

# Tx-Power Control Provisions in the MAC

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IEEE P802.11-94/259

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## Transmit Power control Provisions in the MAC

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### Why Tx-Power Control:

- The Wireless Medium is a scarce resource:
  - Only limited bandwidth available per a given Three dimensional area.
  - Medium must be reused as much as possible.
  - Speed increase will limit the number of useable orthogonal channels also in future bands.
- In practice (loaded) systems will be interference limited rather than noise limited.
  - Co-Channel interference is the limiting factor.
- Reducing the Tx-Power to the "Needed Level" will significantly reduce the co-channel interference level generated.
  - This will increase the available bandwidth and so throughput.

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### Prior work:

- Previous proposals indicate huge benefits:
  - Doc 92/76: "The potential of Dynamic Power Control"
    - » Shows simulation results of Multiple networks with and without Tx-Power Control.
    - » Significant medium re-use potential between a factor 2 and 8 was demonstrated (92/76).
  - Doc 94/59: "Protocol elements needed for Tx-Power Control"
- Purpose is Medium re-use efficiency improvement, not a Power consumption saving.
- The current Phy's specify multiple Tx-Level settings associated with a related CCA sensitivity threshold.

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### Approach:

- Use a transmit level that is suitable to achieve the required SIR at the receiver.
  - Do not transmit more than "Needed".
  - This does NOT mean; "Lower power so that reception is at the minimum sensitivity level".
- Transmitter needs to know the average attenuation to a given destination, to make an informed decision on the Tx-Power Level needed.
- If a lower Tx-Level is needed, then this will reduce the interference level in the surroundings.
  - This means that we can also reduce the "Defer area".
- The Transmit level can dynamically be REDUCED from its nominal specified level.

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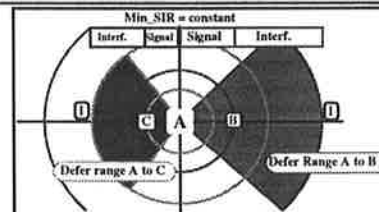
### What is the basic mechanism:

- A mechanism is needed to measure the attenuation between transmitter and remote receiver.
  - Tx knows (controls) its own Tx-Level.
  - Rx to put measured RSSI in the returning response (CTS or Ack).
  - Tx can calculate the experienced attenuation.
  - This knowledge can be maintained per applicable destination.
- A Tx-based algorithm can calculate a more appropriate Tx-Level.
- If Tx-Level is reduced, then also the "Defer Threshold" can be made less sensitive.
  - Result: Lower Tx-Level then less stations to defer for, resulting in a higher throughput per unit area.

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### Reduce Power, Increase Throughput:



- Transmitters control their Power level from the nominal level DOWN.
- Interferers can be closer, so Defer threshold can be less sensitive.

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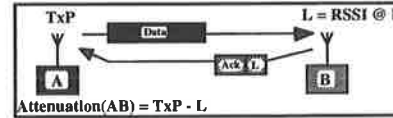
## Minimum MAC Functions needed:

- MAC to specify a RSSI field in the CTS and Ack frame.
  - Specify 8 bit field with 1 dBm resolution.
  - Note that this does not imply a PHY accuracy, but just a range and resolution that the MAC can signal.
- MAC needs to be able to adjust the Tx-Level per frame.
- MAC needs to be able to modify the CCA-Threshold prior to each access attempt.
- The Tx-Level Control algorithm does not need to be specified.
  - Only the mechanism to acquire the necessary information.
  - And the Phy Control mechanism.

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## Gather attenuation information:



- Transmitter can determine the attenuation.
  - It knows its own output power, and receives the RSSI in the Ack.
  - The transmitter can adjust its Transmit Power for subsequent transmissions to that same destination.
- Phy needs to deliver RSSI type information anyway.

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## What is needed in the MAC Standard:

- Assumption: Include the minimum requirement in the MAC to allow the Attenuation calculation.
- Level-1 provisions:
- Specify a fixed field in the CTS and Ack frame.
  - 8 bits field, assume 1 dB resolution.
  - Additional spare 8 bits available if we want word bounded fields (could contain "Background Level" or a Quality indication).

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## Level-2 Provisions:

- Level-2 provisions:
- Specify a way to allow Phy parameter control independent of a Tx activity which can be issued when the MAC starts monitoring the medium prior to an actual access.
  - Add a Transmit\_Enable parameter to the Ph-DATA.request(START\_OF\_ACTIVITY,params), so that parameters can be changed independent of Transmit activity.
  - Specify a separate class Ph-DATA.request(Set\_Param,params), to allow change of the defer threshold.
- Include Tx-Power\_level and CCA\_threshold parameters in the MAC / PHY interface.
- State Machine change may not be needed.

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## Conclusion:

- Lets prepare the frame formats to support the implementation of this important medium sharing function.
  - Its use can be optional.
  - This is possible because a mix of stations that do and don't implement Tx-Power Control can work together without any problem.
- A next level of support would be to specify the necessary provisions to control the Tx-Power\_Level and CCA\_Threshold.
  - Currently no mechanism is available to change the Phy parameters per frame, but independent of transmit activity.

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## Motion:

- Move:  
To add a fixed field to the CTS and Ack frame to report the received RSSI level. 14/38/13 falls.
- Move:  
To specify a Transmit\_Enable parameter to the basic Ph-DATA.request(START\_OF\_ACTIVITY,params) parameters, so that they can be changed independent of Transmission activity.