



# THE NEAR FUTURE OF CONNECTED DRONES


## Strategic Planning for Enterprises





# Skyward can help you take your drone program further, faster.


## Drone Consulting


Skyward consultants help drones prove their value throughout your business as quickly as possible.


 **Proof of Concept**  
We'll show you how drones can deliver ROI across your business


 **Risk Mitigation & Compliance**  
Get the policies and procedures you need to run a safer operation and comply with regulatory and corporate requirements


 **Skyward Implementation**  
Setup and training for your team to help your team get the most out of Skyward

 **Technology Configuration**  
We'll configure your fleet to serve your business, including drones, sensors, and data-processing software

 **Procurement**  
Our team will acquire the hardware and equipment for you and register aircraft with the FAA

 **Team Training**  
Get training for the FAA's Remote Pilot Certificate (Part 107) as well as beginner and intermediate flight training

 **Efficient, Scalable Workflow**  
We'll help you refine your workflow, engage your stakeholders, and create customized flight and ops checklists

 **Ongoing Support**  
Call on our experts during regular check-ins and get early updates on Skyward's product roadmap as well as regulatory developments

## Drone Management Platform

Skyward's software provides operational oversight and transparency, customizable workflows, and access to controlled airspace.

-  Know where you can fly
-  Collaborate with team members
-  Simple & powerful flight planning tools
-  Track and report details that matter to your business
-  Quickly gain permission to fly in controlled airspace
-  Meet regulatory and insurance requirements

Get in touch at [contact@skyward.io](mailto:contact@skyward.io) & schedule a 15-minute consultation

Watch a 2-minute video of Skyward in action at [go.skyward.io/Recorded-Demo-Register.html](https://go.skyward.io/Recorded-Demo-Register.html)

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Skyward, a Verizon company, does not provide legal advice. This guide is for strategic planning purposes only. It does not constitute any predictions or promises of the performance of wireless networks or any devices, including drones, that are connected to them. The information we've provided is based on our analysts' best understanding of connected drones at the time of writing. For legal and regulatory advice on drones or using drones for business, contact an aviation attorney.

# WELCOME

Over the past several years, it's been exciting to see how companies have used drones to help save time, increase revenue, and lower risks to workers in industries as diverse as energy, utilities, media, oil and gas, and commercial construction. And we're just getting started. Drone connectivity will — once again — revolutionize the way companies gather data and accomplish tasks.

As much as drones have added value, we have only just begun to scratch the surface in terms of what they can do. In 2018, 10% of major enterprises in the U.S. were using drones — and almost none of them were connected to a wireless network. At Skyward and Verizon, we're working to change that. When drones are widely connected to wireless networks, the transformative capabilities of drones can be unlocked in ways that will change many aspects of our society.

With all these changes coming so quickly, it can be confusing to set up a drone program ready to adapt to tomorrow's technology and regulatory advances, while still producing today's deliverables and ROI.

## THIS STRATEGIC PLANNING GUIDE COVERS:

1. Connected drones and what they'll mean for the enterprise
2. Potential use cases
3. Artificial intelligence, beyond visual line of sight flights, and autonomy
4. An inside look at an innovative enterprise drone program
5. Practical tips to ensure your drone operations are ready for the future
6. Regulatory requirements to unlock the promise of connected drones

# What Does It Mean to Connect a Drone?

Many common devices today are designed to connect to wireless networks: phones, computers, watches, the navigation system in your car, and even refrigerators, doorbells, and light bulbs. But where the job of a light bulb or refrigerator doesn't really change if it's connected to the network, a connected drone has many more capabilities, including near real-time data transfer, remote deployments, and beyond visual line of sight flights.

We know that 5G will help transform many aspects of society, and we think that drones will be one of the first tools to showcase its full potential. That's

good news! But here's some even better news: **We don't need to wait for 5G to connect drones to the network.** Connecting drones to 4G LTE can dramatically increase the value they provide.

Today, drones are useful as flying sensors. Connected to 4G, those flying sensors can remotely transmit data, safely fly beyond the pilot's visual line of sight, and be remotely deployed.

So what's the real difference between today's 4G and the 5G technology that's just beginning to be deployed?

# The difference between 4G and 5G

The International Telecommunication Union, an agency of the United Nations, defines the capabilities that distinguish different generations of broadband cellular networks. Skyward and Verizon use those definitions when we talk about our wireless network.

Telecom companies began rolling out 4G, the fourth generation of broadband cellular, at the end of 2009. As of 2019, 4G is widely used in the United States and in many other parts of the world. It allows us to stream movies in our homes, have confidence in a car's GPS system, and video conference with our coworkers.

5G is the fifth generation of broadband cellular. Verizon began rolling out its 5G Ultra Wideband mobile network commercially in parts of two cities in early 2019.

5G marks a transformational shift from 4G. 5G will provide faster data speeds and carry a massive amount of data for a large number of simultaneous devices. Users in high-

density areas — like airports, stadiums, and cities — can still experience the fast speeds and low latency of 5G service.

5G performance targets high data rate, reduced latency, energy savings, cost reduction, higher system capacity, and massive device connectivity. Compared to 4G, 5G has the potential to provide about 20 times faster data speeds, a reduction in latency down to 10 milliseconds, network infrastructure evolution that pushes cloud computing to the edge of the network (which means data processing is done close to the end user) for rapid computing in latency-sensitive use cases, support for as many as 1 million devices per square kilometer, and much more.

