THE DRONE DELIVERY REPORT

OPPORTUNITIES AND CHALLENGES FOR RETAILERS AT THE FRONTIER OF DELIVERY

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KEY POINTS

- **Drone delivery offers tremendous benefits in the form of cheaper, faster shipping.** In particular, drone delivery can help companies smooth the incredibly time-consuming and expensive “last mile” of delivery, the last leg of a package's journey before it reaches the consumer.

- **A wide range of companies are testing drone delivery to learn how they can leverage those benefits.** These include e-commerce companies, legacy retailers, logistics providers, and tech firms.

- **There are two main types of drone delivery these players are exploring: home drone delivery and supply chain delivery.** Although home drone delivery receives the bulk of public attention, using drones to make deliveries within the supply chain can smooth out the fulfillment process and increase efficiencies.

- **However, there are significant regulatory and technology barriers that will postpone mainstream adoption of drone delivery until after 2020.** Barriers include regulatory hurdles, consumer acceptance, and technical issues related to ensuring safe and reliable delivery by drone.

- **Mainstream adoption of drone delivery will take place in stages over the next few years as regulations are put in place and drone technology improves.** Right now, most tests are extremely limited in scope, take place in rural areas, and do not actually deliver packages to customers’ front doors. These tests will gradually progress, eventually bringing drone delivery to more customers in populated areas.

Download the charts and associated data in Excel »

INTRODUCTION

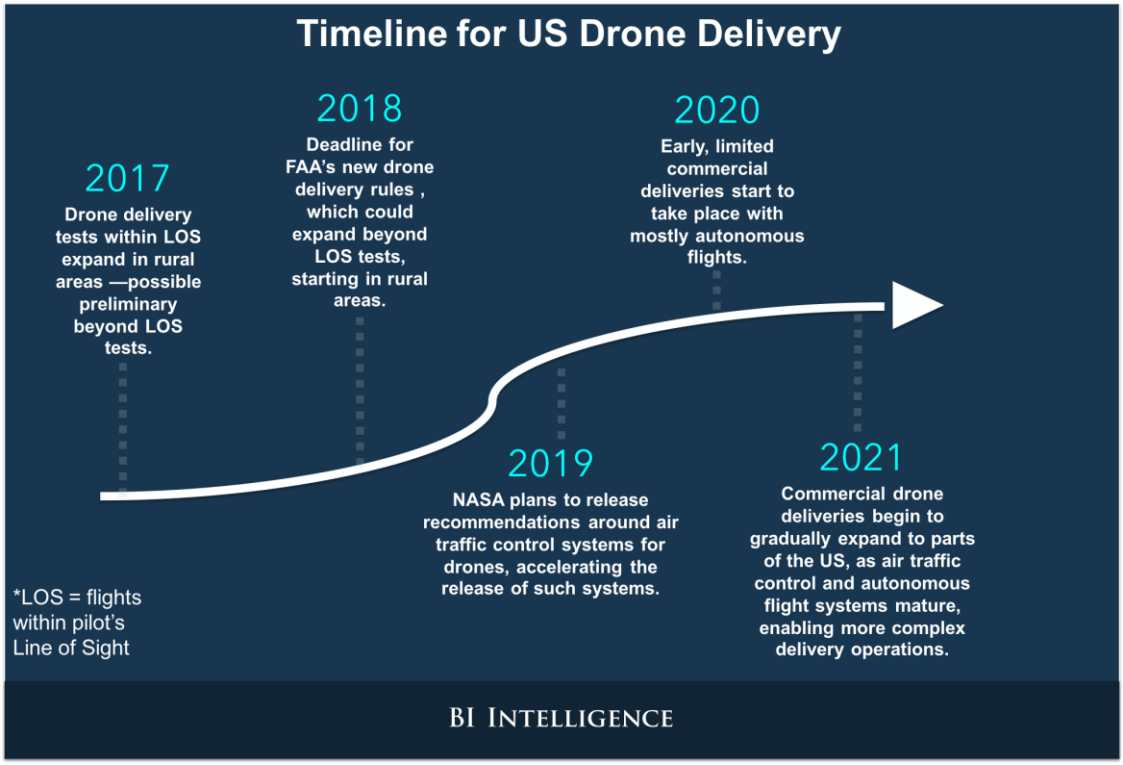
Drone adoption is rising fast among both consumers and companies, and the retail industry is just one of many exploring new uses for the technology. Drones could serve different purposes for retailers, but the most well-known application is clearly delivery by drone, with some of the biggest names in tech like Amazon and Alphabet touting it as the future of e-commerce fulfillment.

Many major retail and logistics companies around the world are testing delivery drones, looking to solve daunting challenges in e-commerce fulfillment, particularly related to the "last mile" of delivery. This last mile — the last leg of the journey when orders reach the customer's doorstep — is the most expensive and inefficient part of e-commerce logistics.

- **Drones can help companies circumvent many of the issues plaguing last-mile delivery today** — like traffic congestion in cities and long distances between rural deliveries.
- **Circumventing those problems would cut shipping times and costs.**
- **Retailers could then offer faster and cheaper shipping by passing the savings on to customers, helping to boost sales and customer satisfaction.**

Still, the barriers to deploying drones for last-mile home delivery are extremely high. These include regulatory barriers, consumer perceptions, and the unproven status of large-scale commercial home drone delivery in the real world. Several years of additional testing and regulatory developments are necessary before commercial home deliveries by drone become widely available.

In this report, BI Intelligence examines the benefits drone delivery can provide as an e-commerce fulfillment method, and explains the different approaches companies are taking as they experiment with the nascent technology. In addition, we detail the key players working in the space and discuss the challenges drone delivery faces in reaching mainstream adoption.



DRONE DELIVERY IN RETAIL

A broad range of companies are exploring commercial drone delivery, drawn by the abundant benefits that drones offer in automating logistics. E-commerce companies want to cut delivery times and costs to improve their customer satisfaction and loyalty, while legacy retailers seek the same advantages to grow their online sales. Meanwhile, logistics providers are experimenting with drone delivery to cut costs and ward off new competition from startups and technology companies, which have latched on to drone delivery as a potential path to disrupt (or partner with) legacy logistics firms.

