

Case Study - DIR-655

20/40 Coexistence Mechanism

TSD

March 2011

Content



Version	Revised Date	Author	Content Revised
V1.00	2011/03/23	Fatman Chen Mina Wu	Initial Version

Agenda

Case Description

Why 20/40 Coexistence Mechanism?

Why 20/40 Coexistence Mechanism in the 2.4 GHz frequency band? **Not in the 5 GHz band?**

20/40 Coexistence Mechanism Wi-Fi Description and Test Bed.

Test result of 20/40 Coexistence Mechanism implemented product.

What else should you be aware of?



Case Description

Case Description – Client can't reach 300 Mbps

DGC20110314000003

Dir sir:

Customers to use DIR - 655, wireless network card use DWA - 133, wireless connection PC can achieve A correlation between 300M, PC B can arrive only 130M. Customer exchange wireless card problem remains. The client finds a regulation, when 655 normal starting, use 133 connection speed for the correlation between 300M, if 655 restart, or desktop computer restarts after connection rate are obsolete 130M. Customer desktop for WINDOWS XP operating system SP3 version.

Please as soon as possible to help solve, thank you!

Case Description – Client can't reach 300 Mbps



DWA-140B2 Status

General Support

Connection

Status:	Connected
Network:	DIR-655B1_NA.201
Duration:	00:07:51
Speed:	130.0 Mbps
Signal Strength:	

Activity

Sent		Received
Packets:	28,879	49,024

Properties Disable View Wireless Networks Close



Why 20/40 Coexistence Mechanism?

Wi-Fi Alliance – Good Neighbor?

Are Wi-Fi CERTIFIED n products protected by security?

Yes. All Wi-Fi CERTIFIED n products are tested for the latest generation of government-grade Wi-Fi security: WPA2 (Wi-Fi Protected Access 2). The only way to be sure that product meets these standards is to only purchase Wi-Fi CERTIFIED products.

I heard Wi-Fi CERTIFIED n products can cause interference problems with other Wi-Fi networks. Is this true?

In some configurations, **Wi-Fi CERTIFIED n can interfere with other Wi-Fi networks when these products are trying to achieve the best performance using 40 MHz channels in the 2.4 GHz band.** However, all products that are Wi-Fi CERTIFIED n that can operate in this mode are required to implement a "**good neighbor**" protocol that helps ensure interference is not a problem. This is another important reason to buy only Wi-Fi CERTIFIED n equipment.

WMM® And WMM Power Save

How does WMM Power Save work?

WMM Power Save increases the efficiency and flexibility of data transmission. Specifically, the client device can "doze" between packets to save power, while the access point buffers downlink frames. The application chooses the time to wake up and receive data packets to maximize power conservation without sacrificing Quality of Service.

Source: http://www.wi-fi.org/knowledge_center_overview.php?type=2

Wi-Fi Alliance – It's A MUST!!!



20/40 MHz channel operation

A feature that enables Wi-Fi CERTIFIED n products that operate with 40 MHz channels in the 2.4 GHz frequency band to sense other Wi-Fi devices in the channel and coordinate a switch to the default mode of 20 MHz channels. **Wi-Fi CERTIFIED n devices that support 40 MHz channels in 2.4GHz must include support for this optional feature.**

40 MHz channel operation

A mode of operation in which two "channels," or paths on which data can travel, are combined to increase performance in some environments. In the 2.4 GHz frequency band, Wi-Fi CERTIFIED n products are configured to operate using 20 MHz channels by default, and **must employ coexistence mechanisms to help ensure that the device defaults to 20 MHz operation when sharing the frequency with other Wi-Fi networks.** In the 5 GHz frequency band, interference is not an issue, so coexistence mechanisms are not required.

