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USER-ACTIVITY DEPENDENT PAGING SCHEME IN A MULTI-CELL CAMPUS WLAN ENVIRONMENT

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ABSTRACT

IEEE 802.11 Wireless Local Area Network (WLAN) is becoming the prevailing technology for the broad band wireless Internet access. However, IEEE 802.11 WLAN has been discovered to be naturally weak in supporting the mobility of mobile host (MH) when there is no traffic to be served for the MHs. Quite a number of commendable works have been done to introduce paging in WLAN and, thereby properly manage scarce network resources such as bandwidth and power. In this work, the authors consider it pertinent to go a step further and design a paging algorithm for campus WLAN, which will take advantage of the unique campus setting and activities. We, therefore, propose a User-Activity Dependent Paging Scheme (UADPS) in a Multi-Cell Campus WLAN Environment; a paging algorithm that considers mobile devices in a multi cell WLAN. This is because we believe that such algorithm will not only be simple to implement, but will make a great positive impact on resource savings for on-campus WLAN users. Results obtained shows that the UADPS utilizes less network resources in searching for an MH when compared to the IEEE 802.11 power save mode algorithm.

Key words: wireless communication, location management, paging, resource Management

1.0 INTRODUCTION

In the communication industry today wireless communication constitutes the fastest growing segment (Richard, 1999). Statistics in literature has shown that the growth rate of personal communication service (PCS) has been exponential in nature and there is the prediction that this rate will continue to increase in the near future (Vincent, 2000).

It has been realized that one of the most important and challenging concerns facing the next generation will be that of mobility management (Richard, 1999). Mobility management supports mobile hosts (MHs), allowing users to roam while simultaneously offering them incoming calls and supporting calls already in progress.

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Thus, an efficient mobile network must be able to locate moving MHs at any time to deliver its services and to maintain connections as the MH moves from one service area to another. Mobility management consists of two components, viz: Handoff management and Location management.

In handoff management, the network switches coverage responsibility from one base station to another for an MH that has a call in progress and is moving from one cell to the other. In location management, the network tracks the users between call arrivals; and when connection needs to be established for a particular user, the network has to determine the user's exact location within the network. Hence location management is a two-step process, viz: Location registration/Location update and Terminal paging or searching (Jiang, 2005). Terminal paging is the search for a mobile host for whom a call has arrived. It typically includes transmitting a search request for a mobile host to a group of network cells in one of which the mobile host is expected to be. This group of cells is called a paging area (PA) and usually consists of neighbouring base stations (see Fig. 1).

An MH, is always in either of the following two states/modes: Active state and dormant state. (Ramachandran et al, 2002). (See Fig 2). An MH is said to be in active state/mode when it is processing a call, then it makes use of full

However, when a MH is not processing a call, it goes into a dormant state/mode to save power. Mobile networks may employ the use of MH states in order to operate more efficiently without degrading the overall performance of the network system.

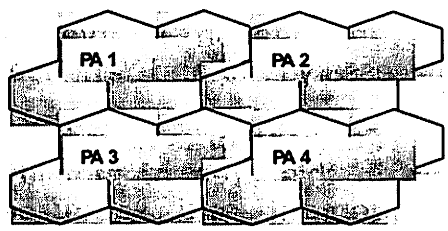

Fig.1 Illustration of a paging area

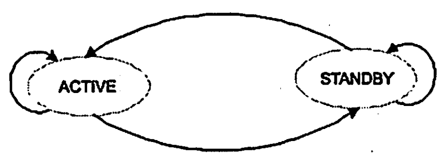

Fig. 2 State Transition Diagram of Mobile Host.(Ramachandran et al, 2002)

The term 'mode' is also common and means the same as 'state'.

