Wi-Fi™ REFERENCE SERIES

XIRRUS®

802.11n DEMYSTIFIED

DATA RATES

Expected 802.11n Data Rates

	Expected First Generation Device Data Rates						Expected Second Generation Device Data Rates					
	One Spatial Stream			Two Spatial Streams			Three Spatial Streams			Four Spatial Streams		
802.11a 802.11g Rates	11n Mandatory Data Rates	With Channel Bonding (40MHz)	With Short Guard Interval	Two Spatial Streams	With Channel Bonding (40MHz)	With Short Guard Interval	Three Spatial Streams	With Channel Bonding (40MHz)	With Short Guard Interval	Four Spatial Streams	With Channel Bonding (40MHz)	With Short Guard Interval
6	6.5	13.5	15	13	27	30	19.5	40.5	45	26	54	60
9	13	27	30	26	54	60	39	81	90	52	108	120
12	19.5	40.5	45	39	81	90	58.5	121.5	135	78	162	180
18	26	54	60	52	108	120	78	162	180	104	216	240
24	39	81	90	78	162	180	117	243	270	156	324	360
36	52	108	120	104	216	240	156	324	360	208	432	480
48	58.5	121.5	135	117	243	270	175.5	364.5	405	234	486	540
54	65	135	150	130	270	300	195	405	450	260	540	600

Obtaining 802.11n Data Rates

Choose New Base Encoding + Modulation
BPSK (6.5)
QPSK (13, 19.5)
QAM-16 (26, 39)
QAM-64 (58.5, 65)

x

Optionally Multiply by 2, 3, 4 for the Number of Additional Spatial Streams

x

Optionally Multiply By 2.077 to Bond Two 20MHz Channels

x

Optionally Multiply by 1.11 for Shorter Guard Interval to Increase Symbol Rate

=

New 11n Data Rate

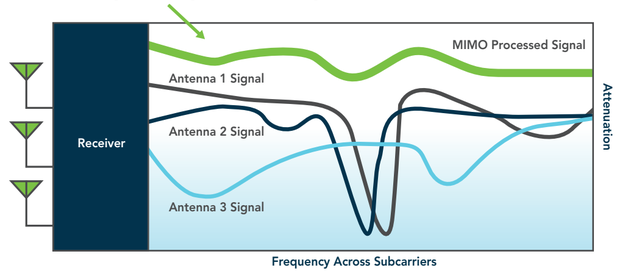
Note: Wi-Fi Alliance 802.11n Certification will require devices to support two spatial streams and channel bonding.

MIMO SIGNAL PROCESSING

MIMO (Multiple In Multiple Out) Signal Processing uses multiple antennas and takes advantage of multipath reflections to improve signal coherence that greatly increases receiver sensitivity. This extra sensitivity can be used for greater range or highter data rates.

MIMO Digital Signal Processing

The newly enhanced signal is the processed sum of individual antennas. Signal Processing eliminates nulls and fading that any one antenna would see. MIMO Signal Processing is sophisticated enough to discern multiple spatial streams (see Spatial Multiplexing).



IMPROVED MAC THROUGHPUT

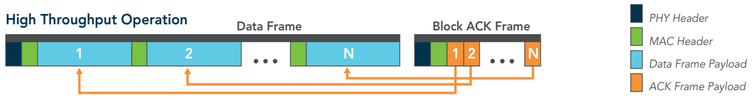
Frame Aggregation

- MAC data frames are combined and given a single PHY header
- Implicit Block ACK acknowledges all data frames within aggregate

New 802.11n modes are 40% more efficient than legacy modes.

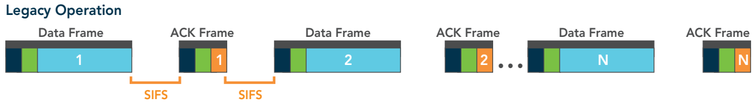
Legacy Operation

High Throughput Operation



RIFS Usage (Reduced Inter-Frame Spacing)

Legacy Operation

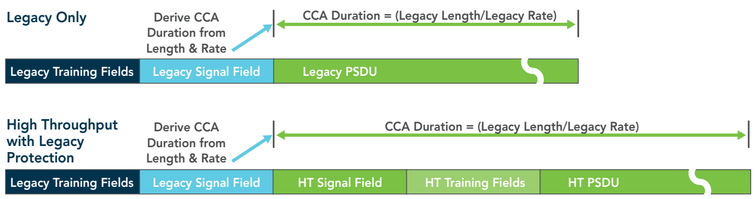


High Throughput Operation

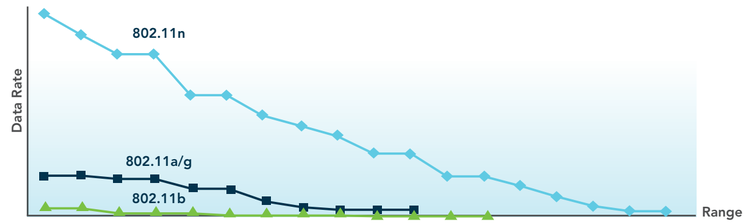
802.11a/b/g/ INTEROPERABILITY

PHY Level Spoofing (Protects Legacy Devices)

- The L-SIG field (Legacy Signal Field) sets the Clear Channel Assessment (CCA) on legacy devices so they do not attempt to transmit during a HT (High Throughput) frame transmission.
  - When an HT frame is transmitted in Mixed Mode, the L-SIG field provides rate and length values for the transmitted packet.
  - The L-SIG rate and length values are used by a legacy STA Station to set the CCA.
  - The L-SIG rate is set to 6Mbps and the length is spoofed to cover the remainder of the packet.