Source: http://www.wi-fi.org/knowledge_center_overview.php?type=3

Wi-Fi Certified D-Link Product – DIR-615E

Wi-Fi CERTIFIED™ Interoperability Certificate

Certification ID: WFA8640



This certificate lists the capabilities and features that have successfully completed Wi-Fi Alliance interoperability testing. Additional information about Wi-Fi Alliance certification programs is available at www.wi-fi.org/certification_programs.php.

Tested Spatial Streams	Single Band	
	2.4 GHz	5.0 GHz
Transmit	2	-
Receive	2	-

Certificate Date: February 25, 2010
Company: D-Link Systems
Product: D-Link DIR-615 Wireless N Router
Model/SKU #: DIR-615E3/E4/
Category: Access Point for Home or Small Office (Wireless Router)

IEEE Standard

IEEE 802.11b
IEEE 802.11g
IEEE 802.11n

Optional 802.11n Capabilities
- 40 MHz operation in 2.4 GHz with coexistence mechanisms

Security

WPA™ - Enterprise, Personal
WPA2™ - Enterprise, Personal

EAP Type(s)

EAP-TLS
EAP-TTLS/MSCHAPv2
PEAPv0/EAP-MSCHAPv2
PEAPv1/EAP-GTC
EAP-SIM
EAP-AKA
EAP-FAST

Multimedia

WMM®

Special Features

Wi-Fi Protected Setup™

Wi-Fi Certificate shows that DIR-615E4 followed the 2.4GHz coexistence mechanism. According to this new rule, it's not easy to 300 Mbps whenever there is an 802.11G or non 40MHz client, AP/wireless router will switch bandwidth from 40 MHz to 20 MHz.

Wi-Fi Certified D-Link Product – DIR-815

Wi-Fi CERTIFIED™ Interoperability Certificate

Certification ID: WFA9197



This certificate lists the capabilities and features that have successfully completed Wi-Fi Alliance interoperability testing. Additional information about Wi-Fi Alliance certification programs is available at www.wi-fi.org/certification_programs.php.

Tested Spatial Streams	Dual-Band Concurrent	
	2.4 GHz	5.0 GHz
Transmit	2	2
Receive	2	2

Certificate Date: May 28, 2010
Company: D-Link Corporation
Product: DIR-815 Wireless N Dual Band Router / DIR-815 v1.00
Model/SKU #: DIR-815 v1.00/
Category: Access Point for Home or Small Office (Wireless Router)

IEEE Standard

IEEE 802.11a
 IEEE 802.11b
 IEEE 802.11g
 IEEE 802.11n

Optional 802.11n Capabilities

- Short Guard Interval
- TX A-MPDU
- STBC
- 40 MHz operation in 2.4 GHz with coexistence mechanisms
- 40 MHz operation in 5 GHz

Security

WPA® - Enterprise, Personal
 WPA2® - Enterprise, Personal

EAP Type(s)

EAP-TLS
 EAP-TTLS/MSCHAPv2
 PEAPv0/EAP-MSCHAPv2
 PEAPv1/EAP-GTC
 EAP-SIM
 EAP-AKA
 EAP-FAST

Multimedia

WMM®
 WMM Power Save

Special Features

Wi-Fi Protected Setup™
 - PIN
 - PBC

Wi-Fi Certified D-Link Product – DWA-121

Wi-Fi CERTIFIED™ Interoperability Certificate

Certification ID: WFA10051



This certificate lists the capabilities and features that have successfully completed Wi-Fi Alliance interoperability testing. Additional information about Wi-Fi Alliance certification programs is available at www.wi-fi.org/certification_programs.php.

