Wi-Fi Analogies for Non-Techies

I had a task to help bring a bunch of non-technical people up to speed on how/why they needed to spend funds and time to upgrade their Wi-Fi networks to support a 1:1 initiative – where each student in K-12 has a minimum of one Wi-Fi enabled device.

I couldn't use much in the way of analogies comparing Wired Networks to Wireless Networks – this audience didn't have the base wired network knowledge as a baseline.

Feel free to use these in your training, or presentations. I hope they may help you interface with other non-technical audiences.

Regards,

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Sending Information Digitally

In order to send information over a network, we must first turn everything into ones, and zeros. The higher the resolution, the closer to the original – but higher resolutions take more ones and zeros.

Why Use Professional Gear

A small plastic inexpensive home garden sprinkler has all sorts of features – but it is NOT designed for heavy industrial work. Likewise, home Wi-Fi Routers have lots of features and work well in a small environment. But they were never designed for enterprise-level work requirements.

Different Devices Have Different Jobs

Some devices do final delivery – like the sprinkler delivers the water to the plants. Other devices are more in the transport business, moving water around your garden. Sometimes you'll want to combine things, or switch flows around. Different size pipes can carry different amounts of water, or different pressures of water.

Pipes Are Designed for Different Needs

Different needs require different designs. Factors include flow, pressure, activity, cost, and most importantly, what is it used for.

