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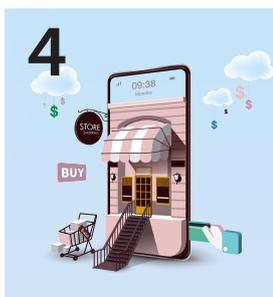
All change in shops

Shopping is a basic social activity, but it's changing fast, hit by multiple revolutions, in e-commerce and in-store technology. We've rounded up the most important and far-reaching retail transformations of 2020 and 2021.

Pandemic reaction
During 2020, the Covid-19 pandemic struck. Shops shut and people started ordering online.

Suddenly, all the predictions of the death of the Main Street came back - and this time, maybe they would come true (p4).

The reality is more subtle, of course. Our best guess is that shops will continue to exist, but will go to extremes: either offering speed and no fuss, or else a leisurely hands-on experience where you get time to make sure you're getting exactly what you want.

In-store automation
Point-of-sale (PoS) systems have been getting smarter for some time, of course.

Grocers have moved to automated checkouts and self checkouts. CCTV has been connecting to inventory and other systems (p10).

These may be specialist systems, but they fall into a generic sector. They need low-latency technology able to handle data locally without depending on the cloud. Retail can learn a lot from Edge computing developed for other applications.

But as change takes on a new urgency, retailers have to decide: do they invest more to compete for the remaining shoppers, or let them go elsewhere?

Goodbye to cashiers?
There's another option. Why not take automation the whole way, and do away with cash, tills, checkouts, and anything which delays the customer from getting their goods and leaving?

It's the highest of high-tech solutions. These outlets bristle with cameras, and customer convenience is provided by a level of surveillance which would give privacy campaigners conniptions.

And cashierless shops would simply not be happening, if Amazon weren't pushing the idea with its Go outlets. If the giant succeeds, everyone else will need an answer (p12).

Smarter service
Before we go think of going cashierless, all retail outlets are using increasing amounts of data, with activities empowered by ever-smarter AI.

If you want to serve your customer, it pays to know what they want - before they know it themselves, if possible (p6).

All change for robots
Finally, automation is increasingly taking on the physical work of shopping - but robots are no panacea (p14).

Warehouse robots make great use of space, and play well with online commerce. In 2020, one Austrian manufacturer took a gamble - and, for his product, the odds were in his favor (p16).

Elsewhere, robots can check shelves, but do we need that now?

And while we all wait in for parcels that never come, the biggest retail question of the year could be: where are the delivery droids?

The state of retail

Shops have shut, people have stayed at home, and the whole world has moved online. *Sebastian Moss* looks back at a year of retail change

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Sebastian Moss
Deputy Editor

It's been difficult."

Physical retail has proved to be one of the sectors hardest hit by the ongoing Covid-19 crisis. With government-mandated lockdowns, well-founded concerns about transmission, and the declining global economy, shop footfall has declined precipitously.

The crisis has changed consumer habits, forced an industry to redefine itself, and left an opening for new businesses to emerge. To understand the crazy year we've just gotten through, and what the future could bring to retail, we caught up with Jack Stratten, senior trends consultant at retail analyst firm Insider Trends.

"A lot of stores have been locked down and shut," Stratten said. "That demand has gone to e-commerce."

Proclamations on the death of the main street in favor of the Internet go back all the way to before the Dot-com Crash at the turn of the century. But the reality is that e-commerce retail growth has been pretty slow, even in nations with high broadband penetration and strong distribution networks. Slow, that is, until the pandemic.

"E-commerce grew infinitely more quickly than anyone could have even imagined," Stratten said, as people both did not want to go to shops, and were finally at home to accept deliveries.

This has meant that retailers have had to adapt to a changing market rapidly.

"I think retailers have had to be innovative to make online shopping work, because they are suddenly doing three or four times more business online, to try and make up for holes in their physical sales. And they've had to evolve pretty fast and improve their supply chains. They've had to adapt pretty quick."

Part of that has simply involved hiring more delivery drivers, but it also meant rearchitecting existing stores as warehouses. For these dark stores, "I've seen a lot of brands making legal applications to basically chop stores in half," Stratten said. "And also, they're retraining front end staff to do that back end stuff.

"Interestingly, it's solving a problem for a lot of retailers, because shops being too big has been an issue for a long time."

However, depending on the country, getting permission to turn a retail space into a warehouse has been difficult. "That's not been straightforward. And some are still going through that."

Omnichannel businesses (ones with both online and store presence) "naturally could turn stores into fulfillment centers," Stratten said, giving them a leg up over online-only

> *"A lot of stores have been locked down and shut. That demand has gone to e-commerce. I've seen a lot of brands making legal applications to chop stores in half."*

shops - beyond those with massive delivery infrastructure like Amazon.

It has also meant that they've had to rethink who they are. "Traditional retailers have thought of retail as their shop," Stratten said. "And yeah, they might have a website and social media, but all these other things were almost just marketing. And that whole model is changing now in front of us - there's no middle, the shop isn't the center of it at all, it's anywhere."

This is again something that was slowly growing before the pandemic, with brands like Glossier harnessing huge social media followings to command massive direct-to-

Lessons from the makeup industry

Times of turmoil have the unintended side-effect of helping make fringe ideas more mainstream.

For retail, one of the surprise hits of the pandemic age has been augmented reality, Insider Trends' Jack Stratten said.

"Big influencers on YouTube are applying makeup through augmented reality, and they're partnering with brands to help sell product. And millions and millions of people are actually using this technology," Stratten said.

"That's been a big change, because augmented reality was something we talked about for years, but the growth rate has been small."

Suddenly the idea has actually become useful, Stratten argued. "People are realizing that it isn't gimmicky anymore."

This is part of the future of commerce, or as Stratten calls it, 'evolved commerce.' It involves "augmented reality, live streaming, social media," and all sorts of consumer interaction.

