Analysis of 802.11 Multirate Throughput

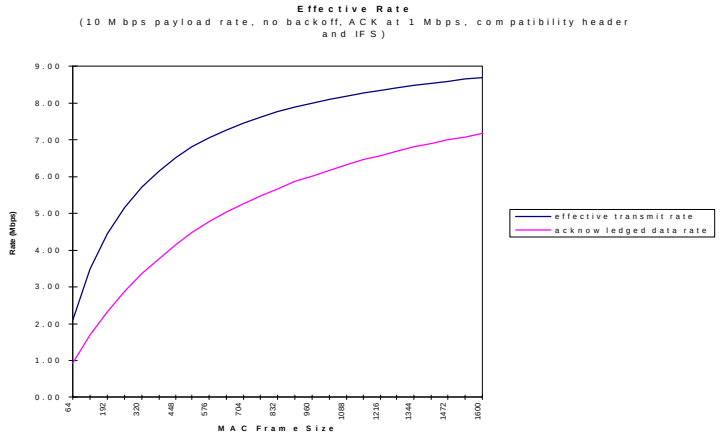
Effective Transmission Rate

- **For a single acknowledged frame:**

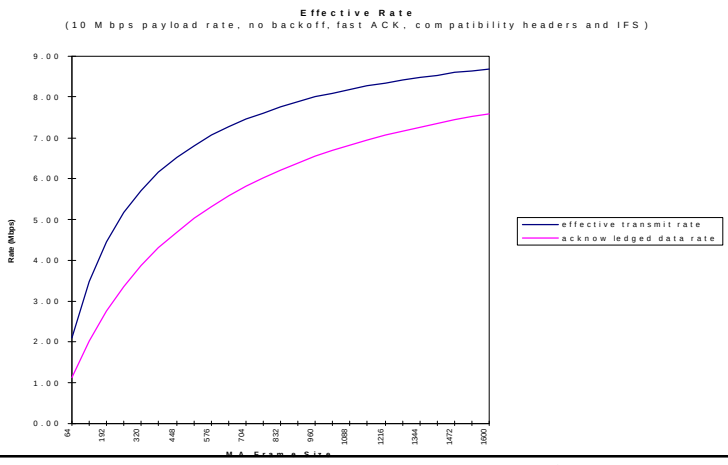
$$R_{effective} = \frac{Length_{frame}}{2\times\left(R_{header}\times Length_{header}\right)+R_{frame}\times Length_{frame}+t_{IFS}+R_{ACK}\times Length_{ACK}}$$

Method of Operation	R_{header}	R_{frame}	R_{ACK}
Full Compatibility	1 Mbit/s	10 Mbit/s	1 Mbit/s
Modified Compatibility	1 Mbit/s	10 Mbit/s	10 Mbit/s
Medium Efficient	10 Mbit/s	10 Mbit/s	10 Mbit/s

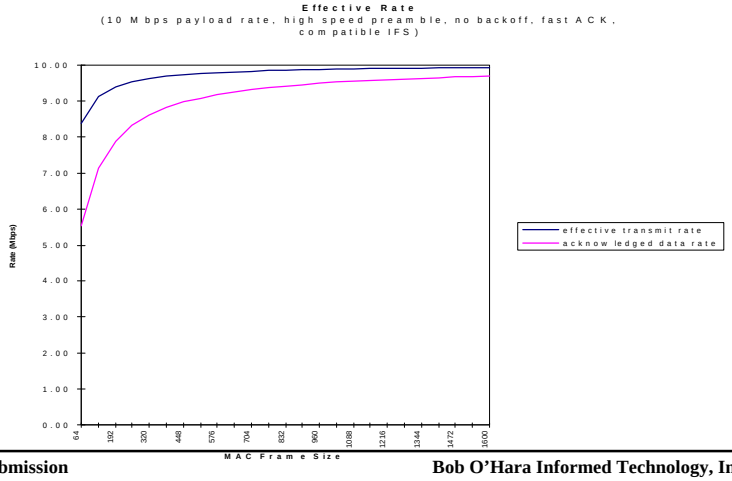
Single Frame - Compatibility



Single Frame - Modified



Single Frame - Efficient



Effect of Contention

- **Determining the time spent in backoff:**

$$t_{backoff} = t_{slot} \times \sum_{i=1}^{n} \left(p_{collision}^{i} \times \frac{CW_i}{2} \right)$$

