



Comparing Wi-Fi and Celona Private Wireless within a real-world distribution center

CUSTOMER

National retail home improvement company with distribution centers across the United States

CUSTOMER SIZE

Large Fortune 100 retail customer

SOLUTION

A Celona private wireless solution for better coverage, 1/5th the latency and up to 81% lower TCO compared to Wi-Fi

VERTICAL

Distribution & Logistics

CHALLENGE

Poor and unreliable indoor/outdoor Wi-Fi coverage impacting operational productivity

Distribution centers, warehouses, and logistics operations are essential elements in the global supply chain. A distribution center, receives pallets of goods, breaks the pallets into smaller sizes, stores the inventory and builds a mixed pallet for delivery to a retail location or warehouse. Operations at a distribution center, involves personnel for keeping track of inventory, operating fork-lifts, and moving goods throughout the center.

With increasing labor shortages and volume of shipments, distribution centers are turning to technology solutions and automations to address these shortages and further scale their operations. Use of tablets, computers, communication devices, Autonomous Guided vehicles (AGV), robots require highly reliable wireless connectivity, without which problems can quickly mount.

A distribution centers Wi-Fi woes

This was the case for the distribution center of a large retail home supply company. Wi-Fi connectivity issues across its property – indoors and out – was significantly contributing to workflow disruptions and inventory management inaccuracies.

THE ENVIRONMENT

Aisles of tall metal shelving racks fill the 700,000 square foot indoor warehouse. Outside, a 560,000 square foot yard is used for parking trucks and trailers, and sometimes as temporary storage for goods. The distribution center required network connectivity for industrial tablets and inventory scanners on forklifts, mobile carts with label printers. Workers used wireless for their tablets, PCs, inventory scanners as well as for voice communications.

Some of the big complaints from warehouse operations included:

- Spotty indoor and outdoor Wi-Fi coverage was causing delays in gathering and transmitting data, often resulting in inaccurate inventory data
- Forklift computers were experiencing lost or erratic connectivity when the equipment moved across the property at speeds greater than 25mph

- Large items stored in temporary locations affected wireless signal propagation and connectivity on the property
- Lack of higher bandwidth, lower latency connectivity for critical business applications led to operational challenges

Beyond day-to-day operational disruptions, the distribution center had plans to adopt advanced technologies, such as collision avoidance systems for forklifts and Autonomous Guided vehicles (AGV), Autonomous Mobile Robots (AMR), High-Def Video surveillance, automated gate check-in/exit of vehicles, and employee training using on-demand video. However, to operate reliably, these technologies would require connectivity with significantly higher bandwidth and lower latencies.

“**Our testing and analysis clearly revealed the value of private wireless in delivering lower latency jitter, improved wireless coverage and seamless mobility at a lower total cost of ownership over traditional warehouse Wi-Fi implementations.**”

Ken Wright, P.E.

Director of Technology

M.S. Benbow and Associates

Improved connectivity began with a deep analysis

Celona has partnered with M.S. Benbow and Associates, a national consulting engineering firm, to perform extensive onsite RF and network performance analysis to compare Wi-Fi products and technology to the new Celona private wireless solution.

THE NETWORK FOOTPRINT AND HARDWARE

The distribution center was utilizing a Wi-Fi solution from a major enterprise Wi-Fi vendor. This included 111 Indoor Wi-Fi access points using 2.4 GHz & 5 GHz, mounted on the ceiling. Meanwhile, the yard was covered by 29 Outdoor Wi-Fi 2.4 GHz Access points mounted on existing light poles. The 5 GHz bandwidth was used only for mesh backhaul.

For comparison purposes, M.S. Benbow studied the Celona private wireless solution, 22 Celona 4G Indoor access points and 3 Celona 4G outdoor access points, to cover the same footprint both indoors and outdoors, as Wi-Fi.