"You have to engage with the consumer where they are," he said.
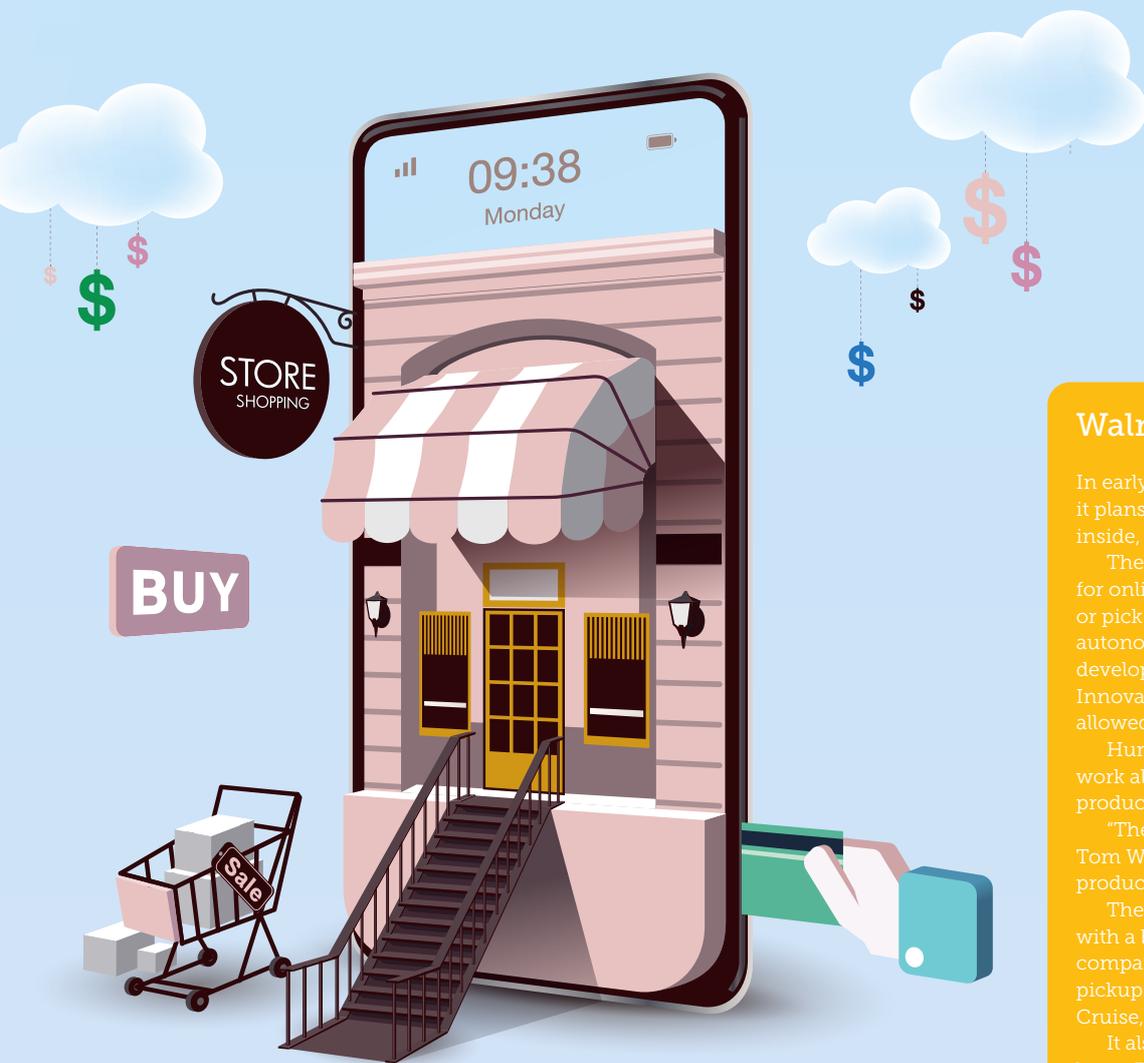
Walmart's warehouses

In early 2021, Walmart announced that it plans to build modular warehouses inside, or adjacent to, its main stores.

The new facilities will be designed for online orders - either for delivery or pick up. Each site will feature autonomous 'Alphabot' robots developed in partnership with Alert Innovation, with human shoppers not allowed to enter the sites.

Humans will, however, continue to work alongside the robots, picking fresh produce such as fruits and vegetables.

"The technology is impressive," Tom Ward, Walmart's SVP of customer product, said.

The company is also partnering with a bevy of autonomous vehicle companies to test out self-driving pickup. It has trials underway with Cruise, Nuro, Waymo, Udelv, and Ford.

It also uses cleaning robots powered by an Brain Corp AI system, cash counting machines called Cash360, and self-checkout machines.

consumer sales based on a carefully-built relationship with their audience.

But this means that a large number of companies may turn to selling their own products directly. That makes it difficult for retailers that only resell others' goods, without their own product lines.

"That's a real challenge," Stratten said. "They need to reinvigorate their online and offline space, they just need to be incredible spaces - either for convenience or something else." He pointed to UK retailer Argos, which has built a retail empire on being one of the quickest and most convenient places to get a variety of household items.

"But if you don't have what they have, which is a massive store network and the ability to just sell products cheaply, then it's very difficult, and that's why we're

seeing those kinds of brands struggle," he explained.

In the future, Stratten's company envisions two types of retail - slow and fast. Slow for those wanting a special experience, where they get to go hands on with a product, talk to an expert, and sample different versions. Fast, where they get what they want as soon as possible with zero fuss. "Anything in the middle will be lost."

The pandemic "has been a final nail in the coffin for average retail," he explained.

While those businesses will suffer, Stratten has a relatively positive outlook for retail as we slowly return to normalcy in the coming months.

"When shops opened up here in the UK between the two lockdowns in the middle of the summer, footfall recovered reasonably well," he said.

> *There will be two types of retail. Slow, where you sample different versions, and fast, where you get what you want with no fuss.*

"Across Europe, it was even higher. There were quite a few store openings in Europe in major cities. Some brands were still opening some interesting new spaces, footfall didn't plummet as much as people thought - basically, when people were allowed to get back out and go in shops, they did."

