



Wireless High Performance

With RouterOs 6

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Mikrotik User Meeting

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Offer of the week

UF-UMTS-ONLYX3G



€ 25.00

Add

OmniTIKU-5HnD



€ 51.00

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

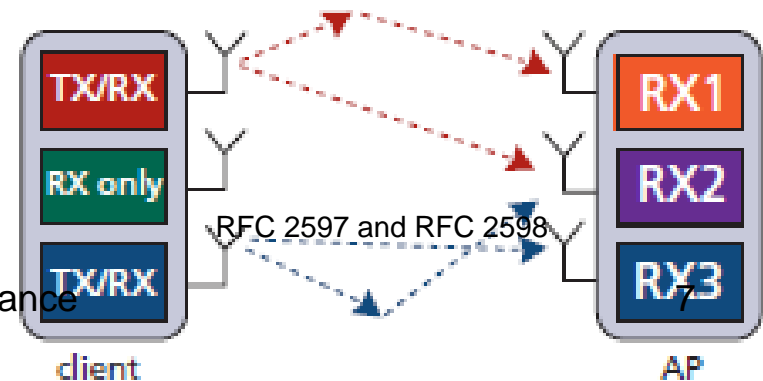
Topics

- 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**

Wireless High Performance

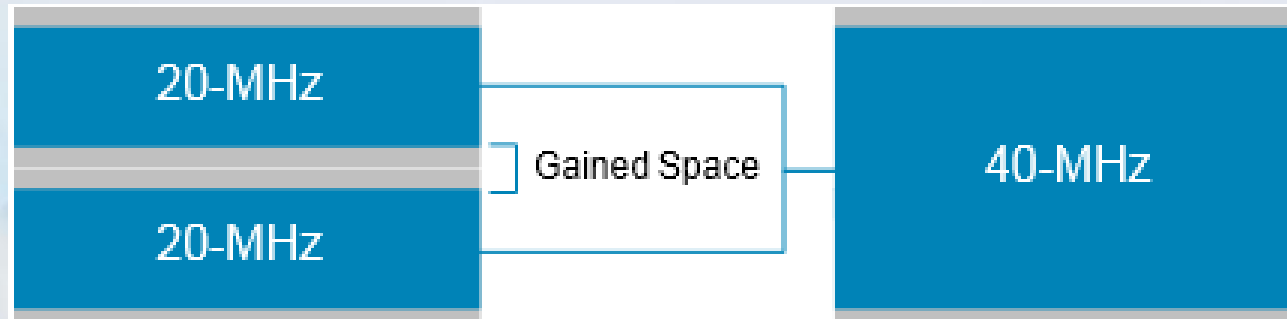


802.11n 40MHz

- 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

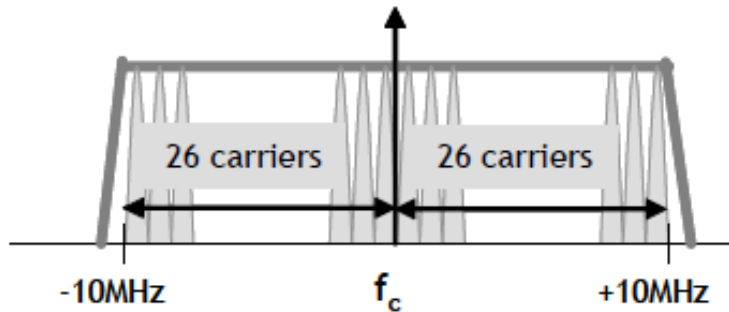


802.11n Channel bonding

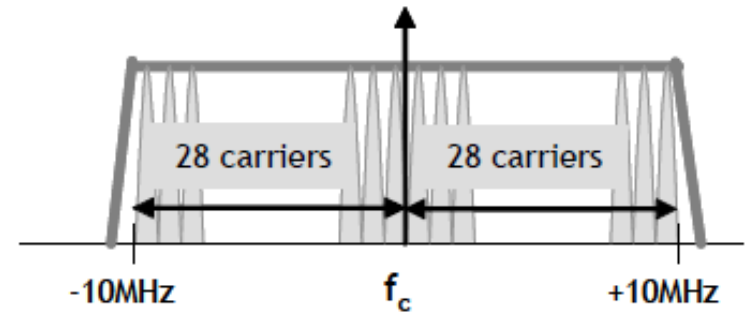


- 802.11n supports 20 or 40 MHz wide channels
- 40 MHz wide channels recommended only for 5 GHz
- also referred to as extension channel
- Second channel must be adjacent
- Can be above or below primary

