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Wi-Fi Best Practices for Industrial Environments

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WIRELESS DESIGN

Introduction

This eBook covers Wi-Fi challenges unique to the manufacturing industry where Wi-Fi is hugely important.

If you're responsible for your company's Wi-Fi, you might be feeling a bit overwhelmed by the prospect of planning, implementing and maintaining a workable wireless network. That's understandable. There's a lot to think about.

Designing and implementing a Wi-Fi network the right way can satisfy your stakeholders and minimize future problems. Getting it wrong can be a headache for everyone from your CEO to your customers.

Industrial and Manufacturing Wi-Fi

Making, storing, and shipping goods typically happens in warehouses where wireless networking is critical, but tricky. Interference from equipment, metal all over the place, high and low temperatures – the list of challenges goes on and on.

In manufacturing environments, there may not be any local IT support staff, meaning that network implementations must be simple and robust. Remote management and administration of factory Wi-Fi devices is commonplace in these environments.

You will also find many types of obstructions in manufacturing environments that you won't see in traditional office spaces. In addition to the sources of interference found in offices (microwaves, wireless cameras, alarms, etc.), the business-critical machinery and lighting used in and around industrial and manufacturing networks produce radio frequency (RF) noise within the same frequencies used by Wi-Fi.

This additional noise makes designing and implementing wireless networks challenging in warehouse environments. Any implementation of wireless networking in an industrial environment must be done using enterprise-quality systems that can withstand dust and extreme temperature variations, as well as provide remote management capabilities.

Mission Critical Wi-Fi

Mission critical means a network cannot fail or it will bring down your manufacturing line. For example, logistics teams use handheld devices to track inventory. Without Wi-Fi access, those handhelds cannot report inventory usage or arrival – leaving your company with too much or not enough inventory. This directly impacts operational costs and the bottom line. If the Wi-Fi is down, business stops.

Just as Wi-Fi is everywhere, so is bad Wi-Fi. Difficulty connecting, choppy video, dropped calls, lost revenue – these bad Wi-Fi issues all impact customer services.

So, what is the definition of good Wi-Fi? When things just work!
This eBook will help you bridge the gap between what you learn in the classroom and what it means to deploy a mission-critical wireless network that works in a complex manufacturing environment.

Manufacturing Environment Issues

Warehouses are like snowflakes – no two are alike. On the warehouse floor, workers going through aisles scanning bar codes with handheld devices need Wi Fi everywhere they go – and are not patient with signal interference from racks. Running a mission-critical wireless environment in a manufacturing plant is never easy.

The physical area of a manufacturing floor is typically very large and open. It's rare to have the optimal amount of access points (AP) to manage a space of that size. Sometimes the best you can hope for is one AP in a 10-20 meters (30-65 feet) radius.

Keep in mind that the more closed the environment (like an office space), the denser the AP setup, the better the Wi-Fi works. Expectation management in warehouses is crucial. Unlike an office setting where you will see 1- to 3-meter (3-10 feet) accuracy, in warehouses 35 feet is more likely.

Power levels are also unpredictable on the manufacturing floor because you have big absorbers, big reflectors and a wide variety of power levels. With this type of power fluctuation, it becomes very difficult to predict Wi-Fi accuracy.

These environment constraints mean you must be very careful in setting up and maintaining Wi-Fi in manufacturing environments, but at the same time be agile and fast. Some of the issues you need to address or over-come include:

- Thousands of access points
- Metal everywhere
- Liquids in stacking
- Mezzanine levels
- Unpredictable racking of products and daily rack location changes
- Moving vehicles like forklifts potentially hitting and disabling wireless equipment
- Very high ceilings causing problems with ceiling mounts
- Safety and security constraints limiting your access

Wi-Fi Survey & Planning

When you deploy a network without pre-planning – or only focus on expansion or rebuilding when necessary – you will run into trouble. Wi-Fi that works needs to be planned and evaluated before you deploy.