Tested Spatial Streams	Single Band	
	2.4 GHz	5.0 GHz
Transmit	1	-
Receive	1	-

Certificate Date: October 21, 2010
Company: D-Link Corporation
Product: Wireless N 150 Compact USB adapter / DWA-121
Model/SKU #: DWA-121/
Category: External Wi-Fi Adapter Card

IEEE Standard

IEEE 802.11b
 IEEE 802.11g
 IEEE 802.11n

Optional 802.11n Capabilities

- Short Guard Interval
- TX A-MPDU
- 40 MHz operation in 2.4 GHz with coexistence mechanisms

Security

WPA® - Enterprise, Personal
 WPA2® - Enterprise, Personal

EAP Type(s)

EAP-TLS
 EAP-TTLS/MSCHAPv2
 PEAPv0/EAP-MSCHAPv2
 PEAPv1/EAP-GTC
 EAP-SIM
 EAP-AKA
 EAP-FAST

Multimedia

WMM®
 WMM Power Save

Special Features

Wi-Fi Protected Setup™
 - PIN
 - PBC

DWA-121 (1x1 150 Mbps)



D-Link Wireless N 150 USB adapter

Wi-Fi Certified D-Link Product – DAP-1525

Wi-Fi CERTIFIED™ Interoperability Certificate

Certification ID: WFA11166



This certificate lists the capabilities and features that have successfully completed Wi-Fi Alliance interoperability testing. Additional information about Wi-Fi Alliance certification programs is available at www.wi-fi.org/certification_programs.php.

Tested Spatial Streams	Dual-Band Concurrent	
	2.4 GHz	5.0 GHz
Transmit	2	2
Receive	2	2

Certificate Date: March 02, 2011
Company: D-Link Corporation
Product: Wi-Fi Booster
Model/SKU #: DAP-1525/
Category: Access Point for Home or Small Office (Wireless Router)

IEEE Standard

IEEE 802.11a
IEEE 802.11b
IEEE 802.11g
IEEE 802.11n

Optional 802.11n Capabilities

- Short Guard Interval
- TX A-MPDU
- STBC
- 40 MHz operation in 2.4 GHz with coexistence mechanisms
- 40 MHz operation in 5 GHz
- HT Duplicate (MCS 32)

Security

WPA® - Enterprise, Personal
WPA2® - Enterprise, Personal

EAP Type(s)

