Panther MU-OFDMA Application Note

2021/10/1

William

Version History

Version	Date	Author (Optional)	Description
0.1	2021-9-23	William	Initial draft
1.0	2021-10-1	Micheal Su	Official release

Outline

- Introductions to Wi-Fi OFDMA and RU Feature
- Basic Concepts of OFDMA and RU Feature
- How to Configure – profile
- How to Debug
- Test Result

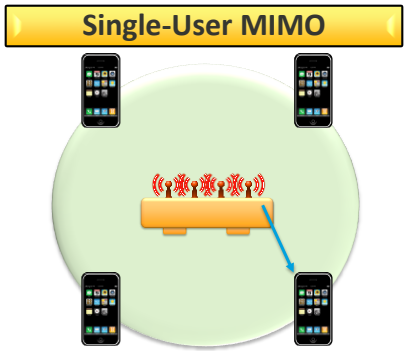
Introductions to Wi-Fi OFDMA and RU feature

802.11ax Features: OFDMA

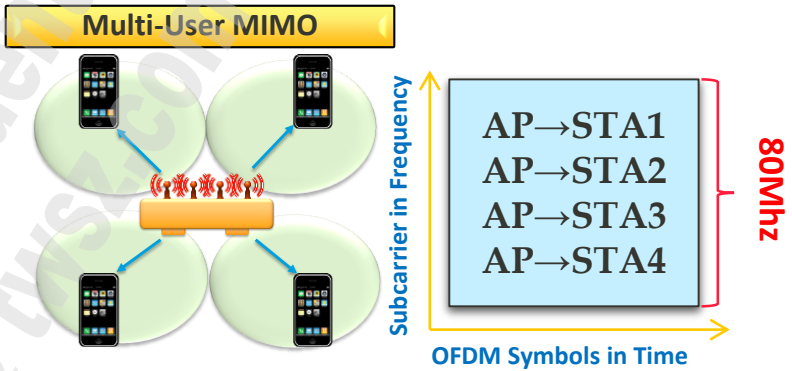
- **OFDMA**
  - As efficient use in 4G LTE and 5G, multiple users can be served by different Resource Units(RUs) /Bandwidth simultaneously
- **Uplink Resource Scheduling**
  - Compared to legacy 802.11, where large users compete each other to send UL data, 11ax provides trigger scheduling in better resource utilization and better latency experience
- **Uplink MUMIMO**
  - Allow users can send uplink data in the same bandwidth simultaneously for sharing heavy traffic such as social media and content sharing
  - Assume: 11ax with 4x4 AP and 2x2 Client. It would increase 2x capacity compared to 11ac uplink