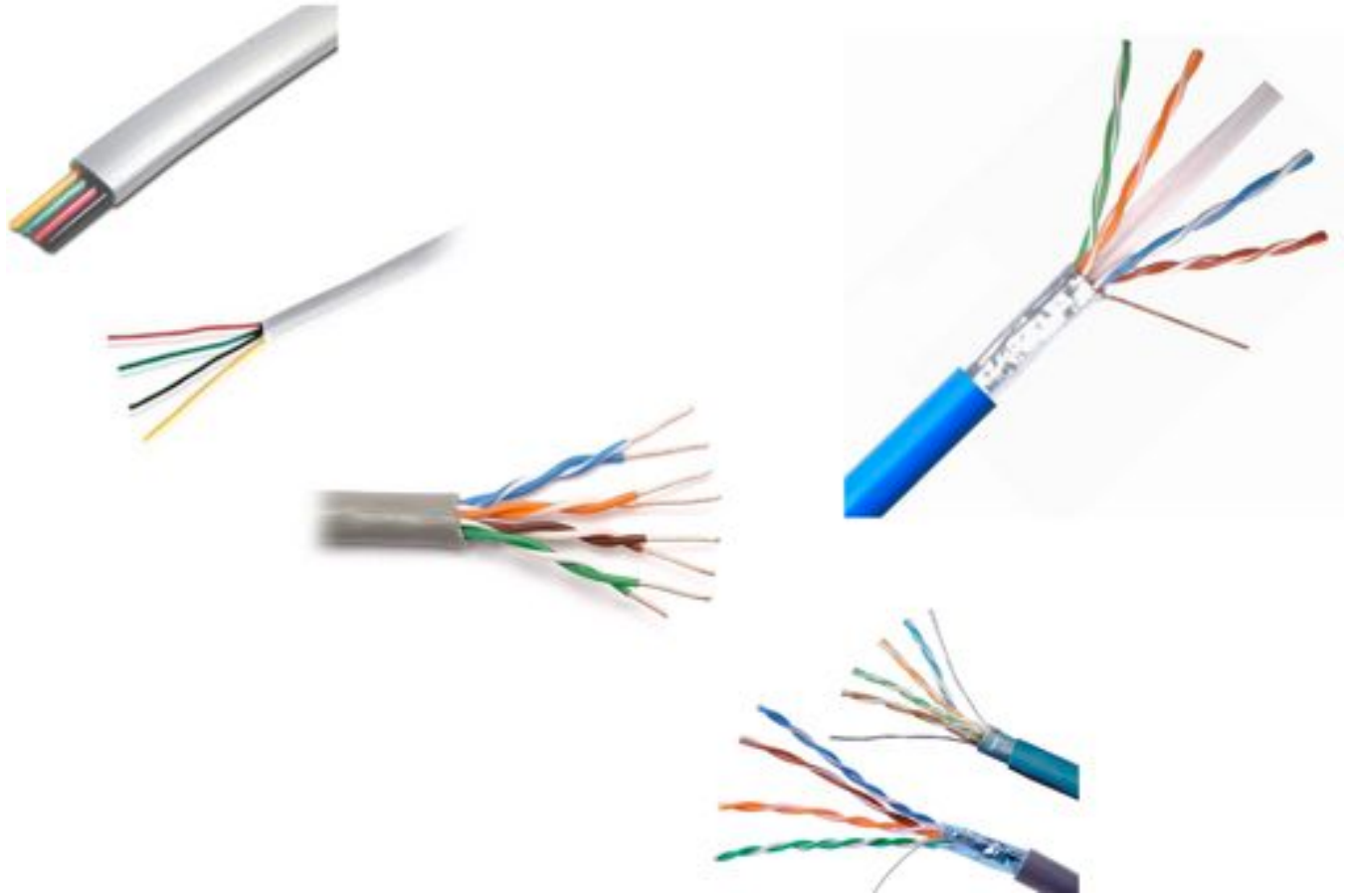
Spread Far vs Deliver Close

Sometimes you need to spread the water far and wide – other times close to the ground. Far and wide has better coverage – but can be wasteful. Close is better. 2.4GHz radio waves go far, 5GHz radio waves deliver close.