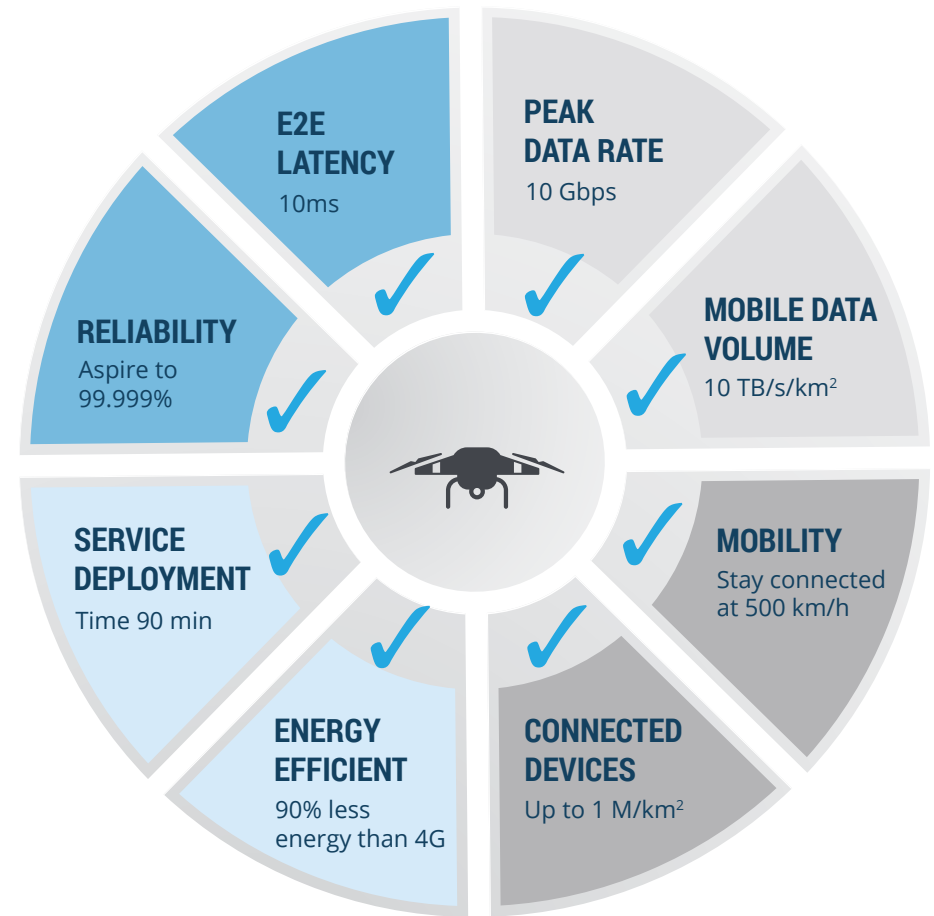
## **So what does that mean for drones?**

# The Eight Currencies of 5G

At CES 2019, Verizon CEO Hans Vestberg unveiled the Eight Currencies of 5G. It will be interesting to see how the Eight Currencies affect many different parts of our lives. Here, we'll show how we anticipate they'll apply to 5G-connected drones.

## 1. Throughput

Throughput refers to the rate of successful data transfer over a network. Verizon has achieved peak downlink data speeds of 953 Mbps in the real world over 4G. 5G has the potential to enable peak data rates of 10,000<sup>1</sup> Mbps (or 10 Gbps). This level of throughput will help enable things like autonomous vehicles, manufacturing efficiencies, and augmented and virtual reality solutions. This also means that individual drones will be able to transfer many times more data from a job site back to the office.



<sup>1</sup> Verizon, Ericsson, and Qualcomm reach superfast 953 MBPS wireless speed in a dynamic, real-world environment deployment, PR Newswire, Aug 2, 2017, <https://www.prnewswire.com/news-releases/verizon-ericsson-and-qualcomm-reach-superfast-953-mbps-wireless-speed-in-a-dynamic-real-world-environment-deployment-300498759.html>

## 2. Service deployment

We feel confident that enterprises that require near real-time network performance will be powered by 5G. 5G and network virtualization (which means using software to perform network functions) enable service and application deployment — without having to install additional hardware. This could lead to a reduction in typical service deployment times from six months to 90 minutes. Where available, these faster deployment times will allow Verizon to roll out new features and security improvements quickly.

## 3. Mobility

5G technology is designed to enable devices traveling up to 310 mph to stay connected to the network. This means that commercial drones should be able to, for example, inspect vast distances of highway in minutes, while staying connected to the network, transmitting data, and reacting to changing information almost instantaneously.

## 4. Connected devices

5G will be capable of supporting up to **one million connected devices per square kilometer!** Verizon's 5G Ultra Wideband network will eventually handle 10 to 100 times more connected devices per square kilometer than 4G. This will allow cities to tap into the power of 5G for things like smart street lights, remote security monitoring, and intelligent rail and smart parking solutions.

Additionally, as chips get cheaper, applications increase, and more devices, like drones, are connected to the network, businesses will change how they operate, the data they collect, and the services they provide. We can imagine a time when 5G-connected drones will be used for everything from home package delivery to supporting search and rescue operations.

## 5. Energy efficiency

Verizon predicts that 5G Ultra Wideband will have lower energy requirements for its network operations, up to 90 percent less than 4G. This is because complex functions can take place at the “edge” — within the network, close



to the end user. That means that devices won't need as much processing capability and will need less energy. This is appealing for any organization with a big stake in reducing carbon emissions. And less energy consumed by onboard systems means longer flight times for drones.

## 6. Data volume

The 5G standard was designed to support up to 10 terabytes of data per second per square kilometer. This means the 5G network can carry a massive amount of data for a large number of simultaneous users, including large numbers of drones. Users in high-density areas — like airports, stadiums, and urban centers — will still experience the fast speeds and low latency of 5G service.

## 7. Low latency

Think of latency as the speed at which a piece of data moves from one part of a network to another. When there's a lag between the audio and visuals of a movie you're streaming at home, you're experiencing latency. 5G will cut data transit speed to many times less than the blink of an eye — eventually less than 10 milliseconds for end-to-end response time. This reduced latency will create a near real-time experience for drone and sensor operators in terms of sensor response, drone control, and delivery of the data collected. Lower latency should allow autonomous drones to navigate with high precision through almost instantaneous communication with nearby infrastructure and aircraft.

