Cisco live!

What You Make Possible

TOMORROW starts here.

CISCO

CCNA Wireless: Find out why it is a great time to work in the wireless field

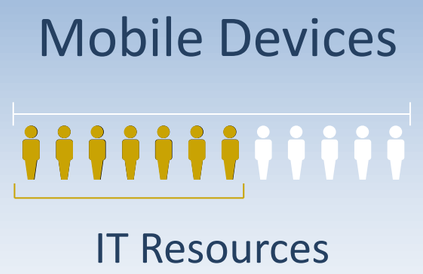
BRKCRT-8302

Market Transitions

More Bandwidth-demanding Applications, More Wireless Devices

Mobility

- 7 billion new networked mobile devices by 2015
- But IT resources are shrinking



New User Behaviours

- Work is an activity, not a place:
- Need to be connected always, from any device

Network Usage

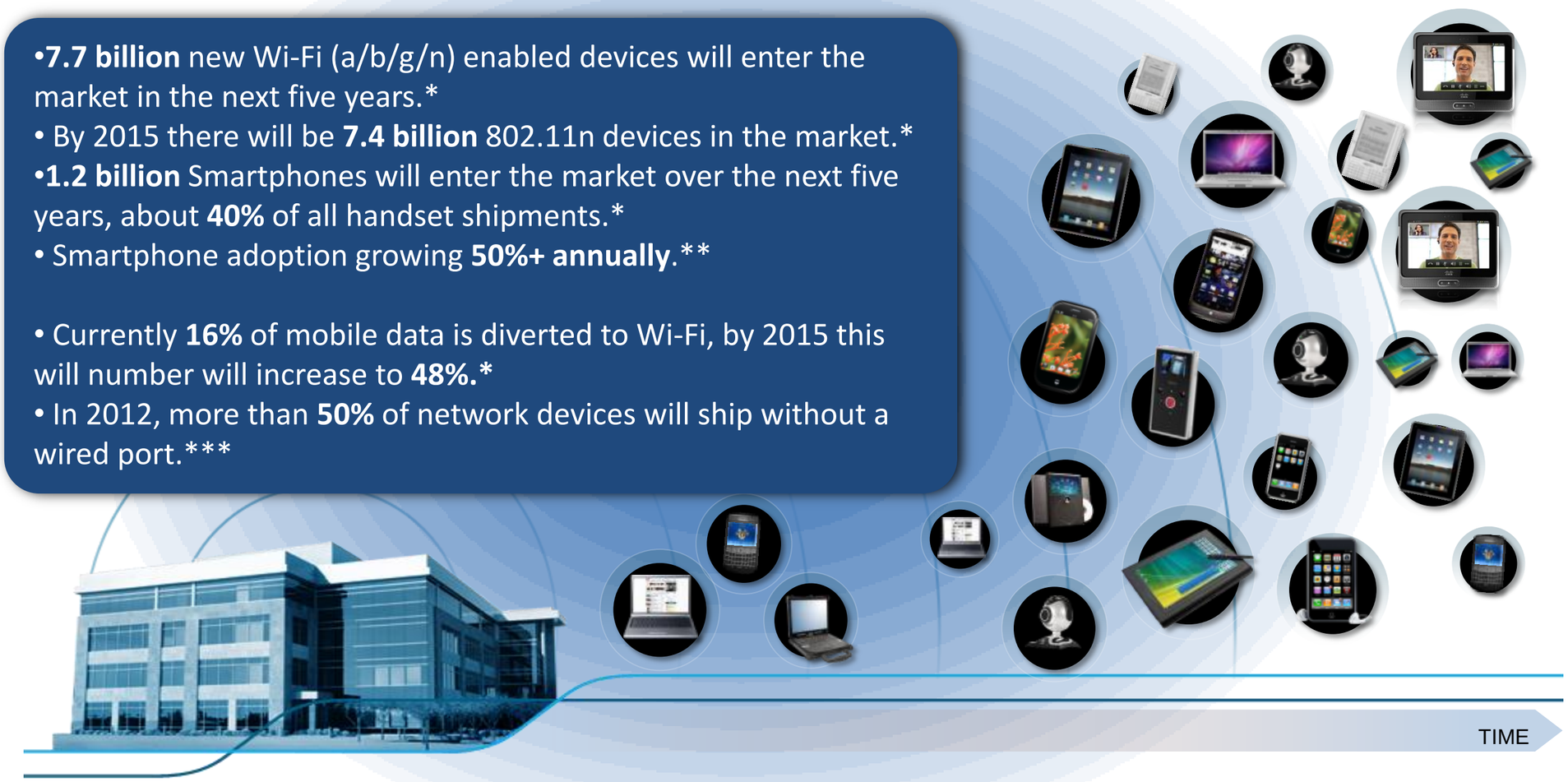
- 50% of all Cisco.com traffic today is video (growing)
- More and more wireless devices embark video

Explosive Mobile Device Growth!

More WiFi Devices, More Handoff to the WiFi Network

- **7.7 billion** new Wi-Fi (a/b/g/n) enabled devices will enter the market in the next five years.*
- By 2015 there will be **7.4 billion** 802.11n devices in the market.*
- **1.2 billion** Smartphones will enter the market over the next five years, about **40%** of all handset shipments.*
- Smartphone adoption growing **50%+ annually**.**

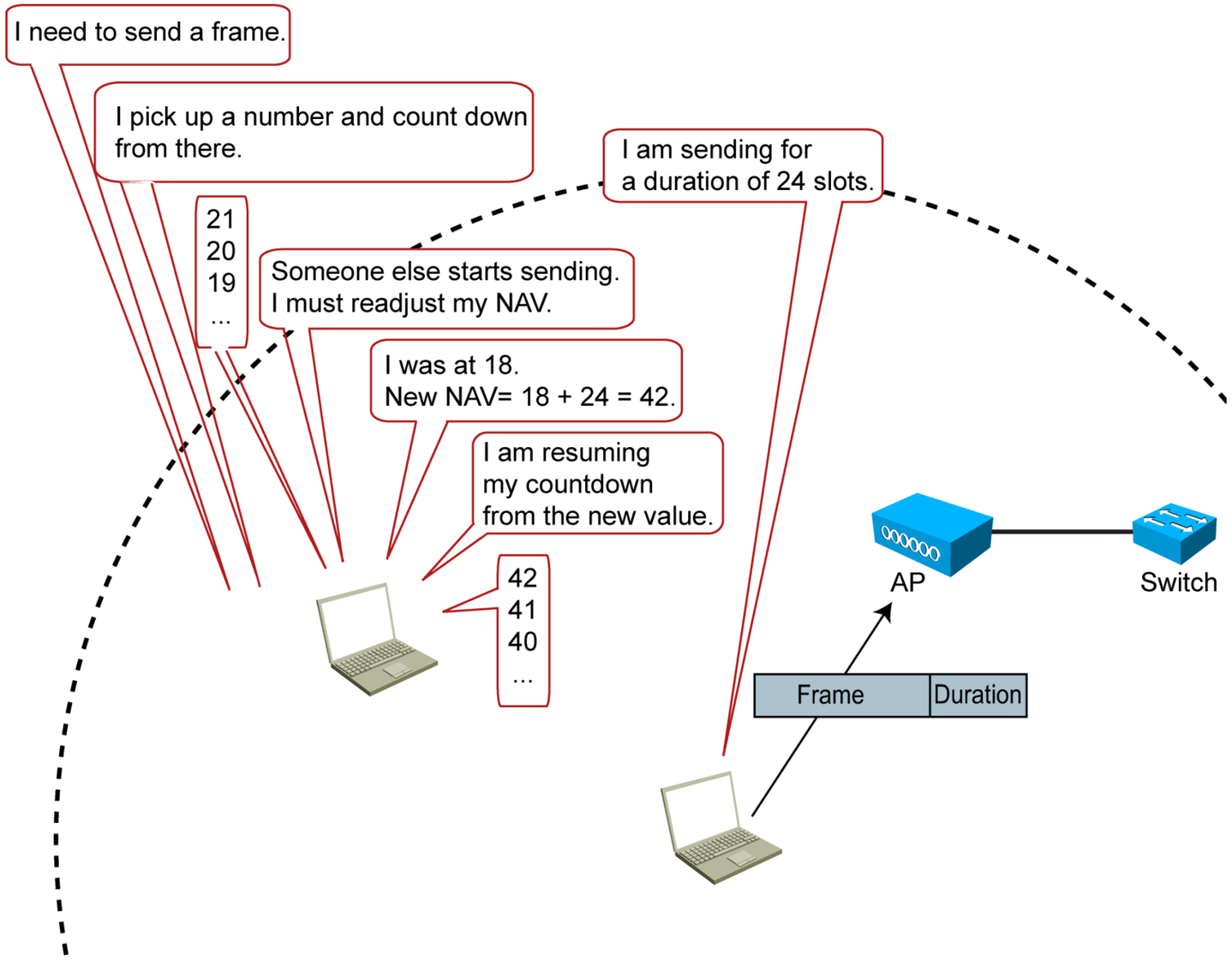
- Currently **16%** of mobile data is diverted to Wi-Fi, by 2015 this will number will increase to **48%.***
- In 2012, more than **50%** of network devices will ship without a wired port.***



▪Source: *ABI Research, **IDC, *** Morgan Stanley Market Trends

The Need for Speed

Traditional 802.11 (DCF), CSMA/CA

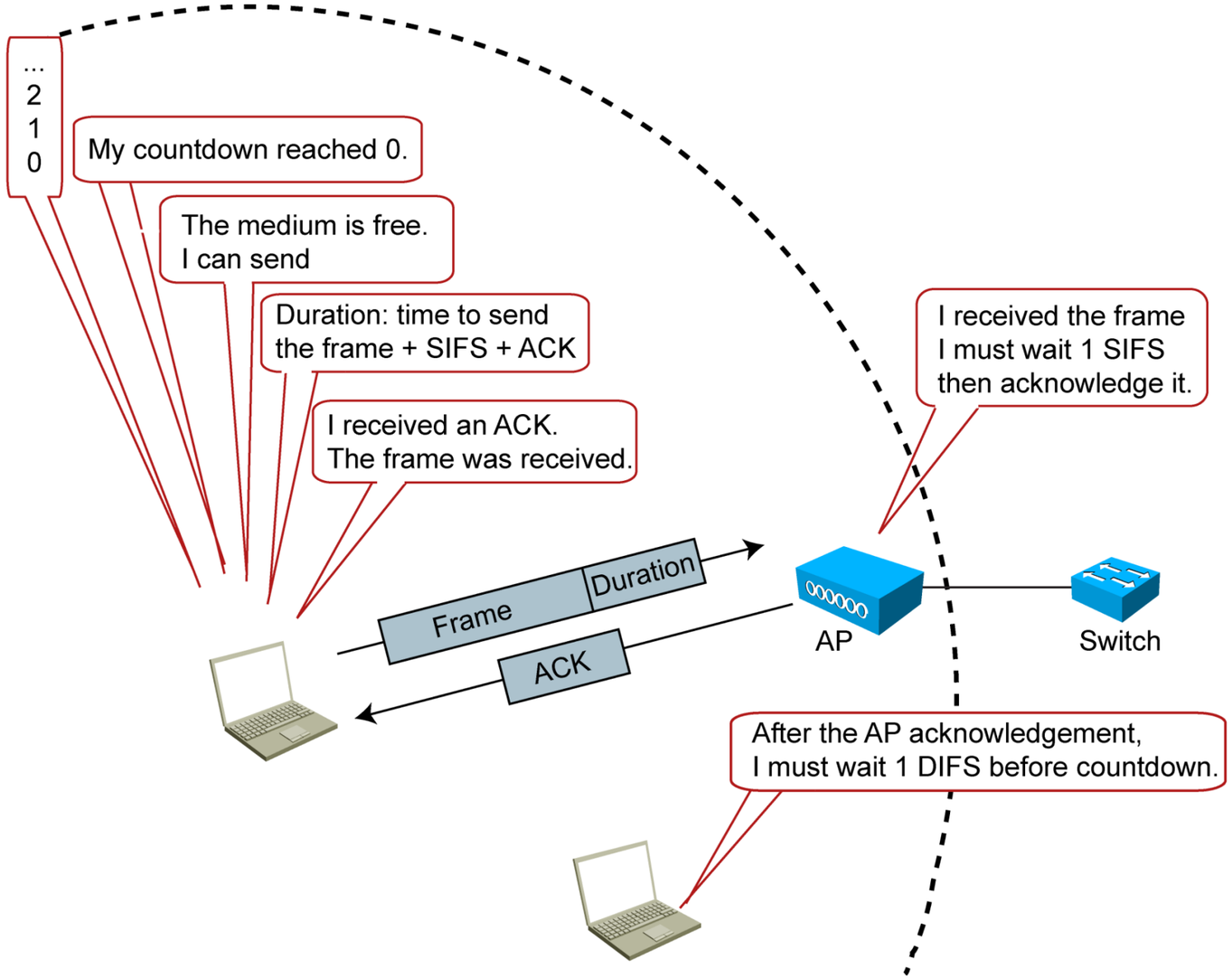


Key terms:

- Backoff timer: the initial number you pick up and countdown from
- Contention window: the possible values for the backoff timer (at least CWMin, at most CWMax)
- Network Allocation Vector: the total time you wait before sending.