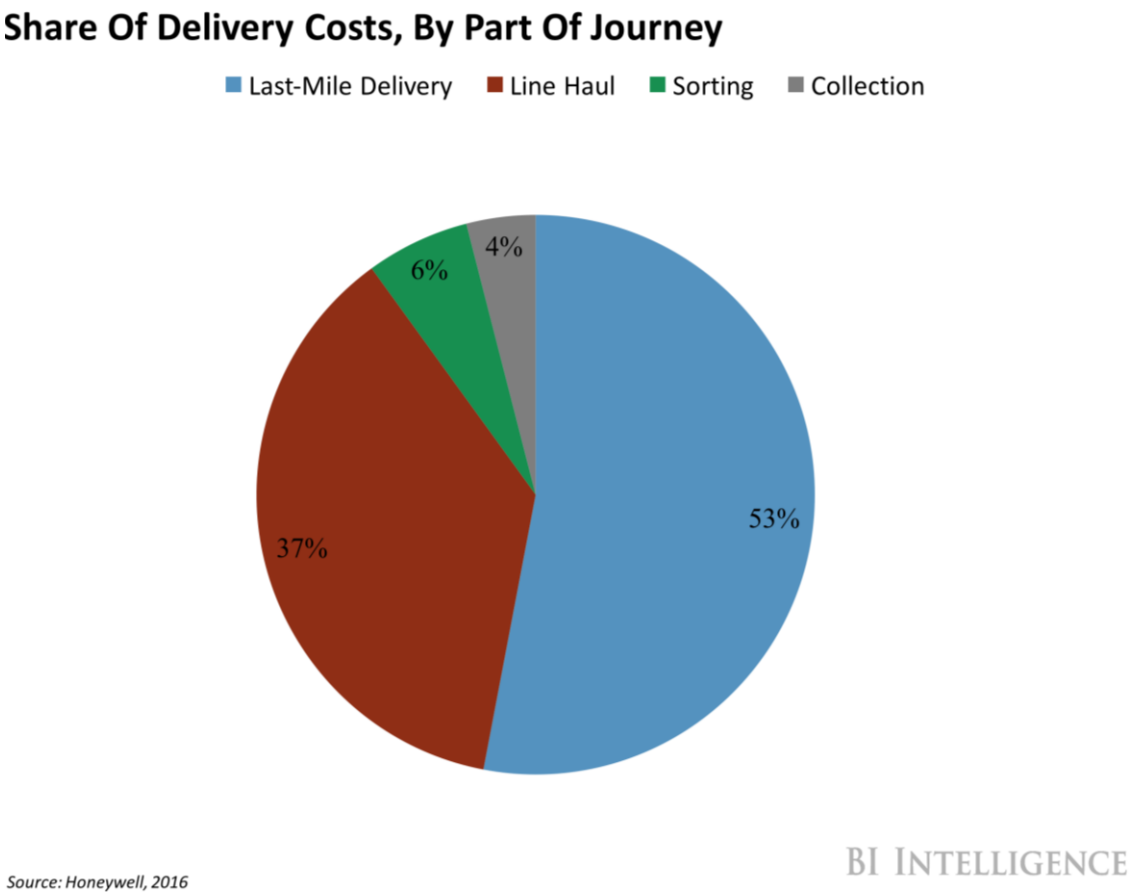
There are two main types of drone delivery these players are exploring: home drone delivery and supply chain delivery. Although home drone delivery receives the bulk of public attention, using drones to make deliveries within the supply chain can smooth out the fulfillment process and increase efficiencies.

Home Drone Delivery

Commercial home delivery is the most talked-about type of drone delivery because the last mile of fulfillment is such a big pain point. Last-mile home deliveries are plagued by issues like invalid or hard-to-locate addresses, and involve low drop sizes — meaning only one or two packages are typically dropped off per stop.

These challenges make the last mile disproportionately expensive:

- **The low drop sizes mean last-mile delivery is by far the most expensive part of the logistics journey, accounting for more than 50% of the total cost of delivering goods,** according to industrial conglomerate Honeywell.
- **In comparison, line haul shipping — which includes the "first" and "middle" miles of delivery that involve moving goods long distances by ocean, air, or ground — only accounts for 37% of total delivery costs,** with warehousing costs making up the rest.

