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Enterprise-Level Coordination of sUAS Aerial Imaging for Disaster Recovery

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INTRODUCTION

On September 10, 2017, Hurricane Irma made landfall on the Florida mainland. After battering the Caribbean and the Keys, causing 60 billion-plus dollars in damage and dozens of deaths, the storm threatened to destroy roads, buildings, and infrastructure across Florida and the coastal Southeast. In the wake of Hurricane Harvey, which devastated Houston and other areas along the Gulf of Mexico, there was widespread concern that cities like Miami and Tampa would face catastrophic flooding and severe damage from Category-5 winds. Organizations across the country mobilized to assist the people of Florida in the form of food, supplies, medical aid, and technological support; thankfully, the worst did not come to pass, and the damage was much less severe than expected.

In preparation for anticipated damage to Verizon's wireless infrastructure in Florida and Georgia due to Hurricane Irma, Skyward, a Verizon company, established the Skyward-Verizon Emergency Response Aerial Operations Cell to manage aerial operations (both sUAS and manned) conducted on behalf of Verizon.

Lessons learned from efforts directed to provide support in the aftermath of Hurricane Irma can be implemented in future disaster scenarios, potentially saving lives, property, and infrastructure. This white paper aims to describe a framework for coordinating aerial imaging operations in a disaster or emergency scenario. The processes described here can be applied to aerial imaging operations for other kinds of structures and facilities, and will help in the recovery process by increasing the efficiency and frequency of inspections, damage assessments, and other recovery-assisting operations.

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PLANNING

As unpredictable as hurricanes can be, they are forecastable events whose consequences can be estimated and prepared for. When an area is in danger of being struck by a hurricane or another forecast disaster, the planning for an aerial imaging operation must start immediately in order to coordinate with vendors, in-house personnel, and regulators, and to stage teams across the affected area if required.

One of the first steps in the process is to draft and publish a written Coordination Plan. The Coordination Plan is the foundation of aerial imaging operations. In a disaster, hesitation can spell the difference between success and failure, life and death. A Coordination Plan empowers stakeholders to set necessary pieces in motion before it's too late. This initial plan will almost certainly undergo revision as the situation develops so it's important to quickly establish a rough framing document rather than to devote time and effort trying to produce an exhaustive or detailed plan.

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A Coordination Plan should cover the following points

1. Essential Tasks

Define the high-level objectives that need to be accomplished in order of priority. It's essential to define the scope of operations to make the best use of limited resources. From these determinations, all else follows.

Initial efforts will generally be directed at general damage assessment in order to inform initial decisions about how recovery assets should be allocated. Where are the affected facilities and infrastructure, and how damaged are they?

More detailed property integrity inspections of damaged infrastructure or facilities can help assure protection from further damage—can a collapse of a structure or secondary damage be prevented by proactively detecting signs of failure?

To protect the physical safety of ground crews, an access assessment is vital. Having up-to-date visual information on roads and other access routes helps prevent situations where a ground crew is either in immediate danger or is unable to operate efficiently (or at all) due to road conditions. Unpredictable factors such as mudslides or sewage overflows can change the conditions on the ground in an instant, and it helps to be as informed as possible.

Last but not least, a detailed infrastructure inspection will inform a more targeted repair and recovery effort. The information collected in this phase can help in the allocation of resources as the team works to rebuild and repair any damages.

2. Planned Timeline

Make a rough timeline for preparations, staging, and deployment. Natural disasters are difficult to predict, so the timeline should be adaptable. There are a few questions a planned timeline should answer:

- When will the first meeting be and who should be there?

- What will the operational rhythm be?
  Set a time for periodic group calls—by phone, on a teleconference, or in person.

- When is the Coordination Plan expected to be finalized?

- When is the data distribution infrastructure expected to go live?

- When should flight teams expect to deploy?

3. Organization, Tasking, and Reporting Chain

Defining the organization, tasking, and reporting chain establishes protocols that will define the role and responsibility of each party. After a disaster or emergency, there are many stakeholders involved including company managers and technicians, government emergency response managers and operators, vendors, other company vendors, etc. The keyword is *coordination*, as the company UAS operations manager is likely to have direct authority over only company internal UAS operations.

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Who is the coordinating authority?

This party receives and aggregates requests from managers, and field staff for aerial imagery and rationalize the requests according to the availability of UAS or manned flight teams near the affected sites.

