Multi Rate Support in the MAC

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Multirate status:

- Doc 94/164 did analyze the MAC Multi rate Issue's
  - Analyzed the configuration requirements.
    - » Need to support mixed bitrate per BSS.
  - Analyzed interoperability issue's.
    - » All Broadcast / Multicast must be at common rate.
  - Analyzed coexistance issue's.
    - » All Control frames must be at common rate.
    - » Allows proper NAV updates in whole BSS.
- Doc 94/164 further proposed definitions and mechanisms.
- Doc 94/234 did identify a patent infringement issue.

Multirate support levels:

Doc 94/164 provisions can be subdivided in:

1-Definition of the Basic_Rate_Set and the rules that assure coexistence and interoperability in a mixed bitrate environment.

2-Provisions to gather / distribute "Rate Capability" information.

3-Rate negotiation per frame procedure.

- Level 1 is the minimum support level needed.
- Level 2 is desirable.
- Level 3 appears to be sufficient close to the patented subject matter that the mechanism has been deleted.

Level-1 Basic Definitions:

- ESS_BASIC_RATE_SET:
  - A set of rates that all the stations on the given ESS are capable of receiving.
  - According to the PHYs definitions the default ESS_BASIC_RATE_SETs for the different PHYs will be:
    - » For DS: {1 Mbps, 2 Mbps}
    - » For FH: {1 Mbps}
    - » For IR: {1 Mbps, 2 Mbps}
- STATION_BASIC_RATE:
  - A value belonging to the ESS_BASIC_RATE_SET, that is used by the station for its transmissions.

Level-1 Basic Definitions (cont):

- EXTENDED_RATE_SET:
  - The set of rates beyond the ESS_BASIC_RATE_SET that a station supports, this could in the future be {1,2 and future x Mbit/s} for any of the existing plus future PHYs.
  - Example for the current FH this would be {1 Mbps and 2 Mbps}.
- PLCP_RATE:
  - The rate used for transmitting the PHY preamble, and PLCP header.
  - This is transparent to the MAC, but must be the same for all stations in the ESS.
  - This assumption is already implemented on all the current PHY proposals.

Level-1 Basic rules:

- The Preamble and the PLCP Headers are always transmitted at the PLCP_RATE.
- The IFS specifications are station bitrate independent and specified per Phy type.
- All the Multicast and Broadcast Messages are sent at one of the STATION_BASIC_RATE set speeds.
- All Control frames (RTS / CTS / Ack etc.) are sent at one of the STATION_BASIC_RATE set speeds.
- "Duration" field is specified in time (usec). This is already in the 802.11 Draft.
- All unicast data frames can be sent on any available Tx-rate.

How is the rate selected?

Multiple approaches possible:

- Transmitter to determine rate (Does not require interaction with the receiver).
  - Tx-only decision based on gathered information.
  - Decide on station characteristics (Power Save mode).
  - Or decide on link condition.

Example:

- Unicast Data Frames are sent on any rate as selected by the transmitter.

  The algorithm for selecting this rate is implementation specific.
  - Some trivial algorithms could be:
    - » Try high, retransmit on lower (go back to high after T time).
    - » Keep fixed tables for each peer.
      - Active query using management Supported_Rate Request/Responses
    - » Keep dynamic tables for each peer using a signal quality (or any other parameter) dependent algorithm.
    - » And, obviously, transmit always in BASIC_RATE.

What is needed:

- To allow rate switching, the transmitter should know:
  - The Supported Rates of the local PHY.
  - The Supported Rates of the destination PHY.
  - Link quality, Power Saving, or other relevant condition if dynamic switching is used (implementation specific).

Level-2 Hooks required:

- Define a "Supported_Rate" MIB variable.
- Include "Supported_Rate" field in:
  - The "Association Request"
    - » It indicates the Rate capabilities of the requester.
  - The "Association Response"
    - » It indicates the Rate capabilities of the responder.
  - In Management Type Request and response Frames to query the capabilities of the destination.
    - » Indicates the Rate capabilities of the requester, and requests a response indicating the remote Rate capabilities.
- The "Supported_Rate" indicates all speeds that the sender is able to receive.

How is the NAV updated:

- RTS / CTS / Ack frames are send in BASIC_RATE.
  - No NAV update problem.
- Situation for fragmented frames:
  - Ack (with CTS function) is transmitted at the BASIC_RATE.
  - Not all Stations can understand the duration field in the data frame (indicating the NAV update for the next fragment), but Physical CS will assure deferal.
  - The returning Ack can suffer from the "Hidden Station" problem.
- This problem is unrelated to the mixed rate situation, and basic to the MAC (need type specific DIFS specification).
  - Has been detected also in the DTBS proposal.
  - Is also present when RTS/CTS is not used.
  - Same effect occurs when RTS or Data frame has CRC errors.
- Solution is provided in a separate submission.

Effect on CCA for different speeds:

- Assumptions about the CCA function:
  - Current PHY's use "Length" to aid in "End Delimiter detection".
  - "Length" and "Rate" are encoded at the common PLCP rate.
  - Use "Length" (and "Rate") to control CCA indication, independent of the modulation used in the Payload area.
- Suggest to code the "Length" and "Rate" in a way that current stations can interprete (future) extended rate headers to determine the "CCA Duration".
  - Preferably this specification should be bitrate independent.
  - An example could be to specify "Length" in terms of the PLCP header symbol rate.

IPR situation:

- Applicability of the '236 patent:
  - Level 1 provisions are definitial and unrelated to the coverage of the cited patent.
  - Rate Negotiation has been deleted, because it was sufficiently close to the subject matter.
  - "Rate Capability" knowledge distribution is changed such that coverage is avoided.
    - » Exchange of Rate Capability information between multiple peer MAC entities needs to be avoided.
    - » In Infrastructure the "Rate Capability" exchange is between a station and the Distribution Services above the MAC.
    - » In ad-Hoc the "Rate Capability" distribution is to be done above the MAC by mechanisms that can access the "Rate Capability" MIB variable.
- Conclusion is that described method does avoid the mechanism as described in the '236 patent.

Summary:

- To support Multiple Rate ESSs in a flexible way, we need to specify:
  - The level-1 definitions.
  - The level-1 basic rules.
- To allow distribution of the "Supported Rate" capabilities:
  - A "Supported_Rate" MIB variable.
  - "Supported_Rate" element / field in (Re-)Association request and responses.
  - "Supported_Rate" element / field in a Probe Request / Response Management frame.

Motion:

Move:

To adopt the recommendations in 94/247b as the basic mechanisms for the support of Multi rate Phy's in the MAC and change section 9.1.4.17, section 9.1.3.2, and section 9.1.2 to replace BSS by ESS.

passes 41/12/12