The Building That Changes Shape: Designing Wi-Fi for Warehouses



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You are not designing for the building you surveyed. You are designing for the building it becomes.

A school is synchronised.

A hotel is repeated.

A hospital is unforgiving.

A warehouse is none of those things. A warehouse moves.

The floor plan you were given is a snapshot. The racking gets reconfigured. Aisles are repurposed. A pick face becomes bulk storage. Stock arrives and the building fills up, then Christmas ends and it empties again.

And every one of those changes alters the RF environment, because in a warehouse the stock is the building.

That is the constraint that dominates everything else here. Not size, although these sites are large. Not density, although peak can be brutal. The fact that the environment you measured will not be the environment your design has to work in.

Full racking and empty racking are different buildings

This is the point that separates warehouse design from every other environment in this series.

An empty aisle can behave much closer to open space. Signal travels, sometimes further than you want.

Fill that same aisle with pallets of stock and it becomes an absorber. Liquids, metal, dense goods, shrink-wrapped pallets stacked several levels high. The attenuation changes dramatically, and it changes aisle by aisle depending on what is in them this month.

So a survey carried out in an empty building is not wrong, exactly. It is a measurement of a state the building may rarely be in.

If you can, measure both. Walk it loaded and walk it empty, or at least walk a loaded aisle and an empty one and understand the difference for that product mix.

If you cannot, be explicit about which state you measured and design margin for the other. A design validated only in an empty warehouse will look excellent in August and generate tickets in November.

The aisles are the design, not the floor

Warehouse RF does not behave like an office because the geometry is completely different.

Racking runs in long parallel rows, floor to ceiling, usually metal, often filled. What you have is a set of corridors with absorbing or reflecting walls, and coverage behaves accordingly. Signal travels along an aisle far better than it travels across the racking between aisles.

Which leads directly to one of the most common mistakes in this building type.

Mounting access points high, at ceiling level, in a building with a twelve or fifteen metre roof.

It feels natural. It is easy to cable and easy to access with equipment already on site. But an omnidirectional AP mounted at that height can put much of its useful energy above the working area, while the racking obstructs the path down to devices operating at pick height.

Coverage can look reasonable on a floor plan and still be poor where the work actually happens.

The answer is usually some combination of lower mounting and directional antennas aimed down the aisles, so the energy goes where the people and the devices are.

That also means antenna selection is a real design decision here rather than a default. Patch and directional antennas down aisles, omnidirectional in open areas such as goods in, marshalling and packing, and a deliberate choice about mounting height for each zone rather than one height across the building.

The clients are the hardest part

Warehouse device estates are unlike anything else.

Handheld scanners, often the same model bought in volume years ago, with small antennas, modest transmit power and roaming logic written by someone optimising for battery life.

Vehicle-mounted terminals on forklifts, moving at speed, roaming through cells while the operator is mid-task.

Voice picking headsets, where the session is the job. A dropout is not an inconvenience, it is a picker standing still.

Wearable ring scanners and wrist terminals, where the human body sits between the antenna and the access point for a good proportion of the working day.

And increasingly, autonomous mobile robots that expect continuous connectivity while following fixed routes.

Two things follow from that estate.

First, some of these will be among the stickiest clients you will ever design for. A scanner may happily cling to a distant AP at a poor data rate while a much better one is directly overhead, because its roaming threshold is conservative, its driver behaviour is limited, or its firmware has not been touched in years.

That makes cell sizing, transmit power and minimum data rates more important here than almost anywhere, and it makes testing with the actual device non-negotiable.

Second, mobility is not an edge case. It is the normal operating mode.

Almost everything in a warehouse is moving while it is working, so roaming behaviour is the design, not a feature you enable afterwards.

Design along the routes

In an office you design for where people sit. In a warehouse you design for where things travel.

Pick routes. Forklift lanes. AMR paths. The route from goods in to putaway. The journey from pick face to packing to dispatch.

Those routes are known, they are repetitive, and they are where connectivity actually has to hold.

A coverage design that averages nicely across the floor plan but has a weak spot at a specific junction will produce a fault report that looks random and is not.

