IEEE 1900.7 White Space Radio

White Space Dynamic Spectrum Access Radio Systems

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Abstract

- This contribution presents a general description of spectrum access radio systems for white space.
- In order to perform a comparison, existing access methods for shared medium will be presented.

Outline

- Cognitive radio description
- Multiple access methods
- Focus on CSMA/CA
- Conclusion
- Perspectives

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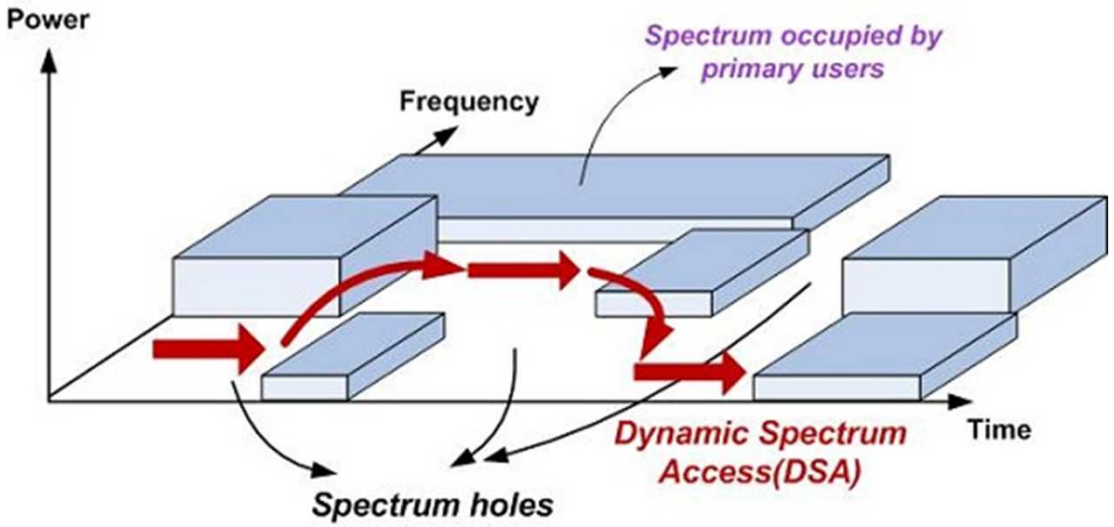
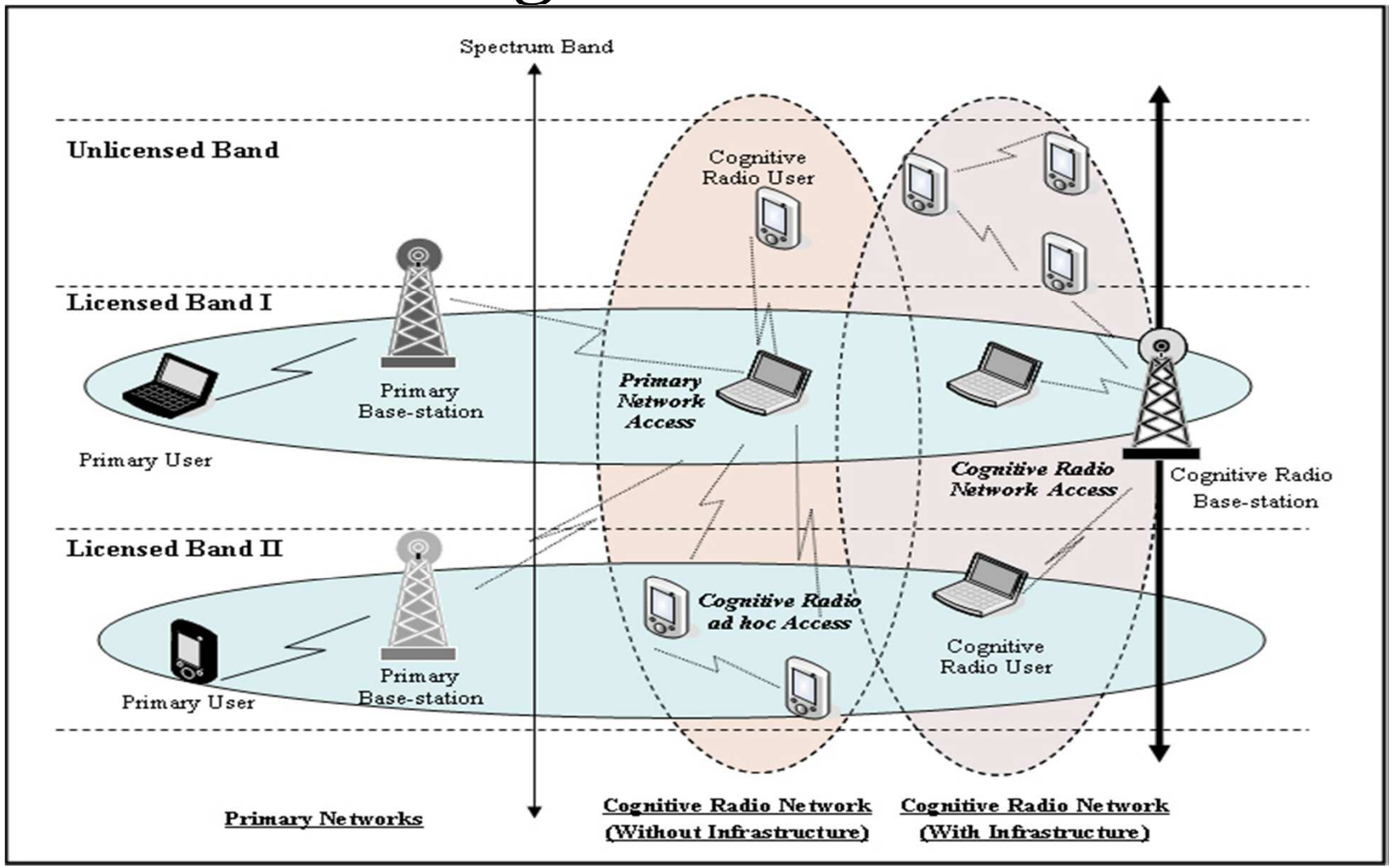
Multi-user access to fragmented spectrum with cognitive radio context.



