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DATA BROADCASTINGUSING SMART ANTENNA

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Abstract

In environments with locality of client demands, the use of multiple directional antennas at the Broadcast Server has been shown to increase performance. In many cases however, such broadcasting systems fail to exploit the full potential of the multiple antennas as they do not take into account the Geographical distribution of clients within the coverage area of the system. This letter proposes an adaptive smart antenna based wireless push system where the client item demand broadcast schedule must be modified this of the proposed approach significantly increases the performance observed by the system clients.

Introduction

Data broadcasting is the broadcasting of data over a wide area via radio waves. It most often refers to supplemental information sent by television stations along with digital television, but May also be applied to digital signals on analog TV or radio. It generally does not apply to data which is inherent to the medium, such as PSIP data which defines virtual channels for DTV or direct broadcast satellite systems; or to things like cable modem or satellite modem, which use a completely separate channel for data**.**

Data broadcasting ([1]-[9]), which has emerged as an efficient way of information dissemination in wireless networks, can be characterized by locality of client demands.

An example is the case of a traffic information system. Such an application is characterized by locality of demand, as a driver is obviously more interested in information regarding her neighboring streets than for information regarding streets further away. In environments with locality of client demands ([10]–[12]), the use of multiple directional antennas at the Broadcast Server (BS) splits the client population to groups of clients that exhibit higher demand skewness and has been shown to increase performance [10]. In such a system, each antenna is equipped with a Learning Automaton (LA) whose probability distribution vector determines the popularity of each information item among the clients in the service area of the antenna. However, depending on the actual placement of clients within the coverage area of the system, there can exist cases where the use of directional, antennas of fixed beam-width limits the amount of performance improvement over single antenna systems ([6], [10], [12]). This is because the coverage area of each such antenna is fixed and does not follow the Geographical distribution of clients within the coverage area of the system. When this distribution is not uniform, but rather there exist areas with higher density of client groups, there can exist cases where one or more antennas serve a very small, possibly even zero, number of clients, a fact that leads to underutilization of these antennas and consequently to their small contribution to performance improvement. The ability of smart antennas to alter their beam-width is exploited so that the coverage of each antenna is adapted according to the current placement of clients within the system. Thus performance will be improved even more compared to the use directional antennas of fixed beam-width in cases of non-uniform distribution of the clients within the coverage area of the system. This is due to the fact that each antenna will now have a similar number of clients under its coverage.

Moreover, locality of client demands is exploited and thus the broadcast schedule at each antenna is altered, so that it excludes items that are never demanded from clients under its coverage. Simulation results reveal that the proposed approach significantly increases the performance observed by the system clients.

I. PRELIMINARIES

This section introduces much of the technology and notational to be used in test of the paper. Database at the server is assumed to be divided Into many *information items.* The items are not necessarily of the same size can be obtained as a special case of the result presented here. The item required to broadcast an item of unit length is referred to as one *time unit*. Hence time required to broadcast an item of length l is l time units. Note that unit of length and time unit may be used interchangeably because of the way they are defined.

M=total number of information items in the server's database. The items are numbered 1 through M.

l_i represents length of item i.

To develop a theoretical foundation for our algorithm, we assume that the broadcast consists of cycle of size N times units. The result presented in the paper also apply to non-cyclic schedules

Instance of an item: An appearance of an item in the broadcast is referred to as an instance of the item.

Schedule: Schedule for the broadcast cycle is an order of the items in the cycle.

Frequency of an item: frequency f_i of item i is the number of instances of item in the broadcast cycle. The f_i instance of an item are numbered 1 through f_i.size of the cycle is, therefore, given by $N=\sum_{i=1}^{M} fili$, where $l_i$is the length of item i.

Spacing: The *spacing* between two instances of an item is the time it takes to broadcast information from the beginning of the first instance to the beginning of the second instance.s_{ij} denotes the spacing between j-th instance of item i and the next instances of item $i(1<j<f_i)$.

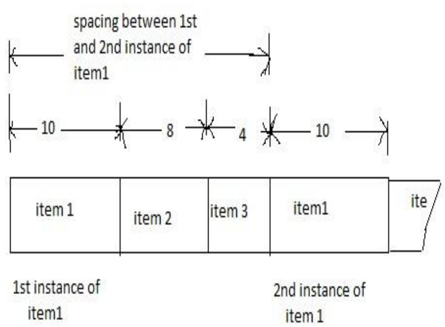

Fig.1. Showing a part of broad cast cycle.