Before you order and install equipment, you'll want to perform a pre-deployment site survey to measure the radio signal propagation on the manufacturing floor. This will help you plan the appropriate number of APs and feel confident that their installation locations are optimal.

A pre-deployment survey also helps you discover all the neighboring or rogue APs, as well as non-Wi-Fi related interference that could impact Wi-Fi performance. Keep in mind that warehouses are typically not high density and it's not uncommon to see warehouses with more APs than clients.

AP on a Stick

One common design method is performing an AP-on-a-stick site survey. To perform this type of survey, use the AP and antenna that is planned to be deployed. Temporarily position and power the AP at the pre-planned locations and height. Validate how far the signal is traveling by walking the area and recording the measurements using Wi-Fi site survey software (e.g., Ekahau Pro) and compatible measurement device (e.g., Ekahau Sidekick). Repeat this process as necessary until all the required areas meet the defined set of Wi-Fi requirements.

Keep in mind that typical AP-on-a-stick planning has limitations on height, which is particularly troublesome in warehouse environments. Typically, AP-on-a-stick is performed using a tripod stand with a power supply and an antenna which reaches about 4 meters (13 feet) in height. This height limitation may also limit your ability to perform the optimal test in a warehouse environment. Be prepared to plan for situations where you may need to assistance in the form of SkyTrak telehandler to test at heights up to 25 feet.

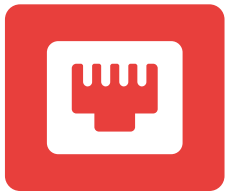
Lessons Learned

- Enlist the help of the appropriate security and warehouse floor management teams who understand the inherent risks on the floor and can accompany you throughout the pre-deployment site survey.
- When possible, perform surveys and testing when the plant is offline, i.e. when no forklift driver can hit your or antenna. If your plant operates 24/7, try to find time with the least amount of disruption in order to minimize safety problems.
- Caution: measuring in a completely empty warehouse with no moving parts may change your results as there may be less interference during a shutdown period than when the plant is in full operation.
- Use pre-deployment software such as Ekahau Pro to help plan, document and troubleshoot issues.

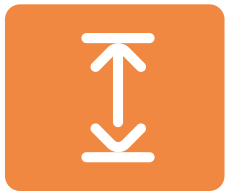
Antenna Deployment & Mounting

The environmental issues in manufacturing warehouses make access point (AP) and antenna deployment especially challenging. Sometimes the best you can do is find the ideal location for your antenna so it won't be knocked, moved or covered.

Here are some key considerations:



Power Distance: Your first task when setting up the AP is to look for the nearest cabinet in order to stay within the optimal ethernet power limits of 100 meters (300 feet) or less. Installing new cabinets costs money, but if you need to do so for optimal power supply, you will need to convince the folks holding the purse strings to stretch your funds, not your cables.



AP/Antenna Height: Remember that Wi-Fi is bi-directional, which means clients have to be able to talk back to the APs. To improve connectivity, place antennas as close to the clients as possible. If the ceiling is mounted, consider lowering the antennas as much as possible. Even if it is only a few feet it can have a significant improvement to the RF.

Cable Length to Antenna: If you don't want to lose signal, keep the cable length to 50 feet when possible. Avoid long 100-ft coax cable and avoid rolling or coiling long cable as this will affect signal strength.

Antenna Mounting: Avoid metal when possible. Place the antenna at optimum height and use extensions to move it away from pipes.

In warehouse planning, use Ekahau Pro to model different antennas to determine the optimal antenna to use for the given environment.

TIP: Determine realistic deployment height during the site survey and match your testing coverage height to actual deployment height.

Where Practice Breaks Theory

Consider this scenario: You're following a site survey that tested coverage with the AP mounted at 2 meters (6 feet) in height. But when you go to install, you learn that location would be hit by a forklift driver and you'll actually need to mount the AP at 10 meters (30 feet). Testing at 2 meters and mounting at 10 meters will make the coverage measurements drastically different.