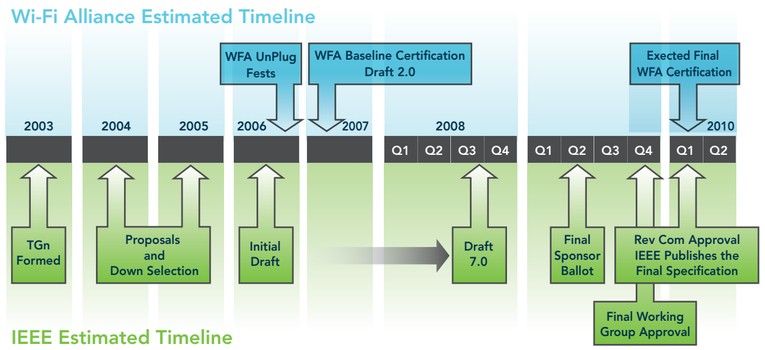


RELATIVE RATE AND RANGE



STANDARDIZATION TIMELINE

Wi-Fi Alliance Estimated Timeline



IEEE Estimated Timeline

GLOSSARY

802.11n—A yet to be released IEEE Standard for wireless networking that has as target of at least 100Mbps of throughput.

Channel Bonding—Using two adjacent channels together as one to increase data rates.

Green Field Mode—Eliminates support for 802.11a/b/g devices when only 802.11n devices are present.

MIMO (Multiple In, Multiple Out)—Signal processing that improves both range and rate by receiving and transmitting signals on multiple antennas.

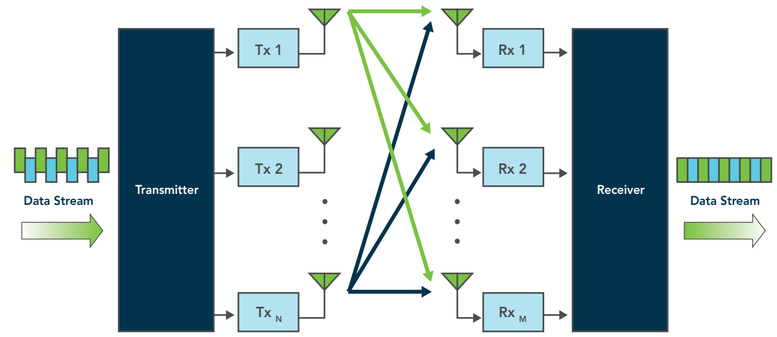
MIMO Power Save Mode—Conserves power consumption by making use of multiple antennas (and radios) only when needed.

Spatial Multiplexing—Transmitting two or more separate data streams on different antennas at the same time in the same channel to increase data rate, requires 11n adapters on both sides of the link.

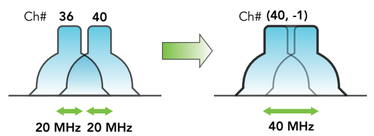
Wi-Fi Alliance—Organization that certifies 802.11a/b/g/n products for interoperability.

SPATIAL MULTIPLEXING

Spatial Multiplexing transmits completely separate data streams on different antennas (in the same channel) that are recombined to produce new 802.11n data rates. Higher data rates are achieved by splitting the original data stream into separate data streams. Each separate stream is transmitted on a different antenna (in the same channel). MIMO signal processing at the receiver can detect and recover each stream. Streams are then recombined which yielding higher data rates.



CHANNEL BONDING



Standard 802.11 channels are effectively 20MHz wide.

Channel bonding combines two adjacent 20MHz channels into a single 40MHz channel providing increased throughput.

40MHz channels are specified by two fields as ($N_{primary\_ch}$, Secondary) where the first field represents the primary channel number and the second field indicating whether the secondary channel is above (1) or below (-1) the primary channel. Channel Bonding won't increase aggregate capacity and can make channel planning more difficult.

40MHz Channel Allocation

Example Channels that can be Bonded

Channel 1	Channel 2	Frequency f, (MHz)	U.S.	EU
36	40	5190	X	
44	48	5230	X	
52	56	5270	X	
60	64	5310	X	
100	104	5510		X
108	112	5550		X
116	120	5590		X
124	128	5630		X
132	136	5670		X
149	153	5755	X	
157	161	5795	X	

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