CELONA 5G LAN - THE ONLY TURNKEY PRIVATE WIRELESS SOLUTION FOR THE ENTERPRISE

Widely considered the most comprehensive Private Wireless solution for today's enterprise, Celona private wireless promises industrial strength private wireless connectivity, performance,

and mobility. The turnkey solution includes access points, LTE/5G core network, edge hardware/software, radio resource management software, and cloud-based orchestration tools.



Wi-Fi technologies

Celona private wireless

Coverage	Poor Network Coverage due to lower transmit power and susceptibility to spectrum noise, and co-channel interference.	More Pervasive wireless due to higher transmit power, lower noise floor and low wireless interference.
QoS	No guarantee on throughput and latency, since Wi-Fi does not support deterministic QoS with strict priority. While Wi-Fi 6/6E APs can use OFDMA to schedule packets to multiple mobile devices for download, APs still need to use contention-based (CSMA-CA) requiring devices to “fight” for access, making prioritizing challenging.	Guaranteed SLA for critical applications. 5G LAN features Microslicing™ technology that enables deterministic QoS with strict priority on a per device, per application basis. Guaranteed bit rate and guaranteed latency values can be configured for each device and application.
Mobility	Not designed for seamless mobility. Wi-Fi requires the Client to perform Off-channel scanning to connect to APs. The roaming decisions are controlled by the client rather than infrastructure.	Cellular networks are designed natively for seamless mobility. The network infrastructure controls handover decisions that are precisely timed.
TCO	More APs are required due to lower coverage range of Wi-Fi. Outdoor install require expensive installation, trenching and cabling.	Fewer APs due to higher coverage range of Private Wireless. Outdoor APs can be roof mounted to provide very large outdoor coverage, avoiding cost of trenching, cabling etc.
Security	Many Wi-Fi networks utilize pre-shared keys and open SSIDs to allow for IoT and/or guest device connectivity – opening doors to additional risk factors for critical enterprise infrastructure.	End-End security for data in-flight and at rest secured using SIM/eSIM technology.

Comparing the performance of the two networks

MS Benbow & Associates undertook the study to compare the two networks based on the following:

- Indoor/Outdoor coverage
 - 67dBm or higher, signal strength, considered as acceptable levels for Wi-Fi
 - 110dBm or higher, signal strength, considered as acceptable levels for Private Wireless
- Latency and throughput on a loaded network
- Latency and throughput when mobile
- Overall Total Cost of Ownership (TCO)

Following is their analysis.

Indoor Coverage (Heat maps)

OBSERVATIONS:

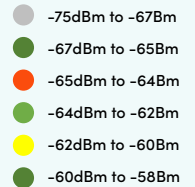
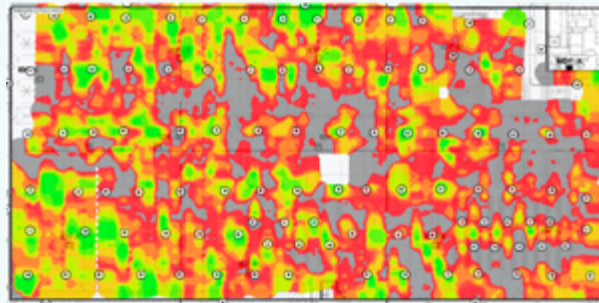
- 775,000 square feet indoor
- 111 Wi-Fi Access points, using 2.4 GHz and 5 GHz, Ceiling mounted offer 78% area coverage
- 22 private wireless Access Points, ceiling mounted, offering 99% coverage

Note: Areas in white are the shelving areas where test equipment did not have access.