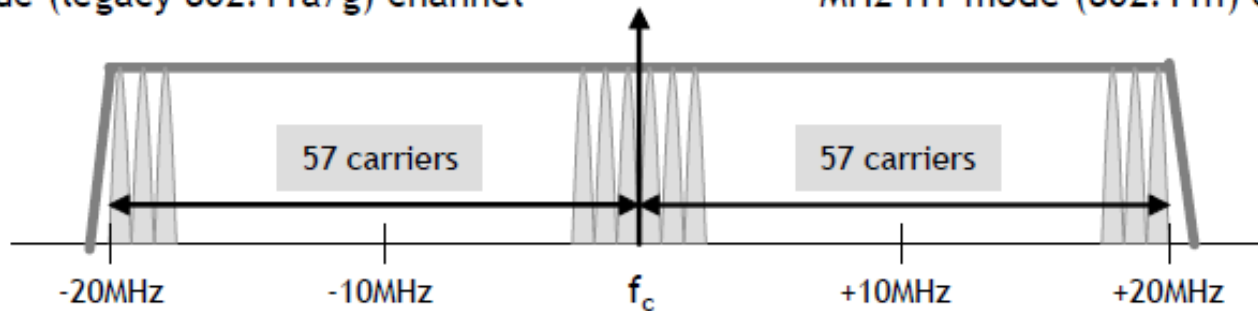
MIMO improvements



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

Efficiency

- 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

How data is sent, Binary Phase Shift (old) Keying or Quadrature Amplitude Modulation (new)

Guard interval, time between transmitted symbols (800ns legacy, 400ns new). SGI = 11% increase in speed

MxN (Tx) x (Rx)

Modulation Coding Schema (0 to 31)

MCS index	Spatial streams	Modulation type	Coding rate	Data rate (Mbit/s)			
				20 MHz channel		40 MHz channel	
				800 ns <u>GI</u>	400 ns <u>GI</u>	800 ns <u>GI</u>	400 ns <u>GI</u>
4	1	16- <u>QAM</u>	3/4	39.00	43.30	81.00	90.00

802.11n: Channel Bonding

Channel Width:	20MHz	▼
Frequency:	5MHz	
	10MHz	
SSID:	20/40MHz HT Above	
	20/40MHz HT Below	
Radio Name:	20MHz	

Interface <wlan1>

Advanced HT HT MCS WDS Nstreme NV2 ...

