EEE P802.11
Wireless LANs

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| MAC Calibration Text to Simulation Scenarios |
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# Abstract

This document describes MAC calibration tests to be added for the Simulation Scenarios document.

The payload considered as throughput is specified.

# Scenarios for calibration of MAC simulator

## Common parameters

The following parameters are common to the MAC tests unless otherwise stated.

|  |  |
| --- | --- |
| **PHY Parameter** | **SUGGESTED VALUES** |
| GI:  | [long] |
| Data Preamble:  | [11ac] |
| BW | 20 Mhz  |

|  |  |
| --- | --- |
| **Parameter** | **SUGGESTED VALUES** |
| Aggregation | A-MPDU max aggregation size =64 No A-MSDUimmediate BA(aggregation is assumed to be ON) |
| TXOP |  4 ms |
| Max number of retries | 10 |
| Rate adaptation | Fixed MCS |
| EDCA parameters | Default parameter values for best effort  |

The follwing parameters are common to the traffic model unless otherwise stated.

Transport protocol- UDP

Traffic model: full buffer

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| OFDM preamble duration | 20 us |
| VHT preamble duration | 40 us |
| Data MPDU MAC header size | 30 B |
| A-MPDU delimiter size | 4 B |
| MPDU FCS size | 4 B |
| PSDU service field size | 2 B |
| PSDU tail field size | 6 bits |
| BA control message MDPU size | 32 B |
| RTS control message MPDU size | 20 B |
| CTS control message MPDU size | 14 B |
| NDBS - VHT BPSK ½ | 26 |
| NDBS - VHT 256QAM ¾ | 312 |
| NDBS - OFDM BPSK ½ | 24 |
| MCS of control PPDUs | OFDM BPSK ½  |
| UDP header size | 8 B |
| IP header size | 20 B |
| LLC / SNAP header size | 8 B |
| PHY mode of data PPDUs | VHT |



This is calculated as throughput

Figure 11 – Structure of the PPDU. IP + UDP + Application data should be considered as throughput.

## Calculation of expected results

$$PPDU\_{duration}\left[μs\right]=\frac{\left⌈\frac{8\* PSDUsize\_{bytes}}{NDBS}\right⌉}{250000}+PLCPpreamble\_{duration}$$

$$DataPPDU\_{duration}= \frac{\left⌈\frac{8\*(3+MPDUs\*\left(74+Appl\_{size}+pad\right))}{NDBS}\right⌉}{250000}+40μs$$

$$BA\_{duration}=\frac{\left⌈\frac{8\*\left(2+32+1\right)}{24}\right⌉}{250000}+20μs=68μs$$

$$RTS\_{duration}=\frac{\left⌈\frac{8\*\left(2+20+1\right)}{24}\right⌉}{250000}+20μs=52μs$$

$$CTS\_{duration}=\frac{\left⌈\frac{8\*\left(2+14+1\right)}{24}\right⌉}{250000}+20μs=44μs$$

$$RTSCTS\_{duration}=\left\{\begin{array}{c}RTS\_{duration}+SIFS+CTS\_{duration}+2\*SIFS=128μs, enabled \\0, disabled\end{array}\right.$$

$$Throughput\_{Mbps}=\frac{ApplicationSDUSize\_{bytes}\*8\*NumOfMPDUsPerAMPDU }{RTSCTS\_{duration}+DIFS+\frac{9us\* CW\_{min}}{2}+Data\_{duration}+SIFS+ BA\_{duration}}$$

### Assumptions on the reception (PER)

## The following reception logic is used in the simulations:

* If collision (simultaneous transmission from two or more STAs) occur during the preamble transmission, the PPDU is not received. (PER = 1 for PPDU)
* If collision occurs during MPDU transmission, the MPDU during which the collision occurred is not received (PER =1 for MPDU).

The simulations may be performed so that link statistics are used to consider the PER or the fixed PER may be configured to the simulator.

In practise PER in tests 1a and 1b is 0.