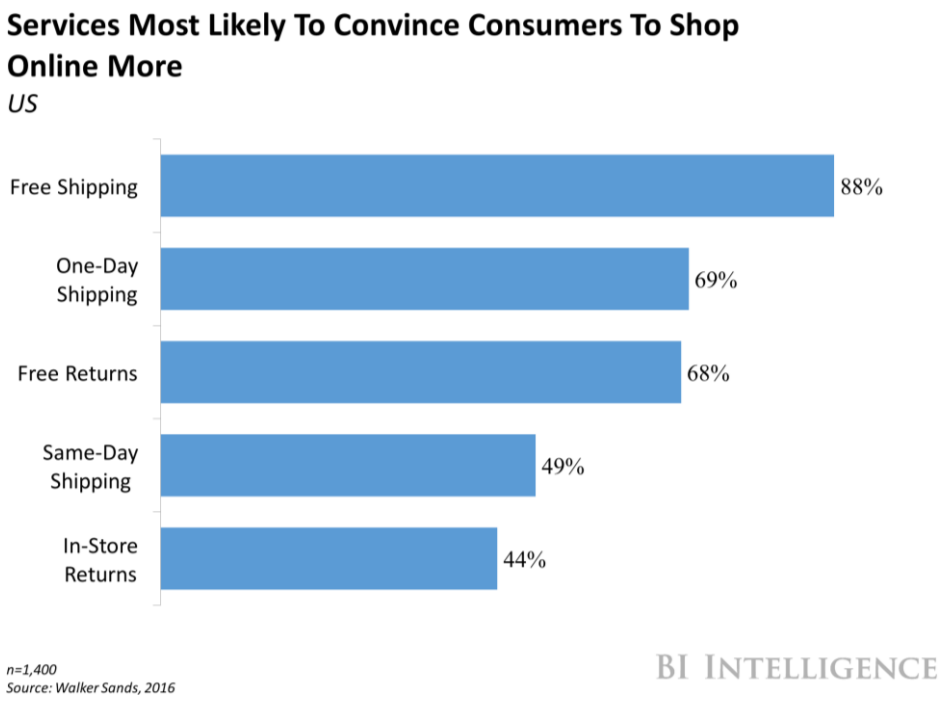


Source: Honeywell, 2016

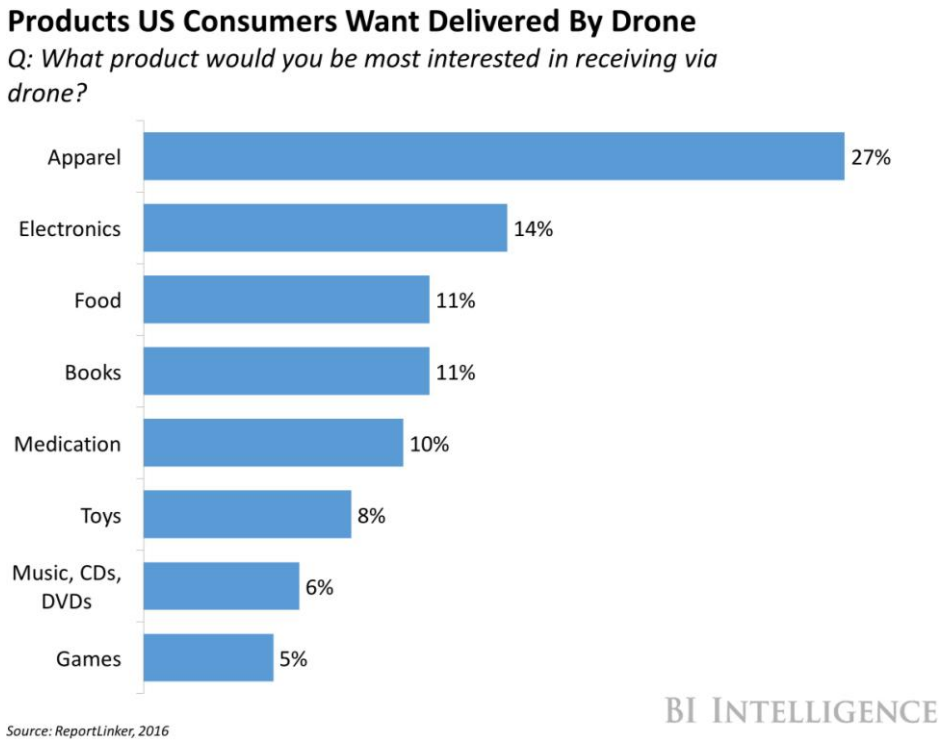
Drone delivery could cut fuel and labor costs by automating last-mile delivery. Workhorse Group, which builds electric delivery trucks for logistics providers, said electricity costs only three cents per mile for its battery-powered delivery drones — far less than fuel costs for delivery trucks. Additionally, if regulators permit, one remote pilot could monitor several autonomous drones at a time, reducing labor costs.

Last-mile delivery is also very time-consuming — rural deliveries can be many miles apart, while urban deliveries are often stalled by traffic congestion. Drone delivery can bypass these road challenges and speed up deliveries. For example, Amazon plans to deliver customers' orders within 30 minutes with its Prime Air drone delivery program. This would improve on Amazon's current two-day Prime shipping and two-hour Prime Now deliveries.

By cutting delivery times and costs, drones can provide key competitive advantages and accelerate the growth of online shopping. Free and fast shipping are the most enticing factors drawing consumers to shop online more, according to a 2016 Walker Sands survey of 1,400 US consumers.



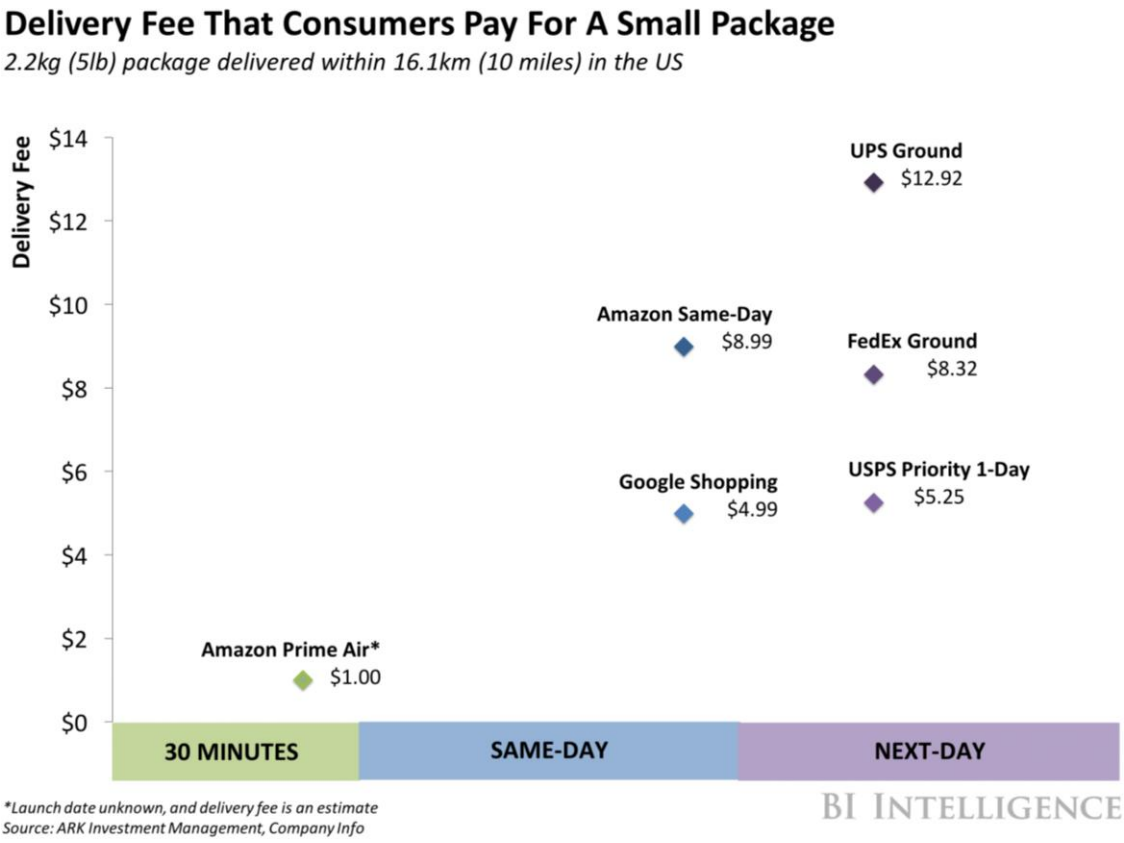
Additionally, faster delivery can open up product categories like household items and baby products for online retailers. Consumers still typically buy these items in-store and demand fast delivery when they do buy them online, according to a recent Internet Retailer survey of 2,800 US consumers. Drone delivery could also provide a competitive advantage for online sales in specific product categories that consumers have shown some interest in receiving via drone, like apparel.



