A Generic Hand-Over Framework for 4G Networks

Utz Roedig and Cormac J. Sreenan
University College Cork, Cork, Ireland
Email: {u.roedig|c.sreenan}@cs.ucc.ie

Abstract

Future telecommunication systems, commonly classified as 3G or 4G networks, will exhibit a range of wireless access technologies, ranging from GSM to UMTS to WLAN and WiMAX. A core issue in such heterogeneous wireless networks is the hand-over between different available access networks [1]. This work presents a novel generic hand-over policy framework that abstracts from specific access technologies. The framework standardizes the way network parameters and user parameters are fed into the hand-over decision process. Thus, new access networks can easily be incorporated in existing network structures.

1. Hand-over Framework

A mobile terminal has the choice among N different base-stations. More precise, some of these N base-stations might belong to the same access network.

I network parameters of interest for each of the N base-stations are used as base for the hand-over decision process. Parameters of interest might be for example signal strength, packet loss rate or number of terminals already served by the base-station. The current value (and history) of these parameters must be available for the decision logic.

The importance of each network parameter for the decision logic is expressed by I utility curves for each of the N base-stations. For each base-station (in practice, for each type of base-station) a different set of utility curves is used. For example signal strength in a UMTS network and a WLAN network need to be weighted differently. The utility curves might also change over time to reflect the changing needs of the user/terminal over time. A user might be engaged in a phone call but might be using a data connection in the future or might be in idle mode.

Network parameters and utility curves are used as input by the decision logic for a hand-over decision (see Fig. 1).

2. Hand-over Decision

For a hand-over decision, the I utility functions $U_{i,n,t}$ are used to evaluate the I network parameters $P_{i,n}(t)$ for each of the N available base-stations as detailed in Equation 1.

$$F_n(t) = \left(\sum_{i=0}^{I} \alpha_{i,n} \cdot \frac{1}{Tp_{i,n}} \cdot \int_{t_0 - Tp_{i,n}}^{t_0} U_{i,n,t}(P_{i,n}(t)) \cdot dt \right) - C_{N_a,N_n} \quad (1)$$

The weights α_i are used to regulate how important a network parameter should be rated. To deal with short term fluctuations of a network parameter, the utility of a network parameter is averaged over the recent time period Tp_i.

In addition, the switching cost C_{N_a,N_n} is included in the calculation. The cost reflect switching cost from the current active base-station N_a to the base-station N_n in question. The switching cost might reflect monetary costs or an technical effort necessary to perform a hand-over. The switching cost is used to remove high frequent switches between two base-stations.

The resulting N values F_n are used for the hand-over decision as detailed in Algorithm 1. The F_n are calculated and if the currently used base-station is not the base-station providing the minimum F a hand-over to this base-station is initiated. The Algorithm 1 must be invoked frequently enough to keep the terminal attached to the most useful network. The update frequency necessary might depend on the terminal speed and the cell size of the access networks.

Algorithm 1 Hand-over Decision

HandoverDecision(P, U, C, act)
  calculate F_n
  calculate $F_{min} = min\{F_1, ..., F_N\}$
  if$\{F_{min} \neq F_{act}\}$
    handover(network(F_{min}))

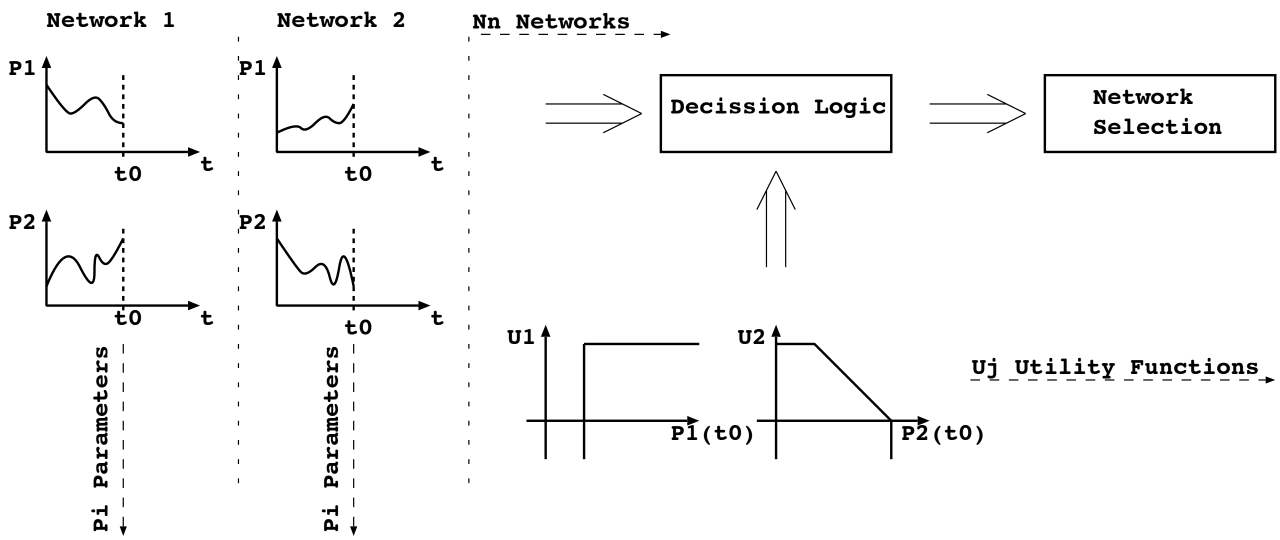

Figure 1. Basic Hand-over Model

3. Summary

The presented framework allows to describe the hand-over decision process in a generic way. However, depending on the nature of the network the framework will be used for, meaningful values for all variables used must be found. In particular, the utility curves U and switching costs C must be specified and the weights α_i and time period Tp_i must be set. This is a challenging and difficult task that is unfortunately dependent on the particular application scenario of interest.

References

[1] Y. Xiao, K. K. Leung, Y. Pan, and X. Du. Architecture, mobility management, and quality of service for integrated 3G and WLAN networks, Wireless Communications and Mobile Computing (WCMC), Issue 5, pp 805-823, 2005.