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Adaptive Network Access Mechanism for Multi-interfaced Terminal over Heterogeneous Wireless Networks

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***Abstract-* This paper proposes adaptive network access mechanism to support multi-interfaced terminal over heterogeneous wireless networks. Mobile devices equipped with multi mode interfaces perform an access request based on information of available access networks with cost function. The proposed cost function adopts the minimum required bandwidth and signal to interference plus noise ratio (SINR). In order to evaluate the performance, we compare the proposed algorithm against traditional algorithms. Simulation results show that the proposed algorithm improves the blocking probability and throughput.**

Keywords: Multiple Interfaces, Heterogeneous wireless network, network access

I. INTRODUCTION

Over the past ten years, various wireless communication technologies (e.g. 3G cellular, IEEE 802.11 WLAN, Bluetooth) have been developed. At the same time, the efficient network access management for multimedia applications with different quality of service (QoS) requirements in the presence of heterogeneous wireless access technologies becomes one of the most challenging issues for NGN (Next Generation Networks). In the heterogeneous wireless networks, a users or network will be able to decide where to connect among the different access technologies based on the bandwidth, signal strength, interferences, service requirements and so on. For that reason, efficient access management and connection strategies will be key components in such a heterogeneous wireless system supporting multi-interfaces and different types of applications with different QoS requirements [1].

Traditional operation for access management is based on Received Signal Strength (RSS) and channel availability. In addition, it is not able to adopt the multiple interfaces over heterogeneous network. When mobile users request a service using multi-interfaced devices, mobile terminal should select the best network in order to use best services. Therefore, adaptive network access solution is needed to efficiently support for both a user and a system over heterogeneous networks.

Figure 1 shows the access networks which are considered in this paper. Generally, 3G (HSDPA) ensures wider mobility range than WLAN (802.11a/b/g), but bandwidth cannot be guaranteed without regional factors. Even though WiMax is a compromise plan, a fairly big cost still occurs when downloading contents. Moreover, a blueprint of 4G becomes clear beyond 3G and 2G service is still contented nevertheless. Therefore, a variety of wireless networks will co-exist in the near future.

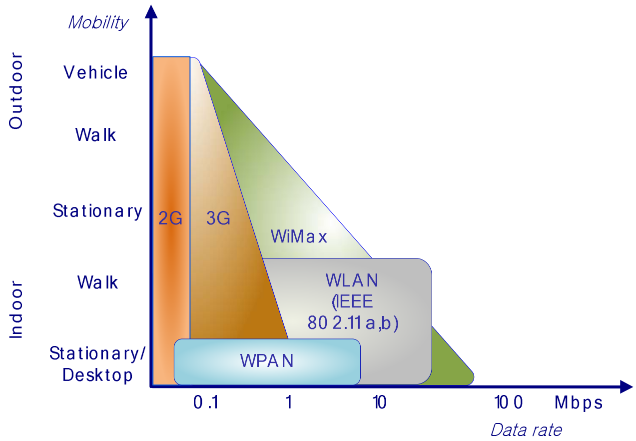

Figure 1. Mobility versus bit rates

This paper is organized as follows. In the next section, we describe the architecture of proposed algorithm. In section 3, we present the proposed algorithm. Simulation results are presented and compared in Section 4. Finally, we conclude the paper in section 5.

II. NETWORK ARCHITECTURE

The proposed adaptive network access mechanism is based on a wireless agent model. In figure 2, we present network architecture over numerous access interfaces as interim system. The wireless agent collects network information from user devices such as SINR, RSSI, bandwidth, and delay time. We assumed that the mobile terminal has WLAN, HSDPA and WiBro interfaces which can accommodate all wireless networks. The wireless agent connects to core network and manages a domain. The access management algorithm is exploited here in this architecture.