The Need for Speed

Traditional 802.11 (DCF), CSMA/CA

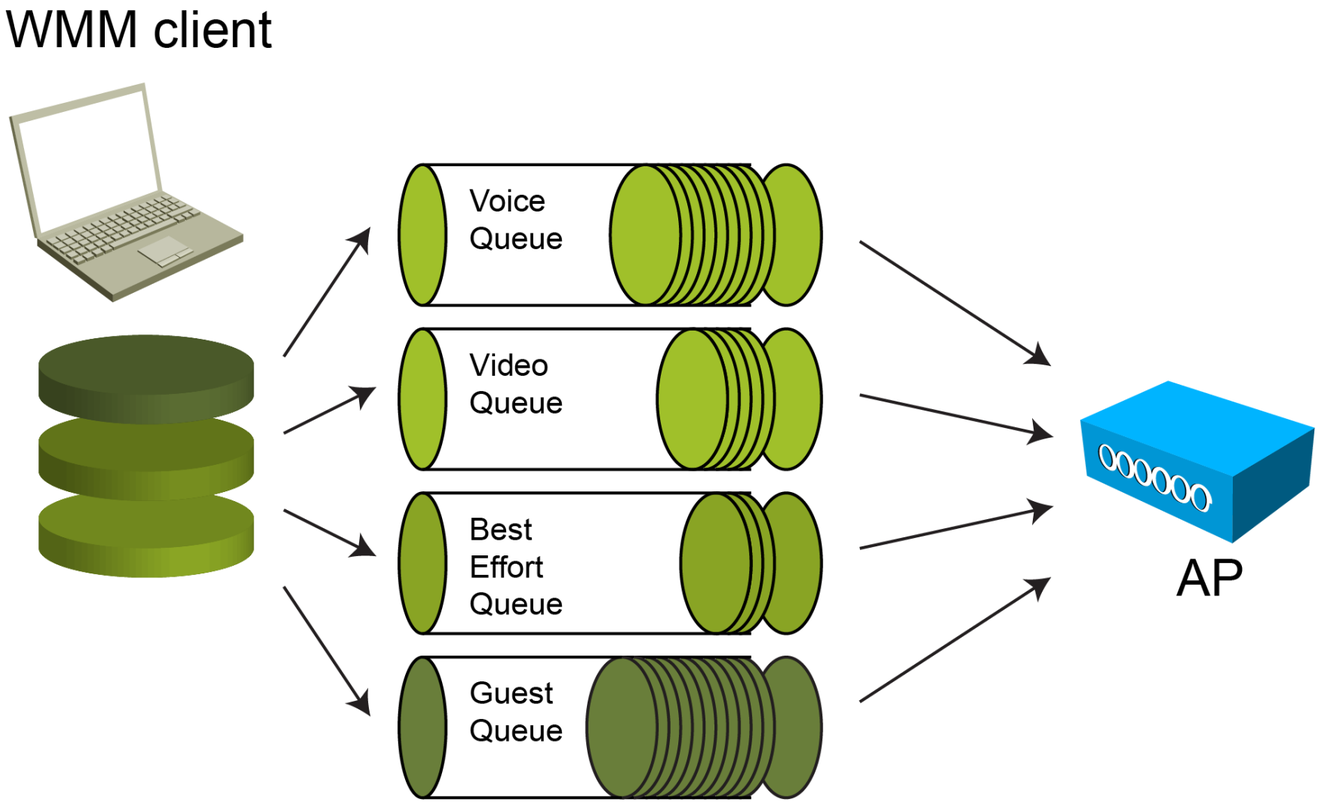


Key terms:

- SIFS: Short Interframe Space (silence between unicast frame and its ACK)
- ACK: Acknowledgement
- DIFS: Distributed Interframe Space (silence between one transmission and the next)

Improving 802.11: 802.11e

Better Countdown Mechanism



Key terms:

- AC: Access Category – Platinum (Voice), Gold (Video), Silver (Best Effort), Bronze (Background)
- AIFS: Arbitration Interfame Space (DIFS equivalent, when QoS is used)

How Much Do We Save With 802.11?

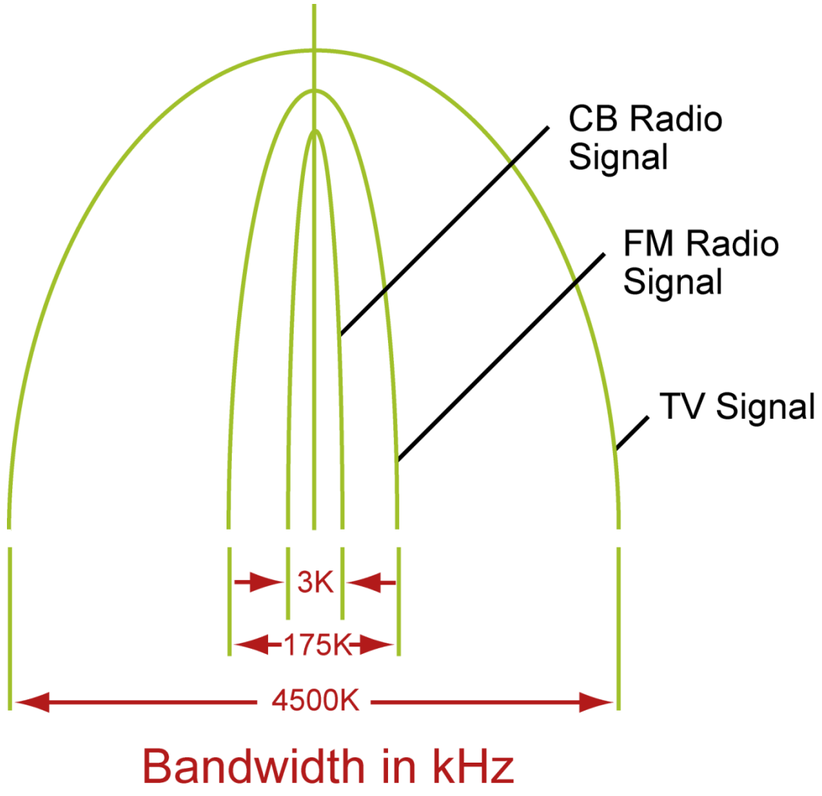
Smaller CW, Same or Larger IFS

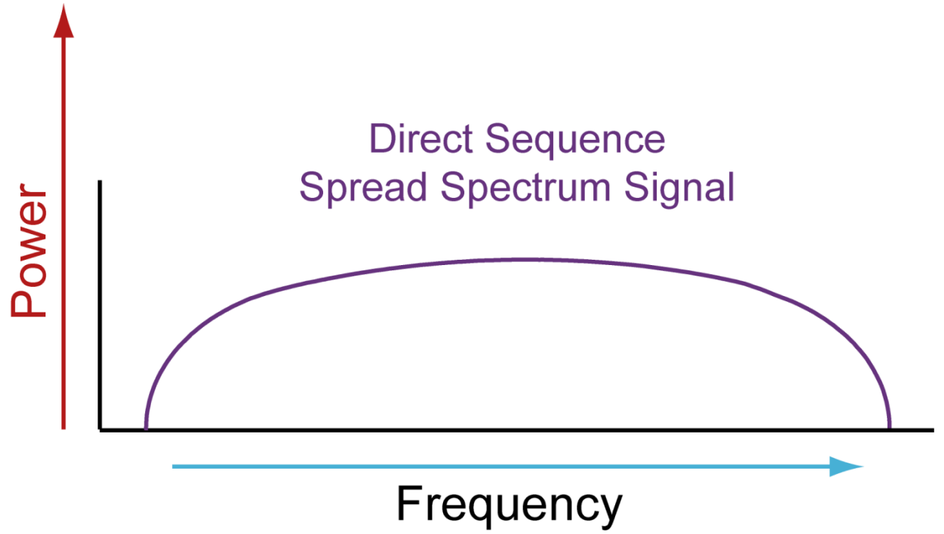
Access Category	CWMin	CWMax	AIFS
DCF	15 or 31	1023	2 (DIFS)
Voice	3	7	2
Video	7	15	2
Best Effort	15	1023	3
Background	15	1023	7

