60 GHz range improvements and multipoint capabilities

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April 2018

Wireless band comparison

2.4 GHz 802.11b/g/n	5 GHz 802.11a/n/ac	60 GHz 802.11ad
- • Crowded spectrum • Low channel count	- • DFS and radar detection • Rapidly increasing channel widths	- • Oxygen absorption • Low distance
+ • Higher distances • Better penetration through objects	+ • High throughput • More available channels	+ • The highest throughput • Free spectrum

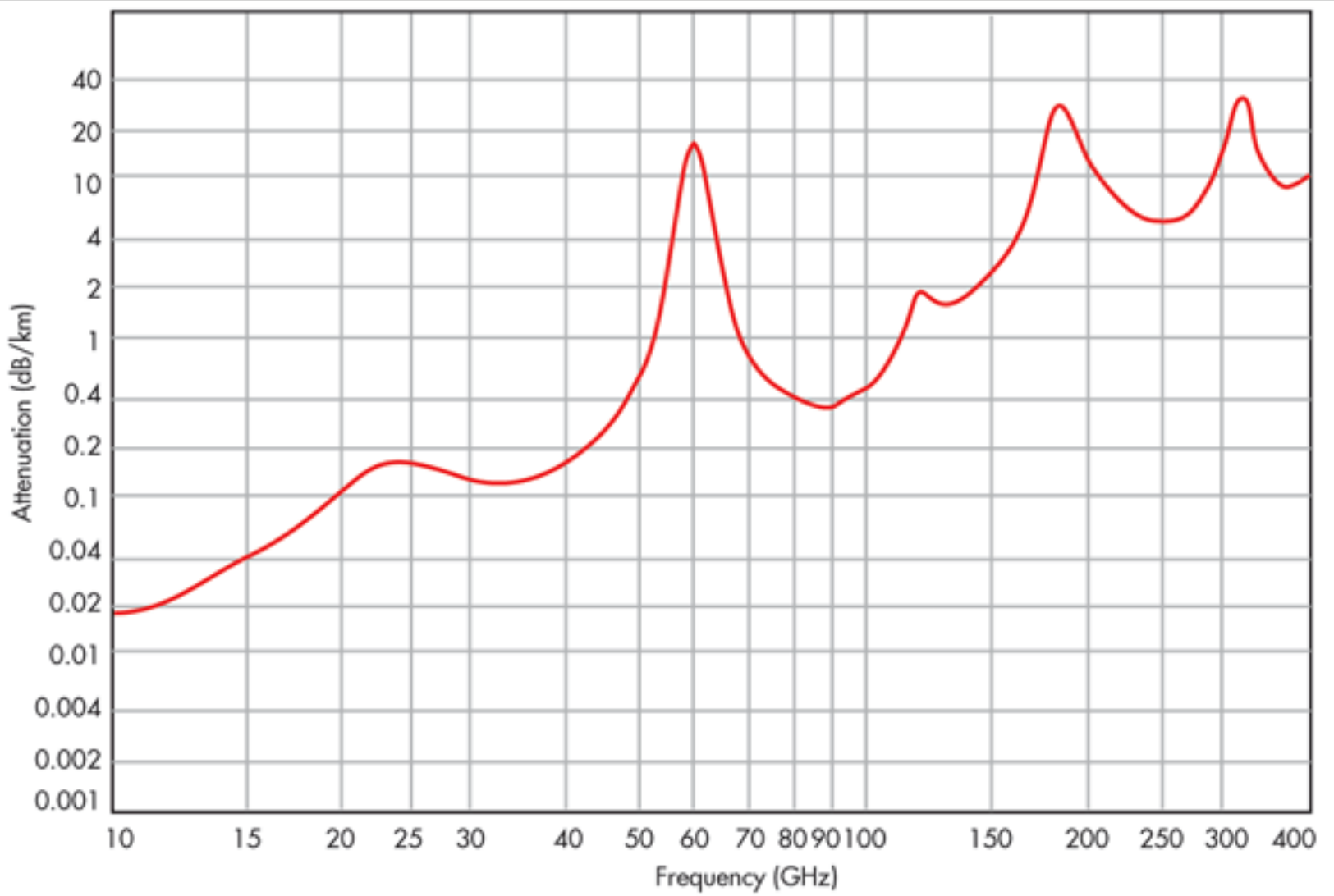


