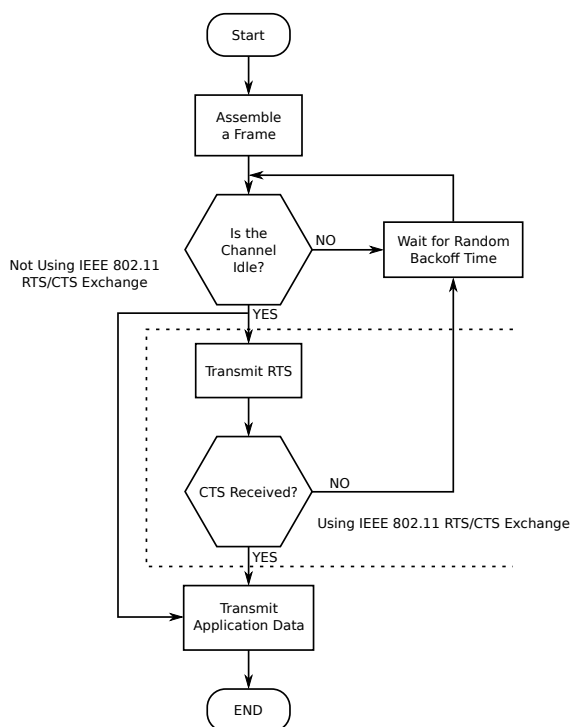


# Carrier sense multiple access with collision avoidance

**Carrier sense multiple access with collision avoidance (CSMA/CA)** in **computer networking**, is a network **multiple access method** in which **carrier** sensing is used, but **nodes** attempt to avoid collisions by transmitting only when the channel is sensed to be “idle”.<sup>[1][2]</sup> When they do transmit, nodes transmit their packet data in its entirety.

It is particularly important for wireless networks, where the collision detection of the alternative **CSMA/CD** is unreliable due to the **hidden node problem**.

CSMA/CA is a protocol that operates in the Data Link Layer (Layer 2) of the **OSI model**.<sup>[3]</sup>



*Simplified Algorithm of CSMA/CA*

## 1 Details

Collision avoidance is used to improve the performance of the CSMA method by attempting to divide the channel somewhat equally among all transmitting nodes within the collision domain.

1. **Carrier Sense:** prior to transmitting, a node first

listens to the shared medium (such as listening for wireless signals in a wireless network) to determine whether another node is transmitting or not. Note that the **hidden node problem** means another node may be transmitting which goes undetected at this stage.

2. **Collision Avoidance:** if another node was heard, we wait for a period of time for the node to stop transmitting before listening again for a free communications channel.

- **Request to Send/Clear to Send (RTS/CTS)** may optionally be used at this point to mediate access to the shared medium. This goes some way to alleviating the problem of hidden nodes because, for instance, in a wireless network, the Access Point only issues a *Clear to Send* to one node at a time. However, wireless **802.11** implementations do not typically implement RTS/CTS for all transmissions; they may turn it off completely, or at least not use it for small packets (the overhead of RTS, CTS and transmission is too great for small data transfers).
- **Transmission:** if the medium was identified as being clear *or* the node received a CTS to explicitly indicate it can send, it sends the frame in its entirety. Unlike **CSMA/CD**, it is very challenging for a wireless node to listen at the same time as it transmits (its transmission will dwarf any attempt to listen). Continuing the wireless example, the node awaits receipt of an acknowledgement packet from the Access Point to indicate the packet was received and checksummed correctly. If such acknowledgement does

not arrive after a timely manner, it assumes the packet collided with some other transmission, causing the node to enter a period of **binary exponential backoff** prior to attempting to re-transmit.

Although CSMA/CA has been used in a variety of wired communication systems, it is particularly beneficial in a **wireless LAN** due to a common problem of multiple stations being able to see the Access Point, but not each other. This is due to differences in transmit power, and receive sensitivity, as well as distance, and location with respect to the AP.<sup>[4]</sup> This will cause a station to not be able to 'hear' another station's broadcast. This is the so-called '**hidden node**', or 'hidden station' problem. Devices utilizing **802.11** based standards can enjoy the benefits of collision avoidance (RTS / CTS handshake, also **Point coordination function**), although they do not do so by default. By default they use a Carrier sensing mechanism called 'exponential backoff', or (**Distributed coordination function**) that relies upon a station attempting to 'listen' for another station's broadcast before sending. CA, or PCF relies upon the AP (or the 'receiver' for Ad hoc networks) granting a station the exclusive right to transmit for a given period of time after requesting it (Request to Send / Clear to Send).<sup>[5]</sup>

## 2 IEEE 802.11 RTS/CTS Exchange

CSMA/CA can optionally be supplemented by the exchange of a **Request to Send** (RTS) packet sent by the sender S, and a **Clear to Send** (CTS) packet sent by the intended receiver R. Thus alerting all nodes within range of the sender, receiver or both, to not transmit for the duration of the main transmission. This is known as the **IEEE 802.11 RTS/CTS** exchange. Implementation of RTS/CTS helps to partially solve the **hidden node problem** that is often found in wireless networking.<sup>[6][7]</sup>

## 3 Performance

CSMA/CA performance is based largely upon the modulation technique used to transmit the data between nodes. Studies show that under ideal propagation conditions (simulations), **Direct Sequence Spread Spectrum** (DSSS) provides the highest throughput for all nodes on a network when used in conjunction with CSMA/CA and the IEEE 802.11 RTS/CTS exchange under light network load conditions. **Frequency Hopping Spread Spectrum** (FHSS) follows distantly behind DSSS with regard to throughput with a greater throughput once network load becomes substantially heavy. However, the throughput is generally

the same under real world conditions due to radio propagation factors.<sup>[3]</sup>

## 4 Usage

- GNET - an early proprietary **LAN** protocol
- Apple's LocalTalk implemented **CSMA/CA** on an electrical bus using a three-byte jamming signal.
- **802.11 RTS/CTS** implements **virtual carrier sensing** using short **request to send** and **clear to send** messages for **WLANs** (**802.11** mainly relies on **physical carrier sensing** though).
- **IEEE 802.15.4** (Wireless PAN) uses CSMA/CA
- NCR WaveLAN - an early proprietary wireless network protocol
- HomePNA
- Bus networks
- The ITU-T G.hn standard, which provides a way to create a high-speed (up to 1 Gigabit/s) **local area network** using existing home wiring (power lines, phone lines and **coaxial cables**), uses CSMA/CA as a **channel access method** for flows that don't require guaranteed quality of service, specifically the **CSMA/CARP** variant.

## 5 See also

- Carrier sense multiple access
- Carrier sense multiple access with collision detection
- CSMA/CARP
- IEEE 802.11 RTS/CTS
- Truncated binary exponential backoff
- Network Allocation Vector

## 6 References

- [1] "Federal Standard 1037C". Its.bldrdoc.gov. Retrieved 2012-09-09.
- [2] "American National Standard T1.523-2001, Telecom Glossary 2000". Atis.org. Retrieved 2012-09-09.
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- [4] Kaixin Xu, Mario Gerla, Sang Bae. “How Effective is the IEEE 802.11 RTS/CTS Handshake in Ad Hoc Networks?” (PDF). UCLA. Retrieved 28 September 2012.
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  - [6] Comer, Douglas. (2009). Computer Networks and Internets. Upper Saddle River, NJ: Pearson Education Inc. ISBN 0-13-504583-5.
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## 7 External links

- CSMA/CA RTS/CTS Simulation

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