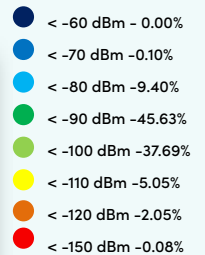
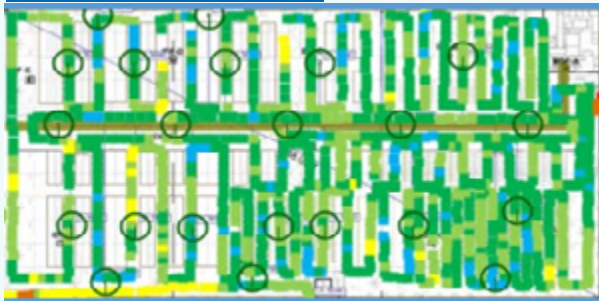
WHY IT MATTERS?

- 78% Wi-Fi coverage was causing poor Wi-Fi connectivity across the property
- Installation costs increase as additional Access Points require power and internet

Wi-Fi Heat map



PVT Wireless Heat map



CELONA PRIVATE WIRELESS ADVANTAGES:

- Higher transmit power requires fewer Access Points
- Lower noise floor improves coverage
- Low interference spectrum

Outdoor Coverage (Heat maps)

OBSERVATIONS:

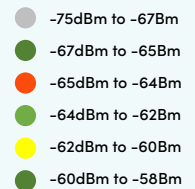
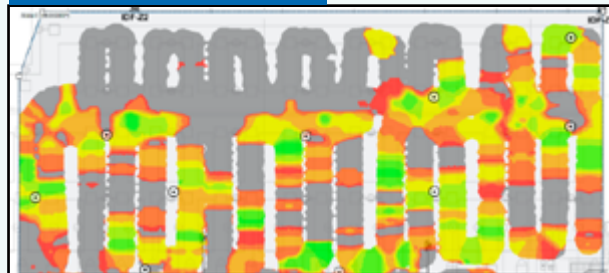
- 561,000 square feet outdoor
- 29 Wi-Fi APs, using 2.4GHz, pole mounted and offering 59% coverage
- 5 GHz channel is used for Mesh reduces overall throughput/reliability
- The customer settled for the 59% coverage due to the cost of adding additional poles
- 3 private wireless APs, roof mounted, offering 95% coverage

Note: Areas in white are trailer parking areas with no access to the test equipment. Wi-Fi use case areas are in gray because Wi-Fi APs could only be placed in poles without power and internet.

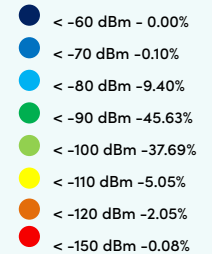
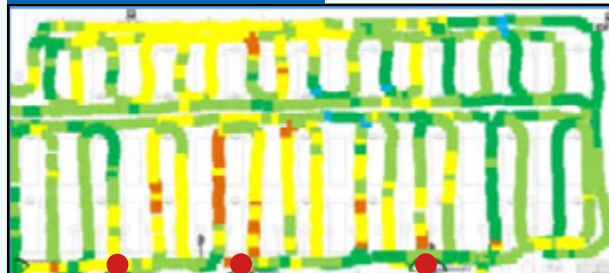
WHY IT MATTERS?

- 59% coverage is the primary reason for poor network at the property
- Running power and fiber optic infrastructure outdoors is expensive, and poles are not always available where coverage is needed
- Improving coverage for Wi-Fi will require more APs and support infrastructure

Wi-Fi Heat map



PVT Wireless Heat map



CELONA PRIVATE WIRELESS ADVANTAGES:

- Higher transmit power so fewer APs required
- Lower noise floor and lower interference extends range

Latency and throughput measurement in a loaded network

WHY IT MATTERS?