This situation could be solved by having the warehouse managers who understand daily activity on the floor involved in your initial testing. At that point, you could have tested the coverage at 10 meters and adjusted accordingly.

Lessons Learned

- During the survey, collaborate with warehouse employees who know the cabinet locations, data conduits, usage of area, and reality of what can and cannot be done about mounting (and know the propensity for a forklift driver to hit your antenna).
- To improve connectivity avoid mounting the antenna to or within 1 meter of dense metal objects (e.g., light fixtures, beams, trusses, racking, etc.) Also, a good general rule of thumb is to place antennas as close to the clients as possible.
- If your warehouse requirements force you to mount antennas at heights like 10 meters (30 feet), consider using directional antennas mounted on the ceiling and pointed down. Keep in mind you might end up with a high AP position with this configuration.
- If you have the luxury to place the AP wherever you want, think about roaming. If money is no object, use directional antennas for anything over 20 feet.

- Find the optimal location to use the shortest possible coax cables. You might need to sacrifice optimal coverage antenna position to avoid losing signal. Remember, even low-loss coax will lose signal with lengths greater than 15 meters (50 feet).

Compulsory Interference

Radio frequency (RF) interference is a problem for all Wi-Fi networks. Almost any device that emits an electro-magnetic signal can cause RF interference. It's unavoidable.

Compulsory interference is where there are devices in your manufacturing environment that share the RF spectrum, but you cannot remove them. Compulsory interference on the warehouse floor might include:

WhereNet location tracker devices used to locate tagged items and supplies transmitting on 2.4 GH

Wireless video cameras with varied transmission channels: some on 802.11 some on 2.4 or 5 GHz

Parallel wireless systems installed by other contractors or teams

Sometimes there are political reasons or even distrust among teams that leads to systems being built in parallel. While these Wi-Fi systems may be mission critical for another team, they could interfere with your Wi-Fi. Although it's never a good idea to have two wireless networks in the same area, sometimes you might have to live with it. The best advice is to document this compulsory interference as a disrupter to your overall Wi-Fi health.

Lessons Learned

- If your company or client does not have an RF spectrum policy, then define one. Set the limitations of what type of device can be put on 802.11, or 2.4 or 5 GHz channels. Then, when someone mounts a wireless camera without following the guidelines, you can use the policy to explain how it the camera interferes with the Wi-Fi signal strength.

- If a third party requires wireless access in your RF space, provide that access on your own network, instead of having a physically separate network. This only works if you do not introduce additional network security concerns.

- If you are forced to implement parallel wireless networks on a specific area, manage the use of channels and power levels wisely to ensure minimum coverage and localize as much as possible.

Clients & Devices

In the manufacturing environment, forget about the tablets, forget about the phones because they usually have the latest and greatest 802.11 protocols. In the warehouse, you will encounter a variety of handheld devices, some good and some bad in terms of signal strength and rate jumping.

When you are planning your network during site surveys, keep in mind the types of devices/clients used in the plant. You also might encounter legacy devices like old PCMCIA cards used in manufacturing equipment. And, these clients might be hidden inside a vehicle or other enclosed structure.

Examples of Bad Device Behavior:

- The device is good at roaming and pursuing the signal, but the antenna sensitivity decreases when moving 5 to 10 meters (15 to 30 feet) away from the AP – with signal differences up to 10dBm
- Rate shifting jumps from 54 Mbps to 1 Mbps if signal drops even a little
- Sticky clients will not roam from the AP on the other side of the warehouse

Lessons Learned

- Design the network for all your clients and calibrate your site survey measurements to ensure all devices work – don't test only using your computer
- Ensure localized coverage for weak receivers and transmitters
- Work with the teams purchasing clients to ensure good wireless cards are chosen: support of 802.11 protocols for security, roaming, etc. (not only for speed!)
- Make sure you are not too far from the client: localized coverage when possible, for example, put the AP antenna closer to the client device
- Forklift terminals and automatic guided vehicles are usually well-behaved clients with no problems with roaming or coverage.
- Make sure you understand where each client will be used (i.e. under a rack, inside a forklift, etc.) and adjust antenna placement accordingly.