Some Things Have Different Needs

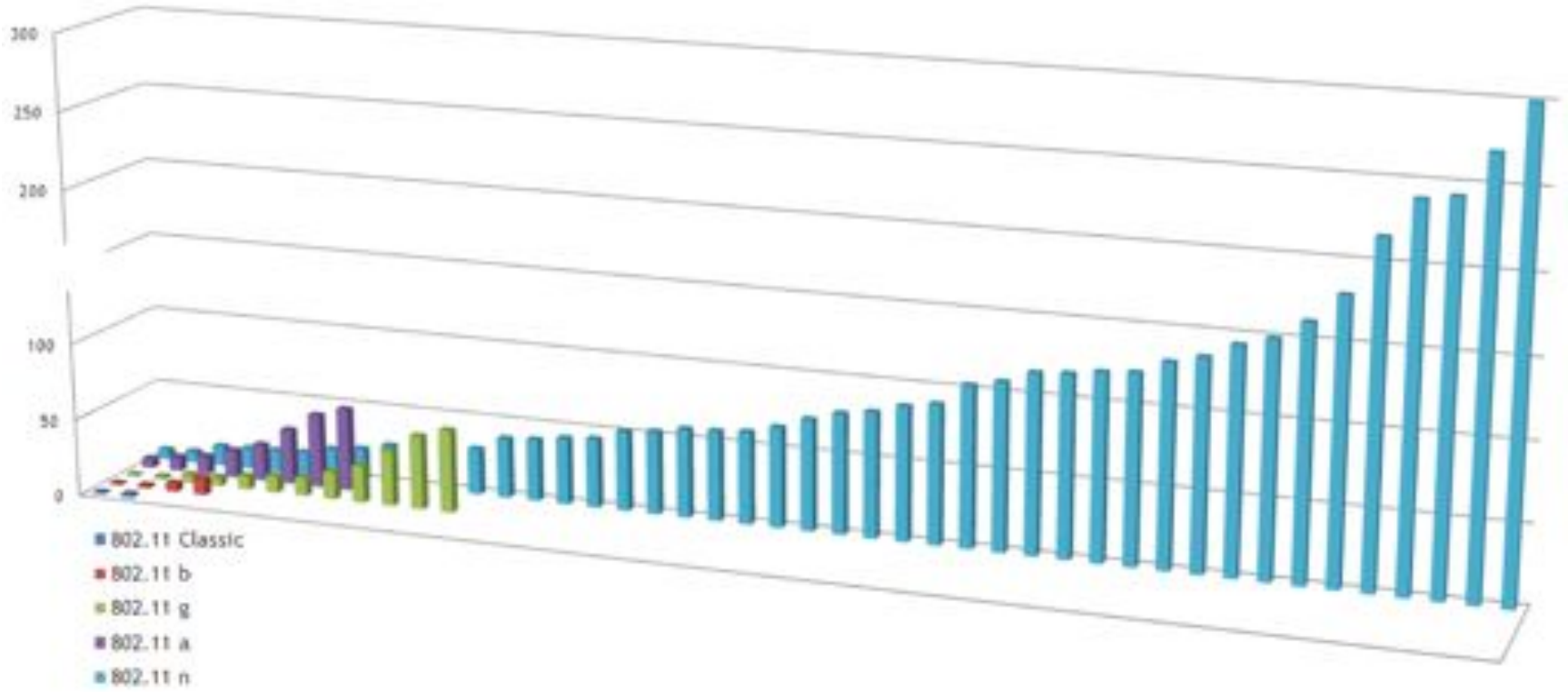
Dry Winter Wheat has a different need for water compared with growing Cotton. In a ‘coverage-only’ model – we have enough RF energy to cover everywhere, but if we need high-density, we’ll need a different design to get more ‘water’.