AI in Aisle six: How retailers are embracing artificial intelligence

Dan Swinhoe
News Editor

Artificial intelligence is driving massive change for retailers, especially in-store.
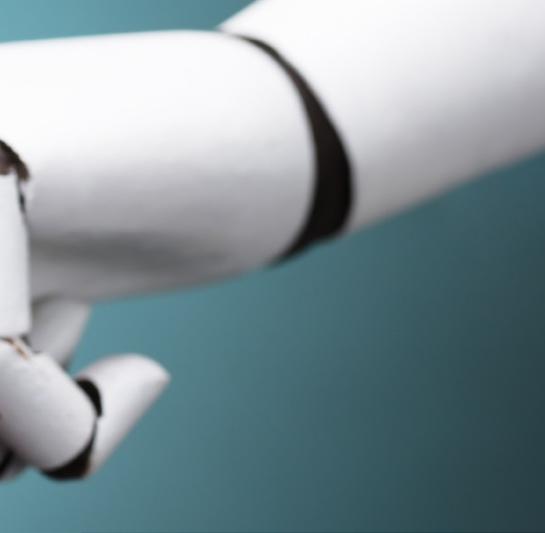
The Covid-19 pandemic made 2020 an apocalyptic year for many retailers. Local lockdowns forced the closure of huge swathes of retail stores, many of which have not reopened, and may never do so.

As we look forward to 2021 and beyond, firms must reassess how they approach both online and bricks and mortar. Many retailers look towards more investment in artificial intelligence to make shopping both online and in-store smarter.

Machine learning and AI were cited as the emerging technologies that would have the greatest impact in the industry over the next year, according to TotalRetail's 2020 Retail Technology Report. Other AI-enabled technologies, including automated checkouts, augmented reality, robots, and facial recognition also ranked as important. Global retailer spending on AI will reach $7.3 billion annually by 2022, according to Juniper Research, up from $2 billion in 2018.

Whether it's driving sales with recommendations and personalization, driving efficiency with robots or sensors, or offering new ways to shop and manage stores, AI is touching every part of the retail industry.

AI at the Edge of retail

Personalized recommendation engines have been a mainstay of shopping for years. There's a folk legend in data mining circles, which claims Target has such powerful data mining and analytics, it once recommended baby clothing to a girl before she knew she was pregnant. Sadly, it's just a myth, dating from a hype-filled 2012 *New York Times* report.

But while big data and AI use cases for online shopping are still largely based in centralized data centers, a growing number of use cases are seeing retailers embrace Edge computing and AI, both at the Edge and in the cloud.

Fulfillment centers are increasingly being used to automate warehouses in order to speed up deliveries and optimize space,

which can make supply chains and logistics more efficient. In-store, robots are being used to stack shelves and clean floors. Machine vision is being brought in to scan shelves and manage inventory, suggest fashion ideas to customers, and in the case of Amazon Go and other competitors, remove the need for cashiers and traditional checkouts. Robots, both in-store and in the warehouse, are becoming increasingly common, and sensors are being used to monitor key equipment for potential failures ahead of time.

Starbucks is rolling out smart coffee machines that are using predictive maintenance as part of the wider Deep Brew AI initiative that CEO Kevin Johnson has called a "key differentiator" for the future. Uniqlo developed an automated personal shopper that uses neuroscience to gauge customers' reactions to different outfits in order to recommend different items to suit their moods and preferences. Kroger has sensors to constantly track the temperatures inside cold and frozen food cases, sending store associates digital notifications if there's a mechanical breakdown or a door has been left ajar. From 2017 to 2020 Walmart used shelf-scanning robots to help manage stock levels (see p16).

While some of the data will be sent to the cloud or central locations, much of the important pre-processing will be done either on-site or at a nearby Edge site to reduce latency. And while many retailers aren't jumping all-in to the cloud for their main workloads, some will utilize the scale benefits of the cloud to train AI models, while many of their retail tech suppliers will be cloud-based to offset costs.

Automation comes to retail en masse

Even before the pandemic, the shift to online had already forced thousands of store closures and many large retailers out of business. Covid-19 has accelerated many of those challenges. And the stores that do survive may well see less room for human staff.

McKinsey predicts in-store retail roles could fall by 40 percent in the UK alone as a result of automation technology, while Juniper Research predicts that transactions using smart checkout technologies like Amazon Go will jump from $2 billion in 2020 to $387 billion in 2025. The firm suggests the bulk of transactions will be in small convenience stores owned by large retailers.

"To compete with ecommerce disruptors

who heavily rely on AI, traditional retailers must adopt AI rapidly to boost efficiency," said Juniper Research analyst Nick Maynard. "If they fail to do so, they will face a highly commoditized retail market with an outmoded, uncompetitive business model."

At the same time, McKinsey has noted a growing number of retailers launching smaller 'neighborhood' or pop-up stores, and highlighted the importance of using AI in order to create the right mix of tailored assortments to offer their local consumers more personalized shopping experiences.

Debbie Bowen-Heaton, partner at consultancy firm Oliver-Wight, says that many retailers - especially the large ones - already have enough data gathered from online stores as well as historical in-store purchases, but often suffer either a lack of urgency or ability to exploit what's sitting in their databases. Fashion, she says, is probably the furthest ahead in embracing AI and embedding it into the business to ensure agility.

"The larger retailers have got the economies of scale, they've got the resources," she says. "But the downside is that scale makes you less agile and they haven't got the ability to respond when things change fast, and it's probably a real frustration for them."

"The big opportunity is that a lot of retailers have data. They've got it, it's at their fingertips, but it's just about how they exploit it more. And for me that's the big opportunity, doing something with that data and really using it to drive your innovation. Not just new products, but services that really excite customers."

As a result of the push to AI, says Dave

> "A lot of retailers have data - but it's about how they exploit it. That's the big opportunity!"

Demlow, VP of product strategy at Scale Computing, retailers are turning to hybrid infrastructure models with a combination of Edge, cloud, and central IT.