HT Tx Chains: chain0 chain1

HT Rx Chains: chain0 chain1

HT AMSDU Limit: 8192

HT AMSDU Threshold: 8192

HT Guard Interval: any ▼

Media Access Control

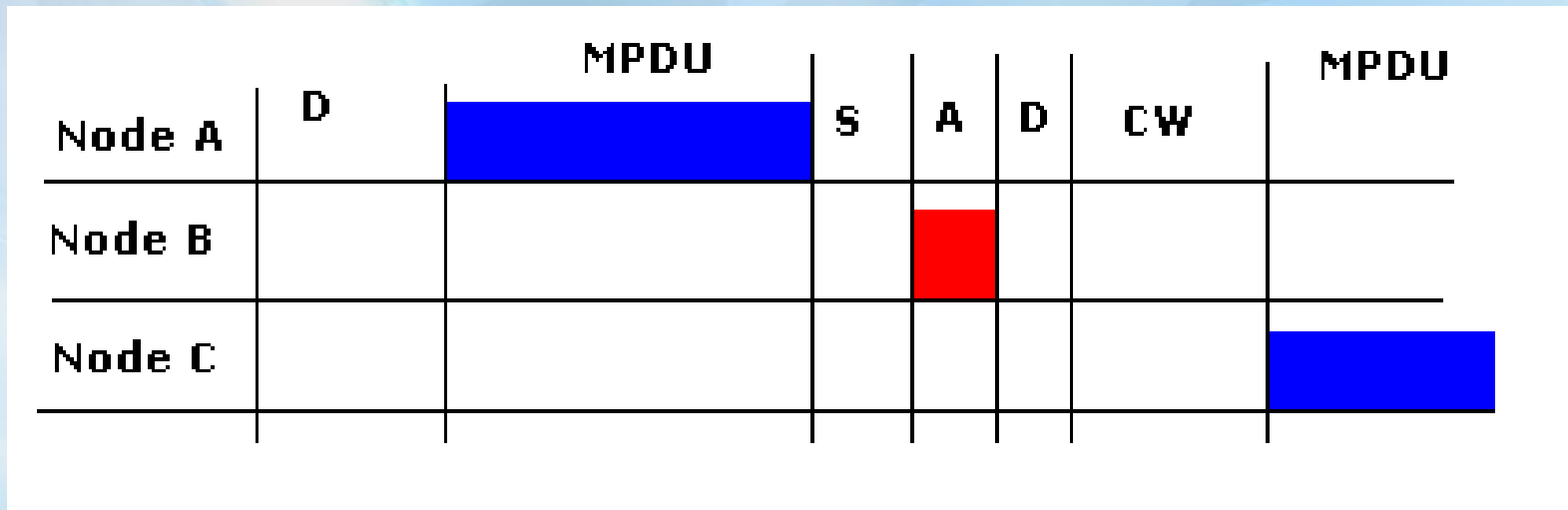
802.11

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

802.11 MAC (Media Access Control)

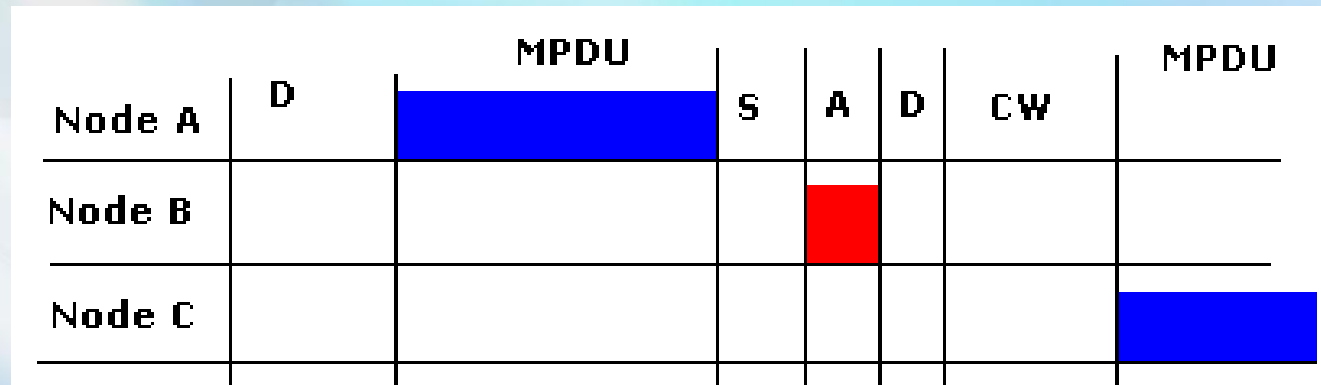
The 802.11 family uses a MAC layer known as **CSMA/CA** (Carrier Sense Multiple Access/Collision Avoidance)

