How to overcome the ultimate Wi-Fi challenge

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Executive summary

After years of development, the IEEE approved in 2014 the 802.11ac standard amendment which finally brings the power of multi-gigabit networking to the wireless domain. This has the potential to fundamentally change the way people connect to the network.

Faster wireless speeds, however, require the allocation of large portions of the spectrum into few non-overlapping channels, which could suddenly make the 5GHz band very crowded. Co-channel interference between neighboring access points (APs) configured on the same channel may drastically reduce performance.

Zyxel partnered with the Wireless Networking Group at the University of Brescia to investigate this impact of co-channel interference and whether smart antenna technology is the answer. Smart antenna technology is a continuous reconfiguration of the radiation pattern that focuses the signal from the AP towards the connected device, reducing the interference that it could cause to other devices.

802.11ac APs from Aruba, Cisco, Ruckus and Zyxel were tested to measure their maximum performance in delivering traffic to end-point devices. The results validate that Zyxel's smart antenna technology can deliver higher aggregate throughput when two neighbouring APs operate on the same channel. This proves that smart antenna technology is vital to enabling the gigabit per second speed promised by the 802.11ac standard.

Introduction

Have you ever wondered why adding a new wireless access point (AP) in a busy user environment doesn't improve the Wi-Fi performance?

Why it's no longer a surprise when the boardroom video conference cuts out or suffers from lag?

How in a school with an AP in every classroom, students still struggle with slow download speeds?

And, why you break out in a cold sweat at the mere thought of providing Wi-Fi access for hundreds of users at a large conference?

These are some of the most common scenarios associated with wireless deployments across a range of user environments. This is despite the fact that Wi-Fi now plays a vital role in keeping us connected in our personal and professional lives and is even predicted to surpass wired connections by 2020.

But what's causing these widespread issues?

Co-channel-interference. This is when you have multiple APs in the same wireless channel and they interfere with each other, which then impacts Wi-Fi performance. Everyone wants better performance from their wireless network, so the last thing they need is the hassle of APs interfering with each other. Unfortunately, this is a problem common to most large-scale Wi-Fi setups.

APs don't play well together when they transmit and receive data on the same channel. We all love high-quality video streaming and lag-free browsing made possible by today's next-gen 802.11ac APs, which provide much faster speeds than the 802.11n standard. 802.11ac unlocks the door to faster, more intelligent, lower latency and high bandwidth Wi-Fi networks that can cater to the demands of a modern business.

But these advantages come at a price — fewer non-overlapping channels, which can lead to co-channel-interference. For example, 802.11ac utilizes wider bandwidth to achieve higher speeds, but there are limited channels available in the 80/160Mhz frequency (5-6 channels for 80Mhz, depending on country regulation, and 2 channels for 160Mhz).

Until recently, no vendor tested its wireless APs to see how they handled overlapping channel configuration with other APs. Why? Simply, because no one had an easy solution to address the problem.

Is there a simple way to avoid co-channel interference? Reducing transmission power is an obvious solution, but this may cause narrower coverage and dead zones. So, in order to have good coverage and reduce co-channel interference, there really needs to be a technical breakthrough.

We have the answer and it's called smart antenna technology.

Zyxel smart antennas eliminate interference and deliver Wi-Fi performance up to 105% better than other industry-leading manufacturers. How do we know this? Because we put our APs head-to-head with the best in the business.

Putting co-channel interference under the microscope

To validate our claims, we commissioned independent performance testing with the Networking Group at the University of Brescia, leading experts in the field of wireless network performance. To put the technology through its paces, they compared 802.11ac Wi-Fi APs equipped with and without smart antenna technology from four leading networking brands: Aruba, Cisco, Ruckus, and Zyxel. Two were equipped with smart antennas, and all featured three special streams and support for 2.4GHz and 5GHz radio bands.

