Wireless Tips and Tricks for RouterOS v6

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Topics

• Quickset for Wireless
• Transparent wireless links
• Useful configuration settings and features
Quickset

• Few clicks to setup MikroTik router
• AP and CPE modes
• Point to Point Bridge mode (starting from RouterOS v5.21)
How to get Quickset
Winbox
How to get Quickset Web-interface
Quickset feature support

- RB SXT
- RB Groove
- RB Metal
- RB 911/711/411
- Other RouterBoards (using first wireless interface)
Quickset Setup
AP Quickset

• Access router by browser or Winbox
• Configure AP settings
  – IP address, gateway
  – Wireless (SSID, frequency, band, security, etc.)
  – NAT
  – Additional configuration
AP Quickset Demo
CPE Quickset

- Access router by browser or Winbox
- Configure CPE settings:
  - Router or Bridge
  - IP address, gateway
  - Wireless (SSID, band, security)
CPE Quickset Demo
Point to Point Bridge Quicket

Client/CPE

Wireless

Server/AP

Client Network

Internet
Server/AP Bridge Quickset

• Access router by browser or Winbox
• Configure Server/AP settings:
  – Wireless Bridge Mode to Server/AP
  – IP address, gateway
  – Wireless (SSID, band, frequency, security)
Server/AP Bridge Quickset Demo
Client/CPE Bridge Quicket

• Access router by browser or Winbox
• Configure Client/CPE settings:
  – Wireless Bridge Mode to Client/CPE
  – IP address, gateway
  – Wireless (SSID, band, security)
Client/CPE Bridge Quickset Demo
Connection Types

Point to Point (PTP)  Point to Multi Point (PTMP)
PTP/PTMP connection modes

• AP-bridge/Bridge <-> Station
• AP-bridge/Bridge <-> Station-wds/Station-bridge
• AP-bridge/Bridge <-> Station-pseudobridge
• AP-bridge/Bridge <-> AP-bridge/Bridge
• AP-bridge <-> WDS-slave
RouterOS license requirements

• PTP link requires at least Level 3
  – Example: Bridge <-> Station

• PTMP link requires on AP at least Level 4 and on clients at least Level 3
  – Example: AP-bridge <-> Station
Regular PTMP setup

RouterBOARD SXT Sixpack
Wireless Setup Type - Routing

INTERNET

10.0.0.1/24

10.0.0.2/24

10.0.1.1/24

10.0.1.2/24

10.0.0.3/24

10.0.2.1/24

10.0.2.2/24
Wireless Setup Type - Bridging

INTERNET

Bridge 10.0.0.2/24

10.0.0.12/24

Bridge 10.0.0.3/24

10.0.0.11/24

10.0.0.1/24
Wireless Setup Types

• Bridging
  • Advantage
    – Less IP configuration needed
  • Disadvantage
    – Clients broadcast traffic or flood can lower wireless network performance
    – Not suitable for large network

• Routing
  • Advantage
    – No broadcast traffic or flood that could lower wireless network performance
  • Disadvantage
    – More configuration needed: multiple IP networks or use of routing protocols
Transparent Wireless Links

- Less configuration needed
- Extends Layer 2 protocol to clients (wireless ethernet switch)
- Suitable for PPPoE access
Transparent Wireless Links Setups

- Bridge <-> Station-pseudobridge
- Bridge <-> Station using EOIP
- Bridge <-> Bridge
- Bridge <-> Station-wds
- Bridge <-> Station-bridge
EOIP bridging setup
Bridge <-> Bridge setup

10.0.0.1/24 <-> 10.0.0.2/24
Station-wds setup
Station-bridge setup
Station-bridge

• AP maintains forwarding table with information on what MAC addresses are reachable over which station device
• AP should have bridge-mode parameter enabled in order to accept station-bridge clients
• Can be connected only to RouterOS AP based devices
• Even less configuration needed compared to station-wds mode
Station-bridge configuration

• On AP enable the bridge-mode parameter
• Configure client to use station-bridge mode
• Bridge wireless interface with ethernet interface to make transparent link
## Wireless protocol limitations on transparent links

<table>
<thead>
<tr>
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<th>802.11</th>
<th>ROS 802.11</th>
<th>Nstreme</th>
<th>Nv2</th>
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</table>
802.11n

- Works both in 2.4 and 5ghz
- Increased data rates – up to 300Mbps or 450Mbps
- 20Mhz and 2x20Mhz channel support
- Uses multiple antennas for receive and transmit
- Frame aggregation
802.11n 2x20Mhz channel option

• Adds additional 20Mhz channel to existing channel
• Channel placed below or above the main channel frequency
• Adds support for higher data-rates – 150Mbps/300Mbps/450Mbps
• Backwards compatible with 20Mhz clients – connection made to the main channel
• Not compatible with legacy 40Mhz Turbo mode
Upgrade legacy wireless link to 802.11n?