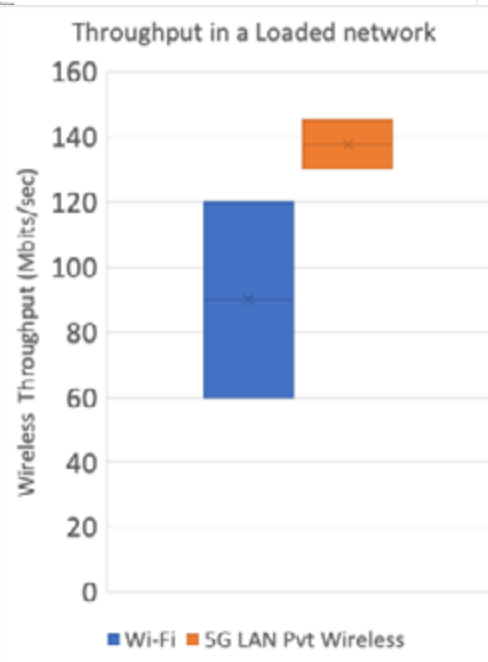
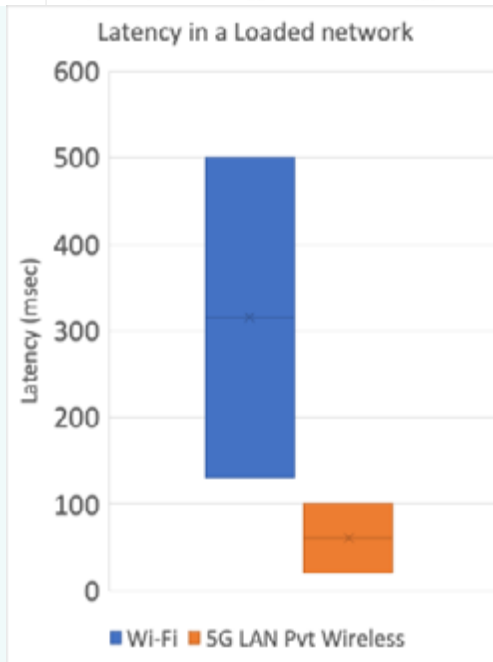
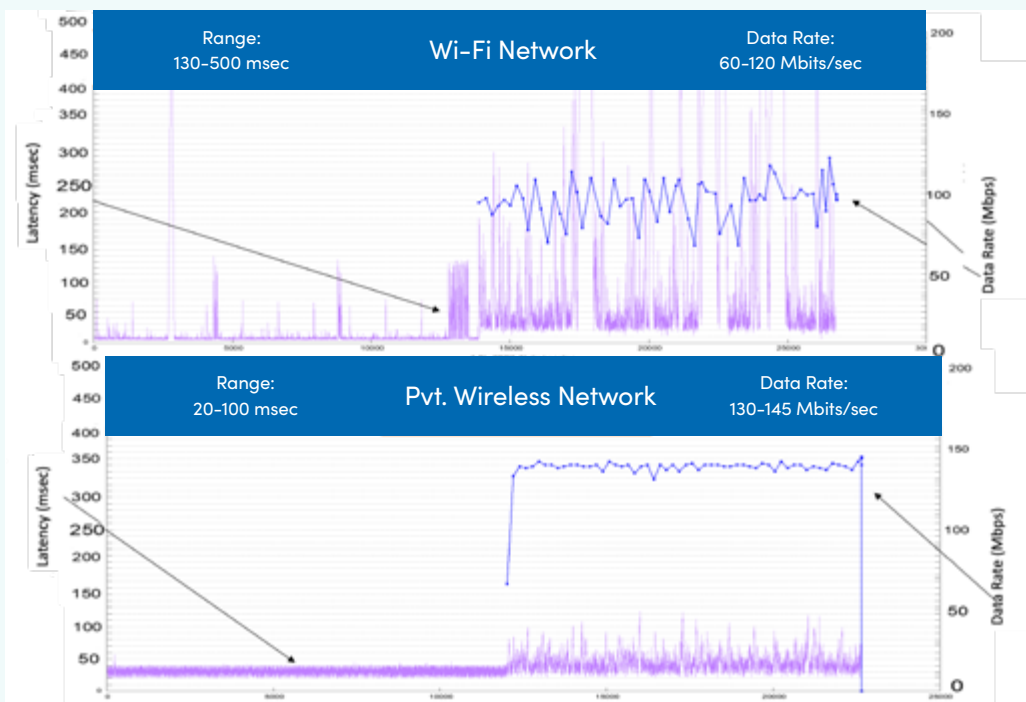
- Tablets and computers require consistent connectivity, regardless of network traffic
- Latency variation results in unreliable operations of AGVs and robotics

