Wireless High Performance

With RouterOs 6

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Wi4Net - Totalconn

- Mikrotik Italian distributor
- Training and Consulting
- Building Certified Devices for EU market
- Wireless distribution
- E-commerce Web site www.wi4net.it

Totalconn

- 17GHz Unlicensed PTP Bridge with RouterOs:
  - 300Mbps aggregated net throughput
  - TDD technique
  - Carrier Level device

Totalconn

- Based on RB435G
- Up/down converted to 17GHz

- Could be done in most of the

Licensed or unlicensed freq.

Eg. 24GHz, 26GHz, 13GHz…

… find us at our stand!

Goal

Discover the maximum possible performance with wireless in RouterOs 6

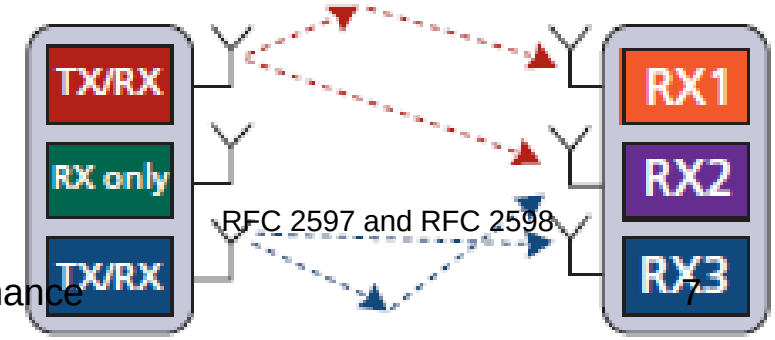
Topics

- Something more about wireless:
- MIMO
- Media Access Control and TDMA
- New functionality (RouterOs 6 rc9)
- High speed and NV2
- Settings
- Near Future

Mimo 802.11n

- MIMO is an abbreviation for **Multiple-Input Multiple-Output**, which refers to the ability of equipment to handle multiple data input and multiple data output operation.

- Wi-Fi 802.11n devices make use of multiple antennas to send and receive more than one communication signal **simultaneously**
- **2x2, 3x3 up to 4x4 streams**

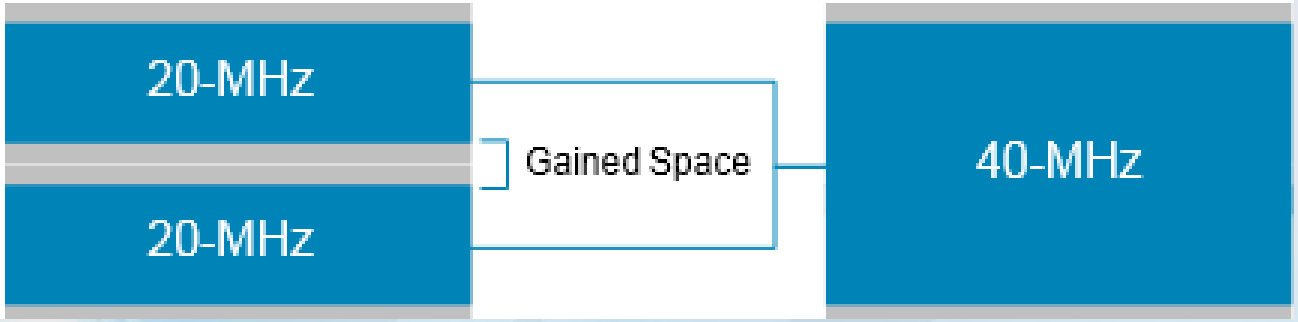


RFC 2597 and RFC 2598

802.11n 40MHz

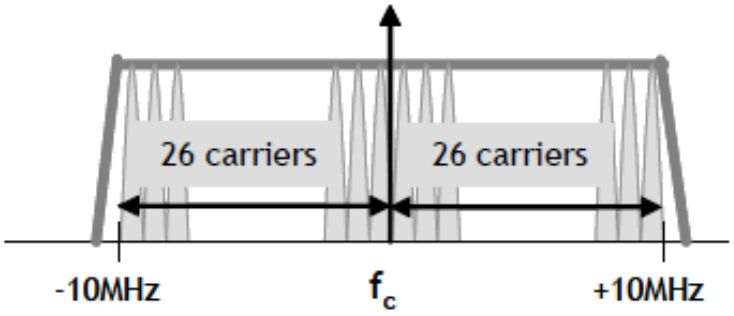
- 40MHz = 2 aggregated 20MHz channels
- takes advantage of the reserved channel space through bonding to gain more than double the data rate of 2 20MHz channels

802.11n Channel bonding

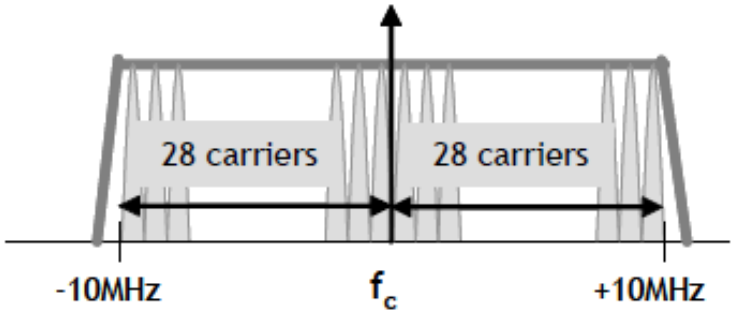


- 802.11n supports 20 or 40 MHz wide channels
- 40 MHz wide channels recommended only for 5 GHz
- also referred to as extension channel
- Second channel must be adjacent
- Can be above or below primary