- We recommend to upgrade your legacy wireless links to 802.11n even if you have one antenna:
  - Higher data-rate than legacy wireless, data-rates up to 72.2Mbps or 150Mbps
  - Real UDP traffic up to 125Mbps
  - No need to change antennas or board – only wireless card
802.11n and WDS

- 802.11n frame aggregation can’t be used together with WDS
- Max transmit speed drops from 220Mbps to 160Mbps using WDS (UDP traffic)
- Station-bridge has the same speed limitations as Station-wds

- Avoid using WDS or use Nstreme/Nv2 wireless protocol to overcome this limitation
802.11n Outdoor Setup

• For 2 chain operation suggested to use different polarization for each chain
• When dual-polarization antennas are used isolation of the antenna recommended to be at least 25db
• If possible test each chain/antenna separately before using both chains at the same time
802.11n speed with encryption

- Avoid using wireless encryption with TKIP cipher as it slows down the wireless link – speed drop from 220Mbps to 38Mbps
- Use AES cipher for 802.11n wireless encryption
AR93xx/95xx wireless support

- Short Guart Interval support on 20Mhz mode – data rates up to 72.2/144Mbps
- 3 antenna connector support for 3x3 MIMO setup
- Up to 3 Spatial Streams
- Up to MCS 23 – data-rate up to 450Mbps
- UDP transfer up to 370Mbps
- No support for advanced channels yet
AR93xx/95xx wireless support
Hidden node issue

- In PTMP setups when client doesn’t see other clients traffic and sends at the same time AP gets “collisions” – lowers performance
- Use hw-protection CTS/RTS or “CTS to self”
- Use Nstreme or Nv2 protocol
NV2

- Proprietary wireless protocol developed by MikroTik
- Based on TDMA (Time Division Multiple Access) media access technology
- Works on Atheros chipset cards:
  - AR5413 and newer chipset cards (R52)
  - N chipset cards (R52n,R52Hn,R11e)
- Supported from RouterOS v5
TDMA benefits

• More throughput
• Lower latency
• Suited well for Point-to-MultiPoint networks
• Solves hidden node problems
Nv2 compatibility and coexistence with other wireless protocols

- Only RouterOS devices will be able to participate in Nv2 network
- Only RouterOS devices will see Nv2 AP when scanning
- Nv2 network will disturb other networks in the same channel
- Nv2 network may be affected by any (Nv2 or not) other networks in the same channel
- Nv2 enabled device will not connect to any other TDMA based network
Nv2 UDP on RB800
Nv2 TCP on RB800
Split horizon feature

- To disable communication between WDS devices usually you would need to add bridge firewall rules which might be complex.
- Another solution is to use split horizon feature in the bridge ports configuration – packets will not be forwarded between ports with the same horizon value.
Split horizon feature

- Create bridge interface
- Add internet access interface to the bridge port
- Add each WDS interface to the bridge port and specify the same horizon value, for example 1
- If you wish to allow communication from every WDS clients to a specific WDS client then add that specific WDS to the bridge port without horizon value
HT TX/RX chain configuration

- When board has both antennas connected it is suggested to use all the TX/RX chains to get the best speed and stability.