## Test 1a: MAC overhead w/out RTS/CTS

Parameters:

 MSDU length: [0:500:2000Bytes]

 RTS/CTS off

 MCS = [0,8] ( to clarify, run a sweep over MSDU length once for MCS 0, and once for MCS 8.



Output metric:

1. Application layer Throughput
2. Time trace of transmitting/Receiving event

To check the performance of simulator

CP1 ( check point 1) start of A-MPDU

CP2 end of A-MPDU

CP3 start of ACK

CP4 end of ACK

CP5 start of A-MPDU

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | Check points | Standard definition | Matching? |
| A-MPDU duration | Tcp2-Tcp1=  | ceil((FrameLength\*8)/rate/OFDMsymbolduration) \* OFDMsymbolduration + PHY Header  |  |
| SIFS  | Tcp3-Tcp2=16 us  | 16 us  |  |
| ACK duration  | Tcp4-Tcp3=  | ceil((ACKFrameLength\*8)/rate/OFDMsymbolduration) \* OFDMsymbolduration + PHY Header  |  |
| Defer & backoff duration  | Tcp5-Tcp4=  | DIFS(34 us)+backoff (CWmin)=34us+n\*9us  |  |

Tcp is the timestamp related with the corresponding simulation event on the check point (CP)

The following is an example calcultation of TPUT when the MSDU size is 1508, and MCS =0

* Number of MPDUs in AMPDU= 2
* Bytes per MPDU:
	+ Bytes from application laye:1472
	+ MAC header 30 bytes
	+ FC=2;Duration=2;Addr1=6;Addr2=6;Addr3=6;SeqContrl=2;QoSCntrl=2; FCS=4
		- Note: Assuming HT control field is not used
	+ MPDU delimiter 4 bytes
	+ 2 bytes padding
* Bytes per AMPDU
	+ Tail bits 1 bytes
	+ Service Field 2 Bytes
* Total Bytes per AMPDU: 3091
* Duration of PPDU w/out preamble= 3091/6.5e6=3.804ms
* Duration of PPDU w/ preamble= 3.844ms
* Duration of ACK 68 us
* Expected time waiting for the Medium = 100.5 us (CWmin =15)
* Expected TPUT= 1472\*8\*2/(3.844ms+68us+16us+100.5us)
* (Note this is application layer tput, oincluding IP and UDP headers and application payload,)

Table 1 - Test 1a expected (theoretical) results and

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MSDU size [B]** | **Data MCS [index]** | **MSDUs per A-MPDU [#]** | **Data PPDU Duration [ms]** | **Calculated Application Throughput [Mbps]** | **Simulated Application Throughput [Mbps]** |
| 500 | 0 | 5 | 3.592 | 5.29 | 5.32 |
| 1000 | 0 | 2 | 2.696 | 5.55 | 5.59 |
| 2000 | 0 | 1 | 2.600 | 5.74 | 5.78 |
| 500 | 8 | 64 | 3.784 | 63.85 | 64.06 |
| 1000 | 8 | 34 | 3.756 | 68.32 | 68.48 |
| 2000 | 8 | 17 | 3.62 | 70.73 | 70.91 |

## Test 1b: MAC overhead w RTS/CTS

Parameters:

 MSDU length:[0:500:2000Bytes]

 RTS/CTS ON

 MCS = [0,8]

Output metric:

1. MAC layer Throughput
2. Time trace of transmitting/Receiving event



CP1 ( check point 1) : start of RTS

CP2 : end of RTS

CP3: start of CTS

CP4: end of CTS

CP5: start of A-MPDU

CP6: end of A-MPDU

|  |  |  |  |
| --- | --- | --- | --- |
| Test Items | Check points | Standard definition | Matching? |
| RTS duration  | Tcp2-Tcp1=  | ceil((RTSFrameLength\*8)/rate/OFDMsymbolduration) \* OFDMsymbolduration + PHY Header  |  |
| CTS duration  | Tcp4-Tcp3=  | ceil((CTSFrameLength\*8)/rate/OFDMsymbolduration) \* OFDMsymbolduration + PHY Header  |  |
| Frame duration  | Tcp6-Tcp5=  | ceil((FrameLength\*8)/rate/OFDMsymbolduration) \* OFDMsymbolduration + PHY Header  |  |