Image Source:
http://www.electronicdesign.com

Wireless Wire

Wireless Wire

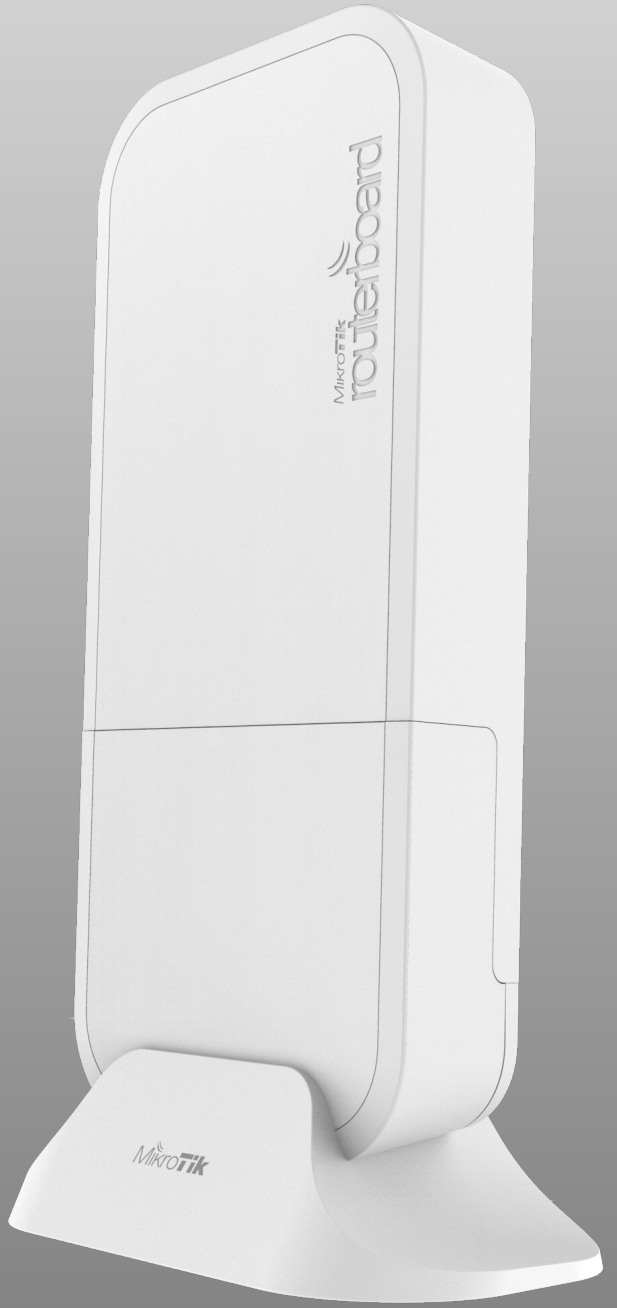
- Pre-configured 60 GHz radio link (Plug and Play)
- 4 core CPU running at 716 MHz, 256 MB of RAM
- Only 5 W of maximum power consumption
- Range of 200 meters or more
- Beamforming and PtMP support

Wireless Wire

- Channel bandwidth 2.16 GHz
- Total EIRP under 40 dBm
- 32 antenna elements
- Sweeps between 64 antenna patterns
- Wireless coverage close to 180 degrees
- Price $198

