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Communication through Psuedo Random Scheduling for Packed Radio Networks via Channel Division

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Abstract: *The paper presents the principal difficulty in scaling a system of packet radio stations where interference from other stations in the system interference comes both from nearby stations and from distant stations Each nearby interfering station is a particular problem, because a signal received from it may be as strong as or stronger then the desired signal from some other station. Far off interfering stations are not individually a problem, since each of their signals will be weaker, but the combined effect may be he dominant source of interference, the paper is superior to ideal time division multiplexing of a clear channel.*

1. INTRODUCTION

Interference from other station is the main reason behind scaling of packed radio networks in transmission. Interference is caused due to nearby stations as well as from distant stations because the signals received from those stations could be strong or week. Thus the overall noise level and interference caused due to the transmission of signal to a particular station are analyzed and found to remain manageable even as the system scales to billions of nodes. Thus to avoid collision in the packet data transmission new concepts are developed in this paper. Telecommunication can be achieved by either sending signals through cables or by letting generated signals propagate naturally through space as electromagnetic radiation cables can provide unlimited bandwidth, but require a lot of capital investment. the cable costing becomes expensive due to labour costing and installation charges.

2. PACKED DATA NETWORKS MODELLING

A signal either transmitted or received is most completely as a real valued function of time. Signal transmitted by source is denoted as $S_i(t)$,and the received signal at the station is denoted as $y_i(t)$.the parameter that are to be considered for the system performance are its power level and bandwidth and both are regulated by government regulation and limitations. Noise and propagation determine the received signals as a function of the transmitted signal assuming linearity and time invariance a general model is

$$yi(t) = ni(t) + \sum_{j=1}^{M} hij(t) * sj(t)$$

Where M=no of stations
H_{ij} = response at station i to an impulse in time transmitted by station j
Where H_{ij} =signal due to thermal noise at station i
*= convolution symbol

3. SOURCES OF INTERFERENCE IN PACKED DATA TRANSMISSION

Interference can come from various sources which include thermal noise, atmospheric effects, extraterritorial effects. Along with all those interference from other source interference create a lot of problem. Thus impulse response hij(t) is a general model for propogation in that can represent the strength of the propogation, the propogation delay and any multipath propogation. So hij(t) will be assumed to be just a scalar multiple of unit impulse hij(t) and the equation above can be simplified to

$$yi(t) = ni(t) + \sum hijSj(t)$$

Where $h_{ij}(t)$ are now scalars and the propogation model is not complete until $h_{ij}(t)$ are specified. The signal will be received successfully at a station i from k if, while ratio is at least small factor >1 and probably around 3. The required signal to noise ratio is

$$\frac{S}{N} \gtrsim \propto (2^{C}/_{w} - 1)$$

Where C = capacity, S=Power of the signal received at station i from sending station K. The power contained is the sum of the interfering signals.

$$N = ni(t) + \sum \sum_{j=1, j\neq k}^{M} hij(t) * Sj(t)$$

4. SPREAD SPECTRUM

Spread spectrum is the term used to describe techniques for practically achieving communication by radio when the signal to noise ratio is less than 1 that is within the used bandwidth spread spectrum is used to get multiple access over a single channel or single bandwidth. Most widely used technique in spread spectrum is direct sequence spread spectrum (DSSS)which is followed by a modulator and a demodulator, but as soon as the modulator signal transmitted a pseudo random code is generated. The receiver then uses a narrow filter and detector to isolate the signal and demodulate it to get the transferred bits. Spread spectrum radio techniques can be used to build systems that are capable of communication at the rates with in the Shannon bounds in channels where the interference has lowered the signal to noise ratio to well below one, but their are some practical limits. Some additional signal levels. or headroom will be needed over the minimum implied by the Shannon bound. It is found that around 5 db of headroom after propagating gain is needed to achieve a 10^{-6} bit error probability using a DS/BPSK radio link with viterbi decoding in a spread spectrum multiple access application. (For example the processing gain of around 30 db would handle a few hundred $100\sqrt{10} \approx 316$ interfering signals each with a error correcting codes.

5. CHALLENGES IN INTERFERENCE SIGNALS

Interference is limited to try to schedule transmission so that each packet can be transferred without experiencing any interference from any other transmissions. For completely filled in propagation matrix, this approach would require co ordination between all stations participating in the system and exclusive one at a time use of channel. The co ordination would be challenging if there are many millions of stations

6. NOISE LEVEL IN LARGE SYSTEM

In presence of high level of interference signal to noise rates are bounded by the Shannon limit and hence rate of communication reduces. Relationship between signals to noise ratio is significantly less than one.

7. MULTIPLE ACESS COMMUNICATION THEORY

FDM is the most straight forward method of managing the separation of users. Different users of the spectrum are isolated from each other in frequency and the receiver can use a band pass filter to separate the desired signal. Same ways TDM can allow for statistical multiplexing of the traffic and eliminates the problem of transient channel assignment, but introduces the problem of resolving contention for the channel. Random aces schemes and explicitly scheduled schemes can nicely solve the problem in situations where all the stations or when all the station can hear each other equally well in case of non uniform propagation and non centralized traffic, the potential performance of random access scheme is less understood. Coode division multiplexing is the term used to denote spread spectrum technique of multiplexing, where the signals are allowed to overlap in time and frequency

8. PACKET RADIO NETWORKS

Packet radio networks comes from work in multiple access communication theory by the use of propagation models that do not have all the receivers receiving the same signal Interference is a quantifiable phenomenon and is measured by the resulting signal to noise ratio a which packets are receive.