"You collect the data locally and you probably do some pre-processing, but training AI models require large amounts of compute for very short periods of time and you can do that model training in the cloud," he says. "But then actually utilizing the model on-prem is a very, very common model for people who are looking at AIs or any heavy data-intensive applications."

Amazon brandishes AI

Amazon's ever-expanding retail empire and increasing moves into physical retail, plus the fact it owns the biggest player in the cloud

Kroger is another retail giant to prefer Azure (and GCP) over AWS, with its CIO Chris Hjelm saying at the time there's no reason "to help grow that business for them." The company later revealed a smart shelf created in partnership with Azure that enabled real-time pricing for items. Microsoft is also reportedly trialing cashier-less, checkout-free technology that it will offer to customers.

Oliver-Wight's Bowen-Heaton says she thinks a lot of organizations are going into denial about Amazon's presence across every sector of retail and are "paralyzed with fear." And while she acknowledges that partnering with Amazon may come at a cost, retailers have to act or face going out of business.

"You've got to make a choice; you either embrace it, or you fight it and make some kind of smart move, flank them," she says. "Embrace disruption, or be disrupted, or find a way to compete. Go find different alliances. But just to ignore it is probably to their significant disadvantage, which I think is what we're seeing."

AI in retail use cases

Mind-reading fashion:
In Australia, Uniqlo partnered with Isobar and Melbourne University to demonstrate an AI fashion booth that used neuroscience to measure customers' reactions to different designs and suggest items that suit the individuals' moods and preferences.

Smart coffee machines:
As part of its Deep Brew AI initiative, Starbucks is installing AI-enabled coffee machines to track what drinks are selling well in different areas, but also use predictive analytics for maintenance to detect failures before they happen.

Shelf-scanning robots:
Walmart tried Boosa Nova's shelf-scanning robots from 2017 to 2020. Simbe Robotics, Fellow Robots make similar systems. Pensa Systems offers a service that uses autonomous drones to sweep stores.

Inventory management:
Startups such as Opticrib are offering technologies to improve stockroom and warehouse management that monitors and updates inventory with reduced reliance on manually scanning barcodes. Other firms are looking to remove humans from the back-end completely and use robots to move items to where they need to be.

computing space, puts it in a strong position, especially when it comes to AI, and puts its retail competitors in an awkward position.

Jeff Bezos' company is already one of the biggest retailers in the world, driving a huge proportion of online sales. And its scale and direct access to machine learning expertise means that it can iterate quickly and experiment with ideas in retail technology, especially in the physical space. While its Dash buttons and barcode scanning wand failed to drive quick physical retail actions at home, its cashier-less Go stores have created a slew of competitors looking to utilize AI to create a walk-in, walk-out checkout-free experience (see page 12). As well as deploying this technology in its own stores, the company is offering it to the industry.

Scale Computing's Demlow says that few retailers have gone all-in on public cloud, partly due to the direct threat posed by the company.

"A lot of the retailers that we see and talk to are very cloud-averse," he says. "Amazon is just the arch-enemy of retailers, and no retailer I've ever talked to wants to put anything on Amazon."

Walmart has turned to Microsoft for its public cloud services, with the two companies acknowledging their mutual rivalries with Amazon and AWS were a factor in the agreement. Walmart has previously been reported as telling suppliers to move away from AWS as well. Target reportedly

"A lot of retailers are cloud-averse. No one wants to put anything on Amazon."

scaled back its investments in AWS after Amazon bought Whole Foods because it didn't wish to directly fund a rival.

Other retail companies face similar challenges on whether they should utilize technology that directly funds one of their biggest rivals, and last year Canalys reported Google Cloud Platform and Azure were both ahead of AWS in the retail and ecommerce sectors as a result of the conflict of interest.

"Due to this competitive aspect, many major retailers have opted to work with other cloud service providers," Canalys research analyst Blake Murray said.

Many retailers are looking to the other public cloud providers as an alternative. Microsoft offers similar level of capabilities for retailers in the cloud, and has made a number of moves directly appealing to the industry. And while Microsoft has dabbled in owning stores that sell Microsoft products, the Redmond company offers a way for retailers to adopt technology without the fear of funding a direct rival.

Visibility and Monitoring in an Omnichannel World

Retail took a quantum leap in 2020. According to eMarketer, ecommerce reached levels we didn't expect to see until 2022. For 2021, retailers will have to continue that innovation.

Consumers are buying in more ways than ever before: it's no longer about buying online or in brick-and-mortar stores. People are buying online and picking up in-store, often curbside or with contactless pickup, or buying in-store and returning online. And many retailers are using so-called "dark stores" as retail distribution to fulfill e-commerce orders.

We'll see those trends brought to life when retailers start integrating artificial intelligence (AI) across their omnichannel operations. AI can enable agility with more accurate supply chain forecasting, stronger meta-tagging in ecommerce and asset protection at self-checkout kiosks.

The retail sector's move to a more distributed set of technology services would be completely unworkable, without an overall upgrade that makes all the technology components visible and manageable - remotely. There are two main ways to make

sure you have the insight you need at all locations:

1. Visibility

Many retail IT sites are at the edge in storefronts, areas usually without tech support nearby or not intended to house critical infrastructure. With a large increase in employees working off-site, you need a line of sight into all the equipment that keeps your platforms up and running.

Take IT equipment that's housed in the stock room of one of your stores. Floor employees may have access to the space to restock items, but you need to prioritize minimal interference with the equipment.

Sensors and detectors can spot security issues and check environmental factors for IT equipment which is now installed on remote sites. When sensors work together, you're able to have a clear picture of your sites, while alerting you to threatening conditions.

Light sensors and motion detectors can monitor activity in the stock room, to let you

The retail sector presents extreme demands, and only a solid response will be adequate

know if a light has been left on or if someone has gotten too close to the equipment.