www.brunel.ac.uk/sed/ece/research/wncc/student-profiles/abdullah-masrub

Cognitive Radio



www.ece.gatech.edu/research/labs/bwn/CR/

Cognitive Radio Functions

- Spectrum detection:
  - Detect un-used spectrum.
  - Share the spectrum between different users.
- Spectrum management
  - Capture best frequencies available to meet the communication needs of users.
- Spectrum mobility
  - Allow users to change its operating frequency.
  - Operate in the best available frequency band.
  - Maintain transparent communication requirements during the transition to a better frequency.

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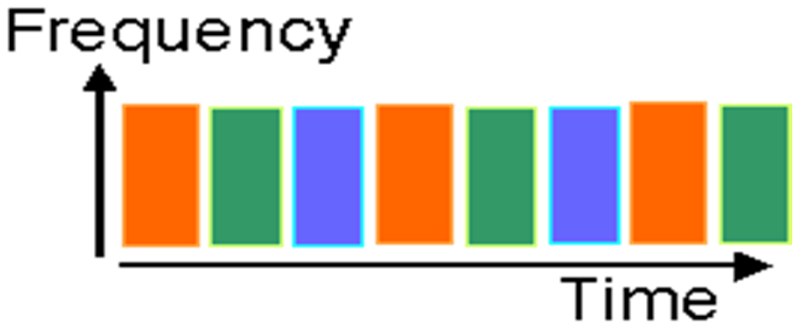
Overview of existing Access Methods for shared medium

- TDMA
  - Time Division Multiple Access
- FDMA
  - Frequency Division Multiple Access
- CDMA
  - Code Division Multiple Access
- CSMA/CA
  - Carrier Sense Multiple Access /Collision Avoidance

