Packet Delivery and Relay in the Foundation MAC

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Goals

- Issue 11.5: "Will an Access Point provide relay of packets to other devices in a BSS?"
- Foundation MAC does not specify a detailed definition of how relay of packets should be handled between two out-of-range stations in the same BSS.
- Offer a comprehensive packet delivery strategy which is compatible with the current Foundation MAC.
- Motions:
  - Answer to issue 11.5: "Yes, but only when necessary"
  - Allow direct peer-to-peer communications when possible.
  - Adopt proposed packet delivery strategy

Packet Delivery and Relay

- Packet Relay is actually one aspect of a much broader packet delivery question.
- Three Aspects of the Packet Delivery Problem.
  - Transport of packets between wireless stations and the wireline network attached to the AP.
  - Station-to-Station Communications.
  - Packet Delivery to Power Saving Stations.
- Two Options for Station-to-Station Communication:
  - Direct all traffic through the AP: Very innefficient
  - Allow direct peer-to-peer communications, let the AP provide relay when needed.

Station to Station Communications

- All Stations required to be in range of the AP.
  - Synchronization
  - Association
- All stations not necessarily within range of each other.
- Foundation MAC needs to define a means for relaying packets between out-of-range stations.
- Source stations do not know if the destination station is in range or not.
- AP does not know if a destination is in range of the source.

Delivery to Sleeping Stations.

- Stations excercising power management go periodically in and out of "sleep" mode.
- When "sleeping," stations can neither transmit nor receive.
- Stations cannot reliably track sleep status of other stations.
- AP must attempt to track sleep status.

Proposed Packet Delivery Strategy

- Allow direct communication when possible
- AP intervenes to relay a packet only when necessary.
  - Source station requests relay on a packet-by-packet basis.
  - AP buffers and relays packets destined for sleeping stations.
- Fully compatible with Foundation MAC's channel access procedure.
- Makes use of the currently defined "From AP" and "To AP" bits.
- Adds a "relay bit" to the Control field of the Fixed Header

Relay by Request to an Awake Station

- Station 1 out of range of Station 2

Step 1: Fragment Window Followed By No Ack

- Station 1 requests Relay

Step 2: Fragment Window Relay = True, Fm = False

Step 3: Acknowledgment Relay = True, Fm = True

- Repeat Step 2+3 until entire packet delivered to AP

Relay by Request to an Awake Station (continued)

- AP Delivers packet to Station 2

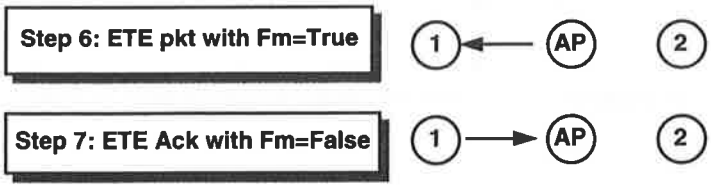
Step 4: Fragment Window Relay bit = True, Fm = True

Step 5: Acknowledgment Relay = True, Fm = False

- Repeat Step 4+5 until entire packet delivered to Station 2

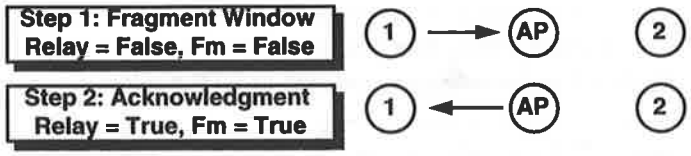
Relay by Request to an Awake Station (continued)

- AP sends ETE packet to Station 1
  - Fm bit = True
  - Relay bit:
    - » True if relay was successful
    - » False if relay was unsuccessful
- Station 1 acknowledges receipt of ETE packet

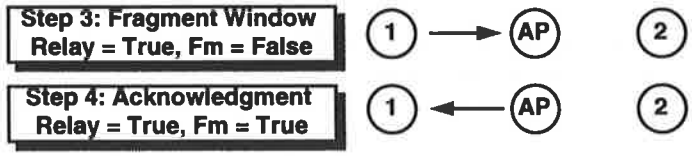


Relay to an Asleep Station

- AP believes Station 2 asleep
- Accepts packet and Acks after PIFS interval.



- Station 1 now directs remaining fragments to AP



- Repeat Steps 3+4 until entire packet is delivered to AP

Relay to an Asleep Station (continued)

- AP Delivers packet to Station 2.