Some large e-commerce companies and brick-and-mortar retailers are developing their own drone delivery programs to cut costs and gain a competitive advantage in faster, cheaper shipping. However, the vast majority of retail companies will have to rely on partners — either traditional logistics companies or upstarts — to gain those benefits, as the high costs of scaling a widespread drone delivery program will prove too high of a barrier for most.

Different studies vary widely on how cost-effective drone delivery would be:

- A 2015 study by ARK Investing Group estimated that drone delivery would cost Amazon less than $1 per shipment.
- For comparison, Amazon charges non-Prime members $8.99 for same-day delivery, and Prime members $5.99 for same-day delivery on orders of less than $35.
- We estimate that Amazon spent roughly $5.75 on shipping per package last year.



Others have estimated that drone delivery costs could be much higher. For example, another 2015 study published on Seeking Alpha said Amazon's drone delivery costs could reach $9.19 per delivery, which would not offer any savings compared to FedEx or UPS ground shipping. It's worth noting that all of these estimates rely on very broad assumptions. There is no existing large-scale operation today delivering packages to homes by drone, so the true costs of home drone delivery remain largely unknown. Until costs are proven out, logistics companies and retailers will take a measured approach to testing and rolling out drone delivery.

Although drones can speed up both rural and urban home deliveries, most drone deliveries today are conducted in rural areas. In fact, drone startup Flirtey just made the first urban home drone delivery in the US last year. This is largely because urban drone deliveries include more complicating factors like tall buildings and other obstacles, making regulators more likely to favor rural environments when it comes to experimenting with the nascent tech. Rural areas are also particularly primed to benefit from drone delivery as trucks must drive long distances between dropoffs in such places. Retailers and shippers could drastically speed up these deliveries by using drones to bypass roads altogether.

It's also worth noting that other technologies could automate urban deliveries — like the ground delivery robots being tested by Starship Technologies and Marble. In fact, a McKinsey report last year predicted that such small delivery robots would dominate urban deliveries in the future, with drones performing same-day and time-window deliveries in rural areas. It's still early to rule out drone deliveries in urban settings, but they will be but one way to automate last-mile delivery in these places, whereas rural areas will likely rely heavily on the fulfillment method. Rural deliveries suitable for drone delivery will account for about 13% of parcel deliveries to consumers, which would equate to roughly 500 million packages in Germany alone in 2025, the report projected.

Supply Chain Delivery

Drones offer significant potential for retailers and logistics companies to automate deliveries within their supply chains. For example, drones can transport packages from regional distribution centers to collection points, where they're picked up by couriers for the last mile. JD.com and SF Express have taken this route to cut costs for transporting goods through their supply chains in China.

Additionally, drones can track inventory and carry goods around warehouses, helping to move inventory out the door faster than humans are able to. Workers at Amazon's fulfillment centers typically walk 10 to 15 milers per day to pick items throughout its facilities, for example; drones could cover that ground much more quickly, speeding up collection and the loading of parcels for delivery.

Drones can also cut labor costs by automating supply chain tasks, helping to reduce overall delivery costs. For example, Walmart uses drones to scan aisles in its distribution centers, logging the location of goods through the use of cameras and image-recognition technology. This allows the company to redeploy workers to more productive tasks than cataloging inventory.

