IEEE P802.11

Wireless Access Method and Physical Layer Specification

Harmonization of Time Encoding

Michael Fischer
Digital Ocean, Inc.
4242–3 Medical Drive
San Antonio, TX 78229
Telephone: +1–210–614–4096
Facsimile: +1–210–614–8192
email: mfischer@CHILD.com

Abstract

The D1.2 draft standard uses more units to represent time than are necessary. This submission identifies the units currently used, and proposes to reduce the number and complexity of such usage. The result will be clear descriptions in the standard document and simpler implementation of conformant devices.

Desired Outcome

Adoption of the modified text for inclusion in the D2 draft of the standard..

Time Encoding in D1.2

The D1.2 draft standard uses four, different time units: **nanoseconds**, used in the MAC MIB for the beacon interval and slot time; **hundreds of nanoseconds**, used for time intervals in the PHY MIB; **microseconds**, used for duration values, NAV updates, and the TSF; and **milliseconds**, used in certain management frames to represent the length of beacon intervals, contention–free periods, and frequency hop dwell times. There are also several MAC attributes, such as aCTS_time and aACK_time, which are stated to be times, but which do not specify the time unit used. This is excessive, and may require unnecessary complexity to implement.

Proposed Harmonization of Time Encoding for D2

This submission proposes to harmonize time encoding as follows:

- **Encode short–duration intervals using a common unit shorter than 1 microsecond**
  If hundreds of nanoseconds are sufficient to specify the operational attributes of the various PHYs, there is no need to specify the beacon interval or slot time at 100X greater precision. The recommended unit is 62.5 nanoseconds (1/16 microsecond), for reasons discussed below; however, the current PHY unit of 100 nanoseconds is also acceptable for this purpose.

- **Encode intervals used directly for NAV and TSF update using microseconds**
  Since time synchronization and NAV operation are to microsecond resolution, the only items which need to be represented in units smaller than microseconds are those which must be added to calculate duration values related to TSF or NAV update.

- **Encode long–duration intervals using a unit of 1024 microseconds (Kmicroseconds)**
  It is justifiable to have an aggregated unit to encode long–duration intervals using shorter fields than would be possible in units of microseconds. A factor of approximately 1000 seems practical, but the use of milliseconds causes unnecessary implementation complexity, as is discussed below.

The unit currently used for long–duration intervals is the millisecond. This causes unnecessary implementation complexity. Stations must perform real–time calculations using "mixed" information — both the amount of time remaining in the long interval (such as time until next beacon, time remaining in the current FH dwell, or time remaining in the current contention free period) and the expected duration of possible next events (time to send the next frame, perhaps under multiple fragmentation assumptions). If the short interval is in microseconds and the long interval is in milliseconds, multiplication and/or division by 1000 is necessary, which generally requires hardware (either logic or memory for a look–up table) to meet the real–time constraints imposed by the protocol. If the long interval is in Kmicroceconds, shifting can be used to implement this multiplication and division.

The magnitude of this time unit is arbitrary, and totally internal to 802.11, because none of the times in question have a fixed relationship to wall clock time. The TSF is a time synchronization function, which uses an extremely long time representation to avoid the ambiguity that would otherwise occur from TSF timer wrap–around. All other times are relative or duration measurement within 802.11 protocol operation. By adopting a unit of Kmircoseconds, implementation where multiply/divide hardware is available is of equal complexity as when using units of milliseconds (and may be faster if the hardware uses Booth's algorithm); while implementation without such hardware becomes much more feasible.

The same argument applies to the short–duration measurement unit. If the short–duration unit were related to microseconds by a power of two, duration field value and NAV update calculations would be simplified. However, the importance is lower because bulk of these calculations can be done staticly, rather than as part of real–time processing.

Modifications to D1.2 Text for Time Harmonization

SECTION 1.1:	Add the definition **Kmicroseconds (Kusec).** A unit of time equal to 1025 microseconds.
SECTION 4.3.1.2:	change "milliseconds" to "Kmicroseconds"
SECTION 4.3.2.4:	change "ms" to "Kmicroseconds"
SECTION 4.3.2.7:	represent times in Kmicroseconds (The relevant text is the subject of a pending submission. The D1.2 text does not mention time units.)
SECTION 6.3:	represent times in Kmicroseconds (The current text is subject revision by a pending submission.)
SECTION 8.4.4.1.18:	change "nanoseconds" to "units of hundreds of nanoseconds" or "units of 62.5 nanoseconds" depending upon which motion is passed
SECTION 8.4.4.2.22:	change "time" to "time in microseconds"
SECTION 8.4.4.2.23:	change "time" to "time in microseconds"

SECTION 8.4.4.2.25:	change "time" to "time in microseconds"
SECTION 8.4.4.2.26:	change "time" to "time in units of hundreds of nanoseconds" or "time in units of 62.5 nanoseconds" depending upon which motion is passed
SECTION 8.4.4.2.27:	change "time" to "time in units of hundreds of nanoseconds" or "time in units of 62.5 nanoseconds" depending upon which motion is passed
SECTION 8.4.4.2.28:	change "time" to "time in units of hundreds of nanoseconds" or "time in units of 62.5 nanoseconds" depending upon which motion is passed
SECTION 8.4.4.1.21:	change "nanoseconds" to "units of hundreds of nanoseconds" or "units of 62.5 nanoseconds" depending upon which motion is passed
SECTION 8.4.4.2.34:	change "time" to "time in microseconds"
SECTION 8.4.4.2.35:	change "time" to "time in microseconds"
SECTION 10.1.4:	change references to "hundreds of nanoseconds" to "units of 62.5 nanoseconds" if this change is approved.