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802 LAN Access Method for Wireless Physical Medium

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TITLE: FURTHER DISCUSSION OF DETAIL FUNCTIONS IN THE SEQUENTIAL ASYNCHRONOUS-ACCESS METHOD (SAM)

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SUMMARY

In the course of discussion and questioning on the Sequential Asynchronous-access Method (MAC subgroup Jan 92 meeting), substantive questions were raised concerning important functions. These questions deserve a thoughtout response that was in some cases inadequate or unrecorded under extemporaneous conditions.

In particular, more detail discussion is believed userful on the following subjects:

a) Detail of processing of isochronous bit streams on a packet transmission medium with characterization of delay factors.
b) The detection and resolution of contention following an Invitation-to-request.
d) Autonomous mode access method operation.
e) Efficiency of non-simultaneously usable Access-points.
f) Frequency of change of access-point coverage for a Station
g) Extending maximum packet length to 512 octets or more.

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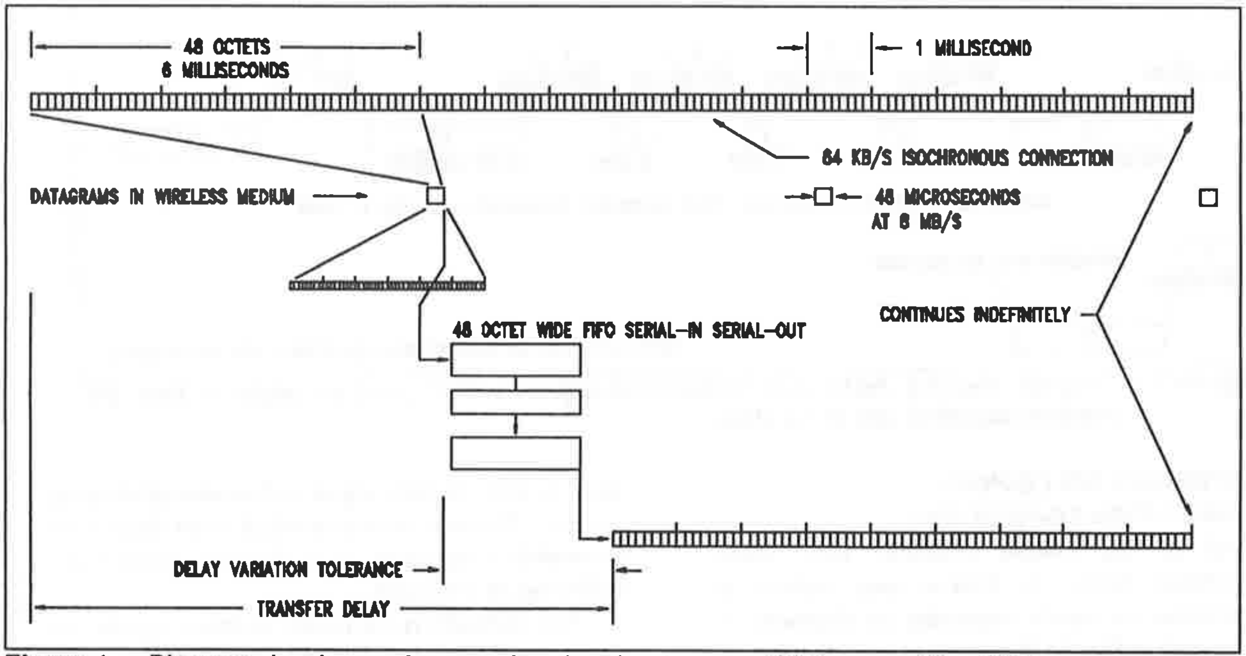

Figure 1 Diagram showing packet transfer of an isochronous data stream of 64 Kb/s over and 8 Mb/s medium to approximate scale.

TRANSMITTING ISOCHRONOUS BIT STREAMS ON A PACKET MEDIUM

As shown above, bundles of octet samples must be accumulated for a burst transmission. For a 64 Kb/s isochronous stream shown as an example, 6 milliseconds is required to accumulate 48 octets. This accumulation delay interval is unavoidable.

After the bundle is accumulated, some time will pass before it can be placed on the medium, even if it is regularly slotted. If it is a packet medium, the worst case delay may be traffic and frame structure dependent.

A bundle which is not delivered in time to be used is a lost bundle.