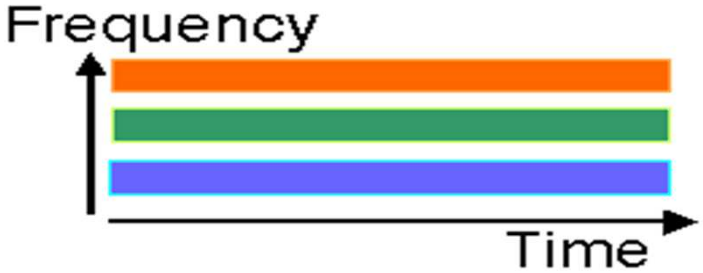
TDMA



- + It will not experience interference from other simultaneous transmissions.
- + Provides the user with extended battery life and talk time.
- - Transmitters must be synchronized to not use the channel simultaneously.
- - TDMA is subjected to multipath distortion.

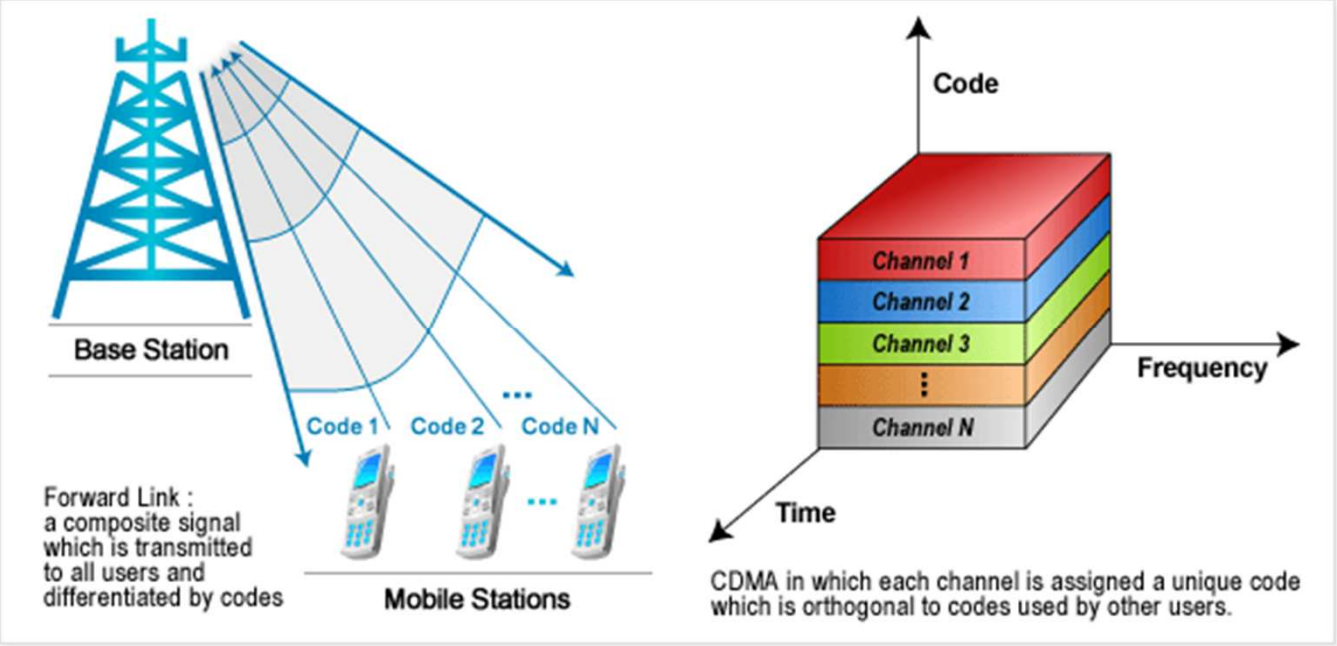
FDMA

- Frequented space is divided among all transmitters. They can then be temporally continuously.



