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The Fulfillment of Design and Simulation for Bandwidth Allocation Algorithm Based on User Satisfaction and Profit

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Abstract. The paper mainly introduces SDBA of heterogeneous wireless network consisting of cellular wireless system and wireless LAN. The SDBA with a main aiming of improving user satisfaction adopts PF algorithm to regulate bandwidth so that fairness is basically guaranteed. In comparison between traditional UDBA and FDBA, SDBA can create a better user satisfaction based on reducing New Call Block Probability (NCBP) and Handoff Call Drop Probability (HCDP). Keyword: heterogeneous wireless network; bandwidth allocation; new call block probability (NCBP); handoff call drop probability (HCDP); user satisfaction.

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1. Introduction

The paper will introduce SDBA, a dynamic bandwidth allocation algorithm based on user satisfaction, that is to firstly classify traffic according to QOS, then adopt corresponding bandwidth allocation method to allocate bandwidth according to various classifications. In the case of shortage of system resources or a complete occupation of system resource,

Resources with calls available should be deprived of to continue accepting service through degradation so that call request from new users will be guaranteed.

Other parts of the paper are arranged as follows. Firstly, Part 2 in the paper introduces traffic model and network model. Then Part 3 concentrates on introducing preferences and performance index. Next, Part 4 introduces in detail SDBA, and Part 5 introduces simulation and makes analysis of simulation result. Last, Part 6 draws the final conclusion.

2. Traffic Model and Networks Model

Some research methods available mostly rely on such a model that traffic arrival conforms to Poisson distribution while service time of traffic conforms to negative exponential distribution. Business arrival conforming to Poisson distribution equals to arrival time of traffic conforming to at intervals negative exponential distribution. Such a model fully utilizing the property of no memory possessed by negative exponential distribution is apt to analyze the analytical model established by system.

We define a small cluster commonly composed of a Cellular area and WLAN area within its covering scope. The fields of two areas are both round, and their respective semi-diameter is R1 and R2. BS of Cellular area and AP of WLAN area is respectively located in the center of each area.

SDBA is introduced in detail as follows and the traffic model is characterized as follows:

The bandwidth amount of the call requesting to networks will be guaranteed to the great extent enough allocation amount when network allocates bandwidth to traffic.

In the case of lack of surplus bandwidth when a new call request is available in network, the call in progress will be treated through degrading bandwidth.

Part of unused or unallocated bandwidth will be allocated to users with demands of resources through real-time monitoring operational state and utilization situation of network resources to ensure they can obtain more bandwidth resources to improve their user satisfaction.

According to different types of users, different upgrading orders of bandwidth are used for different types of calls, when free bandwidth is allocated.

3. Preferences and Performance Index

The volume of system is set to be C, and the surplus bandwidth of system is represented by Na.

The bandwidth for traffic types set in the system is defined as follows:

Maximum bandwidth value $B_{i,\max}$, Type i traffic, maximum bandwidth value available in network

Minimum bandwidth value $B_{i,\min}$: for Type i traffic, bandwidth value to the lowest degree which can guarantee basic transmission and connection

Bandwidth value requested: for Type i traffic, bandwidth value, requested by users, in which $B_{i,\min} < B_{i,request} < B_{i,\max}$

Threshold bandwidth $B_{i,threshold}$: expressed as threshold bandwidth, $B_{i,threshold} > B_{i,\min}$, which is mainly used to degradation of call when new call is requested.

Taking $B_{ij,allocated}$ as an example, Subscript i of any parameter mentioned in the following article represents Type i traffic, j represents Call j, allocated represents allocated bandwidth, so

$B_{ij,allocated}$ represents allocated bandwidth value when Call j in Type i traffic is available.

The details can be seen in Table1 and Table 2.

