

Distributed MIMO saves money in Private 5G



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MOBILE EXPERTS

In the frantic environment of a busy warehouse, time is money. Automating the warehouse, then, requires attention to detail. Let's look at the impact of choosing different kinds of wireless networks for various warehouse scenarios.

This white paper examines three wireless options: we consider a Wi-Fi network, a typical Private 5G network, and a Private 5G network using Distributed MIMO technology. (D-MIMO). In all three cases, we look at the cost of deploying and operating the network over three years, plus the cost of downtime to the warehouse itself. We've chosen some scenarios as an illustration, but you can try this cost modeling for yourself; contact [Globalstar](#) for a copy of the calculator tool.

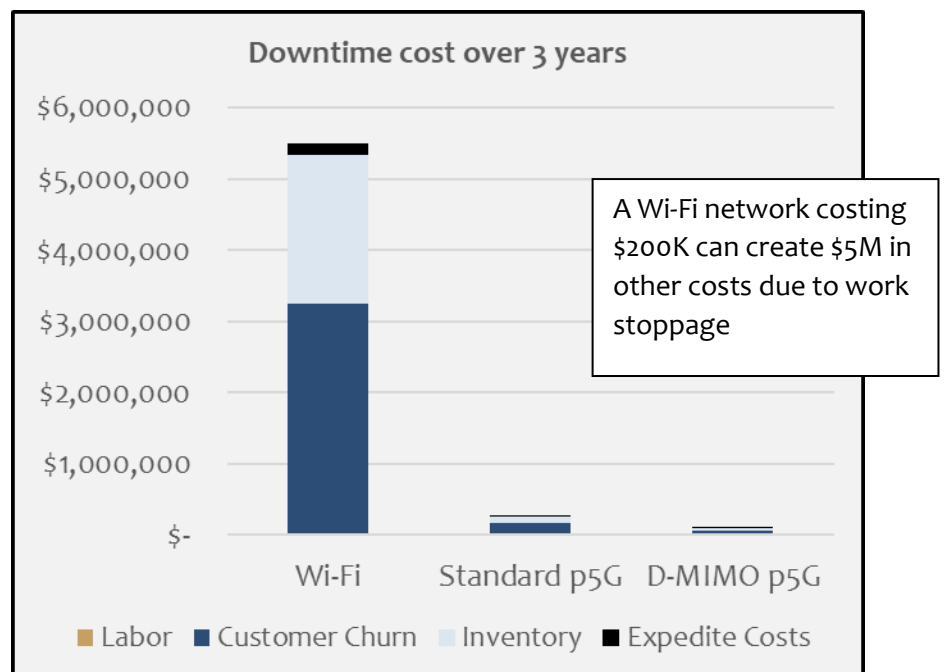
Technology Background

Wi-Fi networks are absolutely everywhere. They fill an important role in connecting human users with information. Human users are very forgiving. A short delay or an occasional mistake is hardly noticed...at least for browsing social media and streaming videos.

Wi-Fi networks are not a good match for sophisticated automation, especially in an environment like a warehouse with hundreds of Automated Mobile Robots (AMRs, or 'bots'). In a complex environment like this, the fundamental nature of the Wi-Fi protocol allows interference to exist in the network. Peer-reviewed testing shows that even in well-configured Wi-Fi networks, roughly 2% of packets will experience a delay more than 50 milliseconds.ⁱⁱ This is true for multiple generations of Wi-Fi, due to the basic "open" nature of the Wi-Fi protocol.

Many industrial users are turning to private 5G instead. A typical private 5G network reduces the number of "late packets" to about 0.1%,ⁱⁱⁱ due to the closed and controlled nature of 5G. This can be improved even more with private 5G networks that use Distributed MIMO (D-MIMO) technology, which sends and receives radio signals from multiple antennas at the same time, reducing the impact when one path is blocked. A private 5G network with D-MIMO can reach a "late packet" rate of 0.04% or even lower.

This comparison is key, because a series of late packets can result in a warehouse robot stopping in its tracks. One lost packet is typically tolerated by the 'bot', but when radio conditions block one packet, a string of consecutive packets can often be late. The resulting traffic jam in the warehouse can be a nightmare, with staff running around in a frenzy to reset one 'bot', and hundreds of other 'bots' unable to move.^{iv}



The Cost Impact of Downtime

Mobile Experts built a cost-comparison tool to evaluate the impact of AMR “traffic jams” in a variety of warehouses. The impact is huge! For a 200,000 square foot warehouse with 700 ‘bots’, the Wi-Fi network can result in more than 90 minutes of downtime every month, costing more than \$180K in idle labor, inventory carrying costs, expedite fees, and customer churn.^v Imagine trying to explain to an angry customer that your automation breaks three times every day!