9. NOISE LEVELS IN LARGE SYSTEMS

In presence of high levels of interference signal to noise ratio will be reduced and hence the communication rate will reduce. The relationship between signal to noise ratio is significantly less than one. If we consider that stations are distributed at some average density ρ throughout the infinite plane, and that each station is operating its transmitter at unit power output and at duty cycle η. Now power radiated per unit area in the plane is an average $\eta\rho$. For a receiver located in the plane, the power level received from a station a distance of one characteristics length $R_o = {}^{-1/2}$ can be computed. If the growth in the overall level of interference then assume that M interfering stations are distributed randomly within a circle of radius R, then stations outside the circle can be ignored Average density ρ is then $M/\Pi R^2$ if M increase the distance to the nearest neighbours also decreases remaining proportional to the distance. The distance to nearest neighbour also decreases, remaining proportional to the distance $R_o = {}^{-1/2}$

The signal level s from such a nearest neighbour transmitting with unit power would be

$$S = \propto / R_o^2$$

$$= \propto / (1/\sqrt{\rho})^2$$

$$= \propto \rho$$

Where depends on the antennas and wavelength used. The total power of interfering signals N, ignoring the contribution from local interference inside the circle of radius $R_o = ^{-1/2}$ can be calculated as

$$N = \int_{Ro}^{R} \propto \left(\frac{1}{r^{2\eta}} 2\Pi r dr\right)$$
$$= \propto \eta 2\Pi$$
$$= \propto \eta 2\Pi(lnR - lnRo$$
$$= \propto \eta 2\Pi(R/Ro)$$
$$= \propto \eta 2\Pi ln\sqrt{M}/\Pi$$
$$= \propto \eta \Pi lnM/\Pi$$

So the signal to noise ratio (SNR) is

$$\frac{S}{N} = \frac{\propto}{\propto \eta ln \frac{M}{\Pi}}$$
$$= \frac{1}{\eta \Pi ln \frac{M}{\Pi}}$$

The expected signal to noise ratio of a signal from one of the nearest neighbours depends only on the M and η(the duty cycle).The signal to noise ratio falls very slowly approaching –db for η=1 as the number of stations approaches $10^{12.}$ This observation is encouraging The signal to noise ratio of a neighbours transmission falls slowly even as the number of stations grows exponentially

10. WORK PERFORMED THROUGH PSUEDO RANDOM SCHEDULING FOR PACKED RADIO NETWORKS VIA CHANNEL DIVISION

Interference from a nearby station transmitter may be a problem if it is used to transmit at high power. It could be problematic if the nearby station transmitter delivers and interfering signal with power sufficient to significantly lower the signal to noise ratio of packet receptions. Whether the effect is significant or not will depend on how much processing gain the stations are using. The power levels are usually discussed in decibels algorithm. But the effect of an additional interfering signal on overall interference level which is already quite high. The power level adds but the logarithmic levels do not increase. Say if two signals one at a power level of 20 db and other the other at a power level of 10 db are added the power level of the resulting signal is 20.4db. which is barely a significant change. In order for the addition of a week signal to increase the overall level of interference by more than 1 db its power level must be at least one fourth the power level of the overall interference One decibel which is about a 25 percent change is a reasonable threshold for significance. While we can strictly budget the additional level of interference we may tolerate from each nearby neighbour independently, as two additional sources of interference can combine to produce an even greater level of extra interference, we can hold each such potential additional sources of interference to a maximum increase of 1 db in total interference and budget a few decibels of addition headroom. It would then take more than four simultaneous high power transmissions each contributing just under1 db threshold from nearby neighbours to have more than a 3db effect on the overall level of interference only in frequent circumstances. And neighbour ‘s transmission increase the level of interference by more than 1 db. In order for an interfering station to significantly increase by more than 1 db the total amount of interference, it would have to deliver more than 20 times or 13 db more the amount of power that it is delivering to the intended recipient. If the noise level is 20 db or the target receive power. Choosing 13 db here is 1 decibel more conservative. Assuming $1/r^2$ propogation, this threshold will be exceeded only when station is more than five times as far away as the interference from the transmitter. If the distant stations we are communicating with are at a distance of $2\rho^{-1/2}$ then the expected no of stations inside a circle with a radius of one fifth this distance only $\Pi(2/5)^2 \approx 0.5$. This no is well under the interference threshold of four nearby transmitter. If when high power must be used, an additional constraints can be placed on the scheduling to avoid interfering with and neighbours reception. Those packet transmission that will require high power must not be scheduled at a time that overlaps with a receive window at a neighbour who is too close.

11. CONCLUSION

This paper presents a pseudo random scheduling method that can be used to ensure that packets are not received at times when the signal to noise ratio would be unacceptably lowered due to nearby near by sources of interference. The method requires neither global synchronization or global coordination. Each station can arrange independently with its immediate neighbours to ensure that its transmission do not mask the reception of packets either by itself or by any particularly close neighbours. The maximum total throughput or fraction of time spent sending out of a station is around 0.21 for a single neighbour and can be increased as more neighbours are added. A station can even spend more than half of the time sending if it has a sufficient number of neighbours. The expected delay per hop due to the scheduling method is a few scheduling slots which, with four sub slots is around two dozen packets. The design strategy introduced above yield a design for an effective packet radio network that can scale to seemingly arbitrary density and requires no centralized centralized co ordination of channel use above paper shows how to ensure that packets are sent only at times at which they will not be dropped due to collisions, but we do not require any global synchronization or co ordination.

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