Because your equipment in the stock room is sensitive to temperature changes, an increase of even a few degrees can wreak havoc on the performance of your IT systems. So temperature, airflow, and humidity sensors can work together to alert you to any potential issues in real-time. Staying ahead of these issues can help you maintain a smooth shopping experience for your customers, no matter how they choose to shop.

2. Monitoring

A robust monitoring solution like Vertiv™ Environet™ Alert or Vertiv™ Geist™ Watchdog with environmental sensors allows you to act on temperature, humidity, and airflow data to ensure security, issue alerts, and fix problems as soon as they arise. That way, retailers can stay ahead of issues, avoid costly downtime, and keep customers satisfied with their purchase process and inform your own important business decisions. And monitoring plays a key role in ensuring business continuity.

The retail sector presents these demands in an extreme form, and only a solid response will be adequate. Vertiv can help you bring visibility and monitoring to your sites, to make sure you can meet your customers' needs.

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Dan Swinhoe
News Editor

Pushing retail to the Edge

The rise of online retail and the Covid-19 pandemic are driving store closures, so retailers need to get smarter about how they use technology at the Edge.

The Edge is the past, present, and future of the retail industry. While the Covid-19 pandemic has shifted the model, in-store is typically where retailers make their money, store their goods, and engage with their customers.

"The retail edges are the things that drive the company's revenue and so it's very very important for them to make sure that they are able to drive revenue continuously, and not have any kind of downtime," says Ezat Dayeh, senior systems engineer UK and Ireland at Cohesity.

But, as retailers look to adapt to the difficult commercial realities of Covid-19, the Edge is becoming an opportunity to consolidate old computing infrastructure to drive efficiency, but also embrace new high-data, low-latency use cases to improve customer experience.

Legacy Edge converges on new Edge
Stores have long been an Edge for the retail industry. Whether it's CCTV for security, control, and monitoring of freezers, or inventory management, each store has historically required some local compute capabilities. And while robots, machine learning, and autonomous stores garner much of the headlines, modern Edge computing is also being used as a way to centralize and increase the efficiency of legacy systems without moving everything to the cloud.

Cohesity's Dayeh says that in recent years virtualization has allowed retailers to consolidate what might have been multiple pieces of hardware into one piece of physical infrastructure. Where once the Points of Sale (PoS), network management, routers, firewalls, transaction processing might all have needed dedicated hardware, these have all been virtualized and condensed into one unit. This will often come in the shape of a tower server or a 1U server attached to communications infrastructure at the location.

"I could be running a hypervisor with multiple VMs on there, they might even have a small cluster. I've seen some retailers have things like hyperconverged clusters of maybe three nodes," he says.

However, as retailers look to evolve, they may move beyond consolidation and connect those Edge locations into a centrally-managed panel to drive greater efficiencies.

"We're seeing new applications being deployed at the Edge," says Dave Demlow, VP of product strategy at Scale Computing. "Some of them are AI-related or customer experience related, but some of them are more of what I would consider mundane things they've always done, like video surveillance, but they're now looking to kind of consolidate all this piecemeal IT infrastructure and treating remote Edge IT with a centralized management oversight."

> *"We're seeing new applications being deployed at the Edge, consolidated with central management."*

As the legacy Edge consolidates and retailers look to add new capabilities, the form factor for the infrastructure has to be reduced. Space is money in retail, and every inch that computing devices take up could be used to store or display stock.

"The smaller the better," says Dayeh. "In an ideal world, they have zero footprint. Everything is run on the PoS machines themselves and they communicate directly over some form of WAN straight to a data center, for example."

"We've had customers literally tell us this 'needs to fit in between the bananas and the freezers,'" jokes Demlow.

Companies are also looking to simplify computing as much as possible, and many Edge computing firms are looking at offer compute devices that require as little configuration as possible so the on-site employees only need to plug in the power and Ethernet cables. The aim for many retailers is to reduce the on-site visits from IT staff as much as possible and enable more remote management.

A hybrid infrastructure model

The Edge has always been a part of the retail industry's infrastructure model, but as the sector looks to stay ahead of competitors, the overall model is changing. Increasing use of AI and real-time supply-chains mean a hybrid model of Edge, cloud, and centralized data center is a common approach to accommodate data gravity and low-latency requirements.

"New applications are being written for hybrid Edge cloud operations," says Demlow, "where they need at least that on-premise ability to collect data, perform transactions, but going to upload to a public cloud or a corporate data center for that centralized operations and processing."

"We do see more retailers tend to look at a centralized data center versus going public cloud for that centralized piece where you aggregate things," says Demlow, "But application providers are delivering software as a service and using the cloud components to deliver that."

Another reason legacy Edge technologies are more likely to see themselves consolidated into smaller form factors than migrated entirely to the cloud is resilience. The Internet being down or being disconnected from the centralized data center doesn't mean it's OK for the store to stop working.

"Applications that are monitoring the freezer's temperature for compliance, those have to keep logging," says Demlow. "If the Internet connection goes down, critical things like PoS have to keep going, video surveillance has to keep going, and you must ensure access control door locks work.

That's usually the kind of the driving factor, because otherwise you could put it in the cloud."

"The worst thing you can do is have all these things in place and somebody walks into the store in an afternoon and our systems are down because the Internet connection is down, that's just not an acceptable answer in the retail space anymore."

Future use cases to drive this hybrid model include smart shelves and digital signage for dynamic pricing, applying more machine vision to CCTV, and more in-store personalization. For retailers, the Edge becomes pivotal in collecting essential in-store information, processing it, sending the aggregated information home, and then receiving instructions back and relaying to the right devices at the right time.

"The Edge is becoming really really important in the pivotal point of all of the data transfer," says Simon Pamplin, director of technical sales at Silverpeak. "Every bit of data has to go to the Edge, out to the cloud, or to a central location - and the intelligent Edge has to know what that traffic is and how to steer it.

"This is just the beginning of it. It will no longer be just devices that are going to be going through this Edge. There will be more integration to following the end-users so that we can give a better quality of experience to that particular user."

What's in store for 2021 and beyond?

