



Sponsored by



Retail Edge Supplement



Shopping for the retail Edge solution

INSIDE

Can retailers buy the Edge networks they want?

> Are Edge network providers ready to satisfy retailers' needs?

How retail giant Ahold Delhaize embraced the Edge

> After a sprawling collection of IT assets took over its back office

Droning on

> How drones and last-mile delivery interact with the Edge



Retailers Need a Fast, Flexible Edge

Be ready for new trends and customer needs.

The idea of retail has evolved from having a single brick-and-mortar shop to encompassing the breadth of the supply chain, multiple outlets, and an online presence. Whether you're adding a couple racks at a single store or scaling operations to new locations across the world, plan your retail Edge deployments with the flexibility you need. Trust Vertiv for reliable critical infrastructure that can manage operations across all spaces and keep you abreast of your customers' existing and emerging needs.

What's Your Retail Edge?

[Vertiv.com/WhatsYourEdge](https://www.vertiv.com/WhatsYourEdge)



Sponsored by

Contents



4. Can retailers buy the Edge networks they want?

The retail industry can be demanding customers. Are the Edge network providers ready to satisfy their needs?

10. How retail giant Ahold Delhaize embraced the Edge

After filling its stores with a growing collection of incompatible IT

12. Energy at the Edge

If the retail Edge is to succeed, a horde of sensors and handheld devices will need to be powered without breaking the energy bank

14. The last mile: At the Edge with drone delivery

How drones and last-mile delivery interact with the Edge



4



10



14

Shopping for the future

Retailers have been disrupted by technology, with the Internet undermining traditional business models.

Now, retailers are taking back control, bringing modern IT onto the shop floor.

Bringing the Edge to retailers offers a whole new host of opportunities for the commerce sector, but brings with it a set of technical and human challenges that have to be carefully addressed.

Networking at the Edge

Retail locations were chosen for foot traffic and ease of access, not with connectivity in mind.

That may cause a problem as shops embrace the Edge. Retrofitting sites for the coming data explosion begs the question - can Edge network providers satisfy the needs of retailers?

The answer to this challenge may lie in partnerships between different retailers, Edge providers, and networking companies - but retailers need to be ready to invest in the infrastructure to support this change (p4).

Getting Ahold of the Edge

One company that has shown a willingness to invest in its digital infrastructure is Ahold Delhaize.

The Dutch retail giant found itself in control of an ever-growing pile of incompatible and outage-prone IT equipment that took up more and more valuable shop-floor and inventory space.

Over a period of several years, the firm replaced all of its equipment with a single two-thirds size set of server racks.

Then it had the even harder challenge of upgrading the IT of its subsidiaries, which includes Albert Heijn, Food Lion, Pingo Doce, Mega Image, and Giant Food.

Building a single system to work across myriad different sites proved a challenge, but a focus on cost-cutting paid dividends (p6).

The Edge sustainability challenge

Data centers are struggling to reduce their power demands on the grid as nations turn against further deployments.

While the industry has made an admirable effort to improve facility efficiency, the Edge risks disrupting that progress as economies of scale are lost.

To combat this are a whole slew of new ways of generating electricity, including low-light solar cells, piezoelectric systems, and even algae systems.

At the same time, liquid cooling and other lower-energy solutions may be necessary to ensure dissipating heat doesn't cost the Earth.

Such systems could prove crucial as Edge deployments begin to grow faster than traditional data center rollouts (p10).

Droning on and on

Look! Up in the sky! It's a bird! It's a plane! It's a drone delivery!

Should such a cry become commonplace, the world may soon be buzzing with drones diligently delivering retail packages to customers.

But such a future will require intricate coordination between flying objects at low latency. That means turning to the Edge (p13).

Can retailers buy the Edge networks they want?



Peter Judge
Global Editor

The retail industry can be demanding customers. Are the Edge network providers ready to satisfy their needs?



Retailers may be one of the definitive Edge computing use cases, as organizations based around sales are crying out for tech that can make them more responsive.

Networks of stores are distributed across the world, with goods in transit between producers, warehouses, shops, and users' homes. Meanwhile, increasingly demanding customers want to buy flexibly, wherever they are, using any device they are holding.

All this is precisely the set of benefits promised by the Edge.

"In Edge, we talk about bringing content to the last mile of your company," says Henk Iispeerd, EMEA key account manager for retail at Vertiv. "In retail it's slightly different we want your IT environment close to everything which you want to support."

But can Edge infrastructure really deliver the benefits it is promising, to retailers who are a fully distributed market sector with established ways to handle their own customers?

