Accenture Technology Labs

It's Time for Flying Robots

Key recommendations for making
unmanned aerial vehicles operational

High performance. Delivered.

Introduction

Savvy business executives are always looking for opportunities to reduce costs, mitigate safety risks, boost production and improve competitiveness. Increasingly, unmanned aerial vehicles (UAVs)—also known as drones—are becoming an attractive technology to help achieve these goals.

Successfully deployed in limited commercial settings during the past few years, UAVs have shown early signs of strong business value in several applications. For example, BP conducted UAV pipeline inspection tests in 2012 in Alaska,[1] Royal Dutch Shell Plc has tested unmanned aircraft for land surveying, and Amazon has announced Amazon Prime Air as a way to optimize the delivery of packages by as early as 2015.[2] In time, UAVs have the potential to alter the way emergency response is delivered, the way food is grown, the way inspections of manufacturing and production facilities are conducted and more. Overall, these examples demonstrate how autonomous UAVs will extend and amplify what humans are already doing by adding remote sensing, actuation and predictive tasks.

The UAV market is gaining momentum with some countries permitting the use of these flying the machines for law enforcement and emergency response, while other countries continue to impose fairly strict regulations on commercial applications. Despite these variances, the aviation and aerospace industry research firm Teal Group estimates that global spending on unmanned aircraft will double over the next 10 years to nearly $90 billion, with the US accounting for 62 percent of research and development spending, as well as 55 percent of procurement spending.[3]
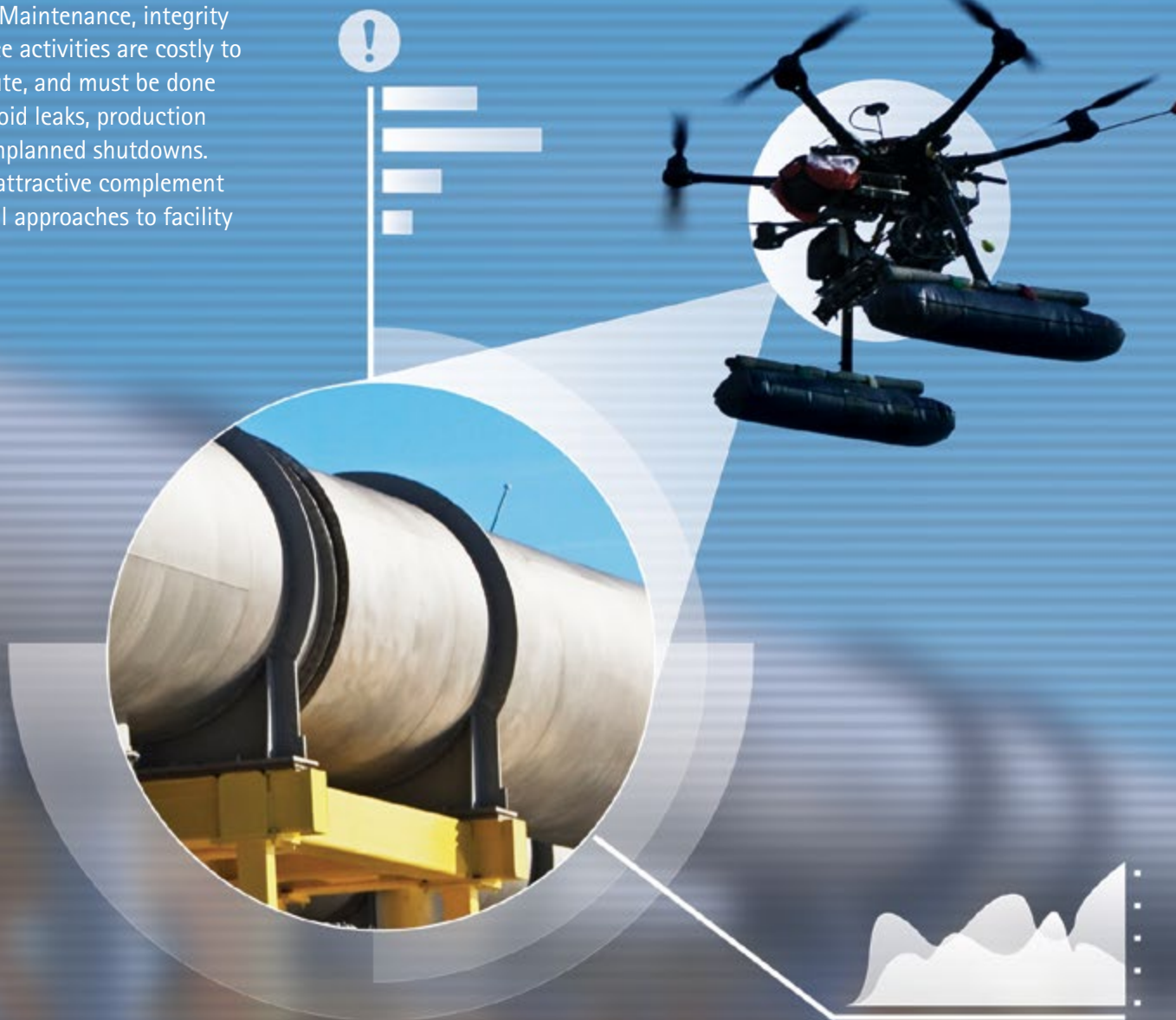
From an enterprise perspective, the possible business uses for UAVs are wide-ranging. However, the technology is also potentially quite disruptive in terms of how these companies will operate in the future. As enterprises leverage UAVs to complete tasks currently done by humans, they must address a number of operational challenges and adjust underlying business processes to accommodate a collaborative environment between humans, robots and IT systems. In addition, they must determine what business value can be derived from automated data gathering, which tasks can be both electronically and mechanically automated in a workflow, and what intelligence can be obtained from data gathered. This point of view offers key recommendations on how to forge ahead with flying robots.

