Problems in a wireless LAN

There are three problems in a wireless LAN, which are not found in wired LANs. These problems are as follows:

- Hidden terminal problem
- Exposed terminal problem
- Inability to detect collision.

Hidden terminal problem

Assume that all the computers have identical radio ranges. This assumption is not necessary for the problem to occur. Rather, the problem becomes more frequent in the absence of this assumption. Thus, for simplicity of our explanation, we make this assumption. Let there be three computers A, B, and C as shown in Figure W4. Their relative locations and radio ranges have also been shown in Figure W4. The figure shows that A and B are within each other's radio ranges, and B and C too are within each other's radio ranges. Thus, the direct communications that can happen are between A and B and between B and C. However, A and C are outside each other's radio ranges. Now, assume that C is transmitting to B as shown in the figure. Since C is far away from A, A is unaware of the fact that there is an on-going transmission between B and C. Because of this unawareness, A can potentially start its transmission to B or another computer (not shown in the figure), thereby disturbing C's transmission to B. This disturbance happens because C is hidden from A. Thus, a hidden terminal problem occurs when a computer

(A) starts its transmission while being unaware of a far-away located computer's (C's) transmission to A's neighbor (B). In other words, the problem can occur if two computers (A and C) have a common neighbor (B), but the two computers can not hear each other's signals.

Because users, and, hence their computers, are mobile in a wireless LAN, the hidden terminal problem occurs in a wireless LAN. Suitable measures are taken in the IEEE 802.11 MAC protocol to address this problem.

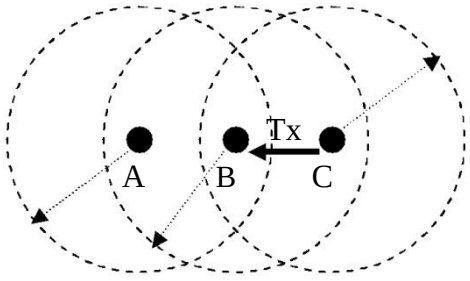

Figure W4: Illustration of the hidden terminal problem

Exposed terminal problem

Referring to Figure W5, assume that the pairs of computers (D, A), (A, B), and (B, C) are Neighbors in the sense that D and A are within each other's radio ranges. Let A be transmitting a data packet to D. Because of the broadcast nature of this transmission, the same signal also reaches computer B. However, B is not an intended receiver of A's signal. We also know that C is not receiving A's signal. Thus, it is possible for B to start transmitting a data packet to C without disturbing the ongoing transmission from A to D. However, B does not initiate its transmission, because it is unaware of D's location. B does not know if its transmission to C will cause a collision at D. Hence, B does not initiate its transmission while being exposed to A's signal. This is called the exposed terminal problem. In other words, a computer does not start transmitting if it senses that there is an ongoing transmission. Researchers are investigating this issue so that network performance is improved by allowing an exposed terminal to transmit subject to the condition that it does not disturb an ongoing transmission.

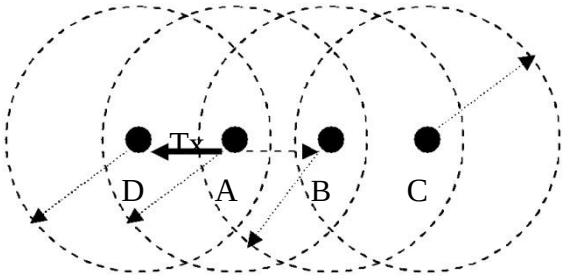

Figure W5: Illustration of the exposed terminal problem

Inability to detect collision

Ideally, a sender should detect collision at a receiver, because it is the collision at the receiver that matters. In a wired LAN, collision is detected at the sender's end by assuming that signals from all computers can reach all other computers. However, this assumption does not hold in a wireless LAN as it has been explained in the context of the hidden terminal problem. Another reason for the difficulty in not being able to detect collision is that many wireless devices use half duplex transceivers to simplify transceiver design. That is, a half-duplex wireless device turns on its transmitter and receiver in an alternating manner.

As an example, GSM phones use half-duplex transceivers, and this is facilitated by skewing the up-link (transmitting) channel and the down-link (receiving) channel by three time slots so that the transceiver can switch its mode from a transmitter to a receiver and vice versa.

Thus, in a wireless LAN, because of the difficulty in detecting collision, MAC protocols do not rely upon collision detection. Rather, the principle of *collision avoidance* is utilized.

Transmit condition and virtual carrier sensing

Before a computer can transmit anything—data or control packets—it is essential to detect idleness of the medium. In a wired LAN, it was sufficient to detect idleness by sensing the physical medium. However, in a wireless LAN, because of the hidden terminal problem, it is not enough to sense the medium to know whether or not the medium is idle. In addition to carrier sensing at the PHY level, the WLAN MAC protocol uses the concept of virtual carrier sensing to tackle the hidden terminal problem.

In virtual carrier sensing, a computer monitors the transmission of all control packets that it can receive, utilizes the duration information contained in those packets, and infers whether or not the medium is idle at its intended receiver.

Thus, the medium is said to be idle if the PHY level carrier sensing mechanism detects no carrier and it is inferred from the virtual carrier sensing mechanism that the intended receiver within its radio range is not receiving data.

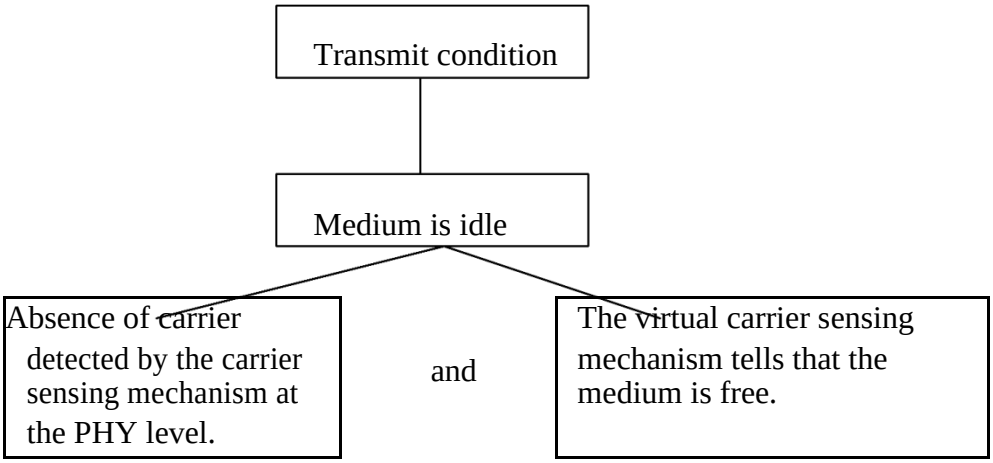

Figure W6: Condition for medium idleness

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