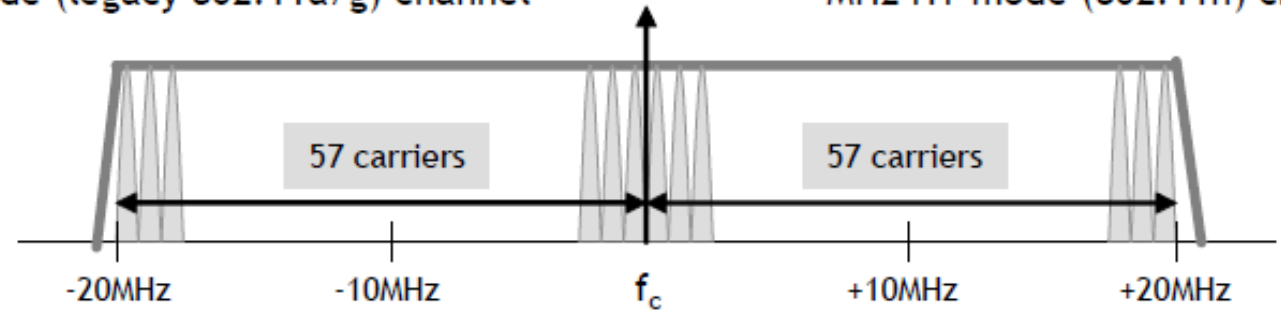
MIMO improvements



52 subcarriers (48 usable) for a 20 MHz non-HT mode (legacy 802.11a/g) channel



56 subcarriers (52 usable) for a 20 MHz HT mode (802.11n) channel



114 subcarriers (108 usable) for a 40 MHz HT mode (802.11n) channel

Efficency

- Much of the throughput improvement in 802.11n comes from **aggregation** techniques. Frame aggregation improves the efficiency of 802.11n systems by reducing the protocol overhead required for transmitting protocol frames.

- The Aggregated **Medium Access Control Service Data Unit** (*A-MSDU*) mechanism increases the frame size used in transmitting Medium Access Control (MAC) protocol frames. The **Aggregated MAC Protocol Data Unit** (*A-MPDU*) mechanism increases the maximum size of the 802.11 frames transported on the air from the legacy 2304 bytes to 64k bytes

Guard Interval

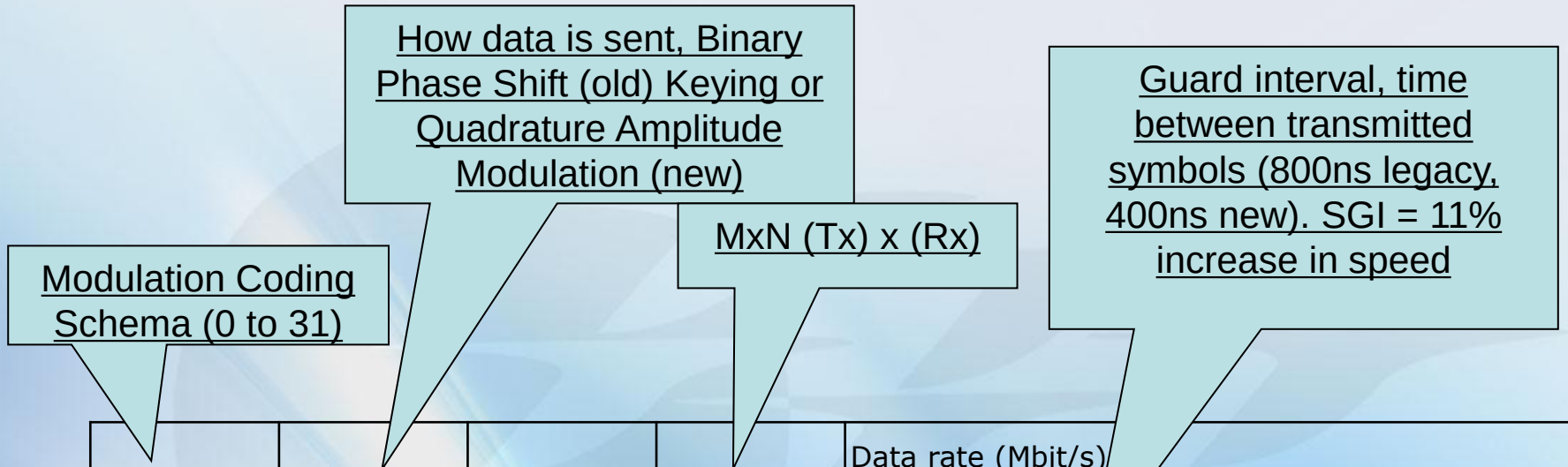
- MIMO and channelization both directly affect a device's data rate. In addition, an 802.11n technique called *Short Guard Interval (SGI)* can also improve data rate by reducing the size of the gap between symbols .

