Every Device Joins At Once: Designing Wi-Fi for Schools

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Designing wireless for a school. The timetable is the load profile, and it is unlike almost anything else you will design for.

Most buildings load gradually.

People arrive over an hour. They open laptops when they get to their desks. Traffic builds and fades across the day, and the network rarely sees one defining moment.

A school does not work like that.

A bell rings, and three hundred devices wake up within the same few seconds.

Thirty of them land on one access point, in one classroom, at once. Nothing much happens for the next forty minutes. Then a teacher says, “Right, everyone open the video,” and thirty devices start

streaming from an idle standing start.

Then the bell rings again and the whole class moves somewhere else.

That is the load profile.

Not necessarily busy.

Synchronised.

A school is not always a high-throughput environment. It is a highly synchronised one.

And almost every school Wi-Fi issue I have investigated has had some connection back to a design that was sized for coverage when the building’s real problem was concurrency.

Coverage is not the design question here

Walk into a school with a struggling wireless network and you will often find access points mounted in the corridors.

It is an understandable decision.

The cabling is easier. The AP count can be lower. A predictive heat map drawn from the corridor may still appear to cover the classrooms either side.

But the RF does not care how convenient the cabling was.

A corridor AP has to reach through walls to serve the clients inside the classroom. Signal levels fall, modulation rates reduce, and frames take longer to transmit.

Meanwhile, that same AP may be heard clearly in multiple adjacent classrooms, which means clients across several rooms can end up competing for the same airtime.

You do not necessarily have a coverage problem.

You have thirty clients sharing a slower, more contended cell through a wall.

For classroom teaching with any meaningful device density, an access point inside the room should normally be the working baseline rather than an AP in the corridor trying to serve several rooms at once.

That placement decision solves problems that no amount of controller tuning can properly compensate for afterwards.

Design for the device, not the access point

This is where school design can still go wrong even when the AP placement is correct.

Schools do not usually buy the fastest wireless clients available.

They buy identical, affordable devices in volume.

A trolley of thirty Chromebooks or tablets may all have the same relatively modest radio capability. Some may be single spatial stream. Many may have no 6 GHz capability. Some will still prefer 2.4 GHz if the network allows them to.

Your shiny tri-band access point cannot rescue that.

The client capability influences the achievable data rate. The data rate affects how long frames occupy the medium. And airtime ultimately determines how much useful capacity the room has.

An AP being heard clearly by a Chromebook does not automatically mean the Chromebook can be heard equally well by the AP either.

Client transmit power matters.

So design around the actual device.

Put one of the real devices in the room, at desk height, and test it.

That result is worth more than a datasheet.

And count devices rather than people.

A class of thirty may also contain a teacher laptop, an interactive display, printers, staff phones, classroom technology and other connected equipment.

What looks like a thirty-person classroom can easily become a forty-plus-client cell before you have accounted for anything outside the lesson itself.

The concurrency moment is the design case

Every environment has a moment that defines its design.

In a school there are several, and they are all worse than the average.

The bell

Everyone moves.

Devices roam, reassociate and authenticate within seconds of each other.

This is not only an RF event.

Your wireless infrastructure, RADIUS or NAC platform, certificate services, DHCP, DNS and the rest of the access path can all be exercised at roughly the same time.

If there is a weakness in authentication or address allocation, this is when it shows.

The bell also exposes poor roaming design brutally because entire groups of clients change cells together.

Coverage overlap, minimum data rates, transmit power and 802.11k, 802.11v and potentially 802.11r behaviour can suddenly matter at exactly the same moment.

The instruction

“Everyone open the video.”

Thirty simultaneous streams start from an idle state.

This is where capacity assumptions get tested honestly.

A room that looked perfectly healthy with three active devices may suddenly behave very differently when every client begins transmitting at once.

The assessment

Online exams are the day when the network absolutely cannot fail.

They may also be the day when the largest number of devices are doing something time-sensitive simultaneously, with almost no tolerance for failed authentication, roaming issues, poor coverage or retries.

Design for those moments and the ordinary school day generally looks after itself.

Design for the average and you may find yourself standing in a corridor with a laptop on results day.

Channel plan matters more than channel width

The instinct with a new wireless deployment is often to use wider channels because wider channels produce higher headline speeds.

In a school building, that instinct is usually wrong.

Classrooms are small, close together and often separated by walls that attenuate less RF than people expect.

Put an AP in every room and you immediately have a dense deployment.

Dense deployments need channel reuse more than they need maximum channel width.

