An Adaptive Area Management Strategy for Adaptive Antenna Array Wireless Networks

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***Abstract*—Wireless networks that employ adaptive antenna array (AAA) have been proposed to increase the traffic-carrying capacity and circuit quality. The AAA divided a cell into several areas. The allocation of areas to sensors will affect the system capacity. Therefore, this study will present an adaptive area management strategy of AAA wireless networks by scheduling the covered areas of sensors. This strategy considers the traffic loads among sensors to allocate the areas to sensors, and, therefore, the deviation of traffic loads of among sensors is minimal. Furthermore, the simulation results demonstrate this strategy will significantly improve system capacity and to achieve traffic load balancing performance.**

***Keywords*—Adaptive antenna array, capacity scheduling, load balance, and wireless network.**

1. INTRODUCTION

Technological advances and rapid development in handheld wireless terminals have facilitated the rapid growth of wireless communications. Since this tremendous growth of wireless communication requirements is expected under the constraint of limited bandwidth[1-2, 6-7]. The AAA[9-10] frameworks that can provide more flexible to handle the limited bandwidth will be the mainstream for wireless networks[3-5].

The geographical area of a system is covered by cells. In each cell, a base station using an AAA in the center supports the wireless communications. Each AAA has a number of sensors and each sensor has a same number of the system codes used to establish communications sessions in a part area of this cell. The available service area of a sensor is the area that the sensor can provide communication services[1, 3]. Using an efficient strategy to allocate areas to sensors will be a matter of vital importance to significantly improve the traffic-carrying capacity and reduce the call incompletion probability[8].

A reasonable area allocation to sensors should consider the balance of traffic loads among sensors. Otherwise, it will experience that the high traffic sensors do not have sufficient codes to carry their traffic loads but the light traffic sensors have many available codes. Thus, the traffic-carrying capacity of a cellular system is reduced and the call blocking probability arises. To consider real-life networks, the traffic distributions among sensors should be changeable according to various conditions. In order to achieve higher codes utilization, when there are variations in traffic, the areas allocated to sensors should be effectively reallocated according to current traffic profile. The conventional method, termed as the fixed allocation, that each sensor serve a fixed area is difficult traffic-adaptive problem.

In light of the above discussion, this study presents an adaptive area management strategy for adaptive array antenna wireless networks. This strategy considers the traffic loads among sensors to allocate the areas to sensors. The allocation is based on the standard deviation of the traffic loads of all sensors is minimal. The rest of this paper is organized as follows. Section 2 introduces the system model and the correlation research. In section 3, we describe the proposed strategy. The numerical results are given in Section 4. Conclusions are finally offered in Section 5.

2. SYSTEM MODEL

The geographical area of a system is covered by cells. In each cell C, a base station using an AAA in the center supports the wireless communications. Each AAA has m sensors, S_1, S_2,…, and S_m. Each sensor S_i must charge a region in C to provide communication service. The service area of S_i is determined by its covered range, a θ_i-degree area of this cell. The available launch degrees of S_i means the available service ranges in C. For convenience, C_1, C_2,…, C_m respectively represents the service areas of the m sensors and for each sensors S_i, $\theta_{i,1}$, $\theta_{i,2}$,…,and $\theta_{i,n}$ means the n available launch degrees.

For instance in Fig. 1, this sensor S_i contains 3 available launch degrees, i.e. $\theta_{i,1}$ as 80^0, $\theta_{i,2}$ as 90^0, and $\theta_{i,3}$ as 100^0, respectively. Since the m sensors must serve the entire area of C, Definition 1 must be satisfied. As shown in Fig. 2, $\theta_1 = 100^0$, $\theta_2 = 80^0$, $\theta_3 = 80^0$, and $\theta_4 = 90^0$ are one of available allocations of the sensors.

Definition 1: $\sum_{i=1}^{n} \theta_i = 360^0$, where θ_i is the covered degrees of S_i, and $\theta_i \in \{\theta_{i,1}, \theta_{i,2}, \ldots, \theta_{i,n}\}$.

