# Wireless Access Network Selection for Live Streaming Multicast in Future Internet

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## Abstract

*In future Internet, live streaming application with the support of multicast will be one of killer applications. If a host has multiple wireless interfaces, a new scheme should be proposed to select most appropriate wireless access network to maximize user satisfaction and ISP's profit at the same time. Our scheme exhibits shorter service disruption time and consumes ISP's network resources efficiently. Especially, the faster users move, the higher users' satisfaction level grows when compared with other schemes.*

## 1. Introduction

Recently, IP multicast is revisited because many applications are emerging which need the support of multicast [1]. Heterogeneity of radio access networks will be also prevalent in future Internet and almost every mobile host will have multiple radio interfaces, which will pose many challenges on how to select the most appropriate access network in terms of user satisfaction and system resource efficiency.

## 2. Proposed Scheme

Our goal is to devise an optimal wireless access network selection scheme for live streaming multicast services to maximize user satisfaction and system profit at the same time.

User satisfactory level is directly impacted by available bandwidth and handoff delay. The degree of satisfaction of bandwidth requirement is given by the bandwidth utility function as follows, where K is constant (0.62086) and b is bandwidth [2].

$$U(b) = 1 - e^{-\frac{b^2}{K+b}} \qquad (1)$$

Another factor of user satisfaction is dependent on handoff latency caused by user's mobility. Satisfactory level decreases as handoff latency, th increases. Service degradation function is given as follows in equation (2), where σ is a constant that has a larger value for non-real time applications and smaller value for real time applications [3]. We set the value as 8.37.

$$S_d(t_h) = e^{-\frac{t_h^2}{2\sigma^2}} \qquad (2)$$

We combine the above two functions into a single value to quantify user satisfaction and we will use this value as the criteria for access network selection. In following equation (3), tiH is i-th horizontal handoff delay and tV is vertical handoff delay.

$$S = \begin{cases} U(b) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots normal\_service \\ U(b) \times \prod_{i=1}^{n} S_d(t_{iH}) \cdots\cdots\cdots\cdots horizontal\_handoff \\ U(b) \times S_d(t_V) \times \prod_{i=1}^{n-1} S_d(t_{iH}) \cdots vertical\_handoff \end{cases} \qquad (3)$$

System resource usage can be simply estimated by bandwidth usage, but in wireless environments, each wireless technology has unique coverage area coupled with bandwidth. So, for the comparison we developed a 'normalized network resource' metric:

*Session Bandwidth / Capacity * Area / # of Users* (4)

Table 1. Network selection algorithm

*When a call request (including user preferences (Max/Min BW, moving speed)) arrives*
*list the available access networks with 2 attributes (User Satisfaction S, Normalized Network Resource R)*
*if (there's no multicast session)*
*select access network (AN) for maximum (S/R)*
*else if (there's already a multicast session only on one AN)*
*if (S >= S_lower_bound) select that AN*
*else select AN for maximum (S/R)*
*else if (there's multiple sessions through multiple ANs)*
*select AN for maximum S*
*end if*

Table 1 shows our network selection algorithm, which can be implemented quite simply.

## 3. Simulation Results and Discussions

Table 2. User profiles

| Profile | Average Speed | Number of Users |
|---|---|---|
| A | 6 km/h | 10 |
| B | 6 km/h | 100 |
| C | 120 km/h | 10 |
| D | 120 km/h | 100 |

We analyze the performance improvement of our scheme in terms of the normalized network resource and service disruption time. Three other schemes compared to ours are MaxUtility, MaxUtility·SD, and MinResource. MaxUtility selects the access network which maximizes the bandwidth utility function, whereas MaxUtility·SD additionally considers handoff delay using the product of the utility and service degradation function. MinResource chooses the access network that keeps the total network usage minimized. In terms of network resource, MinResource scheme is optimal.

Fig. 1 shows the total service disruption time during a session service time (30 minutes) under user profiles in Table 2. Our scheme shows shortest delay under any profiles. Especially under profile D with high speed mobility and dense users, our scheme substantially outperforms three other schemes.

Fig. 2 shows the normalized network resources of the four schemes. For all cases, our scheme significantly outperforms MaxUtility and MaxUtility·SD. Since both MaxUtility and MaxUtility·SD consider the bandwidth utility of each user, they consume more network resource than our scheme and MinResource. In particular, our scheme highlights its performance gain in user profile B and D, which have dense user distribution. Obviously, MinResource is the best, since it minimizes the total network usage. However, our scheme exhibits near optimal efficiency of the MinResource scheme.

In conclusion, our scheme presents best user satisfaction in terms of service disruption time and consumes near optimal system resource usage. Satisfactory level grows even higher when users move with high speed.

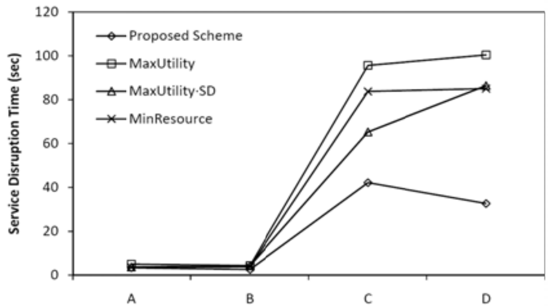


Figure 1. Service disruption time

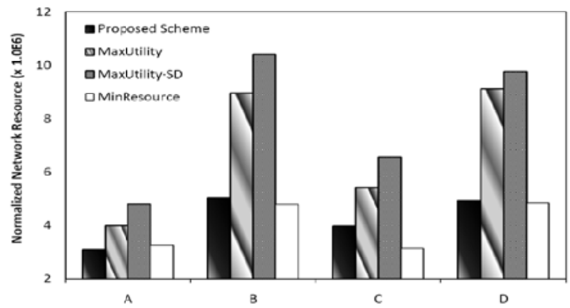


Figure 2. Normalized network resource


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