Cables vs Pipes



When talking about water pipes, the diameter of the pipe determines the amount of flow. When talking about copper cables, the ‘quality’ of the cables determines amount of data that can flow. Cables have evolved – from 10Mbps to 100Mbps to 1,000Mbps all over the same copper – just better designed copper.

More Speed – More Options

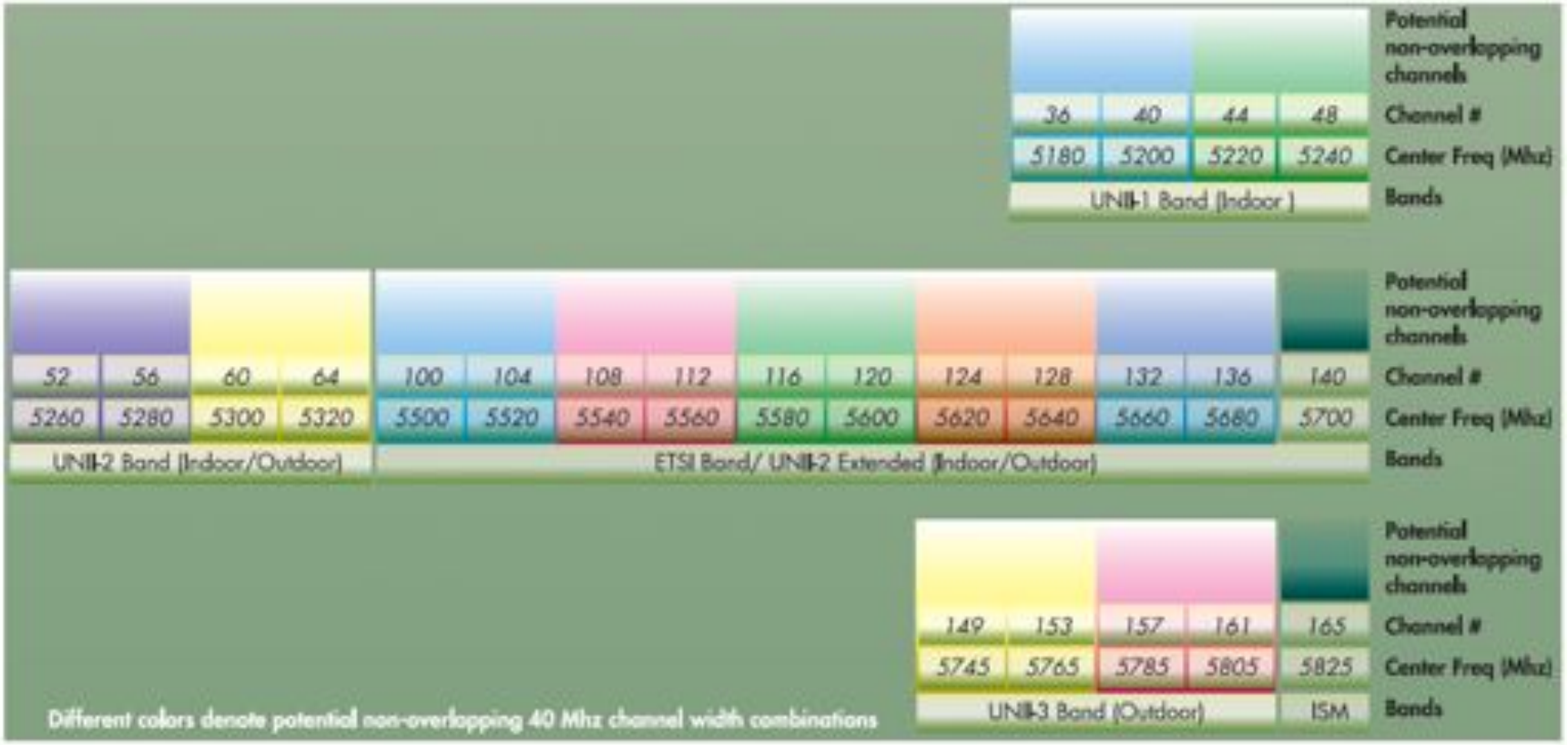


When moving from older, slower technologies, we not only get much more speed – we also get more options – as you move from one speed to another, there are more choices in between.

2.4 GHz Only Has Three Channels

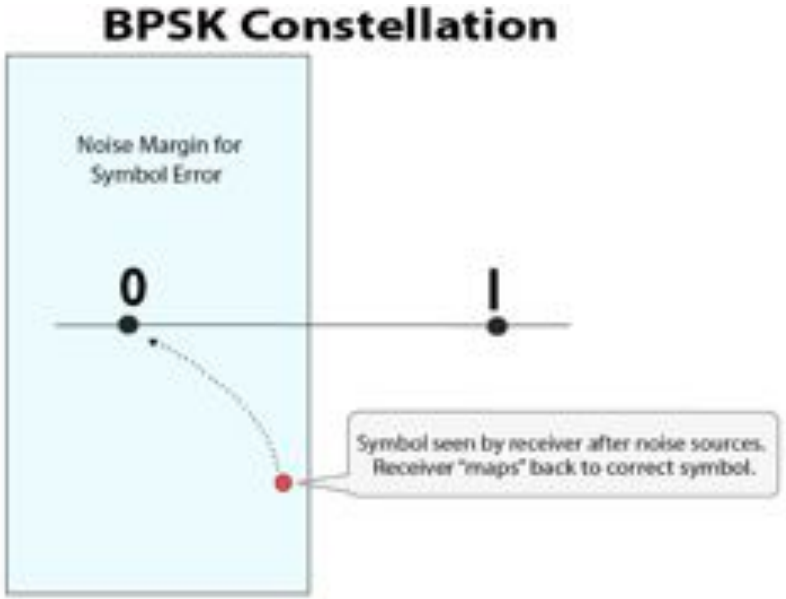
Even though there are more channel numbers, we only have three channels available for use in the 2.4GHz band. Not to mention, we have to share this band with Microwave Ovens, Bluetooth Devices, Portable Phones, and Video Cameras.