The answer seems to be that it is possible, but Edge is forcing operators into a massive overhaul of the underlying networks - while they also have to establish new ecosystems by which those networks are accessed.

A big opportunity

Edge covers masses of markets alongside retail, and telecoms consultants STL predicts that the total addressable market for Edge computing will grow to revenues of \$543 billion by 2030. But getting there won't be straightforward

"There are numerous commercial and technical capabilities that will need to fall into place for Edge to be realized," says Tilly Gilbert, a principal consultant at STL. "It could be that a complete rethink of the network will be needed to enable Edge computing."

Some things won't change, including a lot of traditional racks, says Anders Vasquez, telco segment director cloud & service providers at Schneider Electric: "Everything that is related to Edge, that will support the IoT and the devices at the Edge, needs to run in a data center."

But the networks delivering the Edge will divide into two kinds: "Edge data centers will be located in two types of sites - on-premises Edge, owned and operated by end users, and the network Edge, which is mostly owned and operated by service providers.

"It's a brand new dynamic, with private, public, and hybrid networks deployed under the two models. So some customers are deploying their own physical infrastructure, and they are also able to support and deploy their own private networks," he explains: "At the same time, we have service providers going after infrastructure-as-a-service type of solutions to deploy brand new networks."

Of these two, on-premise Edge deployments have probably matured faster, as they can develop somewhat in isolations, but the service providers will have to catch up, says Gilbert: "[On-premise deployments] provide a tactical opportunity to get involved in Edge computing, at least in market forecasts to 2030, but it's use cases running at the network or regional Edge that are driving the majority of the demand."





New tech, new architectures

Edge networks will include new technologies such as 5G, and fresh ecosystems, says Vasquez. "It is not going to be just about the service providers that we normally work with. It's not anymore about telcos only, it is about a lot of different players. But that's not because we're changing the world. It is just because the ecosystem is evolving."

Steve Schechter, head of network architecture at the CDN player Akamai, says: "We're seeing decentralization, pushing the envelope closer to the Edge, being at the closest customer termination or customer aggregation point, whether that's in the cable or fiber head-end facilities, or a mutual building that's within proximity. We're deviating from the original playbook of how the Internet connects around carrier hotels, and pushing all that infrastructure deeper and closer."

But retailers may not get those benefits immediately. The change may have caught operators on the hop, and at least until recently, they simply could not offer all the connection points retailers needed, says Schechter: "Each country has its own unique topological challenges, and many operators just weren't positioned to accept connectivity closer downstream by the user."

"[On-premise deployments] provide a tactical opportunity to get involved in Edge computing, at least in market forecasts to 2030, but it's use cases running at the network or regional Edge that are driving the majority of the demand"

Some providers simply didn't have aggregation termination points or peering routers where the customers need them, he says: "All they had was their backbone infrastructure that would get traffic from the user up to a carrier hotel."

"Throughout the US in more regional markets, the MSOs [managed service operators] just weren't there. Their network wasn't designed to have those ingress points."





"We're seeing decentralization, pushing the envelope closer to the Edge, being at the closest customer termination or customer aggregation point, whether that's in the cable or fiber head-end facilities, or a mutual building that's within proximity. We're deviating from the original playbook of how the Internet connects"

This is changing, he says, and some MSOs actually want to meet retailers in more distributed locations: "We are seeing more MSOs amenable to interconnecting closer, or actually flat out requiring it, saying 'Hey, if you want more connectivity, stop meeting us in those, traditional top locations. Meet us here in this new space.'"

New meets the old

The new technologies, new locations, and new alliances are all happening alongside existing applications.

Old-school hardware-centric applications are still needed, running in data centers on premises, while the new applications are all cloud-based, where network functions run on a network layer constructed from virtualized servers.

That creates a worry for Vasquez. While doing all that, "how we can manage the older lower latency type of application?"

At one stage, telcos thought they had a ready answer in their central offices (aka telephone exchanges), says Gilbert: "Originally, there was lots of discussion about telecoms operators refurbishing central offices to make them into mini data centers and use them to support Edge functions and distributed network functions.

"But more recently, there's been pushback around that, with people saying these sites were never been designed for this, it would require significant effort to refit and refurb, and it may not be as economically viable as looking at new sites."

Schechter agrees: "Repurposing can sometimes be difficult, so it's just easier to greenfield something than try to squeeze into a brownfield deployment. Frankly, if you reuse some legacy central office facilities, you're penetrating into only

one network, you don't have the reach of multiple networks."

