**David Willems** and **Ewen Stockbridge Sime** explore the growing significance of unmanned aerial vehicles in infrastructure protection and maintenance

# MISSION CRITICAL

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No one, let alone professionals working in the security and defence industries, needs to be reminded of the vulnerability of core national infrastructure assets. The high-profile attacks of 9/11 in New York and also the Pentagon in Washington DC, together with countless other incidents ranging from perimeter breeches of civil airspace and airports to catastrophic loss of people and assets, demonstrates all too clearly the vulnerability of essential infrastructure. From oil and gas pipelines and storage tanks to nuclear and power generation facilities, the requirement to ensure round-the-clock vigilance should be a priority in any strategic asset protection plan.

The US Department of Homeland Security defines 16 critical infrastructure sectors whose assets, systems and networks – whether physical or virtual – are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination of these elements. These are: critical infrastructure, the chemical sector, commercial facilities, communications, critical manufacturing, dams, defence industrial base, emergency services, energy, financial services, food and agriculture, government facilities, healthcare and public health, information technology, nuclear reactors, materials and waste, transportation systems and water and wastewater systems.

What has to be considered when factoring in UAV strategies is that many physical and electronic defence capabilities were developed before their advent. This puts into sharp focus the threats and opportunities provided by Remotely Piloted Aircraft Systems (RPAS). On one hand they present a powerful and essential tool in the development of strategic security and preventative measures, but on the other, they can also present a threat when used for hostile intel gathering or even physical

attacks against a facility.

This is why it is essential that UAV deployment is placed in a strategic context. The obvious versatility of unmanned aircraft enables them to be an essential part of the assessment of risks from the outset. A fundamental role, either as part of a civilian or military organisation should include field assessments to identify vulnerabilities.

For example, nuclear power plant owners and regulators in the US are assessing whether unmanned aircraft systems (UAS) can perform key functions following accidents. UAVs may be able to supplement notification systems (for example, emergency sirens and tone-alert radios) by emitting siren-like sounds that alert people to turn on televisions and radios to hear official declarations about any precautionary measures authorities are recommending. They may also be able to augment radiation monitoring by flying routes downwind of the stricken facility and relaying continuous readings back to an emergency response centre. This radiation level information can be used to fill in gaps between the existing ground-based detectors.

Hurricane Katrina saw the first deployment of UAVs in a disaster, setting the stage for such deployments worldwide — from the Fukushima Daiichi nuclear accident to the Nepal earthquake. The hurricane was a landmark for UAV technologies, pivotal in their development for emergencies.

Katrina also contributed to policy changes that affect how UAVs deploy in disasters: military equipment is now easier to deploy, but when the US Federal Aviation Administration (FAA) "clarified" the certificate of authorisation requirement for drones in 2006, it created restrictions for civilian flights that remain controversial to this day.

An inspection VTOL (vertical take-off and landing vehicle) examined structural damage at seven multi-storey commercial buildings. The rotorcraft was able to provide views of the buildings from angles that were impossible to get from the ground or flyovers. The results not only helped engineers see that the storm's wind damage was much less than expected, but also led to a set of studies that would guide safe crew-organisation practices used by responders in the US, Europe and at the site of the Fukushima Daiichi nuclear accident.

The Katrina flights also showed structural inspection was not simply a matter of taking photographs. Structural specialists who viewed uploaded images had trouble comprehending the state of damage. Addressing such problems in "remote perception" remains a major open research question.

Since Katrina, UAVs have been used worldwide for disasters for two reasons. First, they provide better vantage points and higher-resolution images than satellites or manned planes and helicopters; second, they deploy faster and responders can control them tactically.

Unlike a manned helicopter or National Guard Predator that has to fly in from an airport or base, tactical teams can transport a UAV into a hot zone, deploy it on demand and immediately download imagery — a far simpler and faster process than requesting imagery from aircraft controlled and coordinated by a centralised authority, which requires time, a multitude of people and connectivity to achieve.