Table 1 All Types of Call Parameters [1,2]

Parameter names	Parameter symbols	Parameter values
System capacity (b/s)	Na	4M
Arrival rate of new calls (calls/s)	λ_N	1~10
Service rate (calls/s)	μ	0.1
Mobility parameters	α	1, 2, 3
Cellular network radius (m)	R1	100
WLAN network radius (m)	R2	10

Table 2 Major Preference

Traffic types	Traffic priority *traffic_class*	Max bandwidth value	Minimum bandwidth value	Thresh bandwidth
Voice	0	20	13	14
www	1	160	64	90
E-mail	2	300	20 0	240
video	3	1536	820	900

Performance and evaluation indexes used in the paper are as follows:

New Call Block Probability

N_{block} is number of refused new calls, N_{total} is total number of requested new calls.

$$NCBP = \frac{N_{block}}{N_{total}} \tag{1.1}$$

Handoff Call Drop Probability

N_{drop} represents number of refused handoff call, N_{total} represents total number of requested handoff call.

$$HCDP = \frac{N_{drop}}{N_{total}} \tag{1.2}$$

User's Satisfaction US_{ij} represents average satisfaction of Call j in Type i traffic, N_{US} represents number of user's satisfaction, US represents average user's satisfaction of all types of all calls.

$$US_{ij} = \frac{1}{T}\int_0^T \frac{B_{ij,allocated}(t) - B_{i,\min}}{B_{ij,request} - B_{i,\min}} dt \tag{1.3}$$

F_{jk}^{i} is average value of differences of allocated bandwidth ration (BWR) between Call j and Call k in Type i. N_F represents number of calculating bandwidth degradation difference, F is average bandwidth degradation difference in the system.

$$F_{jk}^{i} = \frac{1}{T}\int_0^T \left| \frac{B_{ij,allocated(t)}}{B_{ij,request}} - \frac{B_{ik,allocated(t)}}{B_{ik,request}} \right| dt \tag{1.4}$$

$$F = \frac{1}{N_F}\sum_{\substack{j=1\\k=1}}^{N} F_{jk}^{i} \qquad (i = 0,1,2,3) \tag{1.5}$$

4. Introduction of SDBA

Bandwidth allocation studied in the system is mainly involved in three events: call arrival event, bandwidth adjustment event and call departure event,

Call arrival event: When bandwidth is sufficient, any types of new call arrival/ handoff call arrival can make allocation according to bandwidth requested by him. When free bandwidth is insufficient to provide requested bandwidth but larger than minimum bandwidth born by this type of call, minimum bandwidth will be allocated to the call.

The method of searching to degrade one by one refers to search one by one n calls in $a_i = \{a_{i1}, a_{i2}, a_{i3}, ..., a_{in}\}$ so as to degrade the calls occupying most bandwidth in this type of traffic. But for different types of traffic, rules of degradation are as follows (in which t is the traffic type of calls requested to connect, i is the traffic type of calls inFig.1 Flow Chart of t=i.

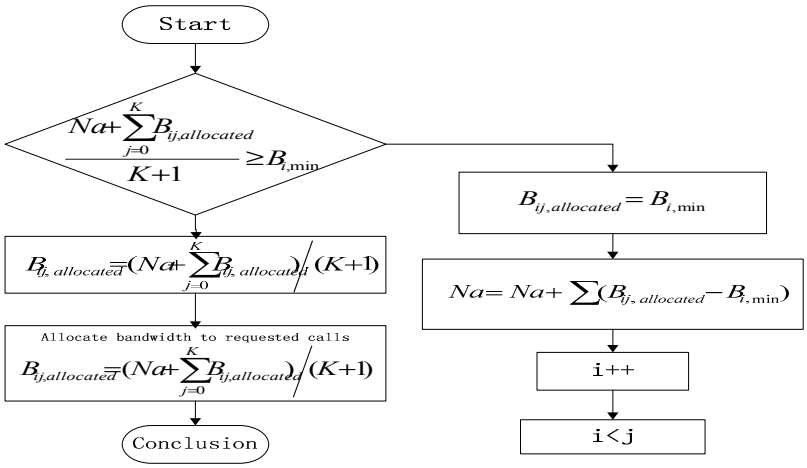

Fig. 1: Flow Chart of t=i

Step 1: When the priority of calls ready to degrade is lower than the priority of requested calls ($t>i$), specific flow chart is the following figure1.

Step 2: When the priority of calls ready to degrade is the same as the priority of requested calls ($t=i$). Specific flow chart is in the following figure2.