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

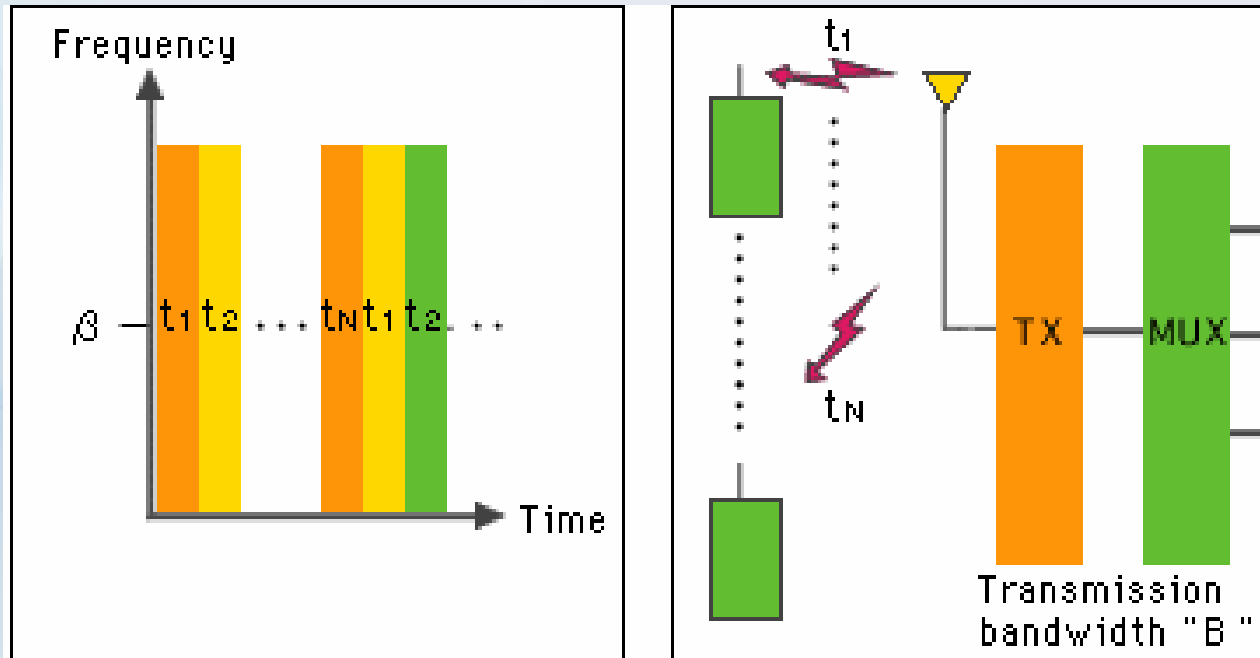
- In CSMA/CA a Wireless node that wants to transmit performs the following sequence:
 - 1. Listen** on the desired channel.
 - If channel is **idle** (no active transmitters) it **sends** a packet.
 - If channel is **busy** (an active transmitter) node **waits** until transmission stops then a further **CONTENTION** period. (The Contention period is a random period after every transmit).
 - 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



- Transmission is divided in Time Slot
- User has his time slot assigned and can transmit 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 than 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 transparent bridge, just enable it

Wireless Protocol:



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



Wireless Tables

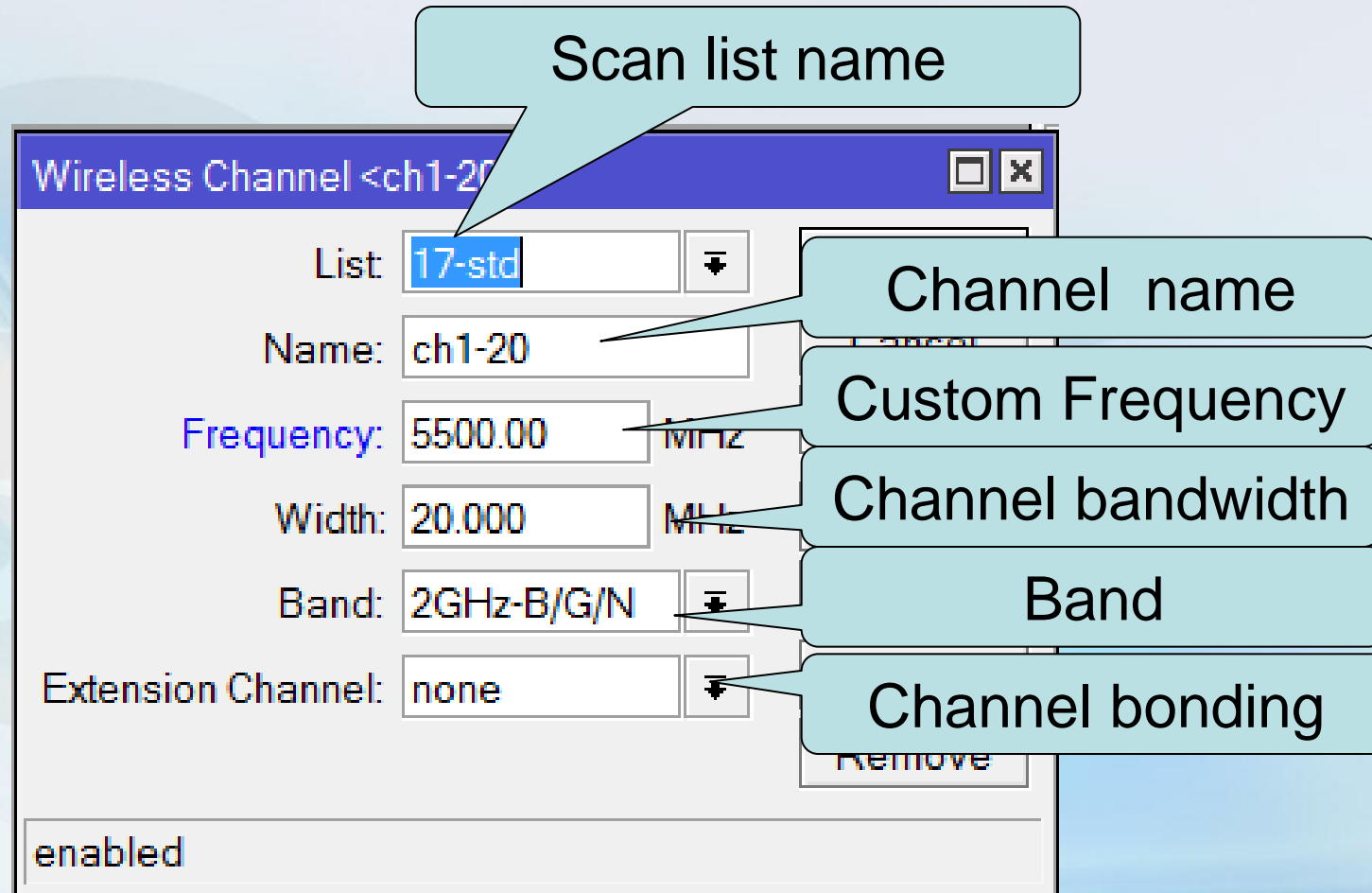
Interfaces | Nstreme Dual | Access List | Registration | Connect List | Security Profiles | Channels

+ - ✓ ✕ [icon] [icon]

Find all [dropdown]