A security aspect that has gained more traction in recent years relates to systems that deal with the increasing number of UAVs, which accidently or deliberately are venturing close to or even over critical infrastructure areas where they should not be. Examples of UAV activity that has given cause for concern range from the multiple reports of unidentified drones flying near French nuclear power stations to near misses with civilian aircraft. In terms of responses to the UAV dilemma, a number of strategies are being reviewed. One answer is a multi-sensor UAV warning system, which reflects the reality that the size, speed, and shape of UAVs make identification extremely difficult for a single monitoring method. This utilises a system of interacting sensors to reliably detect all types of UAVs based on multiple


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parameters such as noise, shape and movement patterns, with the processing done in the device itself or via cloud computing. Interestingly, the United States Federal Aviation Administration (FAA) is evaluating types of anti-UAV system at US airports as part of its Pathfinder programme. No doubt, aviation agencies worldwide will follow trials with keen interest.

New solutions such as UAV deployments are becoming a popular choice not just as new inspection devices, but as defensive measures around critical infrastructure: power, network, emergency response and data centres.

Ways of protecting critical intelligent infrastructure and smart grids include surveillance and remote monitoring. One way to achieve this is to deploy a UAV to monitor any suspicious activities as well as check the status of the condition of hard-to-reach cell towers and other network and power infrastructure. Even if UAVs are just used for routine inspections, they will reduce costs of deploying personnel in the field, and avoid potential accidents when technicians do not have to climb towers to perform routine inspections.

Nordic Unmanned, which among other activities performs lifting operations, pilotline pulling and re-locating pipeline equipment, has utilised UAV systems including UMS SKELDAR's V-200 helicopter and the Lockheed Martin quadrotor Indago for Statnett – the Norwegian energy infrastructure provider. This project involves monitoring 11,000km of high-voltage power lines and 150 stations across Norway. Operations are monitored by one national control centre and three regional centres. Statnett is also responsible for the connections to Sweden, Finland, Russia, Denmark and the Netherlands.

Looking to potential applications to support infrastructure, for example, in emergency situations such as floods and natural disasters, overhead network capacity provided by UAVs is a much faster way to reconnect those on the ground with a functioning communications network infrastructure. Any in-place towers damaged can be augmented by drones providing network services.

Utilities, like Xcel Energy, have received FAA license exemptions for line-of-sight operations in order to inspect thousands of miles of transmission lines. These lines can often be difficult to reach, with access previously limited to helicopters, which cost companies significantly more. Pipeline operators face similar physical obstacles to inspecting their systems, and given that UAVs can be fitted with lidar, infrared and other visual imaging devices, they can help companies to detect methane leaks or other issues.

They have also been used to assist in power plant inspections. Using a UAV to inspect a boiler or cooling tower has the potential to reduce down time, save money and avoid the safety hazards associated with sending workers in to perform these inspections. Similarly, UAVs can help with the efficient and precise inspection of renewable generation, like wind turbines, which are often spread out over wide territories. Blades require regular inspection and companies often send workers out to inspect the equipment with binoculars or, if more intensive inspection is necessary, by climbing the turbines. This work is costly and puts workers at unnecessary risk. UAVs can allow operators to perform up-close inspections in a much more efficient and safe manner. Solar PV operators have started to use UAVs to inspect larger facilities, as well.

In all of these cases, UAS technology has enabled energy companies to take operations and maintenance work that was previously costly, time consuming and sometimes risky, and reduce all of these negative factors substantially.

In summary, the UAV industry is developing globally, led by a dynamic mix of established aerospace players and start ups. Applications range from humanitarian, security, defence and disaster recovery to emergency response, infrastructure, agriculture and wildlife protection.

Unmanned strategies have secured a central and crucial role in helping to build, maintain and protect critical national infrastructure assets. Those who do not integrate RPAS in their strategic plans risk falling short of what is required in the most demanding of situations, where the wrong decision can make the difference between life and death.

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