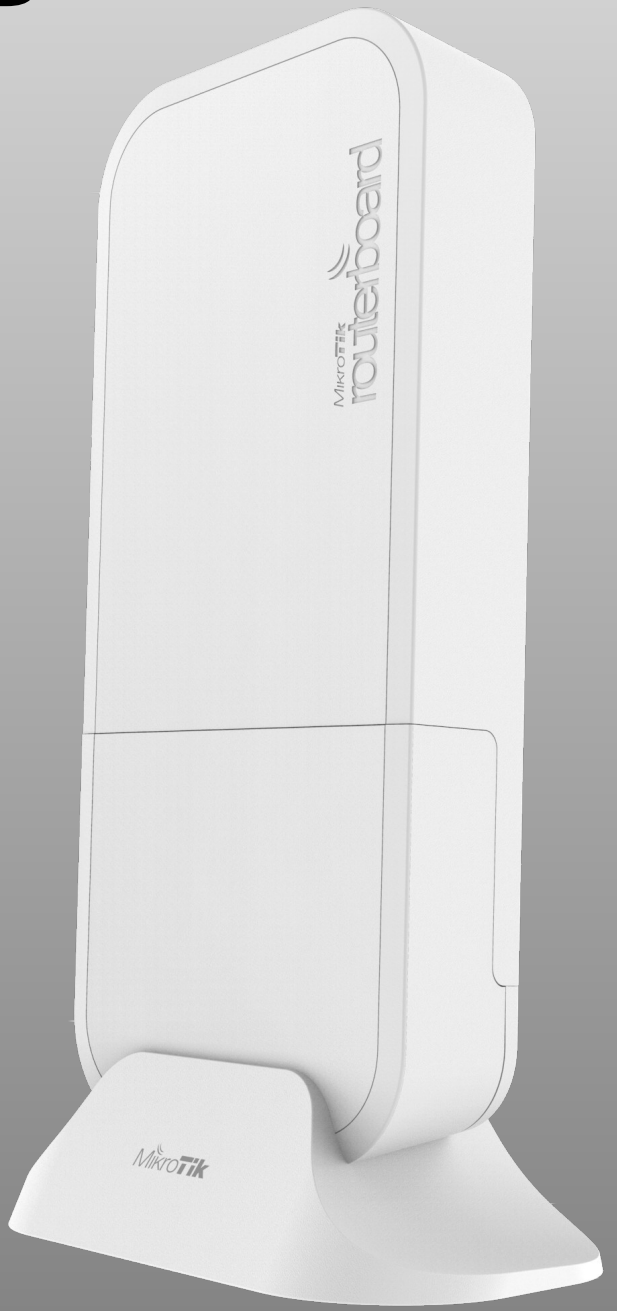
wAP 60G

- Same hardware as used in Wireless Wire kit
- CPE device
- License level 3
- Price $99



wAP 60G AP

- Same hardware as used in Wireless Wire kit
- Access Point device for 8 clients
- License level 4
- Price $129



LHG60G kit

- For distances up to

  1500 m+
- EN 302 217 – Fixed Point to Point compliant
- Antenna gain > 30dBi
- Total EIRP < 55dBm
- License level 3
- Price $298 for kit

Wireless modes

- Wireless modes for 60 GHz
  - “ap-bridge”
  - “bridge”
  - “station-bridge”
  - “sniff”
- Configuration under “/interface w60g” menu
  - SSID
  - Password
  - Mode

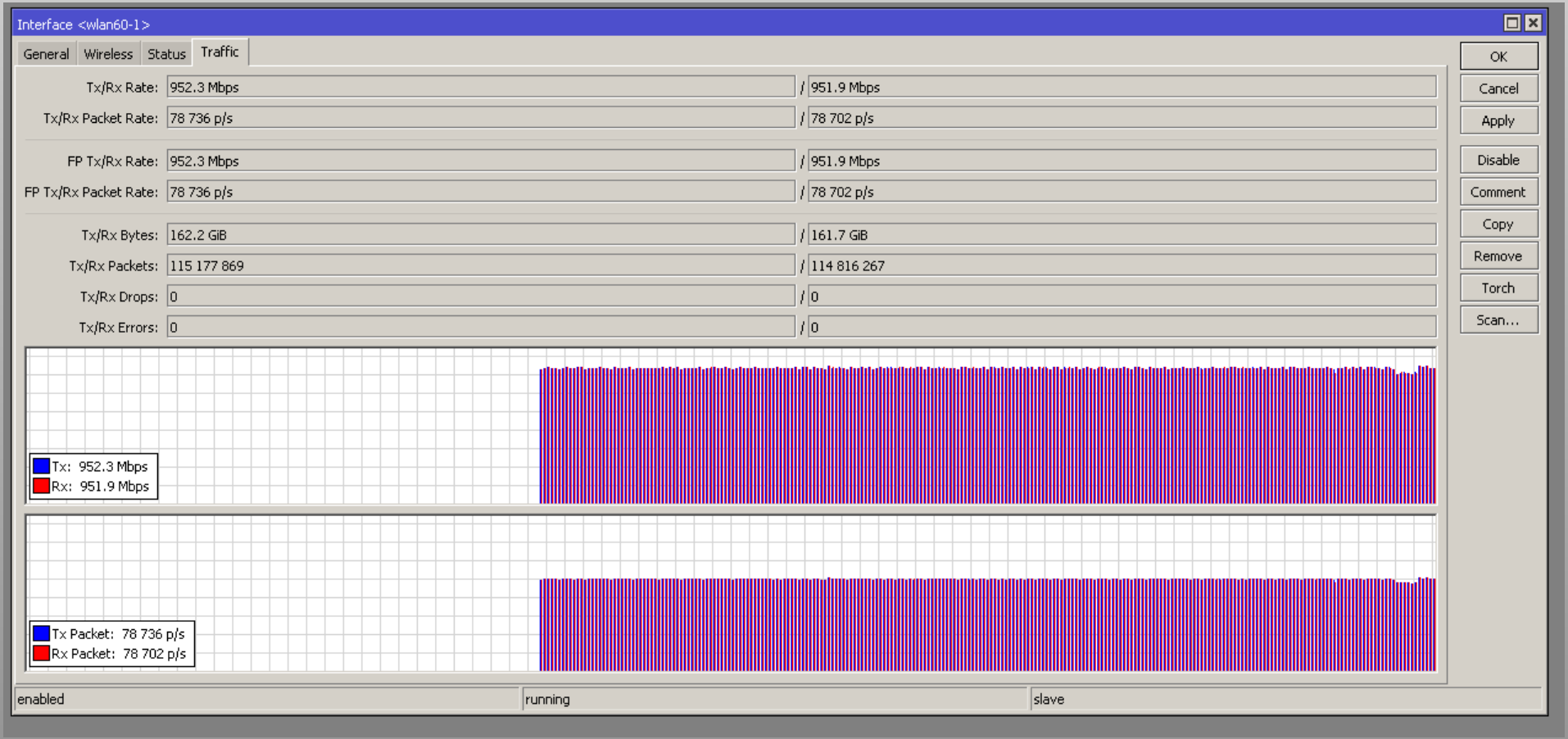
Wireless comparison with other MikroTik devices

