IEEE P802.11
Wireless LANs

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| CID 8028 – High throughput airtime link metric |
| Date: 2016-07-7 |
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Abstract

This document provides suggested resolution to CID 8028, which pointed out scaling problem of the airtime link metric for mesh operation.

**Comment**:

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| **CID** | **Commenter** | **PP.LL** | **Comment** | **Proposed Change** | **Suggested Resolution** |
| 8028 | Kazuyuki Sakoda | 2149.8 | 802.11s introduced mesh procedures. As a part of the mesh procedures, path selection protocol and path selection metric are used to determine a mesh path over multiple hops. Path selection protocol and path selection metric are replacable module. Active path selection protocol and active path selection metric are signaled through Active Path Selection Protocol Identifier field and Active Path Selection Metric Identifier field in the Mesh Configuration element (see 9.4.2.98). For path selection metric, Airtime link metric is defined in clause 14.9, as the default path selection metric. Value 1 is assigned to represent Airtime link metric in the Active Path Selection Metric Identifier.In short summary of the problem, the current Airtime link metric cannot express high throughput link appropriately and causes significant quantization error.Airtime link metric is a value expressed by 4 octet, from 0 up to 4 294 967 295. Roughly speaking, the Airtime link metric is a channel occupancy time to transmit 1,024 octet data expressed in 0.01 TU. If we assume VHT80 Nss=4, 400ns GI, MCS=8, 1.56Gbps for PHY rate, the payload of the data consumes only 2 OFDM symbols, which is smaller than the unit of the Airtime link metric (0.01TU=10usec). Even with VHT80 Nss=2, 400ns GI, MCS6, 585Mbps, payload airtime value is rounded to the unit. This means the metric value cannot express high data rate link appropriately, which results in non-ideal mesh path selection. Also, the Airtime link metric uses 1,024 octet data to measure the airtime, which is quite small if we consider MPDU aggregation which is quite typical for 802.11n and 802.11ac operation. Therefore, it is preferable to define a better metric expression that suites with high throughput links. | Add another Path Selection Metric, "High throughput airtime link metric", that scales to higher throughput links considering 802.11n and 802.11ac usage. To minimize the impact to the specification, the new Active Path Selection Metric shall work with existing Active Path Selection Protocol, HWMP. Only change the metric module. In particular:a) Assign a new Acive Path Selection Metric Identifier in 9.4.2.98,b) Add new clause describing "High throughput airtime link metric" right after 14.9 (Airtime link metric),c) Change MIB variable description relating to dot11MeshActivePathSelectionMetric,d) Add another row to PICS table.Commenter is willing to provide resolution text. Indeed, the changes to the spec is minimal, and does not break any existing operation. | REVISED: Adopt changes proposed in doc11-16/823r0. |

**Discussion**:

As commenter pointed out, Airtime link metric specified by 802.11s is intended for low data rate PHY mainly targeting physical layer defined by 802.11a/b/g. Also, the airtime link metric does not consider MPDU/MSDU aggregation for the metric calculation. It is better to define a new metric that scales to higher throughput transmission.

As the path selection metric is defined as replaceable module, it is easy to add another metric as a part of the specification. It is proposed to add a new path selection metric “high throughput airtime metric”. The new path selection metric works with existing path selection protocol, and does not make further impact to rest of the mesh procedures.

Brief summary of the proposed new metric is as follows:

* Use the same rationale for the metric representation, effective airtime occupancy to transmit 1024 octet data
* Use x1000 finer resolution to express high throughput links with marginal quantization error,
 i.e., in units of 0.01 usec instead of 0.01 TU
* Take aggregation factor into consideration for overhead calculation.

Some comparison between the current airtime metric and proposed high throughput airtime metric are shown in the following table (overhead portion is not included in the calculation below).

|  |  |  |  |
| --- | --- | --- | --- |
|  | Current metric | For comparison | **Recommended new metric** |
|  | Airtime link metric | High throughput airtime metric (0.1usec unit) | High throughput airtime metric (0.01usec unit) |
| Airtime to transmit 1024 octet over 6.93Gbps PHY | 0 = round(0.115) | 12 = round(11.82) | 118 = round(118.21) |
| Airtime to transmit 1024 octet over 1.73Gbps PHY | 0 = round(0.461) | 47 = round(47.27) | 473 = round(472.70) |
| Airtime to transmit 1024 octet over 1.56Gbps PHY | 1 = round(0.512) | 53 = round(52.51) | 525 = round(525.13) |
| Airtime to transmit 1024 octet over 585Mbps PHY | 1 = round(1.367) | 140 = round(140.03) | 1,400 = round(1400.34) |
| Airtime to transmit 1024 octet over 1Mbps PHY | 800 | 81,920 | 819,200 |
| Max. number of hops with 1Mbps PHY | 5,368,709 hops | 52,428 hops | 5,242 hops |

**Proposed changes**:

Apply the following changes.

Corresponding changes to D6.0 are indicated in the following text with “Track Changes” on, to clarify the direction to the editor. Please update the part indicated by the “Track Changes” only.