5GHz Has Lots of Channels



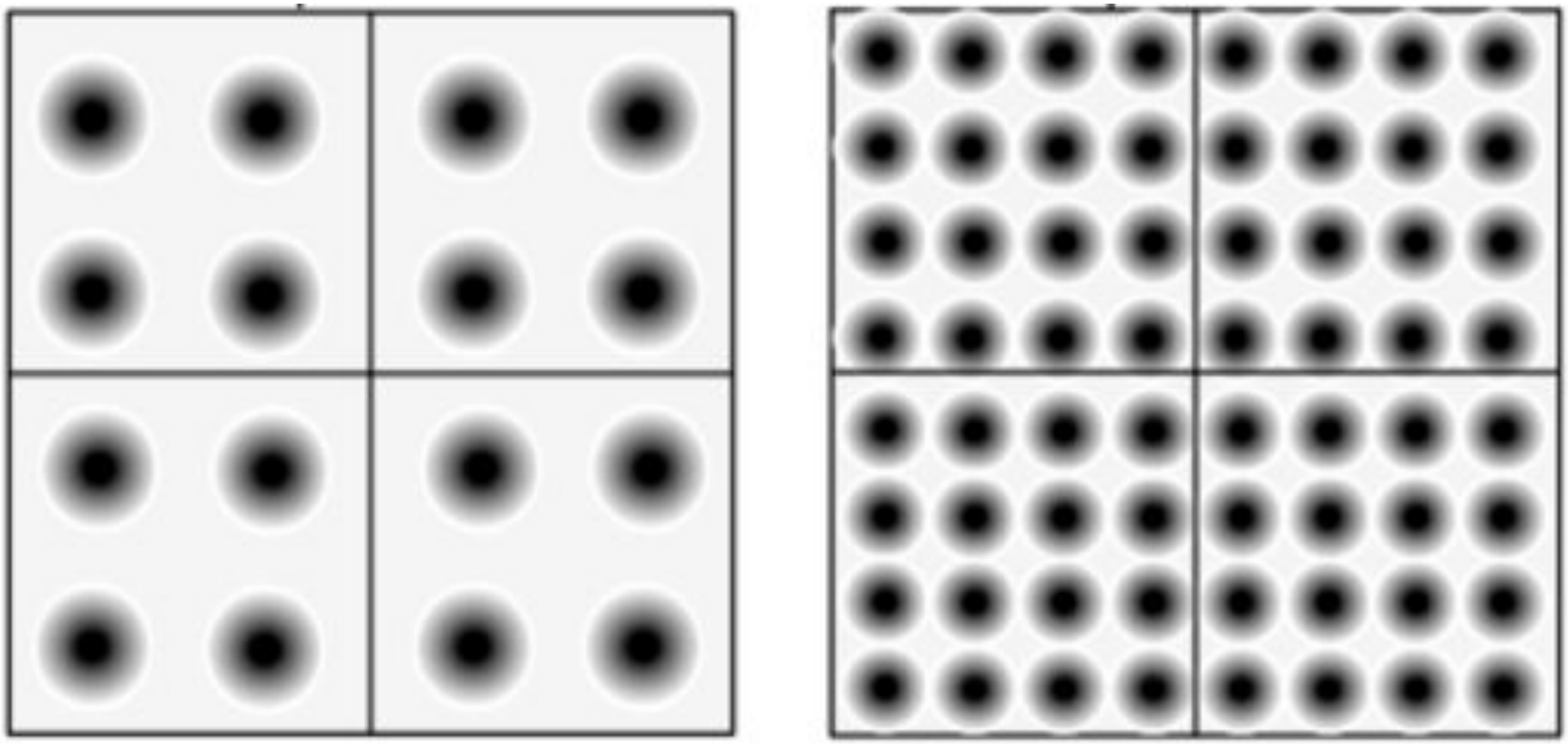
5GHz band has many more channels, and is capable of supporting 20MHz, 40MHz, and in 802.11ac 80MHz, and 160Mhz bands to carry even more information. Unlike the 'garbage' band of 2.4GHz, these 5GHz frequencies are dedicated to transmitting data.

It Is All About Sending and Receiving



In archery, the goal is to get the arrow in the bull's-eye. In Wi-Fi the transmitter also sends towards a target, but like wind in an archery competition, interference can 'blow-away' the RF so it doesn't quite hit the target. With 'Binary Phase Shift Coding' or BPSK – the target is either a 1 or a 0 – anywhere on the left side will register as a Zero. This method can transmit a long way, with lots of interference. Very robust – but can only send one bit at a time.

