Channel Bonding-Aware Access Point Selection

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1. Introduction

Recently, the number of public wireless access points has been increased. As a result, dense wireless LAN will be likely to appear in the near future. In this environment, there are various access points with different settings in terms of channel bandwidths and frame sizes. In such case, the throughput performance is inherently decreased due to the performance anomaly (PA) problem resulting from the imbalance between each STA (station)'s Airtime [1]. In this paper, we propose a new AP selection scheme with considering channel bandwidths and frame sizes.

2. Objective

The objectives of this paper are as follows:

1. Airtime Fairness without the PA problem.
2. Achieving the highest throughput.

3. Proposed AP selection method

We propose two sorts of AP selection methods.

(A) STA initiative method

(1) The STA obtains the various information (RSSI, channel bandwidth, beacon loss rate, the number of STAs) from the received beacon messages. (2) The STA selects an appropriate channel with the minimum impact of the PA problem by the following procedures: First, the STA predicts my own Airtime when connecting to each AP ($Airtime_{own}$) by the equation ($Airtime_{own} = L/R$). Second, the STA measures Airtime ($Airtime_{other}$) for each channel. Third, an appropriate channel is selected based on the relationship between $Airtime_{own}$ and $Airtime_{other}$. The STA selects a channel with $Airtime_{own} \leq Airtime_{other}$ as much as possible, thereby minimizing the impact of PA problem. (3) The STA selects an appropriate AP from among all APs operating on the selected channel as follows: The STA selects an appropriate AP with the highest *Potential Throughput*, which is predicted by the equation (I) for each AP.

$$Potential\ Throughput = \frac{2L \times (1-p)}{(2T_D + T_A) \times (N+1)} \quad \text{(I)}$$

(B) AP and STA cooperation method

(1) The AP sets Airtime of all communication to $Airtime_{standard}$ ($= Max\ frame\ size / Max\ transmission\ rate$). The AP adjusts the frame size in response to the transmission rate in order to keeping the $Airtime_{standard}$ of all communication fair, thereby achieving the Airtime Fairness. (2) As in method (A), the STA predicts each of *Potential Throughput* by the equation (I) and finally selects an appropriate AP with the highest *Potential Throughput*.

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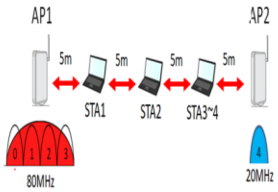

		AP1	AP2
Channel bandwidth		80MHz	20MHz
Frame size	Method (A)	64kByte	1534 Byte
	Method (B)	Change in response to the transmission rate	1534 Byte

Fig1:Simulation model and settings

Table1:GAI (Goal Achievement Indicator)

	(a) FI of Airtime	(b) Optimum AP selection probability	GAI [(a)×(b)]
Proposed method(A)	0.99	0.25	0.2475
Proposed method(B)	0.96	1	0.96

Table2:Throughput obtained by each STA

	STA1	STA2	STA3	STA4	Total
Proposed Method(A)	172Mbps (AP1)	7.9Mbps (AP2)	7.9Mbps (AP2)	7.9Mbps (AP2)	195.7Mbps
Proposed Method(B)	65.6Mbps (AP1)	38.7Mbps (AP1)	24.1Mbps (AP1)	24.4Mbps (AP2)	152.8Mbps

3. Simulation environment

We evaluate the methods (A), (B) through the simulation by using Scenargie2.2. The simulation model and settings are shown in Fig.1. After selecting the AP, the STA performs downlink FTP communication. We use the following two performance criteria.

- Throughput of each STA and total throughput
- GAI(Goal Achievement Indicator)

$$\mathrm{GAI} = (FI\ of\ Airtime) \times (Optimum\ AP\ selection\ probability(\mathrm{OAP}))$$

$$\mathrm{OAP} = \frac{Number\ of\ STAs\ with\ the\ highest\ Throughput}{Number\ of\ all\ STAs}$$

4. Result and discussion

From Table1, we can see both methods (A) and (B) can attain the Fairness Index value close to 1. This means that both methods can provide Airtime Fairness. However, the OAP value of method (A) is clearly smaller than that of method (B). This is because method (A) cannot achieve the highest throughput for each STA, as shown in Table 2.

5. Conclusion

The proposed method (B) can avoid PA problem, while providing the highest throughput reliably.

6. References

[1] M.Heusse, et. Al., "Performance Anomaly of 802.11b," Proc. of INFOCOM2003, pp.836-843,vol.2, Mar. 2003.