Welcome to the era of drone-powered solutions: a valuable source of new revenue streams for telecoms operators

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From major infrastructure projects to agriculture, and from mining to transportation, usage of drones is rocketing in many industries. The early adopters also include telecoms operators, which stand to derive some of the greatest benefits from drone technology. Why? Because, for telcos across the world, drones open up opportunities to generate both internal efficiencies in their own operations, and also new revenues from a wide array of drone-related services, focused on applications ranging from infrastructure inspection and maintenance, to managing and storing data from drones, to setting up drone traffic control centers, and more. Telecoms operators' existing infrastructure and capabilities mean they're uniquely positioned to realize many of these opportunities, while also helping to drive the advance of drones into the business mainstream in all industries. And the prize on offer is huge: PwC has estimated the total market value of drone-powered solutions at over US$127bn. If telcos make the right investments now, they can reap a significant share of that massive pool of value in the years to come.

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The changing landscape for telecoms operators

The global telecoms industry is going through an era of sweeping and rapid change which – as a recent research study[1] from PwC's Strategy& highlights – has been gaining pace and momentum in recent years. Historically, today's telcos evolved and grew in three major waves: first voice, then messaging, then data. The legacy services springing from the first two of these waves – voice and messaging – are now being taken by solutions from over-the-top (OTT) players, which have already claimed more than 80% of the messaging market. The effect, again highlighted by research from PwC's Strategy&, has been to intensify still further the commoditization pressure on telecom carriers, which are seeing compound annual declines in average revenue per user (ARPU) ranging from 1% to 10% depending on the region in which they're operating.[2]

This is the third thought leadership report published by the PwC Drone Powered Solutions team. The first, Clarity from Above, was published in May 2016, examined the whole universe of commercial applications of drone technology. The second, published in January 2017, was an industry-specific supplement on the use of drones in transport infrastructure. The Clarity from Above report estimated the total addressable market value of drone-powered business operations at over US$127bn – a figure that reflects the commercial value of the full spectrum of drone based solutions and services that can be provided within selected industries.

However, the challenges for telcos go beyond the price pressures resulting from commoditization of voice and messaging services. Wave three solutions – data services – are also creating challenges around return on capital employed (ROCE), driven by an ever-growing need to add capacity through heavy capital expenditure, at a time when top-line revenue is flat at best. To respond effectively to this squeeze between rising investment and stalled revenues, telecoms carriers need to take three steps:

- Streamline and modernize their operations to take out cost and protect margins.

- Re-invent their core connectivity business, so they can regain a differentiated position that supports premium pricing.

- Tap into upstream and adjacent revenue streams around digital and internet of things (IoT) vertical use cases.

Drones: a key enabler for telcos' future revenue and cost strategies

Drone technologies can play a key role in helping telcos successfully negotiate each of these three steps. For example, to support the streamlining and modernization of operations, drones can provide a way to make network engineering and maintenance processes faster, more

The addressable market for drone-powered solutions

Research by PwC's Drone Powered Solutions team has quantified the potential value of the market for four types of drone-powered solutions, as follows:

1. Total market value of drone-powered solutions	**US$127.3bn[3]**
Infrastructure	**US$45.2bn**
Agriculture	**US$32.4bn**
Transport	**US$13bn**
Security	**US$10.5bn**
Media & entertainment	**US$8.8bn**
Insurance	**US$6.8bn**
Telecommunication (infrastructure maintenence, inventorying and planning)	**US$6.3bn**
Mining	**US$4.3bn**
2. Drone flight control systems	**US$18.7bn**
3. Data transfer	**US$3.5bn**
4. Data storage	**US$1bn**

1. Source: 2017 Telecommunications Trends, PwC, February 2017: https://www.strategyand.pwc.com/trend/2017-telecommunications-industry-trends

2. Source: PwC research, Commoditization in wireless telecoms: https://www.strategyand.pwc.com/wirelesscommoditization

3. Source: Clarity from above: PwC's global report on the commercial applications of drone technology, May 2016 http://www.pwc.pl/en/publikacje/2016/clarity-from-above.html

effective and more efficient; as part of re-inventing their core connectivity business to sustain pricing, drones bring telcos the opportunity to drive and manage Drone Powered Solutions by providing Cat-M1 and broadband connectivity; and for telcos looking to tap into new digital and IoT revenue streams, drones can be a key component in enabling the development and delivery of new classes of solution across a variety of vertical markets.