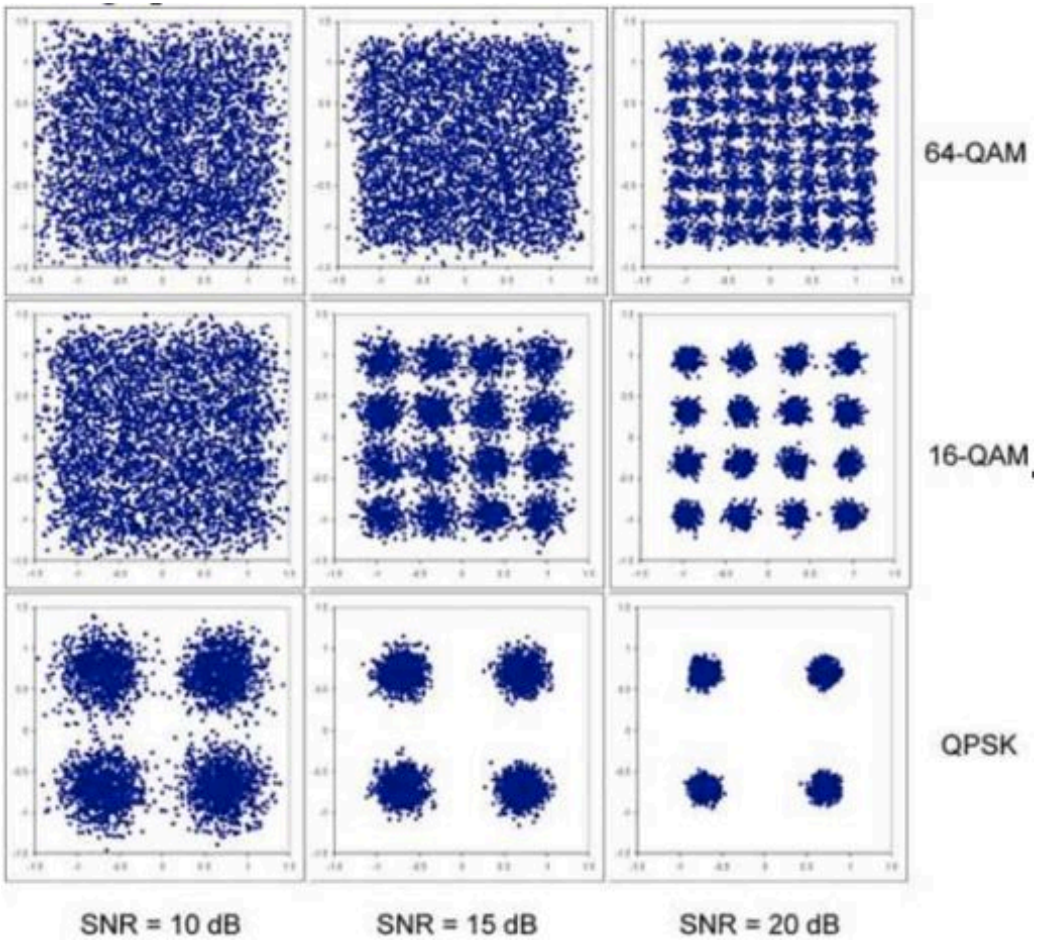
Sending Faster Means Smaller Targets



To send data faster – we need to have more bits sent per cycle – thus we need smaller targets. As we move to faster and faster data rates – the targets get smaller – and we can't send as far and still be accurate. We can go from 2 targets (BPSK) to 4 targets (QPSK) to 16 targets (16-QAM) to 64 targets (64-QAM)

Each increase transmits more data, but at a cost of distance and accuracy.

Higher Speeds Require Less Interference



Signal to Noise Ratio (SNR) compares background noise to the RF Signal received. The bigger the difference between the two, the more 'targets' – or higher data rates can be used. Higher speed is the goal!