EAP-TLS
EAP-TTLS/MSCHAPv2
PEAPv0/EAP-MSCHAPv2
PEAPv1/EAP-GTC
EAP-SIM
EAP-AKA
EAP-FAST

Multimedia

WMM®

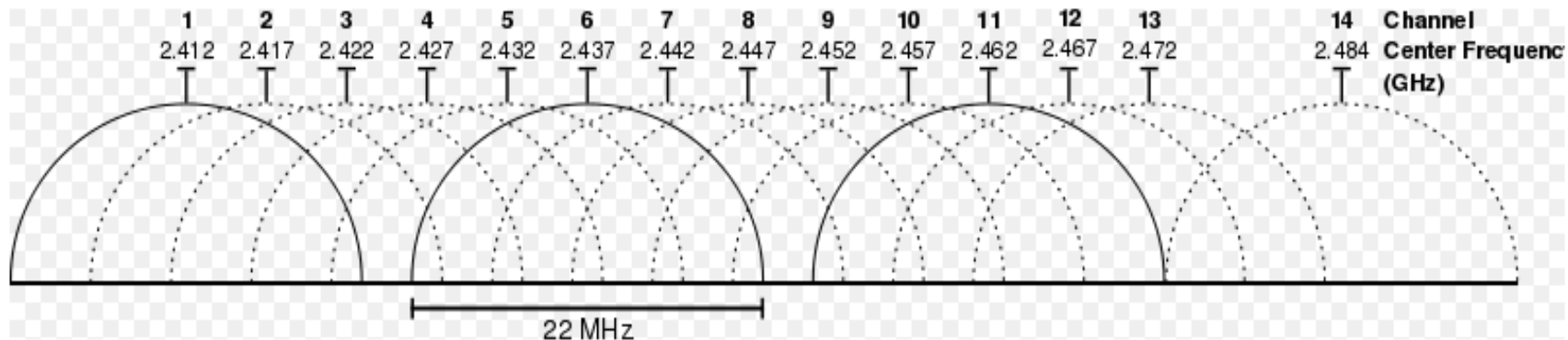
Special Features

Wi-Fi Protected Setup™
- PIN
- PBC
- Internal Registrar
- External Registrar



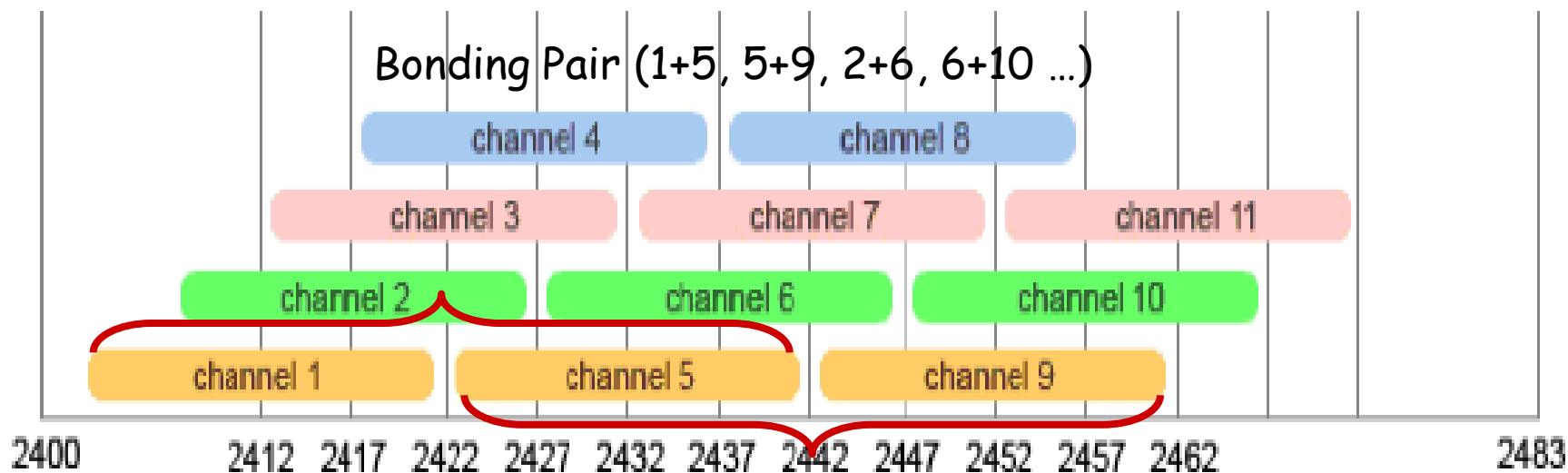
Why 20/40 Coexistence Mechanism in the 2.4 GHz frequency band? Not in the 5 GHz band?

Few channels available in 2.4 GHz



2.4 GHz ISM Band

Overlapping area will cause severe interference and reduce performance.



Two non-overlapping channels for channel bonding.

Bandwidth 40 MHz – Channel bonding



Spectrum Analyzer



Using Spectrum Analyzer to show running 40 MHz occupy two non-overlapping channels.