- In order to use only chain1 the chain0 RX should be always enabled in order to make the wireless link to work.
RouterBoard wireless boards

- Every wireless RouterBoard has RouterOS default-configuration script enabled on the first boot.
- For wireless boards default-configuration enables all available wireless chains.
- Make sure that you have antennas connected to all antenna connectors to avoid damaging wireless cards amplifier!
- Also if you use only one chain on the board make sure you don’t enable it if you don’t have antenna connected to it.
RouterBoard wireless boards

- Routerboard R11e wireless mini-pcie card chains are inverese compared to other mini-pci wireless cards:
  - Chain 0 – Right
  - Chain 1 – Left
WPA2 Private Pre Shared Key

• Allows to specify for a MAC address different pre-shared key from the pre-shared key in the security profile
• It is possible to specify for each MAC address different pre-shared key
• Increases the security level of the AP
• Can be given also by RADIUS
WPA2 Private Pre Shared Key

Private Key: keykeykey2

Private Pre Shared Key: keykeykey2

WPA Pre-Shared Key: keykeykey1

WPA2 Pre-Shared Key: keykeykey1
Rate-selection – legacy

- Rate-selection default value for RouterOS versions older than v5.9
- Removed in v6.x – replaced with advanced
- Works when wireless link is good in all data-rates
- Doesn’t switch so well from B standard to G standard data-rates
- Doesn’t switch from A/G to N data rates where frame aggregation can be used
- Doesn’t switch from 20mhz to 40mhz in N data-rates, for example, when mcs13-15 doesn’t work stable
## Rate-selection – legacy

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<tr>
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<th>MCS</th>
<th>Streams</th>
<th>Modulation</th>
<th>Data rate (Mbit/s)</th>
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</table>
Rate-selection – advanced

- Rate-selection default value for RouterOS versions newer than v5.8
- Next data-rate is calculated/tested simultaneously in all data-rate “blocks” and used the best from the gathered results
- For 1 stream link on 20mhz the switch to N rates goes faster allowing to utilize frame aggregation feature
- Data-rate could go up very fast and doesn’t suffer from problems, like in, legacy when mcs13-15 didn’t work well for 20mhz it couldn’t switch to 40mhz
## Rate-selection – advanced

<table>
<thead>
<tr>
<th>Modulation</th>
<th>Rate</th>
<th>Streams</th>
<th>Modulation</th>
<th>Data rate (Mbit/s)</th>
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<tr>
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<tr>
<td>Value</td>
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<tr>
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<td>nv2</td>
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</table>
Bridge MAC address

- Bridge MAC address is taken from the first added and running bridge port interface
- If the bridge port gets invalid the bridge takes MAC address from the next active bridge port
- When the first bridge port gets active again the MAC address of bridge is changed back to first ports MAC address
- Bridge MAC address changes could cause IP connectivity to bridge IP address
- Use Admin MAC setting to lock the MAC address to one specific that do not change
Bridge MAC address

<table>
<thead>
<tr>
<th>Interface &lt;bridge2&gt;</th>
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<tbody>
<tr>
<td><strong>General</strong></td>
</tr>
<tr>
<td>Name: bridge2</td>
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<tr>
<td>MTU: 1500</td>
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<tr>
<td>L2 MTU: 1600</td>
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<tr>
<td>MAC Address: 00:0C:42:64:A2:A3</td>
</tr>
<tr>
<td>ARP: enabled</td>
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<tr>
<td>Admin. MAC Address:</td>
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</table>

| **Traffic**         |

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<td>Type: Bridge</td>
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<td>L2 MTU: 1600</td>
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<tr>
<td>MAC Address: 00:0C:42:73:3C:15</td>
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<tr>
<td>ARP: enabled</td>
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<tr>
<td>Admin. MAC Address: 00:0C:42:64:A2:A3</td>
</tr>
</tbody>
</table>
Signal reading for each chain

- "signal-strength" - combination of all active chains on the control and extension channels
- "signal-strenght-ch0" - chain 0 control channel
- "signal-strenght-ch1" - chain 1 control channel
- "signal-strenght-ch2" - chain 2 control channel
- No separate signal readings for extension channel
- TX chains signal readings gathered from the remote RouterOS wireless device
TX-power for N cards

- When using two chains at the same time the tx-power is increased by 3db – see total-tx-power column
- When using three chains at the same time tx-power is increased by 5db
TX-power offset for wireless

- Some cards use tx-power offset to get power above 30db – Atheros eeprom limitation
- Real-tx-power – power written in the eeprom
- Tx-power/Total-tx-power – actual output power
- In picture example with 6db offset
Frequency-offset feature

- Frequency-offset feature is designed for easier frequency selection on wireless cards with built-in frequency converter

```bash
interface wireless set wlan3 frequency-offset=+300
```
Antenna-mode selection for RB751U and RB751G

