PACKET RADIO NETWORK BROADCASTING

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Abstract - This article is concerned with studies in shared media or broadcast type of networks based on packet radios and satellite channel.

Because multiple uncoordinated users attempt to gain access to a single channel in a random manner and thus result in contention, such networks are also known as multi access or random access or contention networks .

The central problem in shared media networks i how to allocate the

channel, one at a time to the large number of competing users who are incoordi nated and, possibly geographically dispersed. None of the traditional techniques for sharing a channel, namely, FDM. IDM, Polling and concentration works satisfactorily for shared channels like sofel lie, packet radio, coaxial cable, etc. The basic prob let with FDM and TDM, both of which allocate a channel statically, is two-fold

(a) The number of stations being large and time varying, chariel allocation poses a big problem

(b) The frequent non-utilization of their allocated frequencies or time slots by a large number of users gives rise to considerable wastage of char nel capacity and causes increased delay.Value of the mean delay actually increases N times if the bandwidth is reduced N times So far as Polling is concerned, it is unsuitable because of the large overhead, especially for large propa delay channels like satellites. The round trip delay for a satellite being around 270 min, the minimum time to complete a polling cycle with 100 sations would be 54 seconds. Finally, concentration a simply not possible because, to allow possible simultaneous transmissions by several stations, it i requires a dedicated or private port for each station Thas, a new channel sharing technique is required in building shared media multiple access networks.

Keywords : ALOHA , SLOTTED ALOHA, FDM,TDM PACKET RADIO NETWORKS,CONTENTION PODA, CELLULAR RADIO NETWORK, METROPOLIS, CPODA .

INTRODUCTION:

BROADCAST NETWORKS-NEED FOR A NEW CHANNEL ALLOCATION TECHNIQUE

A novel and elegant technique for allting channel under the condition of multiple independent and random ons was decised in 1971 by Norman Abramson of the University of Hawaii and his colleagues while building a ground radio based computer network The experiment was called ALOHA and the dynamic channel allocation tech nique it employed, popularly referred to as ALOHA technique, is the forerunner of a host of efficient multiple access techniques subsequently used in satellite based WANs and some LANs The ALCHA protocol is described in the following section.

PURE ALOHA PROTOCOL

The ALOHA protocol. recognizes the fact that even though the users are uncoordinated they can utilize the feedback property inherent in the bad cast channel to being about, though in an isolated man ner, and effective coordination between themselves The basic ALOHA protocol is very simple, and it has two variation, namely, pure ALDEIA ALCHA in short, and SLOTTED ALOHA in the pure ALOHA protocol, a station is allowed to send a frame (or packet) whenever it wants to but obviously, this frame may "collide" (overlap in time) with one or more frames transmitted by other sta tions because the stations are uncoordinated. How ever, because of the feedback property of the broadcast channel, the sending station can discover by itself whether any collision took place by simply listening to the channel. Hi there has been a collision the frame will obviously need to be re-transmitted but only after waiting for a random period of time The randomness of the waiting period is essential because, otherwise, the same set of frames (users) will collide over and over again. It should be noted that collision by two or more frames may be caused even by a partial overlap during as small as ane bit period. For example, if the first bit of a frate even partially overlaps the last bit of a frames.

Efficiency of the pure ALOHA protocol in tems of the throughput S was analyzed by Abramson under the following assumptions.

(a) The number of stations is infinitely large.

b) The frames are of fused length and, accordingly, the frame time, Le, the time needed to transmis a frame, is also find say tser

(c) Transmission of frames (both new as well ai ohi frames transmitted by all stations taken together! is a Pouson proces with a meau of G frames/frame time.

Abramion argue that had there been no collision S would have been equal to the offered traffic G itself. However, because of collisions S is reduced compared to G) by a factor Ps, i.e.,

S=PsG

Here p, the probability that the transman of any frame, taken at randorr, is successful or equiv alently, the transmitted frame does not offer a colli son It should be nous that although the throughput S is necessarily limited to inity (1 frame/frame time). G may exceed unity. However, a large value of C only increases the number of colli stans and hence re-transmissions hut does not co tribute to the throughput The success factor , and hence the relation between S and G can be determined as follows

Considering an arbitrary frame which is transmitted at time it occupies the channel during the period [$t_{0,}$+t_0+t] From Figure B1 it may be observed that this frame will escape collision only if no other frame is transmitted within the 25 sec period [t_0-τ, t+τwhich may be termed as the collision zone

Since the frame transmission process is Poisson with a mean of G franues/frame time, Le. 20 frames/21 seconds and the number of stations is infinite.

$$p_s = \text{Prob}\,\{\text{no frame is transmitted during} 2\tau \text{ second}\}$$

$$= \frac{(2G)^0 e^{-(2G)}}{0!} = e^{-2G}$$

$$\text{Hence} \quad S_{PURE} = G \quad e^{-(2G)} \qquad (B.2)$$

The lower curve in Figure B.2 depicts the above relationship between the offered traffe G. ie, the number of frames per frame time that is attempted to be transported across the broadcast subnet and the throughput S, Le, the number of frames per frame time that is actually transported by the broadcast subnet