Bandwidth 40 MHz – Channel Bonding



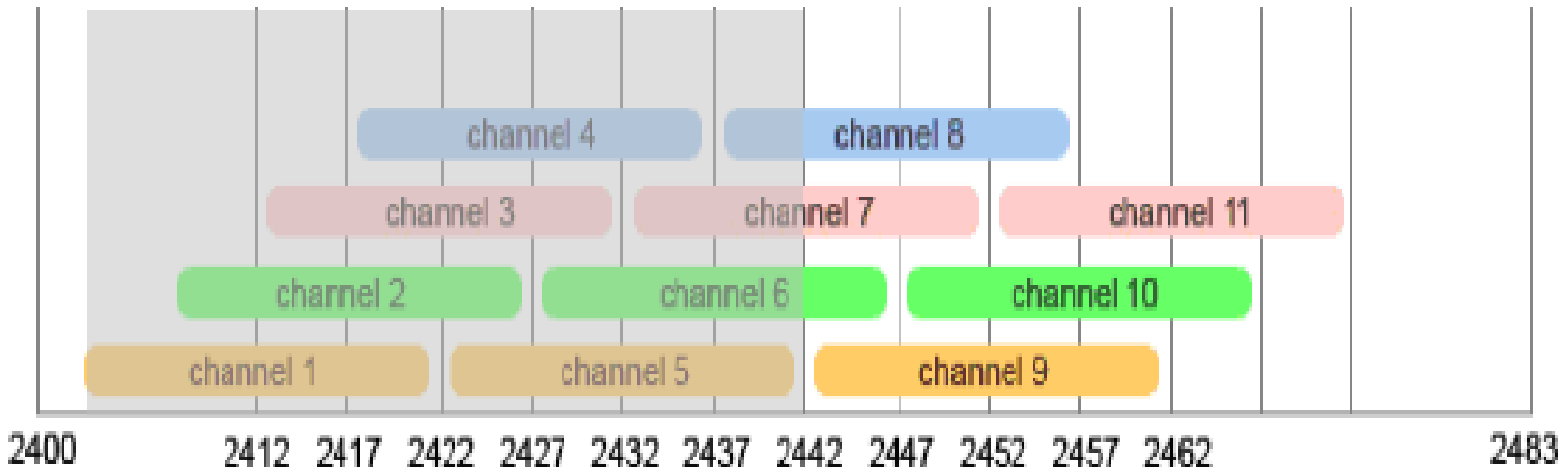
Spectrum Analyzer



Channel Bonding occupied 2/3 of RF band



When channel bonding, the 2/3 of radio frequency will be affected, only few channels, let say Ch 8-13 are available for other WLAN devices.



Two non-overlapping channel for channel bonding.

Channel Bonding occupied 2/3 of RF band

channel	frequency (MHz)
36	5180
40	5200
44	5220
48	5240
52	5260
56	5280
60	5300
64	5320
100	5500
104	5520
108	5540
112	5560
116	5580
120	5600
124	5620
128	5640
132	5660
136	5680
140	5700
149	5745
153	5765
157	5785
161	5805
165	5825

} Bonding Pair (36+40, 44+48 ...)

In the 5 GHz frequency band, interference is not an issue, so coexistence mechanisms are not required.

Coz the channels in 5GHz are separate without overlapped.



20/40 Coexistence Mechanism Wi-Fi Description and Test Bed.

20/40 Coexistence Description and Test Bed

4.2.41 AP 20/40 MHz Coexistence

Purpose and Description

APUT is not starting a 40 MHz BSS in presence of an 802.11g BSS.

APUT is appropriately switching from 40 MHz to 20 MHz in presence of 40 MHz intolerant STA.

APUT is appropriately switching from 40 MHz to 20 MHz when receiving frames disallowing the use of 40 MHz channel width.

Test Environment

802.11n APUT

STA1: Testbed 802.11n 20/40 MHz Capable

AP2: Testbed 802.11g

Wireless 802.11n Sniffer

AP2 is an 11n device operating in legacy g mode

Test Configuration

The following table defines the parameter values for the devices in the test bed. 1x1, 2x2, & 3x3 APs can be tested using this procedure.

It takes effect IMMEDIATELY from 21 July 2010

Notice: Wi-Fi Alliance updated Engineering Change Notice



A D T

Wi-Fi Alliance just announced the ECN 200 document (Engineering Change Notice) in this week. It updated some requirements in the 802.11n testplan version 2.0.6 in CERTIFIED n test. In table 9 and table 139, according to the ECN 200, test 4.2.43 and test 5.2.50 have changed from "optional and tested if implemented" to "Mandatory". (Please refer to below tables.)

*Note: There is no 90 days transition period for this ECN. It takes effect IMMEDIATELY from 21st July 2010.