## 8. Reliability

Aviation requires very high levels of reliability — and for good reason. Verizon is architecting its 5G network to be exceptionally reliable, with uptimes that could potentially reach 99.999%. This will give regulators and enterprises the confidence necessary for drones to be remotely deployed and flown over the network.

5G-connected drones will have the ability to help transport us to work, ship cargo, and carry vital supplies in a medical emergency. On a more personal note, it's very exciting for the Skyward team that, as part of Verizon, we can help to build the infrastructure and the services that will help unlock all those new opportunities for innovation. Verizon's investment in 5G will make it possible to take to the sky with that same network intelligence we trust on the ground, connecting us to each other and transforming the way we see the world.

# Planning for New Capabilities

At Skyward, we want to make sure that our customers achieve drone ROI right away with the technology that's available today. We also want to make sure that we all innovate with the future in mind.

Knowing how you can use drones today, and how you might use them in the future, puts you in a position to set up a digital system of record that can move you into the connected future.

When we think about preparing for the future of connected drones, we're really talking about preparing for the tasks we'll be able to accomplish — the processes that connectivity

can enable. This is important, because there is no reason to connect a drone to a network if your company isn't going to derive value from it.

## **We believe that companies stand to gain from connected drones in three main ways:**

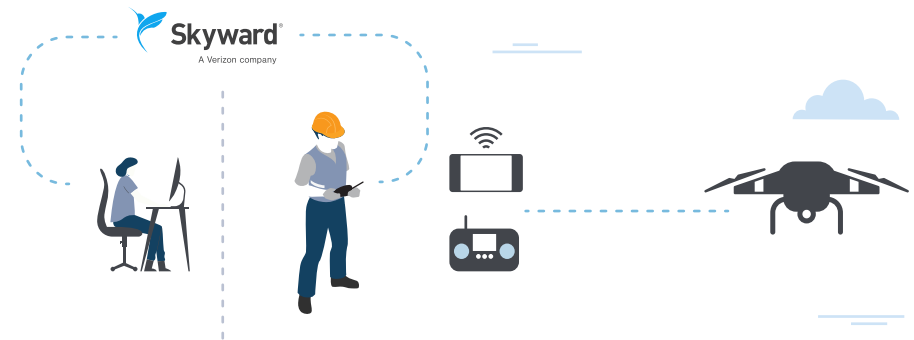
- ▶ Beyond-visual-line-of-sight flights
- ▶ Artificial intelligence
- ▶ Autonomy

# BVLOS Flights

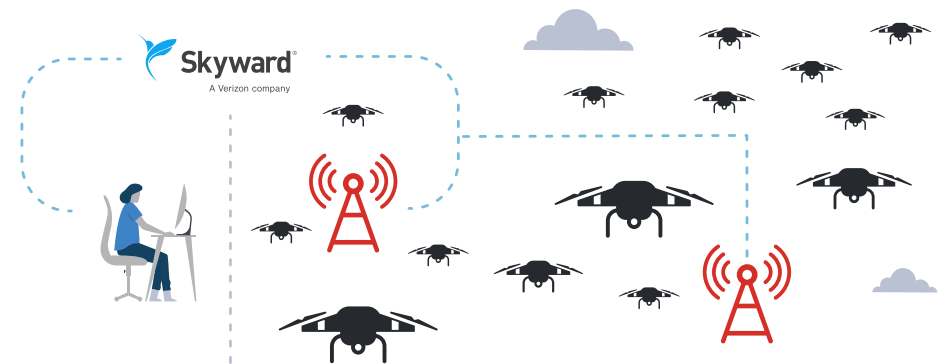
Use of cellular networks is a key enabler to rolling out BVLOS operations at scale while keeping operating costs low — because you don't have to build new infrastructure.

If you're involved in your company's drone program, there's a good chance that you're focused on efficiency, lowering costs, and making the most of your resources. If your drone program is relatively young, you're probably still exploring use cases and working to achieve standardized practices throughout your organization. If your drone program is a bit more sophisticated, you may have identified use cases for drones that aren't feasible just yet — either because of technological or regulatory limitations. These can include tasks such as package delivery, horizontal infrastructure inspections well beyond the operator's line of sight, and simultaneous remote deployments for ongoing surveillance or inspection.

## TODAY VLOS UNLICENSED SPECTRUM WITH LIMITED RANGE



## NEAR FUTURE BVLOS, 1 PILOT TO MANY DRONES MANAGED SPECTRUM WITH UNLIMITED RANGE



These use cases would benefit many companies, but they haven't yet achieved broad adoption. That's because each of these requires the ability to fly beyond visual line of sight. The biggest benefit to cellular connectivity on aircraft is in enabling BVLOS flight on a wide scale. Networks that companies like Verizon have already invested billions of dollars in can be used to connect a pilot to a drone in many parts of the world.

## Why companies care about BVLOS

BVLOS use cases range from infrastructure inspection to delivery. Other use cases that need near real-time transmission of video from the drone to an off-site location are good candidates for connectivity as well. We also see the best traffic management and deconfliction happening when vehicles have connection to a network of Universal Traffic Management services. All of these benefits are realized on Verizon's 4G LTE network today and should be supercharged with 5G.

## How to prepare

First, identify specific and essential use cases that require BVLOS capabilities. Then, partner with a company like Skyward to apply for a BVLOS waiver from the FAA so you can begin to safely test out your use cases while complying with current regulations. Skyward can also help to connect drones to the existing network, or set up a private wireless network for your company.

# Artificial Intelligence

## REMEMBER :

Not every business problem has an AI answer, just like not every problem has a drone answer.