In densely populated areas, it's viable to put resources close to end users, says Schechter: "But in some of the more sparsely populated locations, you have to have a hub and spoke strategy you have compute in a more centralized location, but maybe build your own fiber networks."

The push to partnerships

In the end, not all stores will get great access, if they don't have the customers. Gilbert says: "There has to be a business case for investing in this infrastructure. You can't just expect to be building at sites all over the place, if there isn't the customer demand and the genuine need for this sort of performance and security."

If one provider can't justify it, they may share, says Vasquez: "We're noticing a lot of different players going after this. What we have here is that at the end, we will have a couple of different Edge players, that will be looking to work in some kind of revenue-sharing model as a business case."

He explains: "If they own the fiber optics, or the physical connection, or the spectrum, they need to monetize that investment. But at the same time, they potentially didn't have the money in order to deploy a micro data center every 50 kilometers in order to support the Edge."

Koch agrees: "In this innovation phase, partnerships are critical. But they must figure out what the benefits to the end customer are, because people don't buy technology, they buy benefits."

How will it all play out? Koch thinks it is early days: "It's still so early, that everything is really still evolving, I think we're really a way away from figuring that out. And so time will tell. ●



The Retail Edge



Henk Ijspeerd
Director of
Key Accounts,
Vertiv

To see the acceleration of digitalization firsthand, you don't need to look any further than your favorite store. Technology is embedded in nearly every touchpoint, from the time you walk in to when you walk out with your purchase or make a return.

Retail has been on the forefront of technological advancements for years, and now, consumers have higher expectations than ever before. [According to a 2021 survey](#), 65% of consumers want the ability to scan items in a store to see product details on their phone and 50% expect contactless payment. One-fifth want to be able to try on clothes using "virtual mirrors" that rely on augmented reality.

These applications rely on edge computing, and they are seen across the retail landscape. We're seeing growth at the edge in restaurants, big box stores, grocery stores, and even retail distribution centers. Edge computing is becoming central to modern retail strategies, but those edge resources look different depending on the application.

Vertiv's report, [Edge Archetypes 2.0: Deployment-Ready Edge Infrastructure Models](#), can help us better understand the retail edge so retailers can deploy resources faster and more cost-effectively.

Superstores

The modern "big box" superstore is at the forefront of brick-and-mortar modernization and IT adoption.

The focus on the consumer experience is everywhere — from the visible IT applications like curbside pickup, in-store apps, and mobile coupons to unseen applications like the omnipresent distributed antenna systems for managing mobile demand, local 5G networks and, like it or not, the technologies to track consumer behavior.

Many superstores rely on the Micro Edge to support these applications: small, standalone solutions that range in size from one or two servers up to four racks. Each store location might have its own on-site IT infrastructure to reduce latency and provide the storage needed to collect and use customer data.

Grocery Stores

Grocery stores have quickly emerged as the front line in digital transformation.

COVID-19 made curbside pickup and contactless checkout mandatory options for every grocery store.

Plus, click-and-go technologies and streamlined point-of-sale interactions are absolutely vital to the customer experience.

The pace of change in retail, whether in a large warehouse, a small restaurant, or something in between, will only continue to accelerate.

These technologies have driven the need for more sophisticated on-site computing resources. Similar to big box stores, grocery stores function at the Micro Edge. Each store likely has its own uninterruptible power supply (UPS) system for backup power, rack for physical security of servers, and thermal management system to keep servers cool.

Visibility and monitoring also become critical, since even the most progressive supermarket chains don't employ on-site IT staff at each location.



Restaurants

The pandemic pushed the otherwise “play it safe with technology” restaurant industry into the IT Age. Integration with various delivery apps became a priority, and contactless payment technologies were required when everything shifted to a takeout-only model. Now that in-person dining has re-emerged, restaurants have integrated QR codes for menu access, new ordering platforms, self-serve kiosks, and health screening technologies to ensure customer safety.

Today’s technology-enabled restaurants exist at the Micro Edge. Even more than in supermarkets and superstores, floorspace in restaurants is at a premium. Kitchens are cramped already, and the front of house depends on every table for revenue generation. Squeezing IT systems into existing facilities requires creativity and equipment designed for such small quarters and challenging conditions.

Retail Distribution Center

The retail model is shifting with distribution centers increasingly acting as the hub of a multi-channel approach to customer service and fulfillment. The modern retail network relies on computing to increase efficiency

and speed, reduce costs, and enhance the customer experience.

Today’s distribution center may look familiar — the warehouse might be bigger and the activity more intense — but look closer and you see edge computing systems that manage inventory and logistics, use artificial intelligence (AI) to bridge gaps created by ongoing labor shortages, and manage demand from customers around the world.