Table 9

Test Section	Test Case	Frequency Band (GHz)	Channel Width (MHz)	TP v 2.0.6	TP v 2.0.6 with ECN # 200
4.2. ...					
4.2.39	AP STBC Transmit Test	2.4 5	20 20/40	Optional and Tested	Optional and Tested
4.2.40	A-MPDU Aggregation when the AP is the Transmitter	2.4 5	20 20/40	Optional and Tested	Optional and Tested
4.2.41	AP 20/40 MHz Coexistence	2.4 5	20 20/40	Optional and Tested	Optional and Tested
4.2.42	Ability to Receive 3 Spatial Streams	2.4 5	20 20/40	Optional and Tested	Optional and Tested



Test result of 20/40 Coexistence Mechanism implemented product.

The D-Link Product Test Result



	DIR-825 B1		DIR-655 B1	
	Open Site	Chamber	Open Site	Chamber
DWA-160A1	130	300	130	300
DWA-140B2	130	300	130	300
Intel5100AGN	130	300	130	300

DIR-825 B1 FW v2.05NA

DIR-655 B1 FW v2.01NA

DWA-160 A1 (Driver 3.0.0.170 2010/6/23)

DWA-140 B2 (Driver 1.4.9.0 2009/12/28)

Intel 5100 AGN (Driver 13.5.0.6 2011/1/19)

Enable/Disable Option for 20/40 MHz Coexist

Application Rules

Access Control

Traffic Control

Firewall & DMZ

Advanced Wireless

Advanced Network

Routing

Logout

These options are for users that wish to change the behavior of their 802.11n wireless radio from the standard setting. We do not recommend changing these settings from the factory default. Incorrect settings may impact the performance of your wireless radio. The default settings should provide the best wireless radio performance in most environments.

Save Settings

Don't Save Settings

ADVANCED WIRELESS SETTINGS

Transmit Power: 100% ▾

Beacon Period: 100 (msec, range:20~1000, default:100)

RTS Threshold: 2346 (range: 256~2346, default:2346)

Fragmentation: 2346 (range: 1500~2346, default:2346)

DTIM Interval: 1 (range: 1~255, default:1)

Preamble Type : Short Preamble Long Preamble

CTS Mode : None Always Auto

Wireless Mode: 802.11Mixed(n/g/b) ▾

Band Width: 20/40MHz(Auto) ▾

20/40MHz Coexist: Enable Disabled

Short Guard Interval :

DIR-618A1/FW V1.03B02



What else should you be aware of?

802.11n MCS table



MCS Index	Spatial Streams	Modulation Type	Coding Rate	Data Rate Mb/s			
				20 MHz channel		40 MHz channel	
				800ns GI	400ns GI	800ns GI	400ns GI
0	1	BPSK	1/2	6.50	7.20	13.50	15.00
1	1	QPSK	1/2	13.00	14.40	27.00	30.00
2	1	QPSK	3/4	19.50	21.70	40.50	45.00
3	1	16-QAM	1/2	26.00	28.90	54.00	60.00
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
...	3	...	...	...	...	...	...
23	3	64-QAM	5/6	195.00	216.60	405.00	450.00
...	4	...	...	...	...	...	...
31	4	64-QAM	5/6	260.00	288.90	540.00	600.00

Other Factors for Data Rate 300 Mbps



Spatial Stream - 2x2 or 2x3
Short Guard Interval - 400 ns
Channel Bandwidth - 20/40 MHz
Security - None or WPA with cipher AES