## Why companies care about AI

Until fairly recently, the utility of a drone was limited to the sensors attached to it. But now artificial intelligence software enables drones to map, track, and analyze data in near real time. AI-powered drones assist in addressing emergency situations, assessing storm damage, finding people in the wilderness, and identifying structural defects in infrastructure. Companies are using AI to streamline inventory management and to map and identify all the objects in a vast warehouse or on a corporate campus.

## How to prepare

Getting ready for artificial intelligence means taking the time to understand the business case and value of implementing the tech. AI can do amazing things, but it's important to ask yourself if it's really the right tool, or if you already have a way of gathering the data you need. Find subject matter experts internally or within your community that can guide you in this discovery process. It can be easy to spend too much time collecting data and allocating computing resources in a way that doesn't lead to business efficiencies, customer satisfaction, or sales. Focus on the questions you're trying to answer.

## PRO TIP:

Imagine that AI has allowed your company to gain an important insight. Ask yourself, "Would we be able to act on this information immediately?" If you can't actually use AI insights for your business, then the technological investment may not be worthwhile.

# Other Considerations

## Data management

Determine storage, retention, and regulatory requirements for your data.

- How quickly do you need the data?
- How far back do you need the data?
- Are there special regulatory or data management rules your company is required to follow?

## Quality assurance

Artificial intelligence is a broad term that includes a variety of disciplines. Many of the approaches share common characteristics and need a way for the system to know if the AI processes are producing accurate information. Talk to software vendors about common errors, how they create and validate their models (called training), and whether you will have the ability to provide feedback to the AI software (called supervision). Determine how the AI will be updated and how you will ensure that the system is performing

correctly. Learn the basics about common errors such as false positives and false negatives. If you are working on a system that involves reasoners, inferences, or rules engines, make sure your technology provider explains how these systems work.

# Autonomy

Each company needs an organization-wide point-of-view and policy regarding autonomous drone operations. How will you integrate these rules and policies into your general operating manual, standard operating procedures, and operational checklists?

## Why companies care about autonomy

There are different types of autonomous drone operations. For example, for repetitive tasks that must be done regularly — site surveillance, warehouse scanning, bridge inspections — automation can save a lot of time and money. Drones that can be programmed to perform these tasks on their own will help streamline business operations and cut down on recurring costs.

## How to prepare

Understand what kinds of decisions your drone will make and what sort of situations you want it to deal with. This is something that your drone manufacturer should be able to

help you with. Some drones have very basic levels of autonomy, such as flying along a preset route, while others might be able to execute complex obstacle avoidance maneuvers while continuing to carry out their missions. In any of these cases, it is important that your team understand the drone's terrain, sensing, and other operational capabilities; the autonomy system's needs; how much input is needed from human operators; and how the system signals a failure in an autonomy system and a need for human intervention.

It's also important to have a solid plan for how the system is checked for failures and how much human supervision is needed. Your existing IT environment will influence the level of supervision needed. Operations that could involve higher risk will likely require more handling.

As with all these technologies, understand and rehearse failure recovery, and in the event of a real failure, ensure that a good retrospective process exists for fault analysis, mitigation, training, and future planning.



# Near-Future Use Cases

So far we've discussed drone connectivity and how it will enable BVLOS flights, artificial intelligence, and autonomy. So what might that look like in practice?

Here are a few examples of what may be possible.

## Better visibility during and after disasters

Mobile command centers leveraging 5G could be stationed near disaster-prone locations, with connected drones helping to deliver faster, better visibility to first responders, media companies, and line workers sent in to assess threats and damage. Connected drones could deliver live aerial audio and video in places not safe for people to access. With 5G, a drone could eventually be flown to distant locations at speeds as high as 310 mph while staying connected to the mobile network. Massive stretches of highways, flood zones, power lines, or fire zones could be examined in minutes, with insights on conditions fed in near real time to responders.

## Improved analytics, down to individual power poles

New 5G networks should eventually allow up to one million devices per square kilometer to be connected wirelessly. And coupled with AI, devices operating on 5G wireless could produce actionable information out of raw data faster. Drone-generated videos, LiDAR readings, photos, and point clouds could be processed right where collected and transferred to decision makers in near real time. Utility companies could get better analytics on supply and demand or system waste. Or, in a heat wave, connected drones could assess how each transformer on an aged power line is performing in near real time. This type of granular information could head off equipment failure — or the next megafire.

## Entirely new capabilities via the Internet of Things (IoT)

[Gartner predicts big innovations are coming in sensors:](#)

Information will be collected on a wider range of situations and events; sensors will be packaged in new ways to support new applications; new algorithms will crunch all the data. These will enable use cases for drones that we haven't thought of yet.

## Infrastructure inspections: the need for speed

Many of the systems that Americans rely on for work, commerce, and daily life were built in the 1960s, when the U.S. population was about half what it is today. They've reached or exceeded their design lifespans, and they're overtaxed. Some examples:

- Over \$800 billion is needed to shore up the nation's roads and bridges.<sup>2</sup>
- Nearly one-fifth of all passenger rail lines are in poor condition.<sup>3</sup>
- The U.S. electrical grid dates to 1882, when Thomas Edison unveiled the first power plant, and its basic structure has remained much the same since.<sup>4</sup>

Drones are a proven approach to improving the pace, quality, and frequency of inspections of these creaky systems. Autonomous, connected drones operating on a 5G network should open up even more possibilities, with intelligent video, remote diagnostics, and near real-time analytics that should help infrastructure managers more quickly see what may be on the brink of failing. Managers should be better able to assess damage, prioritize repairs, and predict maintenance. And the systems we rely on for energy, transportation, water, and more should become more efficient and reliable.

<sup>2</sup> McBride, James, The State of U.S. Infrastructure, Council on Foreign Relations, Jan 12, 2018, <https://www.cfr.org/backgrounder/state-us-infrastructure>

<sup>3</sup> Ibid

<sup>4</sup> McBride, James, Modernizing the U.S. Energy Grid, Council on Foreign Relations, Jan 26, 2016.