Pipeline monitoring and inspection for the oil and gas industry

In the Energy industry, one critical function is asset management and monitoring to assess production performance, environmental and safety compliance, overall integrity and other factors. While the needs are straightforward, the complexities, risks and scale involved are immense: pipelines span thousands of miles, manufacturing facilities offer potential exposure to hazardous chemicals, and production platforms are often remote, for example, in deep water and arctic environments. Maintenance, integrity and surveillance activities are costly to plan and execute, and must be done routinely to avoid leaks, production outages and unplanned shutdowns. UAVs offer an attractive complement to conventional approaches to facility management.
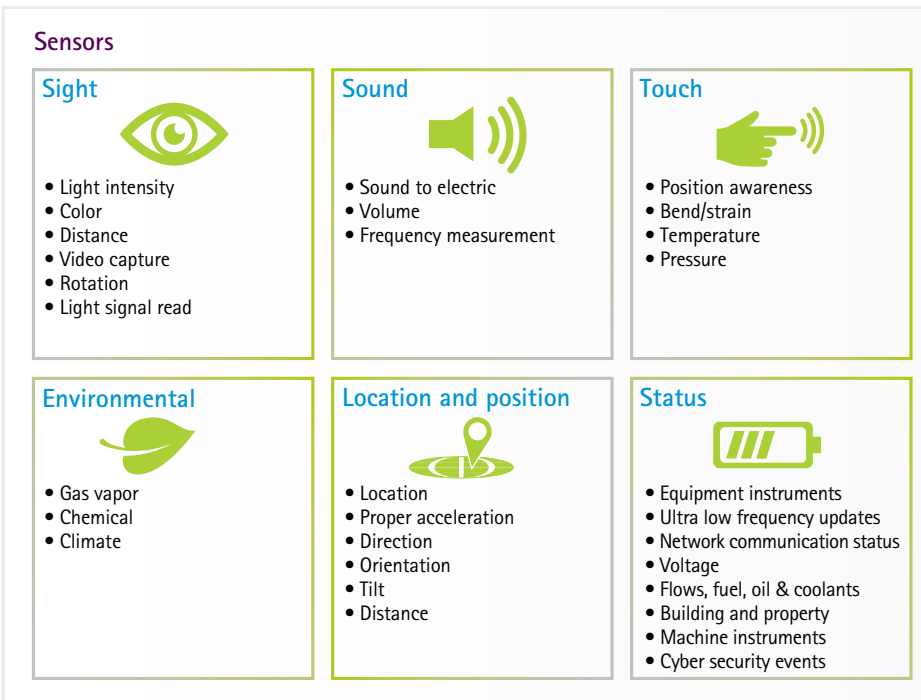
Several global organizations have deployed UAVs, and found that they demonstrated significant, measurable value, including improving industry operator safety. Accenture believes there are even greater untapped opportunities for cost savings through activities such as automated data gathering, automated maintenance, integrity and surveillance workflow, and data analysis to generate predictive insights on facilities. These insights can be used to drive operational decisions and improve business processes, such as shortening lead time to problem detection or predictive maintenance in industries with field force operations.