- RB 751U and RB751G has 3 built-in wireless antennas
  - Chain0:
    - one antenna for TX
    - one antenna for RX
  - Chain1:
    - one antenna for TX/RX
    - MMCX connector for external antenna
- Note that enabling the external antenna disables the built-in Chain1 antenna
Antenna-mode selection for RB751U and RB751G

- **Antenna Mode**: antenna b
- **HT AMSDU Limit**: 8192
- **HT AMSDU Threshold**: 8192
- **HT Guard Interval**: any
- **HT AMPDU Priorities**: 0, 1, 2, 3, 4, 5, 6, 7

The interface shows settings for selecting antenna modes and related parameters.
Spectral Scan/History

• Uses RouterOS
• Uses Atheros Merlin and newer 802.11n chipset wireless cards
• Frequency span depending on card:
  – 5ghz: 4790-6085mhz
  – 2ghz: 2182-2549mhz
• Scan with 10mhz frequency increments for improved data quality
• Audio monitor
Spectral Scan using the Dude
Wireless-signal LED feature

Wireless signal LEDs supported added for RB400 series, RB911/711, RB SXT and RB Groove/Metal:

– 1 LED - on, if wireless client is connected to AP (usually $\geq -89$dBm)
– 2 LEDs - on, if signal strength $\geq -82$dBm
– 3 LEDs - on, if signal strength $\geq -75$dBm
– 4 LEDs - on, if signal strength $\geq -68$dBm
– 5 LEDs - on, if signal strength $\geq -61$dBm
Wireless-status LED

- Used for RB751/RB751G
  - ON when no activity
  - Blinks when there is TX/RX traffic (interval depends on traffic activity – minimal 100ms)
  - OFF for 1s and ON for 2s – no wireless connection made to the wireless card
Additional LEDs on RB wireless cards

• R2/5SHPn and R11e wireless cards have additional 9 LEDs:
  – Enabled-led
  – Search-led
  – Rx-led
  – Tx-led
  – Signal1-led
  – Signal2-led
  – Signal3-led
  – Signal4-led
  – Signal5-led
Additional LEDs on RB wireless cards

- R2/5SHPn
- R11e-2/5HPnD
Registration table entries

- Wireless registration table in Winbox is refreshed every 5s
- Use specific client registration table entry for monitoring the settings every second
- Historical measurements of signal for each previously used data-rate
Bandwidth Test max speed
Wireless Advanced Channels

• Located under 'interface wireless channels'
• Custom center frequency support with 0.5Mhz step
• Custom channel width range from 2.5-30mhz with 0.5mhz step
• Only Atheros AR92xx support and center frequency range 2192-2734mhz and 4800-6100mhz
• Custom 'scan-list' feature
• Support added in RouterOS v6
• Superchannel licenese required to use custom advanced channels features
Wireless Advanced Channels

• Custom scan-list options:
  – default, numeric frequency range, advanced channel name, advanced channel list name

• Example: Scan 10 and 20mhz option on the client
  – /interface wireless channels

    add frequency=5180 width=20  band=5ghz-a list=20mhz-list
    add frequency=5200 width=20  band=5ghz-a list=20mhz-list
    add frequency=5180 width=10  band=5ghz-a list=10mhz-list
    add frequency=5200 width=10  band=5ghz-a list=10mhz-list

    /interface wireless set wlan1 scan-list=20mhz-list,10mhz-list
Wireless Advanced Channels

• Example: Indoor and Outdoor ranges
  – /interface wireless channels

    add frequency=5180 width=20  band=5ghz-a/n list=indoor
    add frequency=5200 width=20  band=5ghz-a/n list=indoor
    ...
    add frequency=5500 width=20  band=5ghz-a/n list=outdoor
    add frequency=5520 width=20  band=5ghz-a/n list=outdoor
    ...

    /interface wireless set wlan1 scan-list=indoor
    /interface wireless set wlan2 scan-list=outdoor
Wireless Advanced Channels

• Example: Scan for AP in 2.4ghz and 5ghz band
  – /interface wireless channels

    add frequency=5180 width=20  band=5ghz-a/n list=band5
    add frequency=5200 width=20  band=5ghz-a/n list=band5
    ....
    add frequency=2412 width=20  band=2ghz-b/g/n list=band2
    add frequency=2417 width=20  band=2ghz-b/g/n list=band2
    ....

    /interface wireless set wlan1 scan-list=band5,band2
Wireless Advanced Channels
Thank you!