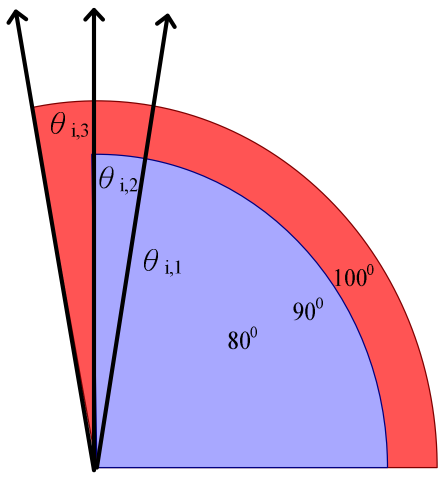

Fig. 1: sensor S_i has three degree to adjustable

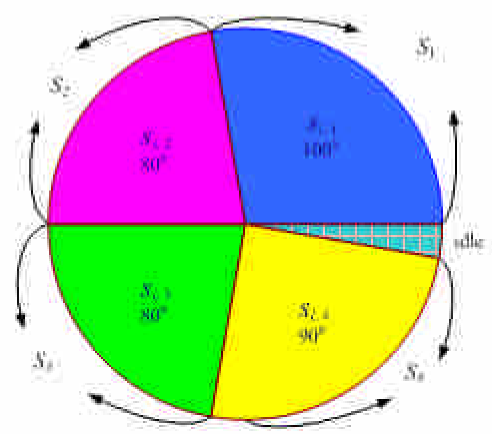

Fig. 2: Allocation result not satisfy 360^0

Table 1. Traffic loads

areas	Traffic loads(hour/per hour)
$a_1(10^0)$	$0.2h$
$a_2(10^0)$	$0.3h$
$a_3(50^0)$	$2.3h$
$a_4(10^0)$	$0.6h$
$a_5(10^0)$	$0.5h$
$a_6(10^0)$	$0.7h$
$a_7(10^0)$	$0.3h$
$a_8(50^0)$	$3.0h$
$a_9(10^0)$	$0.7h$
$a_{10}(10^0)$	$0.6h$
$a_{11}(10^0)$	$0.1h$
$a_{12}(10^0)$	$1.2h$
$a_{13}(50^0)$	$2.0h$
$a_{14}(10^0)$	$0.4h$
$a_{15}(10^0)$	$0.9h$
$a_{16}(10^0)$	$1.0h$
$a_{17}(10^0)$	$0.2h$
$a_{18}(50^0)$	$2.1h$
$a_{19}(10^0)$	$0.6h$
$a_{20}(10^0)$	$0.8h$

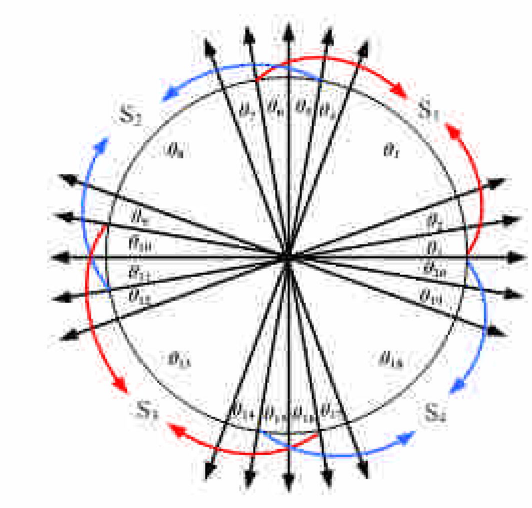

Fig. 3: Area partition in cell C_i

3. SUBJECT STRATEGY

A cell C, which composed by m sensors: S_1, S_2,…, and S_m. Each sensor has n available launch degrees, $\theta_{i,1}$, $\theta_{i,2}$, ..., $\theta_{i,n}$. Therefore, a cell C having m sensors with and n launch degrees of each sensor will has n^m forms to allocate the m areas to sensors. This strategy first is to choose the allocation forms that satisfy the condition of Def. 1.

