within seconds of its occurrence, preserve the end-point of a failed connection in a suspended state for an arbitrary period of time, and automatically reconnect, even when one end of the connection changes IP address, with correct recovery of in-flight data.

2.2 Transport Layer Handover

Transport layer handover mechanisms provide a seamless mobility to application layer by means of enhancements to the TCP implementation. An example of implementation is TCP Migrate [19].

TCP Migrate [19] implements a new end-to-end TCP option, included in SYN segments, to support the secure migration of an established TCP connection across an IP address change. Using this option, a TCP peer can suspend an open connection and reactivate it from another IP address, transparent to an application that expects uninterrupted reliable communication with the peer. In this protocol, security is achieved through the use of a token (connection identifier) exchanged during initial connection establishment.

2.3 Network Layer Handover

Network layer handover mechanisms provide a seamless mobility to upper layers by means of a mechanism used to detect the movement of the terminal between networks and a signaling protocol used to adapt the network layer. Common mobility architectures are: HIP [20], MIP [7], HMIP [8] and FMIP [9].

HIP [20] (Host Identity Protocol) defines a new *Host Identity* namespace that consists of *Host Identifiers* (HIs) and each of them represents a statistically globally unique name for naming any system with an IP stack. The main goal of HIP is the decoupling of the internetworking and transport layers. To do so, HIP also defines the *Host Identity Tag* (HIT) as a 128-bit representation for a Host Identity (a cryptographic hash over the corresponding Host Identifier) which identifies the sender and recipient of a packet. So, IP addresses continue to act as locators while the Host Identifiers take the role of end-point identifiers. The transport-layer associations (TCP connections and UDP associations) are no longer bound to IP addresses but to Host Identities. Hence, HIP requires some changes to the protocol stack architecture.

MIP [7] (Mobile IP) is a standard mobility architecture. This protocol provides a movement detection mechanism and a signaling protocol to adapt the network layer of the mobile node and to update the binding information of the mobile node at the home agent and at the correspondent node. The communication between the mobile node and the correspondent node after the L3 handover may be routed through the home agent over the bidirectional tunnel or directly to the correspondent node, if the route optimization is available. This protocol is a background to our proposal and is revised in section 3.1 .

HMIP [8] (Herarchical MIP) and FMIP [9] (Fast Handovers for MIP) are enhanced extensions of the MIP. The first one aims to minimize the latency of the registration procedure of the MIP and provides a mechanism (by means of the Mobility Anchor Point) to distinguish between micro-mobility (intra-domain) and macro-mobility (inter-domain). The latter aims to optimize the handover latency and reduces the loss of packets during handover. FMIP operates in two different modes: anticipated and reactive. These protocols are a background to our proposal and are revised in sections 3.1.3.1 and 3.1.3.2 , respectively.

2.4 Remarks

During the migration of the mobile terminal between networks, the handover procedure presents two factors that disturb real-time, interactive or delay sensitive applications. The first factor is the high latency of the process, that may generate long periods during which nodes are prevented from sending or receiving packets that may, in turn, cause the service disruption. The second one refers to the high number of packets that may be dropped or delayed due to the change of the point of attachment. These factors result mainly because the TCP/IP architecture was not designed to provide mobility to the terminals. Therefore, if no proper measures are specified at each layer during handover, consequences will be considerably damaging to the communication of the peers.

Because each layer in the protocol stack depends on the lower layers to communicate, mobility management at each layer can only take place after these lower layers have completely concluded their handover procedures. As a consequence, the higher layer is the mobility management of the terminal, the longer will be the latency of the handover which directly contributes to the loss of packets.

The proposed architecture presented on this thesis (section 4) places the mobility management function in the network layer in order to coordinate the L3 handover procedure based on key events provided by the link layer along the L2 handover procedure. The proposed L3 handover intends to be transparent to the upper layers and requires no modification in these layers.