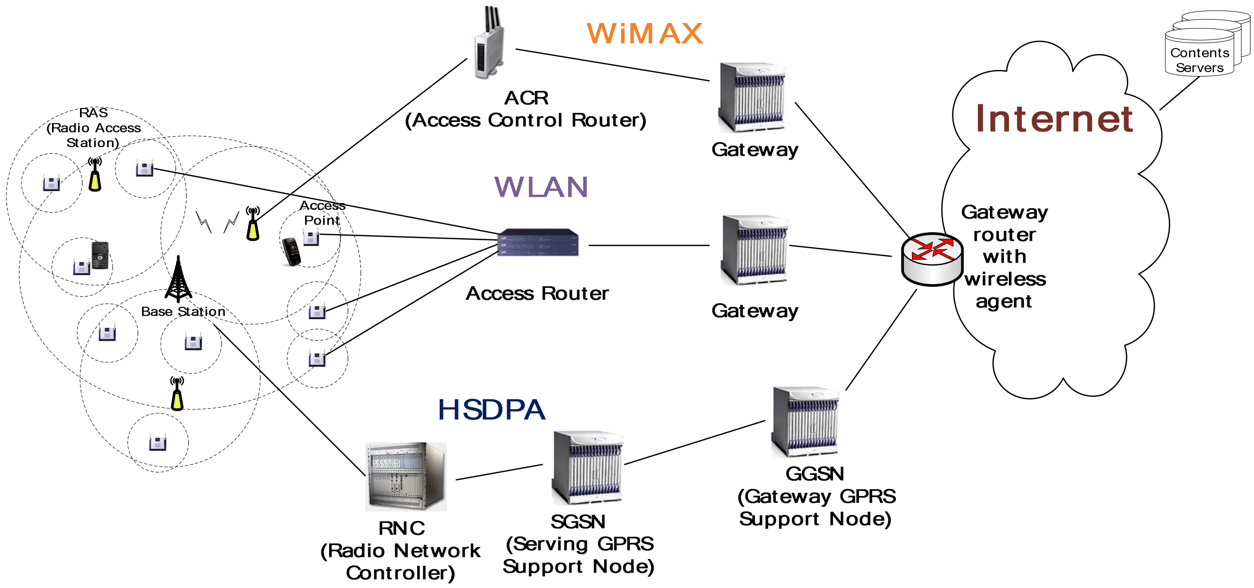

Figure 2. The proposed Wireless Agent Model

III. Proposed Algorithm

A. Cost Function

As we mentioned above, the wireless agent in gateway performs with access decision algorithm. It enables users to access into the best network by considering various parameters (e.g. bandwidth, network cost, and user preferences) along with a cost function. We consider two metrics in the network aspect: minimum bandwidth required by a user and SINR. Minimum bandwidth is considered whether network supports user services or not. The SINR reflects better signal considering noise and interference than the typical RSS based.

In order to consider user's service requirement, we define satisfaction index. As shown in figure 3, the user's satisfaction is defined on the scales of two parameters: satisfaction index and bandwidth ratio [2]. The satisfaction index is a mean-opinion-based (MOS) value graded from 1 to 5, which is divided by two regions: the acceptable satisfaction region and low satisfaction region. The bandwidth ratio graded from 0 to 1 can be separated by 3 regions. In the region from 1 to A, it has low degradation of satisfaction index. It means users are not sensitive in this region. However, it has large degradation of satisfaction index in the region from A to B.

The point indicated as A is called the critical bandwidth ratio used in proposed algorithm. Since this value is the minimum acceptable satisfaction index, it can be used for decision parameter. In the region from B to 0, users do not satisfy their services. Therefore, this region should not be assigned to any users. Generally, the critical bandwidth ratio of Video On Demand (VOD) is 0.6 ~ 0.8 and back ground traffic is 0.2~0.6 [3].

The function (1) shows the cost function evaluated for network n.

$$C_s^n = E_s^n \cdot B_n \log_2(1 + SINR_n) \qquad (1)$$

Here, the interference is not from other systems but from the same system. We denote that C_s^n is the cost function evaluated for requested service s at the network n, and B_n is the bandwidth in network n. The network elimination function, E_s^n is incorporated to remove

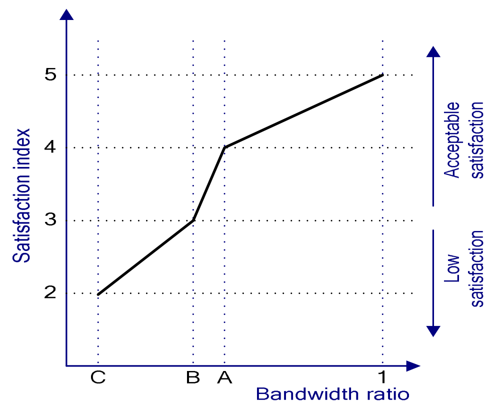

Figure 3. Satisfaction Index

unavailable candidates which cannot support the requested service immediately [4].

$$E_s^n = \begin{cases} 0, \text{if service s cannot be satisfied} \\ 1, \text{if service s can be satisfied} \end{cases} \qquad (2)$$

B. Network Access Control Algorithm

Figure 4 is the flow chart for proposed algorithm by considering cost function. First of all, wireless agent periodically collects information (i.e. available bandwidth, RSSI, SINR) from mobile terminal and proves available bandwidth from networks. And then, wireless agent calculates the cost by using proposed formula (1). After that, candidate network for mobile terminal is listed up in wireless agent. If the number of candidate network is more than two, user preference network is selected.

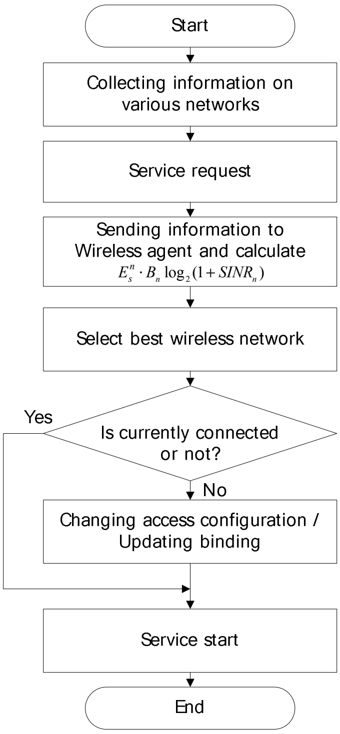

Figure 4. Flow chart for access decision

After the decision for best network, if the subnet of decided network is different from current subnet, wireless agent requests a network binding.