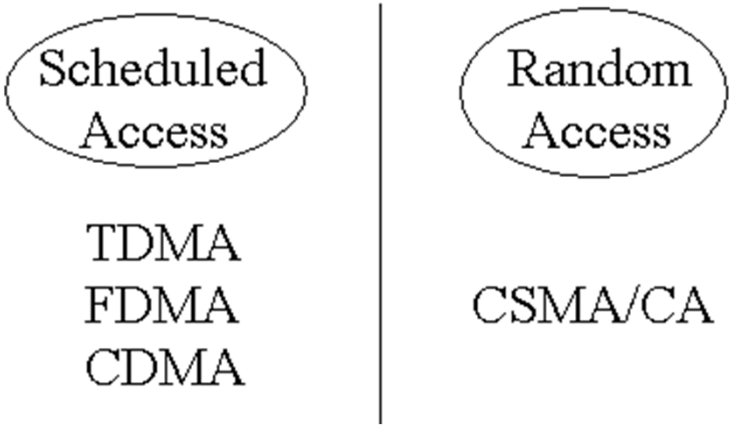
- + True full duplex, no timing problem (compare to TDMA).
- + Channel assignment is simple and straightforward.
- + FDMA algorithms are easy to understand and implement.
- - It takes a dedicated receiver channel to listen.
- - Impossible for receiver to receive the data from more than one station at a single point of time.
- - Maximum Data Rate for every channel is small and fixed.
- - Requires special filters to avoid interference between any narrow channel.

CDMA



- + Use both time and frequency.
- + Has a very high spectral capacity that it can accommodate more users per MHz of bandwidth.
- - Synchronization or advanced power control is required.

