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Power Saving Management in Ad-Hoc Wireless Network

M. M. EL-GAZZAR[1]& BEN BELLA S. TAWFIK[2]
[1]College of Computers & Informatics, Cairo, Egypt
[2]College of Computers & Informatics, Suez Canal University, Ismailia, Egypt

Abstract:

In wireless network Power Saving is an important issue. In this work power savingis done via a sequence of procedures. Power Saving (PS) function describes the necessary steps for a station in PS mode to turnoff the transmitter and receiver circuitry, to inform other stations or to retrieve information about pending packets, and to transmit or receive traffic. The PS function is different for ad hoc and infrastructure networks. The PS function for an IBSS (ad hoc network) operates in a distributed manner.A station that wants to enter the PS mode has to successfully complete a frame exchange with another station with the power bit set in the frame header. Note that neither a specific station nor all stations need to be informed. The power-saving status estimation is based upon local information or the last data frame exchange with that station. The IEEE standard leaves open the solution to the problems of how the estimate is created and on which information the estimate is based.

Key words: Power Saving PS –Ad Hoc – IEEE standard - IBSS

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1- Introduction:

The Power Saving (PS) function describes the necessary steps for a station in PS mode to turn off the transmitter and receiver circuitry, to inform other stations or to retrieve information about pending packets, and to transmit or receive traffic [1]. The PS functionis different for ad hoc and infrastructure networks. The PS function for anIBSS (ad hoc network) operates in a distributed manner. That is, frames destinedto nodes in PS mode have to be buffered locally instead of at a centralized facility.A station that wants to enter the PS mode has to successfully complete a frameexchange with another station with the power bit set in the frame header. Notethat neither a specific station nor all stations need to be informed [4]. Once the frameexchange has been successfully completed, the station may enter the PS state. In thePS state, the station has to wake up periodically at the estimated time of a beacontransmission. The station is further required to stay “awake” for a period referred toas the ATIM window to receive announcements from other stations with bufferedtraffic. The ATIM window can be used by the station itself to announce bufferedtraffic. If there is no traffic announcement for the station, the PS state is reentered.If an announcement in the form of an ATIM arrives, the station has to acknowledgethe ATIM and has to stay “awake” beyond the ATIM window until all ofthe announced buffered frames were received. During the data frame transmissionperiod that follows the ATIM window, announced traffic can be sent followingthe basic channel access rules. Both form the beacon interval. The PS specificationrequires a station desiring to transmit a frame to another station to estimate thepower-saving status of the other station. The estimate can be based on local informationor the last data frame exchange with that station. The IEEE standard leavesopen the solution to the problems of how the estimate is created and on whichinformation the estimate is based [3]. Figure 1 shows two stations operating in PS (power saving) mode. Both stations are requiredto wake up upon every beacon and to listen throughout the ATIM window. Station2 wishes to send a frame to station 1 and therefore announces that frame by an ATIM. Station 1 responds with an ACK, whereupon station 2 starts data frametransmission after completion of the ATIM window, the PS state, the sendingstationcreates an ATIM, which is sent during the ATIM window. Once the ACKof the intended station is received, the station sends the data frame after completionof the ATIM window. It is assumed that a station always is in PS mode if it has notexplicitly indicated that it will stay awake by an ACK in response to an ATIM (evenin the case that it is awake because it has pending traffic) [5,6].