Let $B(C) = \{B_1, B_2, \ldots, B_k\}$ be the set of k allocation forms that satisfy the condition of Def. 1. For B_j in $B(C)$, assume $B_{j,i}$ is the θ_i-degree covered area of sensor S_i. Let $\lambda(A)$ be the traffic load in erlangs of area A. The average traffic load X of sensors in can be formed as (1), where $\lambda(C)$ is the traffic load of C and m is the number of sensors of C.

$$X = \lambda(C) / m \qquad (1)$$

For allocation form B_j, the standard deviation $\sigma(B_j)$ of traffic loads among sensors can represented as (2).

$$\sigma(B_j) = \sqrt{\left(\sum_{l=1}^{m} \left(\lambda(B_{j,l}) - X\right)^2\right) / m} \qquad (2)$$

The proposed strategy can be formed as follows.

Step 1: Evaluate the n^m allocation forms.

Step 2: Filter $B(C)$ from n^m allocation forms, where for any B_j in $B(C)$, satisfies the condition of Def. 1.

Step 3: For $B(C)$, evaluate $\sigma(B(C))=\{\sigma(B_1), \sigma(B_2), \ldots, \sigma(B_k)\}$, where B_j is in $B(C)$ and $\sigma(B_j)$ is the standard deviation of traffic load of B_j.

Step 4: Choose an B_{min} from $B(C)$, where $\sigma(B_{min})$ is minimal among $\sigma(B(C))$.

Step 5: Allocate the m service areas C_1, C_2, ..., and C_m to m sensors S_1, S_2, ..., and S_m according to B_{min}.

For instance in Fig. 3, the cell contains 4 sensors (m=4). Each sensor has 3 available launch degrees: 80, 90, and 100^0, i.e. n=3. Accordingly, the available launch degrees partitioned this cell into 20 areas, denoted as a_1, a_2, …, and a_{20}. The traffic load of area a_i is presented as Table 1. Since m as 4 and n as 3, the cell contains 3^4 (= 81) allocation forms. Table 2 presents the 81 location forms, in which 19 location forms can confirm the condition of Def. 1. Accordingly, $\sigma(B_9)$ as 0.983 is minimal. The result refers the allocation of 4 sensors, i.e., the service areas (with the traffic loads) of each sensors are $C_1=\theta_{1,3}$=4.6h(100^0)，$C_2=\theta_{2,1}$=4.6h (80^0)，$C_3=\theta_{3,2}$=4.6h (90^0)，$C_4=\theta_{4,2}$=4.6h (90^0).

Table 2. All allocation forms

	S_1	S_2	S_3	S_4	satisfy the 360^0	$\sigma(B_k)$		S_1	S_2	S_3	S_4	satisfy the 360^0	$\sigma(B_k)$
1	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		42	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(9c0^0)$	$\theta_{4,2}(90^0)$	N	
2	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{11})$43	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	Y	0.850
3	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		44	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	N	
4	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		45	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	N	
5	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		46	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
6	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{12})$47	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	Y	0.466
7	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		48	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
8	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{13})$49	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	Y	0.736
$\sigma(B_1)$9	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,1}(80^0)$	Y	0.804	50	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
10	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		51	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
11	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		52	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
12	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		53	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
13	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		54	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{4,2}(90^0)$	N	
14	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		55	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
$\sigma(B_2)$15	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	Y	0.638	56	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
16	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{14})$57	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	Y	0.672
$\sigma(B_3)$17	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	Y	0.829	58	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
18	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{15})$59	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	Y	0.835
19	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		60	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
20	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{16})$61	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	Y	1.083
$\sigma(B_4)$21	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	Y	0.672	62	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
22	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		63	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,3}(100^0)$	N	
$\sigma(B_5)$23	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	Y	0.834	64	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
24	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{17})$65	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	Y	0.630
$\sigma(B_6)$25	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	Y	1.083	66	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
26	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		$\sigma(B_{18})$67	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	Y	0.850
27	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,1}(80^0)$	N		68	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
28	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		69	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
29	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		70	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
30	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		71	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
31	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		72	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,3}(100^0)$	N	
32	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		$\sigma(B_{19})$73	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	Y	0.807
$\sigma(B_7)$33	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	Y	0.0829	74	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
34	$\theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		75	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	