Step 3: When the priority of calls ready to degrade is higher than the priority of requested calls (t<i), if released resources are insufficient after Step 1 and Step 2, the calls with higher priority are searched

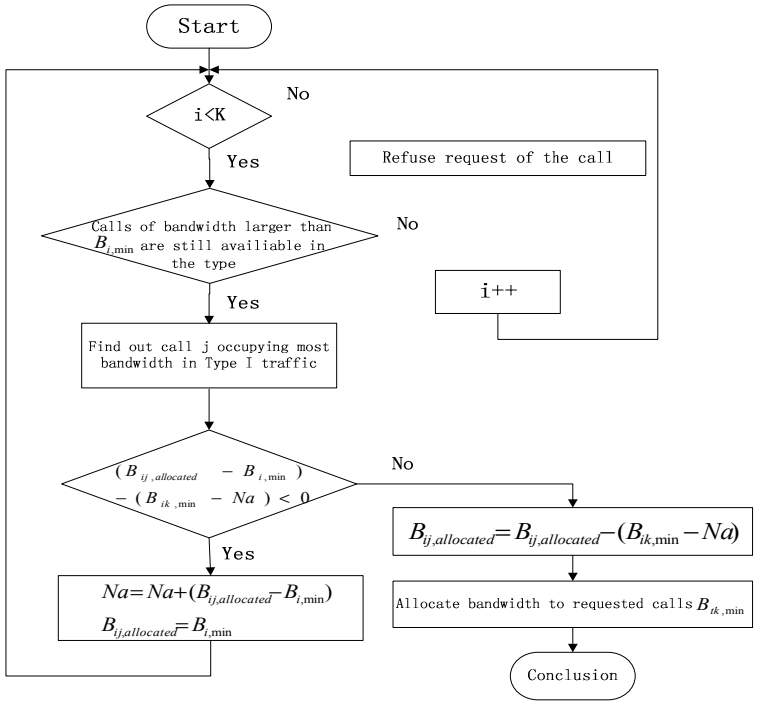

Fig. 2: Flow Chart of t<i

one by one until $B_{t,\min}$ can be provided to the call. If released bandwidth to the type is insufficient, the calls with higher type will be degraded. The flow chart is the following Fig. 2.

If released resources are still insufficient to provide minimum bandwidth values for calls requested to connect after three steps above are taken, the call will be refused.

The whole flow chart of bandwidth degradation part through SDBA is shown in the following Fig. 3.

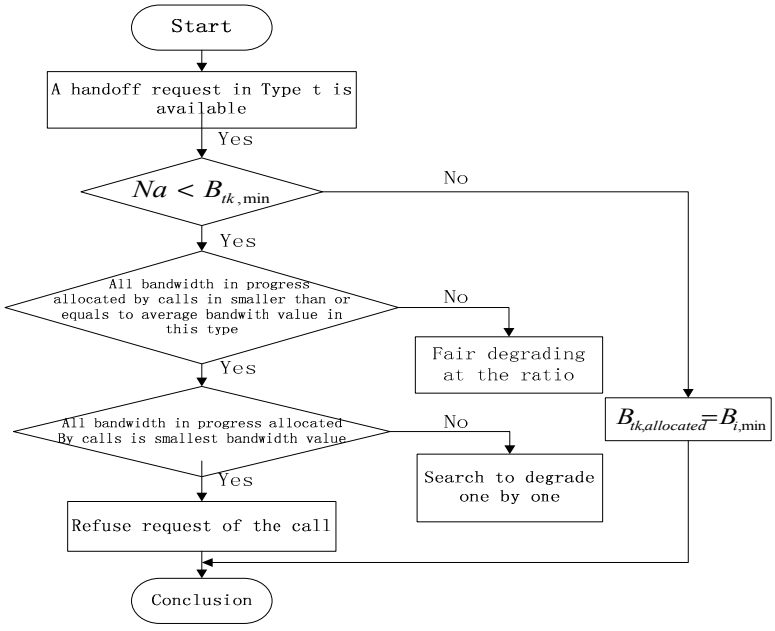

Fig. 3: SDBA Algornism

5. Analysis of Simulation Result

Two algorithms introduced in the paper are compared with other two schemes, one of which is traditional UDBA and the other one is Fair-based Dynamic Bandwidth Allocation Algorithm, noted as FDBA in

simulation. After fair degrading principle is adopted, when each type of users is upgraded (degraded), all allocated bandwidth values after users available are degraded (upgraded) are the same.

