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## General Wireless N Information

First your router must be upgraded to a recent firmware build, check the appropriate forum for your hardware for recommended builds, and obviously **MUST** be an N capable unit. There are many different factors that can affect N performance: RF interference, router brands, congested wireless locations, etc. If you have B or G clients *actively* using your WLAN, they will reduce the overall performance. Unlike previous specs, N spec has optional hardware features that drastically affect performance and there still isn't any hardware commonly available capable of supporting the maximum 600mbps link rate that the spec allows.

N spec allows for 20MHz wide channels similar to previous specs but can also combine two 20MHz channels to form a 40MHz channel for increased bandwidth. N spec also uses MIMO (Multiple Input/Multiple Output) to increase throughput. MIMO means multiple antennas will operate together to provide better signal coverage and increased data rates. The number of MIMO spacial streams that your router and client adapter support will affect their maximum rate and may result in different rates for transmitting and receiving. For instance, on a 20MHz wide channel with a router capable of 2x2 MIMO and a client capable of 1x2 MIMO with a strong signal, the client would have a 65mbps transmission rate but would would have 130mbps receive rate. A table of maximum *link rates* vs *MIMO spacial streams \* channel width* is available [here](#) and you can find how many streams your devices support [here](#) or also commonly found listed in the device's technical specs.

## Wireless-N\_Configuration

N spec is also capable of operating on both the 2.4GHz band and the 5GHz band. Many N spec capable devices are only capable of operating on a single band or are able to operate on one band at a time. For instance, a Cisco E1000 is only capable of using the 2.4GHz band, a Cisco E2000 is capable of using either band but can only operate on one band at a time because it only has one radio, and a Cisco E3000 is capable of operating on both bands simultaneously because it has two radios - one for each band. The same applies to client adapters. Check your device's documentation to find out what bands it is capable of using and whether it is capable of using both simultaneously.

## Basic Configuration

First read [Basic Wireless Settings](#).

### 20MHz vs 40MHz

The N spec is able to use 40MHz of bandwidth for increased data rates, but to maintain compatibility with legacy systems, it requires one main 20MHz channel plus a free adjacent channel at  $\pm 20$ MHz. The main channel is used for legacy (a/b/g) or other clients that aren't able to transmit at 40MHz. The spec also requires the whole WLAN to only use the main 20MHz channel if it detects anything using the additional 20MHz channel.

In 5GHz band, it shouldn't be that difficult to find two free channels, so go ahead and turn 40MHz on.

However, when using 2.4GHz, using 40MHz isn't nearly as easy since the channels were already overlapped in 11b and 11g mode.

Effectively to use this feature, you will block 7/9 of the 13 channels and, of course, ch12 and ch13 aren't available in North America. So yes, it's possible that your neighbors will hate you if you turn this option on. This is why there was a lot of pushback at the end of the final IEEE 802.11n ratification to entirely ban 40MHz in 2.4GHz. That didn't happen as 40MHz is still appropriate for some situations (ie: a warehouse) but the bottom line remains, enabling 40MHz in the 2.4GHz band isn't a good idea for dense residential areas.

Though the end result is the same, different manufacturers are using different methods to have the user pick their 20/40 channels.

- Recent builds of DD-WRT have you choose the 20MHz Control channel and by specifying whether the Control channel is the "upper" or "lower" portion of the 40MHz block. You may need to toggle between upper/lower to unlock the channel you wish to use.
- Some stock firmwares have you choose a Main and Aux.
- It wouldn't surprise me if some had you also choose a main and then the center frequency of the 40MHz channel.

Channels are specified by their center frequency but instead of displaying (center of main 20 MHz + center of additional 20MHz) the devs opted to display it as (center of main 20MHz + center of 40MHz).