CSMA/CA Utility



- Decentralized
- Opportunistic
- Low signaling overhead

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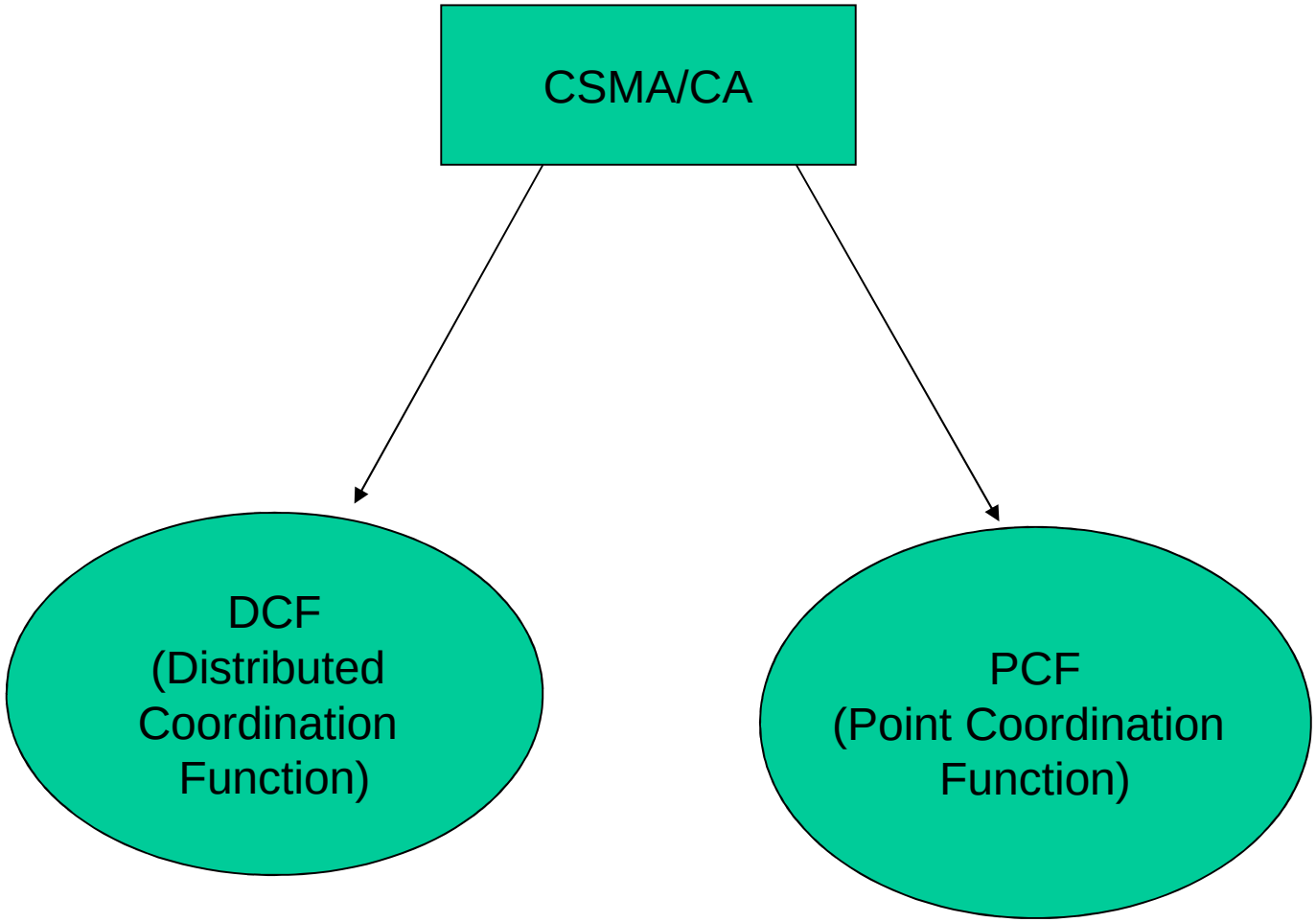
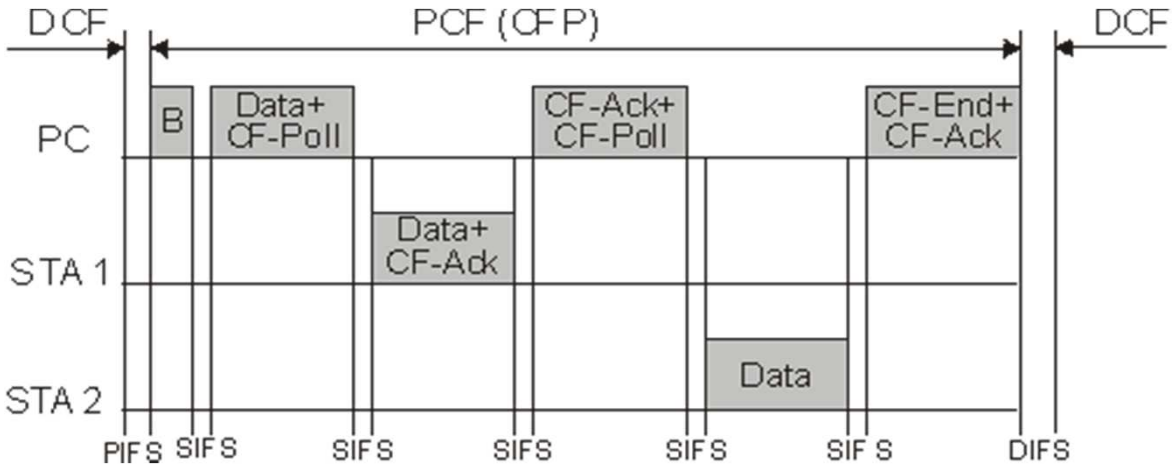
CSMA/CA


CSMA/CA
DCF
(Distributed
Coordination
Function)
PCF
(Point Coordination
Function)

CSMA/CA - PCF



- \+ Non random Access in general
- \+ QOS
- \- All stations should associate an access point based on CSMA/CA DCF
- \- No priority