A closer look at UAV technology

Sensors

Sight
- Light intensity
- Color
- Distance
- Video capture
- Rotation
- Light signal read

Sound
- Sound to electric
- Volume
- Frequency measurement

Touch
- Position awareness
- Bend/strain
- Temperature
- Pressure

Environmental
- Gas vapor
- Chemical
- Climate

Location and position
- Location
- Proper acceleration
- Direction
- Orientation
- Tilt
- Distance

Status
- Equipment instruments
- Ultra low frequency updates
- Network communication status
- Voltage
- Flows, fuel, oil & coolants
- Building and property
- Machine instruments
- Cyber security events

Enterprises can choose between three types of UAV platforms based on the amount of control or autonomy needed in their flight and operations:

Remote controlled

The simplest of the three, a remote controlled platform has no capabilities to control its behavior and relies on a human operator to perform tasks. The remote controlled platform is instructed what and how to make every behavior change, and is guided through each task. Typically normal remote controlled UAVs require line of sight to a human pilot, either from another aircraft or on the ground.

Task following

This type of platform has the ability to be told or shown how to perform a task, and then will repeat the task until told to stop or a predefined exception occurs. Task following UAVs, which have a computer inside, can be flown with or without human monitoring.

Semi- to fully-autonomous

This smart platform is given one or more tasks, access to real-time sensor data, a set of goals

to achieve, and then is turned loose to solve the task using its own intelligence and perception of the world around it. (Note: Robots have been defined as either task following or semi- to fully-autonomous platforms.)

The role of sensors:
Telemetry is a key reason why UAVs are equipped with sensors. UAVs contain built-in intelligence to keep them stabilized in the air and carry sensors to perform dedicated functions. These types of sensors are used to determine the position and altitude of a UAV at any given point in time. Ground control uses a communication channel with the positional and location telemetry to navigate the UAV autonomously according to pre-defined waypoints without any human interaction during the flight.

Based on mission objectives, the UAV can also complement the flight path telemetry with other types of sensors. One of the most commonly attached devices is a video camera mounted on a gimbal (for balanced movement) to obtain high-fidelity video and still photography; however, depending on each aerial platform's lift capabilities and payload specifications, UAVs can also carry

multiple sensors and extract a wide spectrum of surveillance information, including temperature, pressure, audio and others listed in Figure 1.

The role of a command and control platform:
In the longer term, UAVs will be able to carry other processor, output or physical movement subsystems to perform more complex actions. The data architecture will have to evolve to support consumption and interpretation of real-time streams.

The role of flight management and auto-pilots:
Mission operators use a flight management system to plan and communicate directions, as well as other desired flight behavior, which enable UAVs to perform tasks. The system is then used to monitor the UAVs during the operation of their tasks. Ideally, the flight management system will participate in the interpretation of the data gathered by the UAVs. For example, analytics functions can be used as part of a command loop that extends the intelligence of the UAV and modifies behavior in reaction to what the UAV perceives in tasks.

Get ready for innovative enterprise applications of UAVs

Figure 2: UAV adoption across industries based on market viability and solution complexity

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UAV usage is staggered across the globe with companies in various stages of experimentation, research and business case justification. In countries where regulatory restrictions are not an issue, such as Japan and Australia, the rate of adoption is accelerated. There is more limited usage occurring in the UK and Canada and early trials in the US. Despite this lag, the Association of Unmanned Vehicle Systems International (AUVSI) predicts in the first three years of UAV integration in the US, more than 70,000 jobs (including 34,000 manufacturing jobs) will be created with an economic impact of $13.6 billion. By 2025, the number of jobs will increase to 100,000 and the economic value to $82 billion. According to AUVSI, for every year commercial UAV integration into the national airspace is delayed, more than $10 billion in economic potential is lost.[4]

As the market advances, enterprises in many different verticals will explore UAVs to automate workflows by replacing or augmenting human loop, with the oil, gas and agriculture industries taking the lead. Overall, we see the enterprise adoption of UAVs dependent on two variables: market viability and solution complexity. (See Figure 2.)