*User also represents Non-AP STA
*UL: Uplink

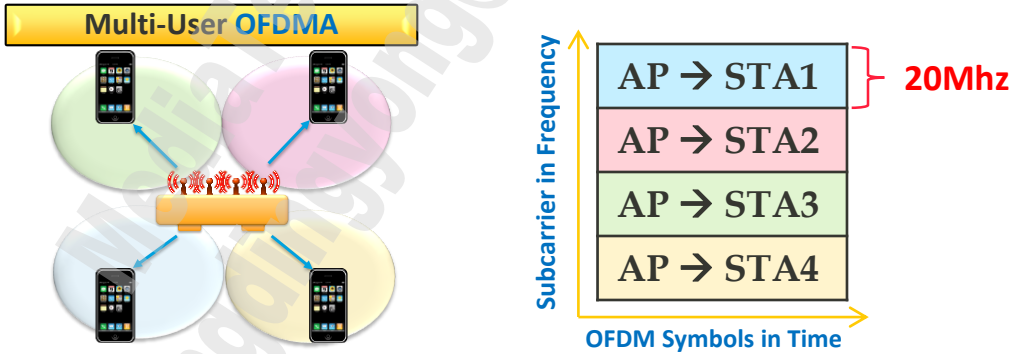
Different Transmit Schemes



Tx/Rx single user at a time



Tx multiple users concurrently in the same bandwidth



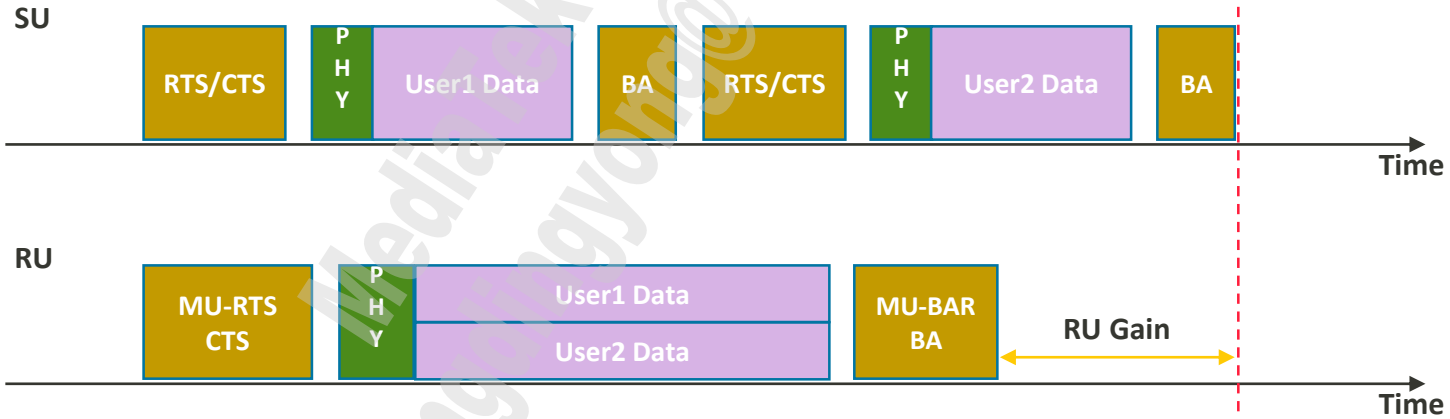
Tx/Rx multiple users concurrently, but in the different bandwidth

Basic Concepts of OFDMA and RU Feature

What is the RU Latency gain factor?

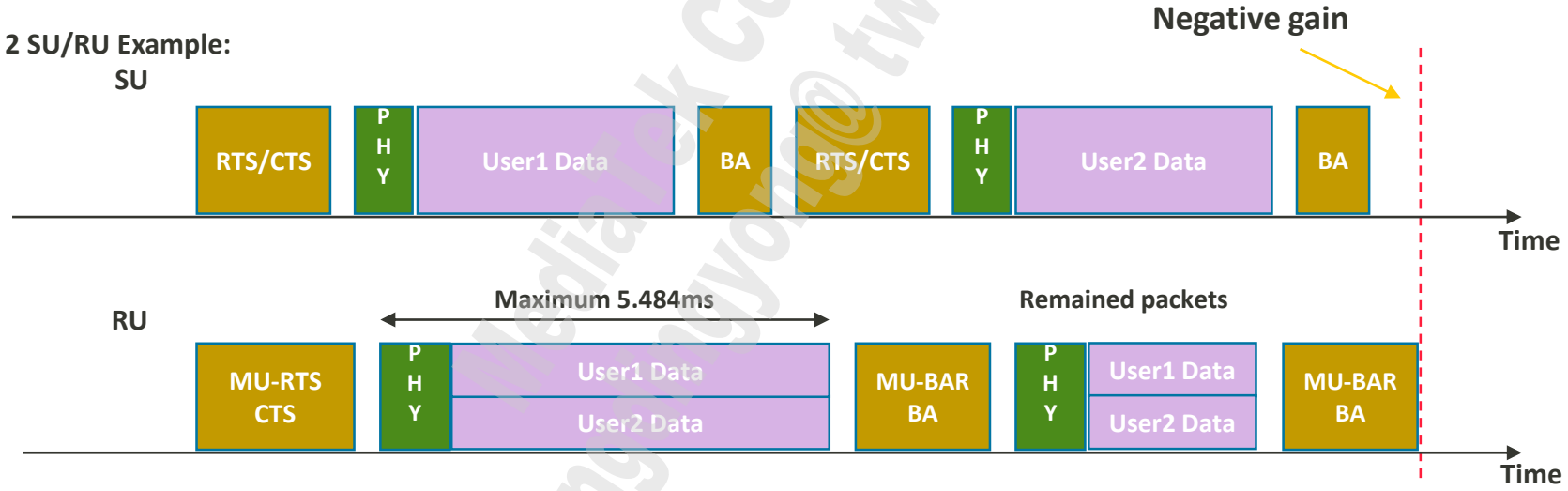
- **RU latency gain in short PPDU**
  - RU gain is from reducing amount of control frame.
  - Despite the duration of single MU-RTS, MU-BAR is longer than legacy RTS and BA.
  - The total duration of control frame(include SIFS) of RU is shorter than SU.

