IEEE 802.11
Wireless Access Method and Physical Specification

Title: Tutorial on DFWMAC frame delivery and relay assumptions.

Prepared by:

Wim Diepstraten
AT&T-GIS (NCR)
WCND-Utrecht
Nieuwegein The Netherlands
Tel: (31)-3402-97482
Fax: (31)-3402-97555
Email: Wim.Diepstraten@utrecht.ncr.com

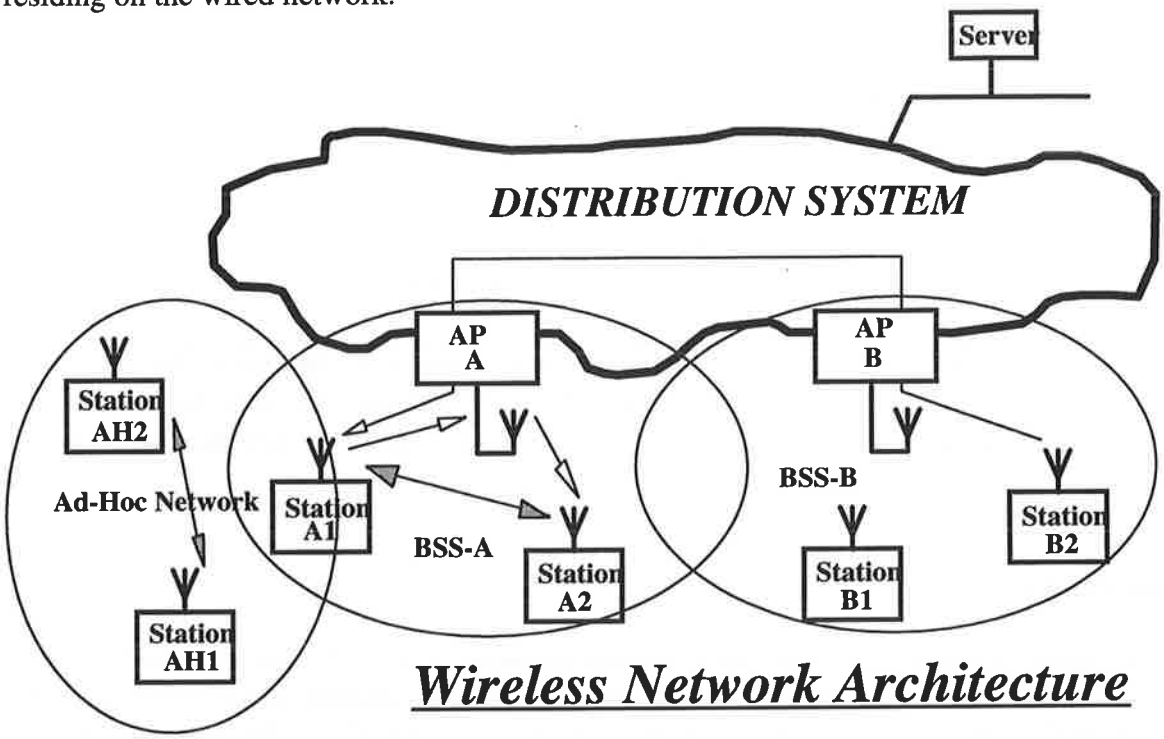
Abstract: This paper is an answer to issue's that arised during the March 94 meeting claiming that the Foundation MAC malfunctions in the area of packet delivery and relay capability. It intends to explain the assumptions of the basic operation of the Foundation MAC in this area.

Introduction:

In the March 94 meeting in Vancouver several proposals were addressing the need to repair potential packet delivery and relay problems in the Foundation MAC. Notably doc IEEE P802.11-94/39 [2] from Motorola and doc IEEE P802.11-94/43 form Lannair are addressing these issue's.
These submissions indicate that the packet delivery mechanism in the Foundation MAC is not well described, and need further explanation. Indeed the packet relay functionality of the AP is not well described. This is partly due to the fact that this function is by some people considered to be part of the distribution system, residing just above the MAC. However it should be seen as a unique functionality of the AP-MAC, residing in the MAC.

