

## Multi Rate Support in the MAC

By: R. Valadas - University of Aveiro,  
B. Dobyms - Photonics,  
W. Diepstraten - AT&T GIS,  
P. Brenner - LANNAIR

## Why Multiple Rates?

- **Extensibility**
  - Migration Path to future higher rates.
  - We want to re-use the current spectrum for the future rates.
- **Speed/Range Tradeoff**
  - Providing the best speed on all the area will be difficult or expensive to the customer. The user will prefer that some areas would be served with a different Quality of Service, rather than having "black spots".
- **Speed/Power Consumption Tradeoff**
  - IR case: higher rates transmission consume more power, hence the AP may transmit in high rates, while the stations may choose lower rates.

## Possible Configurations

- **Fixed Rate for ESS**
  - Not recommended because it restricts ESS to use a single PHY. This limits migration to a complete new network and infrastructure.
  - Would still have an ESS overlap problem.
- **Fixed Rate for BSS**
  - Would require overlapping BSS's on the different speeds.
  - The NAV will not work when BSS's of different rates overlap.
  - Therefore this is not recommended.
- **Multi Rate BSS**
  - Need a way to resolve the NAV update issue.
  - This is the recommended approach.

## MAC Concerns to be analyzed:

- **Control Packets (Probes, Beacons, etc) must be heard by all stations**
- **Multicast/Broadcast must be heard by all stations**
- **How does a station know which rate to use for transmission?**
- **How do stations update their NAV for transactions in other speeds?**
- **What is the effect of fragmentation.**
- **How are hidden-stations affected?**
- **How does CCA work for different speeds?.**
- **How are Contention Free Services Affected?**
- **What hooks are needed?**

## Basic assumptions / definitions:

- **BSS\_BASIC\_RATE\_SET:**
  - A set of rates that all the stations on the given BSS are capable of receiving.
  - According to the PHYs definitions the default BSS BASIC RATE SETs for the different PHYs will be:
    - » For DS: {1,2}
    - » For FH: {1}
    - » For IR: {1,2}
- **STATION\_BASIC\_RATE:**
  - A value belonging to the BSS BASIC RATE SET, that is used by the station for its transmissions.

## Basic assumptions / definitions (cont):

- **EXTENDED\_RATE\_SET:**
  - The set of rates beyond the 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.
- **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 BSS.
  - This assumption is already implemented on all the current PHY proposals.

### Assumptions:

- The Preamble and the PLCP Headers are transmitted always at the PLCP\_RATE
- SIFS, PIFS, DIFS are the same for the whole ESS.
- All the Control, Multicast and Broadcast Messages are sent at one of the STATION\_BASIC\_RATE set.
- All RTS/CTS are sent at one of the STATION\_BASIC\_RATE set.
- The RTS/CTS "duration" field is specified in time (usec). This is already in the 802.11 Draft.

### 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.
- Negotiate rate using the RTS/CTS exchange.
  - This requires Tx-Rx interaction.

Recommend to allow both mechanisms

### 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 rate of the local PHY.**
  - **The supported rate of the destination PHY.**
  - **Link quality, Power Saving, or other relevant condition if dynamic switching is used (implementation specific).**

---

**Multi-Rate support in the MAC**

IEEE P802.11-94/164a

Slide 11

---

**Hooks required:**

---

- Define a "Supported\_Rate" Element to be included in:
  - The "Association Request"
  - The "Association Response"
  - The "Beacon" (usefull for the Ad Hoc networks)
  - Request / Response Management frame to query the capabilities of a destination.

---

**Multi-Rate support in the MAC**

IEEE P802.11-94/164a

Slide 12

---

**Hooks required:**

---

- To support rate negotiation, the following elements are defined.
  - "Requested\_Rate" in RTS Frame
    - » Indicates the rate that the sender wants to transmit the data.
  - "Granted\_Rate" in CTS Frame
    - » Set to "Requested\_Rate" if supported and conditions allow, or BASIC\_RATE if not.

### How is the NAV updated:

- **RTS/CTS messages 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, but Physical CS will assure deferral.

### Hidden station effects:

- **The CTS function (Distribute duration around the receiver) is working fine.**
- **The RTS function (Distribute duration around transmitter) has a potential problem.**
  - NAV is not or incorrectly updated.
  - Stations will hear this transmission and do properly defer until DIFS after !CCA drop.
- **The danger is that the Ack gets jammed by those stations that are outof Rx range.**
- **This problem is basic to the MAC and unrelated to the rate switching (need  $DIFS > 2 * SIFS + Ack$ ).**
  - 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.

## Multi-Rate support in the MAC

IEEE P802.11-94/164a

Slide 15

**Effect on CCA for different speeds:**

- **Assumptions about the CCA function:**
  - Current PHY's use "Length" to aid in "End Delimiter detection".
  - "Length" is encoded at the common PLCP rate.
  - Use "Length" to control CCA indication, independent of the modulation used in the Payload area.
  
- **Suggest to code the "Length" in "Time"(usec) rather than bits/octetes.**
  - This makes it bitrate independent.
  - Rate Coding for future speeds can freely be defined in future standards.

## Multi-Rate support in the MAC

IEEE P802.11-94/164a

Slide 16

**How is Contention Free affected:**

- **Contention Free services are not affected:**
  
- **CF-Ack to be transmitted at the BASIC\_RATE.**
- **The Poll Messages are sent in BASIC\_RATE, and NAV operation of hidden stations (or stations not supporting the transmitted rate) is guaranteed by the stations setting their NAVs to the Maximum CF-Burst length.**



## Multi-Rate support in the MAC

IEEE P802.11-94/164a

Slide 17

**Summary:**

- To support Multiple Rate BSSs in a flexible way, we need to specify:
- "Supported\_Rate" element.
  - In Association, Beacon and Mngt Request/Response PDU's.
- "Requested\_Rate" element / Field (in RTS)
- "Granted\_Rate" element / Field (in CTS)
- And a simple set of rules defined above.

## Multi-Rate support in the MAC

IEEE P802.11-94/164a

Slide 18

**Motion:****Move:**

**To adopt the recommendations in 94/164 as the basic hooks for the support of Multi rate support in the MAC.**

---

**Multi-Rate support in the MAC**

IEEE P802.11-94/164a

Slide 19

---

---

**Multi-Rate support in the MAC**

IEEE P802.11-94/164a

Slide 20

---