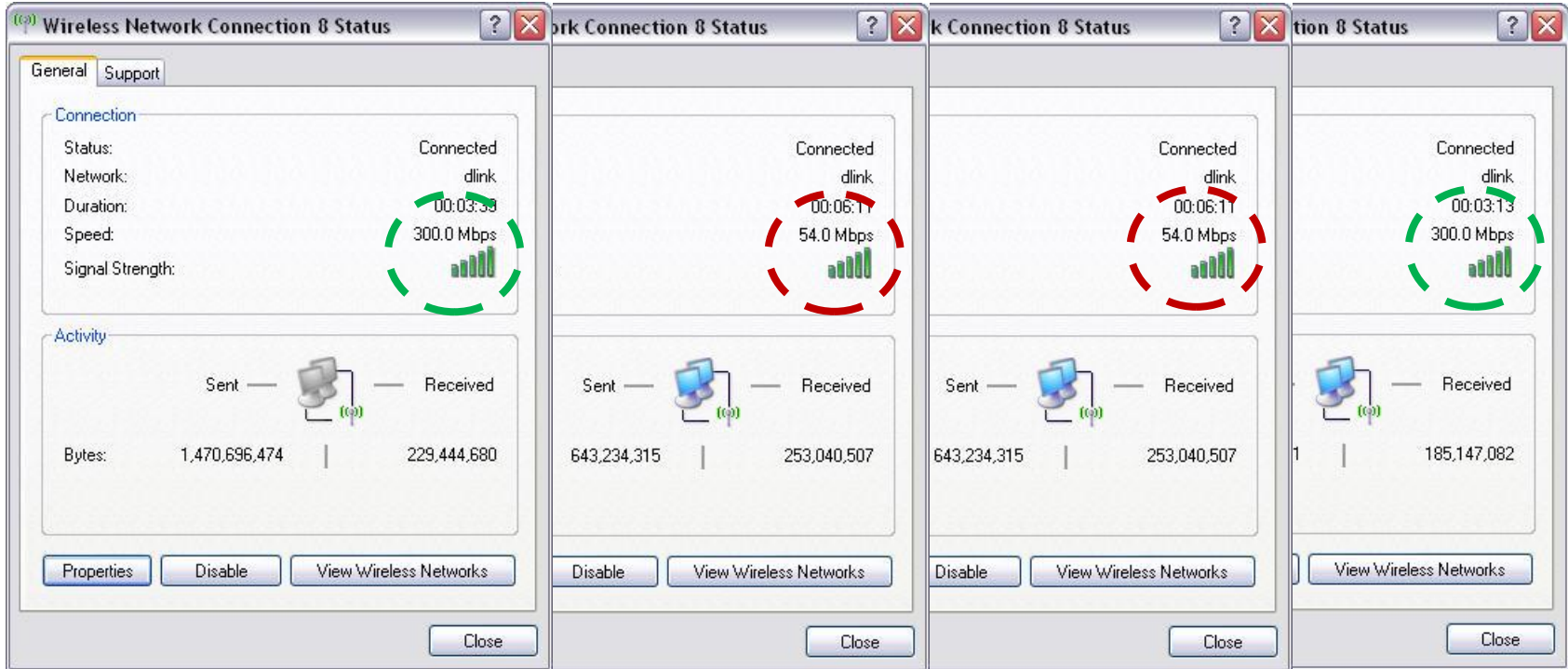
Spatial Stream - 2x2
Channel Bandwidth - 20/40 MHz
Security - None or WPA with cipher AES

