Movement scenario of mobile devices in a heterogeneous network

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Abstract. In today's world, information technology is developing in all spheres of human life, especially the emerging global information society, which led the unification of telecommunications and information technologies. This increases the user requirements for the quality and range of services of these technologies, to which access must be provided continuously and independently of geographical location, according to the concept of continuous best connections (Always Best Connected, ABC). Variety of radio access technologies and the increasing number of mobile devices enable the integration of different technologies into a single network, which makes the question of achieving seamless mobility and seamless service continuity in heterogeneous wireless access networks. In this paper will be considered movement scenario of MD in a heterogeneous network.
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Introduction

Complex issue in the multiservice next generation wireless network (NGWN) is to develop intelligent and optimal vertical handoff decision algorithms for traditional, based only on the signal strength. To determine when to perform handoff and select the optimal access technology network among all available access networks for mobile devices (MD) equipped with a multi-mode mobile terminal [1, 2].

Mobile devices (MD) - man-made object having an internal structure designed to perform specific functions. These include phones, laptops or other mobile devices, as well as robots or unmanned vehicles. For this work, we take MD to help Emergency services. Emergency services and rescue services are organizations which ensure public safety and health by addressing different emergencies. Some of these agencies exist solely for addressing certain types of emergencies whilst others deal with ad hoc emergencies as part of their normal responsibilities. Many of these agencies engage in community awareness and prevention programs to help the public avoid, detect, and report emergencies effectively. Main emergency service functions: Police, Fire department (fire and rescue service), Emergency medical service, and other emergency services [3]. In work [4] were described model of MD and the formalization of the problem domain in which there is a business process that is similar in structure.

Description of the heterogeneous network

There are several issues to consider before integrated heterogeneous wireless access systems in NGWN can provide vision of seamless mobility, including: maintaining connections for MD on the go; choosing between different types of access networks based on network characteristics, services offered, need, and user preferences; power management to extend battery life multimode devices and dynamic spectrum allocation. Solving these problems requires the key functions that need to be performed, including: monitoring the current serving network, access network discovery, handoff decisions and handoff execution.

Seamless mobility and service continuity can be achieved by providing a mobile terminal for seamless handoffs with low latency and minimal loss of packets in a heterogeneous wireless access networks, for example across mobile WiMAX, and 3G (e.g., UMTS) access network, and continues smoothly transfer their current sessions from one network access to the best available target network access. In other words, seamless handoff is the key enabling function for seamless mobility and seamless service continuity among heterogeneous wireless technologies in NGWN. Users experienced a seamless horizontal handoff during cell phone calls when connected to a separate cellular network interfaces for several years. In the future, however, the seamless vertical handover should become commonplace when MD connected to multiple interfaces of NGWN. Seamless handover is usually characterized by two performance requirements:

• The handoff latency should be low and no more than a few hundred milliseconds.

• In QoS, provided the source and destination access networks should be almost identical in order to maintain the same experience.

These two performance requirements are not trivial to satisfy when two or more heterogeneous access networks merged in a single architecture. Soft handoff can eliminate handover latency and instability when using multimode MD. In order to offer seamless handoff, a key issue is to addressed providing efficient vertical handoff algorithms covering three consecutive phases of the handover process: access network discovery, handoff decisions and performing handoff. Vertical handover decision is a major study of this thesis.

Multimode mobile device should be able to [5]:

• Detection of the presence of access networks;

• Search, receiving and processing of measurement on the characteristics of available network access;

• Access, modify and store user profile;

• Allowing the user to dynamically redefine his/her preferences, and

• Support applications smoothly transfer from existing connections from one access network to another.

For their study chose the network that are widespread and are available in major cities of Kazakhstan, that is, in Almaty and Astana. Table 1 described and compared them with each other.

Table 1. Comparison of Wi-Fi, WiMAX, 3G and 4G

Characteristic	Wi-Fi	WiMAX	3G	4G
Standart	IEEE 802.11g	IEEE 802.16e	W_CDMA, CDMA2000	IEEE 802.16m
Data rate	54 Mb/c	10-50 Mb/c	3 Mb/c	Up to 100 Mb/c
Coverage	50-60 m	Up to 50 km	30 m – 20 km	30 m – 20 km
Mobile speed	Up to 1 km/h	60 km/h	Up to 120 km/h	Up to 350 km/h
Cost	low	low	High	high
Objective	To provide BWA to fixed and nomadic users	To provide BWA to fixed and nomadic users	To provide voice and data service to mobility users	To provide voice and data service to mobility users
Mobility	Fixed and nomadic	IP mobility	Full mobility function	Full mobility function
Advantages	Speed, cheap	Speed, range, mobility	Range, mobility	Speed, range, mobility

Consider the movement scenario and the perform algorithm

There are different cases to use MD in emergency services. For an example in this work to explain the scenario took a case, whether when MD gone on a task from a point And on a point of B, found the network and finds out it is necessary to pass to a new network or to remain on flowing networks.