“Higher Speed”: 802.11, 802.11b

Working on the Wave Shape vs. Speed Problem

- Bandwidth depends on the amount of information to send



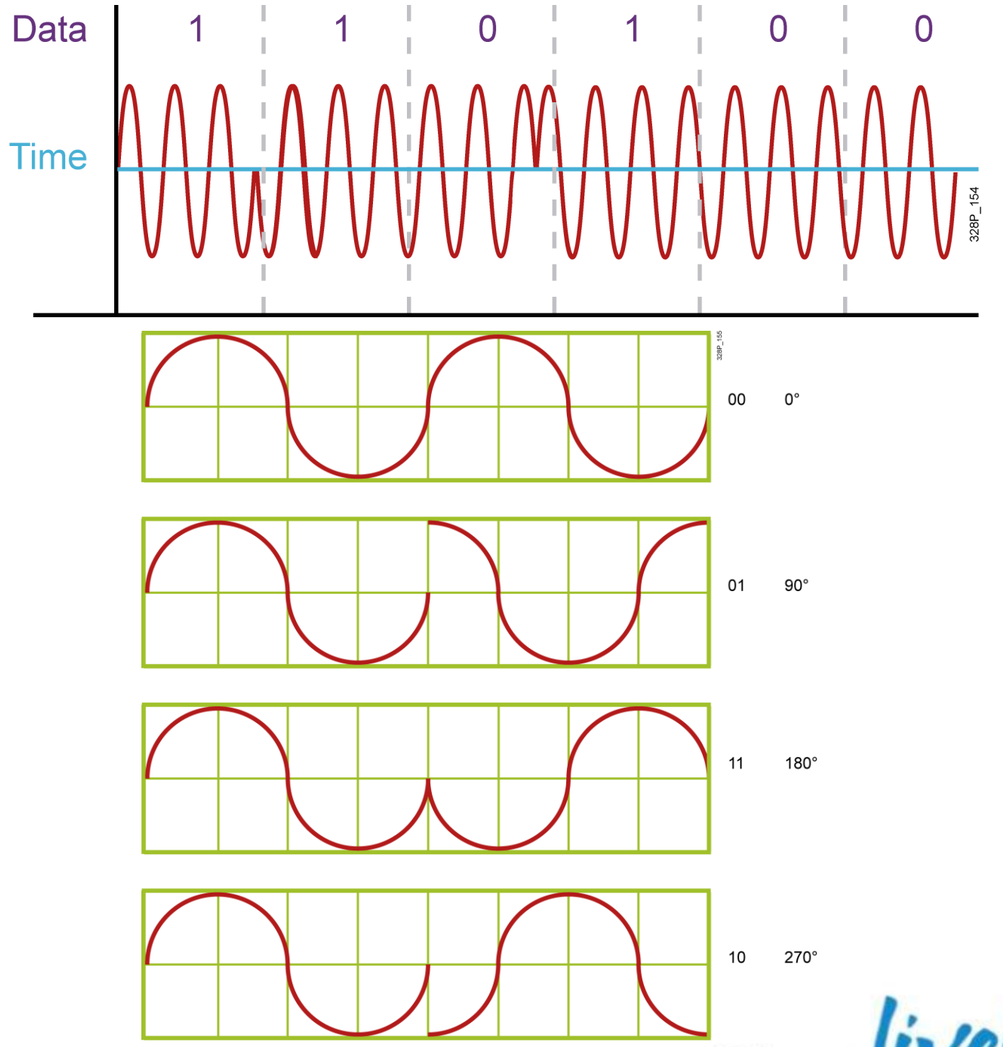


- 802.11, in the 2.4 GHz band, used 22 MHz-wide signals

“Higher Speed”: 802.11 Techniques

Modulations: BPSK, QPSK

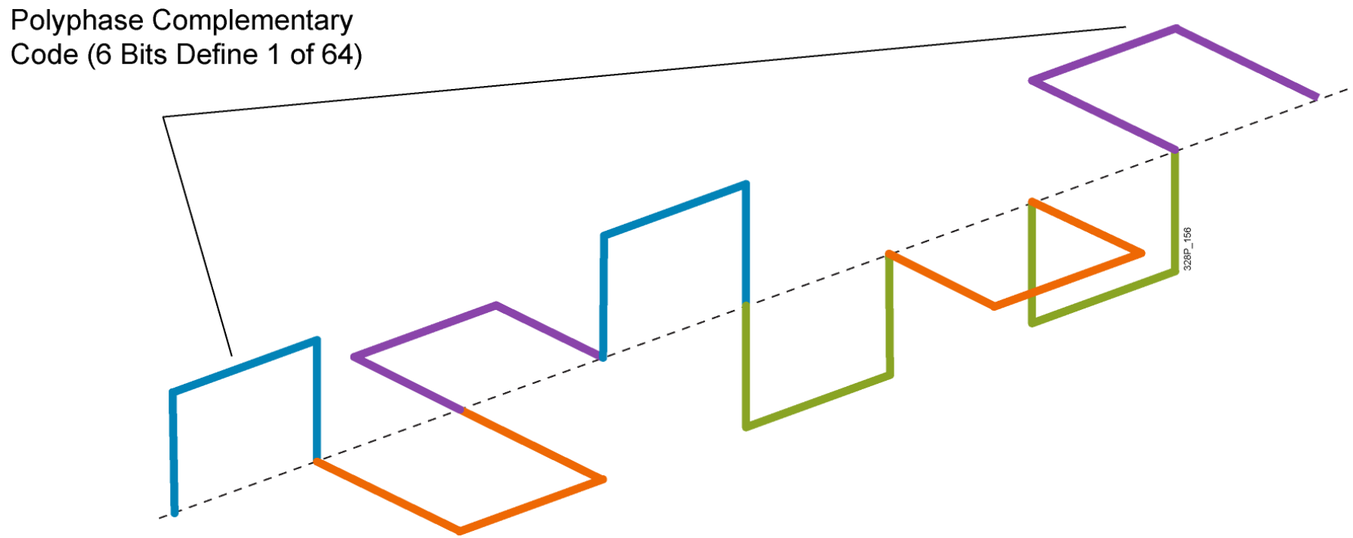
- When using Binary Phase Shift Keying (BPSK), the phase shifts with 180° angles; each shift represents 1 bit. DBPSK allows 1 Mb/s.
- When using Quadrature Phase Shift Keying (QPSK), shifts are 90°; each shift represents 2 bits. DQPSK allows 2 Mb/s



Higher Speed: 802.11b Improvements

Modulations: CCK

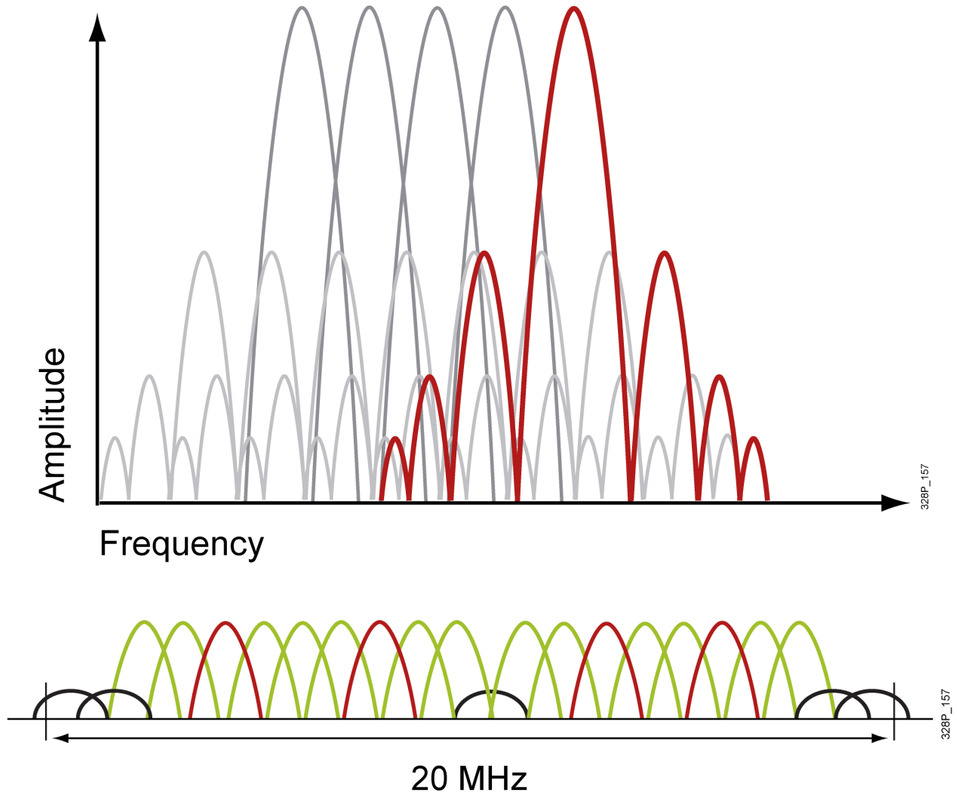
- With CCK, each symbol of 6 bits is associated to a unique code sequence.
- Coding 4 bits per symbol allows 5.5 Mb/s; coding 8 bits per symbol allows 11 Mb/s.



Higher Speed: 802.11g, 802.11a Improvements

Modulations: OFDM

- 64 small waves (called Carriers, or Tones), using BPSK, QPSK… or QAM (Quadrature)
- Some carriers are not used for data:
  - 48 data subcarriers (in green)
  - 4 pilot subcarriers (in red) for synchronisation and tracking
  - 12 zero subcarriers (in black) for calibration on sides and centre

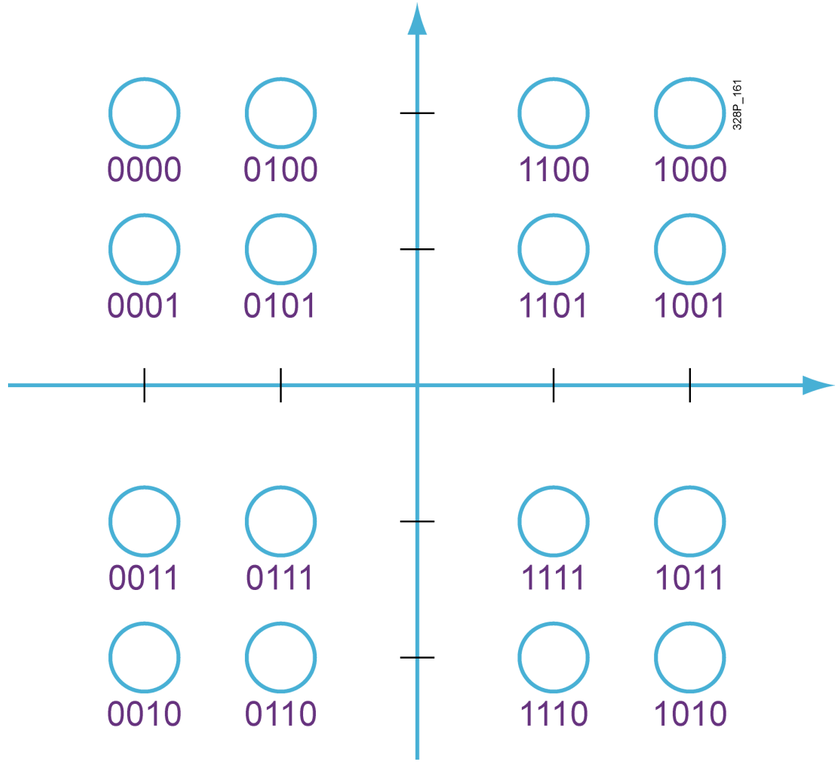


Higher Speed: 802.11g, 802.11a Improvements

Modulations: OFDM

- For each modulation, some information is repeated to avoid losses.
- Less repeats means higher data rate

BPSK	QPSK	QAM 16	QAM 64
6 Mb/s	12 Mb/s	24 Mb/s	48 Mb/s
9 Mb/s	18 Mb/s	36 Mb/s	54 Mb/s