Distribution centers rely on infrastructure both large and small, including a Distributed Edge Data Center to provide the compute needed to keep critical IT functions running across a large space. Warehouses also may deploy Device Edge, where the compute is located at or even within the end device. In this case, the IT hardware may be fully enclosed within pieces of equipment in the warehouse. These smart devices allow data to be collected and transmitted on pieces of machinery within the warehouse to optimize operations and provide visibility.

Each of these locations is often supported with a Distributed Edge Data Center — a small, sub-20 rack data center situated at the enterprise site close to the stores that can filter and aggregate data from across locations, sending only the necessary information to

the cloud. The largest retailers may also rely on a Regional Edge Data Center, which is typically a multi-tenant data center with more than 20 racks, purpose-built to host compute infrastructure.

The pace of change in retail, whether in a large warehouse, a small restaurant, or something in between, will only continue to accelerate. At the same time, building edge infrastructure that is unique to your organization can be a complex and daunting task. Our experts at Vertiv can help explore your needs and recommend [tailored edge solutions](#) for meeting today’s demands and preparing for future growth and evolution at the edge. ●



How retail giant Ahold Delhaize embraced the Edge



Sebastian Moss
Editor-in-Chief

After filling its stores with a growing collection of incompatible IT

Ahold Delhaize had a problem. Across thousands of stores in Europe, its IT footprint was getting out of hand.

In a single store, one could find a server for its own internal applications, another for external parties and checkout counters, yet one more for self-scanning devices, still more for the car park management system, firewalls, and further infrastructure for public and private Wi-Fi.

And that's just in Delhaize's own self-branded stores. After decades of mergers and acquisitions, the company has numerous subsidiaries and franchises, including the US-based Food Lion, Giant Food, and Stop & Shop.

"Some of these franchises might have an affinity with IT and have bought the latest, greatest beautiful servers, in a high availability setup, and others, were still running 12-year-old servers, using them as a coffee plate, and sometimes spilling coffee over them," Johan Pellicaan, Scale

Computing VP and MD for EMEA, said in a DCD>Inside Retail & Logistics panel.

The result was a lot of finger-pointing between different vendors and divisions when something went wrong, extended downtime, and security concerns.

Ultimately, however, Delhaize could not just simply get rid of all the troublesome IT and move it all to the cloud.

"We need IT because some of our applications in the stores needed to have an Edge computing solution because of





the design of the application," Delhaize's IT infrastructure manager, Frédéric Paulet, explained.

"And because of the latency - if you talk about POS (point of sale), and people are scanning items on our cash register, then you need to have a very fast time of response. So we had to choose to keep all the applications running in the store."

Rolf Vanden Eynde, manager of network, strategic infrastructure, at the Dutch company, added: "Delhaize needed to rapidly deploy resilient in-store infrastructure to support existing workloads as well as new data and processing-intensive initiatives such as cashier-less checkout and customer safety and security measures."

Facing this challenge, Delhaize called on the tech community for help. After a lengthy tender process, Delhaize settled on a solution codeveloped with Scale Computing and Lenovo, which would go on to win a DCD Award in 2021.

"The concept is very interesting - what Delhaize has created is what they call the '1-Box,'" Pellicaan said. "Basically it's a complete, integrated, system with three servers and a firewall."

He continued: "They use off-the-shelf two-thirds rack servers, which was a key element also because it helped Delhaize to save space. And they have physical switches in there."

For the system, the company moved from a physical firewall to a virtualized one offered by F5 Security.

"Some of these franchises might have an affinity for IT - others were still running 12-year-old servers, using them as a coffee plate, - and sometimes spilling coffee over them"



AFTER

After an eight month trial at a limited number of stores, Delhaize in 2018 began to roll it out across the hundreds of stores that carry its own brand name. Then, in 2020, came a much greater challenge - trying to get it to work with the thousands of myriad franchise stores around the world.

In many cases, space was even more of an issue, with a two-thirds rack still too large. The team also realized that there was no need to have a traditional server, because there was no one on-site who could service or replace it anyway.

"As a result of this, the 1-Box Level Two came out," Pellicaan said. "And that contained a number of new elements."

Notably, it shifted to the Intel NUC platform, essentially a tiny PC crammed into a small, contained box. "It basically means a completely new way of thinking about service and setup," Pellicaan explained. "It's specially designed. I would say, for the Edge where size is important."

"And when one breaks, we just put a new one in and send the other for warranty exchange. It's a very easy setup, completely different, which makes the life a lot of people filled with much fewer headaches."