An estimated 20,000 to 25,000 stores closed in the US in 2020, double the figure in 2019. While Covid-19 vaccines may be on the horizon, that trend will likely continue to accelerate. However, long term, the physical retail space looks likely to stick around even if it is less ubiquitous than in previous years.

In 2017, Farfetch CEO José Neves said brick and mortar accounted for 93 percent of sales and will still account for 80 percent by 2025.

Admittedly, the pandemic has likely accelerated a further shift away from physical retail, but in-store, sales are set to be around for a while yet, and what remains will likely be fewer massive retail spaces and more smaller, smarter boutique stores acting as drivers of online sales.

In its State of Retail in 2020 report, McKinsey noted a growing of retailers launching smaller 'neighborhood' or pop-up stores that offer personalized services and locally-relevant offerings where custom designs, highly-focused assortments, and experiential elements create more of a showroom than a full store with a whole range of products. The firm predicts retailers will need to utilize AI in order to

"If the Internet connection goes down, critical things like PoS doors and CCTV have to keep going."

create the right mix of tailored assortments for their local consumers.

"If I had a pop-up shop and I'm physically exhibiting some stuff, there could be some interesting capabilities around showing things using computers though and displays," says Cohesity's Dayeh. "Again having that centralized capability though means that I can update all of that on the fly as and when customers come in they can see the latest version of that particular product."

Cashierless checkouts in the shape of Amazon Go and its numerous competitors are set to grow. Juniper Research predicts that transactions using such smart technologies will reach $387 billion in 2025, up from just $2 billion in 2020. These stores will require much more computing at the Edge to process the large amount of data being ingested by machine vision and other autonomous technologies, before being aggregated and sent home to feed into what will need to be real-time supply chains.

"That's the ultimate retail where there are fully automated cashiers following you about the store and monitoring what goes into your basket," says Silverpeak's Pamplin. "That's almost taking technology to the nth degree of what we can do these days but it is the shape of things to come."

At the same time, smart kiosks and lockers from vendors such as Amazon, Cleveron, or Luxor One offer a way for consumers to collect items from physical locations that suit them, whether in-stores, public buildings, or properties, in a self-service manner.

Again, these smaller locations need to be monitored, managed, and embedded with the rest of the company's infrastructure in order to operate effectively. Retailers such as Uniqlo and Best Buy are investing in vending machines at similar locations to provide self-service shopping experiences and make them work.

As stores become smaller and smarter, retail firms will need to rethink how they approach what is processed at the Edge, what data is sent home, and what is sent to the cloud in order to serve customers that increasingly demand instant personalized services delivered to their doorsteps, neighborhoods, and screens.

Frictionless retail

Cashierless shopping requires tons of cameras, and even more compute to track everything

Sebastian Moss
Deputy Editor

We've been locked in an endless fight against friction. As a species, we just can't face waiting. Those in the data center industry know this - just think how many billions have been spent to stop things taking a whole second to load.

For physical retail, this quest to reduce friction is just getting started.

"It's really been a massive industry stuck in the past," Standard Cognition CEO Jordan Fisher explained.

"In ecommerce there's been innovation, and with omnichannel and curbside pickup ecommerce has begun to come into the physical world and meet you at the edge," he said. "But inside the physical world, there's

no innovation."

It's time to learn from ecommerce, Fisher argues. "Time matters. Friction matters. You don't even want a 200 millisecond lag, when you click a button, because it increases the chances someone's gonna walk away - we need to do the same in physical retail."

During busy shopping periods, waiting in lines to checkout can take minutes, "sometimes tens of minutes," Fisher said. "And retailers also make you work: With a self-checkout station, you're literally doing the job of the retailer for them. So you're waiting and then you're working.

"Everyone knows that this is not the way it's supposed to be. It just hasn't been technologically possible to eliminate that until now."

His company is one of a growing number

of firms looking to upend how we checkout in stores, with an aim of removing cashiers and allowing people to simply pick up items and walk out of shops. In an ideal world, those cashiers would be redeployed to different roles to help customers or handle stocking, but it may just lead to fewer job roles.

> *"You don't want to put an insane number of cameras on the ceiling because it can start getting intimidating."*

"I like to compare it to Uber or Lyft," he said. "You used to get into a taxi and you were thinking about the transaction - do I need to take out my wallet, etc. But now you get into an Uber and then you get out and you are transacting behind the scenes and not thinking about it. That's what we want to deliver for retail. Stores really start becoming like your personal pantry."

It's an idea that is simple in its pitch - let's remove this friction - but that is wildly complicated to pull off. You need to be able to understand who a shopper is, what they have picked up, what they have put back, and track them out of the store.

There are several ways to try to track everything, from biometrics, to sensors on shelves, to the Lidar more commonly found in self-driving cars. Standard Cognition relies on cameras - lots and lots of cameras.

"Cameras are constantly improving and getting cheaper," Fisher said. "We're just using off-the-shelf cameras, there's nothing special about them. We strive for what we call triple coverage, we try to have three independent perspectives of any part of the store that we care about.

"That said, you don't want to put an insane number of cameras on the ceiling because it can start getting intimidating. So we do try to be judicious."

All of that camera data - terabytes per store per week - has to be crunched with advanced machine learning algorithms. "Certainly, as we get up to 10,000 stores over the course of a year, you're looking at a lot of data."

Much of this processing, and all of the long term storage, is done on the cloud. But the company also has an on-premises Edge system. "Currently it uses Nvidia GPUs, and it does the heavy lifting - and is where most of the expenses are," Fisher said.

"It's running processing for every single camera for every single frame, figuring out what's happening, merging that together into a cohesive understanding of the entire scene."

The idea is to be able to recognize items when they are picked up, and track them all the way out of the door. When the picking-up action is blocked by the person, the system instead looks at the shelf to see what is missing. For some items, the difficulty is not in recognizing the product, but instead the version - a large and a small chocolate bar look incredibly similar, for example - and for this the company relies on zoom lenses in addition to the wider lenses.