If robots are in scope, treat their routes and charging areas as first-class requirements. A fleet that expects continuous connectivity will notice a gap that a person carrying a scanner might simply walk through without comment.

Cold storage is its own project

Freezer and chilled areas deserve separating out, because they break several assumptions at once.

Temperatures can fall outside the operating range of ordinary access points, pushing the design toward specialist hardware, suitably rated enclosures or other environmental protection depending on the site.

Cabling has to cross a thermal barrier without compromising it. Condensation and ice are real failure modes, and doors that open and close all day change the RF environment at the same time as they change the physical environment.

Access for maintenance is restricted and unpleasant, which means anything you install there needs to be more reliable than the rest of the estate, not less.

Treat cold storage as a distinct design within the design, and budget for it properly rather than discovering it late.

Everything else in the building

Warehouses accumulate environments.

Mezzanines and pick towers create multiple levels of RF that leak into each other vertically, which is a channel planning problem people frequently miss on a single-floor drawing.

Conveyors, wrapping machines, chargers, motors and other industrial equipment can introduce RF noise or other interference, and they are usually installed by someone who was not thinking about your spectrum.

The yard matters too. Trailer loading, yard management systems, gatehouses and outdoor marshalling all need coverage that behaves in weather, with external-grade hardware and antennas chosen for the distances involved.

And offices, canteens and training rooms sit inside the same building with completely ordinary requirements, which is a small design in its own right that nobody mentions until it is missing.

A war story about November

The site was designed and validated in July.

It was a new distribution centre, the racking was installed, and the building was largely empty. The survey was competent, the heat maps were clean, and the sign-off was straightforward.

It worked well through the summer.

Then the seasonal build started.

By late October the racking was filling with stock, and by November the site was at peak with several levels of dense product in every aisle.

The scanners started dropping mid-pick.

Not everywhere, and not constantly. In the aisles holding the densest stock, and worst at the far end from the access points.

Nothing had changed in the wireless configuration. Nothing had failed.

The design had simply been validated against a version of the building that no longer existed, at exactly the time of year when the site could least afford to lose picking time.

The fix involved additional access points and antenna changes in the worst aisles, carried out during the busiest period of the year, which is the most expensive time to do anything.

The lesson is not that the original survey was bad.

It is that a warehouse survey needs a date, a stock state, and an explicit statement about what happens when that state changes.

Validate at pick height, on the move, with the real device

Warehouse validation has its own rules.

Measure at the height the work happens, not automatically at chest height in the middle of the aisle.

A scanner used at a low pick face and a terminal on a forklift at three metres are different measurements in the same physical location.

Walk the routes rather than the floor plan.

Pick routes, forklift lanes, the path to the charging bays, the route through goods in.

Test while moving, because everything here is moving.

A static reading in an aisle tells you very little about a terminal roaming along it at forklift speed.

Use the actual devices.

The scanner your pickers carry. The vehicle-mount terminal. The voice headset. The robot if there is one.

Their radios, antennas, drivers and roaming logic are the design's real test.

And where a site has significant seasonal variation, validate at more than one point in the year, or at minimum document the stock state at survey and agree a trigger for revalidation when the building changes materially.

That last point is the one worth writing into the handover.

Not as a caveat, but as a design assumption with an owner.

Final Thoughts

Every environment in this series has had one constraint that decides the design.

In a school, the timetable synchronises everything.

In a hotel, every room is its own isolated problem.

In a hospital, nothing is allowed to fail and nothing can be turned off.

And in a warehouse, the building itself will not sit still.

So design for the aisles rather than the floor.

Get the antennas and the mounting height right before you argue about anything else.

Respect the client estate, because scanners and vehicle terminals can behave very differently from the laptops and phones you design around in an office.

Follow the routes rather than the square metres.

And treat the stock state as a design input rather than an inconvenience.

Above all, write down what the building looked like on the day you measured it.

Because the design has to work in the building it becomes, not the one you walked through.

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

Jarryd De Oliveira, CWNE #594

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