2.0 RELATED WORKS

IEEE 802.11 WLAN Standard defines only two operational modes in which an MH can operate, namely Active mode (AM) and Power save mode (PSM), also known as sleep or dormant mode. In both modes, an MH stays connected with one of the access points (APs) even when there is no traffic to/from the MH. It has to perform handoff at every AP

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This shows that the IEEE 802.11 WLAN implementation has some limitations in supporting the mobility of MHs when there is no traffic to be served to them; that is, it does not conserve resources.In IEEE 802.11 PSM, MH in sleep mode wakes up periodically to check whether there are some incoming packets. The wake-up period is the same as beacon interval (typical values are in the order of 100 ms) (Sukyoung and Nada, 2006.). However, when there exists a long idle period, waking up at every beacon interval is unnecessary (Ved and Yanghee, 2003).

Further works have been done in this area of mobility management and resource conservation in WLAN. For example, Sukyoung and Nada (2006) investigated "Power-Efficient Interface Selection Scheme using Paging of WWAN for WLAN in Heterogeneous Wireless Networks." They proposed a power efficient protocol that includes turning off the WLAN interface after it enters the idle state and using the existing paging of WWAN in order to wake up the WLAN interface when there is incoming long- lived multimedia data. Sunggeun et al (2006) proposed a novel idle mode operation, which comprises paging, idle handoff and delayed handoff. Under the idle mode operation, a mobile host does not need to perform a handoff within predefined paging areas. Ved, and Yanghee, (2003), in their work titled "Performance Analysis of IP Paging Protocol in IEEE 802.11 Networks", evaluated the performance of IP paging protocol in the IEEE 802.11 networks and defined two types of cost: wake-up cost and paging delay cost. All these efforts are good and are in the right directions. We, however, consider it necessary to carry the WLAN mobility management effort further, by defining a unique paging algorithm for a campus environment. This is because the unique set-up of campuses and their activities will lend simplicity to this scheme and at the same time have a considerable impact on savings of such resources as bandwidth and power. This, we believe, will make life easier for on-campus WLAN users in terms network speed and mobile terminal battery. In this paper we propose a User-Activity Dependent Paging Scheme (UADPS).

3.0 DESCRIPTION OF THE USER-ACTIVITY DEPENDENT PAGING SCHEME PAGING SCHEME

User-Activity Dependent Paging Scheme in a Multi-Cell Campus WLAN environment is a new location management scheme. In this scheme, the MH will be paged based on the faculty address and on its schedule of school *activities*. When a call arrives for a dormant MH, the paging agent (PG) in the paging area where the MH resides intercepts the packets and buffers it until the MH is found and then the packets are forwarded. To locate the MH,

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the PG reads the address on the packets and maps it to the student's/staff's addresses in its data base (The students and staff addresses being considered are the students' matriculation numbers and the staff personal file numbers respectively).

The PG is then able to detect if the MH is a student, staff, or a visitor. It is a visitor if the address is not found in the data base. If the identified MH is a student or a staff the PG further identifies the faculty/school/college of the MH. The statistics of all the dormant MH of the identified faculty in all the cells is also obtained and the PG then starts searching the cells in groups of three at a time beginning with the first three cells with the highest statistics and continues searching until the MH is found and the packets forwarded.

For a dormant MH identified as a visitor, the PG obtains the statistics of the dormant MH that are visitors in all the cells in the paging area and the PG then searches the cells in groups of three at a time beginning with the first three cells with the highest statistics and continues searching until the MH is found and the packets forwarded.

At the end of the search, MH not found is declared unreachable. The packets of unreachable MHs are buffered until when the network later detects the presence of the MH; it then forwards the packets to them. The flow chart of the proposed algorithm is shown in Fig. 3

