# Implementing CSMA/CN with BEL for 802.11 WLAN

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### ABSTRACT

Current 802.3 Ethernet protocol and 802.11 WLAN protocol use Carrier Sense Multiple Access (CSMA) protocol to provide multiple access for many users. In CSMA protocol, it is important to handle collision to increase carrier utilization, however, in 802.11, collision detection (CSMA/CD) mechanism was not adopted as clients cannot detect whether data collide or not. To solve this problem, CSMA/CN is proposed which is an approximated version of CSMA/CD in wireless network [5]. However, it has some problems: first, dedicated antenna cannot be used to transmit data and should listen regardless of collision occurrence; second, 802.11 protocol should be modified for CSMA/CN to be used which takes long time; third, it assumed only single-input single-output (SISO) communication, whereas the latest 802.11 protocol started using multiple-input multipleoutput (MIMO) communication.

In this paper, we use Bluetooth Low Energy (BLE) to provide an another independent communication channel for a transmitter to enable to receive collision information while sending data. When the transmitter tries to send data, it also sends a notification message to BLE module attached to AP simultaneously. If the BLE module detects that multiple transmitters send notification messages, it broadcasts collision message through Bluetooth carrier. As soon as the transmitter receives this collision message, it aborts its transmission and wait backoff time like the original CSMA/CD protocol. By implementing an additional Bluetooth communication layer covering the existing 802.11 mechanism, we do not have to modify the existing 802.11 protocol as well as solve the problems of CSMA/CN.

### **Categories and Subject Descriptors**

C.2.1 [Network Architecture and Design]: Wireless communication

#### Keywords

Wireless, CSMA/CA, CSMA/CN, Collision Detection

### **1. ARCHITECTURE AND DESIGN**

In this section, we introduce our approach to implement CSMA/CN with BLE. As 802.11 uses half-duplex modulation schemes, the AP cannot send any messages to clients while they are transmitting. The CSMA/CN protocol solved this problem by making at least one antenna to listen data collision messages. The problem of this solution is that at least one antenna must not send any data during entire communication so data transfer rate is decreased. We do not divide the role of WLAN antennas, instead, we use BLE technology to send light-weight packets to send some data collision information back to the transmitters while they are sending some data to the AP.

### 1.1 802.11 and BLE Connection

BLE provides two communication mechanism; broadcasting and connections [6]. To send data collision information faster, we use connection mechanism. After a client, i.e. a smartphone, makes a connection with an AP, it also connects to the Bluetooth module attached to the AP via BLE protocol as a peripheral. Figure 1 shows this connection procedure.





Under our mechanism, the client can only access to the Internet after BLE connection established.

#### **1.2** Collision Notification Mechanism

The client can transfer data with 802.11 protocol after making connection to both the AP and BLE module. Following CSMA, it senses carrier first whether another client is sending data. However, rather just sending data like the existing CSMA scheme after sensing carrier, it should send data send notification (DSN) message to BLE module at the same time. Different from RTS in CSMA/CA, the client does not have to wait an RTS like packet from the AP. Right after sending DSN to the BLE module, the client can send its own data. From the view of BLE module, if there is only one client trying to send data, it ignores DSN message. Figure 2 shows the scenario that one client sends data to the AP.



Figure 2. A scenario that one client transfers data

However, if more than one clients send DSN within small amount of time, BLE module detects there should be data collision, so it broadcasts data collision notification (DCN) message to the clients that sent DSN message. Figure 3 shows the scenario that two clients send data to the AP at the same time.



Figure 3. A scenario that two clients transfer data at the same time

When the clients receive DCN message from BLE module of the AP, it aborts data transmission and wait a random backoff time to resend data.

## 2. RELATED WORKS

### 2.1 CSMA/CA

Because there is no way to notify data collision in wireless network due to its half-duplex property, IEEE 802.11 standard has a protocol to avoid collision by using RTS/CTS packet between an AP and clients. As sending and receiving RTS/CTS packet also requires time, it is proved that CSMA/CA reduces the overall throughput [3]. Many AP manufacturers embed CSMA/CA into their products, however, this feature is disabled by default and only be used when data chunk is big so that it is possible to deadly reduce throughput.

### 2.2 CSMA/CN

Souvik at el. proposed a CSMA/CN (*collision-notification*) protocol that is an approximated version of CSMA/CD in wireless network at 2010. It detects whether collision occurs by using physical layer hints and notifies to clients when collision is detected. Several techniques from signal correlation and Soft-PHY based hints are used to detect collision [4]. To send the information back from the AP to clients, one dedicated antenna of

the clients should not be used for data transmission to receive a collision notification. Also, it assumed SISO communication so that further implementation is necessary to be used with 802.11n or 802.11ac, most widely used in these days, as they use MIMO communication.

### 2.3 Bluetooth Low Energy (BLE)

Originally started as a part of Bluetooth 4.0 specification, it becomes totally different from the classic Bluetooth technology and aims a genuine low-power standard. Data throughput is relatively low, however, it is being widely used to embedded devices thanks to their low power consumption. It consumes at most 5 mA which is less than 1% of smartphone's Wi-Fi peak current consumption [1, 2].

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