CS 168 Section 10: Wireless

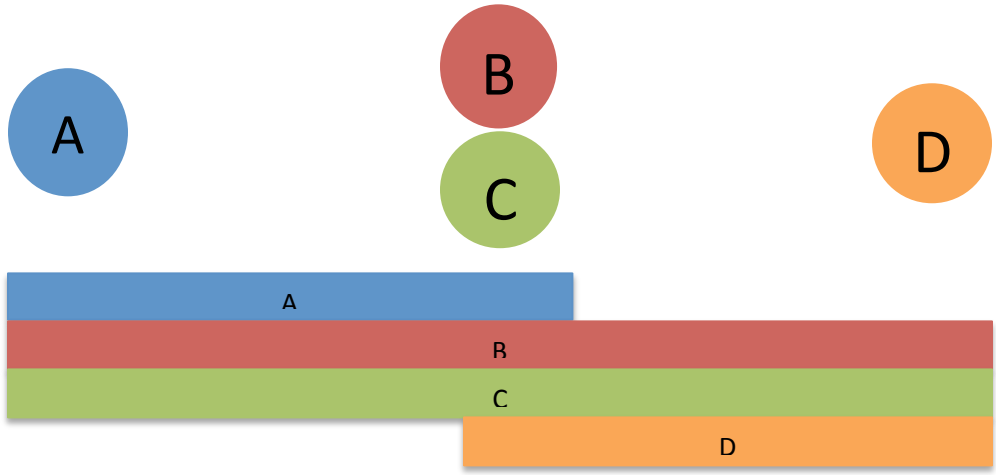
Q1: You've got the power!

A big problem in wireless is signals attenuating as they propagate through the physical environment. One solution for this would be to boost the strength of signal sent by the transmitter. State two problems with doing so.

a. Greater power required for transmission, and wireless nodes have limited power.
b. Signal propagates farther, causing more interference.

Q2: Cheaters

Consider wireless nodes communicating as indicated below, i.e. B and C can hear A, but D cannot; B and C can hear D, but A cannot; and every node can hear B and C. The horizontal bars denote these ranges.



Suppose that A and B are using MACA (Multiple Access with Collision Avoidance), and A is sending a large data item to B requiring many packets (but B does not need to send back acknowledgments). C wishes to transmit data to D (again, D does not need to send back acknowledgments).

a) To what degree can C improve its performance by "cheating" and ignoring the CTS messages exchanged between A and B. (Here "ignoring" means not taking the action that C is supposed to take when it hears the CTS messages.) Explain why and at what cost (would anything be worse)?

The key insight here is that D cannot hear messages sent by A, so C can send freely to D. Even though locally at C there will be collisions with the messages sent by A, D will (successfully) receive only C's messages. Therefore C can significantly improve its performance by transmitting all the time.

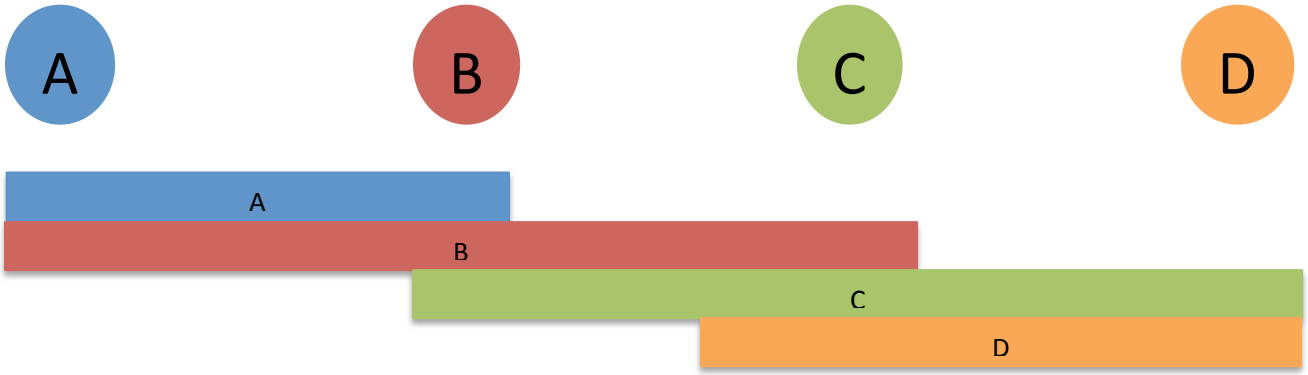
b) Now consider instead B sending a large data item to A. To what degree can D improve its performance by "cheating" and ignoring the CTS messages exchanged between A and B. Explain why.

Whenever B sends to A, C hears it and D cannot fruitfully transmit to C at those times due to collision. D cannot improve its performance.

Q3: More Problems with RTS/CTS

In this problem we will study cases where RTS/CTS fail to meet some desired goals.

