

Is the 802.11 MAC sufficient for wireless high speed mesh LANs?

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This version has been edited for publication as
PDF file at ComNets, RWTH Aachen
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Some animations may not be displayed
correctly in PDF format.

Please see <http://802wirelessworld.com> for
the original version in PowerPoint format.

802.11 Basics

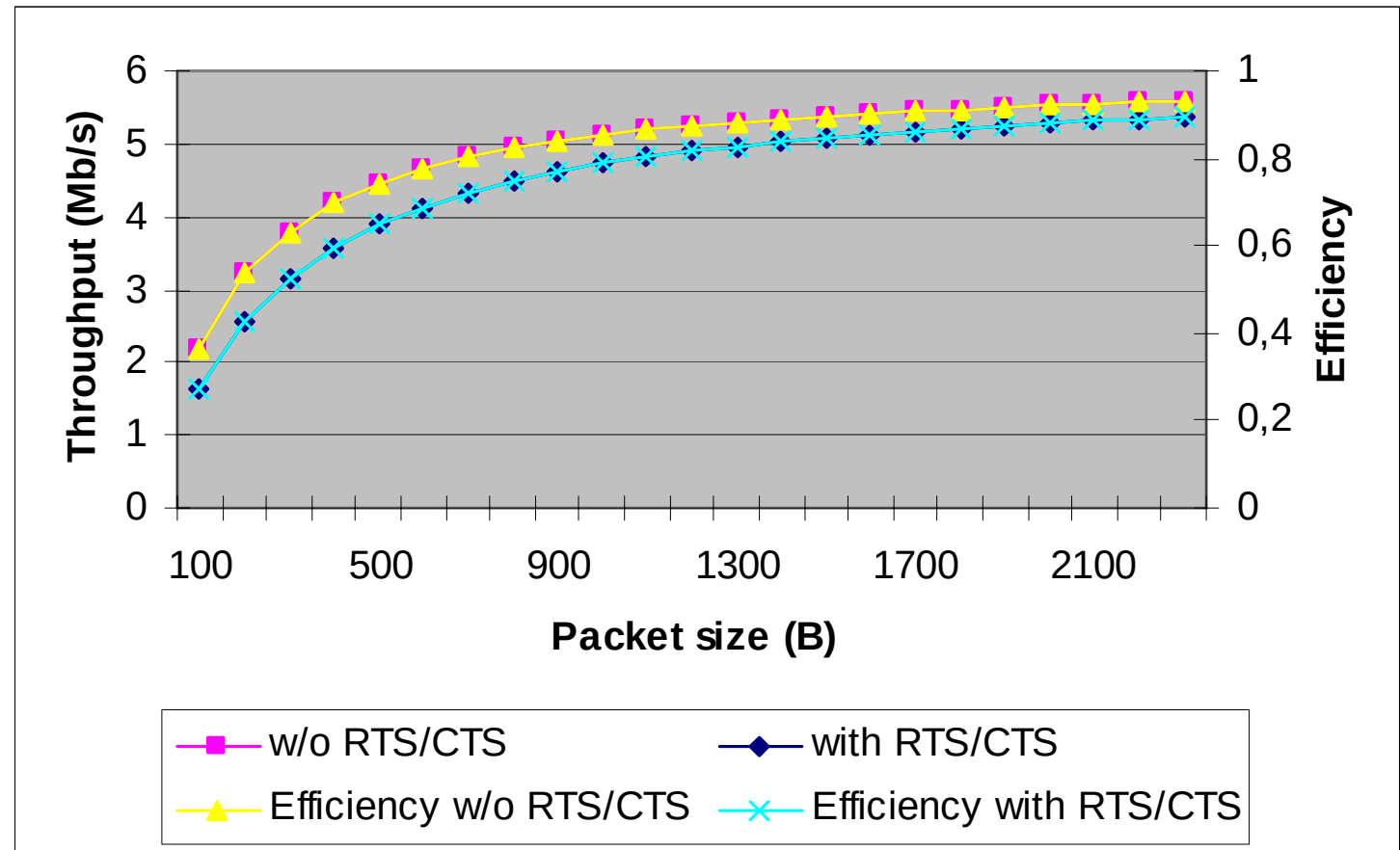
- Fixed interframe spaces (IFSs)
 - aSlot, SIFS
 - All IFS others are sums of the above
- Multiple PHY modes
 - E.g. 802.11a, 802.11b, 802.11g
 - IFS constant for all PHY modes within same standard
 - 802.11 relies here on