None encryption

WEP

WPA-TKIP

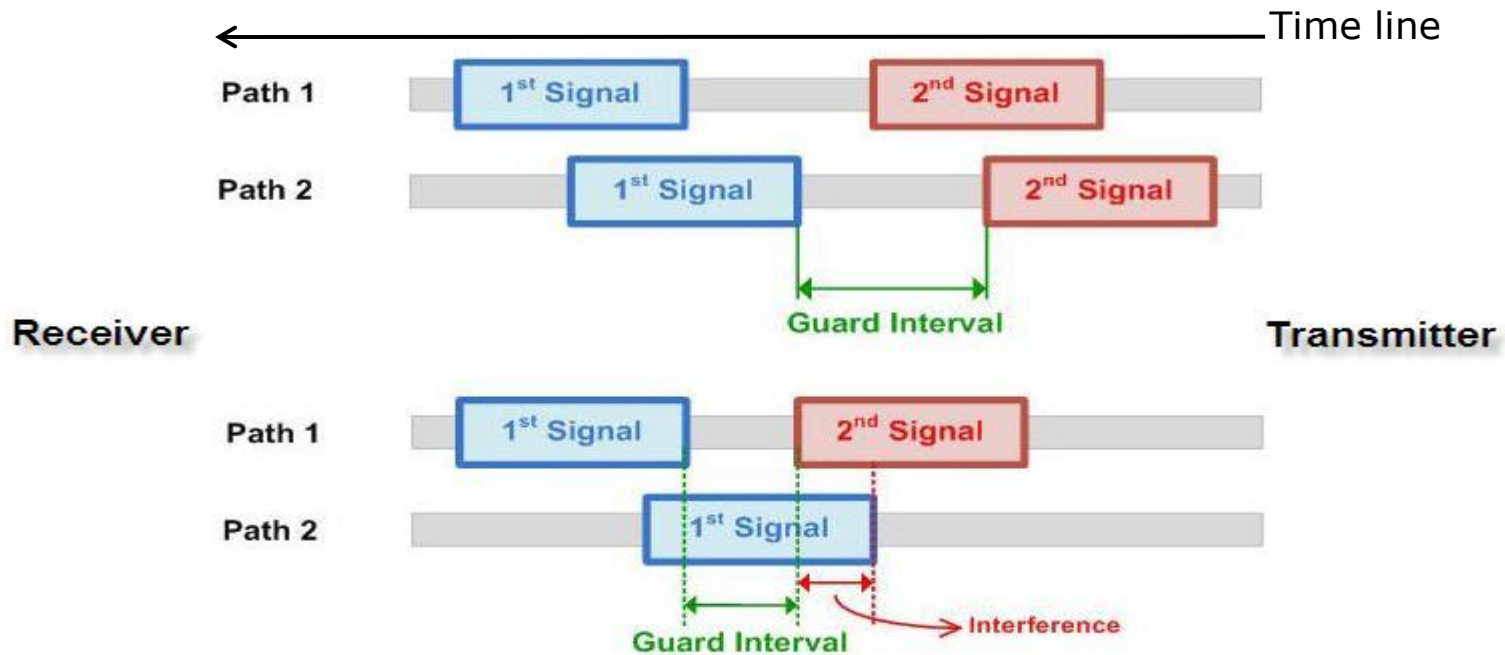
WPA-AES



Guard Interval



Guard Interval is a time period between two transmitted symbols. The purpose is to prevent interference in multipath environments. When two symbols arrive over two different paths, the beginning of a new symbol may arrive at the receiver before the last symbol is completely received.



Guard Interval

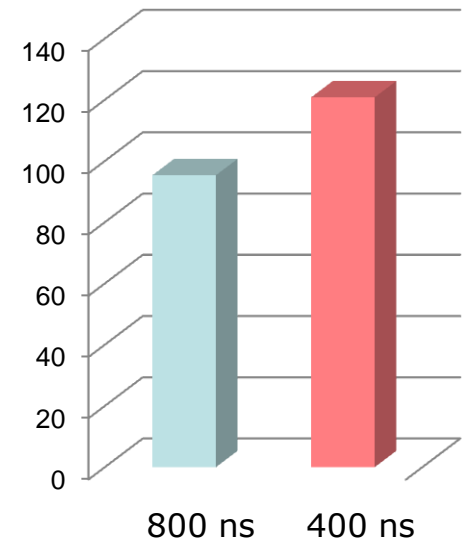


802.11n supports short guard interval which shorten the time to 400ns
It can improve around 10% of performance.



Guard Interval	800 ns	400 ns
Throughput (Mbps)	95.358	120.807

DIR-655 v1.30WWb02; (2T3R)
DWA-160A v1.60WW_S0054; (2T2R)
None encryption; 40 MHz





Thank you!