Devices under test

Vendor	 Aruba	 Cisco	Ruckus	 Zyxel
Model name	AP-225	2702i	R700	WAC6503D-S
PHY	802.11ac	802.11ac	802.11ac	802.11ac
Spatial streams	3x3:3	3x4:3	3x3:3	3x3:3
Radio	Dual Radio	Dual Radio	Dual Radio	Dual Radio
Smart antenna	–	–	Yes	Yes

Key findings

Two tests were conducted:

- **Single-client performance (coverage) test**
- **Co-channel interference test**

Here are the results:

Test	Process	Results
Single-client performance (coverage) test	This test recreates a single AP installation in an open room, similar to a loft or office space. Ten clients are located in nearby rooms with different reflective barriers impacting signal strength.	As expected, the APs equipped with smart antenna — Zyxel and Ruckus — were able to deal with the chaotic array of reflective surfaces. Ruckus had a slight performance advantage at 5GHz, but fell significantly short of the Zyxel AP's throughput by a whopping 66% at 2.4GHz.
Co-channel interference test	Installing today's high-speed 802.11ac APs in big, crowded venues like hotels or dormitories presents a nearly unavoidable challenge in the form of co-channel interference. The co-channel experiment set out to show how smart-antenna technology can easily and effectively overcome this problem. Two APs from the same vendor were installed in two nearby rooms, as shown in ***figure 2 & 3*** below. Both were set up at 80MHz on channel 157 at a transmission power level of 17dBm. This meant that the interference from the APs would be the same because they shared the same channel. ***Figure 5*** shows the total data broadcasted to the connected clients.	In the first three setups, the Zyxel AP outperformed the nearest competitor, Cisco, by 25.5% to 46.7% (70%). A single Zyxel AP was even able to out-perform two Aruba APs working in tandem.

Conclusion

Zyxel's AP with smart antenna outpaced the competition by getting more data to its destination, delivering improved Wi-Fi service in co-channel environments.

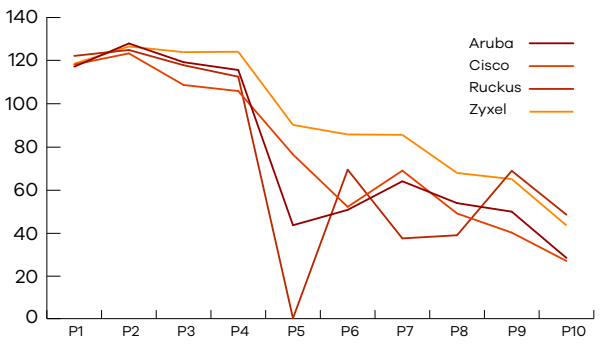
To push the performance envelope further, testers kicked transmission power up to 23dBm on both smart-antenna-equipped APs, while the remaining two continued to run at 17dBm. This put additional strain on the Ruckus and Zyxel APs, to measure the full benefit provided by the smart antenna.

As shown in ***figure 7***, the Zyxel AP won all critical scenarios with a performance advantage of 12.3% to 28% over the second-ranked Cisco AP.
Even Ruckus, with its smart antenna technology, failed to prove itself under extreme conditions.
Zyxel has proven that it is the only vendor that can effortlessly tackle co-channel interference. Due to its superior design and smart antenna technology, Zyxel has outperformed all other vendors.

Table 1: The result at 5 GHz

Position	Aruba	Cisco	Ruckus	Zyxel
P1	431.82	367.35	371.99	497.61
P2	373.06	453.71	377.58	493.11
P3	288.62	247.34	299.09	291.38
P4	248.83	258.82	248.10	333.04
P5	77.13	72.46	125.03	99.76
P6	125.73	108.78	162.15	149.11
P7	103.56	76.88	122.34	141.35
P8	105.32	95.87	128.92	144.24
P9	37.97	28.33	76.83	55.59
P10	7.94	10.26	21.61	21.96

Table 2: The result at 2.4 GHz



Position	Aruba	Cisco	Ruckus	Zyxel
P1	110.59	111.55	115.32	111.90
P2	120.77	116.42	117.92	119.44
P3	112.56	102.56	111.24	116.97
P4	109.12	99.88	106.20	117.14
P5	41.00	72.05	0.16	85.03
P6	47.74	49.06	65.37	80.84
P7	60.28	64.96	35.22	80.67
P8	50.70	46.16	36.61	63.94
P9	46.95	37.75	64.88	61.25
P10	26.62	25.31	45.62	40.92