Basic calculations

- Simple scenario
 - One receiving station, one transmitting station
- Backoff duration equal to $\text{DIFS} + 7.5 * \text{aSlot}$
- Error free wireless medium

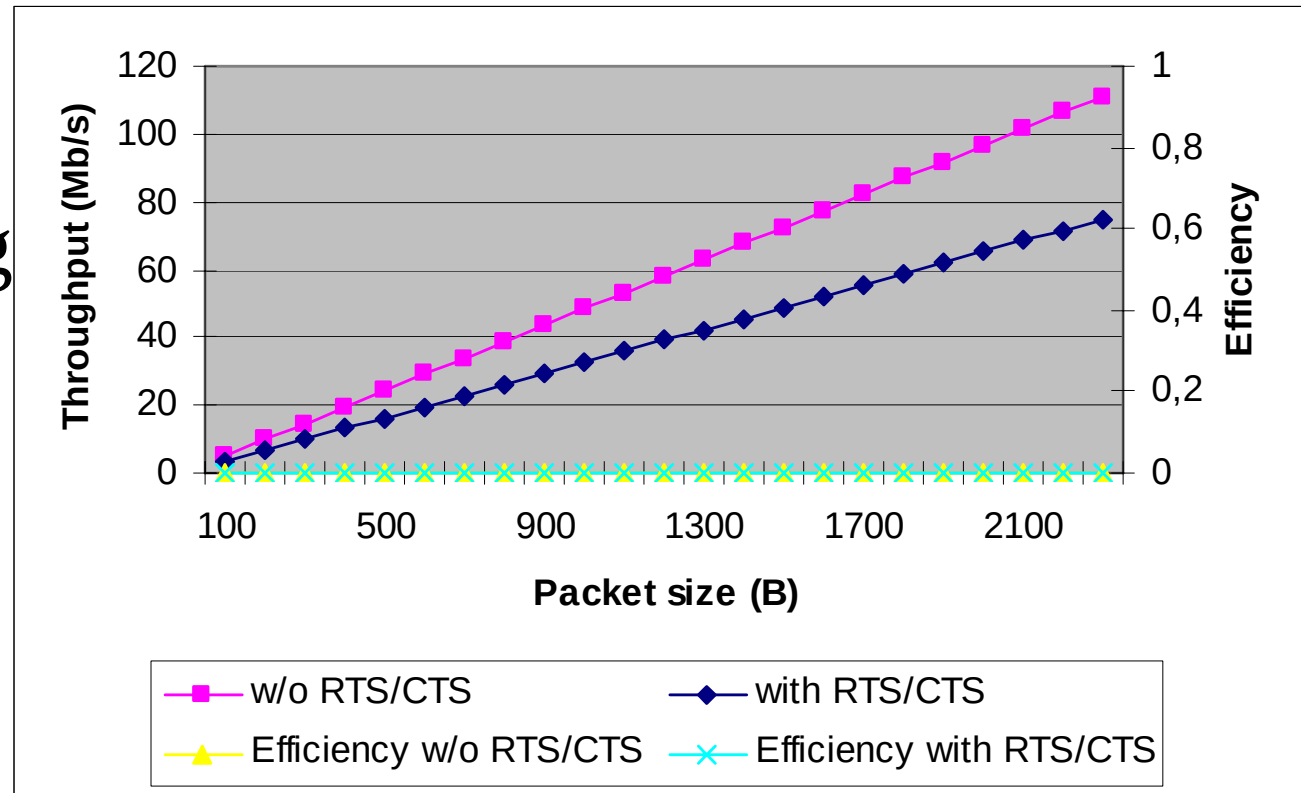
PHY efficiency

- 802.11a
- BPSK $\frac{1}{2}$
- Highly efficient



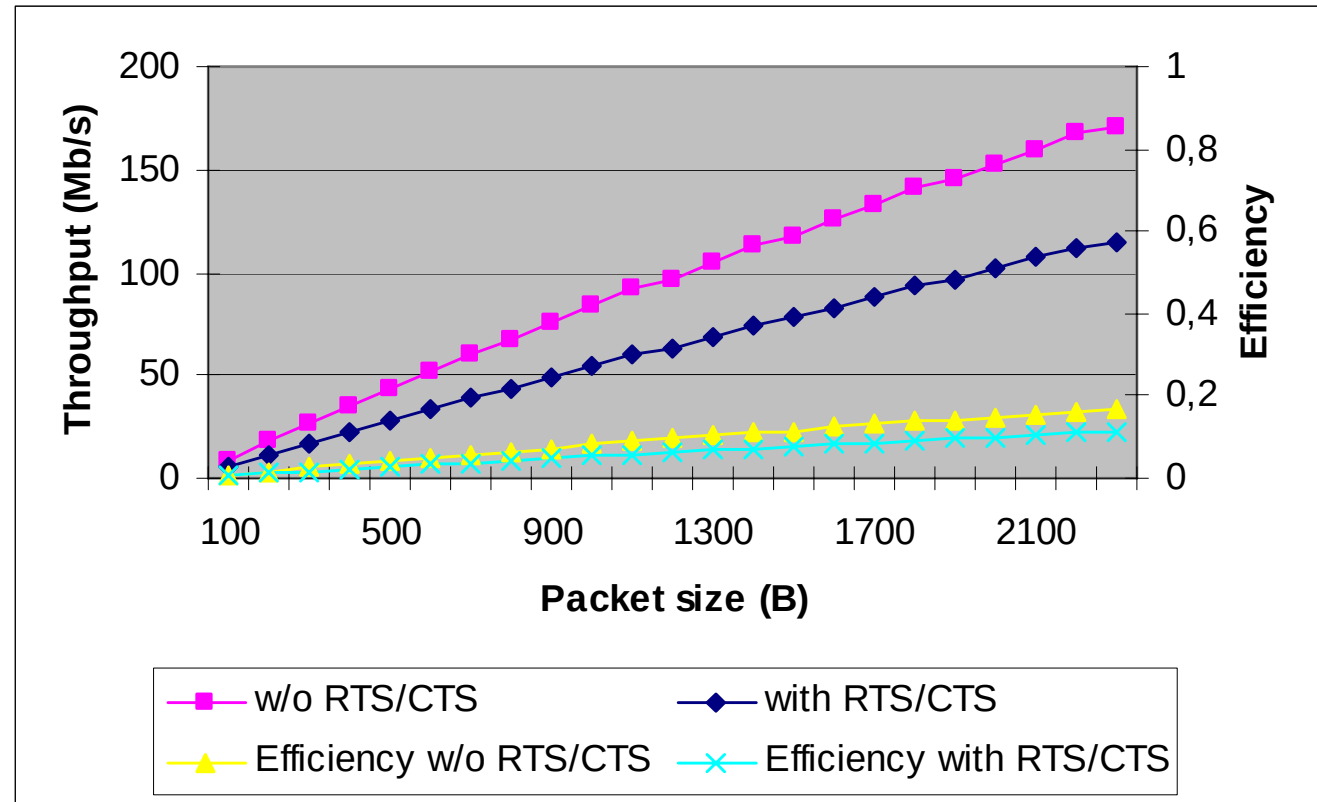
IFS limiting throughput

- OFDM PHY
- IFS according to 802.11a