- The highest wireless throughput compared to any MikroTik wireless device at the moment

Band	Max throughput			Tested devices
	TX	RX	TX+RX	
2.4 GHz dual chain	256Mbps	255Mbps	252Mbps	r11e-2HPnD + RB800
5 GHz dual chain	560Mbps	561Mbps	570Mbps	r11e-5HPacD + RB800
60 GHz	1Gbps	1Gbps	2Gbps	Wireless Wire kit

- Price/performance sweet spot for short wireless links

Performance in 100 meter link



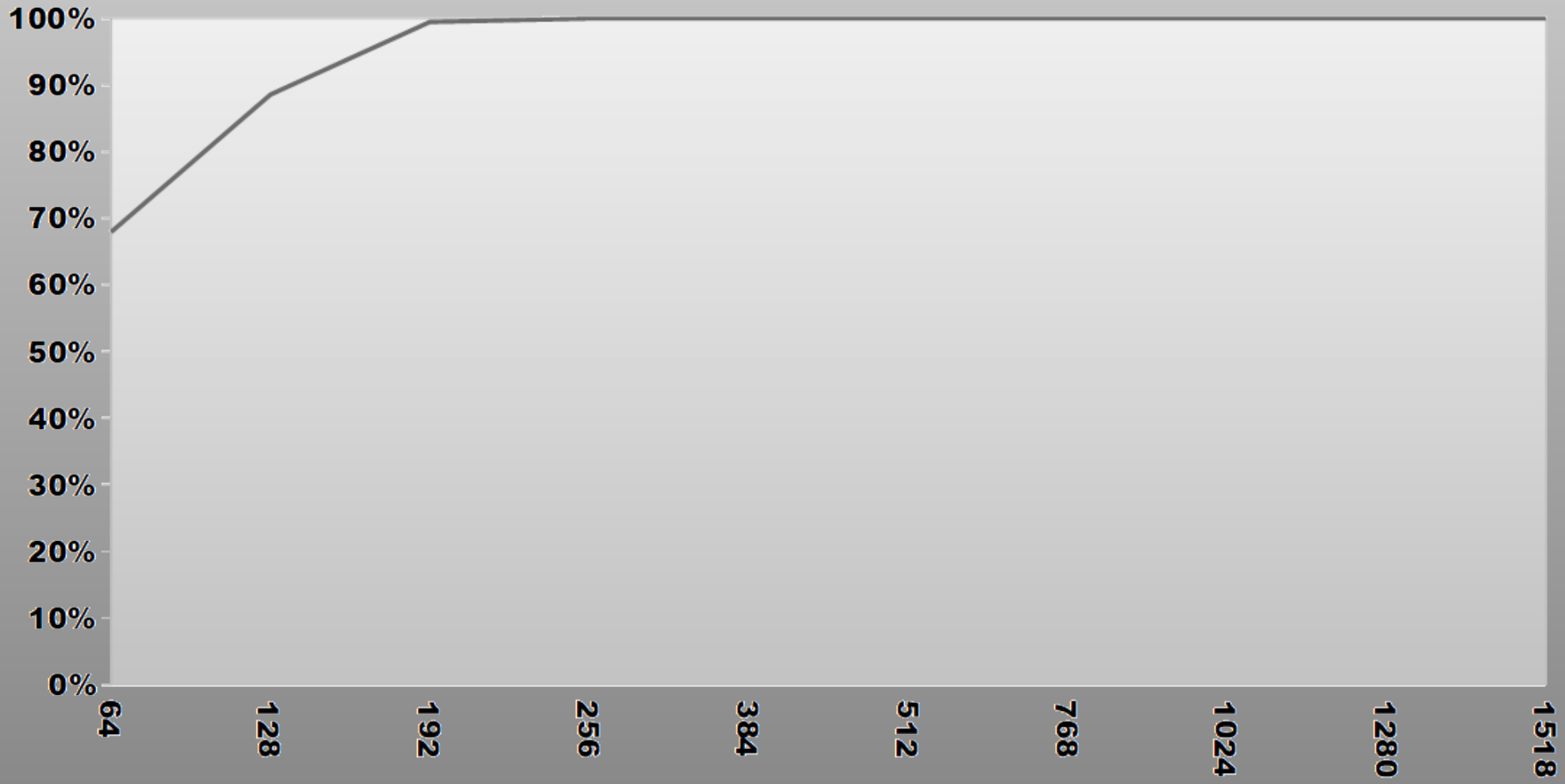
Winbox traffic graph showing “Wireless Wire” speed on 100 m link

