An overview of vertical handover decision strategies in heterogeneous wireless networks

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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

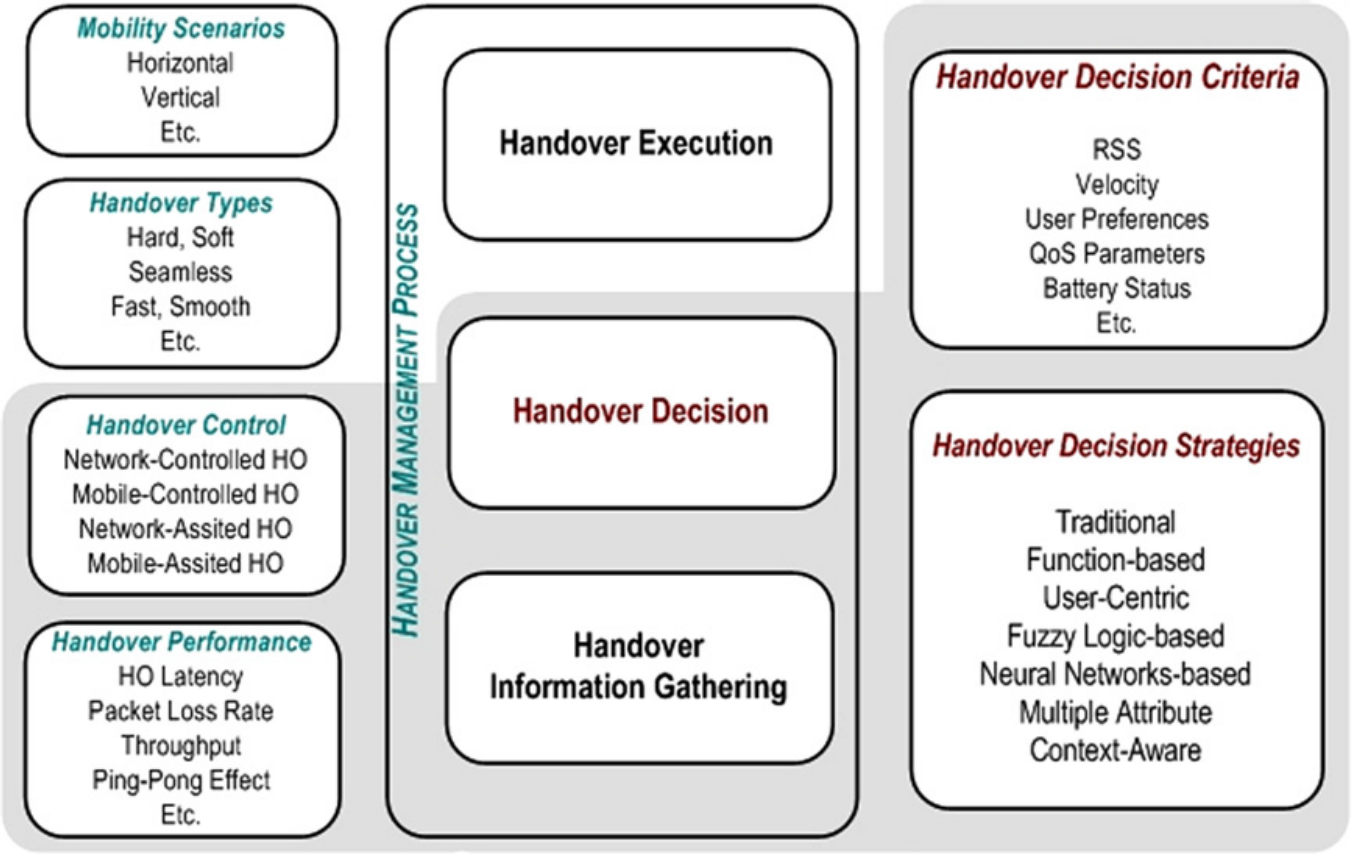


Fig. 1. Handover management concept.