In many classroom environments, 20 MHz channels on 5 GHz remain a sensible starting point.

The objective is not to give one client the largest possible PHY rate.

The objective is to create enough usable RF cells and enough channel reuse for many classrooms to operate at the same time.

Wi-Fi 6E and Wi-Fi 7 give us significantly more spectrum in 6 GHz, which can transform the channel-planning options available.

But only if the school’s client estate can actually use it.

If most of the devices are still 5 GHz only, that 6 GHz radio does not solve your classroom capacity problem.

Then there is 2.4 GHz.

It still has a role because schools almost always have something old that needs it.

But leaving 2.4 GHz running at high power from every classroom AP manufactures co-channel interference in a building that already has enough contention.

Use it where it is genuinely required.

Keep transmit power controlled.

And where appropriate, stay with the conventional 20 MHz channel plan of 1, 6 and 11.

The spaces that break the pattern

Classrooms are the repeating unit, but a school is not only classrooms.

The hall or sports hall is a different design entirely.

High ceilings, hard reflective surfaces and a room that may be empty most of the week before suddenly holding the entire school for an assembly.

Simply fixing omnidirectional APs to a very high ceiling is rarely the best starting point.

Depending on the geometry of the room and the mounting options available, lower mounting positions or carefully aimed directional antennas can provide much better control over where the RF actually goes.

Then there are the awkward spaces.

Temporary classrooms in the playground with their own cabling challenges.

Libraries and open-plan study areas where density is real but less predictable.

Outdoor spaces that someone will eventually decide need coverage.

Old buildings with thick walls.

Listed buildings where you cannot simply mount equipment wherever you want.

And comms rooms that are never where you would ideally put them.

On that last point, remember the structured cabling limits.

A typical copper Ethernet permanent link is designed around 90 metres, with a 100-metre channel once patch leads are included.

Then consider PoE.

Schools are exactly the kind of environments where an AP ends up on a marginally long or poor-quality cable run, connected through ageing cabling or to a switch with an overlooked PoE budget.

The AP may still boot.

It may even appear healthy.

But if the available power is insufficient, some platforms can enter a reduced-power state and quietly disable radios or functionality.

Coverage is only useful if the AP at the end of the cable is operating as designed.

It has to run without you

This is the part that separates school design from many corporate deployments, and it is frequently overlooked.

There is often no on-site wireless engineer.

There may be one IT person supporting several schools.

There may be an outsourced provider.

There may be a teacher who happens to understand IT and has a spare period.

Nobody is going to spend every morning staring at channel utilisation.

Nobody is going to notice immediately that one AP has been operating in a degraded state for three weeks.

Nobody is going to manually retune the RF plan in February.

So the design has to survive being left alone.

That means sensible configuration rather than unnecessarily clever configuration.

Clear documentation showing what is installed and where.

Useful naming.

Remote monitoring that highlights genuine problems.

Management tools that someone other than the original designer can understand.

And ideally, a spare access point on a shelf that is already licensed, documented and ready to replace a failed unit.

A failure should be a swap.

Not a project.

A design that only works while an expert watches it is not a design for a school.

Validate it like a student

Empty-room surveys can tell you a lot about RF coverage.

They tell you considerably less about what happens when the room is actually being used.

Thirty bodies change propagation.

Thirty active devices change airtime.

A classroom surveyed at eight in the morning with nobody in it does not behave exactly the same way at ten past nine when every seat is occupied.

So validate using the real client device.

Test at desk height.

Check the far corner rather than only the centre of the room.

Look at retries, channel utilisation, data rates and roaming behaviour, not only RSSI.

And where possible, validate under realistic occupancy.

Most importantly, test the concurrency moment deliberately.

Have a class connect at once.

Have them open the same application at once.

Test authentication while multiple devices are joining.

Walk devices between classrooms as lessons change.

A five-minute real concurrency test can expose things that a week of perfectly coloured heat maps never will.

Final Thoughts

School wireless is not difficult because schools are large.

Plenty of buildings are larger.

It is difficult because the timetable synchronises everything, the client devices are often modest by design, and there may be nobody on site capable of compensating for a mediocre deployment.

So design for the room, not the corridor.

Design around the client you actually have, not the access point you bought.

Design for channel reuse rather than headline channel width.

Plan for the bell, the instruction and the assessment rather than the daily average.

And build something that keeps working when nobody is watching it.

Get that right, and the network disappears into the background.

Which, in a school, is exactly where it belongs.

This is part of a series on designing wireless for real environments, where the constraint that dominates the building decides the design.

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