- SGI is changed from 800ns to 400ns

- 400ns is used when possible
- SGI increase up to 11% the performance

MCS index	Spatial streams	Modulation type	Coding rate	Data rate (Mbit/s)			
				20 MHz channel		40 MHz channel	
				800 ns GI	400 ns GI	800 ns GI	400 ns GI
4	1	16-QAM	3/4	39.00	43.30	81.00	90.00
5	1	64-QAM	2/3	52.00	57.80	108.00	120.00
6	1	64-QAM	3/4	58.50	65.00	121.50	135.00
7	1	64-QAM	5/6	65.00	72.20	135.00	150.00
8	2	BPSK	1/2	13.00	14.40	27.00	30.00
9	2	QPSK	1/2	26.00	28.90	54.00	60.00
10	2	QPSK	3/4	39.00	43.30	81.00	90.00
11	2	16-QAM	1/2	52.00	57.80	108.00	120.00
12	2	16-QAM	3/4	78.00	86.70	162.00	180.00
13	2	64-QAM	2/3	104.00	115.60	216.00	240.00
14	**2**	**64-QAM**	**3/4**	**117.00**	**130.00**	**243.00**	**270.00**
15	**2**	**64-QAM**	**5/6**	**130.00**	**144.40**	**270.00**	**300.00**
16	3	BPSK	1/2	19.50	21.70	40.50	45.00
17	3	QPSK	1/2	39.00	43.30	81.00	90.00
18	3	QPSK	3/4	58.50	65.00	121.50	135.00
19	3	16-QAM	1/2	78.00	86.70	162.00	180.00
20	**3**	**16-QAM**	**3/4**	**117.00**	**130.00**	**243.00**	**270.00**
21	**3**	**64-QAM**	**2/3**	**156.00**	**173.30**	**324.00**	**360.00**
22	**3**	**64-QAM**	**3/4**	**175.50**	**195.00**	**364.50**	**405.00**
23	**3**	**64-QAM**	**5/6**	**195.00**	**216.70**	**405.00**	**450.00**

MCS index



MCS index	Spatial streams	Modulation type	Coding rate	Data rate (Mbit/s)			
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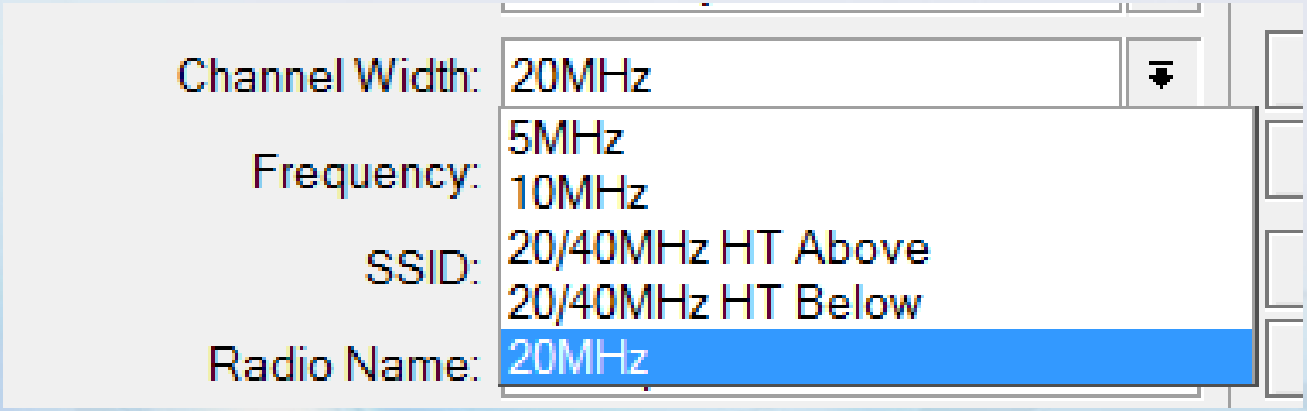
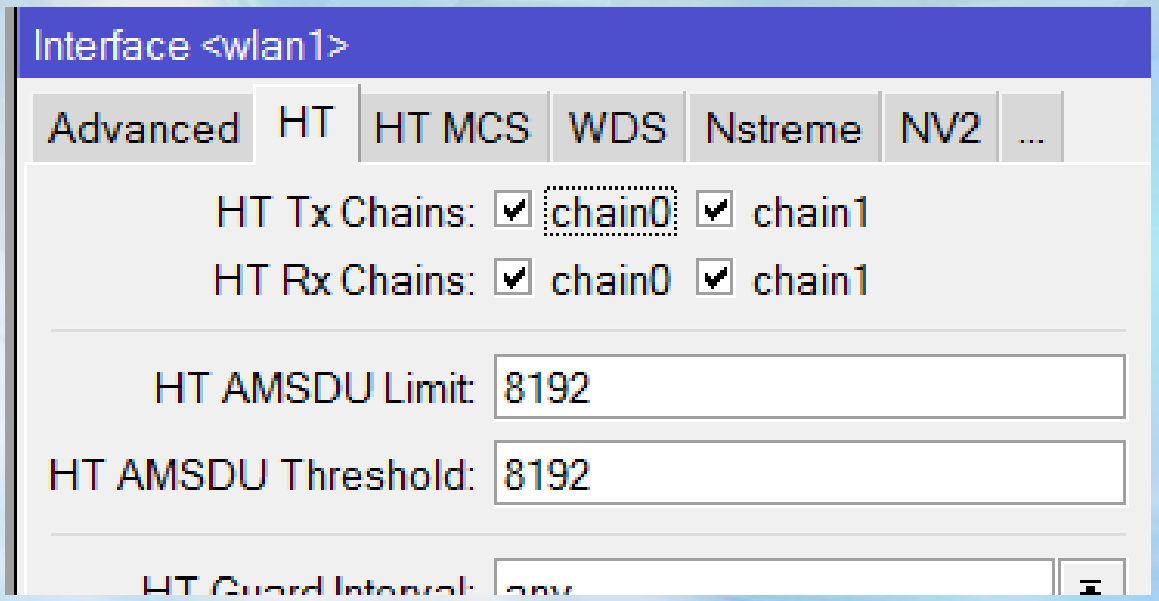
802.11n: Channel Bonding