Fig. 4 is the comparison of NCBP through SDBA, UDBA and FDBA. It can be seen from the figure that NCBP is larger and larger, with call arrival rate increasing, namely load increasing, and that NCBP of UDBA is lower than that of FDBA.

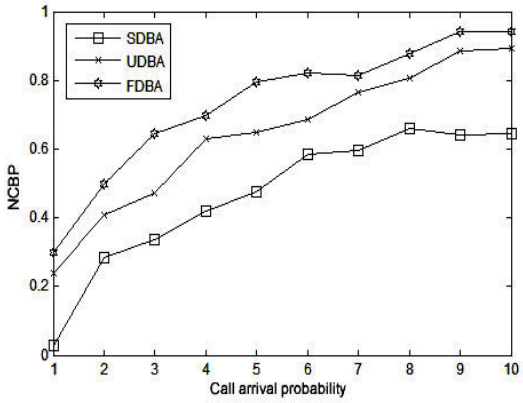

Fig. 4: The comparison of NVBP through SDBA, UDBA and FDBA

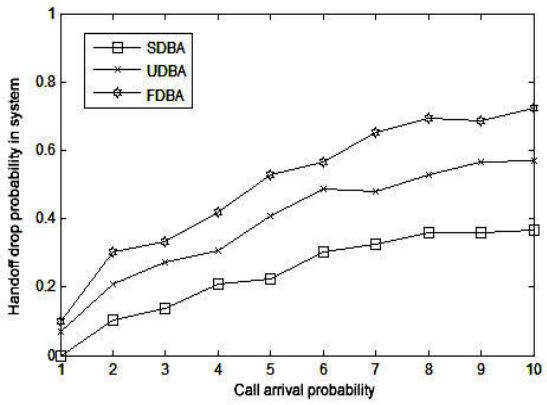

Fig. 5: Comparison of HCDP through SDBA

It can be seen that with call arrival probability increasing, HCBP is larger and larger. So it is thus clear that the algorithm is superior in property.

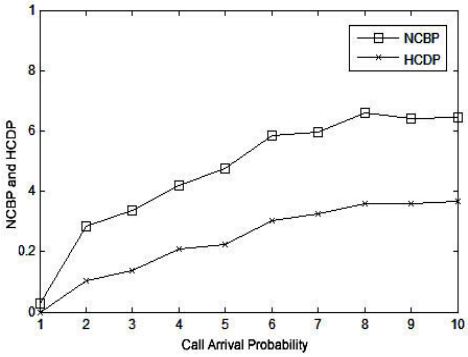

Fig. 6: The comparison between system NCBA and HCDP through SDBA

Fig. 6 is the comparison between NCBP and HCDP for the system through SDBA. It can be seen from the figure that with call arrival probability increasing, NVBP and HCDP are on the rise, and that HSDP through SDBA is lower than that through NVBP.

Fig. 7 and Figure8 are the comparison between NCBP and HCDP under the circumstance of different user mobility. It can be seen from the figure that with call arrival probability increasing, NCBP and HCDP are larger and larger. $n:h=1:1$ in figure means that number of new calls is the same as that of handoff calls, $n:h=1:2$ and $n:h=1:3$ mean the larger user mobility is, HCDP is higher and higher. (Figure for HCBP is omitted)