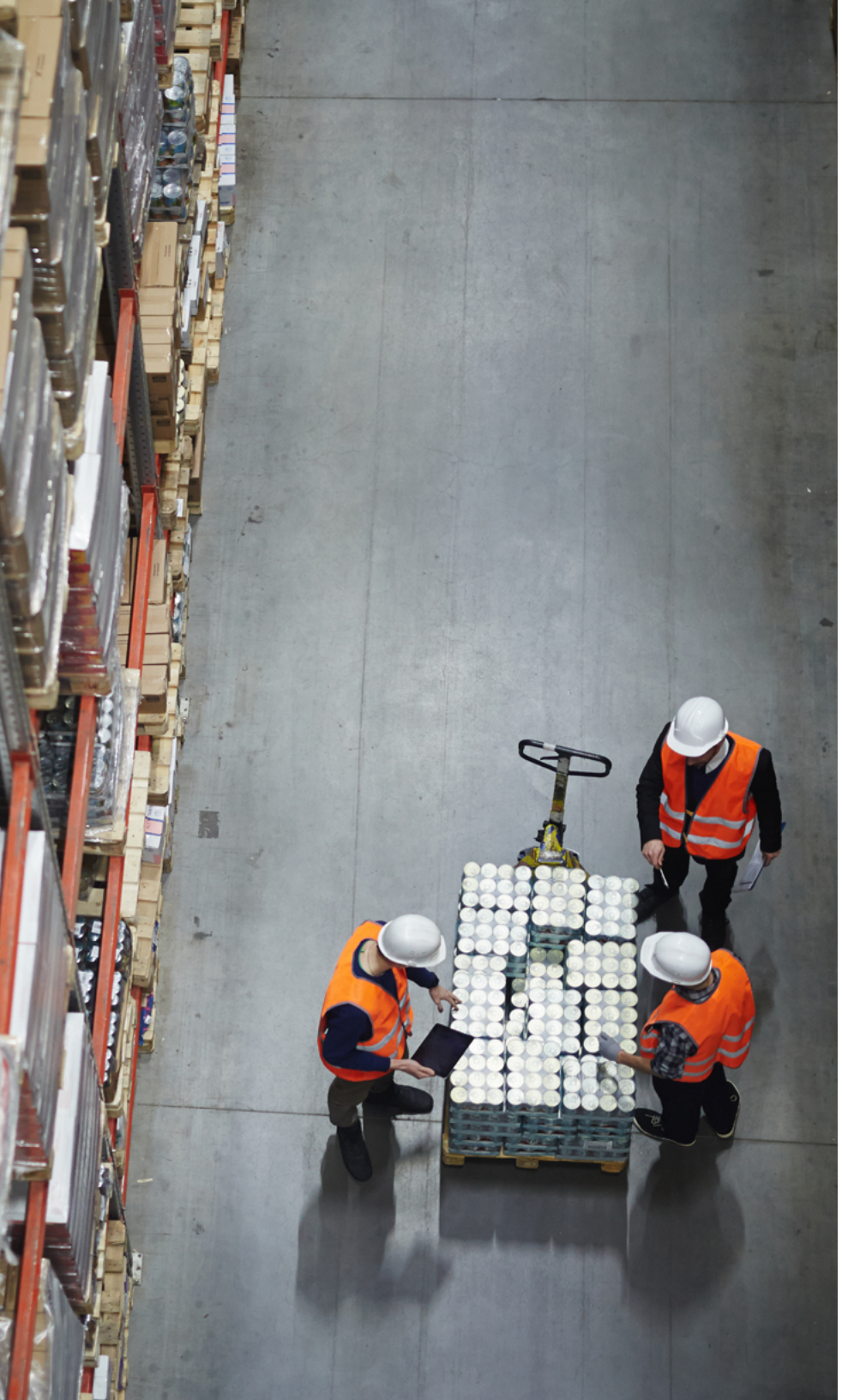
Roaming

Wireless is about mobility. Old networks were not designed for roaming because coverage was not continuous. Even new networks are sometimes not correctly designed for roaming. A mix of standalone and controller driven APs will rarely be configured for roaming between them, if even possible. In warehouses, you'll encounter Wi-Fi problems with roaming more than anything else.

Here are a few tips for best practices with roaming:

- Plan every configuration change with roaming in mind
- Plan IP subnetting and VLAN assignment carefully – adding more subnets to an existing WLAN deployment may affect roaming
- Keep your APs grouped by location as much as possible and keep roaming as simple as possible:
    - Per building: same AP group to ensure matching SSIDs
    - Per site: same WLC (or WLC mobility group)
    - Consider exceptions carefully
- Perform roaming tests: ask the warehouse managers for a scanner or other highly-used clients and then walk around with the client to troubleshoot.

TIP: Don't try to save money buying cheap handheld devices, or you might spend that savings on trouble-shooting wireless connections



Conclusion: Don’t Upset the Status Quo

The key directive in installing and maintaining Wi-Fi in warehouse environments is to not upset the status quo on the manufacturing floor. Big changes all at once are prohibited because of the risk they represent. Instead of big complex changes, divide changes into a series of smaller steps.

As you continue to meet the challenge of planning, deploying and maintaining Wi-Fi in the manufacturing environment, keep these points in mind:

- Wireless networks have become part of mission-critical processes.
- Companies can lose millions if the manufacturing line stops or logistics are disrupted.
- Some networks have grown over many years and this has resulted in a patchy design of old and new access points mixed together: this is hard to maintain, but you may need to live with this as you slowly migrate.