***To REVmc Editor: Insert a new row representing value of 2 in Table 9-217 in subclause 9.4.2.98.3.***

**9.4.2.98.3 Active Path Selection Metric Identifier**

The Active Path Selection Metric Identifier field indicates the path metric that is currently used by the active

path selection protocol in the MBSS. Table 9-218 (Active Path Selection Metric Identifier field values)

provides the path selection metric identifier values defined by this standard.

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| --- |
| Table 9-218—Active Path Selection Metric Identifier field values |
| Value | Meaning |
| 0 | Reserved |
| 1 | Airtime link metric defined in 14.9 (Airtime link metric) (default path selection metric) |
| 2 | High Throughput airtime link metric defined in 14.10 (High Throughput airtime link metric) |
| 3–254 | Reserved |
| 255 | Vendor specific(The active metric is specified in a Vendor Specific element) |

When the Active Path Selection Metric Identifier field is 255, the active path metric is specified by a Vendor

Specific element that is present in the frame. The content of the Vendor Specific element is beyond the

scope of this standard. (See 9.4.2.26 (Vendor Specific element).)

***To REVmc Editor: Insert the following new subclause 14.10 High throughput airtime link metric, right after the subclause 14.9 Airtime link metric.***

14.10 High throughput airtime link metric

This subclause defines a link metric that may be used by a path selection protocol to identify an efficient radio-aware path for high throughput networks. This metric is used when dot11MeshActivePathSelectionMetric is highThroughputAirtimeLinkMeetric (2) (see 14.2.3 (Mesh profile)).

Airtime reflects the amount of channel resources consumed by transmitting the frame over a particular link. This measure is approximate and designed for ease of implementation and interoperability.

The airtime for each link is calculated as follows:

where

*O* and *Bt* are constants listed in Table 14-4 (Airtime cost constants) in subclause 14.9 (Airtime link metric)

input parameter *r* is the data rate (in Mb/s)

input parameter *n* is the typical number of MSDUs aggregated in a single data frame

input parameter *ef* is the frame error rate for the test frame size *Bt*

rate *r* represents the data rate at which the mesh STA would transmit a frame of standard size *Bt* based on current conditions, and its estimation is dependent on local implementation of rate adaptation

number of MSDUs *n* represents the number of MSDUs that the mesh STA would transmit in a typical data frame, and its estimation is dependent on local implementation of the MSDU/MPDU aggregation

frame error rate *ef* is the probability that when a frame of standard size *Bt* is transmitted at the current transmission bit rate *r*, the frame is corrupted due to transmission error; its estimation is a local implementation choice. Frame failures due to exceeding Mesh TTL should not be included in this estimate as they are not correlated with link performance.

The high throughput airtime link metric shall be encoded as an unsigned integer in units of 0.01 usec.

NOTE-- It is recommended that a STA use high throughput airtime link metric when its PHY entity operates either high throughput (HT) orthogonal frequency division multiplexing (OFDM) system (Clause 19 (High Throughput (HT) PHY specification)), very high throughput (VHT) orthogonal frequency division multiplexing (OFDM) system (Clause 21 (Very High Throughput (VHT) PHY specification(11ac))), television very high throughput (TVHT) orthogonal frequency division multiplexing (OFDM) system (or Clause 22 (Television Very High Throughput (TVHT) PHY specification(11af))).

High throughput airtime link metric uses parameters given in Table 14-5 (Parameters of the Airtime link metric for extensible path selection framework) specified in subclause 14.9.

***To REVmc Editor: Change the row representing MP10 in the table in B.4.21.1 (General mesh support) in Annex B as follows:***

* Mesh protocol capabilities

**B.4.21.1 General mesh support**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  MP9.5 | Frame transmission to a mesh STA in deep sleep mode | 14.14.7 (Power save support), 14.14.9 (Mesh peer service periods)(Ed) | MP9:M | Yes  No  N/A  |
| \*MP10 | Link metric computation | 14.9 (Airtime link metric)(Ed) | CFMBSS(#6573):M | Yes  No  N/A  |
| MP10.1 | Airtime link metric computation | 14.9 (Airtime link metric)(Ed) | MP10 (#6573):M | Yes  No  N/A  |
| MP10.2 | High throughput airtime link metric computation | 14.10 (High thruoghput airtime link metric)(Ed) | MP10: O(#6573) | Yes  No  N/A  |
| \*MP11 | Link metric reporting | 14.8.3 (Link metric reporting)(Ed) | CFMBSS(#6573):M | Yes  No  N/A  |

***To REVmc Editor: Change the MIB definition of dot11MeshActivePathSelectionMetric in Annex C as follows:***

* MIB Detail

dot11MeshActivePathSelectionMetric OBJECT-TYPE

 SYNTAX INTEGER { airtimeLinkMetric (1), highThroughputAirtimeLinkMetric (2), vendorSpecific (255) }

 MAX-ACCESS read-write

 STATUS current

 DESCRIPTION

 "This is a control variable.

 It is written by an external management entity.

 Changes take effect for the next MLME-START.request (MDR)primitive.

 This attribute specifies the active path selection metric."

 DEFVAL { airtimeLinkMetric }

 ::= { dot11MeshSTAConfigEntry 13 }

**Reference**:

[1] Draft P802.11REVmc\_D6.0.