Media Access Control

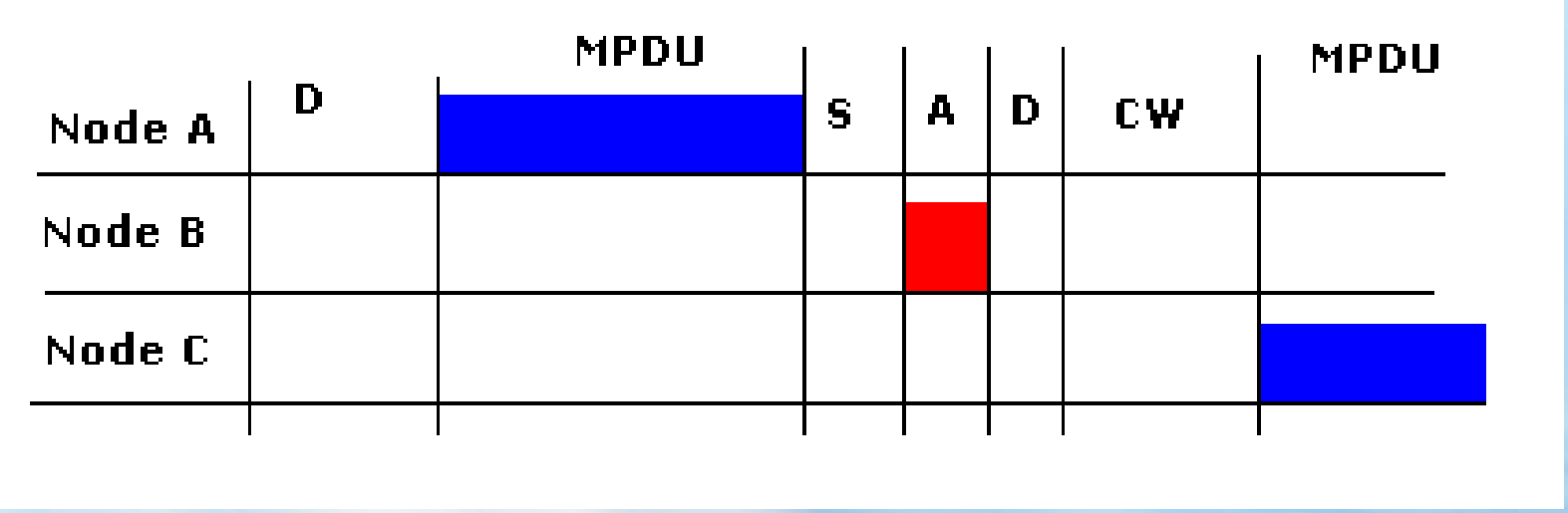
802.11

- 802.11 protocol is Half Duplex protocol
- 1 frequency slot is used for send and receive data at the same time
- End point must acknoledge the trasmission every time, with the CDMA/CA protocol

802.11 MAC (Media Access Control)

The 802.11 family uses a MAC layer known as **CSMA/CA** (Carrier Sense Multiple Access/Collision Avoidance)

NOTE: Classic Ethernet uses CSMA/CD - collision detection). CSMA/CA is, like all Ethernet protocols, peer-to-peer (there is no requirement for a master station).

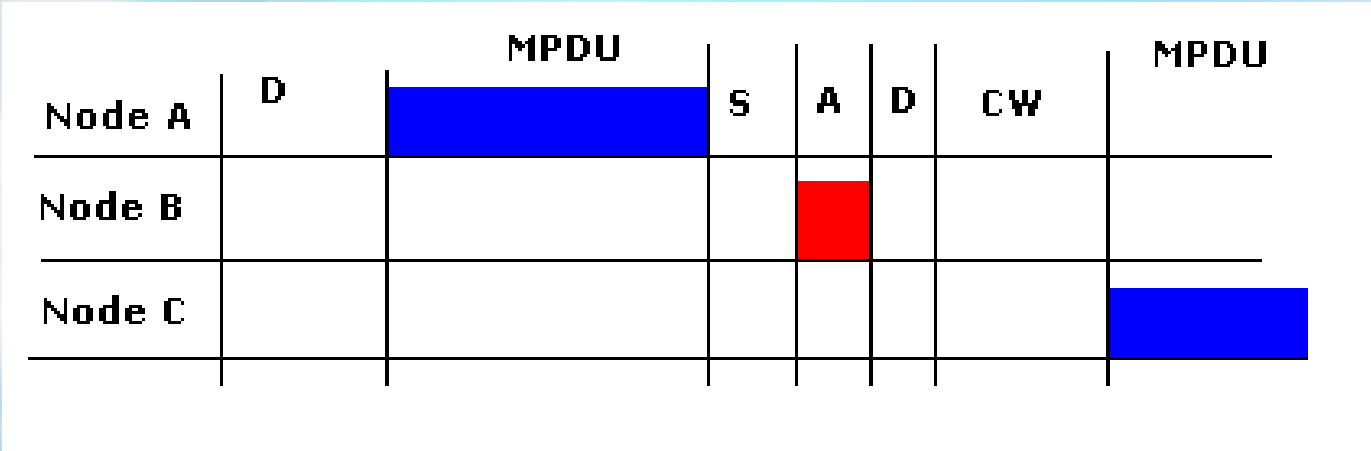


MAC sequence

- In CSMA/CA a Wireless node that wants to transmit performs the following sequence:

1. **Listen** on the desired channel.
2. If channel is **idle** (no active transmitters) it **sends** a packet.
3. If channel is **busy** (an active transmitter) node **waits** until transmission stops then a further **CONTENTION** period. (The Contention period is a random period after every transmit).
4. If the channel is still idle at the end of the **CONTENTION** period the node transmits its packet otherwise it repeats the process defined in 3 above until it gets a free channel.

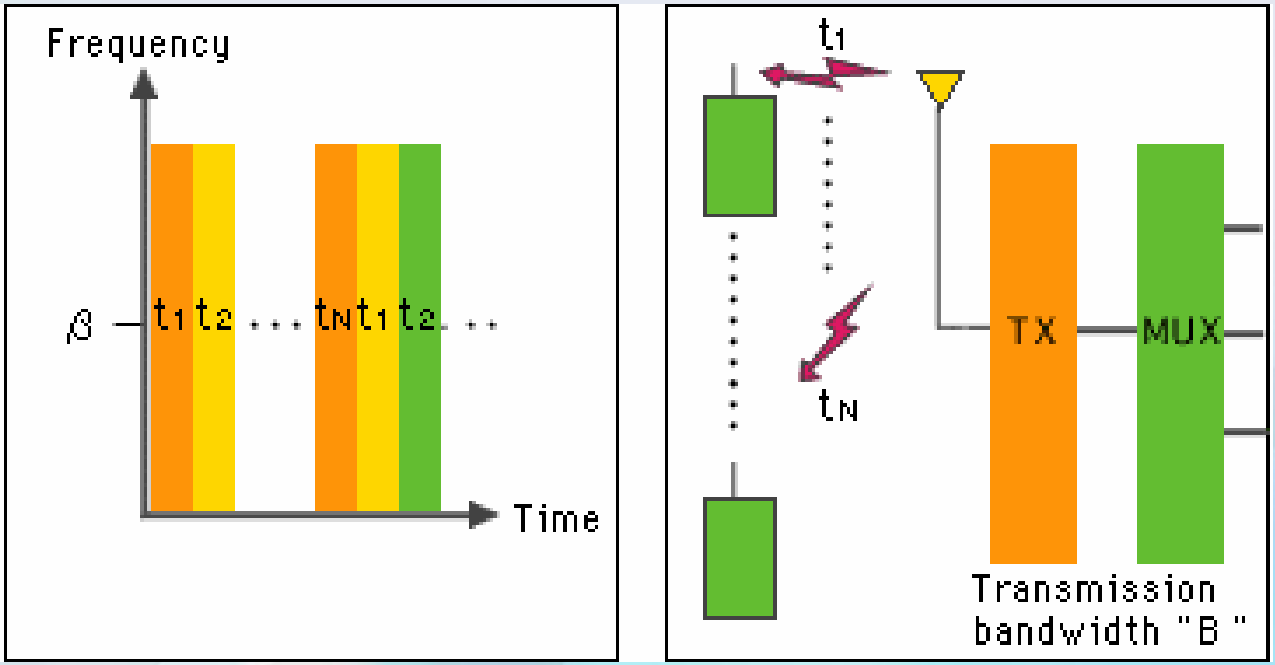
- D = DCF Inter Frame Space (DIFS)
- S = Short Inter Frame Space (SIFS)
- CW = Contention Window
- MPDU = MAC Protocol Data Unit
- A = Ack



TDMA

- TDMA : Time Division Multiple Access
- It implements a rule for deciding WHO speaks with the Access Point and WHEN
- AP divides time in fixed "periods", which are dynamically divided between Upload and Download
- Then clients speak with the access point at their "period"

TDMA



- Trasmission is divided in Time Slot
- User has his time slot assigned and can trasmit at max speed

TDMA: advantages

- Collisions for media contention are eliminated
- More clients could speak with AP
- Hidden node is solved
- Latency is not fluctuating, and low even on busy channel

TDMA : disadvantages

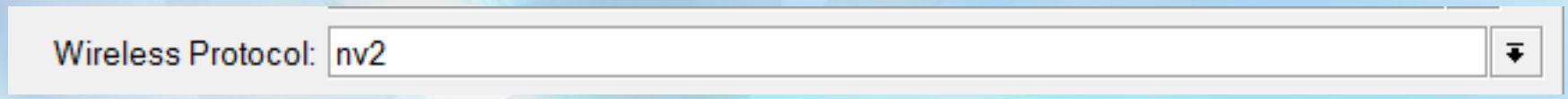
- Latency is higher then 802.11 or Nstreme (with no traffic)
- Higher value for Period-size decrease a little the performance but reduce latency