This should be a relatively small team (3-4 people) composed of people with a mix of your industry-specific and commercial UAS-specific operational and technical backgrounds. Expertise of both types is essential when responding to the variety of operational and technical issues that may arise when operating UAS to obtain and distribute useful information after a disaster.

Who has operational control of sUAS?

In other words, determine who is responsible for the direct operational control: the scheduling, initiation, and termination of each flight. This responsibility should ideally belong to the vendors and operators on the ground who actually perform each flight. Such an arrangement naturally requires a high degree of trust.

How will operational reporting be accomplished?

Up-to-date operational reports are essential to supervising operations that unfold rapidly and over a relatively large area. At minimum a daily report should be generated which includes a summary of operations over the past 24 hours, the current location, status, and availability for tasking of each team and aircraft. In addition, the person with direct operational control should inform the coordinating authority of their general intent and specific planned operations (if known) for the next day. This is also a chance for vendors or other stakeholders to make any requests for information or coordination assistance.

How will your company maintain awareness of where its internal or vendor operated UAS flight teams are?

Tracking the movement of vendors and operators helps coordinate a complex set of priorities. Effort should be made to report when teams arrive at a site, when work is complete, the next destination and expected time of arrival at that destination. If communications are available, these reports should be fed immediately to the coordination channel.

How will imagery and other data be backhauled to company managers and technicians?

Getting to the site, flying safely and efficiently, and capturing the imagery you need is only part of the challenge. Transferring the resulting large files from the field, especially when internet service is affected by adverse conditions may be very challenging if not impossible. Set up your data infrastructure ahead of time to make sure efforts on the ground have an impact as soon as possible.

How will you perform general oversight of all operations?

Using a tool specifically made for managing UAS operations, such as Skyward, is critical to establish structure, accountability, and maintain a complete log of flights. Skyward provides a centralized platform for coordinating multiple flight plans across a few or many flight teams.

Who is responsible for ensuring compliance?
Even with the best intentions or in the worst conditions, an illegal or noncompliant flight is unacceptable. Operators and vendors should be responsible for ensuring that their pilots are certified, and that Emergency Certificates of Authorization (COAs) are in order, but it helps to have the coordinator assist with the flight authorization process. Consider obtaining centralized Emergency COAs instead of each vendor obtaining Emergency COAs separately. This will enable UAS operations within Temporary Flight Restrictions established for disaster response or within controlled airspace.

4. Participants and Points of Contact

Collect a list of the representatives of the parties involved in the aerial imaging operation in order to facilitate communication. Provide company names, contact information for representatives, and any useful information that doesn't detract from the readability of the list. It is helpful to also establish a secure forum for group communication where general information can be pushed instantly to all parties.

MANAGING OPERATIONS

Even though a lot of effort is required to put all of the elements in place, the best case scenario is not having to perform a single flight, with the storm passing uneventfully with minimal damage and no casualties. But if the worst happens, you will be prepared to respond effectively and efficiently.

When the time comes to oversee and coordinate operations, there are many threads to keep track of: vendors, regulators, requests for services, and all other aspects of the aerial imaging effort. The coordinator must be able to react to changing conditions on the ground while adhering to the priorities set out in the Coordination Plan.

The coordinator is responsible for making certain decisions and providing oversight in the course of managing an aerial operation in the wake of an emergency—and even during routine operations.

1. Provide Operational Oversight

The coordinator must have a bird's eye view of the entire scope of operations and maintain awareness of the actions and status of everyone involved. They serve as the conduit between people on the ground requesting aerial data and the teams providing that service, and they act as a nerve center directing the overall effort. Without a careful eye to keep everything on track, it is easy for siloed teams to come into conflict, map the same areas, and detract from

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the effectiveness of the repair and recovery efforts. It's important to *coordinate*, not to control and manage, the details of the operations of individual vendors or flight teams.

It's unlikely that a single individual will possess the mix of operational and technical domain expertise most relevant to the situation so be sure to identify a mix of possible candidates for the coordination cell early. You will need domain expertise in your industry, commercial UAS operations, and aviation regulations as well as skill in managing various types of information exchange tools and file formats.

2. Technical Support

There is a significant amount of data and information that need to be transferred, which requires practical knowledge of data infrastructure to troubleshoot problems as they arise. Especially in a disaster scenario where ordinary means of communication are impaired or completely cut off, the ability to respond knowledgeably to issues that arise with the aircraft, controller, and any tools being used to collect and share the captured images.