Figure 1: The deployment of the single-client performance test

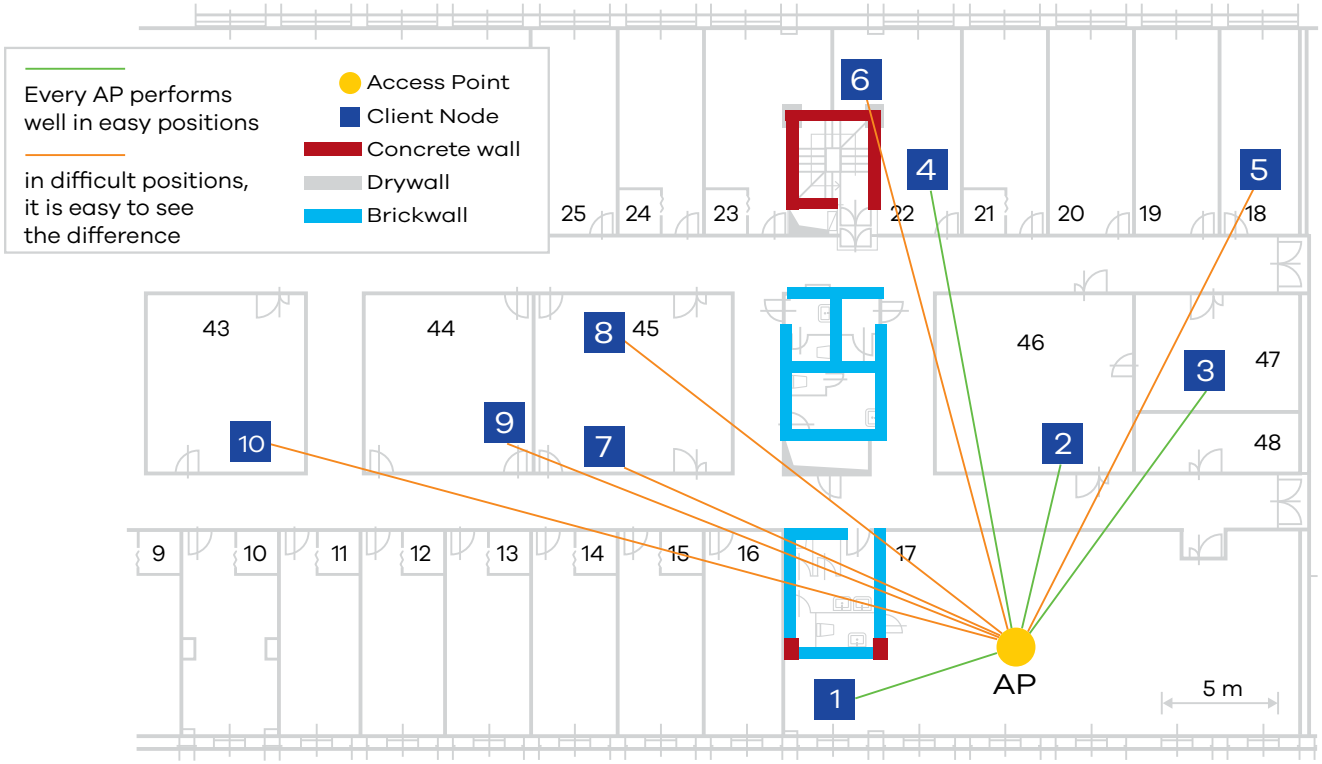


Figure 2 & 3: The four deployments of co-channel interference (1)