Item Mean access time: item mean access time of item i.denotedt_i,is defined as the average wait by a client needing item i until it starts receving item i form the server ,provided that a client is equally likely to need a item i at any instant of time i,$t_i$can be obtained as

$$t_{i=}1/2\sum_{j=1}^{fi} \quad s\hat{}2ij/N\text{--------} \qquad (1)$$

Where $N=\sum_{i=1}^{M} fili$

II. MODULES

A) SYSTEM CHARACTERISTICS AND BROADCASTING ALGORITHM

In this module we have to design the basic system that consists of one broadcasting server and N number of clients. According to the population the clients are divided into several numbers of groups. Broadcasting server uses multiple antennas for transmitting the signals to the clients. According to the number of clients the antennas used on the broadcasting server should be changed. Basic system consists of a broadcasting server and a group of clients. According to the number of clients antennas used at the broadcasting server should be changed. In this system we have to use smart antenna for the transmission of information to the clients. The main use of these kinds of antennas is they accept signal from all direction and also they adjust their beam- width according to the client's location. It should be more advantage over the existing system. We introduce an another technique called Learning Automaton tool. This tool is mainly used to find the client requirement. Because the system used here is push in nature. So the clients want to demand their requirement to the broadcasting server. This should be carried out by using these types of tools at the BS.

The information sent from the BS to clients as a control packet, each information's present in the broadcasting server should be arranged in a specific format according to their characteristics, they are said to be "Broadcasting Schedule". After the information sent by the broadcasting server it should be accessed by the group of clients, according to their response the broadcasting schedule should be arranged by using the learning automaton tool present in this system. In the multiple antenna wireless push system each antenna is equipped with a LA that contains the server's estimate $p_i$of the demand probability $d_i$for each data item $i$among the set of the items the antenna broadcasts.

$$\sum_{i=1}^{N} p_i = \sum_{i=1}^{N} d_i = 1 \text{ --------} \qquad (2)$$

Where $N$is the number of items in the server's database. The server estimates the next transmission by using the cost function present in this system. The cost function mainly used to find the next transmission, by comparing the current transmission with the previous transmission.

$$G(i)=(T-R(i))^2 p_{i/li} ((1+E(l_i)/1-E(l_i))) \text{ ….} \quad (3)$$

In this cost function, $T$is the current time, $R(i)$ the time when item $i$was last broadcast, $l_i$is the length of item $i$and $E(l_i)$ is the probability that an item of length $l_i$is erroneously received. For items that haven't been previously broadcast, $R$is initialized to -1. If the maximum value of (i) is shared by more than one item, the algorithm selects one of them arbitrarily. Upon the broadcast of item $i$at time T,(i) is changed so that $R(i)$=T.

Where 'l' is the length of the item should be broadcast by the server. The length of the item should be calculated by using the equation (4).

$$l_i = round\left(\left(\frac{L_1 - L_0}{M-1}\right)(i-1) + L_o\right), 1 \le i \le M \text{ --} \qquad (4)$$

Where L1 and Lo are the parameters are used to characterize the distributions, 'i' is the number of items present the system. Round () function used to give the rounded integer value at the output.The information sent by the broadcasting server should not be sent for a single time, it should be repeated according to the requirements. Entire operation present in the system should be working in a cyclic way. So we have to find the number of cycles that the program has to be executed and is given in equation (5),

$$N = \sum_{i=1}^{N} f_i l_i \quad (5)$$

Where the spacing between the information arranged in the broadcasting schedule should be calculating by using the equation (6)

$$S_i = \frac{N}{f_i} \quad \text{--------} \qquad (6)$$

Frequency of an item should be find by using the below equation (7),

$$f_i = \left(N\sqrt{p_i / l_i}\right) / \left(\sum_{j=1}^{M} \sqrt{p_i l_i}\right) \quad \text{-----} (7)$$

And the mean access time of the entire system for both fixed and smart antennas are given below in equation (8).

$$T_{opt} = \frac{1}{2}\left(\sum_{i=1}^{M}\sqrt{p_i l_i}\left(\frac{1+E(l_i)}{1-E(l_i)}\right)^{1/2}\right)^2 \quad \text{----} \ (8)$$

Where E(li) is the length of the item that are received erroneously by the clients and they are given by,

$$E(l_i) = 1 - e^{-\lambda l_i} \quad \text{-------} \ (9)$$

B) PROBABILITY UPDATING SCHEME

Learning automata are mechanisms that can be applied to learn the characteristics of a system's environment. A learning automaton is an automaton that improves its performance by interacting with the random environment in which it operates. Its goal is to find among a set of M actions the optimal one, so that the average penalty received by the environment is minimized. This means that there exists a feedback mechanism that notifies the automaton about the environment's response to a specific action. The operation of a learning automaton constitutes a sequence of cycles that eventually lead to minimization of average penalty. The learning automaton uses a vector, $P(n) = \{p_1(n), p_2(n), ..., p_M(n)\}$ which represents the probability distribution for choosing one of the actions $a_1, a_2, ..., a_M$ at cycle.