# Infrastructure Inspections: Today, 4G, and 5G

Let's take a look at long-distance infrastructure inspections — for example, transmission lines, roads, and railways. This is a great way to understand the varying capabilities of connected drones and how they will give enterprises the opportunity to innovate.

## Horizontal inspections today

Today, companies use airplanes, helicopters, and drones for aerial inspections of horizontal infrastructure. For U.S. companies operating under Part 107 rules, a pilot must be within visual line of sight of a drone at all times. Depending on the terrain and distances involved, this sometimes means that it's more cost effective to use a plane or helicopter. If a drone does make sense, pilots may drive hundreds of miles per day collecting raw data, which they store on laptops or external hard drives and upload to company servers at the end of the day. If they don't have the time or expertise to process the data in the field, colleagues back at the office will analyze the data and determine whether any further

action is needed. In this case, the drone is simply another tool in the field crew's truck. Its primary value is that, in many cases, it's cheaper and safer than using a traditional aircraft.

## Horizontal inspections with connected drones

When drones are connected to a wireless network, they can safely be deployed beyond a pilot's visual line of sight (BVLOS). If a U.S. company receives a BVLOS waiver from the FAA, it can remotely deploy drones from thousands of miles away to monitor a hundred miles of pipeline. Drones can capture a certain number of geotagged photos over a prescribed distance. Because they're connected to the network, they can send the photos back to the office in near real time for further analysis. The company's inspectors use software to compare images from the last inspection and spot defects. Then a field crew can be sent out to make repairs. This is clearly more efficient than the standard line-of-sight operations of today. But it can get even better.

## Horizontal inspections with 5G-connected drones

Let's take it a step further. Imagine hundreds or even thousands of 5G-connected drones stationed at regular intervals and ready to inspect railroad tracks, highways, transmission and distribution power lines, levees, bridges, and dams. They're equipped with remote ID, deconfliction technology, and AI-powered sensors, allowing them to avoid collisions with other aircraft and to be tracked by regulators. They're launched by a pilot at the home office and fly autonomously in airspace governed by a Universal Traffic Management system (UTM) that ensures the safe sharing of the airspace by all aircraft.

The drones are connected to an ultra-wideband, energy-efficient, 5G wireless network via small communication nodes placed on structures in the field. Artificial intelligence software guides the drone, detecting potential infrastructure damage and zooming in more closely at problem spots. It may even identify the nature of the problem or recommend the needed repair. The data collected — terabytes of high-definition video, 3D point clouds, or infrared sensor data — is streamed back to the office in near real time.

No longer just another “tool in the truck,” these connected drones can, with some imagination, become a transformative, cost-lowering, irreplaceable aspect of company operations.

# What You Can Do to Prepare for Connected Drones

Connecting drones is an investment for any company. How do you take the next step forward without jeopardizing what you've already built? With a little smart planning and prioritization, you'll have an easier time moving forward. Use the following tips for best operational efficiency and preventing common logistical challenges.

## STEP 1 Prove value

If you've selected high-value use cases and rigorously tracked metrics along the way, this will be easy. Show how drones have saved the company time and money, introduced new revenue streams, or eliminated a risk. The more you can let the numbers speak for themselves, the more likely your executives will see the business value — and be willing to invest more in company operations.

## STEP 2

### Ensure ongoing operational excellence

This includes safety, efficiency, and cost savings. The goal of any business or agency that uses drones is to provide value to customers or colleagues at a cost that allows a business to make or save money. A failure of any kind can have a significant impact on your business's ability to operate or be licensed. It can damage your reputation, drive up operating costs, cause loss of business or damage to your customer, or worse — cause injury to a person.

Consistency, predictability, and good communication are critical to ensuring successful execution and helping to keep people safe even in stressful and unpredictable situations.

High-reliability organizations are those that conduct consistent, sustainable, and low-error operations based on informed, high-quality decision-making and practices.

A high-reliability organization is able to not only avoid mishap but to produce consistently good results even when operating complex equipment with lots of people involved, and in adverse conditions.

At Skyward, it's our goal to help each of our customers run high-reliability drone organizations.

Essential elements of a high-reliability organization include:

- Minimum qualification standards for remote pilots
- Ensuring accountability and consistency in crew training
- Quality control procedures for data collection
- Pre-planned responses to accidents and incidents
- Risk mitigations for operations in special conditions such as at night
- Risk assessment methodology

## Establishing your drone ops culture

There's a big difference between the compliance training videos on HR policies, information security, and federal regulations that many of us are used to sitting through

once a year and the type of ingrained culture vital to highly reliable and effective drone ops on a day-to-day basis under high production pressures in the field.

As you seek buy-in from executives, legal teams, and risk managers, presenting operating manuals and checklists up front is an excellent way to show that safety and compliance are top of mind. Working with compliance managers and lawyers, companies can customize and refine materials, giving them the flexibility to add additional terms to the operating manual and steps to the checklists.

Your checklists are tools. Keep them simple and focused on the most likely hazards. Remember that highly reliable drone operations are a product of culture, not putting marks in boxes. For internal compliance purposes, some organizations may require documentation that a specific procedural item was completed. You can use actual checkboxes on the checklist for that purpose. For example, if your company requires every flight crew to take a five-minute break upon the completion of a flight, you can add that to the checklist. And, if a company operates in multiple airspace jurisdictions, a drone business operations guide can be customized to reflect different rules as well.

## STEP 3

### Manage Your Data

As your operation grows, extracting more actionable data from each flight will become a vital means to increase the efficiency and value of your operation.

With all this information, data storage, security, and management can become a major logistical challenge and cost center. How long do you need to store your data? How can you best search and maintain these databases as they grow? Thinking about these questions now and planning ahead can spare you a few headaches further down the road.