Benefits of using UAVs in enterprise business processes

Decrease costs

A UAV can be used to automate simple tasks and therefore reduce labor costs. For example, aerial inspection of pipelines using helicopters costs approximately $3,000 for an hour of operations.[5] UAVs have the potential to reduce these costs significantly while providing better accuracy through the use of multiple sensors on the same platforms. Holcim, a cement producer, has started using UAVs to provide authorities with information about the amount of gravel extracted from a local quarry. This process used to take five days; it is now done in half a day.[6]

Reduce safety exposure

In areas that have been exposed to contamination or are potential security threats, UAVs enable organizations to explore these areas and even deliver supplies without exposing employees to the associated risks. For example, UAVs were used in Fukushima to assess the nuclear reactor damage.[7]

Increase production

Enterprises can use UAVs to complement the work of humans and expand production capabilities across multiple industries. For example, 3D Robotics is conducting tests with farmers to understand user needs and testing custom UAVs for agriculture.[8] In the energy sector keeping refineries and rigs up and running ensures the flow of product to customers. UAVs can be used to avoid unnecessary shut-downs or reduce the disruption to operations—which keep oil and gas moving.

Improve competitiveness

Increasingly companies are using UAVs as a competitive advantage. Most notably, Amazon recently announced it is exploring UAVs for package delivery by 2015, with UPS and FedEx testing similar services.[9,10,11] Shenfeng Express in China has been testing delivery logistics using UAVs since 2013.[12]

Address global concerns

The Harvard-MIT Division of Health Sciences and Technology received a grant from the Bill & Melinda Gates Foundation to develop UAVs to deliver vaccines and medicines to hard-to-reach locations and disaster zones.[13] Similarly, Matternet is moving ahead with a service using UAVs to deploy medicines to emergency areas with tests done in Haiti and remote parts of Africa.[14] And NASA is sending a UAV into the stratosphere. The flights are the first of a multiyear campaign to study how changes in water vapor and the ozone interact and how changes in the stratosphere can affect the global climate.[15]

Five recommendations to make UAVs operational

Enterprises need to carefully plan for the deployment and integration of UAVs into their business processes. To support this effort, we have identified five key recommendations:

1. Manage for a fleet, not a flight

Much of the experimentation done to date has been hands on and high touch involving a small number of UAVs. However, enterprises should expect that the actual number of UAVs needed will vary by situation. As such, they should work to acquire and manage a fleet of UAVs, some of which will likely be of different types (e.g., fixed wing, quad copter, etc.) based on the business application.

For example, an oil and gas company would need a network of UAVs dense enough to guarantee the time to destination based on a pipeline leak risk analysis. If the threshold for a leak alarm is two percent of 1000 m3/hour nominal flow and the environmental agency requires a maximum volume of the leak to be 10 m3/hour, the UAV must find and confirm the leak within 30 minutes (two percent of 1000 m3/hour during 30 minutes of flow), so that the pumping will be stopped within constraints.

Enterprises will also need to use UAV fleet management software to handle requirements, such as availability, maintenance, deployment locations, spare parts and servicing. And in terms of fleet operations, enterprises will need to translate workflow requests into missions, which will need to be managed and scheduled based on availability and deployment of a specific UAV.

2. Plan global, think local

Many organizations have intentions to leverage UAVs in multiple geographies. Although we encourage enterprises to prepare for such global deployments, these plans will have to be adjusted to accommodate local guidelines and regulations, which vary dramatically based on jurisdiction. For example, the US federal government has instructed its Federal Aviation Administration to publish rules that will permit UAVs to use public airspace by September 2015. In comparison, nearly a dozen European Union member states have no laws preventing small UAVs from flying below 150 meters.[16] As with all business operations, enterprises are expected to be well versed in the legal rules of the countries in which they plan to operate UAVs. For a quick snapshot of major markets, see Figure 3.

In addition to legal and regulatory considerations, enterprises may also be required by law to purchase adequate insurance for UAV operations to ensure that they can meet their liabilities in the event of an accident. This includes coverage for both the UAVs, as well as potential third-party liabilities. Factors that impact the insurance costs will include the type of aircraft, weight category of aircraft, location coverage, potential use, qualifications of the pilot in command, airspace being flown (altitude, controlled or restricted) and experience of the organization managing the operations.

3. Design for data collection and analysis

Enterprises will use sensor data collected by UAVs to guide work processes and generate insight. The sensor data that is collected can be used for preventive maintenance, operational intelligence and/or predictive maintenance. For this reason, companies will need a data management platform to capture, process and analyze the incoming data to identify notable events and create reports. (See Figure 4.)

4. Change how work is done

To take full advantage of UAVs, we recommend that enterprises see them as an active part of the business process. This approach changes the role of existing employees (e.g., field operators, analysts, IT operations), as well as the data, IT infrastructure and operations. Continuing with the oil and gas pipeline maintenance example, UAVs would function as new "digital workers," taking on tasks that were previously done by humans, such as leak detection, perimeter surveillance and right-of-way monitoring. Ultimately, this approach could improve asset integrity, mitigate risks, facilitate faster decision making and increase executive oversight.