2 SU/RU Example:



What is the RU Latency gain factor?

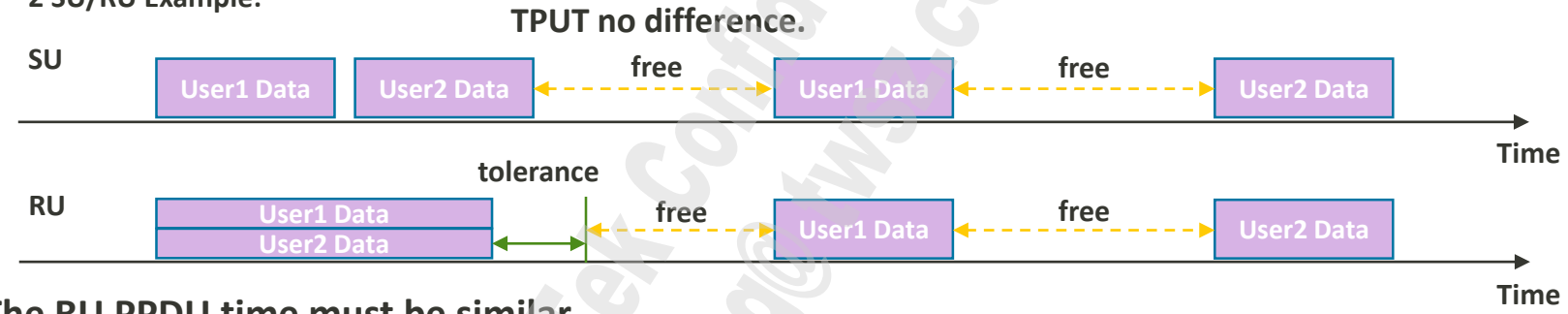
- **RU latency gain in long PPDU is not obvious.**
  - **The maximum duration of PPDU is limited to 5.484ms.**
  - **Because of long packets cannot aggregate into single MU-PPDU, total PPDU count is not reduced.**
  - **MU-variant control frame is bigger than legacy control frame.**



Other RU latency gain factors

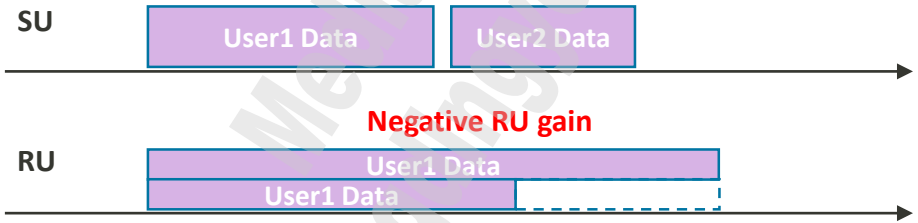
- **The air time must be fully occupied.**