Higher Speeds Mean Higher Density

Application – by use case	Throughput – Nominal
Web - Casual	500 Kbps
Web - Instructional	1 Mbps
Audio - Casual	100 Kbps
Audio - instructional	1 Mbps
Video - Casual	1 Mbps
Video - Instructional	2-4 Mbps
Printing	1 Mbps
File Sharing - Casual	1 Mbps
File Sharing - Instructional	2-8 Mbps
Online Testing	2-4 Mbps
Device Backups	10-50 Mbps

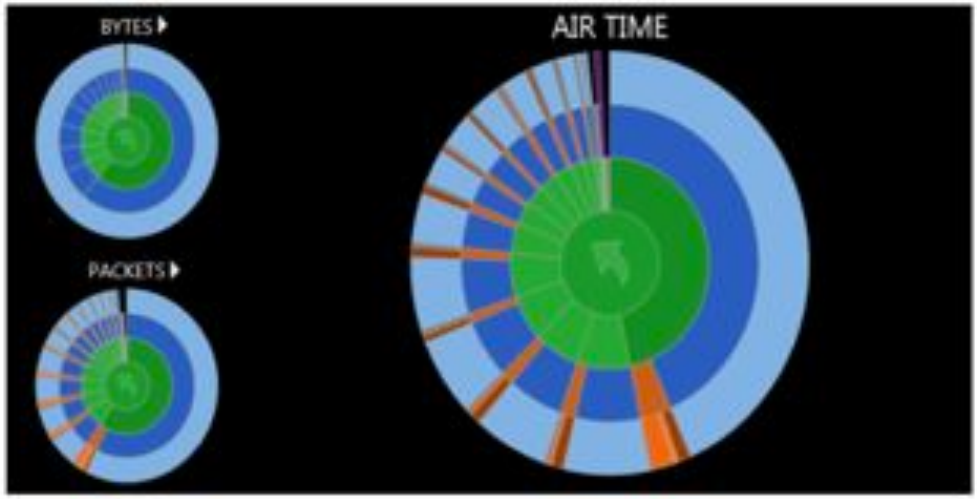
Per-User Throughput Examples

Protocol	Data Rate (Mbps)	Aggregate Throughput (Mbps)	Example User Count	Average per User Throughput
802.11b	11	7.2	10	720 Kbps
802.11b	11	7.2	20	360 Kbps
802.11b	11	7.2	30	240 Kbps
802.11b/g	54	13	10	1.3 Mbps
802.11b/g	54	13	20	650 Kbps
802.11b/g	54	13	30	430 Kbps
802.11a	54	25	10	2.5 Mbps
802.11a	54	25	20	1.25 Mbps
802.11a	54	25	30	833 Kbps
802.11n	300	150	10	15 Mbps
802.11n	300	150	20	7.5 Mbps
802.11n	300	150	30	5 Mbps

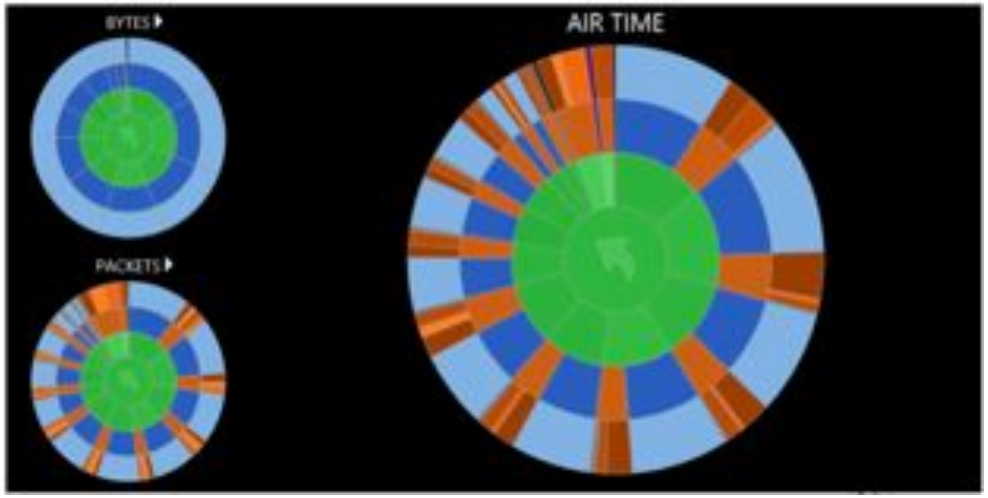
More devices can share same physical space if each device talks as fast as possible.