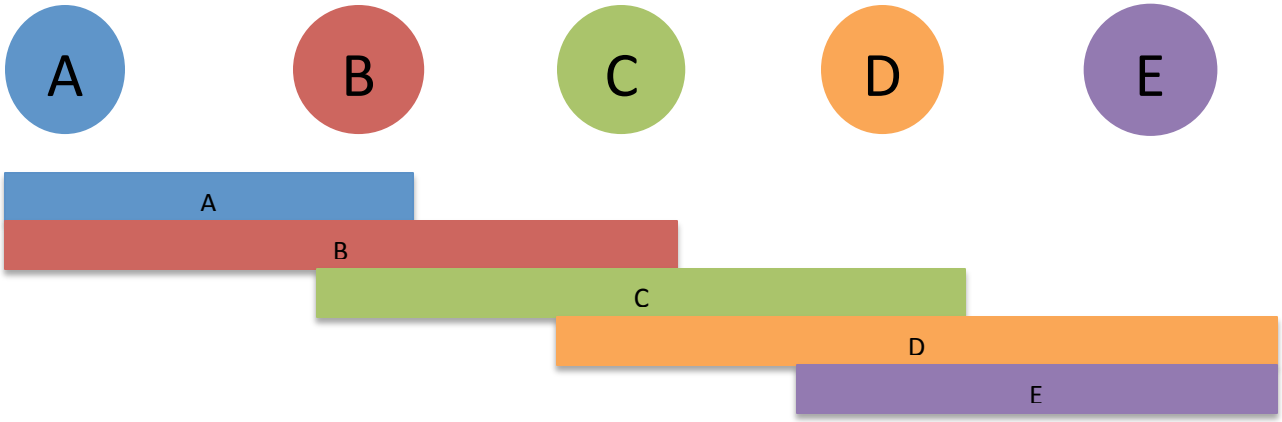
a) Consider the scenario below, A wanting to send to B and D wanting to send to C. (The directions are opposite to what we did in the exposed-terminal problem.). If A and B undergo a successful RTS/CTS exchange, will D be able to send to C? Write down the sequence of RTS / CTS packets.



Answer:

No. A sends RTS to B, B sends CTS to A and C. C listens to this and when RTS of D comes, it doesn't send a CTS back and the transmission doesn't get done. Note that this transmission is safe to do, but RTS/CTS precludes it.

b) Consider the scenario below with A wanting to send to B and D wanting to send to E. Suppose D and E exchange RTS/CTS successfully, then D starts transmitting. Then, A and B exchange RTS/CTS and A starts transmitting. Once D's transmission is over while A is still transmitting, can A -> B communication be affected by some events even though they exchanged RTS/CTS sufficiently? Write down the sequence of RTS / CTS packets.

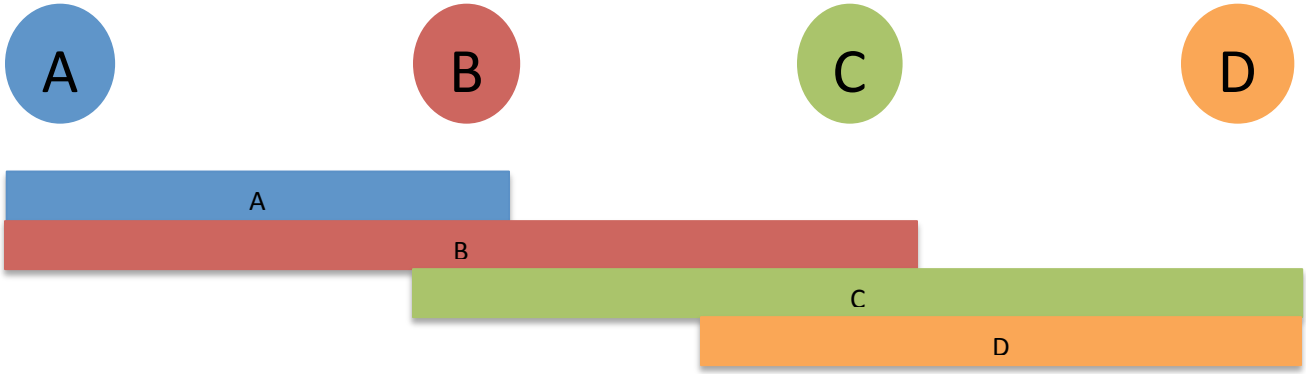


First D and E exchange RTS / CTS successfully and the transmission starts, station C gets blocked by the RTS. During this transmission, a new transmission from A to B starts, the RTS/CTS exchange is successful but C doesn't get to listen to the CTS broadcasted by B (due to collision with D's transmission), and thus C is not blocked by the transmission from A to B (C is now masked).

When D finishes transmission, station, (i) C might initiate transmission to B / D causing collision with A -> B transmission or (ii) D might start a transmission where C's CTS will interfere with A -> B transmission.

Essentially, C is masked from the information that A and B are communicating. Thus even a successful exchange of RTS/CTS packets is not sufficient to guarantee successful exchange.

c) Consider the scenario below with A wanting to send to B, and C wanting to send to D. Let's say A starts transmitting after a successful exchange of RTS/CTS with B. Can it so happen that C never gets a chance to send to D?



Yes, C first hears CTS from B and thus doesn't send RTS (or can't listen to D's CTS).

If A keeps sending to B, C will never get a chance to send to D. Further, in this event, C will keep backing off exponentially, so even if A finishes sending, C is unlikely to send any time soon.

Q4: Overhead

If the packets being sent by the wireless nodes are very short (few bytes each), would RTS/CTS be a useful mechanism if link-layer ACKs are already being used? Why or why not?

No, RTS/CTS would not be useful: the size of the packet would be comparable to the size of RTS/CTS messages, so the overhead of RTS/CTS would be prohibitive.