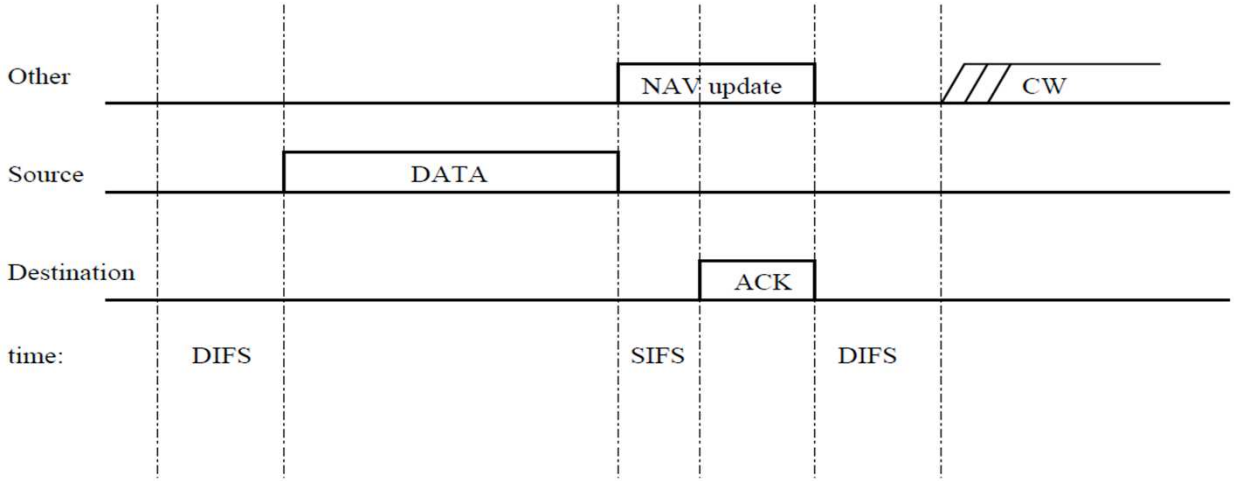
www.invocom.et.put.poznan.pl/~invocom/C/P1-4/p1-4_en/p1-4_8_2.htm

CSMA/CA - DCF

- The DCF protocol in IEEE 802.11 standard defines how the medium is shared among stations.
- Includes a basic access method and an optional channel access method with request-to-send (RTS) and clear-to-send (CTS) exchanged.

CSMA/CA – Basic DCF

- The DCF is a method of access to best-effort mode, without priority and without warranty. It is very effective to carry traffic not requiring warranty on transmission latency or throughput offered (download, web browsing, etc..)



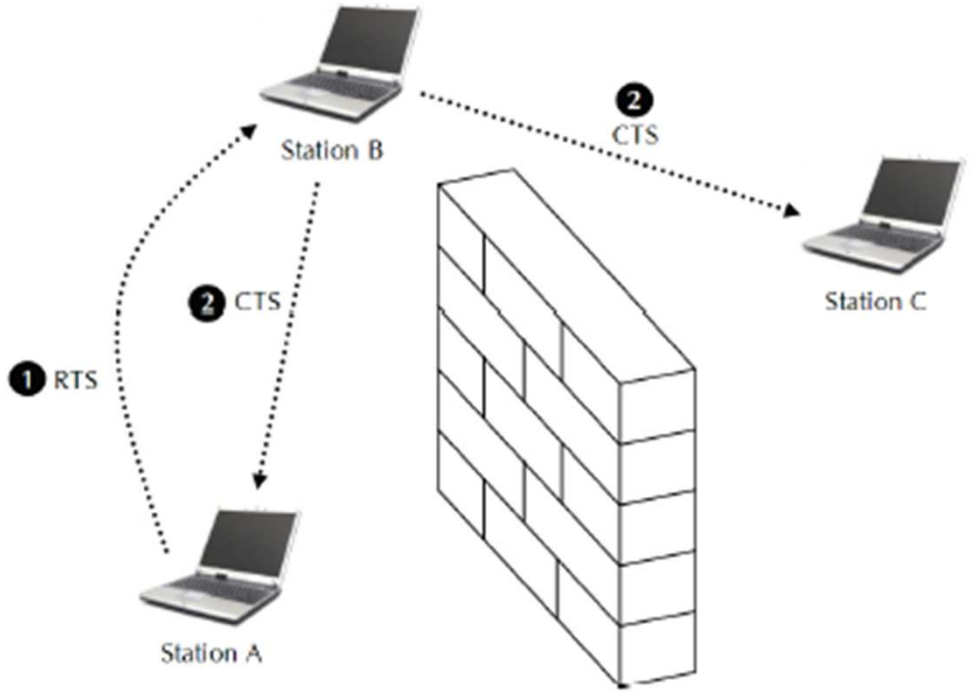
Manshaei, Mohammad Hossein, and Jean-Pierre Hubaux. "Performance Analysis of the IEEE 802.11 Distributed Coordination Function:Bianchi Model, *Mobile Networks", Communication Systems & Computer Science Divisions* (2007).

