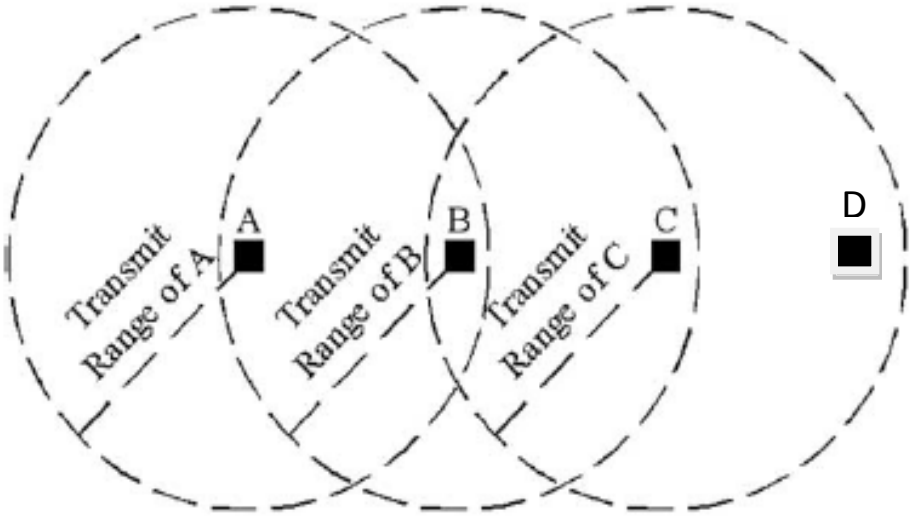
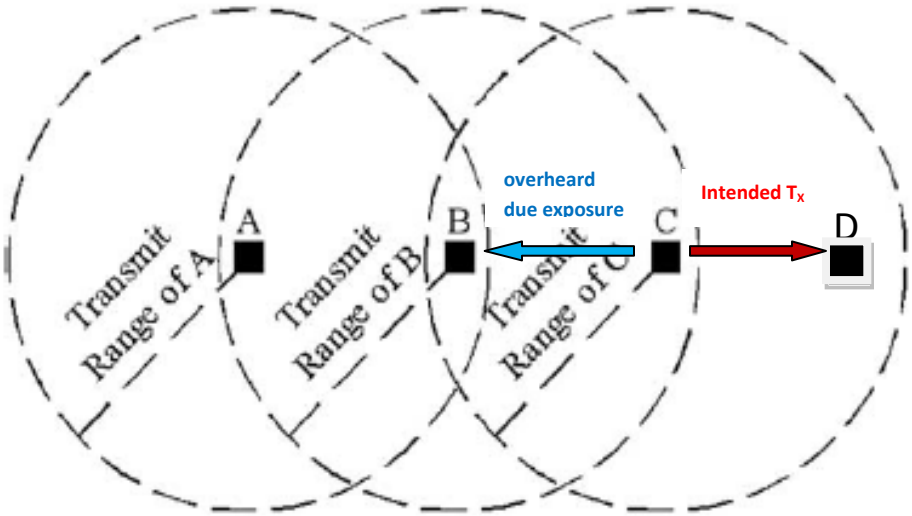
IEEE802.11 MAC Hidden/Exposed Stations Problems

Hidden Terminal Problem: (www.cs.virginia.edu/~cs851-2/course.htm)



- Node B can communicate with A and C both
- A and C cannot hear each other
- When A transmits to B, C cannot detect the transmission using the carrier sense mechanism
- If C transmits to D, collision will occur at B

Exposed Terminal Problem: (www.cs.virginia.edu/~cs851-2/course.htm)



- Node C can communicate with B and D both
- Node B can communicate with A and C
- Node A cannot hear C
- Node D cannot hear B
- When C transmits to D, B detects the transmission using the carrier sense mechanism and postpone **to transmit to A**, even though such transmission will not cause collision (**B can Tx while receiving**, but not receiving two or more at the same time). We say that B is ***exposed*** to C's traffic and stopped Tx, wasting Bandwidth.