2 SU/RU Example:



- **The RU PPDU time must be similar.**

2 SU/RU Example:



Other RU latency gain factors

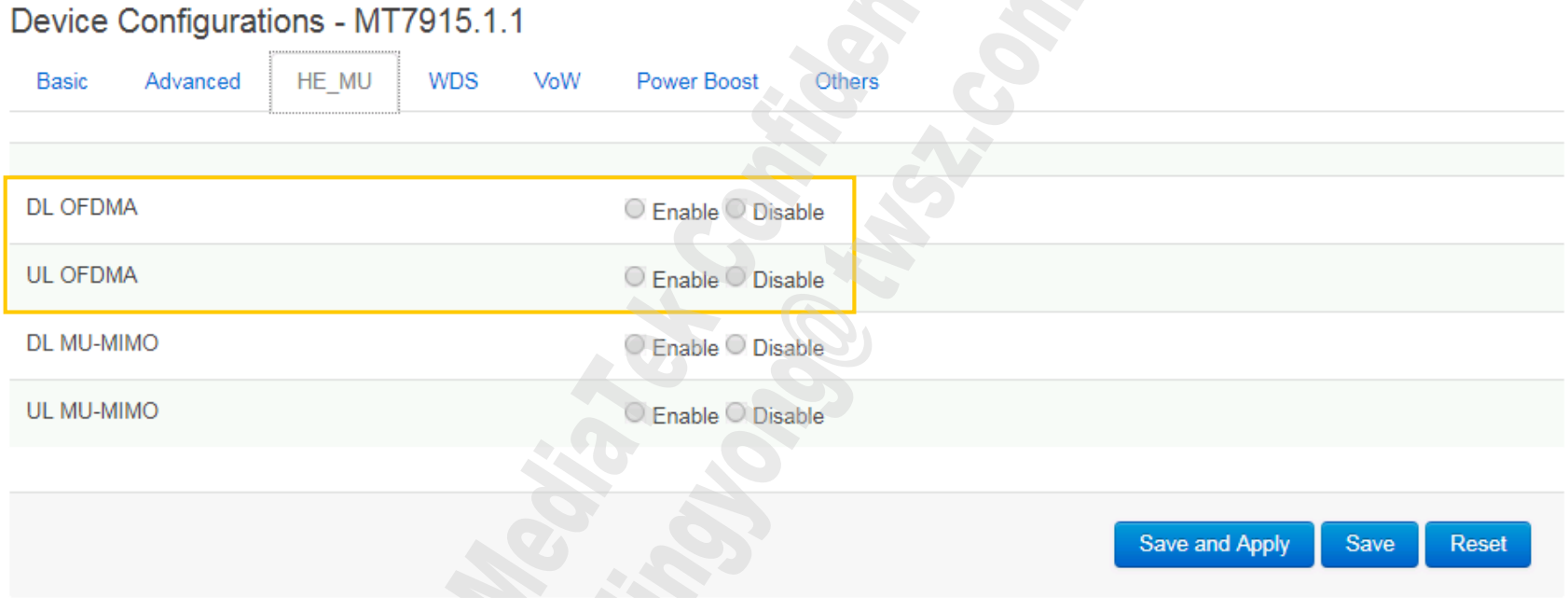
- For MT7986 RU testing, please use small packet size. E.g. 64B or 128B.
- For MT7986 RU testing, It must connected more then 5 (>= 5) STAs.
- MT7986 support max 8(2G) + 16(5G) MU candidate STAs.

How to Configure – profile

Enable OFDMA by Profile

- **Enable DL/UL OFDMA Feature**
- **Key parameters in profile**
  - **MuOfdmaDlEnable=1**
  - **MuOfdmaUlEnable=1**

Enable OFDMA by WebUI



How to Debug

TX Statistics Commands

- **Show TX Statistics with TX Mode(DL/UL)/TX StaCnt (OFDMA/MUMIMO)**
  - **iwpriv ra0 set set_muru_txc_tx_stats=<1:Enable/0:Disable>**
    => enable TX Statistics
  - **iwpriv ra0 show get_muru_txc_tx_stats=<Band>**
    => show TX Statistics

TX Statistics Commands (2/)

1

```
Downlink:          total          tx_mode          sub_mode         stacnt
                   count          ratio            ratio            ratio
=============================================================================
CCK:               18             0%
OFDM:              0              0%
HT_MIX:            0              0%
HT_GF:             0              0%
VHT:               0              0%
  SU:              0                               0%
  MUMIMO:          0                               0%
    2MU:           0                                                0%
    3MU:           0                                                0%
    4MU:           0                                                0%
HE_SU:             44803                  54%
HE_EXT:            0              0%
HE_MU:             37523                  45%
  OFDMA:           37523                                  0%
     2RU:          6203                                             7%
     3RU:          8310                                             10%
     4RU:          8516                                             10%
    5-8RU:         14494                                                    17%
   9-16RU:         0                                                0%
    >16RU:         0                                                0%
 MUMIMO:           0                               0%
    2MU:           0                                                0%
    3MU:           0                                                0%
    4MU:           0                                                0%
```