OBSERVATIONS:

- In a loaded network, the latency is 5x higher for Wi-Fi than for Celona private wireless
- Average data throughput is more than 2x for Celona private wireless versus Wi-Fi

REASONS

- Wi-Fi uses contention based mechanisms to connect to the network. As a result, a device can get deprioritized and suffer with slow speeds or high latency
- Celona private wireless can set up data bandwidth and latency on a per device/ per application basis



Latency and throughput measurement with Mobility

OBSERVATIONS:

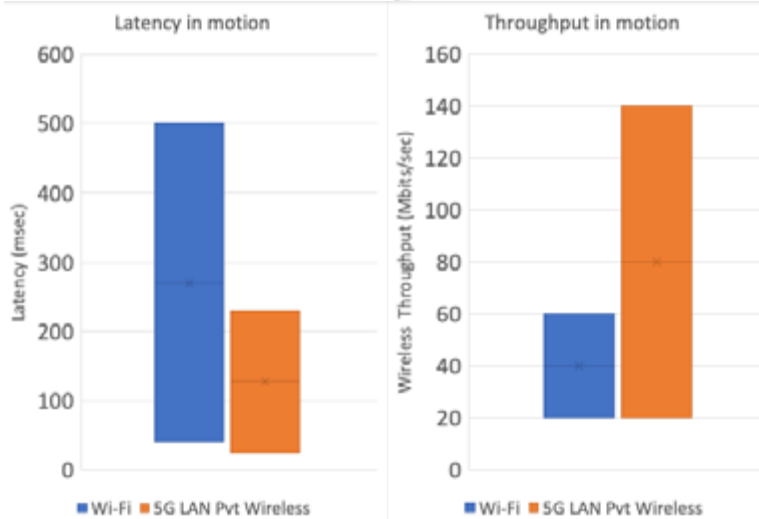
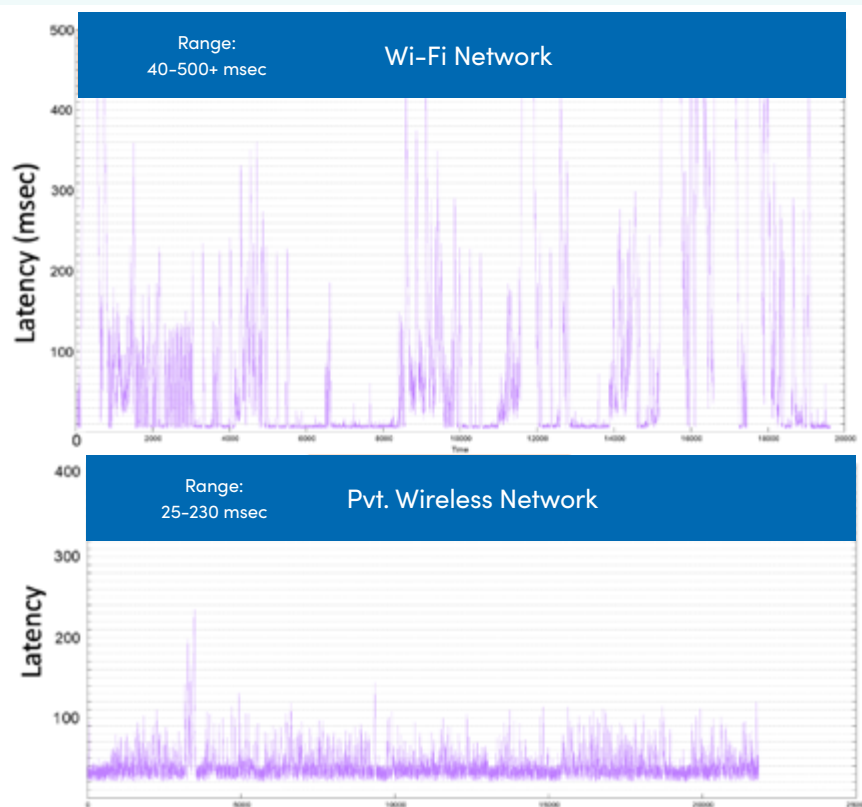
- For mobility use cases, Wi-Fi had almost 2x the latency of Celona private wireless
- Wi-Fi showed a 20-60 Mbps throughput for the mobility and loaded network use cases, while Celona private wireless showed 20-140 Mbps