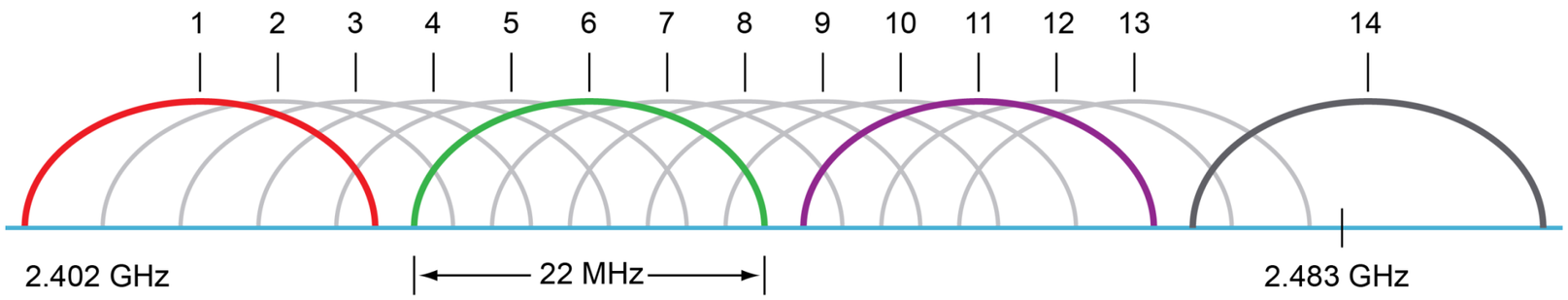


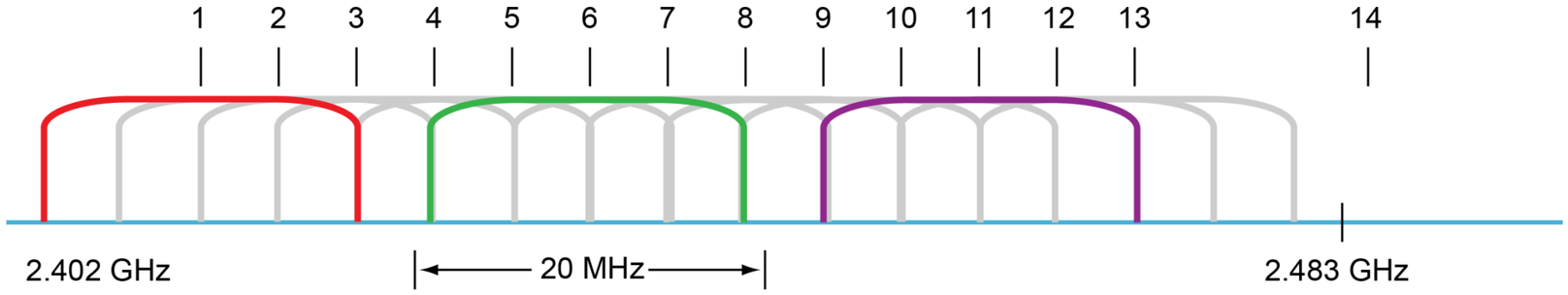
QAM-16

802.11g vs. 802.11a

802.11g Band of Operation

- Up to 13 (OFDM) or 14 (DSSS) channels
- 3 to 4 non-overlapping channels

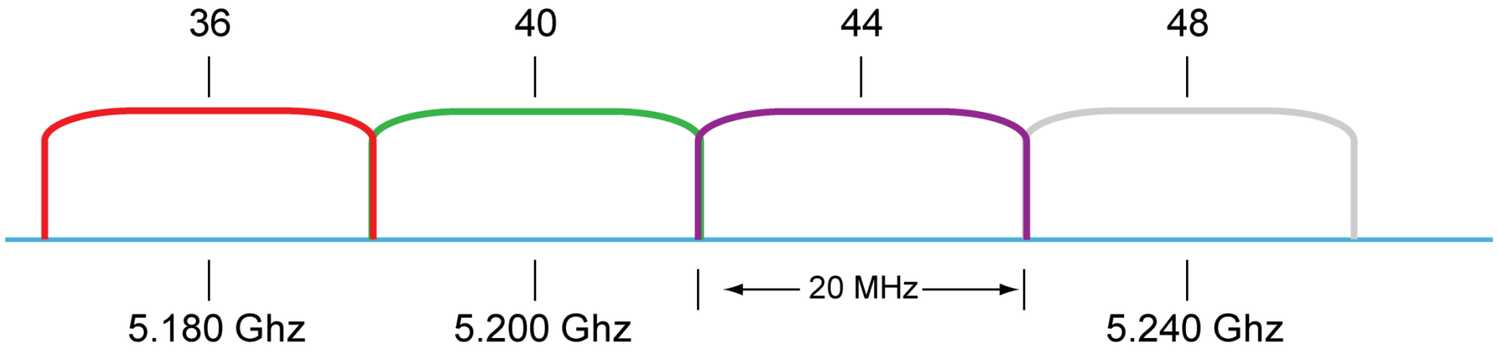


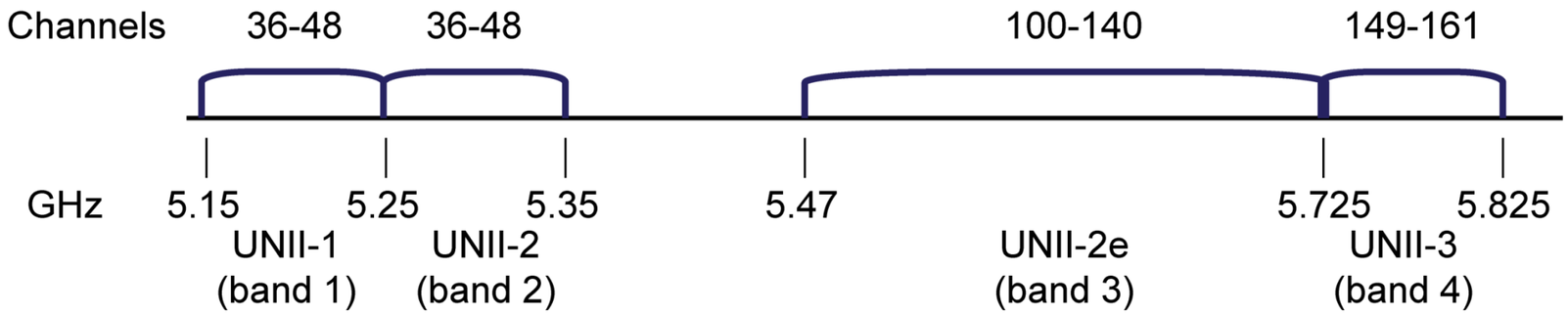


802.11g vs. 802.11a

802.11a Band of Operation

- Up to 23 channels
- All are non-overlapping channels

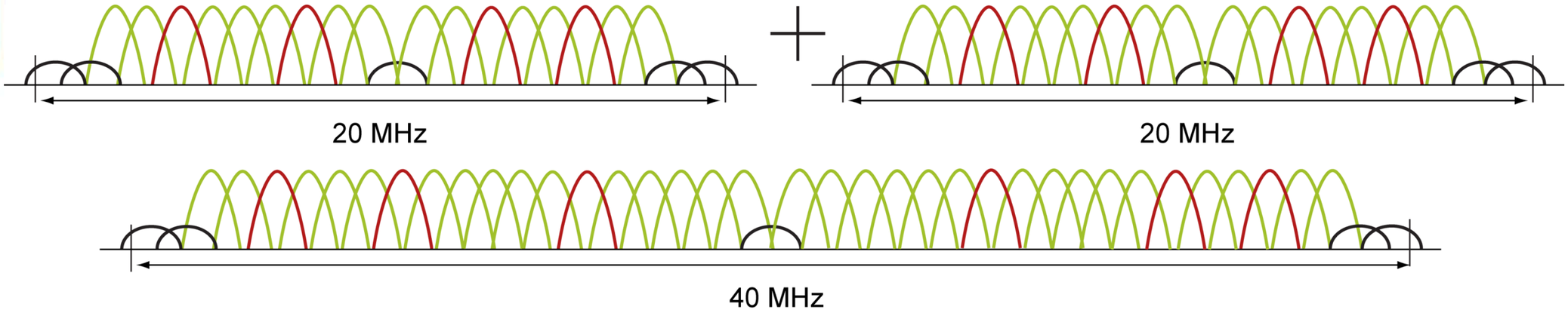




Going Faster with 802.11n

Channel Aggregation

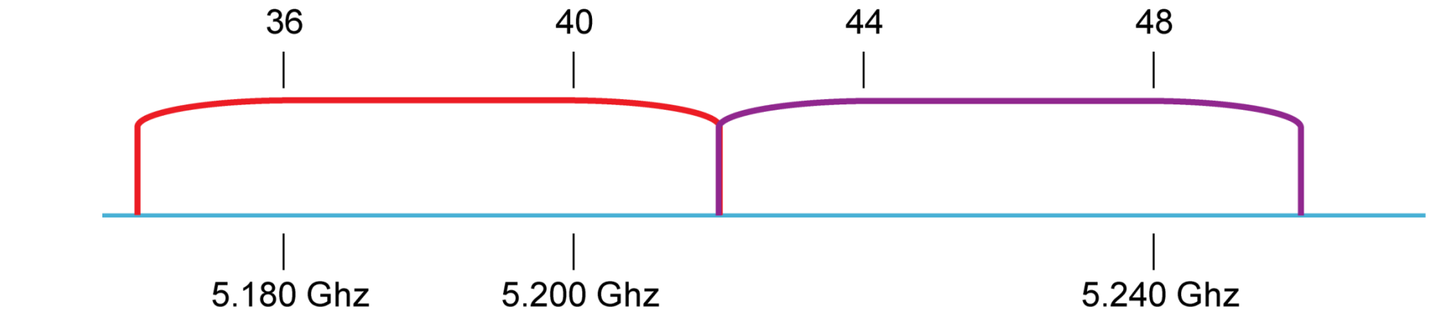
- 802.11n aggregates two carriers to more than double the speed:
  - 128 subcarriers (vs. 64)
  - Still 12 zero subcarriers for calibration on sides and centre
  - 6 pilot subcarriers (vs. 4) for synchronisation and tracking
  - 112 data subcarriers (vs. 48)
  - 54 Mb/s to 108+11 = 119 Mb/s

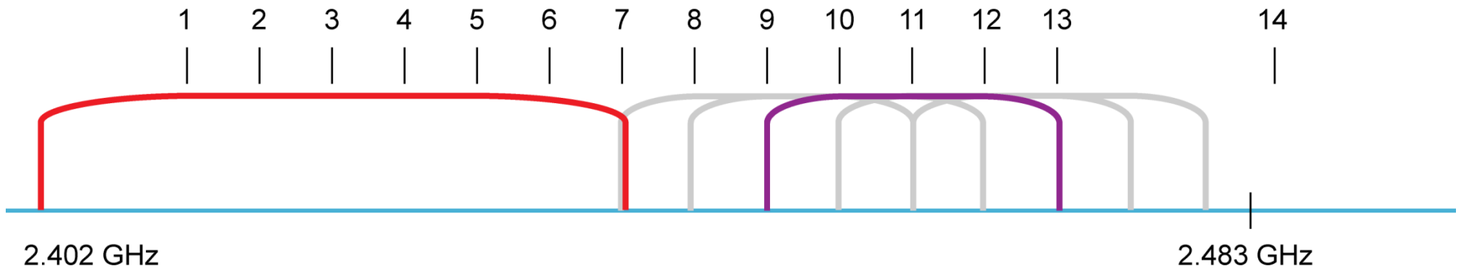


Going Faster with 802.11n

Channel Aggregation

- Great in 5GHz, not so good in 2.4 GHz
  - 9 to 11 non-overlapping 40 MHz channels in 5 GHz
  - 1.5 non-overlapping channel in 2.4 GHz





Going Faster with 802.11n

MIMO

- Instead of one radio per band, 802.11n allows for multiple radios per band
- Each radio typically connects to an antenna, and become a radio chain
- Up to 4 radios per band in the 802.11n amendment
- All radios on a band are on the same channel (20 MHz or 40 MHz)
- Radios on a band can be combined to send a signal from multiple radios, or receive a signal through multiple radios
- Multiple In, Multiple Out (MIMO)
- Older (non-802.11) system used Single In, Single Out (SISO)

Going Faster with 802.11n

MIMO

- Instead of one radio per band, 802.11n allows for multiple radios per band
  - Each radio typically connects to an antenna, and become a **radio chain**
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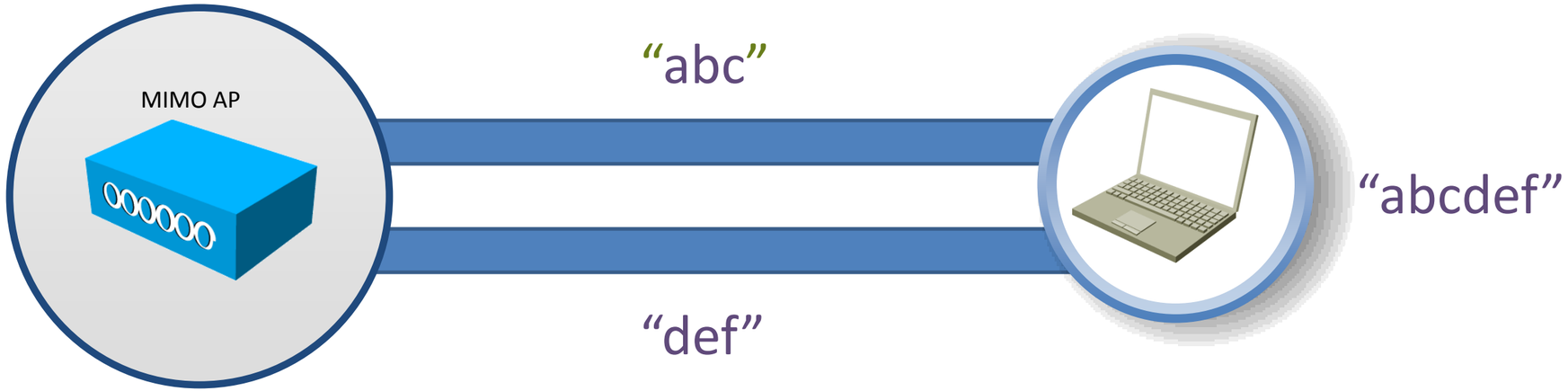
  - Older (non-802.11) systems used Single In, Single Out (SISO)

Going Faster with 802.11n

MIMO: Spatial Multiplexing

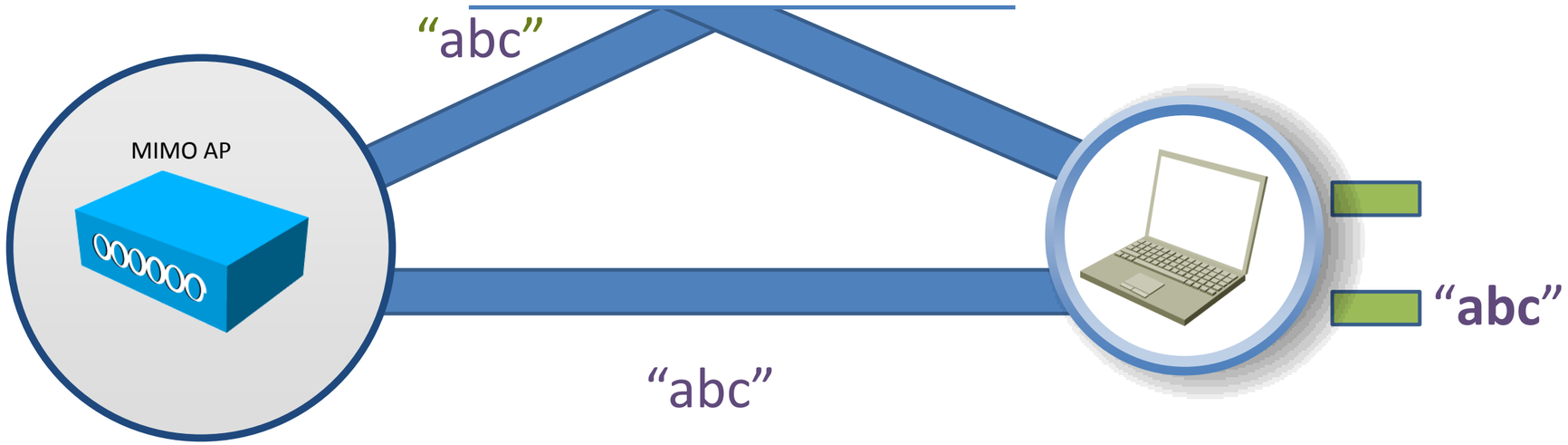
- Each emitter radio sends different information, combined in 802.11n receiver
- Objective: achieve extreme throughput gain