## STEP 4

### Have Strong Internal Systems

Whether you work for a multinational oil and gas company or a municipal hydroelectric dam, having strong internal systems in place will make the process of scaling up much more straightforward.

So many moving pieces at any given moment (permits, personnel, equipment, schedules, multiple vendors) introduce variables and increase risks. As your operation scales up, you'll find it increasingly important to have an easy-to-use system to manage all of these details, especially once you start coordinating multiple jobs in separate locations with different flight crews and managers. You'll want to know that every crew is following the same processes, that aircraft are being maintained to the same sets of standards, and that everyone is meeting internal and regulatory compliance.

Using a drone management platform like Skyward that includes airspace intelligence can help ensure that standardized procedures are being followed, provide an audit trail to evaluate pilot safety, provide efficient access to airspace, and serve as a digital system of record.

# STEP 5

## Know What You're Trying to Accomplish

From site selection to environmental mitigation to surveying and identifying leaks even underground, drones are becoming an essential for companies that want to save time and money. The following list shows some ways that companies, public agencies, and utilities are using drones today.

- Survey-grade maps for siting transmission lines, pipelines, dams, solar farms, and wind farms
- Leak detection in subterranean, surface, and elevated pipelines
- Line-of-sight analysis
- Interactive visual simulations, like transmission line tower heights, for stakeholder engagement
- Vegetation management inspections for T&D lines and water pipeline rights-of-way
- Inspection of T&D lines for equipment wear, corrosion, leaning, sagging wires, broken insulators, or stay wires
- Construction site monitoring and reporting (counting numbers of rigs, avoiding wildlife habitat)
- Substation equipment inspections
- Gas pipeline inspections and leak detection
- Coal stockpile volume calculation
- Pinpointing malfunctioning solar panels
- Mapping ideal orientation of solar panels to maximize energy output
- Inspection of underwater intake pipes
- Hydroelectric dam inspections, including fish ladders on older dam systems
- Aqueduct and canal inspections
- Reservoir monitoring, including water level trends related to climate change
- Landslide documentation
- Wind turbine preventive maintenance inspections
- Surveys and documentation of bird mortality at wind farms
- Discovery of damaged fencing or anti-climb guards from vandalism
- Monitoring for potential terrorist security threats
- Monitoring for criminal activity
- Remediation site monitoring
- Inspections of ash ponds
- Smokestack inspections



# STEP 6

## Pursue Connectivity

It's important to establish a communications plan that meets the critical needs of stakeholders involved in drone use cases where cellular connectivity provides significant improvement in capability.

As we've discussed, connecting drones to a wireless network can transform them from a tool on a truck to something much more powerful.

Connecting a drone beyond visual line of sight over cellular includes more than just the wireless segment most people think of. Various network segments are involved including the cellular on drone, the towers and radio network, the cellular core network, the backhaul telecommunications network, and the connected devices and services. Safe deployment of drones over a network requires you to understand the basics of the whole communications chain. Work with experts like those at Verizon to plan your connected drone network to make sure the whole system is ready for BVLOS operations.



### Before Your First Connected Drone Flight

- Understand the basics of the whole communications chain
- Radio environment
- Functional requirements
- Failure planning

#### PRO TIP:

Work with experts at Skyward and Verizon to identify security, compliance, quality of service, monitoring, and other needs.

## Key Considerations

- **Radio environment**

There are a lot of advantages in reliability when using managed spectrum, but that doesn't mean you don't have to be concerned with signal quality for the duration of your flight.

- **Data use**

Understand how much data your drone use case needs. Data rates, latency needs, and frequency of communications are all helpful for network planners. We have best practices for cellular communication requirements of various drone use cases to help guide you.

- **Failure planning**

Understand what your drones will do in case of a communications failure and what your drone operators and those relying on the drone will do, not just in case of a communications failure, but for all types of BVLOS data failures.

- **Other requirements**

Plan for security, compliance, quality of service, and monitoring, likely guided by your IT department or network operations center.

## CASE STUDY:

# SOUTHERN COMPANY



In the U.S. alone, there are more than 640,000 miles of high-voltage electricity transmission lines, 5.5 million miles of distribution lines, and thousands of electric-power generation facilities. Maintaining this critical infrastructure and fixing power outages safely are two of the biggest challenges public utilities face. And many are turning to drones to bring this work into the 21st century.

The FAA projects there will be over 280,000 utility projects piloting drone technologies in 2021, and Southern Company is paving the way. One of the U.S.'s largest electric and gas utilities, serving about 9 million customers across 19 states, Southern first got interested in UAS technology as a way to decrease helicopter use and lower risks to personnel.

Since then, the company's drone program has rapidly expanded to include many more operations as Southern Company has seen

improvements in reliability and operational efficiencies, as well lower risks to workers.

## **T&D drone inspections as the entry point**

Preventive maintenance of transmission and distribution (T&D) lines and other capital equipment is costly for utilities. It can also mean risks for the field force: driving winding, remote roads; managing vegetation near high-voltage equipment; climbing towers. This is especially true during and after emergencies when workers are assessing what's down and performing triage.

Following a fatal helicopter accident during a T&D inspection flight, Southern Company was on a mission to find safer ways to inspect its 27,000 miles of transmission lines, 3,700 substations, and 300,000 acres of right-of-way.

Drone inspections were the answer. More than just reducing risks, unmanned aerials have improved the quality of information gathered during inspections. “Before, a routine field inspection of vertical infrastructure would involve looking through binoculars, maybe from a manned aircraft,” explains Southern director of system air Harry Nuttall. “Now, you can fly a drone and get much more fine detail on the components on the structure. That’s gonna have huge benefit. We can get early detection of a fault, and that means our customers win with reliability and cost savings, because we’re keeping the system maintained.”

Other opportunities quickly arose, and Southern Company and its affiliates were among the first energy companies to go beyond line inspections and use drones across the business. UAS is now used to support operations across their large portfolio of natural gas, wind, solar, nuclear, and fossil generation infrastructure.