2

```
Uplink:            total          tx_mode          sub_mode         stacnt
                   count          ratio            ratio            ratio
=============================================================================
HE_TRIG            0              0%
  OFDMA:           0                               0%
      SU:          0                                                0%
     2RU:          0                                                0%
     3RU:          0                                                0%
     4RU:          0                                                0%
    5-8RU:         0                                                0%
   9-16RU:         0                                                0%
    >16RU:         0                                                0%
 MUMIMO:           0                               0%
    2MU:           0                                                0%
    3MU:           0                                                0%
    4MU:           0                                                0%
```

1. Downlink part
2. Uplink part
3. Tx mode ratio: ratio of different TX mode PPDU. e.g. CCK/OFDM/ … / HE_SU/HE_MU
4. sub mode ratio: ratio of OFDMA/MUMIMO PPDU
5. stacnt ratio: ratio of different stacnt PPDU

DL OFDMA Commands

- Force to transmit DL HE-MU PPDU with [StaCnt] users
  - iwpriv ra0 set set_muru_manual_config=dl_comm_user_cnt:[StaCnt]
  - iwpriv ra0 set set_muru_manual_config=update
  - SW will choose a proper RU combination for HE-MU PPDU, a general rule is dividing full BW into [StaCnt] RUs with equal size,
    e.g. (RU242, RU242, RU242, RU242)@80M with [StaCnt=4], (RU484, RU484)@80M with [StaCnt=2]
- Release DL HE-MU forcing condition
  - iwpriv ra0 set set_muru_manual_config=dl_init
  - iwpriv ra0 set set_muru_manual_config=update

DL OFDMA Commands (2/)

- **Force to transmit DL SU PPDU**
  - **iwpriv ra0 set set_muru_sutx=1;**

CMDRPT TX SU/RU Ratio:

MODE	TOT_MPDU_CNT	Percentage
OFDM	7	0.00
HE_SU	241301	100.00

- **Release DL SU forcing condition**
  - **iwpriv ra0 set set_muru_sutx=0;**

CMDRPT TX SU/RU Ratio:

MODE	TOT_MPDU_CNT	Percentage
OFDM	5	0.00
HE_SU	438305	91.05
HE_MU	43093	8.95

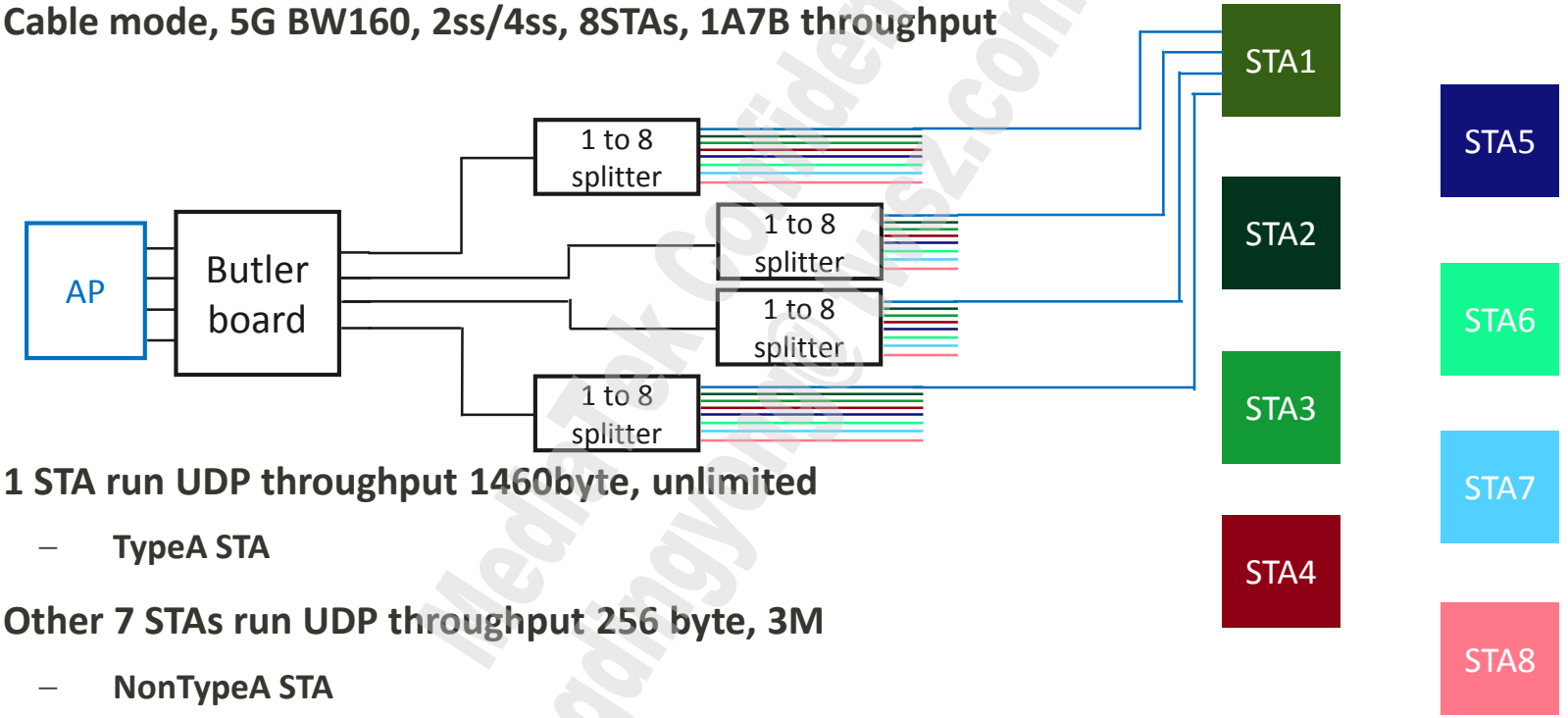
UL OFDMA Commands

- Check MU EDCA status
  - Before delivering throughput, please type the command:
  - iwpriv ra0 show get_muedca=1
  - After Log is captured, please type the command to turn off MU EDCA check:
  - iwpriv ra0 show get_muedca=0
- Check UL OFDMA FW status
  - iwpriv ra0 show get_ulru_status
  - It shows the status of each STA