Step 5: Fragment Window Relay = True, Fm=True

Step 6: Acknowledgment Relay = True, Fm = False

- Repeat Step 5+6 until entire packet delivered to Station 2

Relay to an Asleep Station (continued)

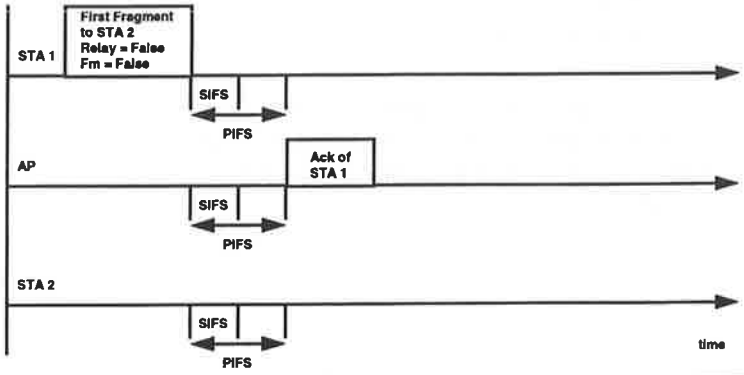
- AP sends ETE packet to Station 1
  - Fm bit = True
  - Relay bit:
    - » True if relay was successful
    - » False if relay was unsuccessful
- Station 1 acknowledges receipt of ETE packet

Step 7: ETE pkt with Fm=True

Step 8: ETE Ack with Fm=False

Relay to Sleeping Stations: Prevention of simultaneous acknowledgments

- AP thinks Station 2 is asleep + Prepares to Ack.
- If SIFS Interval is clear, AP will acknowledge after PIFS



Bits in headers of packets and acks

- "From AP" bit
  - indicates that packet is being transmitted by AP
- "Relay bit" in a packet
  - Allows source station to request relay from the AP
  - Allows AP to indicate that packet originated from another station, not the wireline network
- "Relay bit" in an Ack
  - Allows destination station to direct ack back to AP only
  - Allows AP to indicate that destination of packet was either:
    - » on the wireline network
    - » another station in the BSS

Rules for Station to Accept Packets and Transmit Acks

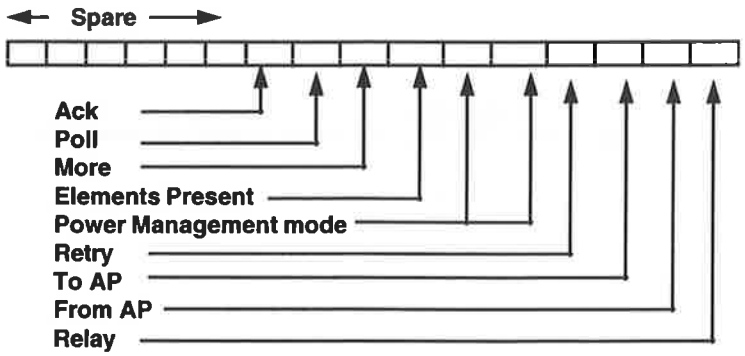
- Accept Packets if:
  - destination address is your own or multicast
    AND
  - (relay = false) OR (Fm = true)
    AND
  - NID is your own
- I.e.:
  - Ignore packets with relay = true and Fm=false
  - Ignore acks with relay = true and Fm=false
- Set relay bit in Ack equal to relay bit in received packet.

Rules for AP to Accept Packets and Transmit Acks

- Accept Packets if:
  - destination station is not associated with this BSS
    OR
  - destination station is asleep
    OR
  - relay = true in the received packet
- Always set Fm = true in Ack.
- Set relay = true in Ack if:
  - received packet is destined for another station within BSS (i.e., RF relay is required).

Header Formats

- Control field: Add relay bit



Frame Formats

- ETE Packet
  - Consists of Fixed header + NID + Dest + SRC +CRC
  - (Source + Dest refered to source and dest stations)

Frame Formats

- ETE ACK
  - Consists of Fixed header +NID + Dest + SRC +CRC

Conclusion

- Proposed Packet Delivery Strategy.
  - Direct Station-to-station communications
  - AP relay only when necessary
- Relay between out of range stations.
- Relay to power management stations.
- Fully compatible with Foundation MAC.

Motions

- Allow direct station-to-station communications in a BSS with an AP.

Motions

- Permit AP to relay a packet only when necessary.
  - when destination station is out of range of source.
  - when destination station is asleep.

Motions

- **Adopt packet delivery and relay strategy proposed in P802.11-94/39 as a basis for inclusion in the draft standard.**