Using Frequency Efficiently Is Important

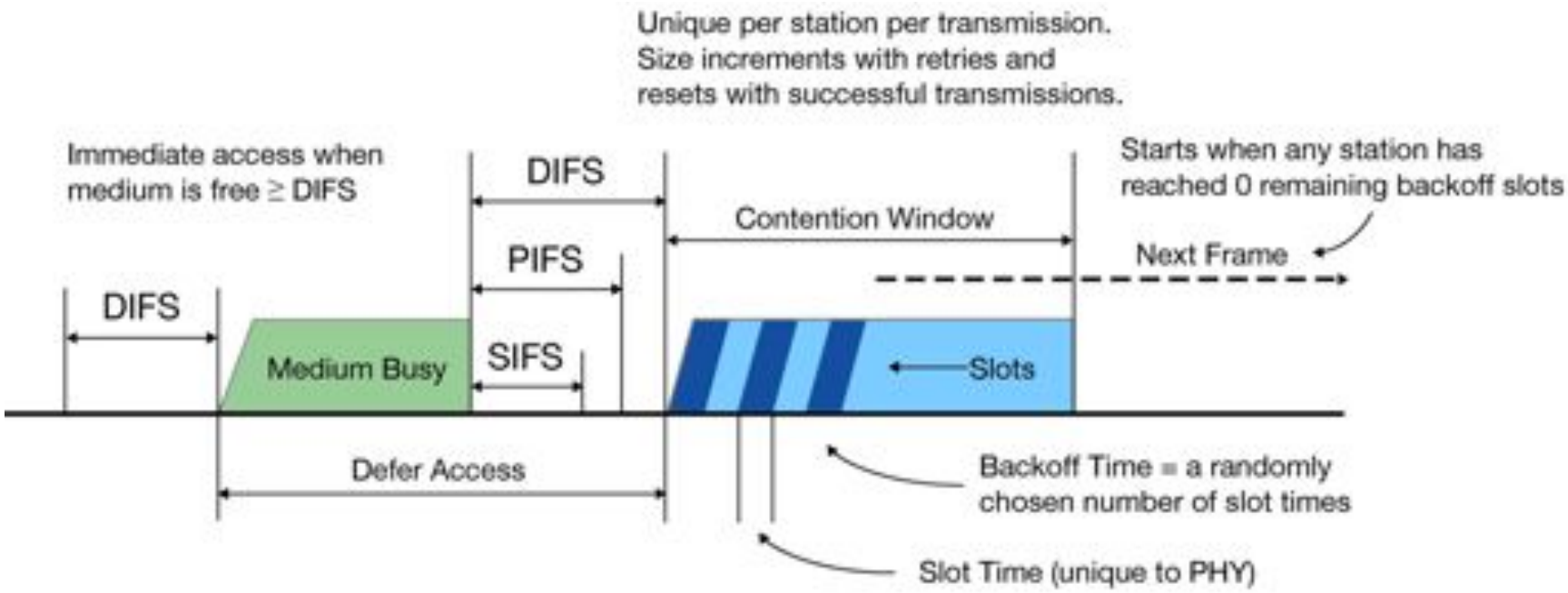
Effective Data Rate of 83 Mbps and 12% Retries



Effective Data Rate of 49 Mbps and 13% Retries



It Is Actually Quite Complex



Wi-Fi is a ‘shared media’ and all devices must share the frequency and ‘play nice’ together. Audience isn’t expected to understand this graphic – it is just thrown in here to share some of the complexity.

Wireless LAN Professionals, Inc.

Define – Design – Install – Validate – Troubleshoot

http://WLANPros.com/Resources

http://WLANPros.com/WiFiStressTestReport

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