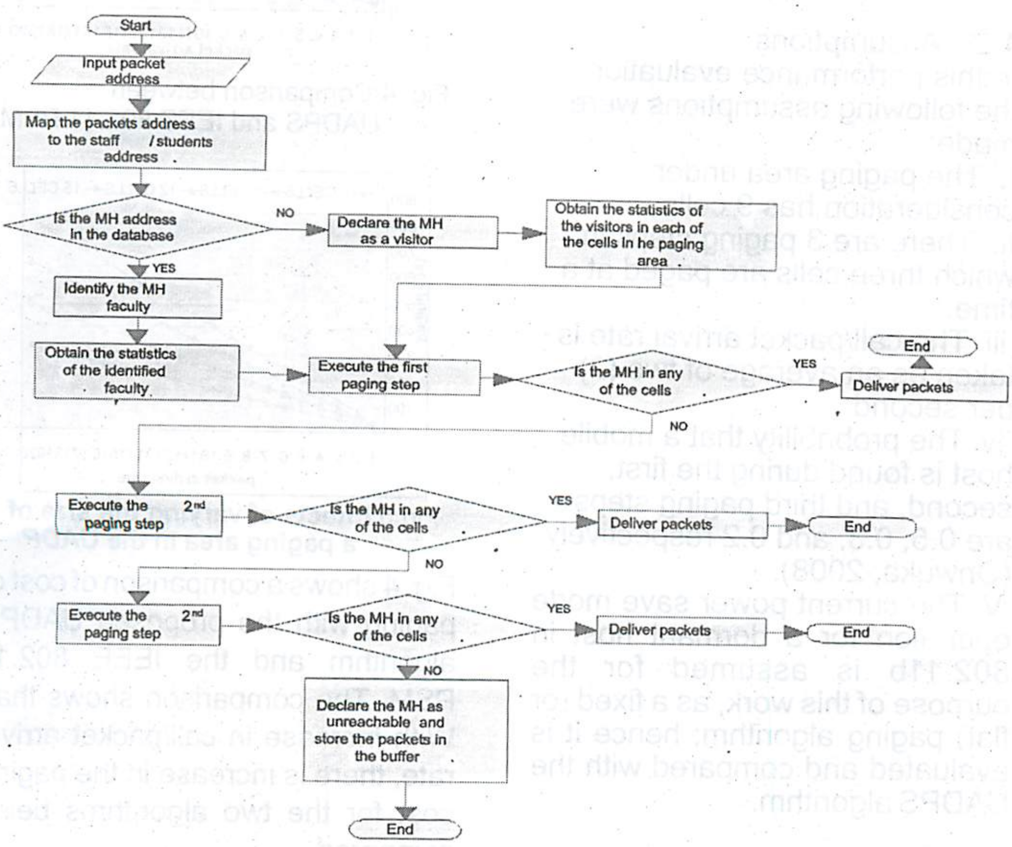

Fig.3 Flow chart of UADPS

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4.0 PERFOMANCE EVALUATION

In this section we carry out the performance evaluation of our paging scheme

4.1 Steps in the Paging Operation

Paging operation involves the following steps. When a call/packet arrives for a MH in the standby mode:

I. The paging agent sends a paging request message to the cells in the paging area.

Ii. The cells receive the request and search for the dormant MH.

iii. The MH, when found, will send Acknowledgement and then update, its location

Iv. The cells send a paging response message to the paging agent.The four steps above constitute the cost of transmission in a flat network and database transaction cost.

4.2. Assumptions

In this performance evaluation, the following assumptions were made:

I. The paging area under consideration has 9 cells

Ii. There are 3 paging steps in which three cells are paged at a time.

iii. The call/packet arrival rate is taken as an average of two (2) per second

Iv. The probability that a mobile host is found during the first, second, and third paging steps are 0.5, 0.3, and 0.2 respectively (Onwuka, 2008).

V. The current power save mode operation for a dormant host in 802.11b is assumed for the purpose of this work, as a fixed (or flat) paging algorithm; hence it is evaluated and compared with the UADPS algorithm.

4.3 Parameters used for the evaluation

Paging cost in each delivery scheme is a function of the number of access points to be paged. Hence:

Paging cost $= n_p * l_c * C_p$ ------------ (1) (Plassmann1994).

where n_p = number of cells per paging area, $\ddot{e}_c$ = packet arrival rate, C_p = net cost of paging per cell. For simplicity of the analysis, it is assumed that each of the paging steps enumerated earlier contributes a unit cost to the net cost.