$\sigma(B_8)$35	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	Y	0.536	76	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
36	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,1}(80^0)$	$\theta_{4,2}(90^0)$	N		77	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
37	$\theta_{1,1}(80^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	N		78	$\theta_{1,3}(100^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
38	$\theta_{1,2}(90^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	N		79	$\Theta_{1,1}(80^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
$\sigma(B_9)$39	$\theta_{1,3}(100^0)$	$\theta_{2,1}(80^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	Y	0.043	80	$\theta_{1,2}(90^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
40	$\theta_{1,1}(80^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	N		81	$\theta_{1,3}(100^0)$	$\theta_{2,3}(100^0)$	$\theta_{3,3}(100^0)$	$\theta_{4,3}(100^0)$	N	
$\sigma(B_{10})$41	$\theta_{1,2}(90^0)$	$\theta_{2,2}(90^0)$	$\theta_{3,2}(90^0)$	$\theta_{4,2}(90^0)$	Y	0.497							

4. SIMULATION RESULTS

In the simulation, a cell has 6 antennas, and each antenna has five launch degrees, including 50^0, 55^0, 60^0, 65^0 and 70^0, respectively. Each antenna has 10 units of bandwidth, where each call request needs one unit to support the communication session. In this simulation, each cell contains *h* hot-spot points. Each hot-spot points contains 10% mobile hosts, where p = 0, 3, 4, and 5. Moreover, there are 100 mobile hosts which are randomly distributed to this cell. Each mobile host contains traffic from 0.10 to 0.30 in erlangs. The call blocking rate of each antenna is evaluated according to Erlang-B formula, as shown in (1).

Erlang B formula:

$$Prob(\lambda(A), n) = \frac{\lambda(A)^n}{n!}\left[\sum_{k=0}^{n}\frac{\lambda(A)^k}{k!}\right]^{-1} \quad (1)$$

where *n* is the number of bandwidth units in an antenna *A* and $\lambda(A)$ is the traffic loads of *A*.

Figures 4-7 demonstrates the simulation results, in which fix, min, and max strategy are compared. Symbol "fix" means the allocation areas of antennas is fixed and fair, "max" means the upper bounded (worst case) allocation, i.e., the standard deviation of traffic loads among antennas is maximal, and "min" means the proposed strategy.

In Fig. 4, the average call blocking rates are 0.01% to 5.42% for the max strategy, 0% to 3.13% for the fixed strategy, and 0% to 2.16% for min strategy. In Fig. 5, the average call blocking rates are 0.08% to 8.67% for the max strategy, 0.03% to 5.15% for the fixed strategy, and 0% to 3.08% for min strategy. In Fig. 6, the average call blocking rates are 0.1% to 9.97% for the max strategy, 0.03% to 6.29% for the fixed strategy, and 0% to 3.79% for min strategy. In Fig. 7, the average call blocking rates are 0.13% to 10.31% for the max strategy, 0.05% to 6.62% for the fixed strategy, and 0.01% to 4.09% for min strategy.