WHY IT MATTERS?

- AGVs and forklifts operate at 20 mph or higher and require precise and timely control - guaranteed low latency and reliable connectivity - to avoid collision avoidance and low latency

REASONS

- Wi-Fi uses client off-channel scanning to detect new Access Points and client controls for handover decisions
- On the other hand, Celona private wireless has precisely timed handovers and the infrastructure controls handover decisions



Total Cost of Ownership

THE TCO HAS MULTIPLE CONSIDERATIONS:

- Number of Access Points needed
- Power/back-haul is required for each AP
- Availability of poles and installation cost
- Cabling pulls: trenching, distribution
- Switches and supporting software
- Future proofing

OBSERVATIONS:

- Even comparing 77%/59% coverage with Wi-Fi compared to the 99%/95% indoor/outdoor coverage with Celona Private Wireless, TCO remains much lower for Celona private wireless – this is primarily due to fewer access point hardware needed and a lower cost of installation.
- Outdoor shows an even higher saving as installing Wi-Fi access points would require trenching and installation of new poles.

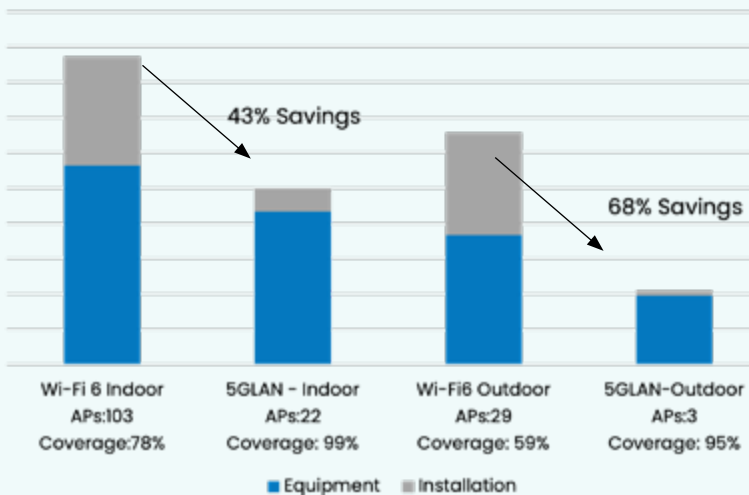
ASSUMPTIONS IN THIS ANALYSIS

- The analysis is based on the current setup at the warehouse with 77% indoor and 59% Wi-Fi coverage
- HW/SW is a three-year subscription
- Comparing list prices of enterprise Wi-Fi with Celona (4G)
- Wi-Fi outdoor – pole mounted
- Celona private wireless outdoor – roof mounted.
- No Day 2 managed services include

