An overview of vertical handover decision strategies in heterogeneous wireless networks

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Computer Communications 31 (2008) 2607–2620
Outline

• Introduction
• Handover management in heterogeneous wireless networks
• Vertical handover decision
• Vertical handover decision strategies
• Our proposal
• Conclusion
Introduction

• The fourth Generation (4G) represents a heterogeneous environment with different access networks technologies

• Mobility management is the essential issue that supports the roaming of users from one system to another

• Handover management controls the change of the MT’s point of attachment during active communication
Introduction

- The vertical handover decision process answers *when* and *where* to hand over in a heterogeneous environment
  - The first choice can minimize
  - The second choice can satisfy network and user requirements
Handover management in heterogeneous wireless networks

Fig. 1. Handover management concept.
Handover management in heterogeneous wireless networks

• Handover management process
  – Handover Information Gathering
    • collect the information required to identify the need for handover
  – Handover Decision
    • whether and how to perform the handover by selecting the most suitable access network
  – Handover Execution
    • change channels conforming to the details resolved during the decision phase
Handover management in heterogeneous wireless networks

• Mobile IP
  – MN detects whether it has moved to a new access network
  – MN obtains a new temporary address, CoA (Care-of-Address) when it enters a new access network
  – Once the new tunnel is set up, the HA tunnels packets destined to the MN using the MN’s new CoA
Handover management in heterogeneous wireless networks

- Mobile IP
Vertical handover decision

- Handover decision criteria
  - Network-related: coverage, bandwidth, latency, link quality (RSS), SIR (Signal-to-Interferences Ratio), BER (Bit Error Rate), monetary cost, security level, etc.
  - Terminal-related: velocity, battery power, location information, etc.
  - User-related: user profile and preferences.
  - Service-related: service capabilities, QoS, etc.
Vertical handover decision

• Handover decision policy
  – The traditional handover decision policy is based only on RSS
    • RSS: choosing the new Base Station (BS)
      if RSS_{\text{new}} > RSS_{\text{old}}.
    • RSS with Threshold $T$: choosing the new BS
      if RSS_{\text{new}} > RSS_{\text{old}}$ and $RSS_{\text{old}} < T$.
    • RSS with Hysteresis $H$: choosing the new BS
      if RSS_{\text{new}} > RSS_{\text{old}} + H.
    • RSS, Hysteresis and Threshold: choosing the new BS
      if RSS_{\text{new}} > RSS_{\text{old}} + H and RSS_{\text{old}} < T.
Vertical handover decision strategies

• Decision function-based strategies (DF)
• User-centric strategies (UC)
• Multiple attribute decision strategies (MAD)
• Fuzzy logic and neural networks based strategies (FL/NN)
• Context-aware strategies (CA)
Vertical handover decision strategies

• Decision function-based strategies (DF)

\[ f_n = \sum_s \sum_i w_{s,i} \cdot p^{n_s,i} \]

\( p^{n_s,i} \): the cost in the ith parameter to carry out service \( s \) on network \( n \).

\( w_{s,i} \): the weight (importance) assigned to using the ith parameter to perform services.
Vertical handover decision strategies

• User-centric strategies (UC)
  – user preferences, in terms of cost and QoS, is the most interesting policy parameter
Vertical handover decision strategies

• User-centric strategies (UC)
  – A. Calvagna, G. Di Modica propose a model
    • (1) the MT will never abandon GPRS connection without connection blackouts
    • (2) the algorithm searches for just WiFi access points with connection blackouts

\[ C = T_{\text{WiFi}} \cdot c_{\text{WiFi}}(h) + T_{\text{GPRS}} \cdot c_{\text{GPRS}}(h) \]
Vertical handover decision strategies

- Multiple attribute decision strategies (MAD)
  - SAW (Simple Additive Weighting): the overall score of a candidate network is determined by the weighted sum of all the attribute values.
  
  - TOPSIS (Technique for Order Preference by Similarity to Ideal Solution): the chosen candidate network is the one which is the closest to ideal solution and the farthest from the worst case solution
  
  - AHP (Analytic Hierarchy Process): decomposes the network selection problem into several sub-problems and assigns a weight value for each sub-problem
  
  - GRA (Grey Relational Analysis) is then used to rank the candidate networks and selects the one with the highest ranking
Vertical handover decision strategies

• Fuzzy logic and neural networks based strategies (FL/NN)
  – These are combined with the multiple criteria or attribute concept in order to develop advanced decision algorithms
  – Deal with imprecise information
  – Combine and evaluate multiple criteria simultaneously
Vertical handover decision strategies

• Context-aware strategies
  – based on the knowledge of the context information of the mobile terminal and the networks
  – evaluate context changes to get decisions on whether the handover is necessary and on the best target access network
Vertical handover decision strategies

<table>
<thead>
<tr>
<th>Vertical handover decision strategy</th>
<th>Traditional (RSS-based)</th>
<th>DF</th>
<th>UC</th>
<th>MAD</th>
<th>FL/NN</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-criteria</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (FL)</td>
<td>Yes</td>
</tr>
<tr>
<td>User consideration</td>
<td>No</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
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<tr>
<td>Efficiency</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
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<tr>
<td>Flexibility</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
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<tr>
<td>Implementation complexity</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Service type supported</td>
<td>Non-real-time</td>
<td>Non-real-time and Real-time</td>
<td>Non-real-time</td>
<td>Non-real-time and real-time</td>
<td>Non-real-time and real-time</td>
<td>Non-real-time and real-time</td>
</tr>
</tbody>
</table>

DF, decision function; UC, user-centric; MAD, multiple attribute decision; FL/NN, Fuzzy Logic/Neural Networks, CA, context-aware.
Our proposal
Conclusion

• An overview of the vertical handover decision process with a classification of the different vertical handover decision strategies.

• To build a handover management solution, some issues have to be considered
  – handover control
  – information gathering
  – handover execution procedure
  – more available access networks
  – handover performance evaluation