Performance comparison to wired network

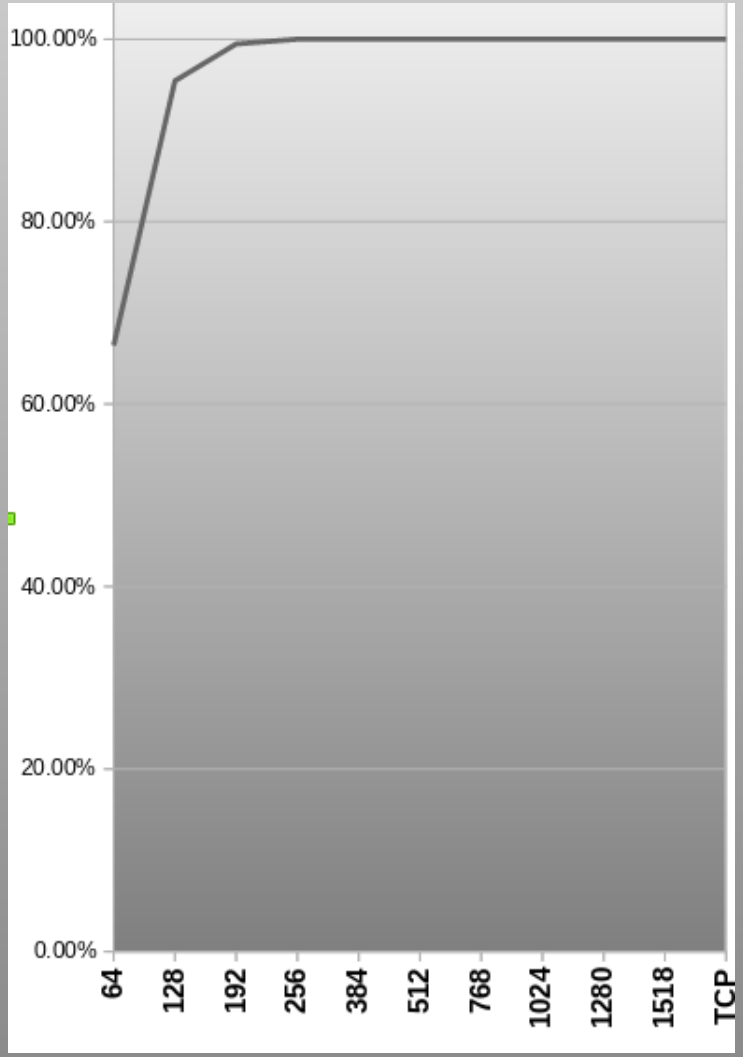
Throughput (<0,1% loss)	Theoretical max		16 Streams both ways			4096 Streams both ways		
Frame size (bytes)	kpps	Mbps	kpps	Mbps	%	kpps	Mbps	%
64	2976,1	1 523,8	2022	1 035,3	**67,94**	1977	1 012,2	**66,43**
128	1689,2	1 729,7	1496,2	1 532,1	**88,57**	1612	1 650,7	**95,43**
192	1179,2	1 811,3	1173	1 801,7	**99,47**	1173	1 801,7	**99,47**
256	905,8	1 855,1	905,8	1 855,1	**100,00**	905,8	1 855,1	**100,00**
384	618,8	1 901,0	618,8	1 901,0	**100,00**	618,8	1 901,0	**100,00**
512	469,9	1 924,7	469,9	1 924,7	**100,00**	469,9	1 924,7	**100,00**
768	317,2	1 948,9	317,2	1 948,9	**100,00**	317,2	1 948,9	**100,00**
1024	239,4	1 961,2	239,4	1 961,2	**100,00**	239,4	1 961,2	**100,00**
1280	192,3	1 969,2	192,3	1 969,2	**100,00**	192,3	1 969,2	**100,00**
1518	162,5	1 973,4	162,5	1 973,4	**100,00**	162,5	1 973,4	**100,00**
TCP connection	181,6	1 970,6	181,6	1 970,6	**100,00**	181,6	1 970,6	**100,00**

