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Due until 18 May 2007

Exercises of lecture
Mobile Ad Hoc Networks
Summer 2007
Sheet 4

SECTION 1:
Exposed Terminal Problem

1. A student claims to improve MACAW such that after receiving DS, a node could start sending data to any other node instead of waiting for the end of data. That student makes following claims. *(1)* Node-A could send data to any node, other than node-B because node-C is out of range of it. *(2)* The exposed terminal problem is solved. *(3)* To support his above claim, he says that if one cannot send data, then what is the use of DS? You are asked to review the suggestions given by the student, and find out any mistakes he had made while making above claims.

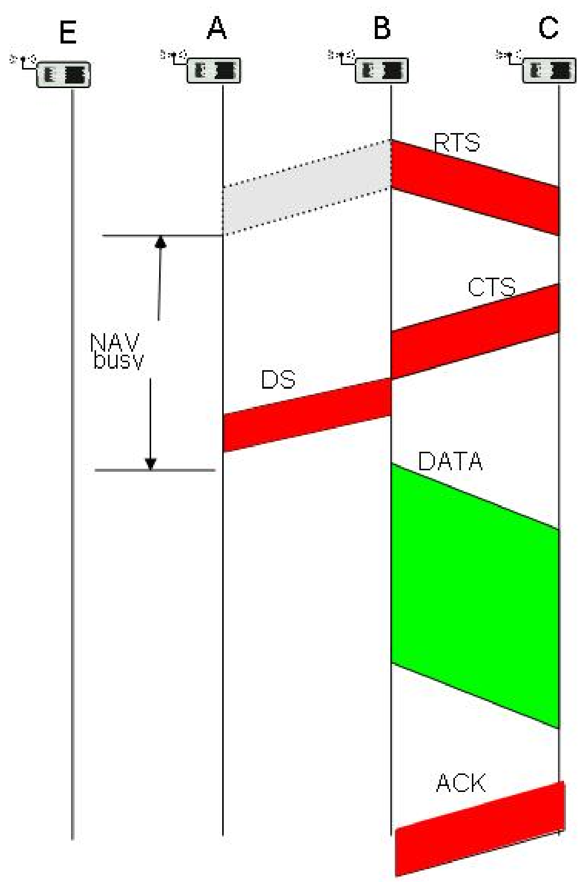

Figure 1:

Solution: *(1)* That is a right claim. Node-A *ideally* could should send data to any node other than node-B. *(2)* It can send but cannot receive. Therefore, while using MACAW, it will not be able to receive CTS and start data transfer. *(3)* DS could be used to wait for a shorter duration. Hence, in a case no DS is received, a node now does not have to wait for data transmission to end. It could initiate RTS in order to compete for share medium.

SECTION 2:

Power Aware MAC: Power Control

1. Based on the PCM protocol, a data tranmission involves sender A and receiver B. Given that the minimum necessary received signal strength of A is 0.3987 W (equivalent to -64 dBm), the maximum transmit power for both nodes is 0.7079 W, and A receives a CTS from B at $P_r = 0.5011W$, compute the minimum transmit power, P_{tmin}, sender A should use for the data transmission to B.

   Explain the method used in *BASIC* or *PCM protocols* to determine P_{tmin}, and its drawback (if any).

   Solution:
   Using the formula below:

$$P_{tmin} = p_{max}/p_r \cdot Rx_{threshold} \cdot c$$

   P_{tmin}
   $= 0.7079/0.5011 \cdot 0.39987$
   $= 0.5632W$ or $27.5dBm$

   The drawback is that computing P_{tmin} at node A assumes that the signal attenuation between source and destination nodes is the same in both direction.

   Let A and B be the sender and receiver respectively.
   Method 1: First, A sends RTS to B using P_{max}. B replies with CTS transmitted to A at P_{max}. A computes P_{tmin} based on formula given above. A and B can then use P_{tmin} to transmit data and ACK respectively.

   Method 2: First, A sends RTS to B using P_{max}. B computes P_{tmin} based on formula below:

$$P_{tmin} = max(\frac{Rx_{Des}}{G_{AB}}, \frac{SIR_{Des} \cdot Pn_{D_b}}{G_{AB}})$$

   ,where Rx_{Des} is the necessary received signal strength that must be at least the minimum necessary received signal strength, G_{ab} is the signal power gain and Pn_{D_b} power of the noise including the thermal noise observed at a receiver B.

   Then, B inserts this power value in CTS before sending the CTS back to A using P_{max}. A and B can then use P_{tmin} to transmit data and ACK respectively. This method requires modification of the CTS format. However, since the signal-to-inteference ratio at the receiver B is taken into consideration, this method can accurately estimate the appropriate transmit power level for DATA.

2. Does PCM completely solve the problem of *BASIC* protocol? If not, elaborate the problem that you think might still happen in PCM.
   Solution:
   PCM does not solve the problem of collision with data, but only the collision with ACK. Taking the example scenario in the lecture, since PCM only increase the transmit power for DATA transmission periodically, the low transmit power is still used for ACK. In this case, node H may initiate a new data transmission since it is not within the carrier sensing zone of DATA transmission. Then, collision will happen at the receiver node of the data transmission. It is also a problem for 802.11 MAC protocol.