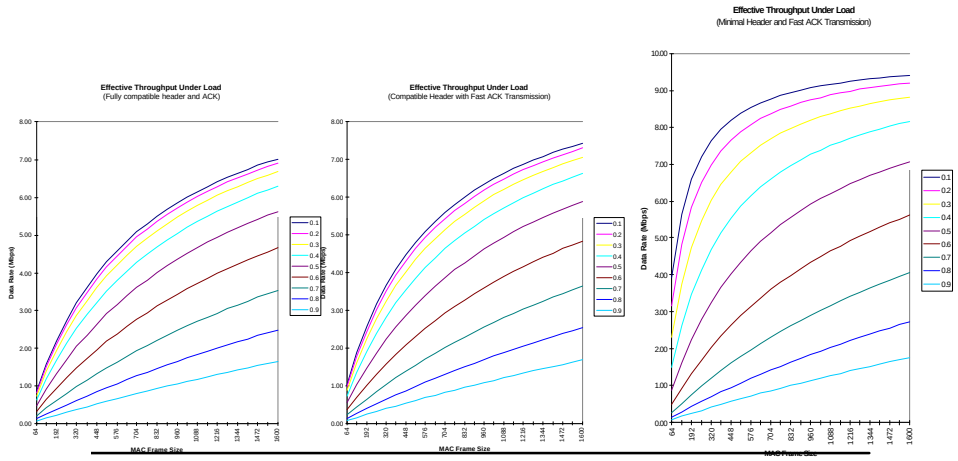
  - **Where:**

    t_{slot} is the slot time,

    $p_{collision}$ is the probability of collision, and

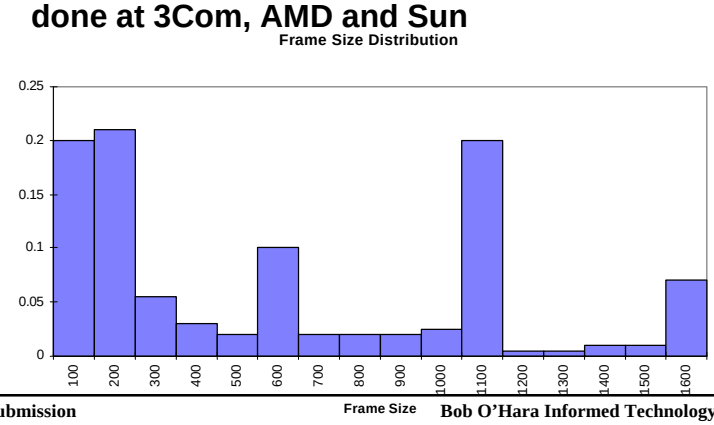
    $\frac{CW_i}{2}$ is the mean number of slots chosen in the *i*th backoff.

Effect of Contention



Bring in the Real World

- **Workgroup frame size distribution, from work done at 3Com, AMD and Sun**

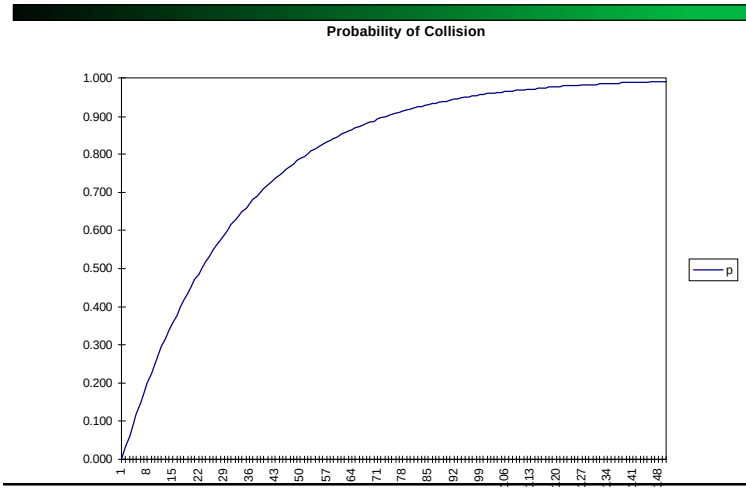


Total Throughput in a BSS

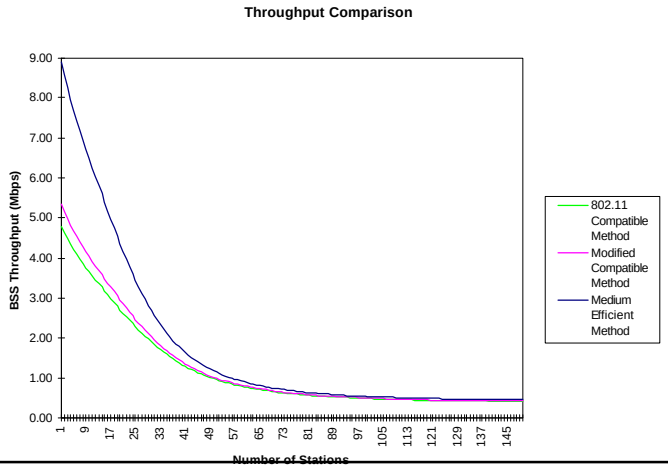
- Using the mean frame size from the workgroup distribution (607 bytes)
- Combining equations for effective transmit rate and probability of collision
- Determining probability of collision based on number of competing stations in a BSS:

$$p = 1 - p' = 1 - \left(1 - \frac{1}{CW}\right)^n$$

Probability of Collision



Mean Throughput in a BSS



Conclusion

- The current multirate mechanism in 802.11 fails to deliver the benefits of using higher rates at the physical layer
- A PHY that does deliver the benefits of higher PHY rates is desirable
- Suggestion: design a PHY that delivers both compatibility AND efficiency by being modal:
  - Standalone mode: highly efficient
  - Compatibility mode: backward compatible