Partial Solution: ***Virtual Carrier (VC)***

Multiple **A**ccess **C**ollision **A**voidance **MACA** **(1, 2, and 4 only)**

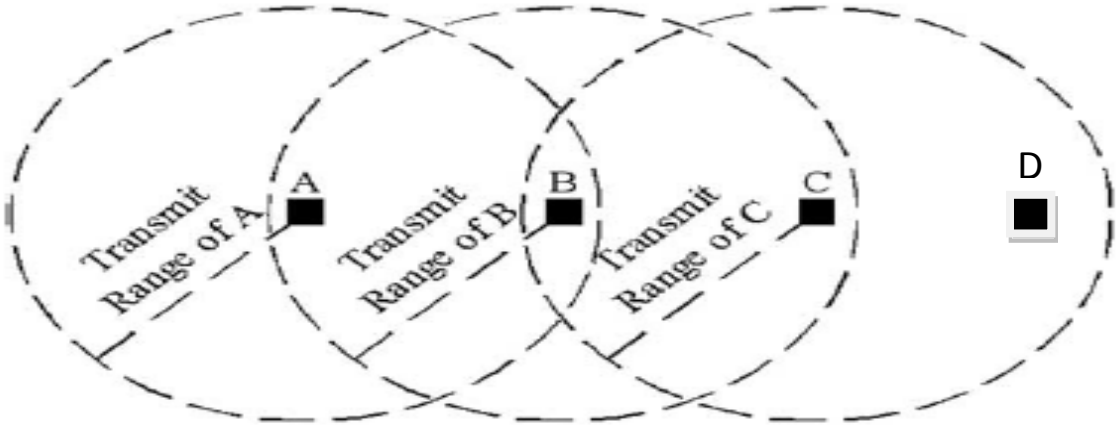
& **MACA** for **W**ireless **(MACAW)** **(1-to-5)**

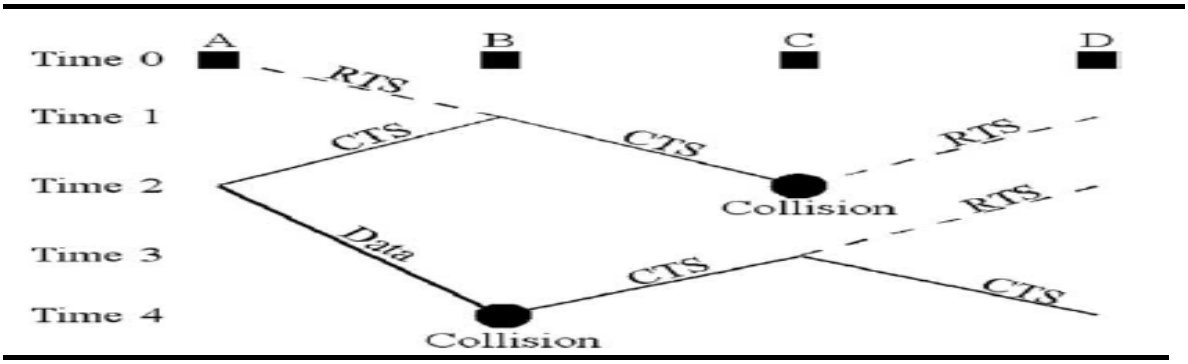
Stations A&B communicate, via the following sequence of handshaking *VC* steps:

1. **"Request To Send" frame (**RTS**) from A to B**. (All A's neighboring stations are going to sleep for the session duration which is included in the RTS control frame)(Problem?!?! YES. WHY?!?!?) Assume node Y only with range of A, hears A's RTS to B, then blocks for the duration, which is unfair to Y in case of B never answers!
2. **"Clear To Send" frame (**CTS**) from B to A.** (All B's neighboring stations are going to sleep for the session duration which is included in the CTS control frame)
3. "Data Sending" frame (DS) from A to B. (All neighboring stations are going efficiently to sleep for the session duration which is included in the control frame)**[NOT in *MACA*]**
4. DATA fragment frame from A to B, and (All detecting stations sleeps until ACK+ small random time)
5. Acknowledgement frame (ACK) from B to A. (all sleeping stations wakeup).

Now, when A transmits RTS to B, B will respond by CTS to A, which will be overheard by C. Hence, C will sleep on its own initialized NAV (CTS includes the time duration of the sleep), NO collision scenario as before in CSMA above!! *(Really?!)*

The VC technique will solve the HS problem with special timing scenario, yet still, ***fails*** to handle the ***Hidden Station*** problem in general:





Hidden terminal problem after using RTS/CTS control packets

(paper.ijcsns.org/07_book/201010/20101020.pdf)

1. ***A*** wants to send ***data*** packet to ***B***.
2. ***A*** sends ***RTS*** to B.
3. Upon receiving the ***RTS***, ***B*** sends CTS to ***A***, but ***C*** gets it too.
4. At the same time ***D*** sends ***RTS*** to ***C*** for transmitting data packet, which collides with ***B***'s ***CTS*** at ***C***.
5. After receiving ***CTS*** from ***B***, ***A*** transmits data to ***B*** and ***D*** times out and resends ***RTS*** to ***C***.
6. When ***C*** gets the resubmitted ***D***'s ***RTS*** (no collision this time), ***C*** sends ***CTS*** to ***D***, but ***B*** gets it anyway (wireless broadcast medium) while still receiving ***data*** from ***A***, hence collision at ***B***!!!

Does MACA fail also to handle the *Exposed Station problem*????!!! (left for you to research!!)