BEFORE

There are other benefits he rattles off - lower power usage, fewer material emissions given the smaller size, and cheaper shipping.

These were all critical factors in deciding to take this approach, Delhaize's Paulet said. "We are always driven by the cost, that was really the main point."

This cost-cutting focus also meant that the Level Two when back to physical firewalls.

"F5 was an expensive solution and also it needed people with a good knowledge, and it was really a mess to find people who are able to manage the solution," Paulet recalled, adding that there were also issues where the virtual machine went down and took the service offline. "So we looked for another solution, looking for something cheap, then cheaper, and cheaper."

They settled on a Fortinet virtual firewall, but then noticed that the physical version was even cheaper. It also allowed for another cost cutting measure - removing the two switches found in the Level One, and just using the physical firewall.

"The two drivers were cost and stability," Paulet said.

The new One Box is now making its way through Delhaize's sprawling network of retail outlets, bringing a modern Edge to some stores that date back to the 1800s. ●

Energy at the Edge



Peter Judge
Global Editor

If retail becomes more digitized, will that break the energy bank? Maybe not, if stores share energy with the grid, and Edge devices learn to power themselves

Edge computing is praised as the next big tech wave, in which tiny data center resources are placed close to where data is produced and consumed, so new applications such as the Internet of Things, can have the benefit of low latency and fast response times.

The Edge is supposed to revolutionize retail, with applications that could include smart mirrors, personalized interactions with customer smartphones, and other innovations to improve the customer's experience in the shop.

If a shop wants to deploy these applications, it will need to have small cabinets of IT resources locally, in the building close to the retail floor, so that for instance, personalized adverts can be sent to a customer while they are still close to the product.

A lot of Edge debate has focused on the practicality of providing enough network connectivity to provide this kind of application. But this approach might be missing what could be an even bigger issue: power.

"One of the challenges of the retail Edge is

power," says Henk Ijspeerd, EMEA key account director retail, at Vertiv. "If you don't have power in the store, then it's dark. People can't pay, nothing will work, and nothing will be done - and you have a responsibility to get people out safely."

The problem gets more extreme in modern self-service stores: "You'll see in the UK and Germany, there are already on demand stores where no people are available," he says, "This is growing rapidly - so power becomes more and more important."

Becoming an energy store

Power also becomes something a high-tech store can offer to customers, Ijspeerd suggests: "When you park your car, the store will identify you. Your car will be charged in front of the store because that's one of the added values of the grocery store."

And the store also has a role to play in using stored energy to help the local energy grid, he says: "If the grid is not strong enough to support everybody, the stores can be an important player. They can store energy from windmills, they can store energy from solar panels, to support the grid supply."

"The store UPS can deliver a nice solid sinus for the grid," he says. "It's very stable"

Getting into energy storage is not just altruistic, he continues, but a way to deal with urban regulations: "For instance it's not allowed to install diesel generators in the big cities anymore - and if you're not allowed to install diesel generators, imagine the grid failing. Your fridge will warm up and then you can throw away everything. It will be hundreds of thousands of euros of food per store."

Stores will install energy storage modules, says Ijspeerd. "And the modules can be for the store itself - but also for grid support, and electric car charging. I see this already in some countries, and it will happen everywhere."

"Knowing that the grid is getting more unstable, they have to take action," he says.

The first sign this is happening is stores buying larger UPSs, says Ijspeerd: "It's increasing. From 1.2 to 1.7 MW, it's moving up. I already see some stores where they really do energy storage. They do not get enough power from the grid, so they build these energy blocks where they store the energy to support to create parts."

Centralized data centers are already being criticized for their energy demands, with some states like Ireland and Singapore placing strict limits to the number of facilities which can be built, to make sure that data center energy demands don't derail the governments' plans to decarbonize.

Edge resources do not replace any of these centralized facilities, they are in addition to them. So for instance, A retail organization will still need its back-end applications running in the cloud or an in-house data center, while Edge applications operate on top of that.

And while each individual data center, or IoT device may have a small requirement



for energy, these applications envisage such vast numbers of tiny modules, it is clear that the Edge will add up to a considerable demand for energy, and authorities will have to address this.

“At the Edge, deploying 100,000 data centers, each consuming 10kW of power would create a power consumption of 1,000MW for the IT energy alone,” says Wendy Torrell, senior research analyst at Schneider Electric.

That works out at around 10TWh for the IT, and the total power could go up by as much as 50 percent if we assume a PUE of 1.5.