5. Reinforce security across the spectrum

While UAVs deliver a variety of operational benefits, enterprises must be cognizant of the added risk they are incurring and take the steps necessary to proactively manage it. UAVs expose themselves and connected elements of an organization's network to a new set of attack vectors and outcomes. The safe operation of UAVs within civil airspace will also be dependent upon robust mechanical and navigational systems, as well as repeatable operational processes, and training. Here are key recommendations moving forward to reduce risk:

Hardware:
UAVs should have the following engineered into their design: redundant mechanical components, accurate and consistent obstacle detection, collision avoidance with a high fault tolerance and low margin of error, and adherence to modern encryption protocols during all communication. UAVs will also need to be adaptable to account for unmodeled circumstances, such as a person attempting to sabotage the device by jamming communications or flooding navigational sensors with false information.

Many commercial off-the-shelf UAV platforms do not use encryption communications, and those that do come with implementation challenges. Similar problems can be seen when addressing the security of wireless sensor networks (WSNs). In WSN processing, power is the limiting factor for secure communication. Failure to implement encryption, whether using satellite

Canada
- Legislation in place since 2008 —Transport Canada oversight with special flight operating certificate filed for every flight

UK
- Legal for <20kg and 150 meters away from congested area
- Civil Aviation Authority permit required—limited permits handed out

Japan
- Permitted

US
- Integration of commercial UAVs into airspace by 2015
- Six test sites chosen in 2014
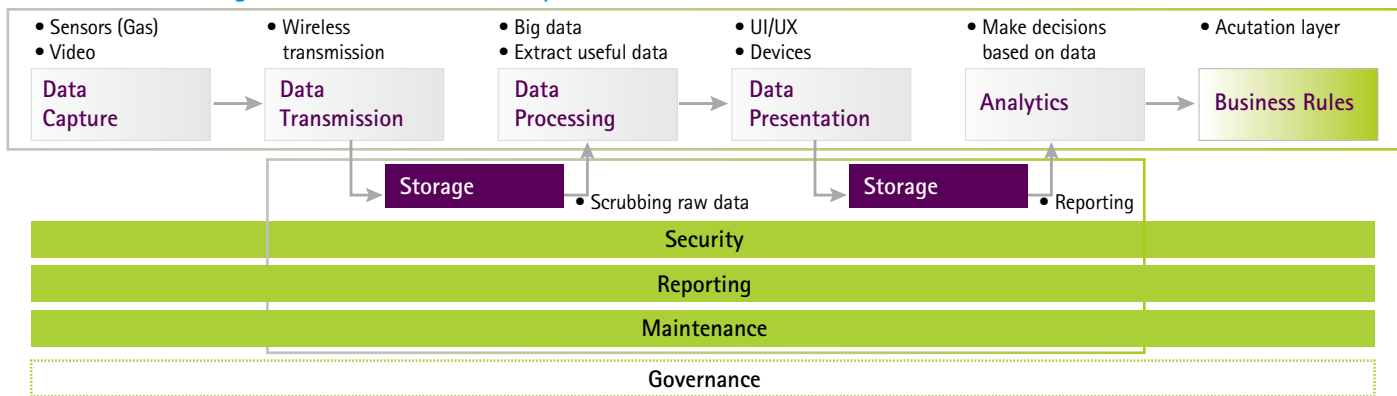
Australia
- Permitted
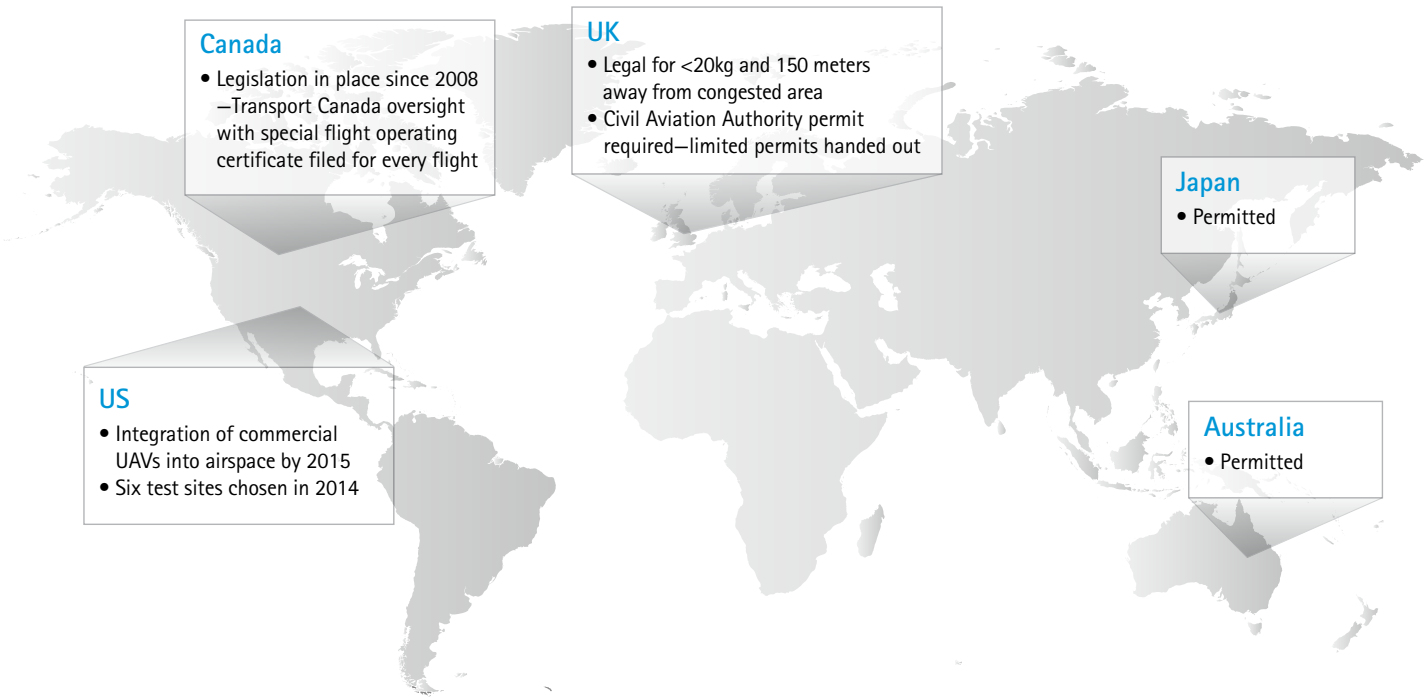
Figure 4: Enterprises must incorporate UAV data sources into the end-to-end data supply chain