CSMA/CA – Basic DCF

- - Randomness
- - Even if the station doesn’t transmit, it should listen to the medium to send ACK if it receives any frame
- - Hidden nodes (excepted if RTS/CTS strategy is considered)

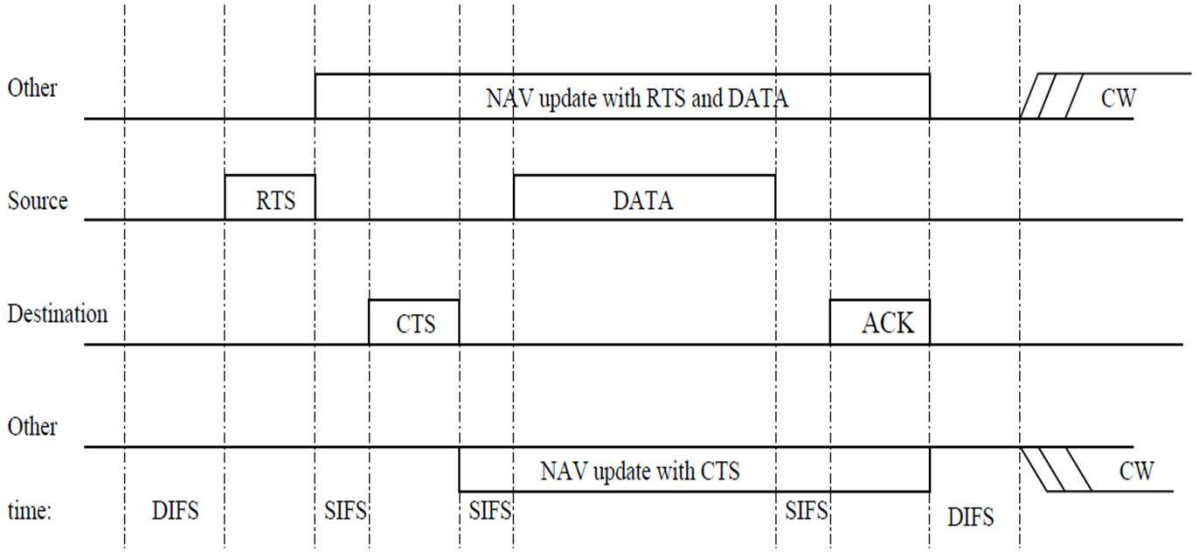
- + Decentralized
- + Opportunistic
- + Work with CR

How to solve hidden nodes problem?



From PhD thesis manuscript of Adrien VAN DEN BOSSCHE.