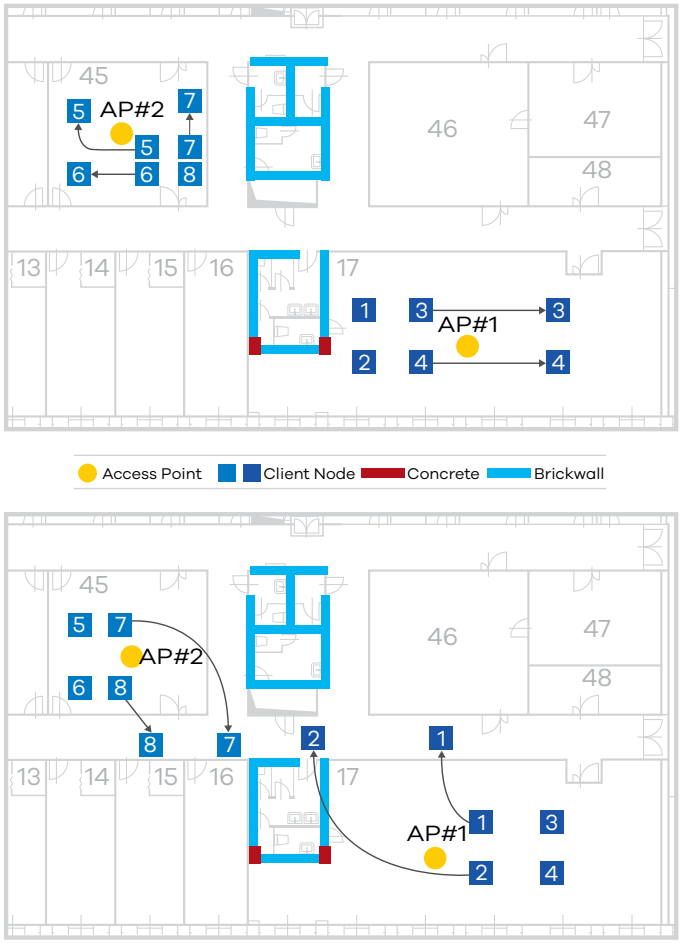
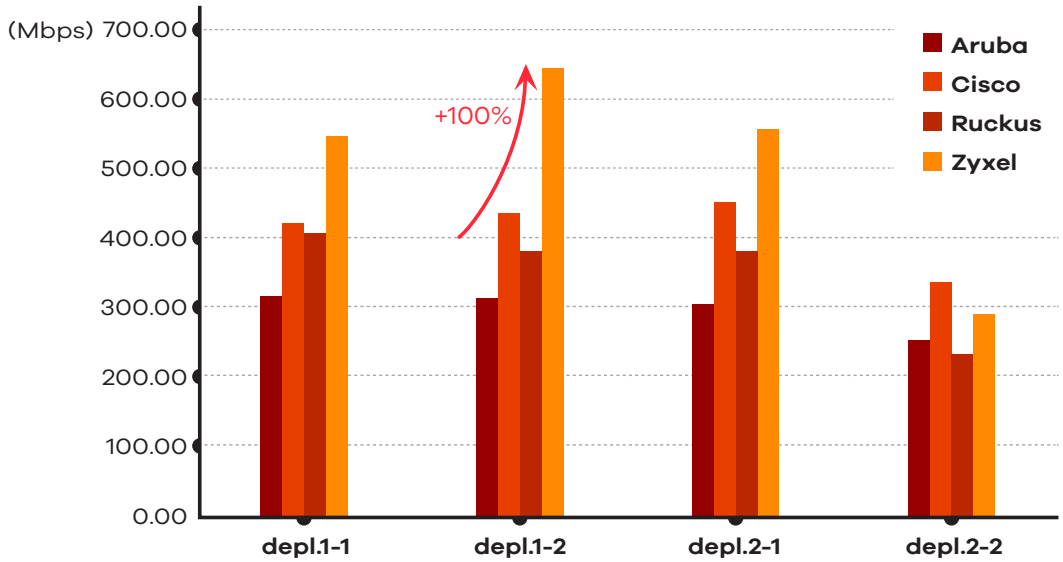


Figure 4: The result of the co-channel interference test (1)



Zyxel smart antenna provides +70% aggregated throughput than Aruba in average

Figure 5 & 6: The four deployments of co-channel interference (2)