- In many cases, significant wireless improvements are needed so that customers can maintain a competitive advantage (wireless = agility).
- Sometimes, risk must be taken, but make sure the business side of the company understands the risks and reasons for the change.
- Engage all teams required for any improvement in security, clients – better to buy good clients then cry over bad performance.
- Use clients that support as many 802.11 protocols as you can get.
- Test as much as possible to avoid problems on a live network.
- Document everything you do.
- Finally, cross your fingers and pray to the networking gods!

Ekahau Can Help

Ekahau Connect™ is a suite of Wi-Fi tools that enable you and your team to design, optimize and troubleshoot any Wi-Fi network faster and easier than ever before.

- Design reliable, high capacity Wi-Fi networks
- Validate a new Wi-Fi deployment or optimize an existing Wi-Fi network
- Analyze and troubleshoot Wi-Fi issues in real-time

Learn more about how Ekahau can help you design, validate, analyze, report and troubleshoot Wi-Fi networks:

LEARN MORE

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Ekahau Connect™

The All-in-One Product Suite for Better Wi-Fi

Ekahau Pro™ - the industry standard tool for designing, analyzing, optimizing and troubleshooting Wi-Fi networks

Ekahau Sidekick® - precise Wi-Fi diagnostic and measurement device used by professionals for site surveys, spectrum analysis and packet capture

Ekahau Survey™ - first ever professional Wi-Fi site survey and analysis tool for iPhone and iPad
**Requires Ekahau Sidekick, Ekahau Pro and Ekahau Cloud*

Ekahau Analyzer™
The most powerful Wi-Fi validating and trouble-shooting tool in the market for iPhones and iPads
** Requires Ekahau Sidekick*

Ekahau Capture™ - easy to use packet capture tool helps anyone detect complex problems without waiting for a Wi-Fi expert
**Requires Ekahau Sidekick*

Ekahau Cloud™ - choose a collaboration method that works best for you - cloud or local