1step. MD on the go in certain areas that are already connected to the wireless there C, detects new network N.

Network discovery is the process where a MD equipped with several interfaces searches for reachable wireless access networks. As the multimode MD moves across the network, it must discover the other access technologies available in its surroundings, which can be preferably used in the access network currently. For example, a multimode MT using a UMTS access network system NGWN necessary to detect when the Mobile WiMAX access network become available, and may handoff to a mobile WiMAX, if it is preferable for the operator and/or user, or if a radio signal from the his acting in UMTS cell starts to deteriorate significantly. The network discovery phase collects information about the network, mobile devices, access points and user settings to be processed and used for decision-making at the stage of the handoff.

2 step. After the network discovery, MD collects information about network.

In order to perform intelligent handoff decisions in heterogeneous next generation wireless environment and provide a smooth vertical handoff, the following parameters are proposed in addition to the RSS [6, 7]: 1. Quality of Service (Terms of networks, network latency and congestion, RSS, the propagation characteristics of the channel path loss, inter-channel interference, signal to noise ratio (SNR), and bit error rate (BER)). 2. Cost of services. 3. Battery power. 4. Security. 5. MD conditions. 6. Application types. 7. Users preferences.

3 step. The information collected results in a system using fuzzy logic.

The information collected by the description is very different, and it makes the whole process more vertical handoff complex and ambiguous, since different factors must be taken into account at the same time to make a good decision handover. One of the promising directions in multi NGWN lies in the development of intelligent algorithms for solving vertical handover to determine when to perform a handover and ensure an optimal choice of access network technology all available access networks for MD. In this paper we propose a fuzzy logic as an effective means of addressing these. As incomplete knowledge representation techniques, fuzzy logic is well suited to address the discrepancy [8, 9].

Fuzzy inference system (FIS), or fuzzy logic system is a nonlinear mapping the input data vector in scalar output. This is the basis of calculations are based on the concepts of the theory of fuzzy sets and fuzzy logic. Two types of the fuzzy inference system that can be implemented are the Mamdani-type and the Sugeno-type. Fuzzy inference systems have been successfully applied in fields such as automatic control, data classification, decision analysis, and expert systems.

Handover Initiation Algorithm uses fuzzy inference system (FIS) for the treatment of multiple vertical handover initiation parameters (criteria). We use a FIS Mamdani, which consists of function blocks [10], a fuzzifier, the fuzzy rule base, a database of fuzzy inference, and the defuzzifier. Since the inputs and outputs of the FIS clear character, fuzzifier and defuzzifier required to turn them in and out of a fuzzy representation.

4 step. It is also necessary to calculate the weight of the criteria on the situation.

Determination of Attribute Weights: Data from the system is fed into fuzzifier to be converted into fuzzy sets. Assume that $A = \{A_1, A_2,..., A_m\}$ is a set of m alternatives, and $C = \{C_1, C_2,..., C_n\}$ is a set of n handoff criteria solutions (attributes) that can be expressed as a fuzzy sets in the space of alternatives. The criteria are rated on a scale of 0 to 1. Degree of membership in the alternative A_j in the criterion C_i, denoted $M_{Ci}(A_j)$, is the extent to which alternative A_j satisfies this criterion. Decision-maker (eg, the working field or mobile user) sends the data available in the paired comparisons, answering the basic question: Given a specific criterion and two alternatives, A_i and A_j, which one is preferable, and to what level of intensity? Decision maker makes this comparison linguistically and assigns values a_{ij} judgment on a scale proposed by Saaty [11], with a less important element used as a unit and more important element is assigned a value of this scale as a multiple of this unit:

- 1 - equal importance (A_i and A_j are equally important);
- 3 - weak importance of one over another (A_i weakly more important than A_j);
- 5 - strong importance of one over another (A_i is strongly more important A_j);
- 7 - more clearly or very strong significance of each other (A_i is clearly more important than A_j);
- 9 - absolutely or extremely important one above the other (A_i absolutely more important than A_j);
- 2, 4, 6 and 8 - represent a compromise solution that is intermediate between the values of two neighboring solutions.

Possible values a_{ij} 1, 2, 3, 4, 5, 6, 7, 8, 9, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9. Depending on the criteria that compared the following cases exist:

1. $a_{ij} = 1$, as compared with the attribute itself.
2. $a_{ij} > 1$, when attribute i is considered to be more important than attribute j.
3. $a_{ij} < 1$, when attribute j is considered to be more important than attribute i.