Going Faster with 802.11n

MIMO: Maximal Ratio-Combining (MRC)

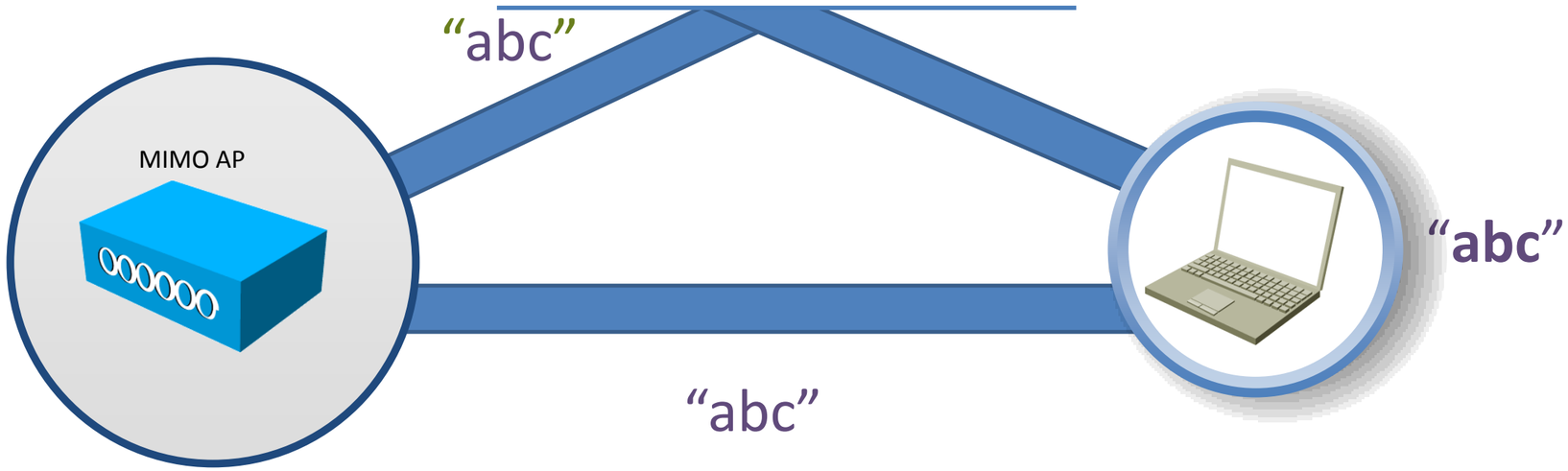
- The receivers aligns a signal received on different radios
- Objective: achieve extreme reliance
  - Longer range or Better speed at same range



Going Faster with 802.11n

MIMO: Transmit Beam Forming (TxBF) – Cisco ClientLink

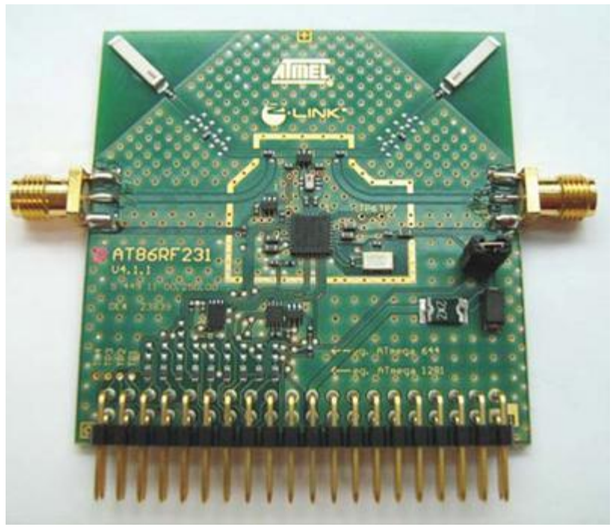
- The emitter coordinates the signal sent on different radios so that they reach the receiver at the same time
- Objective: achieve extreme reliance
  - Longer range or Better speed at same range

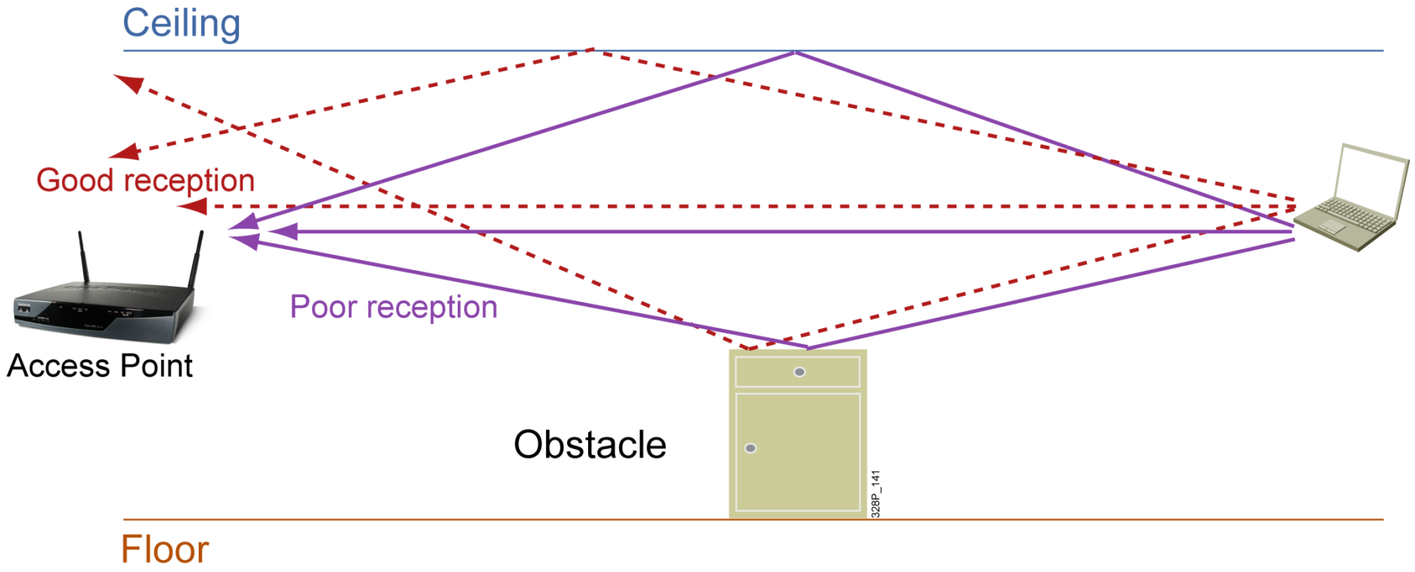


Going Faster with 802.11n

MIMO

- Older (non-802.11) systems used Diversity
  - 2 antennas, but one radio circuit (one radio chain)

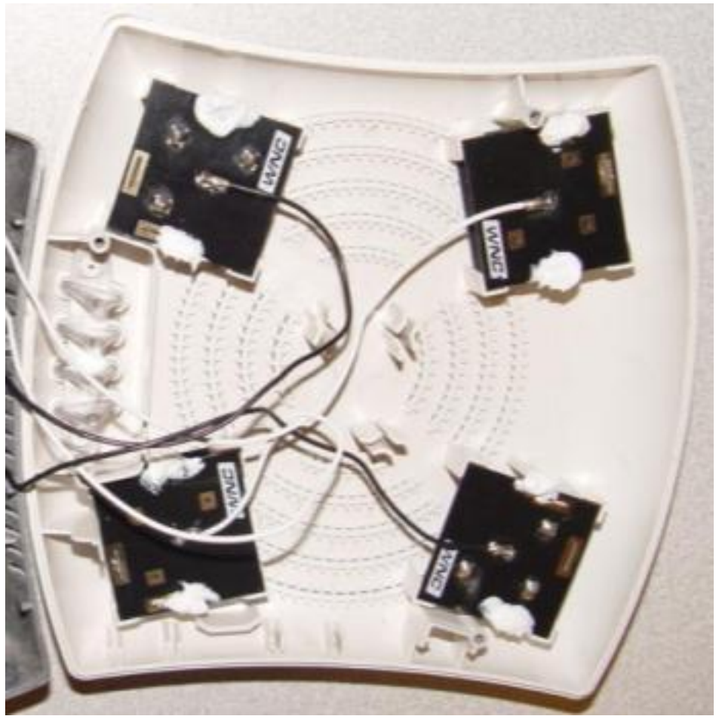




Going Faster with 802.11n

MIMO

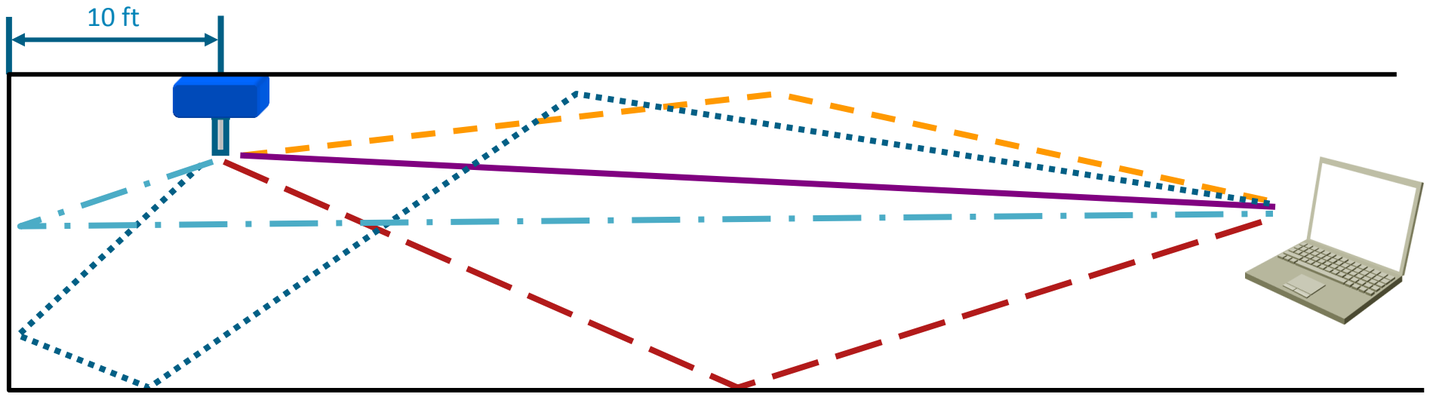
- With MIMO, each antenna connects to a radio circuit
- Typically, not all radio chains are used at the same time when sending or receiving
- Combination of the best chains based on client location
- AP specs mention the number of radios used to transmit (Tx), to receive (Tx), and the number of parallel streams. E.g.: 4x4:3, 2x3:2

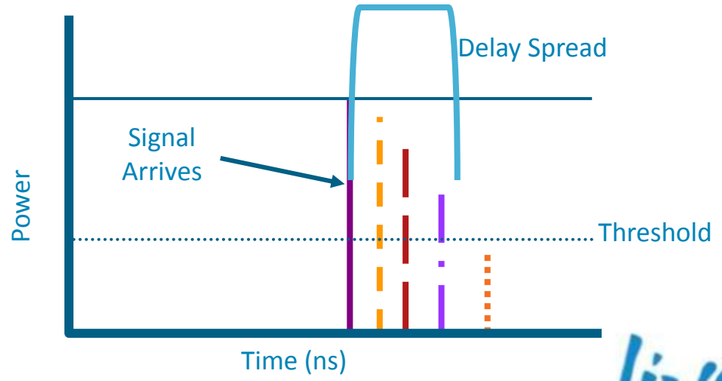


Going Faster with 802.11n

Short Guard Interval (SGI)

- With 802.11a and 802.11g, there are small silences between two signals on the same radio wave
- Objective is to let reflections occur before the next useful part of the wave hits the receiver
- 802.11n can reduce this silence from 800 ns to 400 ns
  - 11% increase in throughput, but possible increased collisions