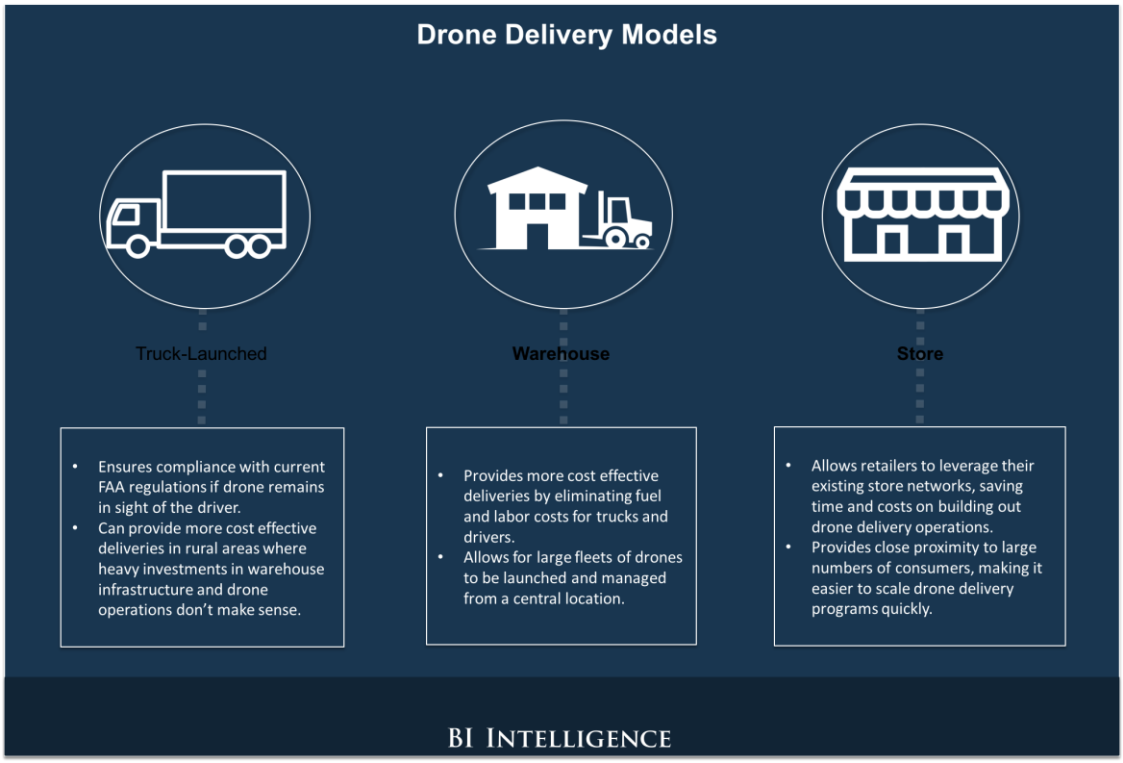
Drone Delivery Models

Implementing drone delivery into existing supply chains is a complex undertaking, and can involve retrofitting existing distribution centers (as Amazon has done), hiring new staff, and rethinking inventory management processes. Several different operational models are emerging for drone delivery, including:

- **Launching drones from delivery trucks.** This model provides compliance with the Federal Aviation Administration's (FAA) line-of-sight rule, which requires drones to remain within sight of their pilots at all times, as the drivers can monitor the drones' flights. This means the model will likely progress faster in the US than others that require drones to fly autonomously over long distances.

- **Delivering parcels directly from warehouses by drone.** Such deliveries are still not approved by the FAA, but could offer greater cost and time savings than launching drones from trucks by cutting ground transportation out of last-mile delivery.

- **Launching delivery drones from store locations.** Several brick-and-mortar retailers have been experimenting with this model. For example, 7-Eleven conducted a drone delivery test at one of its locations in Nevada last year. The drones had to stay within sight of employees at the store location, though, severely limiting the range of the tests.



More models will likely emerge as drone delivery tests progress around the world, with different options to fit different types of deliveries. For example, drone deliveries from stores, warehouses, or some other central location could be useful in areas with higher population densities, while truck-launched drones may be used in more remote areas where building such infrastructure doesn't make economic sense.

KEY PLAYERS IN DRONE DELIVERY

Right now, nearly every drone delivery operation around the world falls into one of two categories — they are either in the very early stages of testing home deliveries, or are either testing or performing supply chain deliveries.

Early Testing Home Delivery

Amazon

No company has done more to increase public awareness of drone delivery than Amazon, which created its Prime Air drone delivery program in 2013.

- **Amazon tested its first drone deliveries last year in the UK.** The tests started with just two customers living close to an Amazon fulfillment center near Cambridge, and the company has plans to expand the tests to more customers in the area.

- **It has also dropped hints that Prime Air tests could be coming to the US soon.** Amazon aired an ad during the Super Bowl in February showing a drone delivery, and it demonstrated a delivery by drone in the US at its robotics conference in March.

However, the company has not received permission from the FAA to fly its drones in the US out of sight of their pilots. In the UK, Amazon's drones fly mostly autonomously with only some remote human intervention. This means that until it receives FAA permission for autonomous drone testing — which is unlikely to happen soon — Amazon will probably be forced to remain focused on testing in international markets. In fact, Amazon announced an expansion of its research and development efforts in the UK recently, saying it will dedicate an entire facility to furthering its drone project there.

Alibaba

The Chinese e-commerce giant began testing drone delivery in 2015, in partnership with shipping company Shanghai YTO Express Logistics. The tests involved using drones to deliver orders of ginger tea from Alibaba's Taobao marketplace to 450 select customers in Beijing, Shanghai, and Guangzhou. The drones dropped their deliveries off to couriers, who then delivered the packages by hand.

The tests were very limited in scope, and Alibaba has not announced any plans to further its drone delivery tests since. The company relies heavily on partners connected to its Cainiao Network affiliate for its logistics operations, which could be partly why it hasn't moved to invest big in drones. As a result, it's unlikely that Alibaba will try to build out a full-scale delivery program anytime soon.

UPS

Earlier this year, the global logistics provider began testing a drone delivery program developed by Workhorse Group. Here's how the system works:

- **The drones launch from Workhorse's electric delivery trucks, dropping packages at customers' front doors.**
- **They stay within the drivers' sight at all times, keeping in compliance with FAA regulations.**
- **The drones recharge while docked inside of the electric trucks**, enabling drivers to easily reload them and plot the flight path for the next round of deliveries.

UPS says it's specifically interested in using drones for rural deliveries, and believes it would save $50 million per year in fuel costs by cutting just one mile per day from each driver's delivery route. Using drones to deliver packages in rural areas within the sights of its drivers will likely allow UPS to progress its drone delivery efforts more quickly than others like Amazon or Alphabet.

Alphabet

Alphabet's highly publicized Project Wing drone delivery experiment aims to expand the Google Express shipping business, which provides delivery for retailers. After testing its drones overseas for a couple of years, Project Wing got permission last summer to test delivery drones in the US for the first time.

However, in late 2016, Alphabet reportedly started to scale back the project after it failed to develop a drone model that fit its needs. One such prototype, dubbed "hummingbird," repeatedly crashed or got lost during testing last year. After the hummingbird debacle, two of the project's top executives were pushed out.

Alphabet had reportedly planned to charge its retail partners $6 per drone delivery, and it'd already scored a partnership with Chipotle to deliver meal orders. However, it now seems highly unlikely to launch a commercially viable service anytime soon.

Testing Supply Chain Delivery/Use Cases

DHL

Germany's DHL, the world's largest logistics company, has been testing its own drone model, dubbed the "Parcelcoptor," for several years now.

- **The Parcelcoptor has a large, six-foot wingspan, and can travel up to 45 miles per hour and carry packages weighing up to 4.5 pounds.** The drone has a special tilt rotor that allows it to take off vertically like a helicopter and then fly horizontally like an airplane.
- **DHL said it made 130 deliveries between the Swiss villages of Alm and Reit im Winkl using Parcelcoptors as part of a test from January through March 2016.** The drones launched from and dropped off packages at designated "Skyports" in each village.