#	List	Name	Frequen...	Widt..	Band	Extension Cha...
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Custom Channel

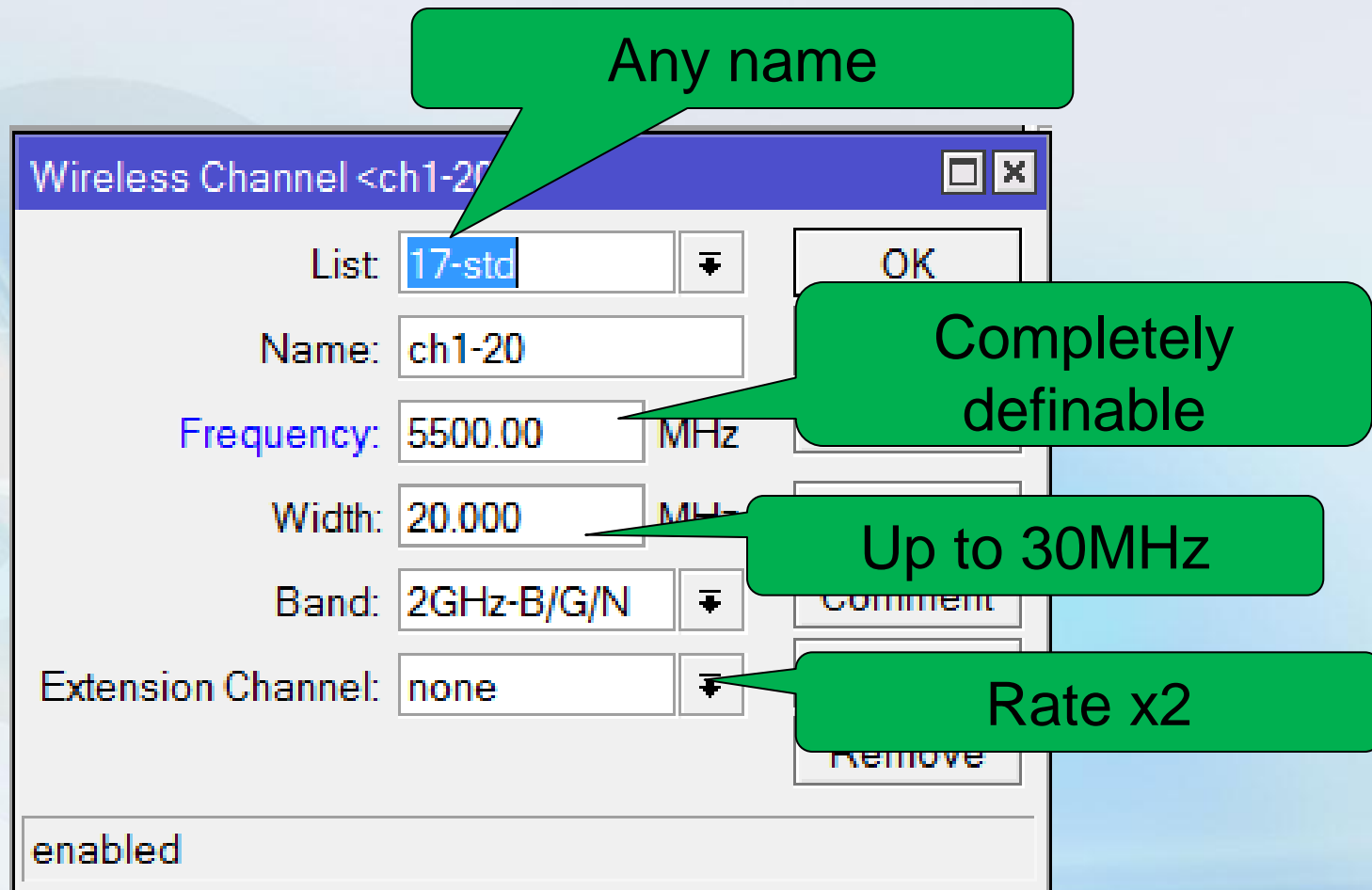


The screenshot shows a configuration window titled "Wireless Channel <ch1-20". It contains several fields with callouts:

- Scan list name:** A callout points to the "List" dropdown menu, which is currently set to "17-std".
- Channel name:** A callout points to the "Name" text field, which contains "ch1-20".
- Custom Frequency:** A callout points to the "Frequency" text field, which contains "5500.00".
- Channel bandwidth:** A callout points to the "Width" text field, which contains "20.000".
- Band:** A callout points to the "Band" dropdown menu, which is set to "2GHz-B/G/N".
- Channel bonding:** A callout points to the "Extension Channel" dropdown menu, which is set to "none".

At the bottom of the window, there is a checkbox labeled "enabled" which is checked.