Going Faster with 802.11n

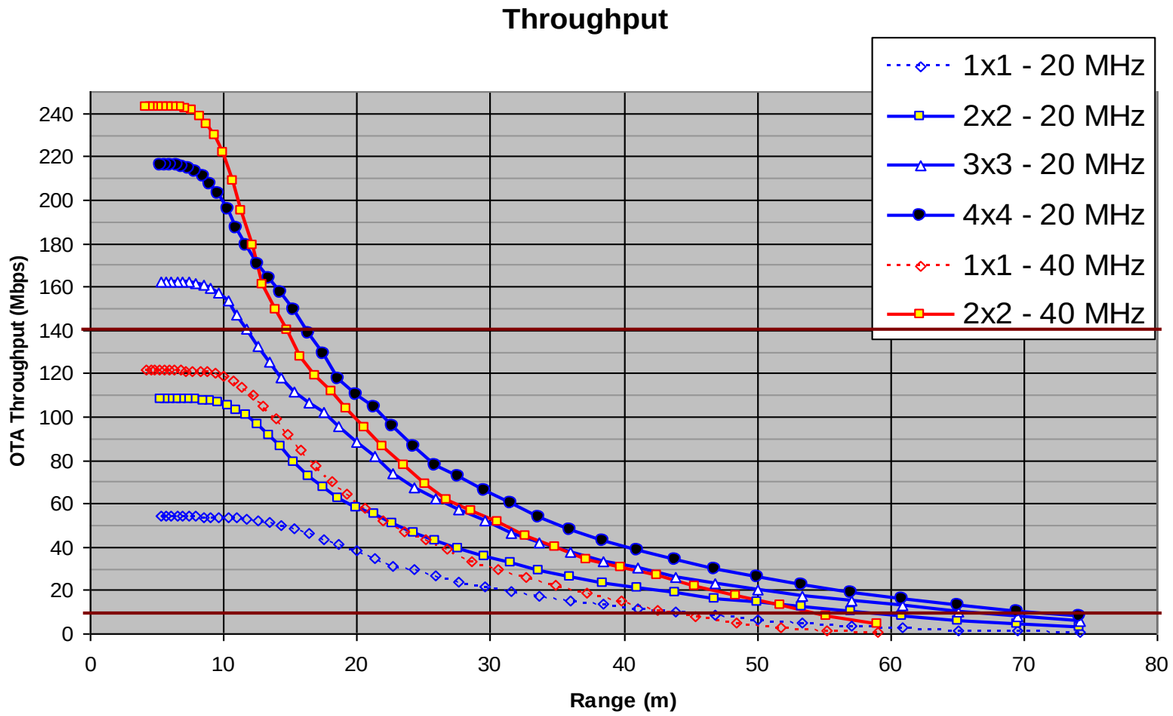
802.11n Max Speeds (Modulations Coding Schemes – MCS), Mbps

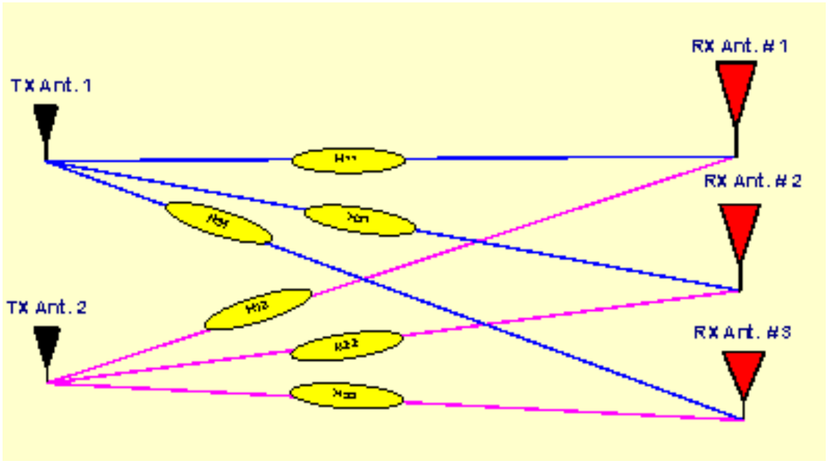
Spatial Streams	Data rate (20 MHz channel, 800 ns GI)	Data rate (20 MHz channel, 400 ns GI)	Data rate (40 MHz channel, 800 ns GI)	Data rate (40 MHz channel, 400 ns GI)
1	65.5	72.2	135	150
2	130	144.4	270	300
3	195	216.7	405	450
4	260	288.8	540	600

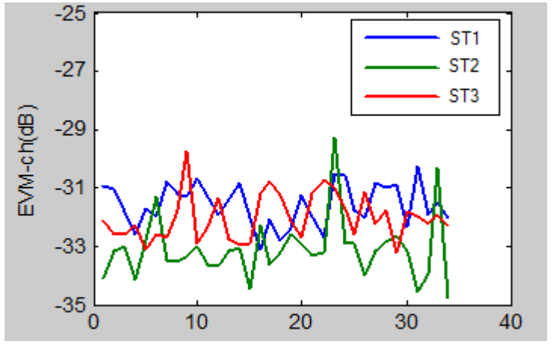
Why Not 802.11n With 10 or 100 Streams?

What Can We Do, What Do We Gain?

- Multiple streams reach multiple receiving circuits
- Distinguishing one from the other is difficult
- Larger channel is easier than more streams







Faster Than 802.11n

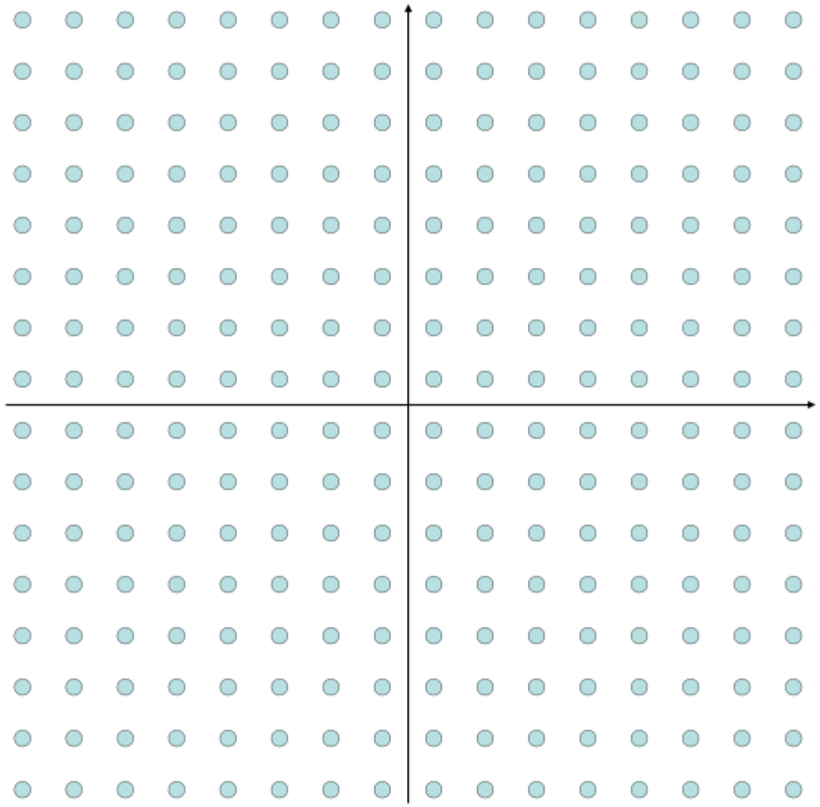
How to Increase Speed Without Making it Impossibly Difficult?

- Increase channel width… beyond 40 MHz
- Increase number of spatial streams… more than 4
- Improve the modulation? Is 64-QAM the best we can do?
- Better manage the cell
  - Why would only one device send at a time?
    - If we can have one device send 3 streams at the same time on the same frequency, why not have 3 devices send 1 stream at the same time on the same frequency instead?
  - Why would all devices be on the same frequency?
    - If we can send one 40 MHz signal, why not send two 20 MHz signals instead?

Faster Than 802.11n: 802.11ac

Beyond the 1 Gbps Bar

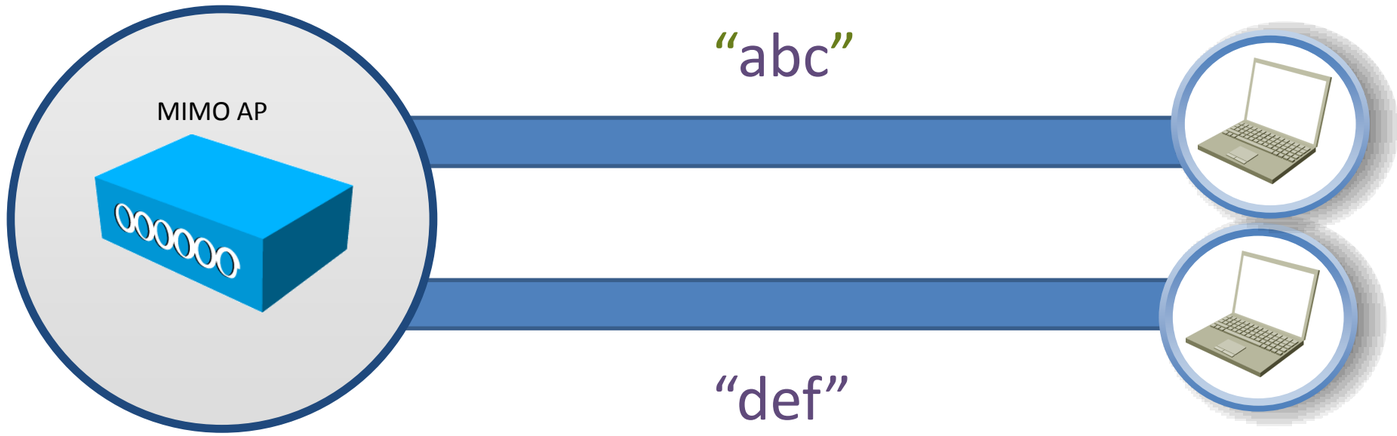
- 160 MHz-wide channel width…
  - Up to 160 MHz for APs
  - 80 MHz for stations, 160 MHz optional
- More spatial streams
  - Up to 8 spatial streams
  - 8 radio circuits sending or receiving
- Better modulation
  - QAM-256
    (8 bits per symbol vs. 6 bits for QAM-64)
    Up to 4 times faster



Faster Than 802.11n: 802.11ac

MU-MIMO

- 2 clients can receive signals at the same time, on the same frequency
  - Each client has a dedicated spatial stream
- Or , better yet, each client receives an allocated frequency range
- Or both!
  - No collisions anymore
  - Full-duplex becomes possible



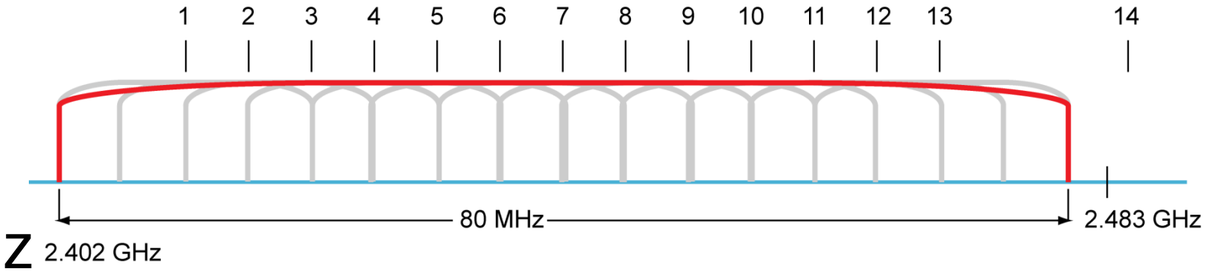
Faster Than 802.11n: 802.11ac

How Fast Can 802.11ac Go?

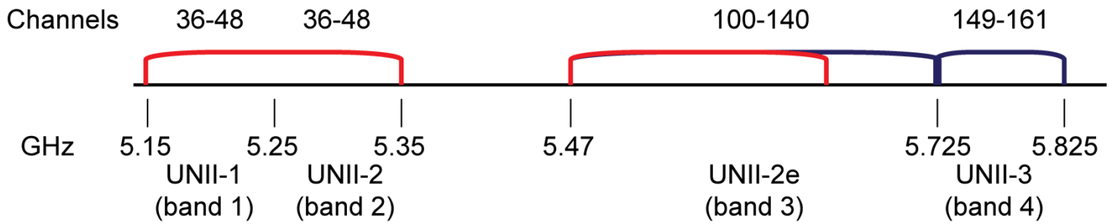
- Throughput will all depend on stations!
- Example best case:
  - 160 MHz-wide channel, 8 antenna AP with MU-MIMO support
  - One 4-antenna client, 3.47 Gbps data rate to this client
  - One 2-antenna client, 1.73 Gbps data rate to this client
  - Two 1-antenna clients, 867 Mbps data rate to each client
  - **Total cell throughput, 6.93 Gbps!**

Faster Than 802.11n: 802.11ac

What Are We Waiting For?