Edge-centric IT

The actual construction of Edge facilities is going to have a big impact on all this. When ASHRAE, the influential American Society of Heating, Refrigerating and Air-Conditioning Engineers, looked into Edge facilities, it found that before energy could be addressed, there were other considerations, including the reliability of the systems.

Edge data centers are in small boxes which open directly to the outside air, instead of climate controlled buildings, so they are vulnerable to dust dirt and temperature extremes.

“Many items that are non-issues for brick and mortar data centers are real issues for small Edge data centers,” says Jon Fitch, a data scientist and lead author on ASHRAE’s bulletin about building Edge capacity.

Some in the industry reckon there’s a single answer to the problems of energy and dust and dirt: liquid cooling.

Liquid cooling enables a small rack of equipment to operate without the need for air conditioning, and since the equipment is immersed, it doesn’t experience airborne dust.

“Liquid immersion is particularly well suited for Edge facilities in harsh environments,” says James Weynand of GRC, pointing out that liquid cooled units “are self-contained, improve security and protect sensitive IT equipment from dust and other hazards.”

In other words, liquid cooled Edge resources will actually fit in better in the retail environment, because they won’t hit the customer with heat or noise.

Device energy

Beyond the energy used by the Edge data center resource (or cabinets, as they will probably be) Edge has another issue. All the sensors and devices that connect to Edge applications will need to be powered.

Some applications suggest instrumenting a vast amount of the things about us, and

they don’t necessarily consider how those sensors themselves will get their power to operate, and to transfer data over wireless networks.

In the retail environment, large stock items could be instrumented, or pallets of goods, to make sure that they are moved to the right places, and are not exposed to extreme temperatures or other environmental dangers.

Most people start with the idea of powering these sensors with batteries - but this brings big problems. Batteries only store a finite amount of energy - and that means they have to be replaced. If IoT sensors are going to be cheap enough to deploy everywhere, then that precludes having staff on regular callouts to change the batteries

Retail staff are already stretched far enough, without asking them to spend large parts of their day changing batteries on stock pallets or warehouse shelves.

The most obvious source of device energy is solar, and items like roadside equipment are often fitted with a solar panel that meets its power needs almost indefinitely.

Retail Edge equipment that is outdoors could be instrumented with solar-powered sensors.

But light harvesting doesn’t have to rely on direct sunlight. Amazon has invested in Ambient Photonics, a company that is working on low-light energy harvesting photovoltaic (PV) technology.

It says it can harvest energy across the entire light spectrum – including both artificial and natural light.

The Amazon funding will help Ambient build a factory for low-light solar cells, that could produce millions of units per year. “The future of IoT and connected devices is energy harvesting, and that future requires massive scale,” says Ambient CEO Bates Marshall.

Ambient is proposing remote controls that don’t need batteries. The same technology could offer barcode scanners or credit card scanners that never need recharging.

There are other options, including mechanical energy. Devices in a vibrating environment can collect almost 150mW per square centimeter, converting it to electricity with the piezoelectric effect.

So sensors on a production line might just be powered by a noisy environment. Meanwhile, wearable devices, such as smart badges for employee location, might also pick up enough power from our restless movements.

Thermal energy is another possibility. Some sensors placed in hot or cold environments, to monitor the performance of ovens or fridges, could generate power

from the very temperature differences they are measuring.

The thermoelectric effect would let them convert some of that heat energy into electricity.

The Edge must power itself

In the end, the stark reality is that energy use is becoming a crucial factor everywhere. If the Edge can’t power itself, its deployment will be delayed or blocked.

Devices must operate with ambient power, and Edge cabinets will have to keep to a minimal power budget - so capacity running at the Edge does not use masses more energy than equivalent resources in the cloud. ●

Your devices could run on algae

It may sound unlikely, but Cambridge University scientists have run an electronic device for more than a year, fed only by sunlight and water.

An Arm Cortex M0+ sat on Dr. Paolo Bombelli’s windowsill for six months, powered only by algae growing in a glass vial of water no bigger than a AA battery.

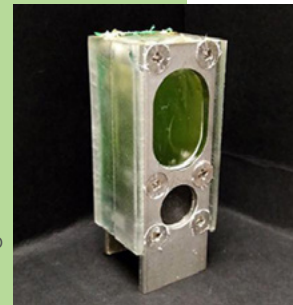
The device consumed 0.3MW performing integer sums for 45 minutes each hour, with 15 minutes of rest during which it consumed 0.24 microWatts on standby.

“We were impressed by how consistently the system worked over a long period of time – we thought it might stop after a few weeks but it just kept going,” said Bombelli.