Basic Foundation MAC frame delivery strategy.

In an infrastructure based system it is very likely that the whole network exists of several BSS's, interconnected via a wired DS, that consist of or is connected to the wired network. It is very likely that the main shared resources are networked, via servers residing on the wired network.



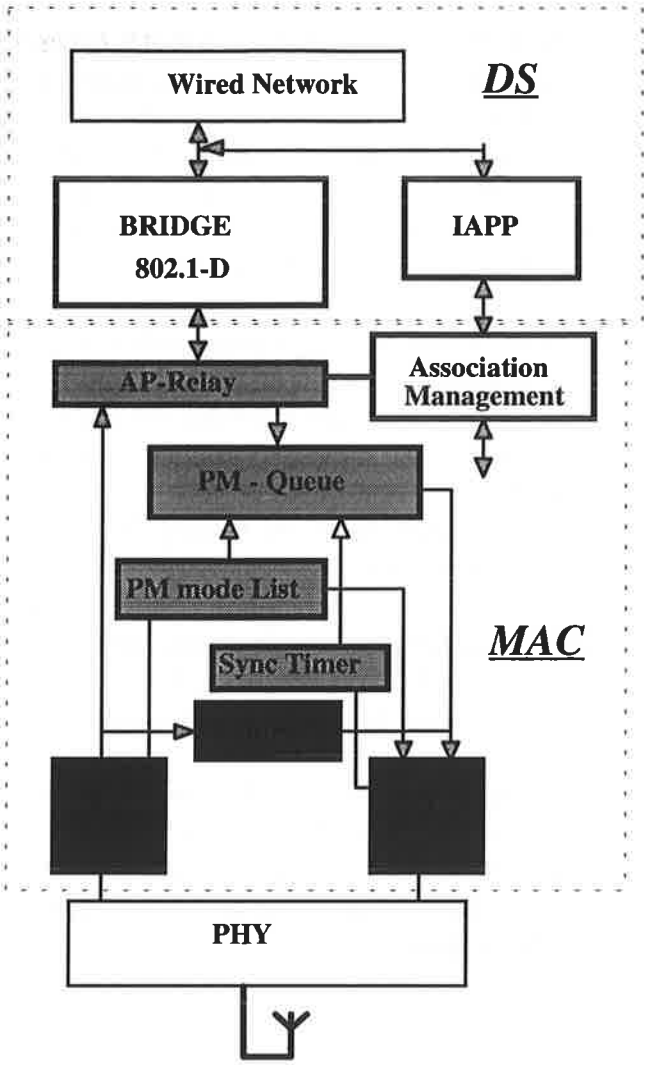
The majority of traffic in such a system will likely be via or to these resources on the wired network. An other type would be direct station to station traffic between any station in any BSS, and between the wireless stations and stations on the wired network. In any event the majority of the traffic will need to go through the AP.
An other very important consideration is that most mobile stations will need to operate in a Power Conservation mode, by turning of their transceiver as much as possible. This Power Conservation Management functionality is a major part of the Foundation MAC. The primary assumption is that an AP is always awake (in CAM mode), and will therefore be able to maintain knowledge of the Power Management state of the individual stations within its BSS. Stations that are themselves operating in a Power Conservation mode, will not be able to maintain that information of all stations that are within that BSS, unless those stations are operating in a "Continuous Active Mode (CAM). Therefor those type of stations can only safely send their frames via the AP, which will relay the frame either through the Distribution System or relay it within the BSS at the appropriate time when the destination station is known to be awake.

Therefore the main assumption of the Foundation MAC is that by default all traffic will go through the AP. Stations can do so always by setting the ToAP bit in the frame header. Stations will receive frames only when the ToAP bit is turned off.