The following is an example TPUT calculation when MSDU size is 1508, and MCS =0

* Number of MPDUs in AMPDU= 2
* Bytes per MPDU:
	+ Bytes from application layer:1472
	+ L4 header: 36 bytes
	+ MAC header 30 bytes
	+ FC=2;Duration=2;Addr1=6;Addr2=6;Addr3=6;SeqContrl=2;QoSCntrl=2; FCS=4
	+ MPDU delimiter 4 bytes
	+ 2 bytes padding
* Bytes per AMPDU
	+ Tail bits < 1 bytes
	+ Service Field 2 Bytes
* Total Bytes per AMPDU: 3091
* Duration of PPDU w/out preamble= 3091/6.5e6=3.804ms
* Duration of PPDU w/ preamble= 3.844ms
* Duration of ACK 68 us
* Duration of RTS 52 us
* Duration of CTS 44 us
* SIFS= 16us
* Expected time waiting for the Medium = 100.5 us (CWmin =15)
* Expected TPUT= 1472\*8\*2/(3.844ms+68us+16us+100.5us + 52us+44us+2\*16us) (Note this is application layer TPUT)

Table 2 - Test 1b expected (theoretical) results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **MSDU size [B]** | **Data MCS [index]** | **MSDUs per A-MPDU [#]** | **Data PPDU Duration [ms]** | **Calculated Application Throughput [Mbps]** | **Simulated Application Throughput [Mbps]** |
| 500 | 0 | 5 | 3.592 | 5.12 | 5.15 |
| 1000 | 0 | 2 | 2.696 | 5.32 | 5.36 |
| 2000 | 0 | 1 | 2.600 | 5.49 | 5.52 |
| 500 | 8 | 62 | 3.704 | 61.73 | 61.94 |
| 1000 | 8 | 33 | 3.684 | 66.04 | 66.34 |
| 2000 | 8 | 17 | 3.660 | 68.45 | 68.76 |

## Test 2a: Deferral Test 1

(AP1 and STA2 are essentially co-located)

Note:

AP1 and AP2 should defer to each other.

The only packet loss is due to collisions when backoffs end at same time.

Parameters:

MSDU length:[0:500:2000Bytes]

Data and Control MCS index [0]

 RTS/CTS [ OFF, ON]

 MCS = [0]

Outputs:

|  |  |  |
| --- | --- | --- |
| **MSDU size [B]** | **RTS/CTS** | **Simulated Application Throughput per STA [Mbps]** |
| 500 | Off | 5,04 |
| 1000 | Off | 5,32 |
| 2000 | Off | 5,50 |
| 500 | On | 5,18 |
| 1000 | On | 5,40 |
| 2000 | On | 5,56 |

## Test 2b: Deferral Test 2

Parameters:

MSDU length:[0:500:2000Bytes]

 RTS/CTS [OFF]

 MCS = [0,8]

Outputs:

|  |  |  |
| --- | --- | --- |
| **MSDU size [B]** | **MCS Index** | **Simulated Application Throughput per STA [Mbps]** |
| 500 | 0 | TBD |
| 1000 | 0 | TBD |
| 2000 | 0 | TBD |
| 500 | 8 | TBD |
| 1000 | 8 | TBD |
| 2000 | 8 | TBD |

## Test 4: NAV deferral

(AP1 and STA2 are essentially co-located)

Assumptions:

All devices are within energy detect range of each other.

APs send single MPDU, but sets NAV to txoplimit, 4 ms

APs defer due to NAV setting.

Parameters:

MSDU=1500 bytes

RTS/CTS off

MCS=0

Outputs:

|  |  |  |
| --- | --- | --- |
| **MSDU size [B]** | **MCS Index** | **Simulated Application Throughput per STA [Mbps]** |
| 500 | Off | 5,32 |
| 1000 | Off | 5,59 |
| 2000 | Off | 5,78 |
| 500 | On | 5,15 |
| 1000 | On | 5,36 |
| 2000 | On | 5,52 |