All UDP tests are done with Xena Networks specialized test equipment (XenaBay),and done according to RFC2544 (Xena2544) with 0,1% acceptable loss
TCP tests done by using iperf3:
https://iperf.fr/

Performance comparison to wired network



Performance comparison to wired network



Throughput (<0,1% loss)	Theoretical max		4096 Streams both ways		
Frame size (bytes)	**kpps**	**Mbps**	**kpps**	**Mbps**	**%**
64	2976.1	1,523.8	1977	1,012.2	**66.43**
128	1689.2	1,729.7	1612	1,650.7	**95.43**
192	1179.2	1,811.3	1173	1,801.7	**99.47**
256	905.8	1,855.1	905.8	1,855.1	**100.00**
384	618.8	1,901.0	618.8	1,901.0	**100.00**
512	469.9	1,924.7	469.9	1,924.7	**100.00**
768	317.2	1,948.9	317.2	1,948.9	**100.00**
1024	239.4	1,961.2	239.4	1,961.2	**100.00**
1280	192.3	1,969.2	192.3	1,969.2	**100.00**
1518	162.5	1,973.4	162.5	1,973.4	**100.00**
TCP connection	181.6	1,970.6	181.6	1,970.6	**100.00**

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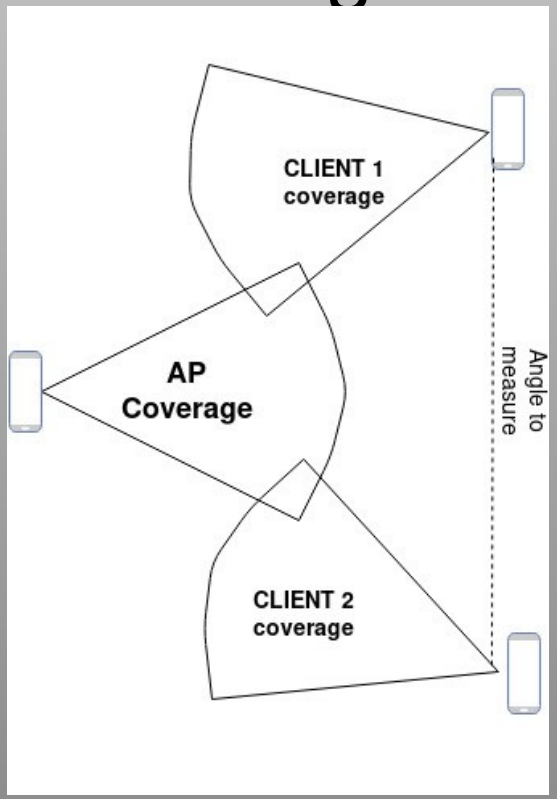
Point to Multi Point support

- Experimental support already available starting from 6.41
- Requires level 4 license for AP device
- Connected clients are treated as individual interfaces - easy to configure and manage
- Supports 8 simultaneously connected clients

PtMP performance

- Beamforming capability provides larger coverage area



Distance in meters			
AP –CLIENT 1	AP –CLIENT 2	CLIENT 1 – CLIENT 2	Angle degrees
100	99	62	36.3
93	99	94	58.5
93	102	105	63.7
91.6	89	93	61.9
99	89	111.5	72.5
109	89	130	81.3
76	89	119	91.9
87.7	89	140	104.8
82.7	89	152	124.5

Tests done with 450 Mbps full duplex traffic to each client device

PtMP performance

- Up to 400 Mbps simultaneously to each client in PtMP setup with 4 clients

```
[admin@60_AP] > interface monitor-traffic wlan60-slave-1,wlan60-slave-2,wlan60-slave-3,wlan60-slave-4
                        name:  wlan60-slave-1 wlan60-slave-2 wlan60-slave-3 wlan60-slave-4
       rx-packets-per-second:          16 431          16 034          16 106          16 933
          rx-bits-per-second:       198.7Mbps       193.9Mbps       194.8Mbps       204.8Mbps
    fp-rx-packets-per-second:          16 431          16 034          16 106          16 933
       fp-rx-bits-per-second:       198.7Mbps       193.9Mbps       194.8Mbps       204.8Mbps
         rx-drops-per-second:               0               0               0               0
        rx-errors-per-second:               0               0               0               0
       tx-packets-per-second:          16 431          16 050          16 106          16 622
          tx-bits-per-second:       198.7Mbps       194.1Mbps       194.8Mbps       201.0Mbps
    fp-tx-packets-per-second:          16 431          16 050          16 106          16 622
       fp-tx-bits-per-second:       198.7Mbps       194.1Mbps       194.8Mbps       201.0Mbps
         tx-drops-per-second:               0               0               0               0
   tx-queue-drops-per-second:              13             364             318               0
        tx-errors-per-second:               0               0               0               0
-- [Q quit|D dump|C-z pause]
```