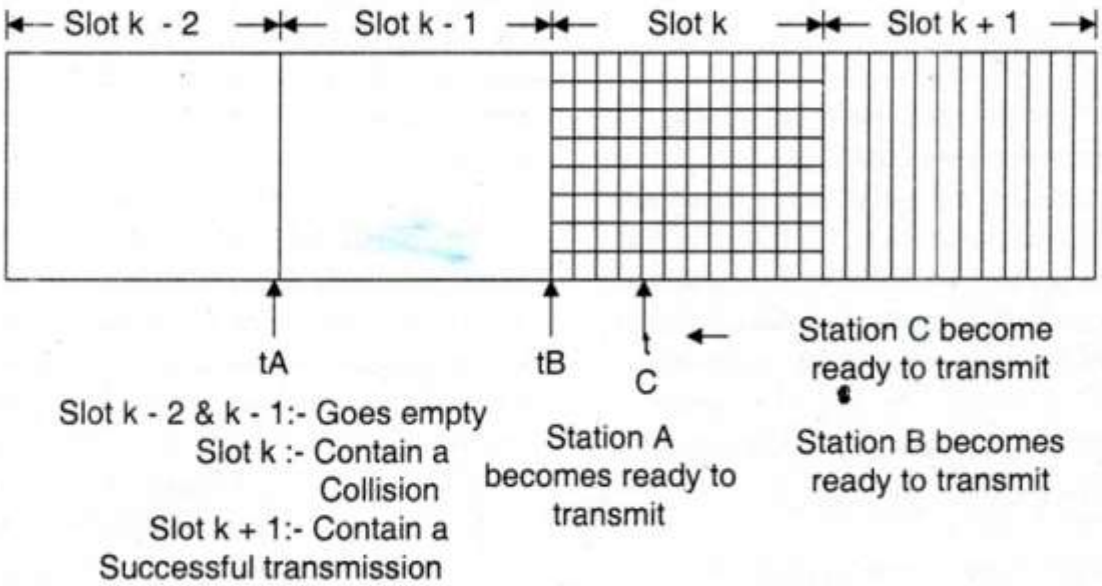

Figure B.3 Functioning of a slotted ALOHA system.

The maximus thoughput ot, equivalently, the maximum efficiency or channel utlization of the pure ALOHA protocol i 1/2) (a little over 18%) and is obtained when G-0.5 frames/frame time

SLOTTED ALOHA PROTOCOL

In slotted ALOHA protocol which was proposed by L. Roberts in 1972, stations are not allowed to trans mit whenever they want. Le, asynchronously, but are constrained to transmit only in synchroniem, with a system clock Time is divided up into fixed size intervals of slots, each slot being equal to one frame time, and one of the statistis a synchro nization puise at the beginning of each slot. This arrangement, shown in Figure B3, which coreverts a continuous time ALOHA system ipure ALOHA) to a discrete time ALOHA system sletted ALOHA) clearly reduce the collision zone to only seconds so that p_s-e^{-G} and

$$S_{SLOTTED}=Ge^{-G}$$

The relation between G and S for a slotted ALOHA system is shown by the upper curve in Pig ure B.2. Maximum throughput for slotted ALOHA 1/e which is exactly double than that of pure ALOHA and is obtained when G-1. Beyond C1. the throughput starts falling almost drastically because of a marked increase in the number of colle sions resulting in a large c se in the number of re-transmissions. As a matter of fact, it can be shown that the mean number of transmission per frame varies exponentially with G.