A worst-case medium access delay tolerance of 3 milliseconds is shown in the diagram. If the bundle is gains transmission access in less than 3 milliseconds or rather a slightly smaller value recogizing the transmission time of the message (about 50 µsec) and the shuffle time of the UART function, then it is usable. There is no advantage or disadvantage resulting from earlier delivery.

The bit stream is reconstructed at the receiving point by separate receiving and transmitting shift registers with an intermediate register that is loaded and dumped parallel. This is not the only way to implement this function, but it has been commonly used in UART devices.

The transfer delay is the sum of the accumulation delay and the worst-case access delay. The output bit stream is a delayed replica of the input. "Jitter" is not an applicable term.

By design, any amount of delay tolerance may be built into the system, however, once selected, the built-in transfer delay is defined for all cases.

If the isochronous medium is being used to transport voice, FAX or video, the loss of 1 per hundred bursts would be psychologically undetectable. The situation might be different for analog modem information at terminal/host rates. The necessary design goal for the possibility of lost bundles must be softer than never, but rare.

A more subtle consideration is the matching of transmit and receive clocks. A difference in rates will eventually cause a valid octet to be deleted or a null octet to be inserted. Generally, autonomous clocks will be matched within one part in 100,000 or better. The clock mismatch will cause the buffering capacity of 3 milliseconds to expand or shrink with time until eventually a whole bundle is lost. There will be a tolerance limit on the minimum connection time before there is a bundle slip.

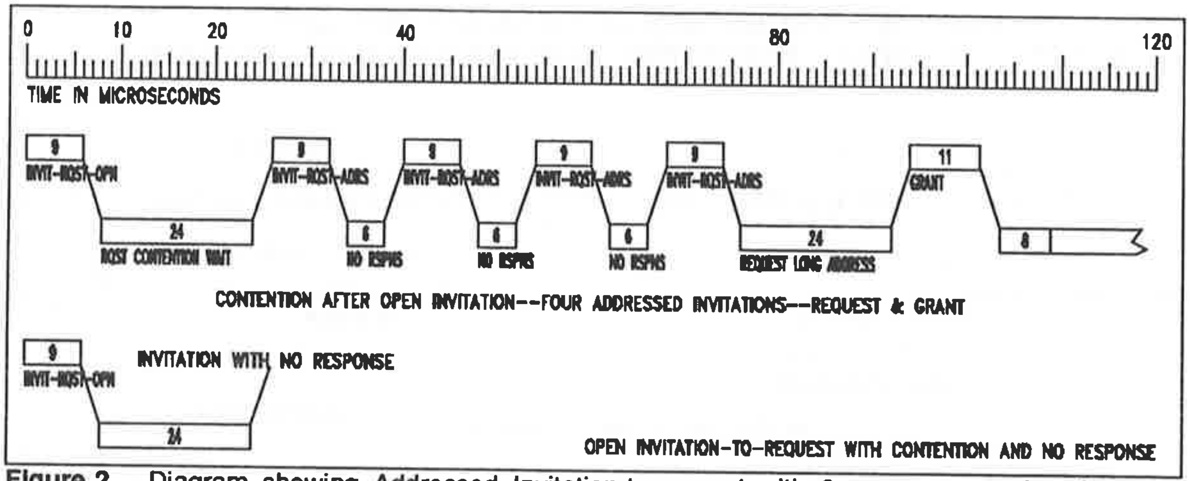

Figure 2 Diagram showing Addressed Invitation-to-request with 2 μsec propagation time and medium signaling rate of 12 Mb/s.

CONTENTION FOLLOWING AN INVITATION-TO-REQUEST

All of the offered proposals have some precondition before a Station may initiate a transmission commonly requesting an allotment of time to send traffic. In this access method the Station may Request service only after an enabling Invitation-to-request transmission. Normally these will occur more frequently than every 1.8-2.4 milliseconds from one Access-point operating at 12 Mb/s in a scan group of 4.

Following an Invitation message, there is a possibility that contention will be undetected, falsely detected, unresolvable or unfair. All of these must be considered.

Contention Undetected from Data Stream

Contention may go undetected from bit stream indications if two requests are about the same signal level at a registered access-point. If they contend and have substantially different levels, there is a probability that the stronger will capture the access-point receiver and be taken out of queue.

The weaker has the possibility of being received adequately at a secondary access point and being processed normally in parallel with the stronger.

In addition, an unsuccessful Station is not constrained to use the registered Access-point after a first failure of Request. An unsuccessful Station may also Request when polled.