W60G new features

- Revised "master" and "slave" interface modes to more familiar "bridge", "ap-bridge", "station-bridge"
- Added "put-stations-in-bridge" and "isolate-stations" options to manage connected clients
- MCS rates under MCS4 now are supported
- SNMP support starting from 6.42rc7

W60G new features

- Re-calibrated antenna sectors increasing distance over 200m (RouterOS update required)
- Added RSSI for monitoring signal strength
- TX power control

Wireless device testing

Few suggestions:

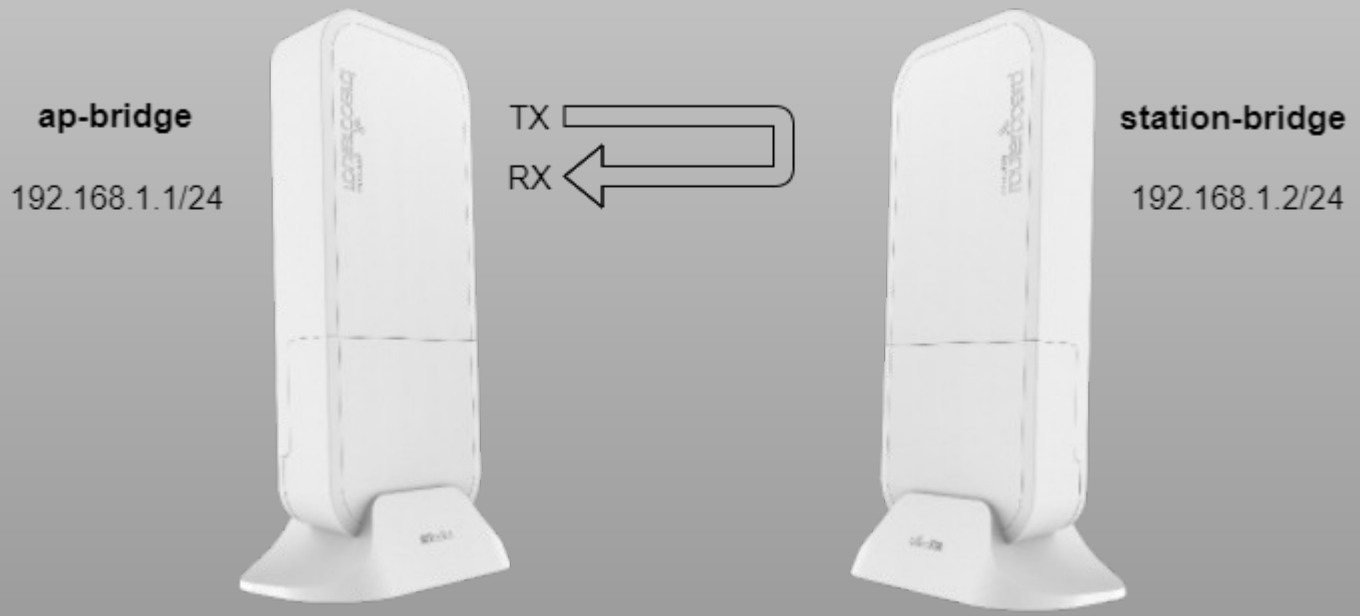
- It is preferred not to run testing tools on devices under test
- Check for bottlenecks
- Wireless devices can suffer from interference
- Test at power outputs that will be used on the device

Testing software

- Bandwidth test
  - Works under RouterOS, PC (Windows, Mac, Linux)
- Traffic Generator
  - Works under RouterOS
- Iperf and iperf3
  - Works on PC (Windows, Mac, Linux)
- Speedtest.net
- Other tools

Live demo

Test setup:




```
/tool traffic-generator packet-template
add ip-dst=192.168.1.1 ip-gateway=192.168.1.2 ip-src=192.168.1.10 name=test1 udp-dst-port=100-300
/tool traffic-generator stream
add mbps=900 name=stream1 packet-size=1500 tx-template=test1
```

Live demo

- To start Traffic Generator run:

  /tool traffic-generator start

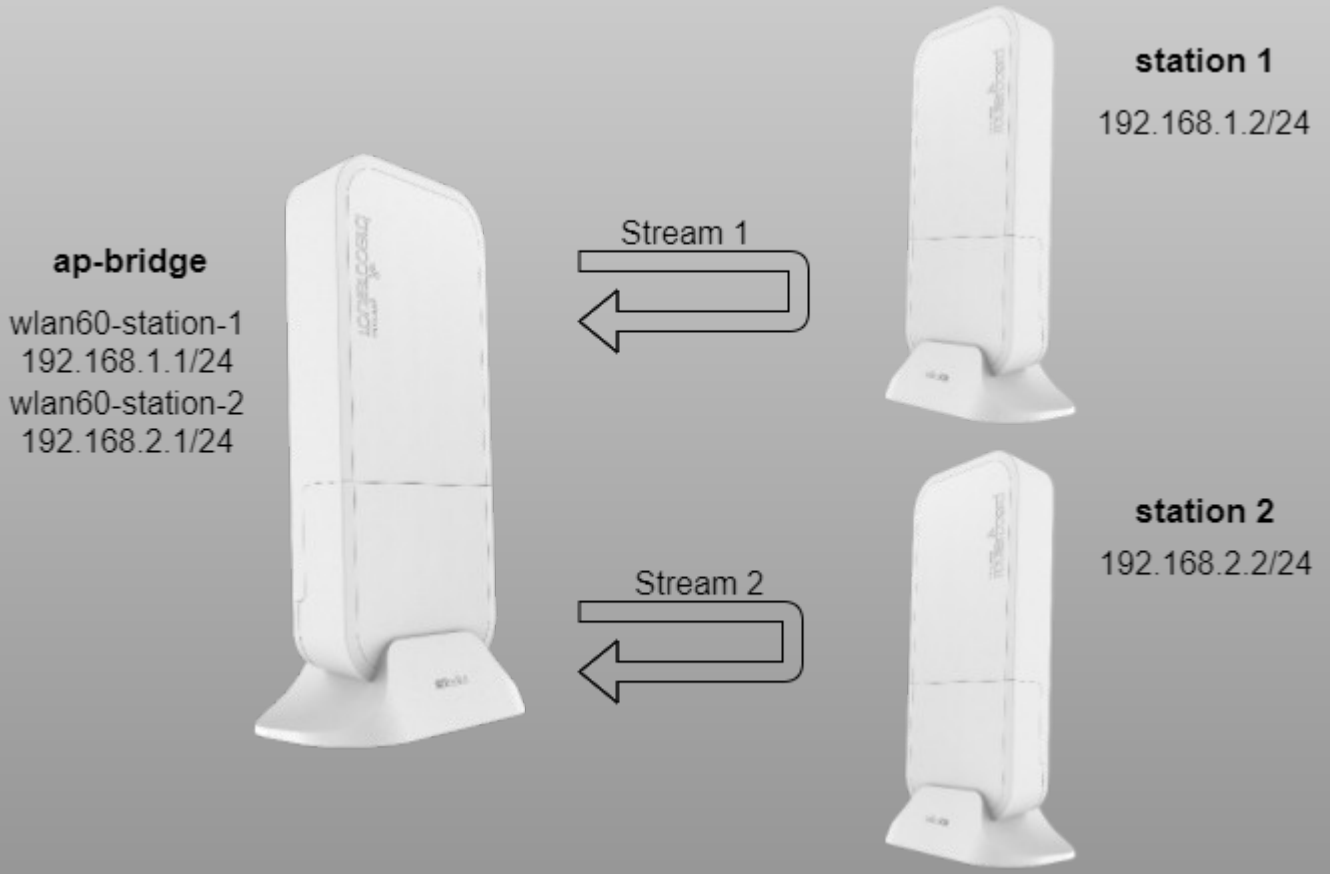
- To stop:

  /tool traffic-generator stop

- To run temporary Traffic Generator with extra arguments:

  /tool traffic-generator quick mbps=300 packet-size=256 duration=100

Live demo




```
/tool traffic-generator packet-template
add interface=wlan60-slave-1 ip-dst=192.168.1.1 ip-gateway=192.168.1.2 ip-src=192.168.1.10 name=pt0
add interface=wlan60-slave-2 ip-dst=192.168.2.1 ip-gateway=192.168.2.2 ip-src=192.168.2.10 name=pt1
/tool traffic-generator stream
add mbps=400 name=str0 packet-size=1500 tx-template=pt0
add id=1 mbps=400 name=str1 packet-size=1500 tx-template=pt1
```

Thank you for your attention