Test Result

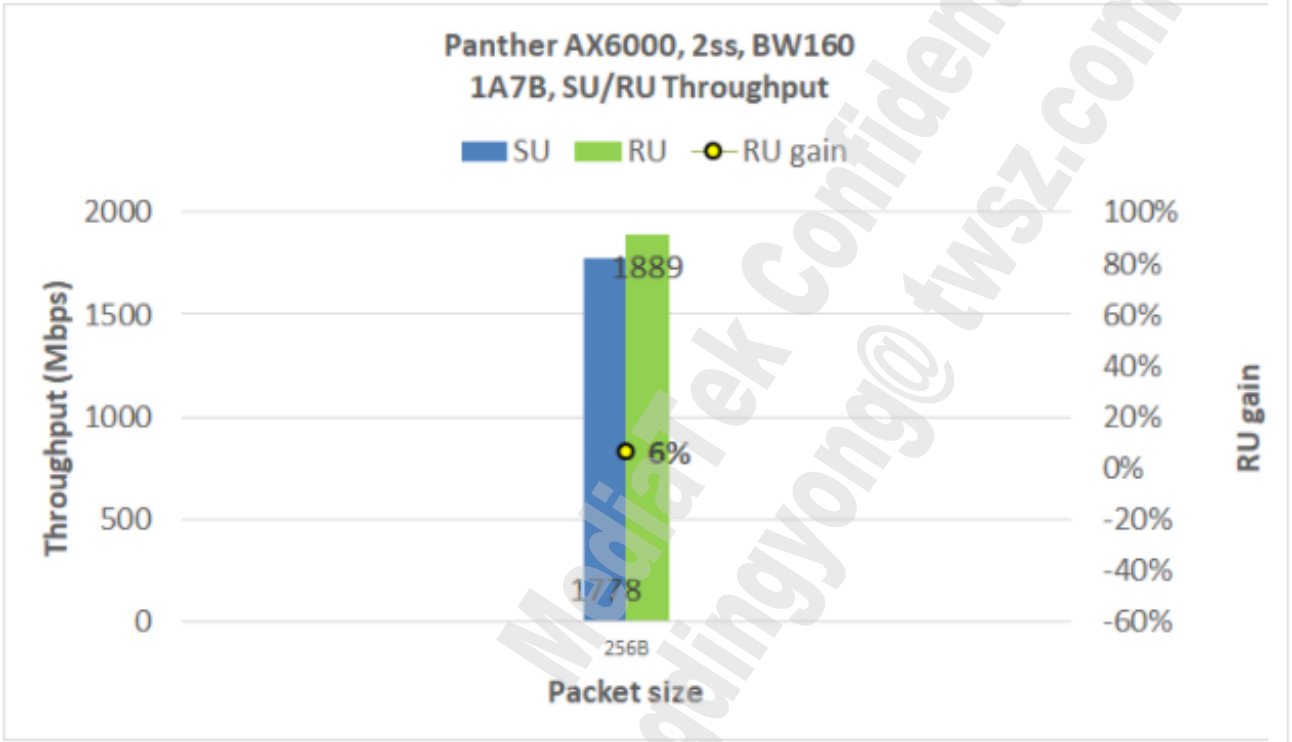
DL/UL OFDMA MTK test Scenario

- **Cable mode, 5G BW160, 2ss/4ss, 8STAs, 1A7B throughput**



- **1 STA run UDP throughput 1460byte, unlimited**
  - **TypeA STA**
- **Other 7 STAs run UDP throughput 256 byte, 3M**
  - **NonTypeA STA**

DL OFDMA MTK test report



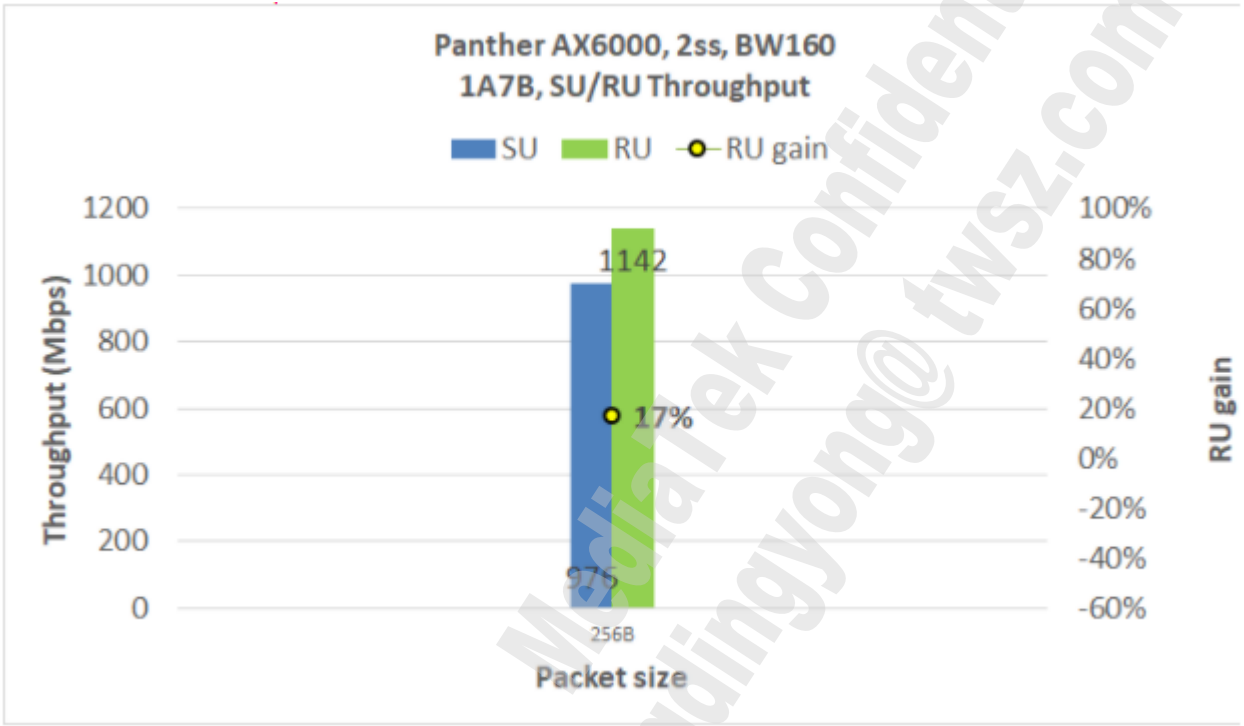
STA:

Panther AP client x 2 +

Toucan x 2 +

Harrier AP client x 12

UL OFDMA MTK test report



STA:

Panther AP client x 2 +

Toucan x 2 +

Harrier AP client x 12