Contention Detected from Carrier Present

There is also the case that the Access-point (and Hub Controller) has indication of probable contention from presence of radio signal and absence of decoded request. This case is only invoked when there is no successful recognition of a Request immediately following an Invitation.

The difficulty is not failure to detect signals, but rather persistent reporting of signals present when there has been no Request attempt. The obvious reaction is to raise the receiver threshhold until a stronger signal is required. This theshhold can only be raised sofar before valid attempts are not recognized.

It is possible to take advantage of the known timing of the Request to distinguish it from signals that are present as background, and therefore arrive at a failed attempt indication.

Procedure Following Carrier-based Contention Indication

When the Access-point has an indication of contention, it may follow a Poll or a sort procedure. The Poll for requesting Stations is called an "Addressed Invitation-to-request." A diagram of this sequence is shown above in Figure 2.

Since this indication has a significant probability of being false, it is important to minimize the consequences of following procedure. The normal Poll determines as of the last few seconds what Stations may have been depending on that Access-point so the length of the poll in the worst case might be 16-32 Stations and is more likely to be 8-16. The smaller the number of Stations to be polled, the less time lost from false contention indication (and the less probability of contention in the first place).

An interesting possibility is coupling "sleep mode" to this problem. By polling only known "awake" Stations, the list can be further shortened. It is probable that only a fraction of active Stations are awake at any one time.

Contrast with Other Carrier-based Contention Resolution Methods

Many other CSMA and similar systems use a carrier-based decision on all Requests. The method above is invoked only after the failure of several other means.

Two earlier contributions have proposed a pattern of on-off bits in a preamble that would provide a contention indication. The off-condition is as likely to be falsely reported in these methods causing at least some degradation in the reliability of the function possibly indication contention when there is none.

A further distinction is that the signal measurement is an infrastruction function, and is not required at Stations.

POLLING FUNCTION AND SLEEP MODE

An arbitrary decision might be made that no more than 1% of available channel-time be used for polling.

Poll Dimensions

One slow POLL on a 12 Mbits/sec medium requires 16 µsec/stn (9 oct + 8 oct + 4 µsec). For 128 stations in one scan group or 32 stations per Access-point, the poll would use 2.048 milliseconds. Following the 1% criteria, a poll could be initiated at intervals of 0.2 seconds.

Assuming 0.5 seconds, arbitrarily chosen, the duty cycle would be closer to 0.4% for use of channel time and 0.003% for any one station.

Poll Controlled Sleep Mode

Suppose that each Station sleeps from one POLL to the next unless awakened or wakes itself. Using the POLL to wake the Station, the worst case access delay to a sleeping Station would be the POLL period--in this case 200-500 milliseconds.

Stations may wake themselves at any time, and make the infrastructure aware of it by activity.

AUTONOMOUS MODE ACCESS METHOD OPERATION

This Access-method is designed for large scale and high capacity systems which must have infrastructure for outside access and wider area coverage reasons at least. This scope is not possible with an autonomous system, nor can autonomous systems be allowed to operate within this environment without unpredictable loss of capacity.

Autonomous mode is a required function but it cannot be stretched to where it will provide the capacity and range of the infrastructure based system. Therefore, let it be simple and a method of last resort.

If the signaling rate is high, and it is used by relatively small ad hoc groups; the capacity will be adequate, and the contention loss will be small with Aloha slotted or not.

The cost and complexity of a portable access-point will not be any different than that of a Station except that the antenna will have to be higher above the floor than the surrounding obstacles.

The battery drain of a Station may be higher than ordinary Stations. It will be possible to modify some parameters to minimize this drain for systems that are lightly used compared with the base design.

EFFICIENCY OF NON-SIMULTANEOUSLY USABLE ACCESS-POINTS

The sequential rather than simultaneous use of Access-point appears may appear to some to be wasteful. It must be understood that simultaneous use is not possible if non-interference and continuous coverage are required. Cellular is based on the closest possible spacing of reused frequencies; and is known to require at least 7 separate sets of channels. The number of sets may be reduced with directive antennas and decreased required signal-to-interference ratio.

The problem must be approached with a **given: the available spectrum is N MHz, and now how may it best be used.** For the 2.4 GHz band, N = 83.5 MHz, and Apple told the FCC that N = 40 or 10 MHz is usable.

The maximum chipping rate for spread spectrum is probably 0.75 bits/Hz for simple binary modulations.