The system kept going at night, because the algae built up energy reserves with photosynthesis to consume when there was no light.

The researchers believe the algae directly produced electrons, as the anode in the system had no visible corrosion.

One major benefit compared with an actual rechargeable battery is the system used no expensive minerals like lithium. It’s been calculated that IoT devices can’t all use lithium batteries, as there is simply not enough lithium produced in the world.



THE LAST MILE:

At the Edge with drone delivery



Dan Swinhoe
Editor

How drones and last-mile delivery interact with the Edge



While the use of robotics and Edge computing for the likes of machine vision is becoming increasingly common within the confines of retail stores and distribution warehouses, the machines are also coming to your front door. Luckily they're usually bearing gifts like cups of coffee.

Autonomous last-mile delivery – whether via terrestrial wheeled robots or aerially via drones (aka Unmanned Aerial Vehicles, or UAVs) – are predicted to be a major growth industry in the coming years, with household names in the eCommerce and logistics spaces getting in on the action.

Creating the necessary compute and connectivity conditions for robots in a controlled store or warehouse is relatively easy, but is the wider Edge infrastructure ecosystem ready for the household arrival of packages delivered autonomously from the sky?

Drone delivery takes flight

Far from a future use case, drone delivery is actively being tested by a host of major

names. According to Emergen Research, the drone delivery market will reach \$18.65 billion by 2028. Established delivery giants FedEx, UPS, and DHL are exploring drone delivery, as are startups including Matternet, Zipline, Flytrex, Flirtey, and Wingcopter.

Cloud giants with large infrastructure footprints to both train and communicate with drones are also interested in the space. This year saw Amazon announce that Lockeford, California will be “among the first” locations in the US getting access to the company's Prime Air drone delivery service. In March 2022, Google's parent company Alphabet announced its drone delivery service Wing had reached 200,000 commercial deliveries.

Most drone delivery operations are still restricted to a geographically small area while trials are ongoing and regulations catch up. But, from a hardware point of view, UAVs are a relatively mature technology; on-board compute modules are able to do at least basic collision detection & avoidance and autonomous route planning, even on simple consumer devices.

When it comes to on-board compute and connectivity for commercial operations

above the general public, redundancy and safety are key considerations, according to Alan Hicks, CTO of Dublin-based Manna Drone, says.

“Because we're flying over people, we need to be obviously highly redundant. On our craft at the moment, we've got eight motors, two motors on each arm so if we lose a motor we can still fly.

“We've got multiple batteries. So if we lose a battery, we can still fly. We've got multiple flight control systems and sensors. So we've got three GPS sensors. We've got three flight controllers.”

Founded in 2018, the company operates a drone delivery service in Ireland using its customized Manna drones.

Following a trial phase in Moneygall, a small village on the border of counties Offaly and Tipperary, delivering medical supplies and groceries to the elderly isolating during Covid-19, the company is now running a delivery operation in Balbriggan, a suburb of Dublin home to around 40,000 people. The drones are currently able to carry a payload weighing up to 2kg.

Drones: rugged Edge nodes connected to the cloud

While it's not a rugged server in the traditional sense, Manna drones are designed and customized to be 'workhorses' with high flight time (one might even say uptime) and high redundancy.

"At this moment in time in the world, you can't just go out and buy a reliable aircraft. The drones that are used for non-critical items like delivery, they're just not built to the same spec. They don't have the same level of redundancy.

"A typical drone that you would buy for either hobby or even doing inspections and things like that, might fly for a few hours a month. Our aircrafts are flying up to 12 hours a day, it's a different level in terms of what they need to operate at. And they need to be kind of workhorses."

The drones have four on-board compute modules that do different levels of processing for flight control and LiDAR sensors.

"Compute is definitely not a blocker for us," says Hick. "At the moment, there's not a very high level of processing needed – we have a LiDAR sensor but we don't build a full point cloud and it's low-compute – and it's more about reliability, which is why we have so many modules."

Currently, the company is a heavy user of AWS for all of its non-aircraft operations. As is common with most AI use cases, machine learning models for things like collision avoidance are trained in the cloud and a smaller agent is placed on the drone itself once trained.

"There are two kinds of collision avoidance: Strategic deconfliction, which is you pre-plan your flight strategically based on the known snapshot of the sky. And then there's tactical deconfliction which is essentially on-board or very close to on board and real-time reaction, for example, if a bird flies into it, or a drone that isn't registered, or is somewhere it shouldn't be.

"We do a lot in the cloud, particularly in terms of route planning and route optimization, because they tend to be bigger calculations that we do off-board, and so we can strategically deconflict all of the aircraft that are in the sky."