Settings

NV2 settings

- NV2 is the Mikrotik implementation of the TDMA in the 802.11 protocol

- In PTP trasparent bridge, just enable it



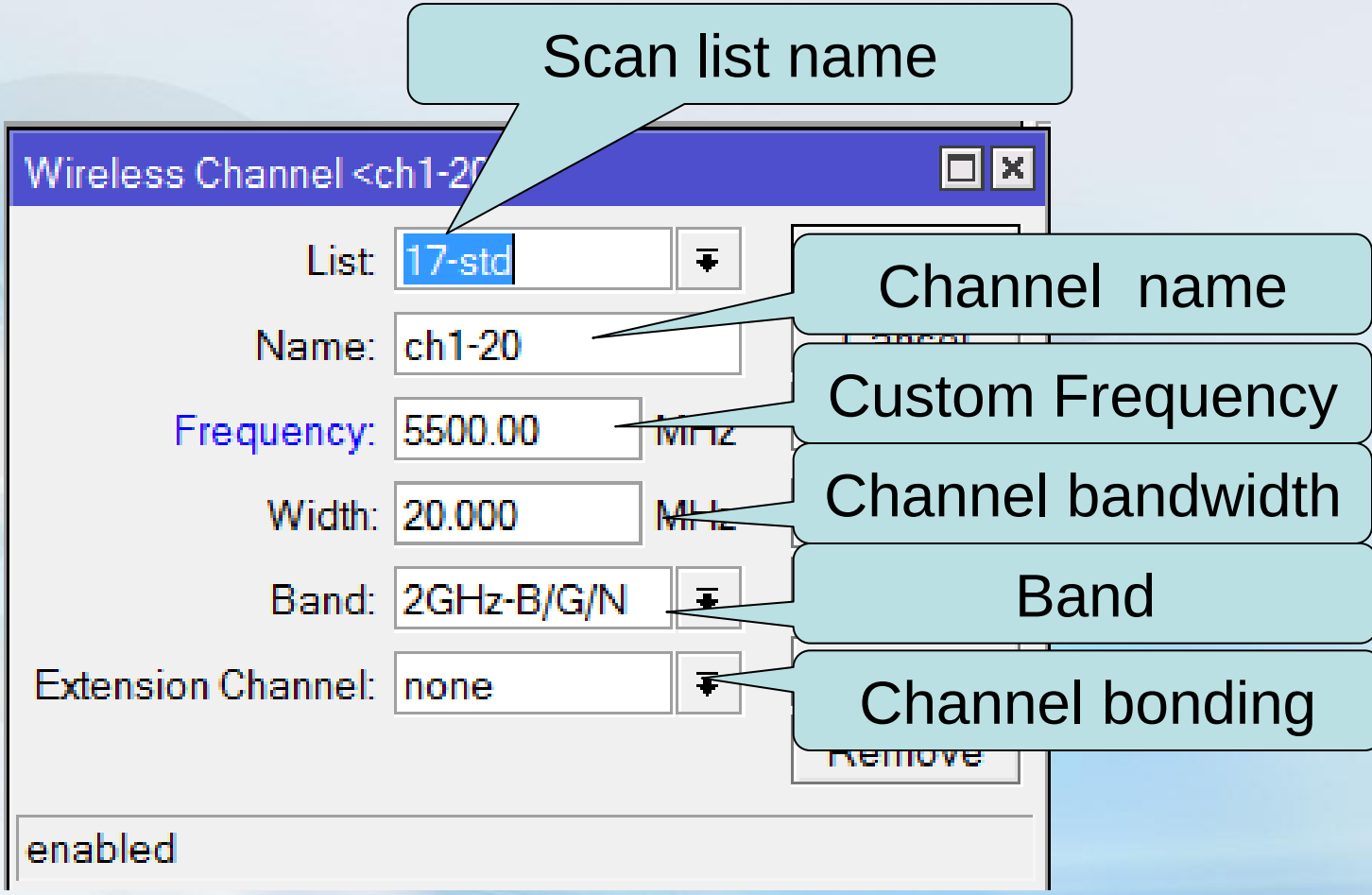
Nv2 TDMA

- It has two parameters:
- **Nv2-cell-radius** - specifies distance to farthest client in Nv2 network in km. This setting affects the size of contention time slot that AP allocates for clients to initiate connection and also size of time slots used for estimating distance to client.
- **tdma-period-size** - specifies size in ms of time periods that Nv2 AP uses for media access scheduling. Smaller period can potentially decrease latency (because AP can assign time for client sooner), but will increase protocol overhead and therefore decrease throughput