- Where do I find 160 MHz?
  - One 80 MHz channel in 2.4GHz
  - Two 160 MHz channels in 5 GHz (with DFS; one without DFS band)
- 802.11ac focuses on 5 GHz
- Even in 5 GHz, a new protocol does not make the spectrum wider



- One great advantage of 802.11ac will be to increase the 5 GHz adoption
  - But multiple 802.11ac cell coexistence will be a challenge
  - And can you afford 8 radios in your mobile device?

Is 802.11ac a Good Idea?

"802.11n Will Never Take-off" (Computers magazine, 2007)

- 160 MHz is an obvious choice for SOHO
- Adoption in corporate environments will be longer
  - Great opportunity for wireless professionals
  - 802.11ac wave will follow 802.11n wave
- New ideas are yet to be found to go even faster

What Else is on the Roadmap?

7 New Amendments Are Under Developments

- **802.11ah, sub 1 GHz**
- Lower frequency allows for longer range (GSM type)
- One WiFi cell could span across an entire campus
  - Sensor monitoring for industry
  - Car and other object/people location
  - Campus-wide hotspot
  - Internet in cars (+ real time traffic warning)
- Indoor, can cover entire building
  - Temperature control, gym performances, security (presence detection, hazards, door/windows, etc.)

What Else is on the Roadmap?

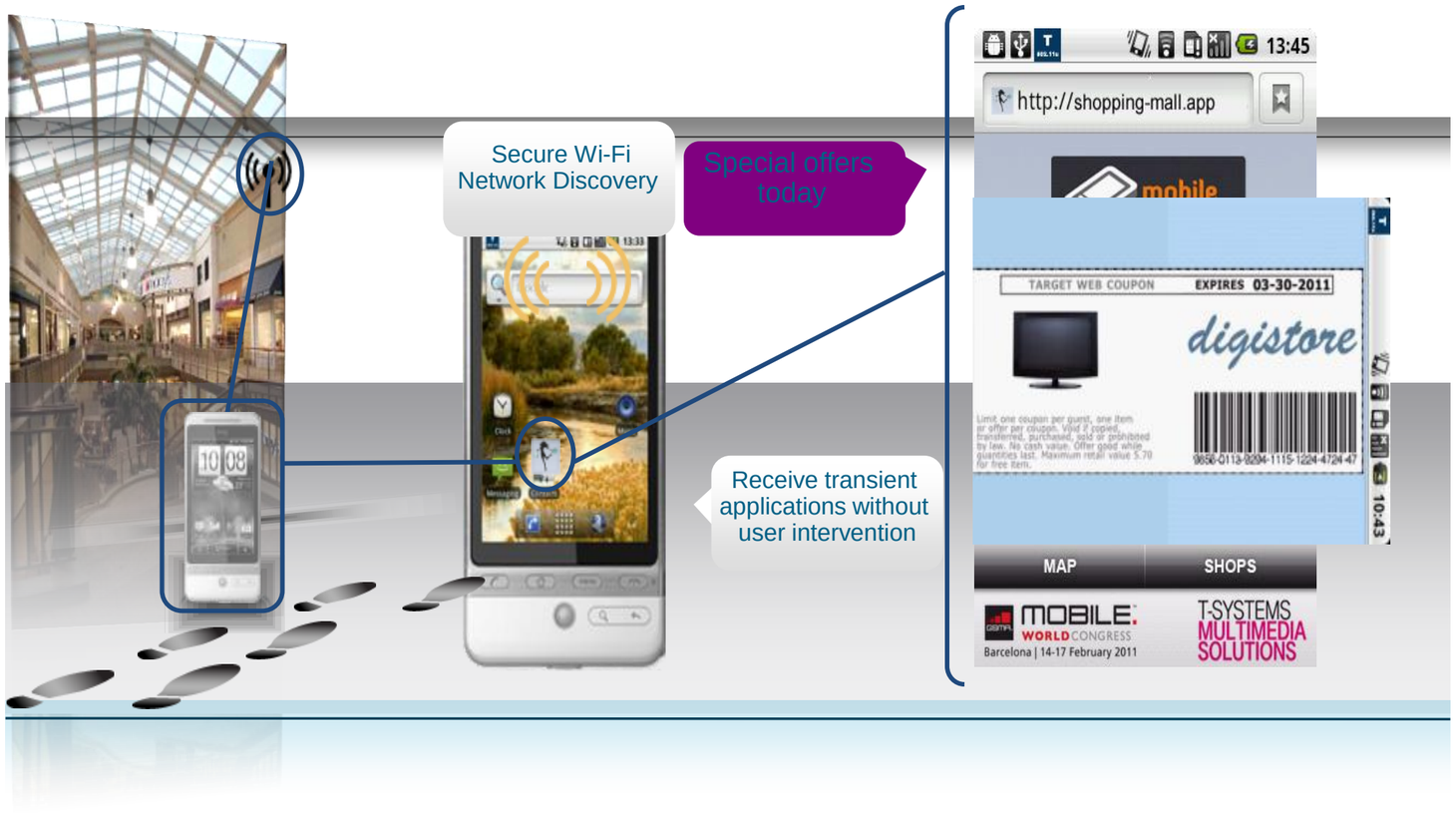
7 New Amendments Are Under Developments

- **802.11af, TV Whitespace**
- Frequencies previously used by analog TV become available
- Digital TV can send more information in less channels
- These frequencies could be used to deploy long range Wi-Fi
- 802.11af-enabled clients would scan and select the best frequency for connection, based on signal, load, amount of information to send
- Connections would be possible for mobile devices (cars), but also for widely distributed fixed devices (e.g. smart grid)
- In all cases… more APs, site surveys and wireless professionals will be needed!

What Else is on the Roadmap?

Some Amendments are Already out, and Cisco is also Improving 802.11

- **802.11u-2011**
  Service Discovery
- Automatic offload from GSM to WiFi
- **MSAP**
  Mobility Service Advertisement Protocol
- Cisco proprietary enhancement to offer additional services



So… Should You Work in 802.11?

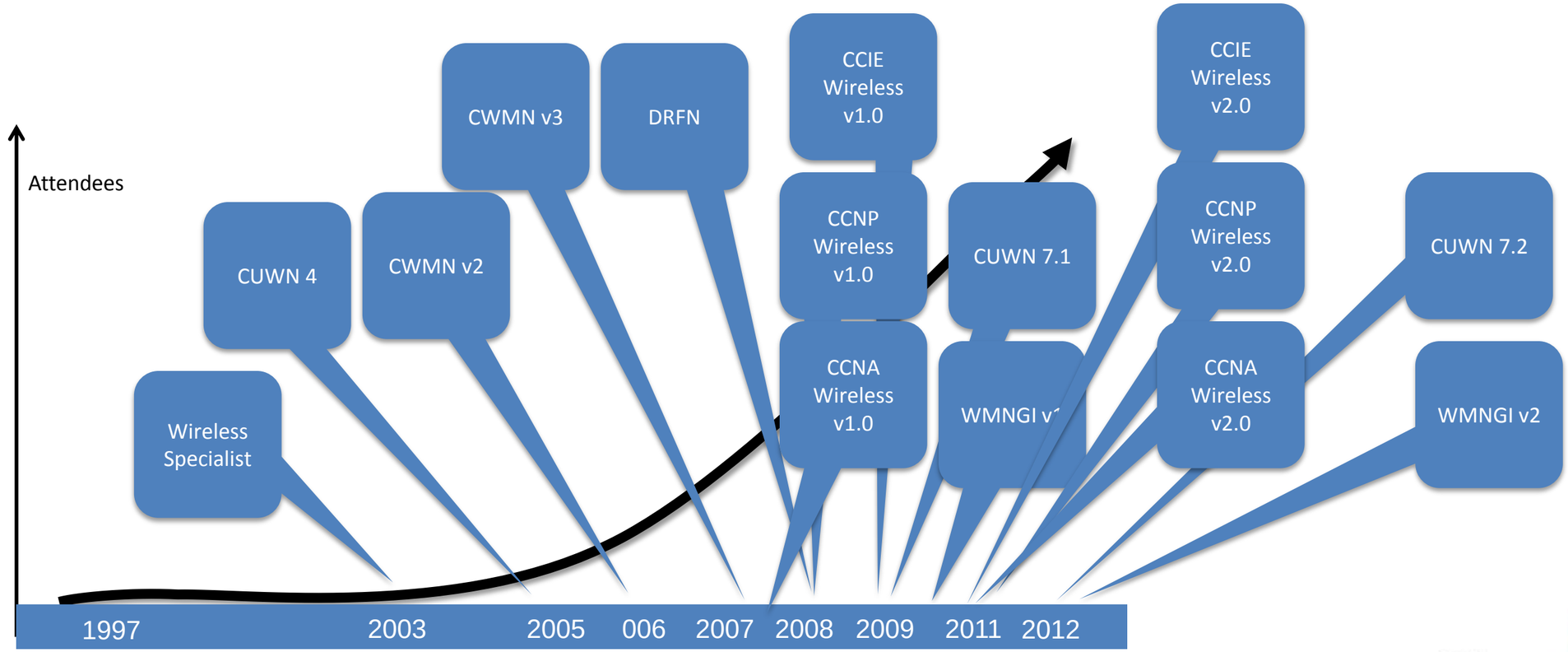
For Most Managers, Wireless is Just an Access Method, but Wireless is Complex

- Design depends on applications, user behaviours, density, roaming paths, cloud/no cloud, environment, other RF devices, etc...
- Troubleshooting implies knowledge of RF, and detailed knowledge of the 802.11 30+ amendments and new features (close to 100 new features in Cisco controllers every year)
- Wireless is just not about plugging APs anymore, and requires expertise

So… Should You Work in 802.11?

Wireless Skills Become Critical, And is a Differentiator

- Wireless skills become more and more valuable
- Clear sign of this trend: Cisco wireless courses and certifications

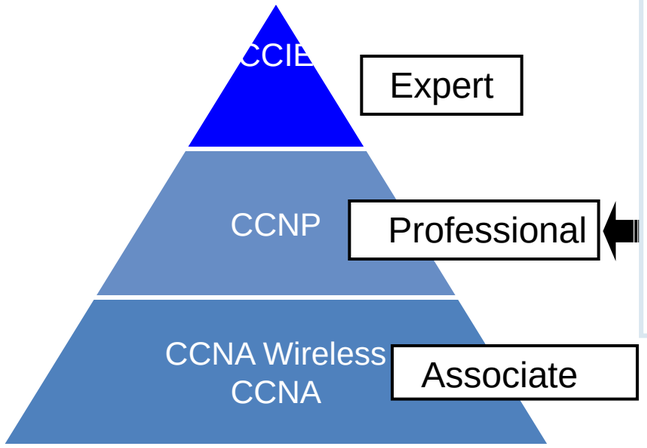


Where to Start

Professional Course, or Certification?

- Professional courses: CUWN, WMNGI
- Certification: IUWNE, then CUWSS, IUWVN, IAUWS, IUWMS, then CCIE W

Professional Level Recognition in Wireless



Recommended Training Through Cisco Learning Partners

Conducting Cisco Unified Wireless Site Survey
Implementing Advanced Cisco Unified Wireless Security
Implementing Cisco Unified Wireless Mobility Services
Implementing Cisco Unified Wireless Voice Networks

Implementing Cisco Unified Wireless Network Essentials

Wireless LAN Certification

www.cisco.com/go/certifications

Exam Taking Tips!
Preparing for the CCNA Wireless Exam

Exam Taking Tips

- ✓Eliminate options—look for subtleties
- ✓Look for the best answer
- ✓Budget time—total and individual
- ✓Sw/Hw context—v5.0, not later
- ✓Make an intelligent guess
- ✓Provide feedback during exam

Exam Format

Preparing for the CCNA Wireless Exam

Exam Format

Test Practical Implementation Skills

- Question formats
  - Declarative
  - Procedural
  - Complex procedural (simulation)
  - Drag and drop
- Avoided question formats:
  - Memorisation of command syntax or interface/menus
  - Trick questions

Exam Format—Declarative

A Declarative Exam Item Tests Simple Recall of Pertinent Facts:

Which of the following is an 802.11b speed?

