Chapter 2

Analysis of mobility protocols for multimedia

Mobility management consists of two components: location management and handoff management. Location management enables the network to discover the current point of attachment of the mobile user so that the new connection can be established when a new multimedia call arrives. Handoff management, often known as terminal mobility, allows the network to maintain the user’s connection binding as the mobile node moves from one attachment point to another in the network. I focus on handoff management in my thesis.

2.1 Summary of key contribution and indicative results

Over the last three decades, few generations of mobility protocols have evolved without any systematic design approach and these protocols use ad hoc mechanisms to optimize the handoff performances. Without any systematic analysis of the handover components and optimization mechanisms, it is difficult to predict the systems performance of these mobility protocols or design any new mobility protocol for next generation networks.

I analyze the system architecture of each of the available mobility protocols (e.g.,
1G, 2G, 3G and several IP-based mobility protocols), describe the respective handoff mechanisms, and then compare the handoff mechanisms in terms of their common mobility functions. For example, I extrapolate how discovery, configuration, authentication and media routing functions are performed for each of the cellular and IP-based mobility protocols and then map the respective network parameters for these mobility protocols with each of the common mobility functions.

There is no prior work that extrapolates these common mobility functions from the existing cellular and IP-based mobility protocols. My comparative analysis and extrapolation of the abstract primitives can determine the required handoff functions that are needed to design a new mobility protocol with certain resource parameters and design optimization mechanisms for these functions.

2.2 Introduction

As a mobile goes through a handover process, it is subjected to connection disruption because of the rebinding of its association at several layers of the protocol stack. Delays incurred due to rebinding within each of these layers affect the ongoing multimedia application and data traffic within the client. Several basic operations are associated with the re-establishment of the binding process across these layers. These operations can be affected by several factors, such as access characteristics (e.g., bandwidth, channel characteristics), access mechanism (e.g., CDMA, CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance), TDMA (Time Division Multiple Access)), re-configuration of identifiers, re-authentication, re-authorization, and rebinding of security associations at all layers.

Mobility protocols have evolved over a period of last three decades. Based on access characteristics and bandwidth, these can be classified into five main categories: 1G cellular, 2G cellular, 3G cellular, 4G, and IP-based mobility. The definition section in Appendix C
### Table 2.5: Multicast mobility - Remote subscription

<table>
<thead>
<tr>
<th>Mobility Protocols</th>
<th>JOIN latency</th>
<th>Point of failure</th>
<th>Hierarchical mobility</th>
<th>Tunnel convergence</th>
<th>Differentiator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote subscription</td>
<td>Less than home subscription</td>
<td>FA or DHCP</td>
<td>No</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Multicast Agent</td>
<td>Same as RS</td>
<td>MA</td>
<td>No</td>
<td>Tunnel between FA and MA</td>
<td>Uses coordinator MA between FAs</td>
</tr>
<tr>
<td>MSA</td>
<td>Less than RS (pre-registration)</td>
<td>MSA</td>
<td>No</td>
<td>No tunnel</td>
<td>Pre-registration</td>
</tr>
<tr>
<td>MMA</td>
<td>Less packet loss due to forwarding</td>
<td>MA and MF</td>
<td>No</td>
<td>One IP tunnel (MA and MF)</td>
<td>Forwarding technique reduces packet loss</td>
</tr>
<tr>
<td>TBMOM</td>
<td>Less than RS</td>
<td>DMSP</td>
<td>No</td>
<td>Does not use IP tunnel</td>
<td>Uses hybrid forwarding approach</td>
</tr>
<tr>
<td>Hierarchical SSM</td>
<td>Less delay than RS</td>
<td>BGR</td>
<td>Yes</td>
<td>IP tunnel between source and BGR</td>
<td>Reduces JOIN latency for micro mobility</td>
</tr>
<tr>
<td>Mobicast</td>
<td>Less packet loss buffering</td>
<td>DFA</td>
<td>yes</td>
<td>Does not use IP tunnel</td>
<td>Buffering solves packet loss</td>
</tr>
</tbody>
</table>

...to the existing multicast mobility protocols to reduce the join latency and leave latency. In Chapter 8, I present some of the optimization techniques that I have developed for multicast stream delivery that reduces the join latency in a hierarchical multicast environment.

### 2.8 Concluding remarks

A careful survey and analysis of the handoff processes for the cellular mobility protocols and several IP-based mobility protocols extrapolate the common functions that are required to complete a handoff event. Since many of the functions such as discovery, authentication are access dependent, one needs to take into account the access...
characteristics of the multi-layer handoff operations for the IP-based mobility while
designing the optimization techniques. Lessons learnt from optimization techniques
from cellular mobility can easily be applied to improve the optimization techniques
for IP-based mobility. For example, mobility proxy-assisted forwarding technique for
IP-based mobility benefits from GSM’s MSC-anchored forwarding techniques to re-
duce packet loss by forwarding the media from the previous network. Soft-handoff
technique for CDMA-based cellular networks can be used as guidelines while design-
ing IP-based fast-handoff mechanisms by applying bicasting or multicasting mecha-
isms. Thus, while designing any new mobility protocol for next generation networks,
or proposing a new optimization technique, it is very important to investigate the
abstract handover primitives and study the optimization techniques for cellular mo-
bility.