Prior to these tests, DHL tested an earlier version of the Parcelcoptor to deliver medicine and other supplies to Juist, an island 12 kilometers off the coast of Germany in the North Sea. The two different trials allowed DHL to test the Parcelcoptor's performance in both coastal and high-altitude areas.

Walmart

Walmart filed an application with the FAA in late 2015 to begin testing drones for both home delivery and warehouse operations. The FAA granted the exemption last year, but said any delivery tests would have to be in compliance with the line of sight rule.

There have been further developments since then:

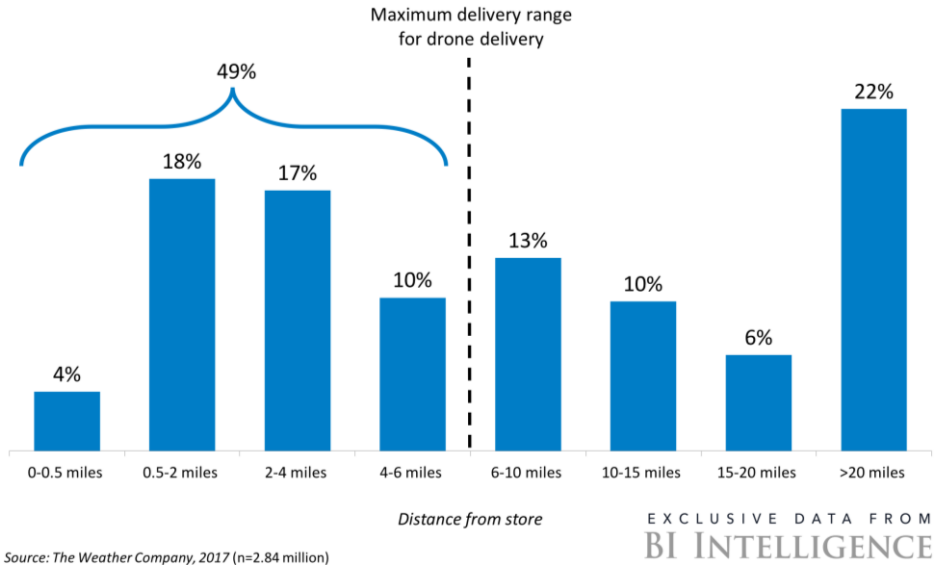
- **The retail giant has been using drones to check inventories in its warehouses.**
- **It also filed a patent to use drones to transport items between different departments in its stores,** and said it's exploring using drones to carry grocery pickup orders out to customers in store parking lots.

Walmart has made the most progress in using drones for its warehouse and supply chain operations. The company's inventory-scanning drones fly up and down warehouse aisles, taking 30 images per second of inventory stocked on the shelves. According to Walmart, they log the same amount of inventory in one day that workers do in a month manually.

But there is also considerable potential for the company in home drone delivery. Although drone delivery is typically seen as a substantial threat to traditional brick-and-mortar retailers like Walmart — because it will likely accelerate consumer adoption of online shopping — it also gives them an opportunity to compete better in e-commerce by launching delivery drones from their stores.

Walmart's Potential Customer Base For A Drone Delivery Service

US, Q1 2017

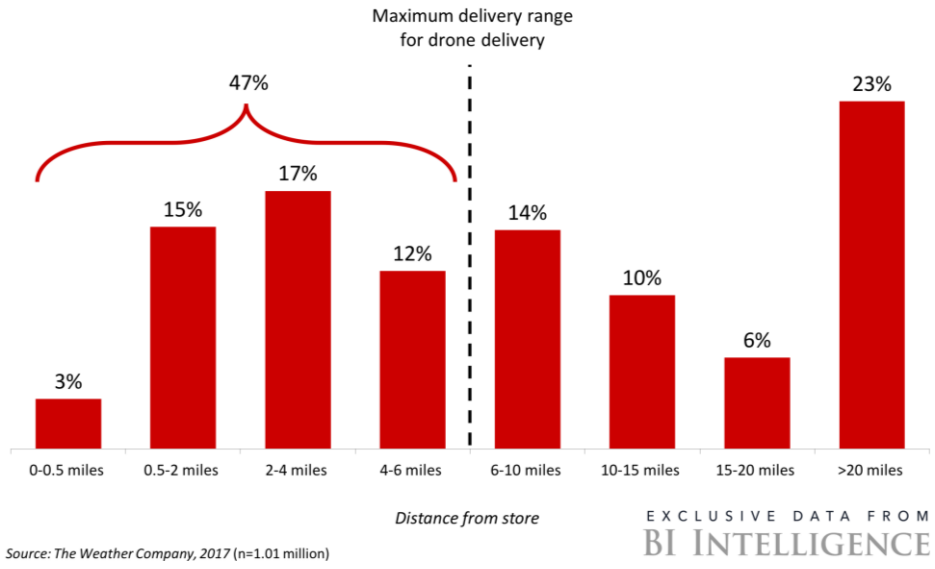


Source: The Weather Company, 2017 (n=2.84 million)

This would allow legacy retailers to quickly implement drone delivery programs that reach large numbers of customers by leveraging their existing store infrastructure. According to BI Intelligence's exclusive analysis of data from The Weather Company, nearly half of Weather Company app users who shopped at a Walmart or Target store location during Q1 2017 live within a deliverable range of one of their stores for a drone.

Target's Potential Customer Base For A Drone Delivery Service

US, Q1 2017



Source: The Weather Company, 2017 (n=1.01 million)

Operational Supply Chain Delivery

JD.com

Chinese online retailer JD.com has one of the most extensive commercial drone delivery programs in operation today.

- **Its drones don't deliver goods directly to customers' homes, but rather deliver parcels from regional distribution centers to local couriers,** who then deliver them to customers in rural villages.

- **JD.com started the drone delivery program in October 2015 with a fleet of 30 drones, and has since expanded it.** It recently said it would build 150 new ground facilities for its drone operations over the next three years.

The drones have significantly reduced costs and allowed JD.com to speed up deliveries in rural China, where long, windy roads are often in poor repair. The drones cut JD.com's delivery times in rural areas from hours to less than 20 minutes, and reduced costs to less than $1 per delivery.