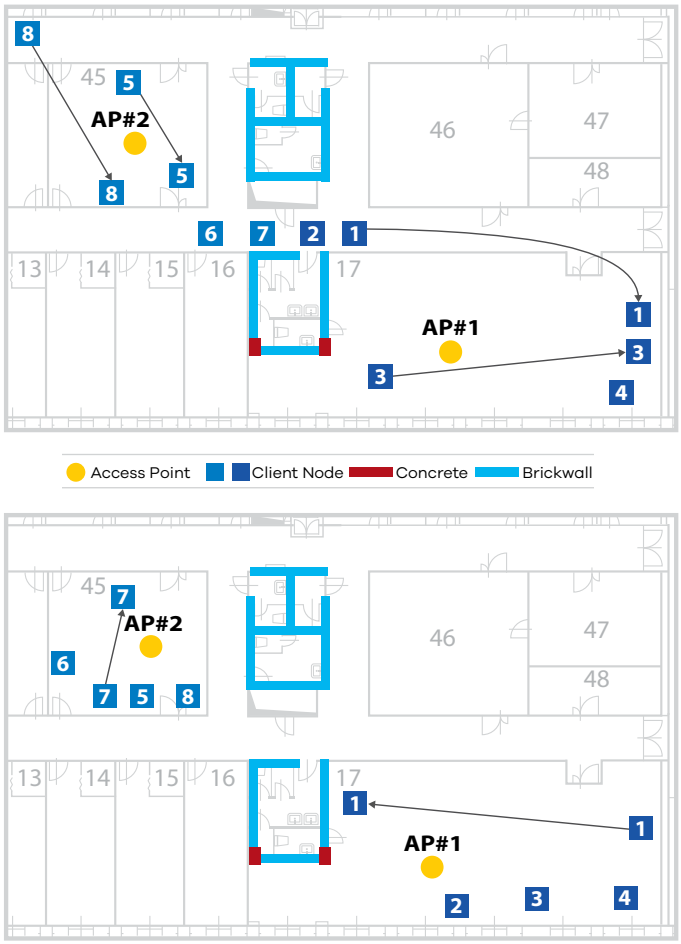
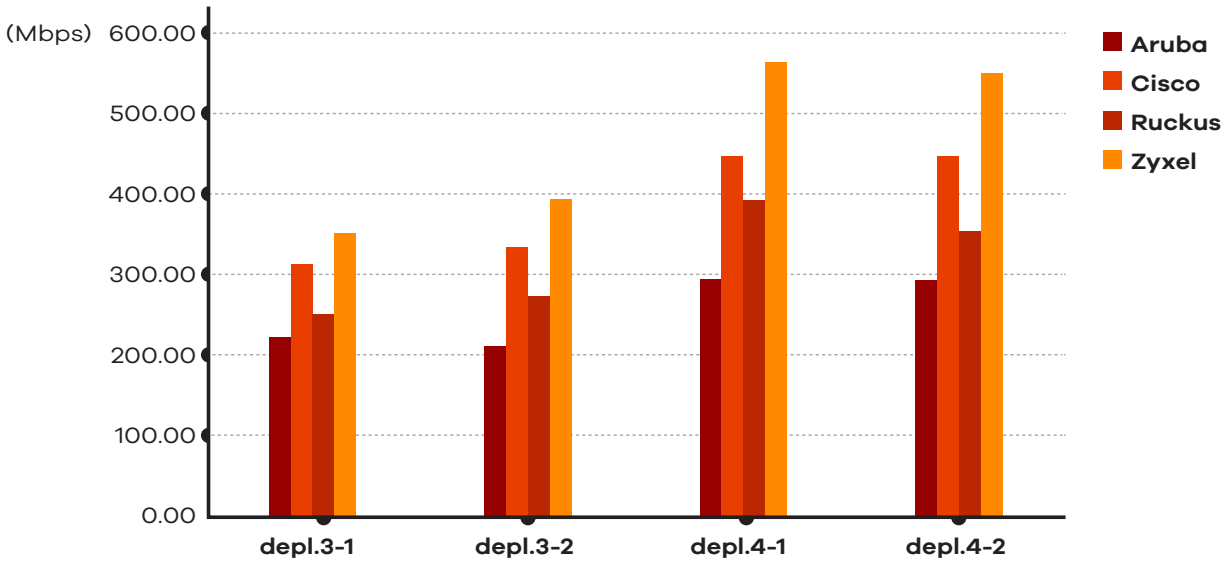


Figure 7: The result of the co-channel interference test (2)



Zyxel smart antenna sweeps in this critical situation

About the University of Brescia

The Wireless Networking Group at the University of Brescia specializes in the analysis, design and experimental characterization of the performance of wireless networks at the physical and medium access control layers. Research activities include the opportunistic exploitation of 802.11 networks for localization, jamming and pseudo-deterministic channel access algorithms.

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