Figure 3 on the following page shows a frequency space occupied by one channel and of four channels of one-fourth the signaling capacity. With very clever antenna and system design, it is probably possible to get 90% coverage while simultaneously using four channels. Exactly the same thing can be done with one channel used one-fourth of the time at four different places.

The first point to notice is that with a spreading code using an 11-bit Barker, the data transfer rate of the single channel is only 2.7 Mb/s. Four channels cannot support the 802 minimum transfer rate.

If the symbol length is 31, then the data transfer rate (at 1 bit/symbol) is 1 Mb/s. Using the Cheah code set, 12 channels might be derived at this rate for a parallel capacity of 12 Mb/s. These channels won't have the 20-30 dB protection ratio of the FDM channels.

There is an argument for code-division channelization, but both code-division and frequency-division will require careful site placement and coordination of frequency assignments.

In addition, there may be a requirment for a common setup channel so that the Stations are more readily accessed independently of location.

Using all of any potential frequency band for one channel, it is barely possible to get a high transfer rate and an adequate resistance to multipath propagation at the same time.

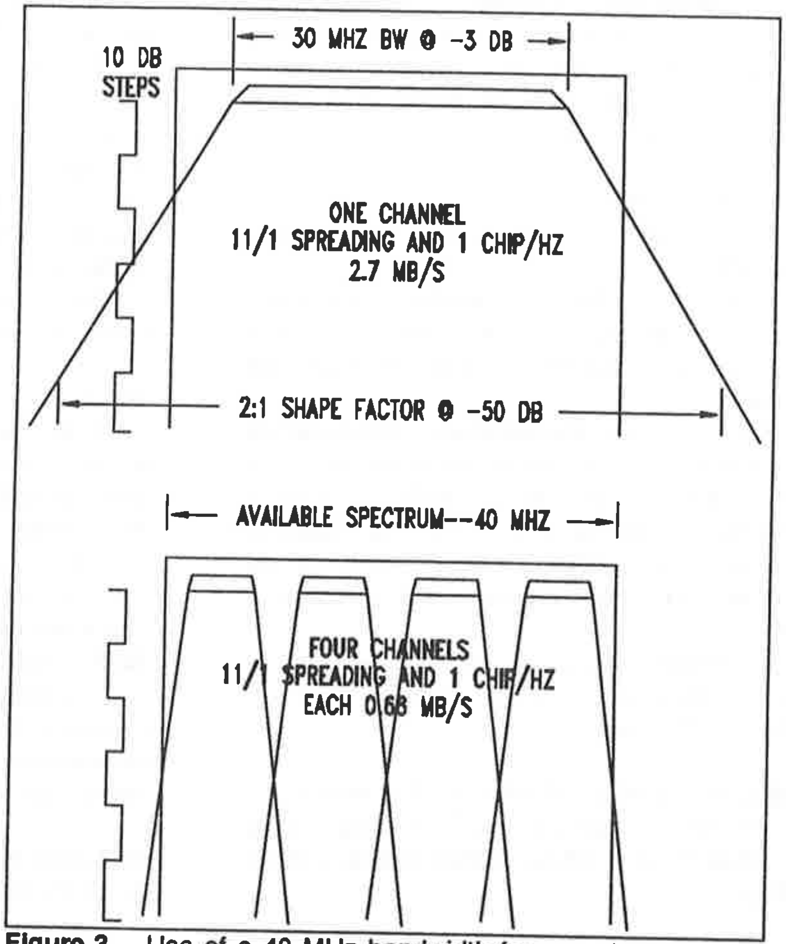

Figure 3 Use of a 40 MHz bandwidth for one channel or for four channels of one-fourth the capacity.

FREQUENCY OF CHANGE OF ACCESS-POINT COVERAGE FOR A STATION

It has been argued that the potential frequency with which a station may move from one coverage to another is not more often than 30-60 seconds. This parameter is important to the feasibility of allowing network routing equipment to treat each Access-point as a separate network.

This proposal treats a group of Access-points as one network. The movement of a Station from one coverage to another is a diversity event without significance to external networks and routers.

In order to arrive at the 30-60 second interval, it was necessary to assign dimensions to a coverage radius and to the movement speed of a pedestrian. This approach restricts the feasibility of the technique to large coverage radio systems with all attached implications.

Had the speed of interior vehicles (robots, fork lifts) been considered, the speed would be five times greater, and the frequency of transfer fives times more frequent.