A. 6 Mbps

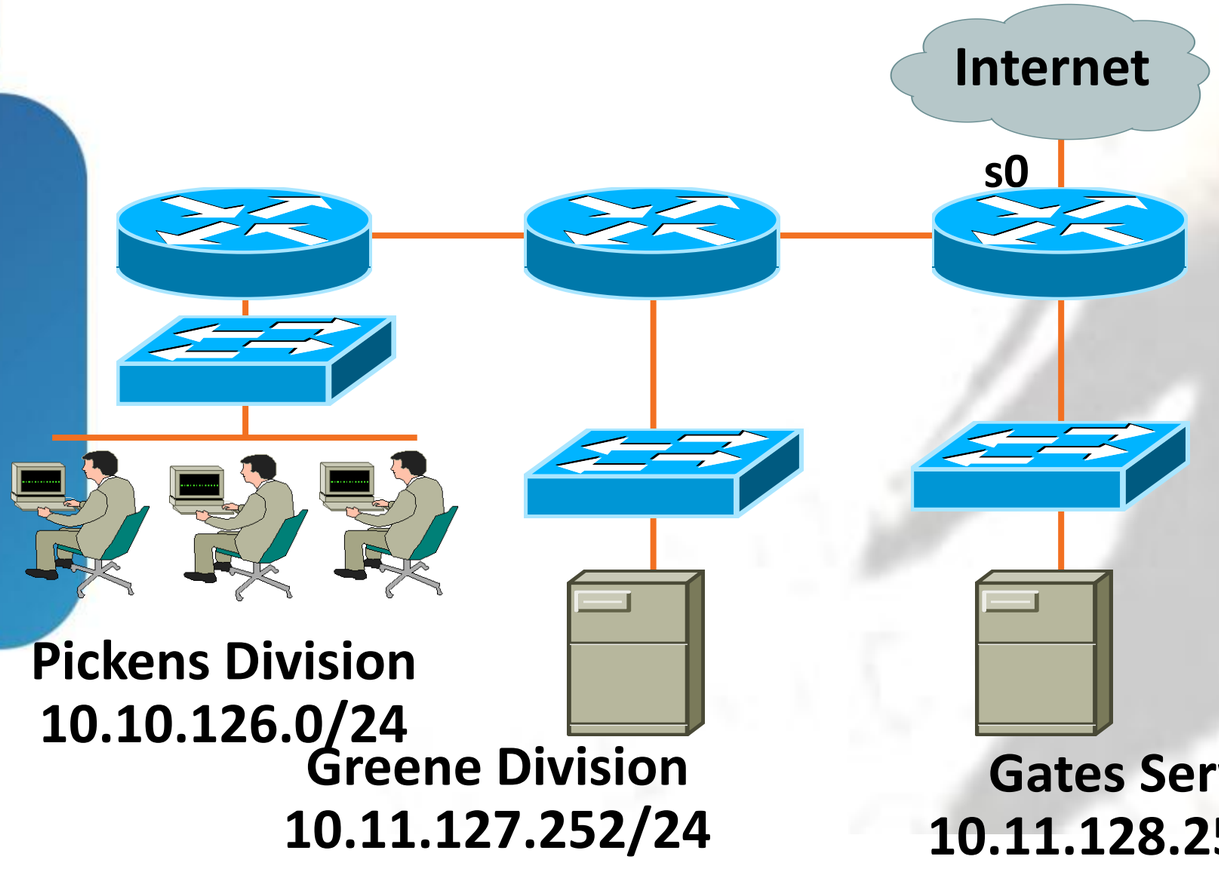
B. 11 Mbps

C. 18 Mbps

D. 48 Mbps

Exam Format—Procedural

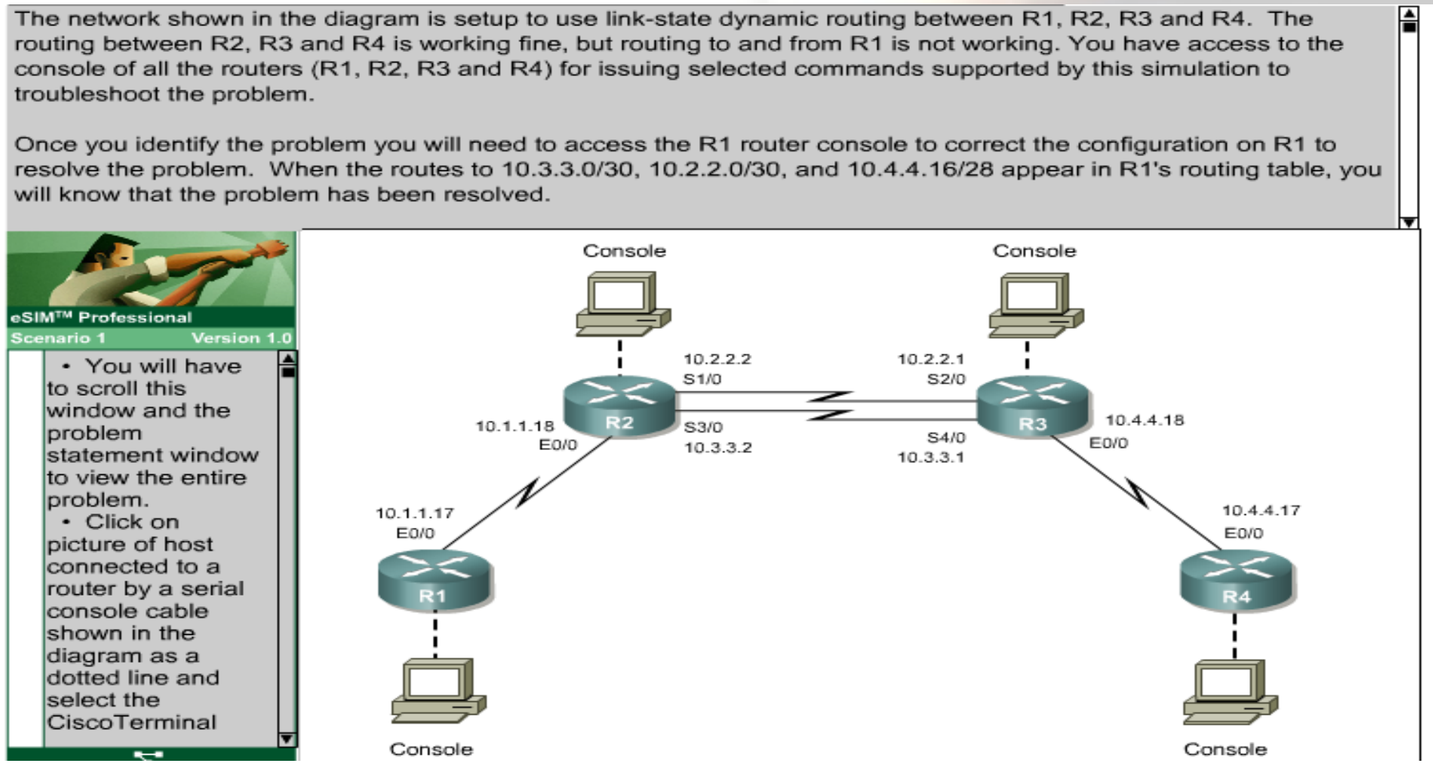
A Procedural Exam Item Tests the Ability to Apply Knowledge to Solve a Given Issue:



Which two access list statements are necessary on s0 of the Guilford router to allow FTP access to the Greene Division server from the Internet while blocking all other traffic? (Select two)

Exam Format—Simulation

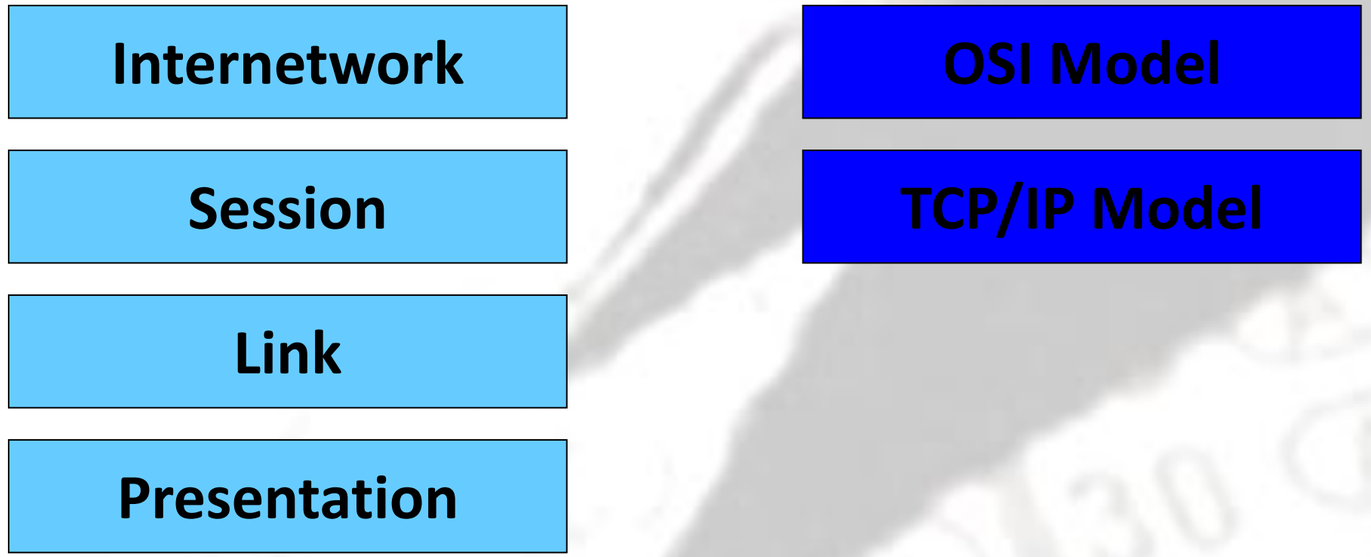
A Complex Procedural Exam Item Tests the Ability to Apply Multiple Knowledge Points to Solve a Given Issue:



Exam Format—Drag and Drop

A Drag and Drop Tests the Ability to Relate Concepts:

Click and drag the correct Layer to the Network Model to which it applies



CCNA Wireless Exam Practice

Preparing for the CCNA Wireless Exam

Practice Item #1

What is the name of the distance between the higher crest of a wave and the lower crest?

A. Amplitude
B. Wavelength
C. Frequency
D. Phase

Practice Item #1—Solution

What is the name of the distance between the higher crest of a wave and the lower crest?

A. Amplitude
B. Wavelength
C. Frequency
D. Phase

Practice Item #2

How is a CAPWAP access point code upgraded?

A. WLC GUI or CLI via **config AP** command
B. WLC CLI only via **config AP** command
C. AP CLI via **tftp** command
D. no commands since it is automatic

Practice Item #2—Solution

How is a CAPWAP access point code upgraded?

A. WLC GUI or CLI via **config AP** command
B. WLC CLI only via **config AP** command
C. AP CLI via **tftp** command
D. No commands since it is automatic

Practice Item #3

What is the purpose of an AP monitor mode?

A. Provide information on the RF environment
B. Provide detail information on associated clients
C. Capture 802.11 frames for remote analysis
D. Analysis wired side traffic for rogues

Practice Item #3—Solution

What is the purpose of an AP monitor mode?

A. **Provide information on the RF environment**
B. **Provide detail information on associated clients**
C. **Capture 802.11 frames for remote analysis**
D. **Analysis wired side traffic for rogues**

Practice Item #4

Which version of the Cisco Compatible Extensions introduced PEAP-GTC?

A. v1
B. v2
C. v3
D. v4

Practice Item #4—Solution

Which version of the Cisco Compatible Extensions introduced PEAP-GTC?

A. v1
B. v2
C. v3
D. v4

Practice Item #5

AP has configured a transmit power of 20mW connected to an antenna of 6dBi using a cable inducing a loss of 3dB. What is the final resulting EIRP?

A. 23 mW
B. 30 mW
C. 33 mW
D. 40 mW

Practice Item #5—Solution

AP has transmit power of 20mW connected to an antenna of 6dBi using a cable inducing a loss of 3dB. What is the final resulting EIRP?

A. 23 mW
B. 30 mW
C. 33 mW
D. 40 mW

Note : EIRP = Tx Power – Cable Loss + Antenna
Prior Example Starting RF Math 20 mW = 13 dBm

	dBm	mW
Baseline	13	20
Decrease	10 (-3)	10 (/2)
Increase	16 (+3 +3)	40 (x2 x2)

Q & A

Thank you!

Final Thoughts

- Get hands-on experience with the Walk-in Labs located in World of Solutions, booth 1042
- Come see demos of many key solutions and products in the main Cisco booth 2924
- Visit www.ciscoLive365.com after the event for updated PDFs, on-demand session videos, networking, and more!
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