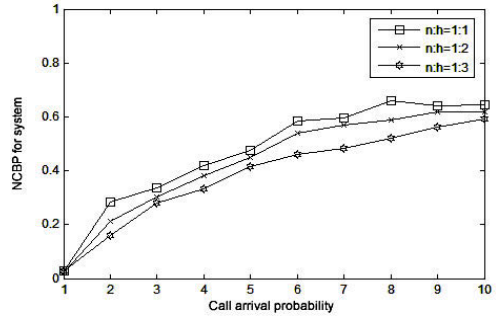

Fig. 7: Comparison of NCBP for system under different mobility circumstance

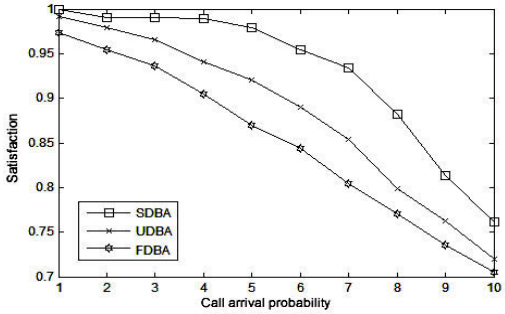

Fig. 8: Comparison of user satisfaction through DBA, UDBA and FDBA

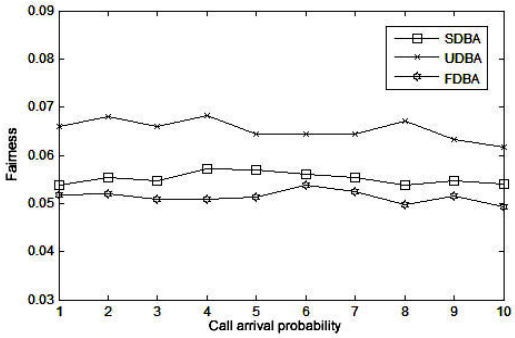

Fig. 9: The comparison of fairness through DBA, UDBA and FDBA

Fig. 8 is the comparison of user satisfaction through DBA, UDBA and FDBA. It is concluded that user satisfaction through SDBA is the highest.

Fig. 9 shows the comparison of fairness through DBA, UDBA and FDBA. It can be seen from the figure that with call arrival probability increasing, fairness remains basically stable almost without changes. It is found that fairness through FDBA is the best followed by SDBA which is better than that through UDBA which is the worst in fairness. Thus, the fairness through SDBA is superior apparently to that through UDBA and approaches that through FDBA.

6. Conclusion

It can be seen through simulation analysis that SDBA designed in the paper has apparent advantages in NCBP, HCDP, fairness and user satisfaction, and can ensure HCDP to be higher than NCDP so that practical needs will be satisfied.

7. References

[1] Perez A F C, Ortigoza G L. Flexible resource allocation strategies for class-based QoS provisioning in mobile networks [J]. IEEE Trans. On Vehicular Technology, 2004, 53(3): 850-869.

[2] Ramesh B H S. Call admission control mechanism for optimal QoS in next generation wireless networks [A]. Intelligent Systems, Modelling and Simulation (ISMS) [C], Liverpool, 2010, 350-355.

[3] Dramitinos M L. A bandwidth allocation mechanism for 4G [A]. European Wireless Technology Conference [C], Rome, 2009, 96-99.

[4] Zhen H, Pei T, Zhang Z X. Bandwidth reservation based call admission control for coexisting heterogeneous wireless technologies [A]. Computer Network and Multime- dia Technology [C], Wuhan, 2009, 1-4.

[5] Teck K L, Jayabal R J. A bandwidth pre-allocation scheme for 'Beyond 3G' multi-standard base station using measurement-based admission control [A]. Crown-Com 2008 3rd International Conference on Cognitive Radio Oriented Wireless Networks and Communications [C], Singapore, 2008, 1-5.

[6] Chan J H S, Tsang D H K. Comparison of static and dynamic bandwidth allocation schemes for multiple QoS classes in ATM networks [A]. ICCS'94 Conference Proceedings [C], Singapore, 1994, 728-732.

[7] Xie H, Kuek S. Pdofity handoff analysis [A]. IEEE Vehicular Technology Confer-ence [C], Secaucus, NJ, 1993, 855-858.

[8] Hwang, I S, Ku L F, Chang P. Adaptive bandwidth management and reservation scheme in heterogeneous wireless networks [A]. IEEE International Conference on Sensor Networks, Ubiquitous and Trustworthy Computing [C], Taichung, 2008, 338