**Illustrations of 2.4GHz Channels**

These illustrations show ALL Wifi channels but channel 14 is only available in Japan for B spec, so you can pretty much forget about your dreams to fit two 40MHz channels in the 2.4GHz Spectrum. As you can see, there is barely enough room to fit three non-overlapping 20MHz channels, or one 40MHz channel + one 20MHz channel. The tops of the blocks reflect the actual 20 or 40 MHz required by the channel whereas the bottoms account for the extra 1MHz on each end that the channel is allowed to attenuate, hence the 22MHz and 42MHz maximum widths. It may be possible to use channel 1 Upper and 13 Lower to produce two 40MHz channels but the signals may bleed into each other with that 1MHz they're each allowed to before attenuating.

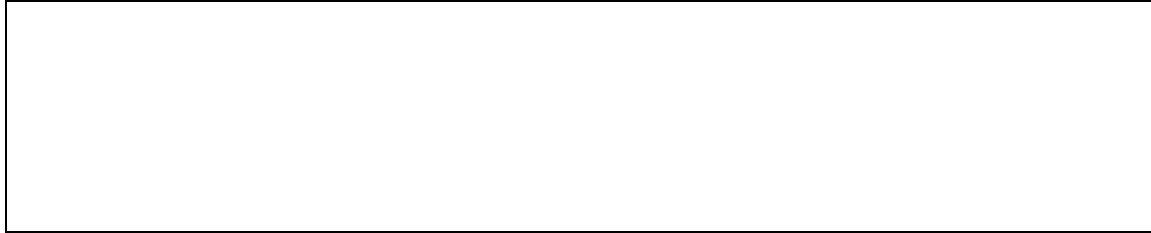


Illustration of non-overlapping 20MHz channels.

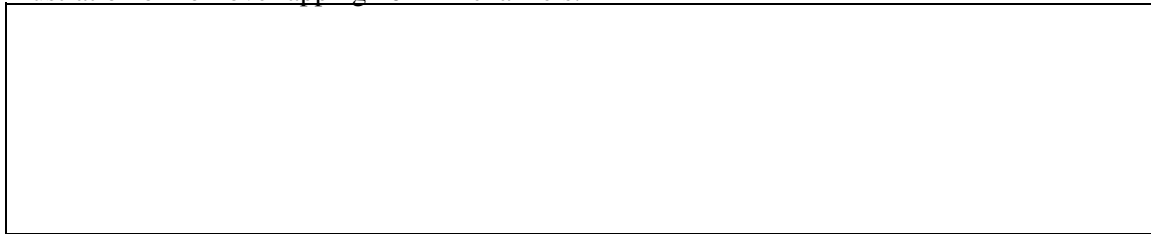


Illustration of Channel 6 Lower. Channels 6 and 10 are combined and Channel 8 is where the center of the combined channel is.

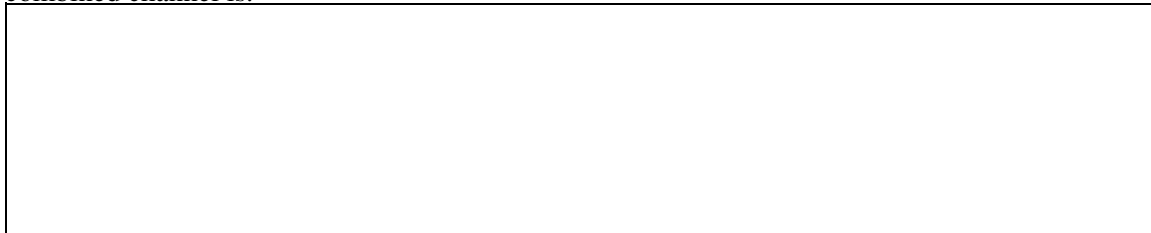


Illustration of Channel 6 Upper. Channels 6 and 2 are combined and Channel 4 is where the center of the combined channel is.

**Table of 2.4GHz Channels**

Green are good choices that have minimal overlap, Red are bad choices that overlap too much, and White are uncommonly used channels that should only be used in substitute of channel 11.