When the ToAP bit is active, then the AP will accept the frame and return the Ack, after which the station can directly send subsequent frames to the AP. Please note that the AP does not need to do any table look-up to determine whether it should acknowledge the frame, because that is directly indicated by the ToAP bit, so no time critical actions are required from the AP. Please note that also broadcast traffic coming from a station with the ToAP bit on would be acknowledged by the AP, and would not be received by the other stations within the same BSS until the AP will retransmit the broadcast frame with the ToAP bit turned off.
As discussed above this is also the best strategy for communicating with stations that are operating in a Power Conservation mode. The impact of this strategy is that some more bandwidth is needed then absolutely necessary, which very much depends on the traffic patterns. Only traffic between end stations within the same BSS could potentionally benefit from direct station-to-station transfers.
This mode of operation is possible in the Foundation MAC, by turning the ToAP bit off. However the station should only use this mode when it knows that the subject destination station is in direct reach within the same BSS, and not operating in a Power Conservation mode. In practise, stations that use a Power Conservation mode themselves, can only maintain this knowledge for stations that are in a CAM mode. Else, if they are continuous awake, they could use extra intelligence to maintain the Power Management state of the stations within reach.
It is an implementation flexibility that stations can implement this mode of operation, but they are not required to do so. The simplest operating mode would be to send all their traffic through the AP by default. Care should be taken during switching from a "via AP" to a direct station-to-station mode, to prevent frame sequencing problems. This can be done by a simple timeout mechanism in the stations.

Frame relay mechanism.

In an infrastructure based system, there will be one AP per BSS, which are interconnected by the DS to form an ESS. When we assume that one likely DS will be build form existing wired LAN's interconnected by MAC level bridges according to 802.1D, then the functional blockdiagram for the AP could look as follows.



All frames received (with the ToAP bit on) will be Acked by the AP, and forwarded through the AP-relay function.

This function needs to recognise whether the destination address resides in the local BSS or not. If not then the frame is forwarded to the Bridge function, else the frame is to be retransmitted by the AP onto the local BSS. The AP-relay function will need to check whether the destination is listed in the association table that is supposedly maintained by the "Association Management" function.

It should be understood that this function is needed, because in a wireless environment full connectivity between all stations within a BSS can not be assumed, and is in fact unlikely.

For broadcast frames received from a local station the functionality is a little different. This frame will be forwarded to the DS, and back to the AP transmitter.

Frames coming from the AP-relay or DS will either be directly forwarded on the medium, or they will be put in the Power Management Queue, when the destination station is known to be asleep. The PM-Queue function will need to examine the Power

Conservation state of the destination by examining the PM mode list. An AP needs to maintain this list for all the stations associated with this BSS. This is needed, because the AP needs to know at all times whether the station is in a Power Conservation mode, so that the AP needs to buffer the frame in the PM-Queue, for later forwarding to the station when it is known to be awake.
Please note that the same list can also be used to maintain other status information on a per station basis, like the bitrate at which the stations can and do operate, or the TxPower level to use to reach this destination. These functions if not part of the standard might be implementation specific functions.

Conclusion:

In the Foundation MAC, stations that operate in a infrastructure mode can default assume that all traffic goes through the AP as indicated by the ToAP bit. The AP will have a non time critical relay function build in to recognise which traffic is to be relayed onto the local BSS, or to be forwarded to the distribution system (DS). This will handle the majority of traffic, and deals automatically with source and destination stations that are operating in a Power Conservation mode. Stations that do operate in a continuous active mode (CAM) have the option to identify which destinations can be reached via direct station-to-station transfers that are possible by turning the ToAP bit off.
Switching from "To-AP" to "To-Station" and visa versa needs to be done in a way to assure that proper frame sequencing is maintained, which can be protected by holding traffic during a timeout period.

References:

[1] DFWMAC Distributed Foundation Wireless MAC Protocol", W. Diepstraten NCR-WCND-Utrecht, G. Ennis Symbol Technologies, P. Belanger Xircom; November 93, IEEE P802.11-93/190. See also P802.11-93/191, P802.11-93/192, P802.11-93/193.

[2] "A packet delivery and Relay Strategy for the Foundation MAC", Mark Demange Motorola; March 94, IEEE P802.11-94/39

[3] "Proposed change to MAC draft: AP-based CTS", Pablo Brenner Lannair. March 94, IEEE P802.11-94/43.

[4] "Draft Standard IEEE 802.11", P802.11 Editors P802.11-93/20b.