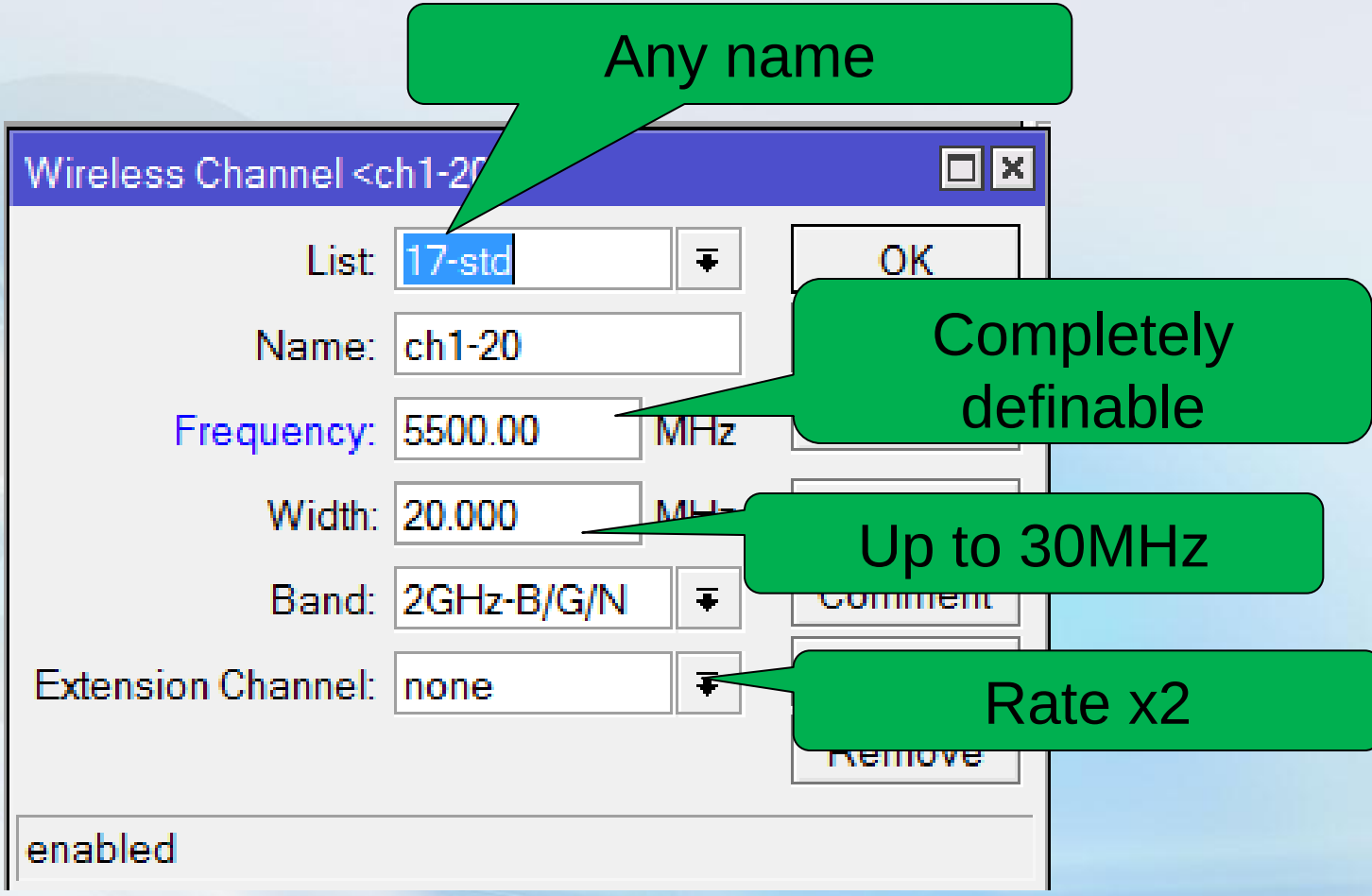
Superchannel

- RouterOs 6 has a new superchannel feature
- It allows you to :
  - Build a new channel definition
  - Define a custom channel width
  - Define a custom Scan List