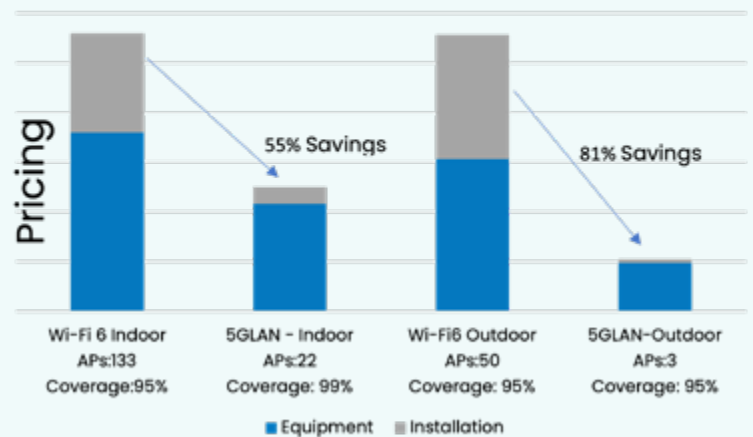
ACCOMPLISHING 95% COVERAGE WITH WI-FI

An alternative may be to densify Wi-Fi access points to reach 95% coverage. 133 Access points indoors and 50 Access Points outdoors would be needed to achieve 95% coverage for Wi-Fi. In this case, the TCO savings are even more prominent for Celona private wireless since existing network is already at this level of coverage. The chart below shows this analysis assuming > 95% coverage.

3-yr TCO: As Implemented (< 100% coverage)
Indoor 775K Sq-ft, Outdoor 561K Sq-ft



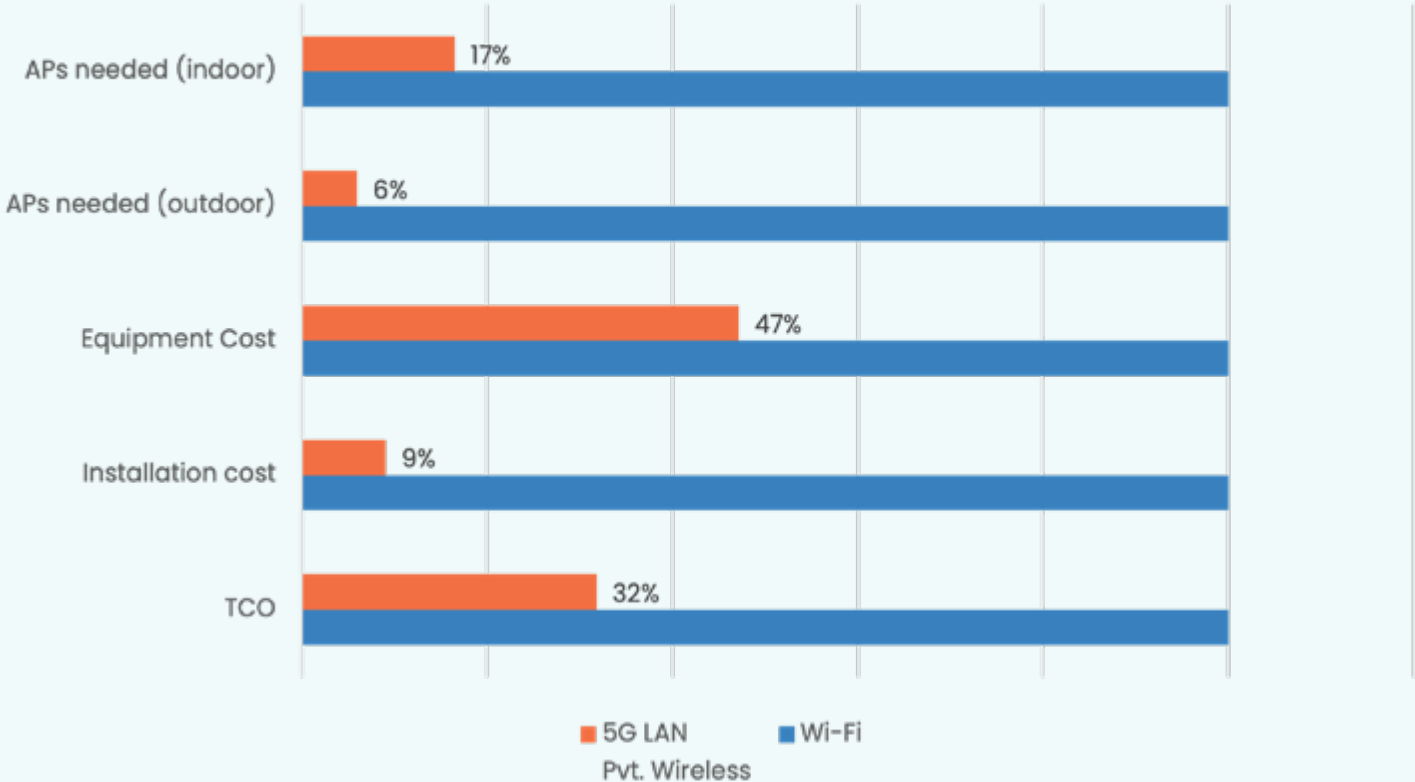
3-Yr TCO with >95% coverage (Estimated)
Indoor ~775K Sq-ft, Outdoor ~561K Sq-ft