Data integration and real-time processing will be necessary to support high impact UAV applications

Use Cases
- Storage and recall of sensor data
- Historical archiving and retrieving
- Remote expertise/collaboration
- Next generation sensor data visualization
- Time sequenced data evaluation
- Facility rendering

Shared Data Management and Visualization Capabilities

- Sensors (Gas)
- Video

Data Capture

- Wireless transmission

Data Transmission

- Big data
- Extract useful data

Data Processing

- UI/UX
- Devices

Data Presentation

- Make decisions based on data

Analytics

- Acutation layer

Business Rules

Storage
- Scrubbing raw data

Storage
- Reporting

Security

Reporting

Maintenance

Governance

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or terrestrial communication methods could result in a number of problems, such as UAV theft, crashing UAVs into cars or other susceptible, high-impact targets, and/or halting operations with misinformation.

Infrastructure:
Enterprises will need to plan for multiple layers of security, specifically the communication link infrastructure with air traffic management and ground control.

They will also need to develop compliance, security and governance policies that account for varying flight data integration and application use-cases.

Operations:
The more you know about your adversary the better prepared to mitigate a threat outcome. Through an understanding of attacker targets and capabilities, as well as the current set of vulnerabilities to which the operator's UAV

missions and infrastructure are susceptible, attacks can be identified sooner, and in some cases, prevented from occurring at all. In an ideal scenario, enterprises would proactively hunt for the slightest evidence of possible compromise. The right mix of personnel (operations, technology and security) should be prepared to keep operations running normally, or safely react to confirmed evidence of a cyber-physical breach or incident.

Where do we stand?

With some parts of the world already using or experimenting with the commercial application of UAVs and others awaiting imminent regulatory approval, now is the time for enterprises to start planning for innovative use-cases. In order to do so, they need to understand the impact to the status quo and be ready for a new interplay of people, processes and robot technologies.

Accenture can help enterprises evaluate where best to leverage and benefit from the use of UAVs in business process automation. We provide services in business strategy formulation, UAV technology capability alignment and road mapping, identification of relevant use-cases, proof of concept and pilot development, and full scale deployment.

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