$$\sum_{i=1}^{M} p_i(n) = 1 \quad \text{-------} \ (10)$$

The core of the operation of the learning automaton is the probability updating algorithm, also known as the reinforcement scheme, which uses the environmental response triggered $\beta(n)$ by the action a_i selected at cycle 'n' to update the probability distribution vector 'p'. After the updating is finished, the automaton selects the action to perform at cycle n+ 1, according to the updated probability distribution vector $p(n+1)$.

$$p_{z,j(K+1)} = p_{z,j(k)} - L\left(1-\beta_z(k)\right)\left(p_{z,j}(k) - a\right), \forall j \neq i$$

(11)

$$p_{z,i}(k+1) = p_{z,i}(k) + L(1-\beta_z))\sum_{j \neq i}(pz, j(k) - a)$$

Where $p_{z,i}(k) \in (a, 1), \forall i \in [\![1..N]\!], L, a \in (0 \ldots 1)$, are parameters of the LA. L defines the rate of convergence, while the role of α, is to prevent the probabilities of non-popular items from taking values very close to zero in order to increase the adaptively of the LA.

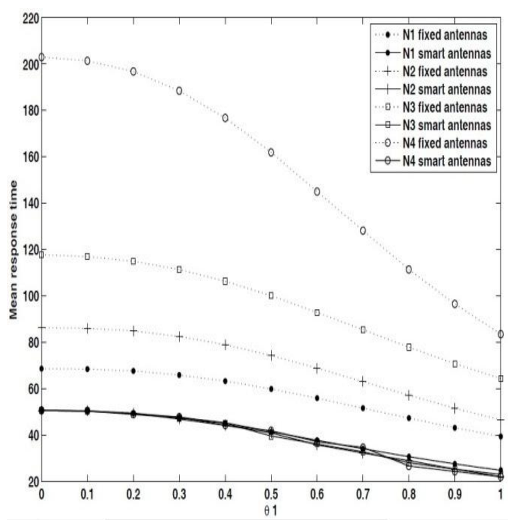

Fig. 2.The mean response tie versus group size skew coefficient θ1 in networks N1, N2, N3, N4 using four antennas.

III. PERFORMANCE EVALUATION

In this module we make some performance calculation, system performance should be concluded by calculating the mean response time. Mean response time is the mean amount of time units that a client has to wait until it receives a desired information item. We consider SAantennas having replicas of the same database of equally-sized items. The antennas are initially unaware of the demand for each item, so initially every item has the same probability estimate. group

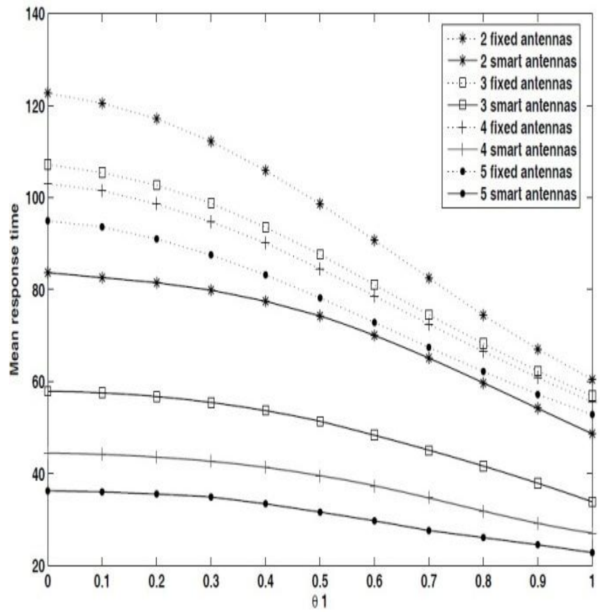

Fig. 3. The mean response time versus group size skew coefficient θ1 in network N5.