To identify a customer, without turning to biometrics like facial recognition or palm prints, Standard just uses the phone in someone's pocket. Users have an app with their details, and when they leave, it sends them a message with all the items it's worked out that they have bought.

"Behind the scenes, we're communicating with your phone and trying to work in collaboration to figure out 'okay we're gonna go in and charge you for the Slurpee that you're grabbing at the convenience store.'"

All that data could also prove useful to retailers for item stocking, as well as for pickers who are paid by the likes of Instacart to fetch produce for others. "We know, down to the centimeter, where everyone's standing and where every item is. So we can start doing routing in stores and saying to pickers 'here's the fastest way you're going to get through the store to get those 27 items that you're looking for.'"

This potential goldmine of data will also be stored in the cloud. Standard chose Google for cost and AI reasons - and importantly, because it's not arch-rival Amazon.

"Most retailers don't want to work right with their biggest competitor, and there are horror stories from past retailers that have partnered with Amazon," Fisher said. "They ask which cloud provider we use, because they won't work with you if it's on AWS, because they don't want a single one of their dollars, even if it's indirect, to go to Amazon."

It's this sentiment that also reassures him that his business won't be swept away by Amazon Go, the Seattle company's very own cashierless initiative that it is trialing in its own stores, but also hopes to sell to other retailers.

Given their fears over simply using Amazon's cloud, it's debatable how many retailers will freely hand over their shopping processes to the company. Instead, Standard and a bevy of rivals hope the threat of Amazon's competition will encourage those retailers to use their competing platforms - ones that ideally will work from shop to shop.

But that still leaves the possibility open for the other two major cloud providers to step into the ring. Both Microsoft and Google have retail customers, AI chops, and buckets of money. Plus, neither inspire the same level of loathing amongst retailers.

"Google and Microsoft are both investing heavily into retail and its analytics through cloud solutions. They both recognize that it's a massive market," Fisher said. "What they haven't done, though, is turn their AI engines towards retail in this sort of computer vision way."

If they did, though? "I don't want to say I'm scared of Microsoft and Google. But certainly, if they entered the space with a mature technology platform, then I would be... well, we still have a great team, we've raised close to $100 million, we're over 100 people."

Should it turn into a head-to-head fight between tech giants and startups, the crown may go to the company that best solves that initial pitch: Zero friction.

"It's common to wait a few minutes after you leave the store before the receipt gets to you. And we're always working on reducing the latency ahead of our competitors, we're always going over to Amazon Go stores and making sure we're measuring their latency. I think this is going to be a constant arms race over the next couple of years."

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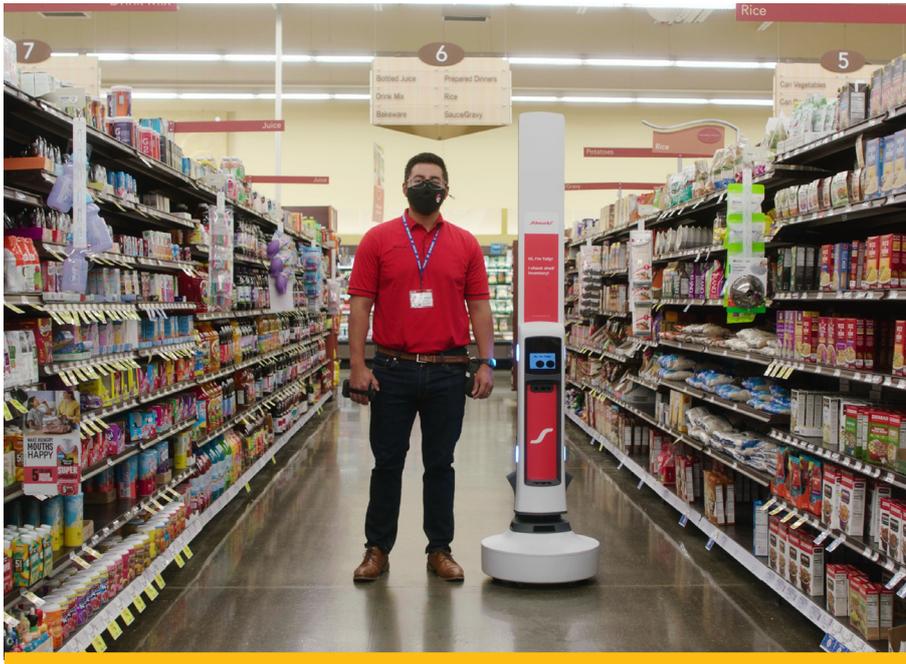
Not the droids you were looking for?

The last year saw a retail revolution - but not the one that technologists had been predicting. It's left some technologies parked in places they weren't expecting

A lot of commentators like to say that 2020 saw years of digital transformation telescoped into a short period, as users were forced to go online and forego traditional interactions such as going to the shops. But that's a simplification.

Take retail and the use of robots and automation, for instance. We've been promised a variety of robots in retail settings, but it seems that, during the pandemic, some retailers found some of the droids weren't the ones they were looking for. While some robots are thriving, others have actually been made redundant by the pandemic.

Digital transformation is almost always a shift away from real-world services to digital ones, and a major driver is the reduction in human staff. This can involve increasing web interactions, and using automated assistants.

"This past year has illuminated the need

for better data across the retail supply chain, especially on retailers' shelves," said Brad Bogolea, CEO and co-founder of California-based robot maker Simbe, adding: "The pandemic has accelerated the adoption of autonomous technology to keep humans safe."

Robots come into play because they can be more capable than humans, but some argue their cost-effectiveness is also effectively compensated by the tax systems our businesses work within.

Government taxes can be a system of reward and penalty which has unintended consequences. In this case, robotization taxes treat humans as a cost, and technology as an asset. In her book Doughnut Economics, economist Kate Raworth argues that robots become a must-buy because of "perverse tax policies which charge firms for hiring humans (through payroll taxes) and subsidize them for buying robots (through tax-deductible investments)."

In retail, the biggest digital

transformation process is not based around robots, but the closure of brick and mortar shops, as commerce shifts online. During the pandemic, this did indeed speed up, but we also saw a move to curbside collection and click-and-collect from stores.