“Drones have changed the energy landscape in a way that I didn’t foresee when we first started using the aircraft around the company,” notes Southern’s chief UAS pilot Corey Hitchcock, who runs drone standardization and operations for the company. “Initially, I thought that we were just going to

do utility inspections on vertical infrastructure, and that was it. I quickly found out that construction, mapping, and coal pile analysis were other practical uses.”

Specifically, Southern Company’s utility drone services have included:

- Mapping new construction sites and gaining construction progress insight.
- Volumetric studies of coal piles.
- Nuclear cooling tower inspections.
- Damage recovery assessments.
- Wire transport/line pulling, especially in rugged areas.

## Key benefits of drone use in utilities

Improved workforce safety is the biggest impetus behind Southern’s drone program. “Many of the things we’ve done in traditional ways have required manned helicopters, humans climbing things, or our people getting in harm’s way to do inspections or routine maintenance,” notes Nuttall.

“Putting an unmanned system in there really enhances safety and efficiency.”

Better infrastructure resilience is another driver of Southern's drone adoption. Drones have made it possible for Southern to surveil systems in new ways and potentially predict equipment failures. And when there is a storm, drone technology is helping direct resources to the right place in the aftermath, so power is restored as quickly as possible.

Cost and time savings are one more benefit. For example, drones can greatly speed up power line repair following severe wind events. "The traditional method for repairing downed wires was shooting a pilot rope over a tower with a potato gun," says Hitchcock. During post-Hurricane Maria restoration work in Puerto Rico, the Southern drone team pulled 72,000 feet of rope for conductor wire using drones. Work that in the past would have taken six to eight months took just eight weeks. "Simply put, drones got the lights on months faster."

## **Southern accesses best practices for drones with Skyward**

Skyward provides drone ops management software for airspace access, company-defined workflows, and compliance, as well as consulting, regulatory support, hardware, and APIs. The flight team at Southern Company points to six capabilities

the software and company provide that are critical to making their drone program a success:

1. Timely flight plan authorizations. "In the utility space, we have to be very fluid and dynamic with our operations," explains Hitchcock. "Things can take place at a moment's notice. We have a power outage, and we need to go look at it right then. So we use the Skyward app to acquire LAANC authorizations, which allow us to fly in controlled airspace a lot faster than we could in the past."
2. Data collection and analysis. "One of the biggest problems Southern had was being able to track our drone operations, gather data from them, and be able to communicate that data across the company," says Hitchcock. "We decided to partner with Skyward and Verizon due to the quality of their product." On Skyward's platform, everything from safety management system data to flight hours per asset can be digitally tracked and reported, information that Southern used to collect on paper. Nuttall adds, "Without a system like Skyward's, all the performance-based data we're gathering would be lost, and we need to track this so we can build better processes."

3. Staying ahead of regulations. Drones are a rapidly evolving technology, with federal rules that guide how, where, and when pilots can fly in flux. “Skyward’s regulatory knowledge and relations with the FAA have allowed us to focus on what we do best, and that’s keeping the lights on,” says Hitchcock.
4. Real-world training. Hitchcock notes, “Having Skyward’s quick digital access to controlled airspace lets us train new pilots using exactly the same process we use in our day-to-day operations. The ability for us to train in [near] real time really makes operations in the field that much easier.” The company can often get a very proficient drone pilot up and running in a matter of weeks.
5. Scaling across the enterprise. Skyward’s consulting team and fleet management software have made it simpler for Southern to begin to scale drone operations. “We want to make drones a tool for any employee who wants it, not some specialized thing that only a certain person can do,” explains Hitchcock. “We want an engineer to have it as a tool in their toolkit. We want our linemen to be able to use it to cut down on outage times and find easier access into isolated environments.”
6. Deconflicting during disasters. Hitchcock: “Tracking our data, knowing where our pilots are, and deconflicting our airspace are all really important during disasters, when we have manned helicopters flying our lines and rescue helicopters doing operations. Skyward lets us know where manned aviation is and where our operators are, so we can keep those assets apart and allow safe operations inside the National Airspace System.”

## **What’s next for drones at Southern: BVLOS and connected drones**

BVLOS flights are the next advance for the drone industry. Coupled with 5G LTE technology, it should mean a whole new ballgame for drone usage.

5G cellular connectivity, with the low latency and higher data capacity it will bring, could underpin an eventual Universal Traffic Management system: an air traffic management system that can manage all types of aircraft. Fleets of drones could take to the air, autonomously avoid collisions, and be safely controlled from anywhere in the world. They could provide live photos, video, LiDAR data, gas sensor information, and more over a persistent, lightning-fast cellular network.

Southern Company is preparing now for this future. They're particularly excited for the potential combination of BVLOS and 5G technologies to restore power more quickly after natural disasters.

"Getting data out of the field is very critical to our storm recovery efforts," says Hitchcock, "to make timely decisions on how many personnel to get and where to deploy them. Our biggest challenge with getting data in a disaster situation is the lack of connectivity. Having 5G technology to speed that data transfer out of the field would decrease the amount of time for the restoration and decrease the outage time."

The future of drone operations, he adds, "involves 5G-connected aircraft that we can command and control from anywhere and eliminate the need for manned pilots to fly in dangerous environments." Hitchcock envisions mapping service areas using LiDAR cloud points, then comparing such maps after a storm moves through, using change detection to determine what assets are damaged.

"BVLOS would allow us to pre-position unmanned aerials, launch them before it's safe for manned aircraft, and then fly and patrol the line, gathering data more accurately than a pair of human eyes. Imagine getting data in near real time to allow decisions to be made about how much material to get on hand and how many personnel we're going to need for the restoration. It could quickly and safely identify problems, so we can get the materials and personnel on the ground."