SF Express

SF Express, China's largest parcel and mail delivery company, also has a sizable drone delivery program in operation. It first started experimenting with drone delivery in 2013, and developed its drones in partnership with Chinese drone manufacturer XAircraft. By 2015, the company said it was delivering 500 packages per day by drone in parts of Southern and Eastern China, with plans to double that number.

Like JD.com, SF Express' drones don't deliver directly to consumers' homes, but rather drop off parcels with couriers to make the final delivery. SF Express has said it wants to expand its drone delivery operations to more remote and mountainous locations.

CHALLENGES FOR DRONE DELIVERY

The vast majority of drone delivery efforts today are still in early phases of testing, with only a few commercial operations underway. It will take several years for many of these tests to develop into commercially viable operations that can reach wide audiences. That's because there are still very tough and broad challenges that must be solved before drone delivery — particularly to consumers' homes — can become mainstream.

Regulatory Barriers

Regulatory barriers form the highest hurdle to drone delivery right now, as governments broadly remain concerned about fleets of delivery drones flying over residential neighborhoods. However, regulators in some geographies have been more open to drone delivery than others.

US

In the US, the FAA has allowed limited drone delivery tests, but approved far more commercial drone activity for less risky applications like aerial construction site surveys and oil rig inspections. A major issue for drone delivery projects in the country is the FAA's line-of-sight rule, which makes it impossible to test commercial drone deliveries over long distances. The US Congress previously ordered the FAA to create new rules by 2018 to allow companies to obtain licenses for highly automated drone deliveries over such stretches. However, recent developments in Washington, DC have raised concerns about whether the 2018 deadline will be met.

Earlier this year, President Donald Trump signed an executive order mandating that federal agencies rescind two existing regulations for every new regulation they implement. This would require the FAA to abolish two existing regulations for each new drone delivery rule it enacts. Many FAA regulations are vital to air travel safety, so this requirement tremendously complicates the possibility of new drone delivery regulations. A lawsuit aimed at blocking the executive order is currently pending, and if it's successful, the FAA will probably move to roll out drone delivery rules in stages, pending more tests. For now, though, the immediate future of US drone delivery regulation is murky at best.

China

China has yet to enact permanent commercial drone regulations. Its Civil Aviation Administration passed temporary provisions in December 2015 to govern drone operations while the government collects more information for setting formal regulations. Those temporary provisions included a ban on using drones to deliver packages in urban areas, a major setback for e-commerce companies looking to use delivery drones in major cities, which are driving China's e-commerce boom. The administration said collision avoidance systems for drones need greater development before multitudes of drones can navigate dense, urban areas.

However, the provisions have given companies like JD.com and SF Express freedom to conduct drone deliveries in rural areas. Several of the largest drone delivery programs in the world today are taking place in rural China, allowing Chinese companies to optimize logistics operations with drones faster than their counterparts in other markets.

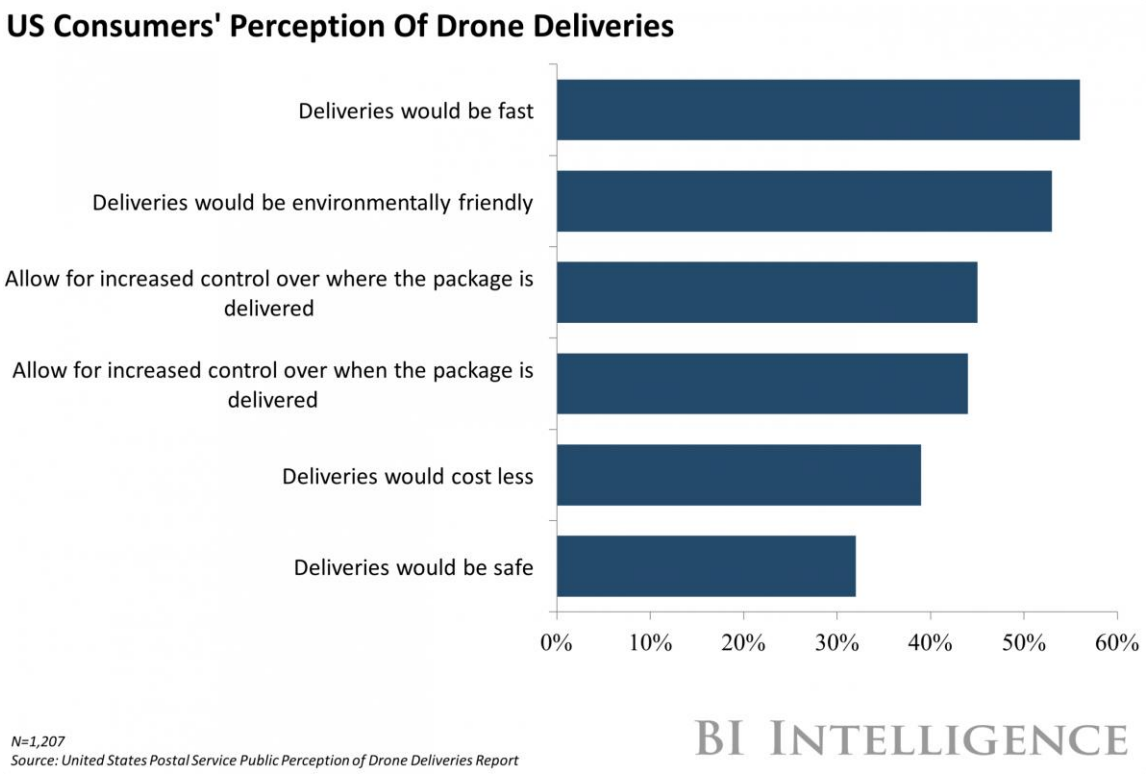
UK

The UK's Civil Aviation Authority (CAA) has also progressed further in authorizing drone deliveries than the FAA. That's largely because the CAA has a faster rules-making process, allowing it to implement guidelines and respond to companies' requests for special waivers more quickly, Recode reported late last year.

Amazon's early testing of autonomous drone technology could also help the UK roll out an air traffic management system for drones before the US does. The CAA is collecting data from Amazon's tests to develop such a system, which is being built through a public-private partnership with NATS, an air traffic control systems provider. If the UK rolls out a low-altitude air traffic control system for drones quickly, then it would put the UK on track for widespread commercial drone deliveries — including in cities — well ahead of the US.