This change had interesting consequences for the different classes of robots in the evolving ecosystem which serves our commercial sector.

Automated warehouses

Online ordering means a lot more items will be sent directly from warehouses to the customer by post or courier. This means warehouses handling a lot more individual items and turning into what Amazon has dubbed "fulfilment centers". Robotic warehouses have come into their own in 2020 as they enable staff in those warehouses to fulfill more individual orders.

These retail robots are not semi-autonomous mobile creatures. The most developed warehouse systems treat the entire building as an organism. In its guts, a set of moving parts acts as a mechanical "digestive system." Stock is ingested in a loading bay, sorted into bins that fill the three-dimensional space of the building. Mobile trolleys on a grid floor pick the products and take them to dispatch where they are labeled automatically.

The process is vastly more efficient. For Giesswein, a woolen shoe maker in Austria, an automated warehouse enabled a shift from shops to the post: "The whole business of shoes is old. 80 percent was done by stationary shops," he told us. Covid changed everything, and with the help of an automated warehouse, the company now sends 80 percent of its stock to online customers (see Soft Sell p9).

This story is not unusual, and similar warehouse systems are emerging elsewhere, but the field is fiercely competitive.

In the UK, Ocado began life as a delivery firm associated with Waitrose grocery stores, but became a separate retail company and eventually morphed into a technology provider. Ocado Technology develops systems including automated warehouses, and the Ocado Smart Platform online shop system.

As well as running automated warehouses for its sibling company Ocado

> *"The pandemic has accelerated the adoption of autonomous technology."*

Retail (part-owned by Marks & Spencer), the company has supplied its Ocado Smart Platform to customers including Sobeys in Canada, Casino in France, and Kroger in the US.

Ocado has bought two US robotics startups, Kindred Systems and Haddington Dynamics. At present, however, Ocado is being sued by Norwegian automated warehouse firm AutoStore for alleged patent infringements. Neither company wanted to speak to *DCD* for this supplement.

Stock checkers

There's another category of retail robot that has been less well-served by the pandemic. In the last few years, some pioneers have experimented with robots that move along the aisles, checking stock levels and tentatively attempting to help with customer inquiries.

These robots tend to be tall and thin, moving on a Roomba-like base, and equipped with sensors to detect people and avoid collisions. Simbe's Bogolea described his company's Tally stock-checking robot to *DCD*: "Tally is slim and narrow, making it easy for shoppers to maneuver around it,
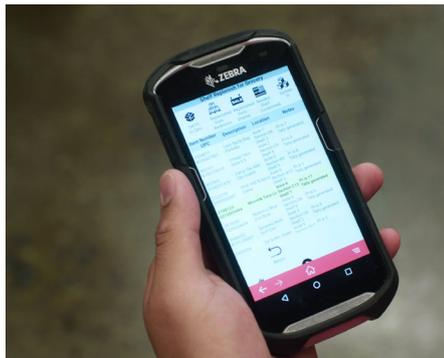
"Warehouse robots are designed to be dexterous like a human hand, able to pick and move products."

and Tally has great manners, always giving shoppers the right of way."

A robot's look depends on its function, said Bogolea: "Warehouse robots are designed to be dexterous like a human hand, able to pick and move products. Because Tally's function is to operate in stores and scan inventory, it is designed to be shy and non-threatening, able to work harmoniously alongside store teams and shoppers."

Also in California, Lowes has tested the Lowebot, developed by San Jose's Fellow Robots, a sort of mobile kiosk which rolls around the store checking stock. Customers can use a touch screen or microphone to ask it where to find things, and then follow as it leads them to the right aisle.

Giant Food Stores and Stop & Shop used another pillar-shaped bot named Marty.

But despite Bogolea's optimism, there are some signs that it might not be working out. In 2017, Walmart started rolling out BossaNova shelf-scanning robots to 500 of its stores - but the Wall Street Journal revealed in November 2020 that it had dropped the robots.

It seems that the pandemic, and its ensuing boom in online sales, had put these robots out of a job. During the pandemic fewer customers visited the shops in person, relying instead on staff to make up their order for them. As staff walked the aisles collecting orders, they performed the stock

checks and the robots were redundant.

This might be more than a bump in the road for in-store robots: BossaNova has laid off half its staff in response to the setback.

But Bogolea thinks the click-and-collect boom won't hurt Simbe: "Tally's real-time product location and availability data is instrumental to store teams, helping them more quickly replenish store shelves and fulfill online orders. Schnuck Markets [a US grocery chain] provides Tally's product location and availability data to grocery pickers, enabling them to more quickly find items in-store or make a replacement if a specific item is out-of-stock."

Delivery droids

There's a final corps of robots looking for work in retail, and that's the delivery droids. These can look like diminutive electric vehicles or, for the more adventurous retailers, could be drones taking to the air.

In Australia, Domino's has tested the idea of delivering pizza with a robot vehicle called the Domino's Robotic Unit (DRU). The company says its plan is to use GPS data kindly provided over the years by its human drivers, to replace them with an autonomous vehicle. Domino's has also promised - and even tested - a drone-based airborne delivery unit.

One could call that a prototype, but a more honest description would be a stunt.

More realistic is the FedEx SameDay Bot, announced in 2019, and now called Roxo. It's a box on wheels, designed to climb up and down curbs and get packages to their destination. It's not a road vehicle and is street-legal in seven US states.

Amazon has a smaller unit called Scout, which is already making deliveries in four US states, and is reported to be preparing for launch in the UK.

However, there's one thing that makes it clear these are still not ready for widespread use. 2020 saw a huge rise in demand for deliveries, and a pandemic that suddenly turned the job of delivery driver into a dangerous frontline occupation.

If anything could turn delivery robots into a winning use case, it was the pandemic. If delivery robots were ready to go, we would have seen platoons of them taking to the streets, bringing supplies to sheltering humans.

The fact that we have not tells us that these droids aren't really ready yet.

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