- Assuming infinite PHY speed



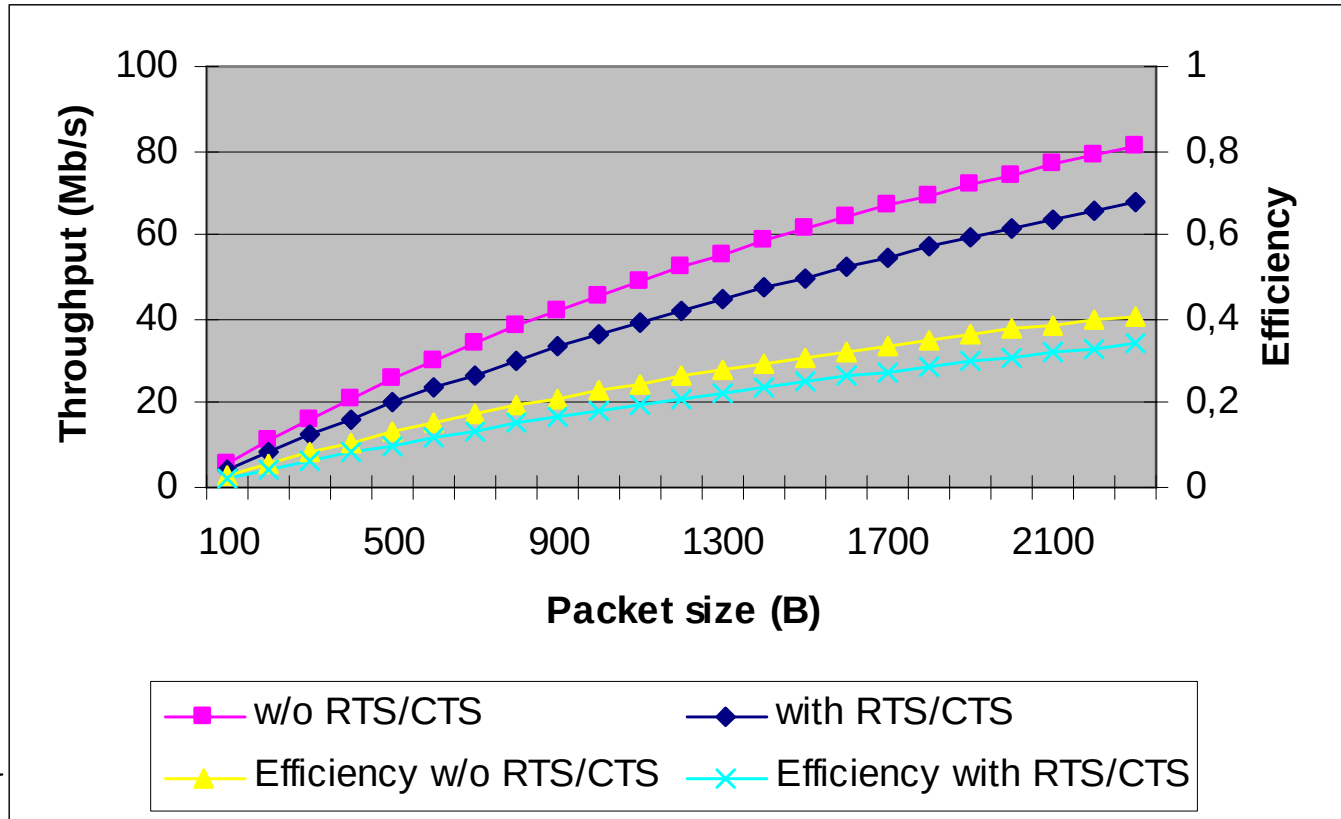
Assuming new PHY

- OFDM based
- Preamble = $12\mu\text{s}$
- Header = $3\mu\text{s}$
- tSYM = $3\mu\text{s}$
- aSlot = $4\mu\text{s}$
- SIFS = $8\mu\text{s}$
- 1024Mb/s PHY



802.15.3a PHY

- OFDM based
- Preamble = $9.375\mu\text{s}$
- Header = $2.188\mu\text{s}$
- tSYM = 312.5ns
- aSlot = $10\mu\text{s}$
- SIFS = $10\mu\text{s}$
- 200Mb/s PHY



Performance problems

- Static overhead (e.g. OFDM)
 - Independent of PHY speed (IFS etc.)
- Protocol overhead
 - One ACK per one DATA frame
 - 802.11e Block ACK very important to increase efficiency!
 - Often transceiver turnaround
 - Duration limited by hardware
- Constant preamble duration (OFDM)
 - Can be become quite large compared to DATA