Handover management in heterogeneous wireless networks

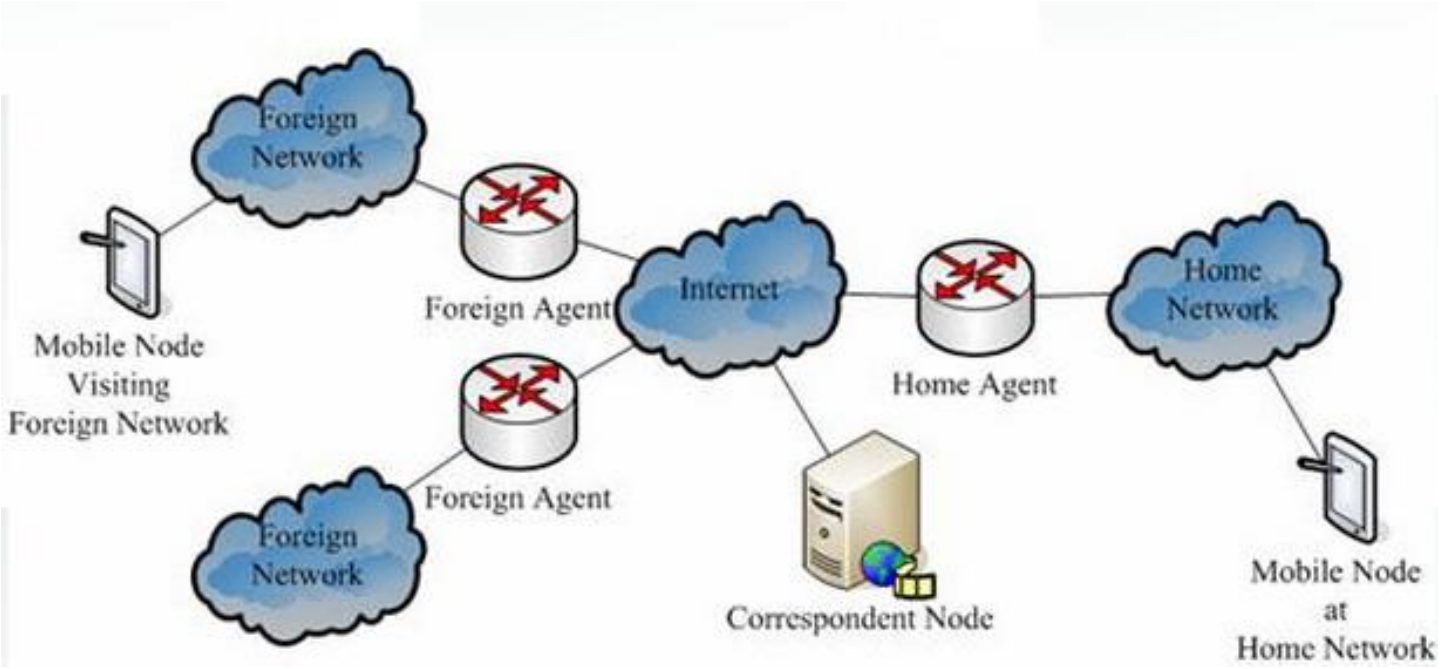
- Handover management process
  - Handover Information Gathering
    - collect the information required to identify the need for handover
  - Handover Decision
    - whether and how to perform the handover by selecting the most suitable access network
  - Handover Execution
    - change channels conforming 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 RSSnew > RSSold.
    - RSS with Threshold T: choosing the new BS

      if RSSnew > RSSold and RSSold < T.
    - RSS with Hysteresis H: choosing the new BS

      if RSSnew > RSSold + H.
    - RSS, Hysteresis and Threshold: choosing the new BS

      if RSSnew > RSSold + H and RSSold < 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)

$$f_n = \Sigma_s \Sigma_i w_{s,i} \cdot p^{n_{s,i}}$$

$p^{n_{s,i}}$: 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

$$C = T_{\mathrm{WiFi}} \cdot c_{\mathrm{WiFi}}(h) + T_{\mathrm{GPRS}} . c_{\mathrm{GPRS}}(h)$$

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

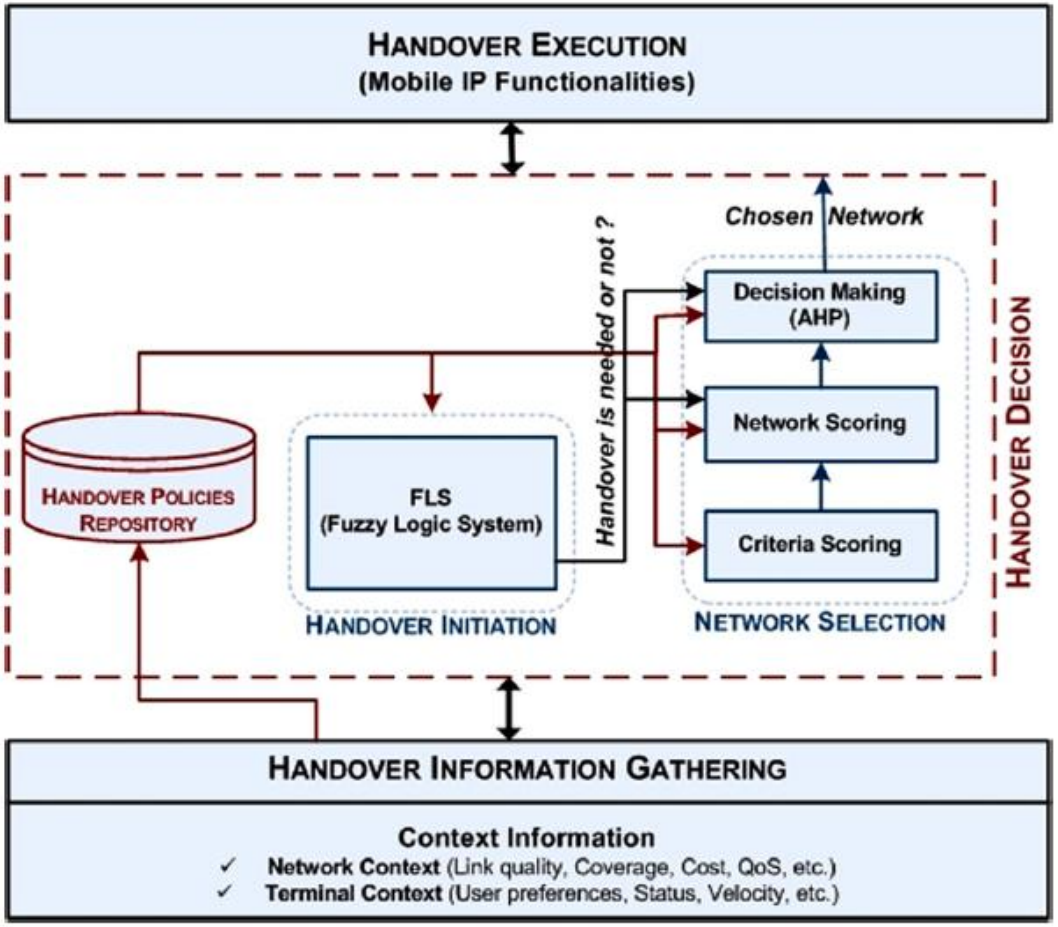
Vertical handover decision strategies

Comparison between vertical handover decision strategies

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

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