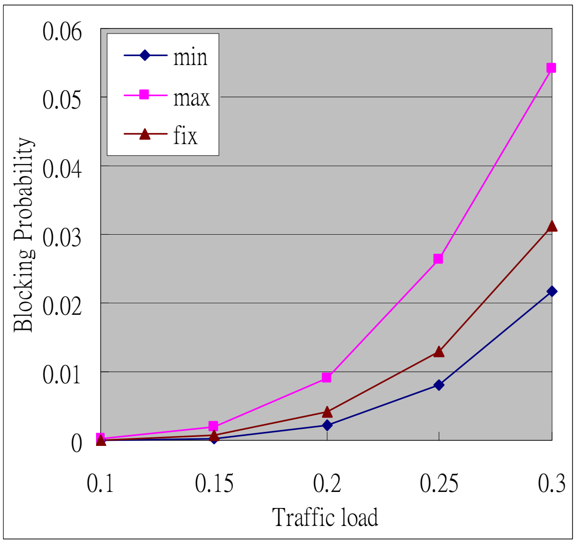

Fig. 4: Hot spot = 0

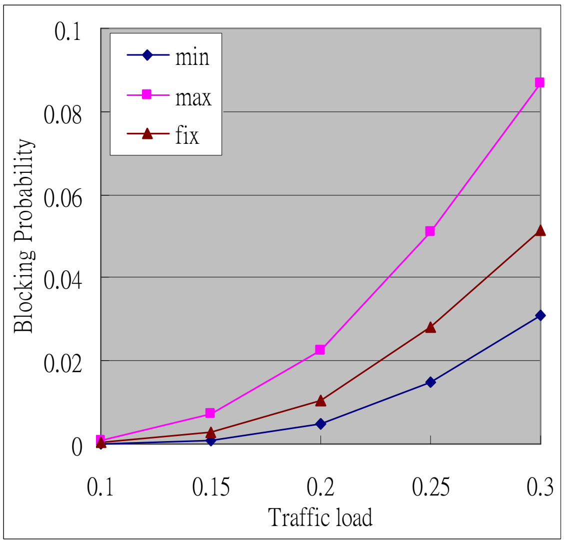

Fig. 5: Hot spot = 3

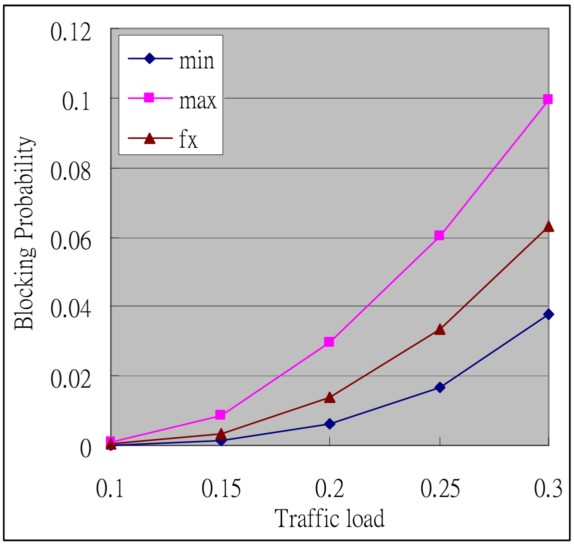

Fig. 6: Hot spot = 4

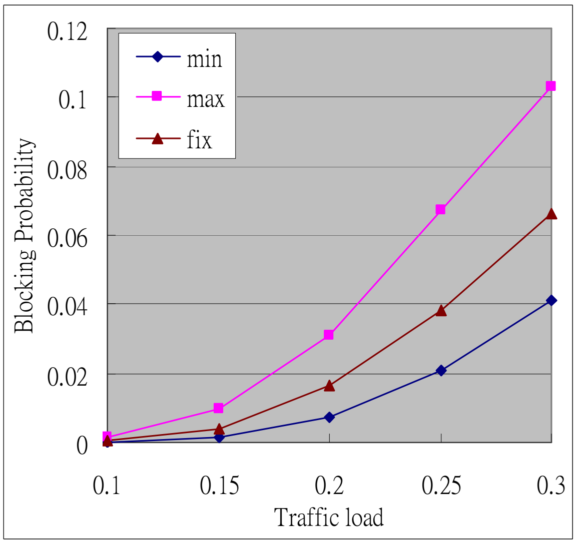

Fig. 7: Hot spot = 5

Simulation results demonstrated that the fixed strategy is better than the max strategy and the min is better than the fixed strategy. The reason is describe as follows. In the fixed strategy, all sensors contain the same number of bandwidth units and, however, the traffic loads among these sensors are different. Under the same number of bandwidth units, if the services areas among sensors cannot conform to the traffic loads, high traffic sensors often lack enough available codes to severing the incoming calls while other light traffic sensors contain a larger number of unused codes. Our strategy first lists all possible allocations. The standard deviation of each allocation next is evaluated. Then, choose the allocation that has the minimal standard deviation. Therefore, the load-balance degree is best for other strategy that will reduce the call blocking probability.

5. Conclusions

This study presented an area management strategy for AAA wireless networks. Our strategy considers the traffic loads of antennas to balance the traffic loads of antennas. Therefore, our strategy presents better performance than others. This strategy considers the balance of traffic loads among sensors to determine the service areas of antennas. Considering ergonomic and economic factors to allocate codes among sensors that can satisfy new trends in the telecommunication industry is one of our future works.

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