Design issues for future MAC

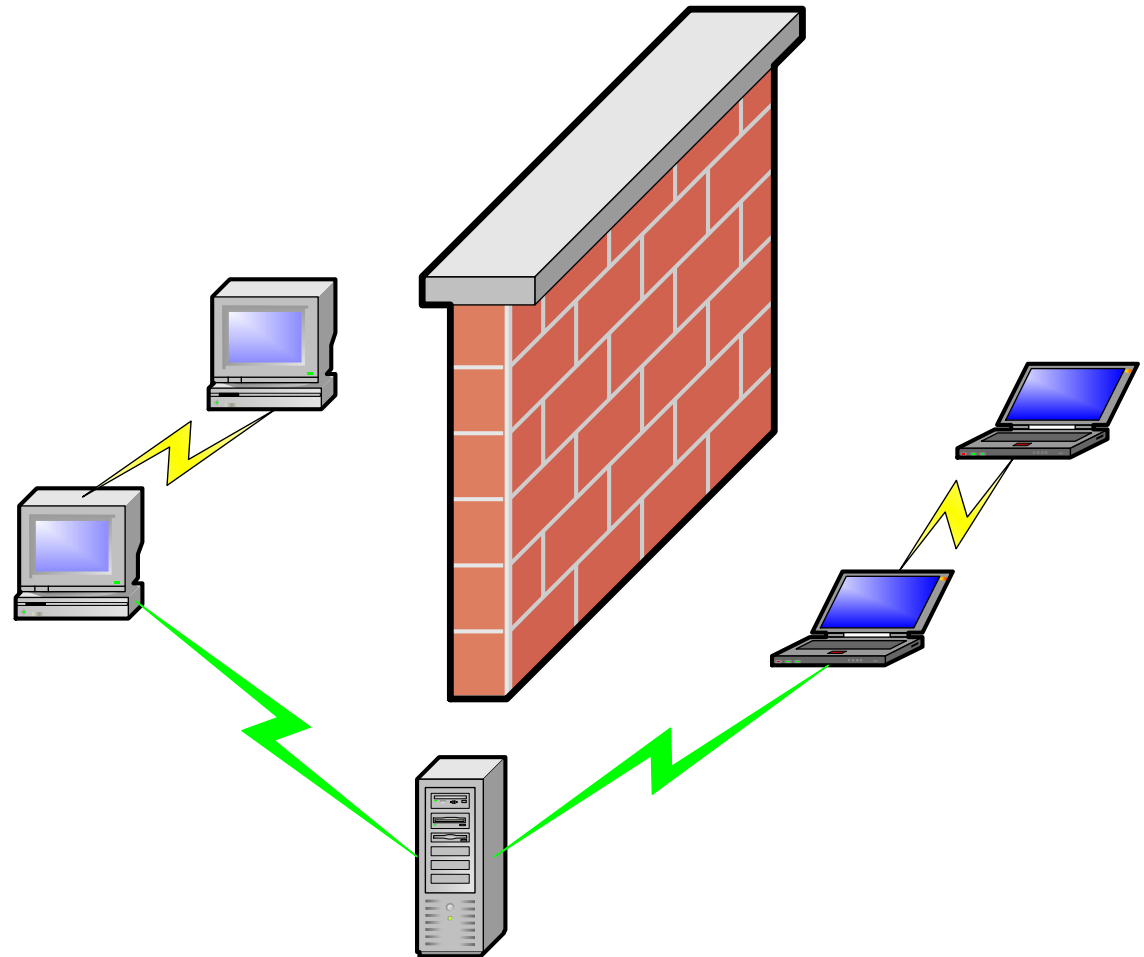
- Idle channel is unused capacity
- Develop collision free MAC
- Avoid signaling for channel competition
- Piggyback additional information
- Use all available information
 - Channel busy histogram (11-03/340r1a)
 - Listen to neighbors
 - QoS sensitive traffic may be “predictable”
 - RTS but no CTS reception enables parallel transmission

MAC design for high speed PHY

- Higher data rate → lower reception range
- Much bandwidth at high frequencies
 - High attenuation, especially walls etc.
- Avoid small frames
 - Concatenate frames
 - Multiplex data
- Interference range determined by transmission power
 - Regardless of PHY mode
- Incremental redundancy
 - Always highest PHY
 - Combine retransmitted & failed frame