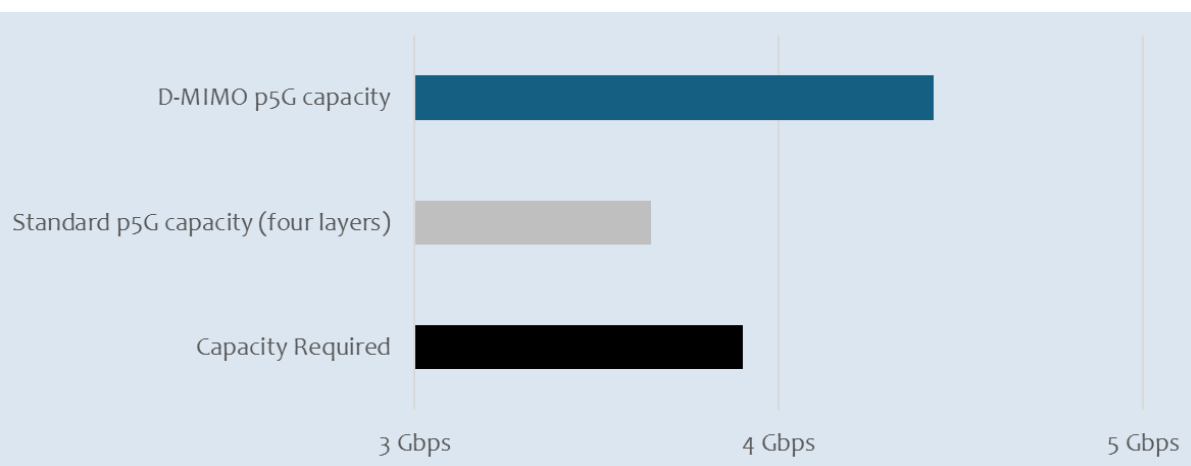
With private 5G, on the other hand, downtime from a stalled ‘bot’ can become a rare event, and the monthly cost can drop by 98%.

Capacity is Important

D-MIMO helps to make the 5G radio signal even more reliable, and it adds capacity through better coordination.^{vi} A typical private 5G network involves many independent radios that re-use the same frequencies, creating a level of self-interference in the network that is managed very carefully. But D-MIMO coordinates the traffic among all of the radios covering a typical warehouse building so that every radio bit is “signal” and not “interference”.

Consider a 100,000 square foot warehouse, with 780 ‘bots’. Each ‘bot’ streams video at 5 Mbps to the control center, so almost 4 Gbps of capacity will be required. The warehouse can be covered with:

- 50 Wi-Fi APs;
- 52 standard private 5G small cells (or 26 dual-band small cells); or
- 16 D-MIMO dual-band private 5G small cells.



In fact, for a high-density warehouse with more than about 750 ‘bots’, standard private 5G solutions can become impractical without resorting to mm-wave bands. Most available small cell products have limited capacity, both in terms of the bandwidth and in the number of connections possible.

In the end, the D-MIMO solution can be well suited for high-capacity scenarios with large numbers of devices.

Real-world uplink performance

Distributed MIMO: 34 bps/Hz

Standard 5G: 5 bps/Hz

Conclusion

The cost of downtime in warehouse automation can far outweigh the cost of the network itself. And some 5G small cells are optimized for simplicity and coverage, not capacity. Warehouse owners should be very careful in choosing the right wireless approach to support their automation initiatives with the highest possible return on investment.



“D-MIMO can improve both reliability and capacity, making D-MIMO the best way to ensure smooth AMR operations.”

Joe Madden, Mobile Experts

ⁱ Cover image courtesy of MIR.

ⁱⁱ Performance statistics from Segura, et.al. in IEEE Access: An Empirical Study of 5G, Wi-Fi 6...in Indoor Industrial Scenario <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10538029>

ⁱⁱⁱ https://vbn.aau.dk/ws/files/311896874/AAU_wirelessMES_implementation_and_evaluation_VTCFall2019.pdf

^{iv} Latency sensitivity info from Omron AMR technical guide: https://files.omron.eu/downloads/latest/manual/en/72503-100_amr_wireless_communication_technical_guide_technical_manual_en.pdf?v=2

^v Labor cost refers to the idle labor during an AMR shutdown. Customer churn assumes that 1% of shutdowns result in a lost customer. Inventory carrying costs reflect 1% of inventory value per month. Expedite costs refer to rush delivery costs to ‘catch up’ after AMR shutdowns.

^{vi} Capacity calculation for D-MIMO based on Signals Research benchmark study: *The X Factor: A Third-party Benchmark study of the Xcom-Labs' XCOMP Solution*, Signals Research Group, February 2024

^{vii} Image courtesy of Omron