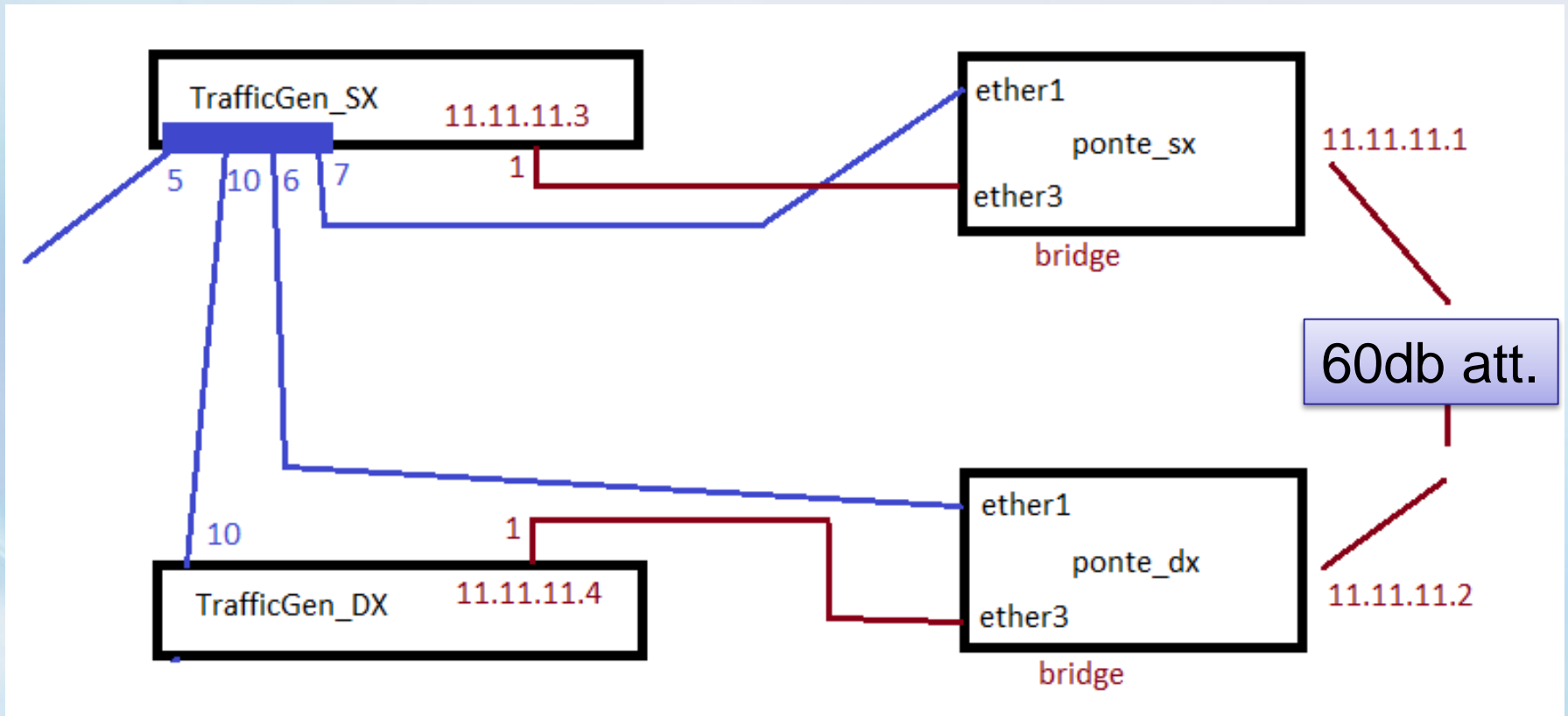
Custom Channel



The screenshot shows a configuration window titled "Wireless Channel <ch1-20". It contains several fields and buttons:

- List:** A dropdown menu with "17-std" selected. A green callout bubble points to it with the text "Any name".
- Name:** A text field containing "ch1-20". A green callout bubble points to it with the text "Completely definable".
- Frequency:** A text field containing "5500.00" followed by "MHz". A green callout bubble points to it with the text "Up to 30MHz".
- Width:** A text field containing "20.000" followed by "MHz". A green callout bubble points to it with the text "Up to 30MHz".
- Band:** A dropdown menu with "2GHz-B/G/N" selected.
- Extension Channel:** A dropdown menu with "none" selected. A green callout bubble points to it with the text "Rate x2".
- Buttons:** "OK", "Comment", and "Remove" are visible on the right side.
- Status:** A checkbox at the bottom left is labeled "enabled".

Test



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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