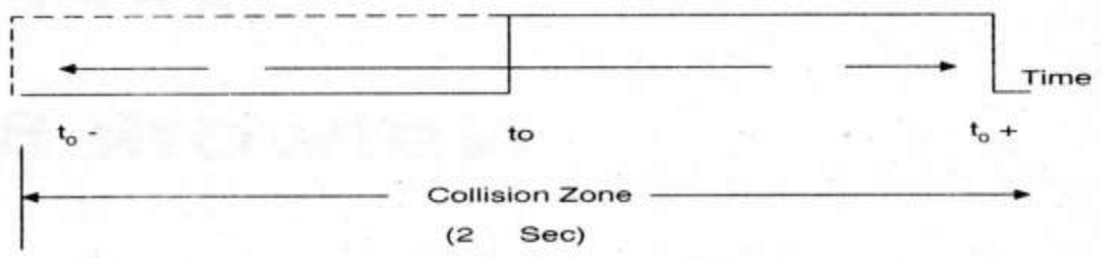

Figure B.1 Collision zone of a frame in pure ALOHA

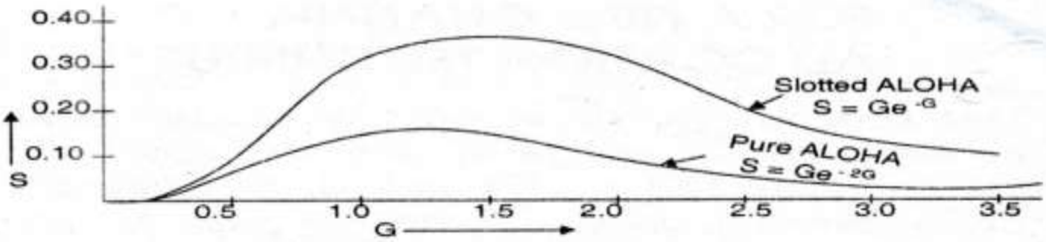

Figure B.2 Throughput Vs. offered load curve for pure and slotted ALOHA system.

PACKET RADIO NETWORKS

In a packet radio network, there are a large number of interconnected stations each equipped with a radio transmitter-receiver unit. The network based neither entirely on point-to-point commun cation not entirely on one broadcast channel: instead, it may be looked upon as a kind of broadcast in parts subnet. Each station can only hear a subset of the other stations and correspond ingly, it can be heard by all the stations in this subnet. Thus, any two stations transmittin simultaneously will collide at a station if they both belong to its subnet but will not collide otherwise. Thus, multiple nodes (stations) can transmit simultaneously without interference Packet radio net works are attractive as relatively low cost networks (especially compared to satellites where the stations are in poorly developed areas lacking telephone communication, the stations are mobile (eg, a fleet of ship, cars and taxis in a metropolis, etc) or the stations have a high peak-to-average traffic ratio making dedicated communication links wasteful.

The topology of a ratio network can be described by a graph, as shown in Figure B.6 although even for a moderate sheed network the graph becomes unmanageably complex. Mobility of the stations dynamically changes the topology of a packet radio network. It should be noted that if a station's trans mitting power is increased, it can be heard by a larger, set of stations and, in a similar manner, it can hear larger set of stations if the sensitivity of its receiver is increased.

As an alternative measure, repeater stations may be installed to receive and rebroadcast the messages transmitted by each station within its range. The basis property of partial connectivity together with the highly dynamic changes in the topology make packet radio networks the most. complex among all the different types of networks.

An interesting and important development in the area of packet radio network is the cellular radio which used for mobile voice communication The total area covered by the cellular tadio network (eg, a metropolis) is divided into a large number of local areas called cells. Eads cell has a set of fre eney bands for use within the cell.

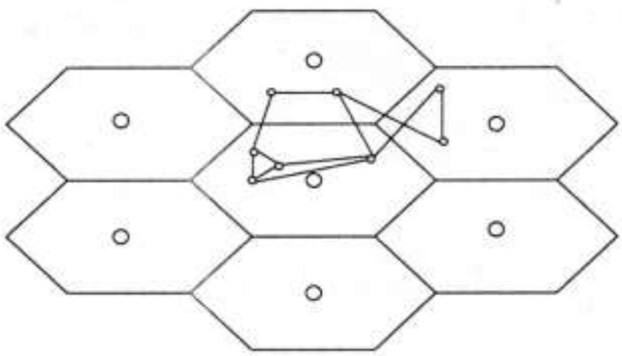

Figure B.7 Partial graph of a cellular packet radio network.

Theoretically, cell should have hexagonal shape so that the whole area is completely covered by cells in a mutually exclusive way (see Figure 87). The cell ze corresponds to the range of the mobile trans mitters. This ensures that a station is heard by all stations within its own cell some cell beyond that Clearly, to avoid interference, neighboring call must have different frequencies. The problem of alloca tion of sets of frequencies to the cell under the con dition is just the well known graph colouring problem. In addition to the large number of mobile stations in each cell, there is a centrally placed (at a high altitude) non-molde "base" station which cant communicate with all stations within its cell.

When a mobile station (for example, a cellular telephone m a car) is switched on it first determines Its base station by monitoring sgnals from all se stations and determining the strongest one among them Immediately, it announces its triephone num ber to this base station which then tells it the coll number and the set of frequencies to be used V the mobile telephone wants to make a call, it trane mits a message to its base station which then allo cates it a frequency, if available, and later deallocates this frequency at the end of the call. A station monitors all base station signals all the time When it moves into a different cell, it discovers that the signal from some other base station has now become the strongest. It then informs its present base station about its new hase station and the for mer then hands it over to the latter. Its new base station then instructs it to switch to the set of frequencies of the new base station. A central com puter keeps track of the current location of every mobile station and all base stations have access to this central computer. Whenever a base station receives an incoming call to be forwarded to a particular station, it accesses the central computer to find out the destination station's whereabouts and then routes the incoming via the proper base station.

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