MAC regarding high attenuation

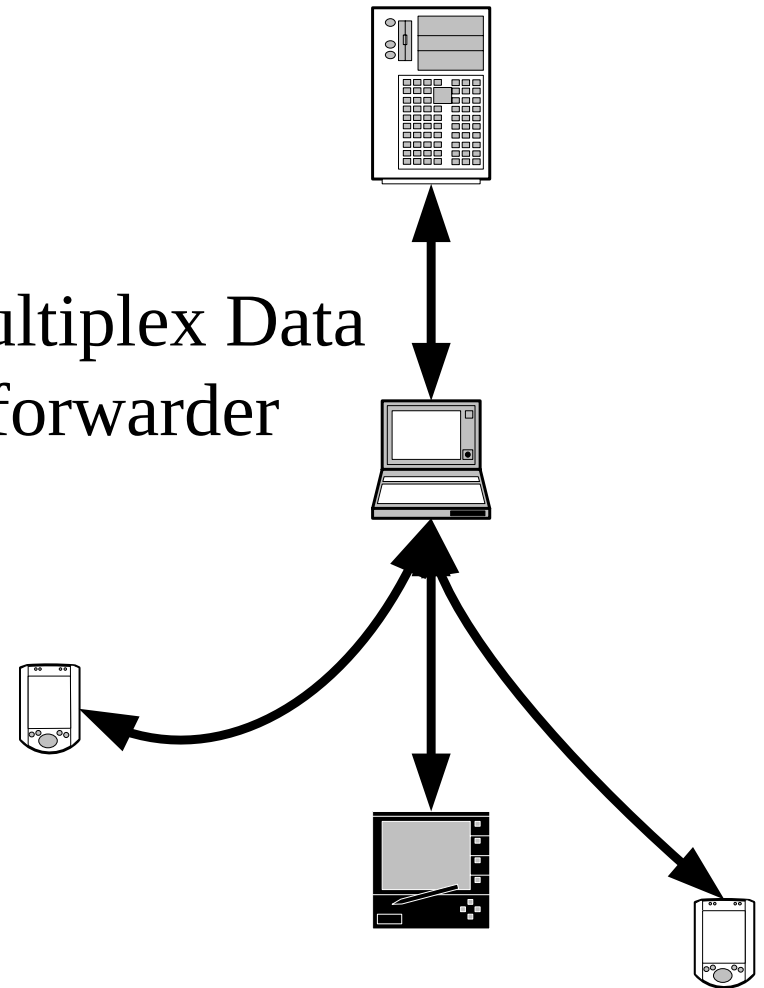
- Use attenuation to the benefit
- Spatial reuse possible
- Multi hop support needed
 - High speed links with limited range



Multi hop MAC issues

- Avoid hidden station problem
- Avoid “Neighborhood capture” (11-01/596r1)
- Mux data on streams
 - Avoid separate transmissions on same route

Multiplex Data
at forwarder



Multi hop needs routing

- No information exchange between layers
- MAC layer routing instead L3 routing
- New routing aware of
 - PHY mode
 - Transmission power
 - Interference level, etc.

Layer 3 → ISO/OSI: Internet: Wired BGP OSPF etc.	Routing Network Layer IP Wireless DSDV (proactiv) AODV (reactiv) TORA (pro-/reactiv)
Layer 2 → ISO/OSI: Internet: Wired CSMA/CD, Full-Duplex (switching)	Medium access Data Link Layer MAC Wireless CSMA/CA Half-Duplex (collision)
Layer 1 → ISO/OSI: Internet: Wired Twisted Pair Fibre Link Coax cable	Data Circuit Physical Layer PHY Wireless DSSS FHSS OFDM

MAC regarding higher layers

- WLAN drawbacks on TCP
 - TCP transmission window
 - MAC retransmissions
- Terminate TCP at AP
 - Possible? Connection tracking? How to replace TCP on wireless link?
- WLAN aware of applications?
 - VoIP
 - Discard than retransmit
 - Concatenation of frames

Conclusions

- 802.11 MAC worked very well
 - Highly efficient at low speed PHY
 - Drawbacks at high speed
 - Today's "ethernet" (802.3) is switched
 - WLAN is different
- Future WLAN will need new MAC
 - Support for multi hop, MAC routing
 - Increased efficiency
 - Avoid "legacy" backoff

Thank you for your
attention

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