Client demands are a-priori unknown to the server and location dependent. We consider $NumCl$clients that have no cache memory, an assumption also made in other similar research; Clients are grouped into Ggroups each one located at a different geographical region. Any client belonging to group g, $1 \leq g \leq G$, is interested in the same subset $Secg$of the server's database. All items outside this subset have a zero demand probability at the client. The items broadcast are subject to reception errors at the clients, with unrecoverable errors per instance of an item occurring according to a Poisson process with rate λ. Finally, there do not exist common demands for items between any two clients belonging to different groups. Assume that each such subset comprises Numitems. The demand probability $di$for each item in place $i$in that subset is computed according to the Zipf distribution, which is used in other papers dealing with research in data broadcasting as well (e.g. [1]-[6], [10]-[12], [23]): $di= c(1i)\theta$, where$c$= $1/(\Sigma k(1k)\theta)$, $k\in[1..Num]$. The data access skew coefficient$\theta$is a parameter that when increased, increases client demand skewness, meaning that the clients increasingly tend to make demands concerning only a few of the servers data items. Additionally, to model more general cases, we also included results where the item demand probabilities are produced according to an (a) uniform distribution, (b) Poisson distribution with rate $l$and (c) Gaussian distribution with mean $\mu$and variance $\sigma 2$. The sizes of the client groups are also computed via the Zipf distribution, defined by the group size skew coefficient $\theta 1$. The larger the value of $\theta 1$, the more skewed is the distribution of the group sizes, meaning that the majority of clients in the system will belong to a small number of certain client groups. The results in Figures 1-4 were obtained via a simulator coded in Matlab. The simulation runs until each antenna broadcasts Mdata items. The results presented are obtained with the following values to the parameters: $NumCl$=5000,=200000, L=0.15, a=10−4, Num=20, λ=0.1, θ=0.5, l=10,μ=10, $\sigma 2$ = 5. In all Figures, for a total of Ggroups, the total number of the data items Nin the BS is equal to $Num* G$.In these results the smart antenna system is compared to the directional antenna system of [10] which uses antennas of the same fixed beam-width covering the entire area around the BS.[10] also employs a LA per antenna for estimating the data item demand probabilities. The comparison is made in terms of mean response time (in item transmission times) versus group size skew coefficient $\theta 1$. Mean response time is the mean amount of time units that a client has to wait until it receives a desired information item. Figure 2 compares the mean response time of the proposed smart system against the system of [10] in an environment with G=20 groups and SA=4 antennas. We consider a coverage area divided into 4 quadrants. We study four network configurations, *N*1, *N*2, *N*3 and *N*4, in which the groups of clients are positioned randomly at the 1st to 4th, 1st to 3rd, 1 st to 2nd and exclusively in the 1st quadrant respectively. Thus,in*N*2, *N*3 and *N*4 the clients are not spread across all thequadrants and therefore there exist empty quadrants. Figure2 shows that the mean response time of the proposed smartantenna-based system is significantly lower than that of [10].This is due to the fact that the proposed system adjusts itsbeam-width so as to efficiently assign the client groups to itsantennas. It is worth mentioning the performance difference isincreased in networks where the clients are located in fewer

quadrants, as in such cases antennas in the system of [10]remain unused.It is also noticeable that while the performance of the system of [10] is affected by the geographic distribution of the groups (it exhibits different mean response time for networks *N*1, *N*2, *N*3 and *N*4), the proposed scheme has the same performance,despite differences in client placement. This is due to the fact that the ability for beam-width alteration of the antennas enables the proposed system to assign a similar number of clients to each antenna and thus yield the same performance

despite differences in client placement. Figures 3 and 4 address a dynamic environment, where the number of client groups alters during the simulation, taking values in the interval of [10..20]. In these Figures, in network configurations *N*5 and *N*6 the groups are located at the 1st to4th and 1st to 2nd quadrant, respectively. To model a dynamic environment, the location of each group changes every 4000item broadcasts while the smart system repeats the antenna assignment procedure every 5000 item broadcasts. The above environment is simulated for 2, 3, 4 and 5 available antennas. Again, it can be easily observed that the proposed system provides superior performance to that of [10]. Moreover it can be observed that the superiority of the proposed approach increases for an increasing number of antennas used at the BS.Assign a similar number of clients to each antenna and thus yield the same performance despite differences in client placement.

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IV. CONCLUSION

This letter proposed an adaptive smart antenna-based wireless push system where the beam-width of each smart antenna is altered based on the current placement of clients within the system. After the antenna assignment procedure, each antenna excludes from its broadcast schedule the information items that refer to geographic areas that are out of its coverage.

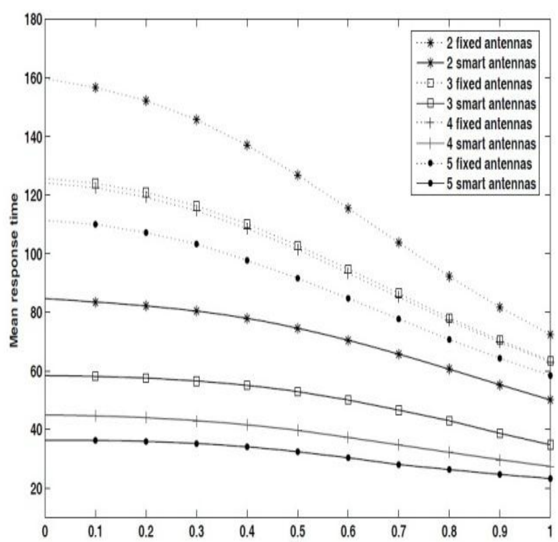

Fig.4.The Mean response time versus group skew coefficient θ1 in network N6.

Simulation results reveal that the above-mentioned properties of the proposed system provide a significant performance increase over the system of [10] that utilizes multiple antennas of fixed beam-width.

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