Consumer Acceptance

Drone technology is just starting to make its way into consumers' everyday lives, and this novelty has led many to express hesitancy when asked about their willingness to receive packages by drone.

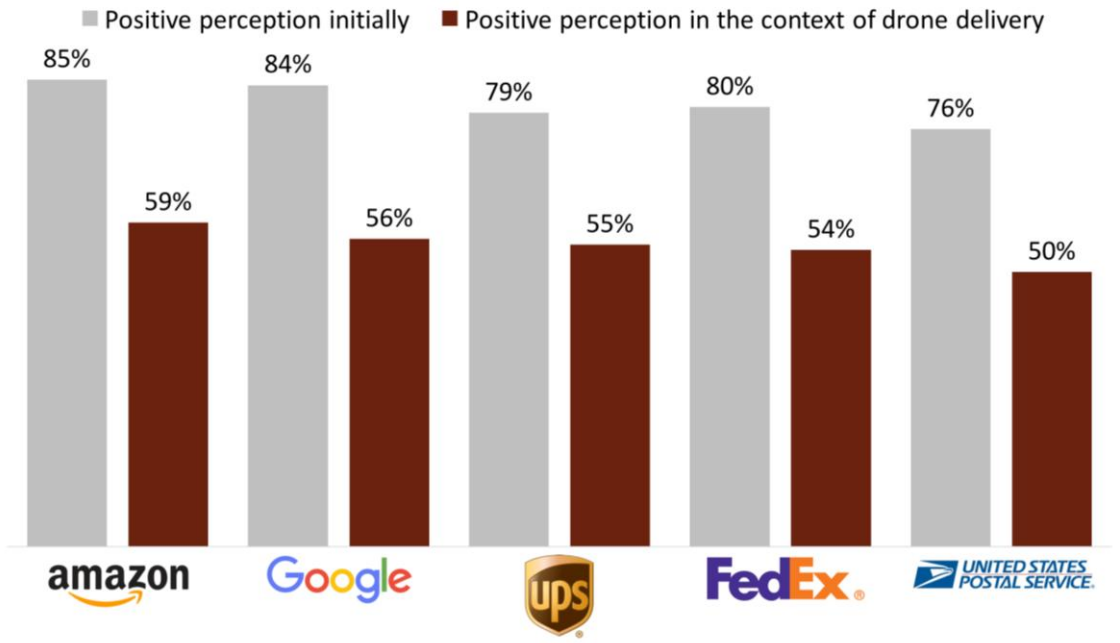


- **Only 32% of more than 1,200 US consumers surveyed by the US Postal Service last October said they believe drone deliveries will be safe.**
- **The respondents' perceptions of different companies — including Amazon, Alphabet, FedEx, and UPS — also dropped significantly when thinking of them as drone delivery providers.**

This represents a significant barrier for drone delivery, as consumers won't opt for drone delivery if they feel there's a risk their package could be damaged or the drone could crash on their home. Additionally, 31% of the respondents expressed concern that delivery drones might "not be used in a way that respects my privacy." Such concerns could be amplified if large numbers of delivery drones equipped with cameras take flight in residential neighborhoods.

US Consumer Perceptions On Companies Using Drone Delivery

2016



Source: US Postal Service Office of Inspector General, n=1,126

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Technical Issues

Drone technology in general is still developing, and companies will have to prove drones are safe and reliable before widespread drone delivery in populated areas will be approved by regulators. Alphabet's Project Wing's struggles illustrate how drone technology needs further development before that happens. Officials will likely want to see additional development and testing to ensure that autonomous flight software, network connections, and hardware models are ready for deployment before approving large-scale drone delivery programs.

In addition, companies still need to figure out how to safely deliver packages to consumers' homes. They're experimenting with a range of options, but there's no clear winner yet on the horizon. For example, Amazon has patented a system for dropping packages from drones with parachutes attached, but the drones it's testing in the UK land at designated areas on customers' lawns to make their deliveries. Meanwhile, Project Wing tested drones in Australia in 2014 that lowered packages from hovering drones by a cable wire.

A variety of factors must be considered to conduct these deliveries safely. For instance, whether the delivery is destined for a home with a front yard or a high-rise apartment building may determine how the drone performs the dropoff. The drone may also have to wait for the recipient to sign off on the delivery, or else risk the package getting stolen before it's collected. JD.com and others have avoided these issues by having traditional couriers pick up packages from drones and then deliver them to the final address by truck or bike. Those couriers could be eliminated if companies can figure out how to execute this final step of residential deliveries.

MARKET OUTLOOK FOR DRONE DELIVERY

The aforementioned barriers will postpone mainstream adoption of drone delivery until after 2020 in most regions. In the meantime, retailers and logistics companies will continue to expand tests within regulatory limits to learn how they can use drone delivery to their advantage. This will drive a slow-but-steady march toward reality for the fulfillment method, with mainstream adoption of drone delivery taking place in stages over the next few years. In particular, we expect tests to gradually progress as regulations are put in place and drone technology improves.

As autonomous flight and collision avoidance technology improves, regulators will allow further tests in more populated areas involving progressively more autonomous drones. Additionally, the testing and development of low-altitude air traffic control systems that can track and manage large fleets of drones will be a prerequisite to broad commercial availability of drone delivery. These systems are still in early testing today, and, once completed, will be gradually rolled out in various geographies and integrated with different drone models. That process will lay the foundation for commercial drone deliveries to operate on a large scale in more and more places over several years.

THE BOTTOM LINE

- Drone delivery offers tremendous benefits in the form of cheaper, faster shipping.
- A wide range of companies are testing drone delivery to learn how they can leverage those benefits, including e-commerce companies, legacy retailers, logistics providers, and tech firms.
- There are two main types of drone delivery these players are exploring: home drone delivery and supply chain delivery.
- However, there are significant regulatory and technology barriers that will postpone mainstream adoption of drone delivery until after 2020.
- Mainstream adoption of drone delivery will take place in stages over the next few years, as regulations are put in place and drone technology improves.

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