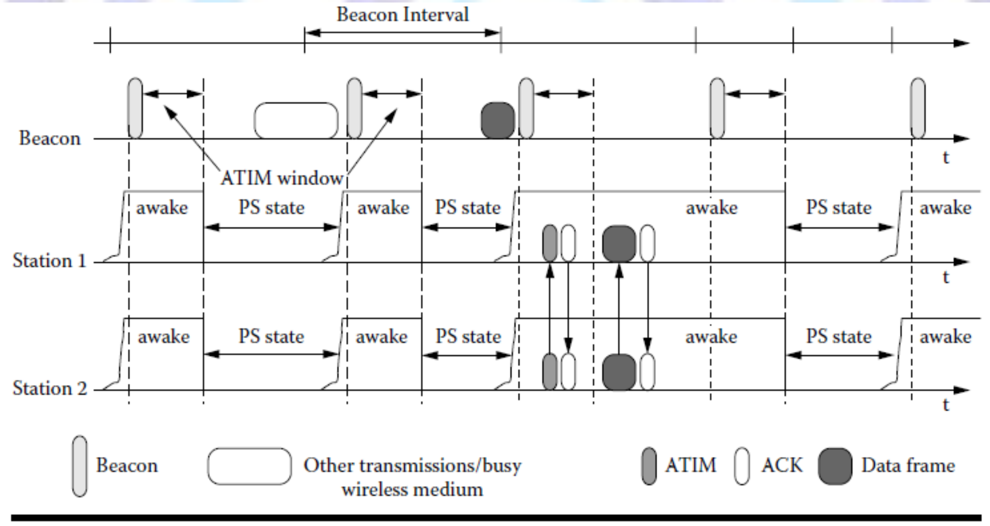

Figure 1: Two stations Operating in Power Saving mode

2- Proposed Model

The model reflects for each period of time, the sending time (uniform random selection) for each station, and the receiving time (uniform random selection) for each station.The model has the following assumptions, 1. Analysis is done for 100 periods of time , each is 10mS (total time =10*100= 1sec), and 2. Number of stations (in this program) n=50 (can be changed), scattered randomly, where each one has the same weight.

2.1 Discussing the sleeping time in each period of time (1-100)

It means that analyzing the power saving which is function of the sleeping time.

Whatever the procedure, the end result during the sleeping time in each period of time for each station is either acquired or not (not acquired in case of sending or receiving).

Assume for each station , during each period of time T= 10ms ,is divided into three regions

t1=1ms (beacon time)

t2=4ms (awaketime)

t3= 5ms(sleepingtime)

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2.2 Algorithm

Inputs: Assuming the slot time =100 ms, Number of time periods =100 period, and Number of stations =50
For each time slot, np, from 1 to 100, check if in this time slot there is a backoff (or) reservation for sending from previous sending.
If there is a previous reserving, give it the high priority.
Formulate a vector of length equal to number if stations, with values zeros and ones (ones mean this station require a sending, zero means no sending. The probability of sending for each station is 0.01.
Add the previous sending station in first.
Check the number of sending at this time slot, there are three cases.
Number of sending is zero, power saving, go to the next time slot.
Number of sending is equal to 1, no collision. Pick randomly the receiving station, save the sending and receiving station number for this time slot and change the sleeping time to be zero for both sending and receiving (add it to the awake time).
In case of number of sending is bigger than 1(collision), reschedule the second, the third ………and so on station for the next time slots with random selection to avoid collision. Keep the first station to be sending this time slot and do the same sequence as number of sending is equal to one.
For each station do the calculation by summing the cumulative awake /sleep time at each time slot
For the whole network calculate the network cumulative awake/sleep time.
Plot different graphs, open a text file and save the collision parameters.
Figure 2 shows the proposed model flow chart. Note that the network awake time in a specific period of time t2 for the network = maximum of t2 for all the stations at this period of time.The network sleep time in a specific period of time t3 for the network = minimum of t3 for all the stations at this period of time.

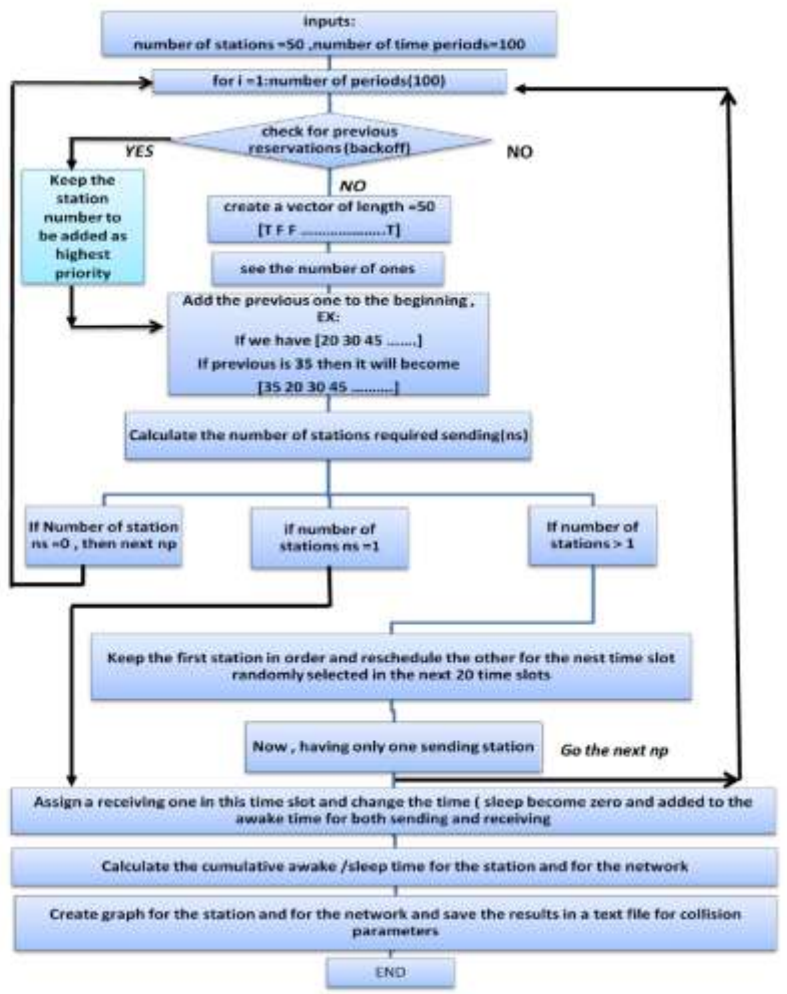

Figure 2: Flowchart of the proposed model

3. Results

For each station:

Calculate the commutative awake time, in other words, at a period =np, the awake commutative time = (t1+t2)1+(t1+t2)2+(t1+t2)3+…………(t1+t2)np.

Calculating the commutative time (logic) so at period np=20. For example the commutative time = T*np= 10ms*20=200msec.

Calculate the relative awake time (utilization time) which is equal to the awake time divided by the commulative time at a specific period np.

Then repeat for the sleeping time.

Now plot the commutative time with the awake –relative time, for each station. Note that the result is random because each station has the same weight. (No base station, no location effect).

Table 1 illustrates the result of the simulation.

Figure 3 describes the network utilization time analysis, it shows that the stability is maintained after almost 300 milisecond which is the normalized network awake time with the total time. The steady state value is about 0.77.

4.Conclusion

In this work, the effect of changing number of stations is introduced. In theillustrated figures, plot the sum of awake time for each station till the end of the last period of time, then dividing this sum by the total time and taking the average of this relative time by dividing it by the number of stations. In other words:

Relative- average-awake time = $\frac{\sum_{n=1}^{number\ of staions} awake - timeforstationn\ /\ (totaltime\ )}{numberofstations}$

Note that for each station, the sum of awake time/relative time and sleeping time/relative time is always equal to 1 at each time.It can be concluded that the simulation results emphasize matches the logic reality. Also, the model describes different collision cases and reschedules the transmission without affecting the network performance.

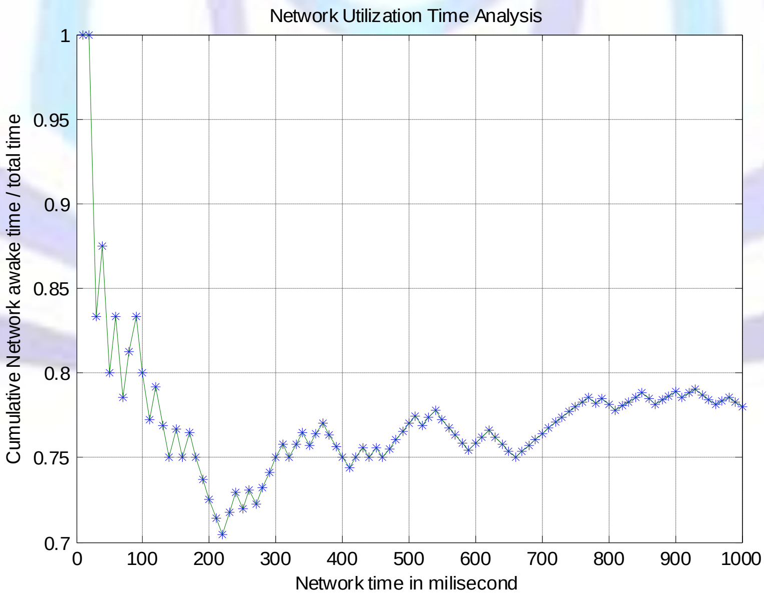

Figure 3: Network utilization time

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Ad Hoc, Power Saving Analysis
Collision Locations, and Solution
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The calculation is done for the following values:
Number of time intervals (initially)=100 periods
Each time interval T = 10 milisecond
Beacon time in milisecond t1 = 1
Awake time in milisecond t2 = 4
Sleep time in milisecond t3 = 5
Number of stations =  50
=============== Collision Analysis ================
* More than one station required to send at the same time *
```

Coll. Time Slot	stations before coll. avoidance
23	22 34
28	39 45
31	25 38
33	34 30
34	45 4
45	4 16
48	13 20
60	20 1
67	5 7
70	3 27 47
74	27 46
83	47 8
84	7 23
89	13 42
92	30 35
97	3 30

* Sending Rescheduling to avoid collision *

station No.	From time slot	To time slot
34	23	33
45	28	34
38	31	37
30	33	47
4	34	45
16	45	62
20	48	60
1	60	77
7	67	84
27	70	74
47	70	83
46	74	90
8	83	93
23	84	85
42	89	109
35	92	103

Table 1: Simulation Results

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