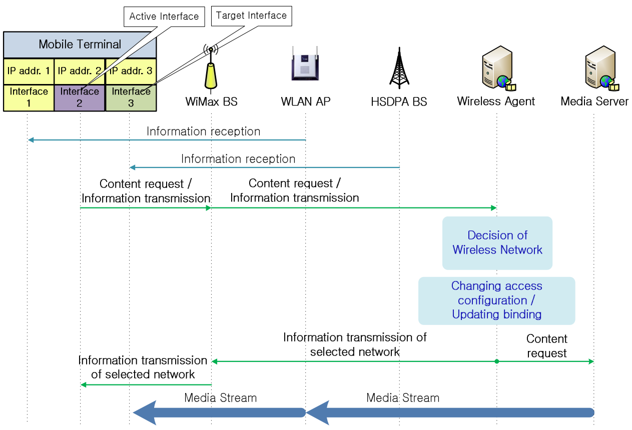

Figure 5. Message procedures

IV. SIMULATION RESULT

In this section, we present the simulation results for the comparison of performance. We compared two decision algorithms: single interface based and proposed algorithms. In the simulation model, 35 WLAN AP, 4 WiBro RAS, and 1 BS are considered as shown in figure 6. We also assumed that the mobile terminals are using video stream service with 1Mbps from the server.

In this environment, we simulate that 90 mobile terminal is randomly created and uniformly distributed within wireless network coverage during simulation. Therefore, the available bandwidth of each network is changing simultaneously.

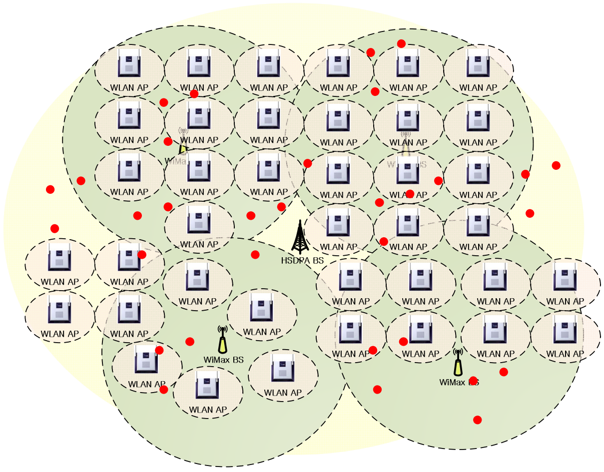

Figure 6. Simulation Environment

Figure 7 shows the blocking probability of a multi-mode mobile terminal which performs a request to access networks. With this simulation environment, we compare the blocking probability of each algorithm as the request rate increases.

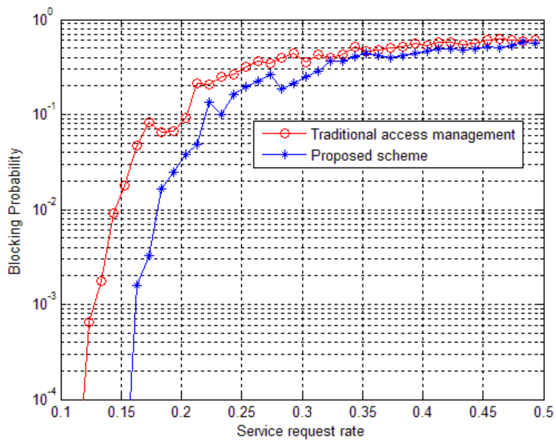

Figure 7. Blocking probability comparison

At the same manner, we also observe that proposed algorithm has higher throughput as shown in figure 8.

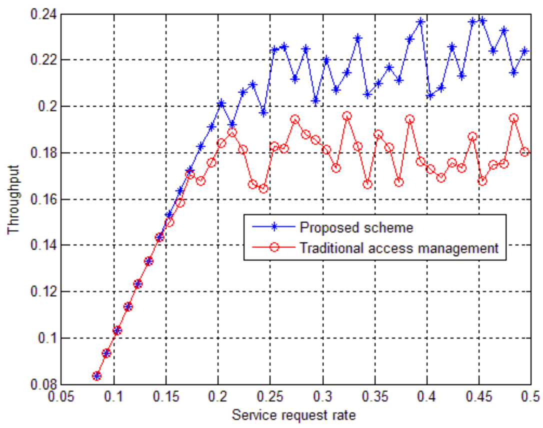

Figure 8. Throughput comparison

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V. CONCLUSION

In this paper, we propose that wireless agent based access management algorithm for attaching to heterogeneous wireless networks. Proposed access control algorithm utilizes cost function by considering SINR, bandwidth and user preferred network to select the best network. In simulation result, we showed that the proposed access management algorithm has lower blocking probability and higher throughput in heterogeneous networks.

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