An n×n matrix B pairwise comparison judgments about the relative importance or preference between any two criteria is constructed so that:

$$\begin{cases} b_{ij} = 1 \\ b_{ij} = a_{ij}, i \neq j \\ b_{ij} = 1/b_{ij} \end{cases} \quad (1)$$

b_{ij} value of this matrix represents the relative importance of the i-th criterion by j.

Using this matrix, the unit eigenvector, V, corresponding to the maximum eigenvalue, L_{max} of the B is then determined by solving the equation:

$$B \cdot V = L_{max} \cdot V \quad (2)$$

Search unit eigenvector, V, corresponding to the maximum eigenvalue of B produces a cardinal ratio scale comparable attributes. Eigenvectors then normalized to ensure consistency. In other words, the scaled value V to be used as weighting factors in the membership values for each attribute by dividing the scalar sum of the values V for V, to obtain a weight vector or vector priorities

$$W = \{w_j | 0 \le w_j \le 1, \sum_{j=1}^{n} w_j = 1\}. \quad (3)$$

Optimal wireless network optimization problem is given by:

$$\max f_i(x) = \max\{\sum_{j-1}^{n} w_j \cdot M_{Cj}(A_i)\}. \quad (4)$$

such that

$$0 \le w_j \le 1, and \sum_{j=1}^{n} w_j - 1, \quad (5)$$

and

$$\{M_{Cj}(A_i)\}_{min} \le M_{Cj}(A_i) \le \{M_{Cj}(A_i)\}_{max} \quad (6)$$

5 step. Uses optimization algorithm.

Multiple attributes decision making (MADM) deals with the problem of choosing an alternative from a finite and countable set of alternatives, which are characterized in terms of their multiple attributes.

A typical problem is formulated as a MADM [12]:

select Ai from A1, A2, …, Am
using C1, C2, …, Cn (7)

where {A1, A2,..., Am} m represents an alternative and {C1, C2,..., Cn} n represents criteria or attributes. Selections are generally based on maximizing the utility function of multiple attributes.

The decision on selecting an access network in a heterogeneous wireless environment can be solved by using several specific attribute decision (MADM) algorithms, such as:

1) Weighted Sum Model (WSM) or Simple Additive Weighting (SAW) - If there are m alternatives and n criteria, then the best option is the one that satisfies the following expression:

$$A_{WSM} = \sum^{n} w_j \cdot a_{ij}, \quad for\ i = 1,2,...,m. \quad (8)$$

A_{WSM} is where WSM score of the best alternatives, a_{ij} is the actual value of the i-th alternative in terms of the j-th criterion, and w_j is the weight of importance of the j-th criterion. Overall rating of the candidate network determined the weighted sum of all the values of attributes;

2) Weighted Product Model (WPM) or multiplicative exponent Weighting (MEW) - Each alternative is compared to the other by multiplying the number of coefficients, one for each criterion. Each coefficient in the power equivalent to the proportion of the relevant criteria. In general, in order to compare alternative A_K and A_L, the following product is obtained:

$$R(A_K / A_L) = \prod_{j=1}^{n} (a_{Kj} / a_{Lj})^{w_j}, \quad (9)$$

where n-number of criterion, a_{ij} is the actual value of the i-th viewpoint alternatives j-th criterion, weight and w_j is the j-th importance criterion.

If $R(A_K / A_L)$ is greater than or equal to unity, then the alternate A_K is more desirable than the alternative A_L. The best alternative is the one that is better than at least equal to all other alternatives;

3) Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) - This is a method for ranking a finite number of alternatives using a variety of decision-making criteria. The successful candidate network using this method is the one that is closest to the ideal solution and farthest from the worst decision;

4) Analytic Hierarchy Process (AHP)- AHP method is used as a means of finding the optimal solution for complex decision problems. This problem is decomposed first network selection system hierarchies, i.e. several subtasks and then pairwise elicitates judgment criteria and assigns a weight value to each sub - problem and

5) Grey Relational Analysis (GRA) - Method GRA gray builds the relationship between elements of the two series to compare quantitatively each member. It is used to rank the candidates networks and choose the one with the highest rating.

6 step. Select a network. That is the achievement of the main goal.

Conclusion

The work is very important operational services every information that would help in their difficult work. In a heterogeneous network is very important to ensure the efficient use of its resources and transparently moving through her MD. This procedure is implemented through the optimal vertical handover as inefficient handover can result in loss of connectivity to an unsatisfactory level, or QoS significant costs.

This paper focuses on the procedures VHO, formulating scenarios network selection purposes in the process of handover, but also provides intelligent multicriteria handover initiation algorithm and select the destination network.

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