The opinion now offered is that the permissible frequency of transfer should be such that **consecutive transactions are not required to use the same Access-point.** In this case, the dimensions of a coverage or the degree of interpenetration of adjoining coverages (see Masleid 91-100) becomes a small consideration. The implication is that there must be a common function within the infra-structure where received information can be processed independently of the Access-point from which it comes. In this proposal, this function is part of the Hub Controller.

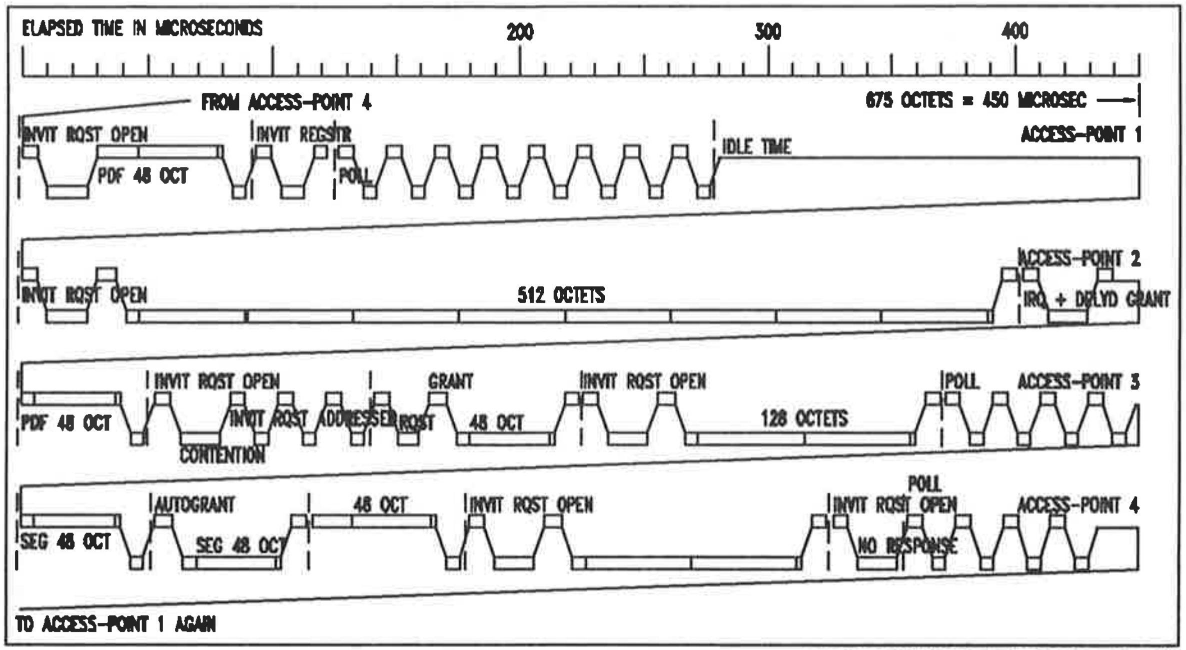

Figure 4 Diagram showing a variety of message functions on four sequentially-used access-points with uniform maximum available time for 12 Mb/s and 4 µsec propagation time.

512 OCTET MAXIMUM PACKET LENGTH

Earlier contributions on this access method have assumed a maximum payload segment length of 288 octets based on 6 millisecond bundles for a 384 Kb/s connection. It has been pointed out that a 512 octet maximum would avoid a lot of further segmentation for widely used network software. Smaller numbers favor better worst-case access delay, and larger numbers increase efficiency for moving large files.

A further change has been the reduction of the assumed size of the sequential scan group from 16 to 4. The justification for this has not been fully stated but will be at some future date. Without a justification, it can be assumed that the same amount of traffic will be carried either way, and the difference will only be in interference-caused losses which may not be very large for systems operated at less than 25% of capacity.

It is now believed workable to allow the maximum segment payload size to be as large as 512 octets. Such a transfer is shown in Figure 4 above for Access-point 2. An important question is whether the allowed time per Access-point should be tightly fitted to the maximum transfer to maximize access opportunities or whether a larger time should be allowed sufficient for additional transactions in the same time allocation. In this illustration, 400 of 450 µseconds are used for the long transfer with long address handshake. The corresponding sequential scan time or access opportunity period is 1.8 milliseconds

The Figure shows a variety of transactions taking place with the 1.8 millisecond scan.