3. Operational Support

Experienced pilots sometimes describe an "operational rhythm," because when a well-structured workflow is established it feels like a choreographed dance or musical composition. Establishing an operational rhythm supports

repeatability, consistency, and accountability. The rhythm determines when the teams' days begin and end, when they communicate, when they fly, when data is expected—all of this goes toward enabling consistent output despite the high stress and disruption of a disaster recovery effort.

Crews on the ground will encounter unforeseen circumstances to which they must respond safely and effectively. Roads may be flooded or blocked, winds can rapidly shift in direction and velocity, and other flight or surface conditions may change with little or no warning. The coordinator can provide guidance on how to proceed by liaising between those in charge of the facility and the flight team, and also by drawing on both intrinsic and extrinsic knowledge of risk gained from operational experience and reliable flow of information to the coordination cell. In addition to operational experience specific to your industry, completing the FEMA National Emergency Management Basic Academy is recommended to strengthen the ability of coordination cell members to work with government and other private emergency managers.

4. Managing Flight Personnel

Deciding how and where to deploy the teams—whether an in-house aerial services division or an independent contractor or a combination—is a vital function of the coordinator, and it requires balancing two key considerations: How can the coordinator provide

the best and most comprehensive service to the affected area, while avoiding waste and inefficiency by using only the resources needed to get the job done?

Though one can't be sure ahead of time which resources will end up being needed, that uncertainty can be built into how the operation is organized and how the vendors are contracted. When dealing with a forecast event, vendors should be notified of a possible need for sUAS services and asked to provide a bid for a certain number of active crews. After the incident occurs, a decision should be made to activate crews as needed. Initially, it's best to contract for just a handful (3-4) of sUAS crews. The nature of post-disaster recovery suggests that it will take a minimum of two days after the event to determine if aerial imagery services will be required.

If the time comes to activate your teams, distribute lists of affected sites to specific vendors for aerial imagery. There should be clear and explicit standards for the work product expected. The coordinator's role is to synchronize vendor operations with other activities and hazards, and prevent conflict or bleed-over between teams in order to protect proprietary information for all involved. In order to avoid lapses in communication, the coordinator should serve as a single point of contact for all vendors providing aerial imaging services. Finally, and perhaps most importantly, maintaining operational rhythm is the responsibility of the coordinator. The coordinator should ensure that all vendors maintain awareness of flight team movements, provide daily operations summaries, and notifications of conditions which may affect operations.

5. Managing Business Operations

It's very tempting to allow the exigency of a disaster to cause one to shortcut sound business practices such as ensuring that:

- Proper services agreements are in place

- Vendors provide evidence of a track record of successful completion of similar tasks

- Vendors are properly insured for sUAS/UAS operations

- The scope of work and required deliverables are well understood by all parties

- Vendors properly bid for the provision of services and that your company considers each vendor's bid for the value it provides

It's a good idea to separate the operational coordination function from the function of managing the business elements of using vendor UAS flight or data services. It's best if service agreements are already in place before the disaster occurs.

Keep in mind that for many vendors, it's in their own interests to have UAS flight or data service capacity in place. The burden of deploying or staging vendor capacity is not necessarily something your company should bear.

The Future of sUAS Usage for Disaster Recovery

Expansion of the constructed environment exposes more infrastructure to the effects of natural disasters. Unmanned aerial imaging technology offers the opportunity to make the process of recovery safer and more efficient. Though they have some very clear limitations, drones are cheaper to operate, require less energy than a fuel-powered helicopter or plane, and don't require that a human put their life at risk by flying in poor conditions. By virtue of these facts, unmanned aircraft can often fly more frequently and at a lower cost, potentially providing more up-to-date, high-quality aerial data. This data can help preserve and repair vital infrastructure upon which lives and livelihoods depend.

As with any new technology, the optimal applications for sUAS are still being discovered, and the proper organizational and logistical structures are bound to evolve along with the capabilities of the operators and equipment. Nevertheless, the undergirding principles of aviation will remain. The values of safety, accountability, and repeatability that are fostered in a well-run professional aviation operation are especially important in times of chaos and disaster, when distractions and dangers are more prevalent than ever.

Download a sample of Skyward's
General Operating Manual
and Operational Checklists
at go.skyward.io/takeflight

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