Summary of analysis comparing Wi-Fi and Celona 5G LAN private wireless

- Celona private wireless required only 17% of the Wi-Fi indoor access points and 6% of the outdoor access points
- For the same level of coverage, Celona private wireless equipment is 47% the cost of Wi-Fi and 9% the installation cost of Wi-Fi 6 and the TCO aggregating indoor and outdoor is about 32% of Wi-Fi
- Peak latency on the Wi-Fi loaded network is 5x-6x the latency of Celona private wireless

Comparing Wi-Fi and Pvt. Wireless
Based on data from an actual distribution center



Why use Celona 5G LAN for Private Wireless at Distribution centers.

The industry's only turnkey private wireless expressly engineered for the enterprise	<p>Celona 5G LAN delivers an end-to-end solution from the radio, core, spectrum management to network and subscriber management systems. It's built from the ground up to create the best possible Day 0, Day 1 and Day N experience for customers at a lower TCO.</p> <p>5G LAN Feature Brief</p>
Industrial strength private wireless designed for the most critical business apps	<p>Business critical apps need deterministic performance from wireless, but the exact requirements vary from app to app. Celona 5G LAN features MicroSlicing™ technology for deterministic performance for all your mission critical applications.</p> <p>MicroSlicing Feature Brief</p>
Tight integrations to secure all wireless communications	<p>A business-critical wireless network requires enterprise-grade security to protect against cybersecurity threats. The Celona 5G LAN solution extends the inherently strong security architecture of cellular networks such as support for eSIM, IMEI lock, with a tight integration between existing enterprise security systems to safeguard the network from edge-to-cloud.</p> <p>5G LAN Security Solution Brief</p>
Enterprise friendly management and operations	<p>Get unmatched simplicity and ease-of-use with Celona's cloud-based management system for deploying, configuring, and monitoring your private 5G network.</p> <p>Orchestrator Product Brief</p>
Global spectrum model support	<p>Support for a wide range of spectrum bands for LTE and 5G enabling its use in most parts of the world.</p> <p>Access Point Product Brief</p>
Device certification program eliminates guess work on compatibility	<p>Many popular devices used at distribution centers are certified to work with Celona private wireless:</p> <ul style="list-style-type: none">• Zebra: TC26, TC58, TC78, ET45, ET85, L10 Series tablet• Honeywell: CT47• Getac: ZX10, F110G6• Digi: EX50 iX10• Sierra Wireless: RV55• Cradlepoint: R500• MultiTech: MultiConnect rCell 600 <p>See full list of certified devices</p>

5G LAN for Distribution & Logistics

Leverage private wireless to combat spotty coverage, unreliable QoS, mobility issues, inadequate security and increasing network costs.

[See how Celona is changing warehousing](#)

hello@celona.io | celona.io

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