### **BVLOS inspections and other innovation on the way**

Southern is working toward obtaining a waiver from the FAA for trial BVLOS flights. "Verizon's expertise in the mobile communications space really is going to cut down on our development time and really get us to our beyond visual line of sight goal faster," Hitchcock states.

"We use drones at the company to help keep the lights on, because without power, you can't communicate, you can't navigate, and you can't refrigerate," says Hitchcock.

5G will help transform the way Southern uses drones. That's because 5G offers low latency, high bandwidth, and security—foundational elements required for autonomous flights.

When drone flights are connected to the Verizon network, we should have digital access to the physical world at scale. Southern should be able to remotely deploy hundreds or even thousands of drones to inspect thousands of miles of transmission lines and receive near real-time reports — as often as necessary.

AI will help provide insights to changes in the infrastructure, connectivity will allow remote deployments and near real-time analysis of imagery, autonomy will allow the drones to fly a precise pattern, and return-to-home at the base of the station, or tower, and automatically upload their results to the cloud.



# Needed Regulatory Innovations: Remote ID & UTM

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Connected drones can be a gamechanger. But without regulatory innovation, we won't be able to maximize the technology. We need a system for universal air traffic management — which would allow air traffic controllers and law enforcement to understand where drones are flying and for what purpose — in order to more safely deploy connected drones.

## **Public-Private Partnerships for Universal Traffic Management**

Historically, UTM has stood for UAS Traffic Management. We believe that a more inclusive concept — Universal Traffic Management — will enable safer airspace sharing among all aircraft. We see UTM as a system of systems, a decentralized network — like a wireless network or the Internet — for coordinating all types of aircraft. This could be the most efficient, cost effective, scalable, and safest method for managing the national airspace. It would require aircraft manufacturers, sensor engineers, software developers, network providers, and regulators to agree upon standards to create and regulate an interoperable worldwide ecosystem.

This sounds ambitious, but there are already effective public-private partnerships encouraging innovation and reducing barriers for businesses on a smaller scale. One example is the U.S. Department of Transportation and FAA's UAS Integration Pilot Program, which is enabling state, local, and tribal governments to partner with companies to develop new systems and use cases.

The Low Altitude Authorization and Notification Capability (LAANC) is another great example. Previously, the FAA required companies to apply for authorization to fly in controlled airspace — which blankets vast swaths of U.S. cities — a process that took up to 90 days. Now, companies request access within the Skyward application to fly for a specific volume of controlled airspace and typically receive approval in seconds. This partnership is already an enormous success.

The success of LAANC is the direct result of the FAA partnering with industry to create safe, sensible regulatory processes that have been automated and delivered by software providers such as Skyward. This is just the beginning. For all its popularity, LAANC is a point solution that mitigates a specific logistical burden. A system of

Universal Traffic Management that enables safe sharing of the airspace, from commercial airliners to small drones as well as the flying vehicles of the near future, is what the industry needs to truly flourish.

In practice, the future of Universal Traffic Management means that protocols will be baked into every aircraft, ground control station, and piece of software to help ensure safety and reduce human error. Any drone should be able to work on any aviation-grade communications network, such as Verizon's 4G LTE network, through any number of applications, following standard protocols. An operator should be able to deploy multiple drones at once, autonomously and from a remote location. Any aircraft should be able to safely navigate among dozens or hundreds of other aircraft of all sizes that are all going about their business. By sharing minimal amounts of essential, standardized information, a global, Universal Traffic Management system that will help safeguard the integrity of the airspace and allow for seamless, equitable sharing of airplanes, helicopters, drones, and other airborne vehicles is possible.

## **Regulatory Innovation and Enforcement**

In the past two years, the FAA has been both forward-thinking and realistic with its approach to commercial drone use, as shown by its adoption of Part 107 of the Federal Airspace Regulations, the Part 107 waiver process, and LAANC.

Moving forward, we would like to see additional funding for the FAA that would allow it to continue to develop sensible regulations and a more efficient waiver process, as well as specific direction to collaborate with industry and implement standards toward this Universal Traffic Management system, including one requiring remote identification of all aircraft, both hobbyist and commercial. Congress should also direct the FAA to work with industry and law enforcement stakeholders to better enforce the regulations and laws that we currently have.

## **Encouraging Market Competition**

Federal regulations must support the efforts of industry for competition to flourish, and there is an opportunity for regulators to manage all vehicles in the air safely and in a way that enables commerce. A requirement for remote identification could directly enhance safety and spur economic growth. But without remote ID legislation, Universal Traffic Management will never become a reality, the potential for drones won't be maximized, and commerce will be restricted, slowing an important source of economic growth for the country.

In the meantime, Skyward continues to develop networked fleet deployments and Universal Traffic Management. Operating drones on Verizon's 4G LTE Network will be critical to a distributed UTM network — for remote ID, flying beyond line of sight, and remote networked fleet deployments. 5G infrastructure will help enable secure aviation-grade routing and beyond line of sight flights. 5G's

latency, reliability, and the high density of micro cell sites should eventually make it a good candidate to support autonomous air taxis. Virtual network slicing in 5G can protect pieces of the network for safety applications like search and rescue.

The technical and regulatory project of integrating the airspace is enormous, and small steps are already having a tremendous impact — but now we need to make bigger strides. LAANC represents a successful technological-regulatory first step toward airspace integration, but in the near future we'll need highly sophisticated, dynamic, and secure technical networks to ensure safety and competition.

# Manage and Scale with Skyward's Drone Operations Management Platform



## **Validated Drone Airspace Map**

Gain access to fly in controlled airspace in seconds & collaborate with flight crews



## **Digital System of Record**

Store & organize licenses, insurance policies, & regulatory paperwork



## **Drone Flight Logging**

Track flight hours & maintenance for regulatory requirements.



## **Manage All of Your Teams & Operations**

Schedule crew members, create efficient workflows, & track business metrics

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