5.0 RESULTS & DISCUSSION

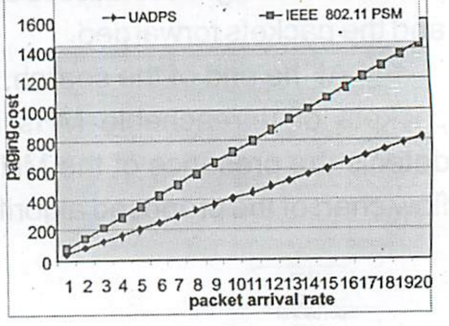

Fig. 4 Comparison between UADPS and IEEE 802.11 PSM.

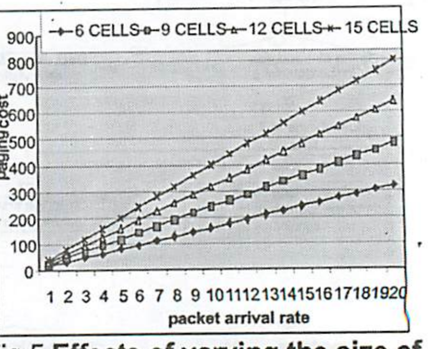

Fig.5 **Effects of varying the size of a paging area in the UADP**

Fig. 4 shows a comparison of cost of paging with the proposed UADPS algorithm and the IEEE 802.11 PSM. The comparison shows that: With increase in call/packet arrival rate, there is increase in the paging cost for the two algorithms being compared.

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However, the cost of paging **with IEEE 802. 11 PSM is approximately 2.55 times higher than the cost of paging with UADPS algorithm.** Fig. 5 shows the effects of varying the paging area on paging cost. It is obvious that paging cost increases with increase in the paging area (the number of cells per paging area), which suggests that paging area size must be optimised for cost-effectivèness

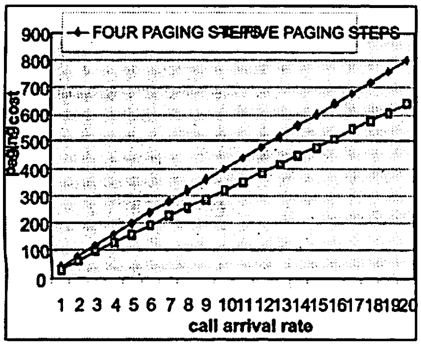

Fig. 6 **Effects of varying the number of paging steps in UDPA.**

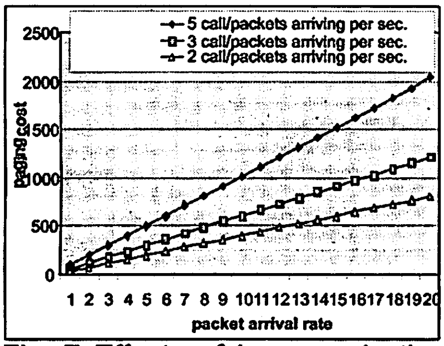

Fig. 7 Effects of increase in the number of packets arriving per second in UADP.

Fig.6 reveals the effect of varying the paging steps on the paging cost. It could be seen that the paging cost is inversely proportional to number of paging steps; however increasing the number of paging steps will increase the delay.

Finally, from Fig. 7, it could be seen that paging cost increases with increase in the number of packets arriving per second. In practical systems, these parameters must be tuned to adjust the cost of paging.

6.0 CONCLUSION

In conclusion, we have presented a paging algorithm that is proposed for application in a WLAN network in a campus setting. The proposed algorithm is approximately 2.55 less in paging cost when compared with the power save mode of the IEEE 802.11 WLAN. However, it is important to note that paging area and number of paging steps must be optimised for cost effectiveness and. the speed of locating an idle mobile host respectively.

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