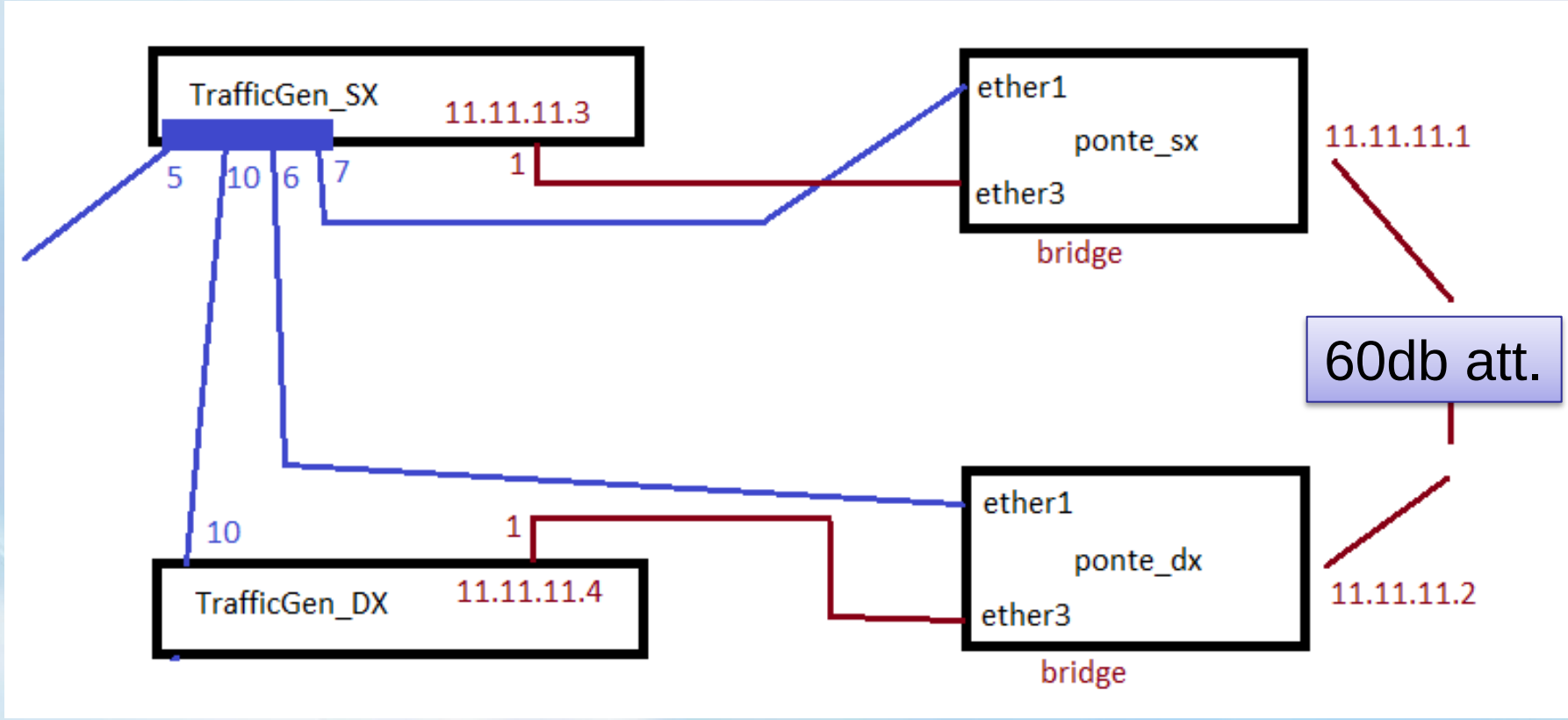
Custom Channel



Custom Channel



Test


TrafficGen_SX
11.11.11.3
5
10
6
7
1
ether1
ponte_sx
ether3
bridge
11.11.11.1
60db att.
10
1
TrafficGen_DX
11.11.11.4
ether1
ponte_dx
ether3
bridge
11.11.11.2

Results

Trasmission mode	MCS modulation	Signal	Speed	Real Throughput	Efficiency Bit/Hz
20mhz	mcs0-5,8-11 (fb 54mbps)	-50	54/54	44,1	2,21
	mcs13	-50	104/104	88,2	4,41
	mcs14	-50	117/117	101,9	5,10
	mcs15	-54	130/130	113,3	5,67
40mhz	mcs12	-55	180/180	158,8	3,97
20/40below	mcs13	-52	240/240	209,8	5,25
	mcs14	-52	270/270	234,8	5,87
	mcs15	-56	300/300	248,1	6,20
50mhz	mcs12	-48	225/225	201,4	4,03
	mcs13	-48	300/300	261,9	5,24
	mcs14	-48	337,5/227,5	292,2	5,84
	mcs15	**-48**	**375/375**	**321**	**6,42**
60mhz	mcs10	-48	135/135	98,1	1,64
	mcs11	-49	180/180	92,9	1,55
	mcs12	-48	270/270	149,7	2,50
	mcs13	-49	324/324	163,4	2,72
	mcs14	-47	364/364	212,8	3,55
	mcs15	**-47**	**405/405**	**184**	**3,07**
54mhz	**mcs14**	**-47**	**364/364**	**319,4**	**5,32**
	mcs15	**-47**	**405/405**	**321**	**5,94**

Speed vs Latency

- Speed:
  - Use old Nstreme protocol or 802.11 in the wireless protocol mode
  - Increase the TDMA period size

- Latency
  - Use NV2 to schedule transmissions
  - Reduce period size

NV2 TDMA interval

TDMA interval	Traffic MBPS
3	294
4	321
5	328
6	323
7	305

The Future ?

802.11ac

Theoretical throughput for single Spatial Stream (in Mb/s)										
MCS index	Modulation type	Coding rate	20 MHz channels		40 MHz channels		80 MHz channels		160 MHz channels	
			800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI
0	BPSK	1/2	6.5	7.2	13.5	15	29.3	32.5	58.5	65
1	QPSK	1/2	13	14.4	27	30	58.5	65	117	130
2	QPSK	3/4	19.5	21.7	40.5	45	87.8	97.5	175.5	195
3	16-QAM	1/2	26	28.9	54	60	117	130	234	260
4	16-QAM	3/4	39	43.3	81	90	175.5	195	351	390
5	64-QAM	2/3	52	57.8	108	120	234	260	468	520
6	64-QAM	3/4	58.5	65	121.5	135	263.3	292.5	526.5	585
7	64-QAM	5/6	65	72.2	135	150	**292.5**	**325**	**585**	**650**
8	256-QAM	3/4	78	86.7	162	180	**351**	**390**	**702**	**780**
9	256-QAM	5/6	N/A	N/A	180	200	**390**	**433.3**	**780**	**866.7**

802.11ac with two streams

Theoretical throughput for two Spatial Stream (in Mb/s)										
MCS index	Modulation type	Coding rate	20 MHz channels		40 MHz channels		80 MHz channels		160 MHz channels	
			800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI	800 ns GI	400 ns GI
6	64-QAM	3/4	117	130	243	270	**526.6**	585	**1053**	1170
7	64-QAM	5/6	130	144.4	270	300	**585**	650	**1170**	1300
8	256-QAM	3/4	156	173.4	324	360	**702**	780	**1040**	1560
9	256-QAM	5/6	N/A	N/A	360	400	**780**	866.6	**1560**	1733,4

Thanks for your attention !

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