Hence IEEE802.11 MAC defines two modes:

1. ***DCF*** **(*D*istributed *C*oordination *F*unction) &** ***PCF*** **(*P*oint *C*oordination *F*unction)**
2. ***DCF*** **is based on CSMA + MACAW+ NAV**

   - **4 steps handshaking (Virtual CS): RTS-CTS-DATA-ACK**
   - ***Physical*** **CS +** ***Virtual*** **CS via the NAV (network allocation vector) containing time value that all overhearing station will await on (as obtained next) until medium is free again.**
   - **Every of the above handshaking control packets contains the time duration** ***remaining*** **in the communication session.**
   - **NAV is continuously updated via any new *overhearing*.**

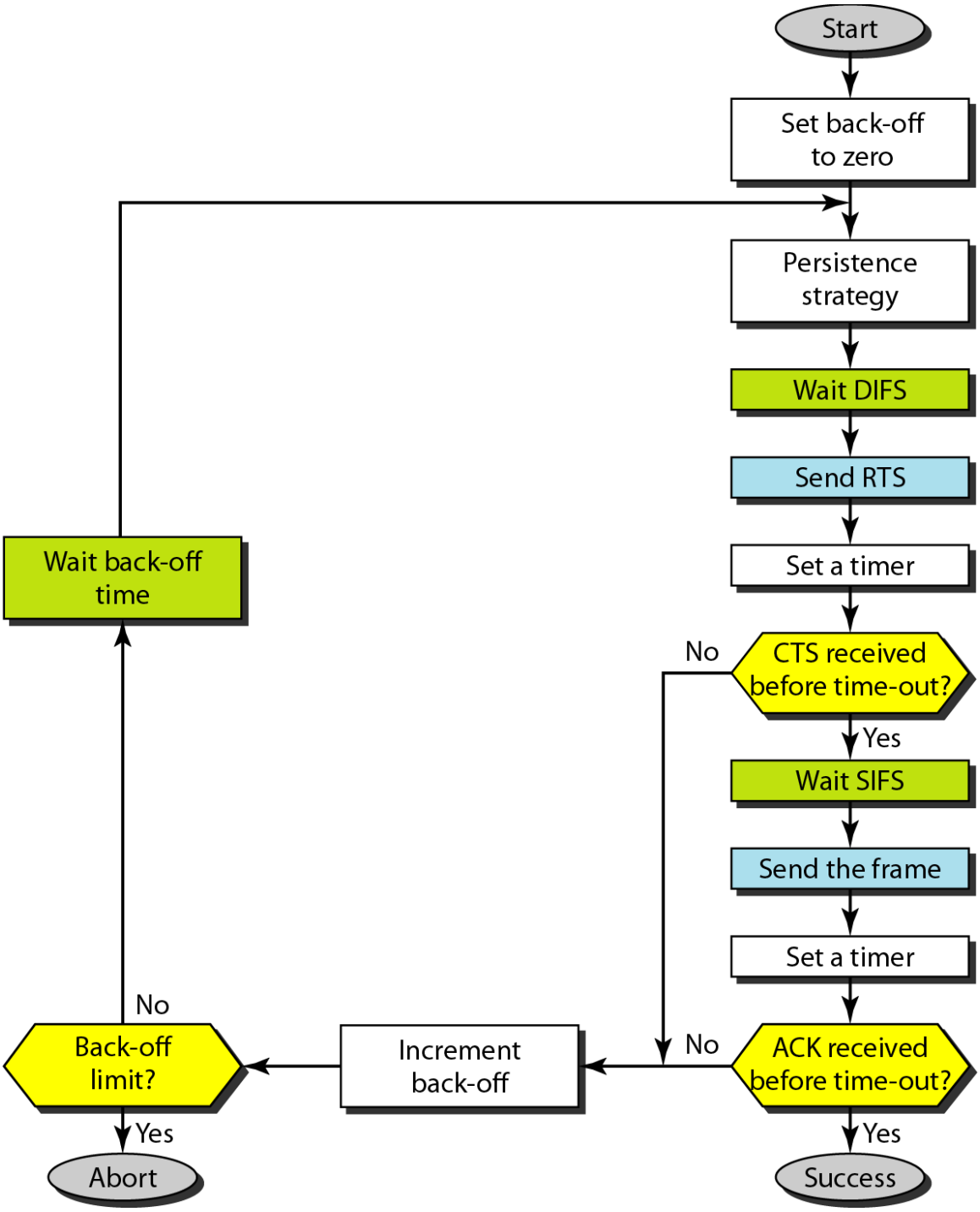
- **IFS (inter frame spacing)**

  – **Short IFS (SIFS), PCF IFS (PIFS), DCF IFS (DIFS), Extended IFS (EIFS)**

The *IEEE802.11 MAC' DCF* combines a mix of features from the following: CSMA & MACAW (-DS) +*NAV* (*Network Allocation Vector).*

The *NAV* counter is established by other noninvolved stations (neighbors of A&B) to await on! (for *VC* Virtual *Sensing*).

The *NAV* initial value depends on when a station gets into the action, i.e., overhearing: RTS, CTS, DATA, ACK.



IEEE802.11 MAC (DCF) [ad-hoc]Protocol

It is a mix of CSMA & MACAW (-DS) with NAV (virtual sensing *VC*).