Main Channel	20 MHz	40 MHz Lower		40 MHz Upper			
	blocks	Aux.	center	blocks	Aux.	center	blocks
1	1-3	5	3	1-7	Not Available		
2	1-4	6	4	1-8	Not Available		
3	1-5	7	5	1-9	Not Available		
4	2-6	8	6	2-10	Not Available		

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5	3-7	9	7	3-11	1	3	1-7
6	4-8	10	8	4-12	2	4	1-8
7	5-9	11	9	5-13	3	5	1-9
8	6-10	12 <sup>a</sup>	10 <sup>a</sup>	6-13	4	6	2-10
9	7-11	13 <sup>a</sup>	11 <sup>a</sup>	7-13	5	7	3-11
10	8-12	Not Available			6	8	4-12
11	9-13	Not Available			7	9	5-13
12 <sup>a</sup>	10-13	Not Available			8 <sup>a</sup>	10 <sup>a</sup>	6-13
13 <sup>a</sup>	11-13	Not Available			9 <sup>a</sup>	11 <sup>a</sup>	7-13

<sup>a</sup> = Setting generally not supported by devices in the U.S. although the FCC has clarified that it is permitted.

### Picking a Channel

To check what channels your neighbors are using, open the Web-GUI and navigate to Status->Wireless. Click the "Site Survey" button at the bottom to view all AP's nearby and use the information you learned above to pick your channel. You may want to experiment with different channels but it is strongly recommend to always keep your control channel set to either 1, 6, or 11 so that you minimize interference for yourself and your neighbors.

### Wireless Security

You **MUST** use **WPA2** authentication with **AES** encryption only, or use no security at all if you wish to achieve N rates. Anything else is against the N spec and typically results in the client falling back to G rates.

If you need to support another type of encryption for older clients in mixed mode, then create Multiple WLANs.

### Advanced Settings

WMM is required to be on for any Wi-Fi Alliance Certified N product. By default WMM is already on but many users disable it which may prevent N rates or lower throughput.

## Problems and Resolution

### Actual Speeds

Even if you are connecting to your N router at 130 mbps or 270 mbps, **actual throughput will be roughly 60% of the link rate** due to modulation and error correction. The best test is to play with transmit power and channels to figure out what works best for you. Typically lowering the transmit power to 20-40 mW is good for N spec routers, going above the default 70 mW will likely reduce your throughput in addition to potentially overheating the radio and damaging it.

## Wireless-N\_Configuration

See the [Wireless-N Throughput Testing](#) page for actual user results.

### Testing

When testing throughput do it ~1 meter from the AP and test between a wireless client and a wired client. Doing it far away/behind walls/downstairs/etc will have reduced rates and is a different problem to solve. Being extremely close can lower performance by overloading the receiver. Testing from a wireless client to another wireless client will reduce the throughput because the AP will be repeating the signal.

If you're unable to achieve satisfactory performance, please list all of this information in a forum thread:

- Exact router model listed on the bottom sticker:
- Exact firmware build:
- Exact client adapter model:
- Exact client adapter driver version:
- Which spectrum 2.4GHz or 5GHz:
- Which channel:
- Channel width:
- Encryption settings:
- Distance between the client and AP:
- Link rate (speed) of the client adapter listed in its connection status in your OS:
- Signal/Noise/SNR of the connection listed in the router's wireless status:
- Type of materials between client and AP (wood, brick, metal, sheet-rock):

### Device Drivers

As always, make sure your wireless cards have the latest drivers. Ensure that the advanced properties of this card are set to match what your router is transmitting (examples: different channel widths, N-only)

**March 6, 2009** - Intel's 64bit WLAN drivers have had poor performance until now. See [\[this thread\]](#) for information and updated drivers that resolve the problem.

## Device Specific Information

### Broadcom

[phuzi0n] - I've done many tests with NEWD and NEWD2 wireless drivers on various builds with a WRT150N v1.1 and WRT300N v1.1 and found the 40MHz channel (2.4GHz spectrum) throughput to be extremely lackluster. Most often it gave worse throughput than 20MHz width even though I have no nearby interference on any channels.

## Ralink

[phuzi0n] - I've had very strong 40MHz channel (2.4GHz spectrum) throughput with my WHR-G300N. It capped at ~90mbps throughput due to the 100base-t Ethernet ports.

## References

1. Wireless-N Throughput Testing - User submitted throughput test results.