CSMA/CA – with RTS/CTS



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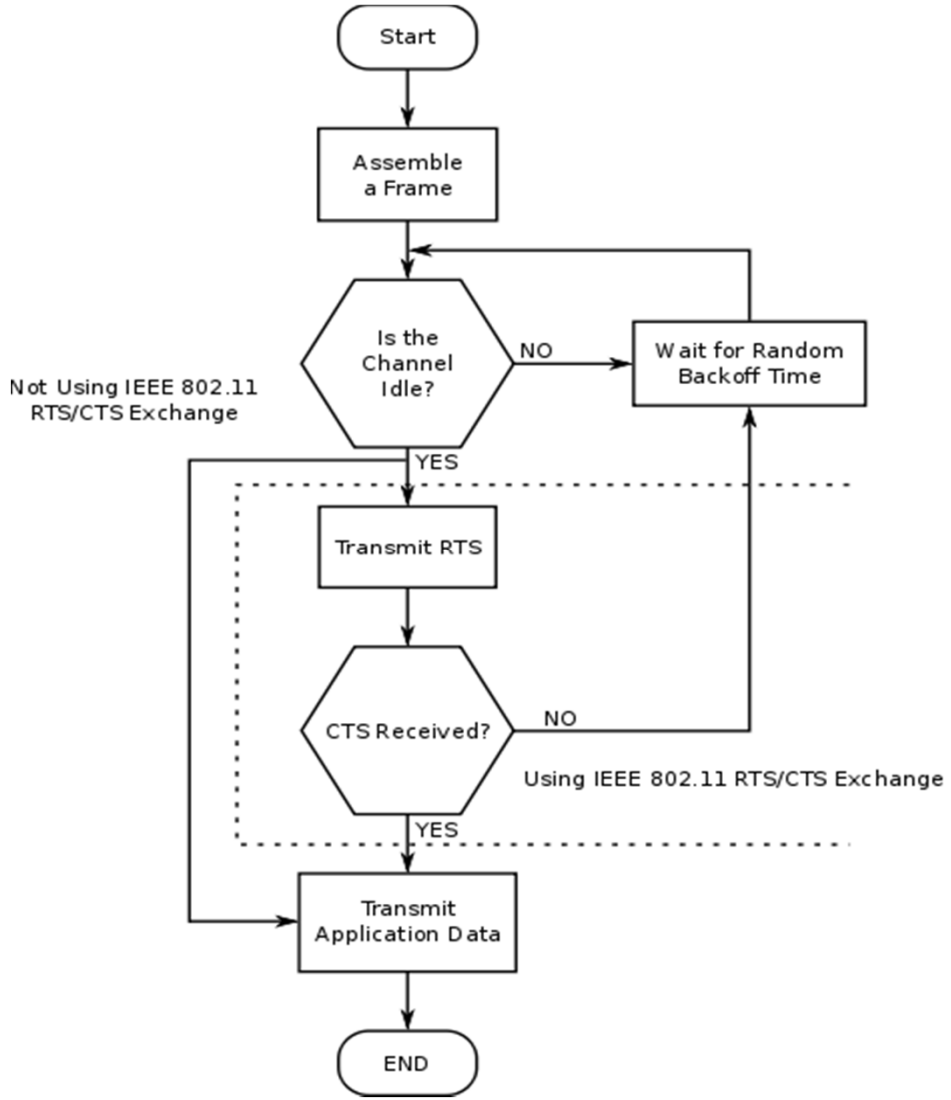

http://en.wikipedia.org/wiki/Carrier_sense_multiple_access_with_collision_avoidance

CSMA/CA protocol

- Due to randomness nature of the access it is not simple to predict the performance of the access method.

- Problematic:
  - How to predict the performance of the medium access?

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Conclusion

- To gain more bandwidth, we have to benefit from the dynamic fragmented spectrum.
- There exist many access methods that could be used for Cognitive Radio.
- CSMA/CA is a candidate for single and multiband dynamic access method.
  - Decentralized
  - Opportunistic

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Perspectives

- Performance evaluation for CSMA/CA.
- Optimize the access methods (MAC Layer) in order to gain in the total system performance.
  - More studies concerning the backoff.
  - Decrease the MAC overhead.
  - Decrease collision probability.
- Hybrid access methods.