As the company rolls out its services more widely, Hicks acknowledges the company may have to roll out more infrastructure in different locations to ensure low latency communications, but still envisions the company remaining in the cloud.

"For latency, we will definitely have a local regional instance for each area because we want to cut down the latency where possible," said Hicks. "At a country level would be fine,

certainly initially, and then we [might] have to go further."

5G: the killer app of last mile delivery?

Currently, Manna drones rely on 4G/LTE communications to connect the drones to the company's cloud-based route planning portal. The drones use two independent hardware LTE modems utilizing two different operators, again for redundancy purposes.

While Hicks says the company isn't relying on 5G, the wider roll-out of the technology could help with network management, and in the future potentially change the equation around on-board and off-board processing.

"4G is sufficient for what we need today, but 5G would obviously open up a lot more potential for us, just in terms of dedicated bandwidth, and managing the network will be a lot more straightforward over the 5G network," he says.

"We love doing things on board because it de-risks things. But, 5G might make comms ultra-reliable, which means we can move some of the compute off. Some of what we do needs to be based on where we're going to be flying the drones and if they've got the infrastructure to support what we want to do, we can always pivot a little bit.

"It's not a blocker for the industry at the moment, but the faster it becomes the norm, the faster we can move where we do our computing.

"If you have 100 percent reliable comms, you can do it off-board because you know you can react fast enough [to potential collisions events] because the sensors are good enough that they can pick up aircraft quite far away."

The Edge might be ready, but regulation & air traffic control are still in development

While the company is currently within the confines of its Dublin suburb, it aims to expand across Ireland and into the rest of Europe and the US by 2023.

The company is currently limited in its operational area by the fact drone operators are required to have a visual line of sight (VLOS) with the machines at all times, even though they are flying autonomously.

Though moving to allow UAVs to fly Beyond Visual Line of Sight (BVLOS) has been high on the agenda of drone operators for years, regulators have still been slow to make the change, though trials to allow this are being conducted.

Another aspect that needs solving – that will be a combination of regulations,

commercial cooperation, and technical competence – is air traffic control for drones.

"One of the things that hasn't been fully solved yet in the drone world is how that airspace management is going to work. And there are lots of companies working together to figure out that problem and to do it in an equitable way and in a federated way."

Though many companies will have internal tools – known as Unmanned Aircraft System Traffic Management (UTM) – to manage their own operations, the industry and regulators are yet to agree on a common system that can span a whole country with multiple parties.

"There's questions that need to be answered. If we're delivering something and the police need to come through in a helicopter, and we're delivering something and another company is delivering something at the same time, who gets priority?"

While current air traffic control is largely predictable and something that can involve people to accommodate short notice flights or diversions, a future where there are potentially thousands of drones flying short distances at regular intervals – Hicks says most of Manna's flights last around three minutes – means a more automated system needs to be developed.

"The volume that can be pushed through is going to require full automation. With drone-based inspections at a wind farm etc, routes can be pre-planned three or four weeks in advance, and that route can be plugged in via a very similar way to how manned aviation is done.

"But the reality of drone delivery is somebody places an order, and three minutes later they're getting their delivery. You can't pre-book that flight, you can't pre-flight plan when it's such a short duration."

The FAA currently maintains nearly two dozen Air Route Traffic Control Centers (ARTCC) across the US that provide air traffic control services to manned flights. It's still unclear how a wider automated UTM system would play out, but it would likely also require a central compute cluster controlled by the regulating authority and a number of regional Edge nodes to maintain order in the skies.

On the human side, Hicks seems confident people are ready to accept drones once they see their usefulness. Despite the often negative headlines around drones – scare stories about drones at airports are regular tabloid fodder – he says people can acclimatize to drones remarkably quickly once they are in operation in an area.

"A few weeks after we're in a town, it's just normal, and people don't look up and it just becomes part of daily life. It becomes boring, which is the way we like it." ●



Seamlessly Deliver Amazing Shopping Experiences

Your retail offerings continue to expand so that you can innovate and meet customer demand. Secure and reliable Edge computing is now a must-have to enable your inventory management, collection of customer buying and behavior data, and e-commerce efforts. Rely on Vertiv, the critical digital infrastructure provider that has been supporting retail companies for more than 50 years.

Simple, reliable Edge infrastructure that is easy to deploy and maintain in all your retail locations.

What's Your Retail Edge?

[Vertiv.com/WhatsYourEdge](https://www.vertiv.com/WhatsYourEdge)