While many of the challenges facing telcos reflect the disruptive impacts of new technologies, the applications and services enabled by drones underline the key opportunity amid the disruption: the chance to leverage new technologies in ways that turn them from industry disruptors into growth enablers. New technology and convergence effects can create a new path for telecom carriers – and that while telecoms operators' legacy revenues may be largely stagnant, applying new innovations can open up fresh sources of revenue to restart their growth. We'll now drill down into these new revenue streams in more detail.

To do this, telecoms infrastructure operators can either develop the necessary capabilities internally or acquire established drone services companies. PwC estimates that the largest slice of the addressable market value from deploying drone solutions in the telecoms industry derives from applications in maintenance, worth almost US$6bn. The combined addressable market value of drone services in asset inventory and network planning in the telecoms industry is close to US$0.4bn.

Telcos' drone-related revenue opportunities

Revenue stream 1: offering drone-based services to other telecoms operators

The market for commercial applications of drone technology is booming, with the telecoms sector helping to drive a global wave of drone-powered disruption. One example of drones' commercial potential is their growing usage to enable faster and safer inspections of telecoms infrastructure. Real-time, accurate and comparable 3D modelling data can transform the inventorying and maintenance of cell towers, while also being useful for investment planning and network optimization – and all of this data can be acquired and analyzed cost-effectively using intelligent drone-powered solutions. What's more, the benefits can be increased still further by integrating emerging technologies such as machine learning.

One clear opportunity that these drone capabilities open up for telcos is internal cost savings. Like any business with an extensive outdoor infrastructure to maintain, such as oil & gas or electricity distribution companies, telcos can use drones to help make their own maintenance and repair operations much faster and more efficient. However, these same services can be monetized by selling them externally both to companies in other industries and also to other communications carriers. Telecoms operators are already entering the drone space and looking to offer drone-related services to other operators to generate additional revenue.

"Drones can play a vital role in the telco towers sector. The data they provide is a useful tool enabling faster and safer inspections of telco towers for the purpose of inventorying and maintenance. Such a solution has already been tested by a number of companies around the world. Data captured by drones can also increase the efficiency of investment planning and support the process of network optimization."

- Jad Hajj, Partner at Strategy&, part of the PwC network

Drones in maintenance

The primary application of drone technology in the telecoms sector is in asset management and maintenance monitoring of operators' infrastructure. To ensure continuity of operations, telecoms towers have to be examined regularly – and drones capable of precise aerial imaging are a perfect tool to accelerate and improve this process.

The earliest uses of drone technology in the telecoms infrastructure ecosystem were to support preventative inspections. This solution has already been tested and adopted by several major telecoms infrastructure operators, enabling them to monitor tower structures and antennae safely and efficiently. Traditionally, telco field engineers would go to the tower, climb it to identify the scope of work required, go down again to get spare parts and tools, and climb it again to carry out the repairs.

Improving safety and efficiency

With drones, much of this becomes unnecessary – with the result that including drones in technicians' standard equipment dramatically improves both the safety and efficiency of their work. Engineers can use real-time video from the drones for pre-assessment of what has to be done and to establish what the conditions are on the tower. This information also enables them to ensure they have all the necessary equipment and tools to minimize the risk from height and electrical hazard on the tower, or on large venues with a lot of antennae such as stadiums. In many cases, using drones proves to be several times faster and more efficient than traditional inspections – and each climb that is avoided results in a corresponding reduction in the risk that an employee could get injured.

Optimizing annual operational and safety inspections

Moreover, the benefits offered by drones in telecoms maintenance go beyond the aerial images or videos drones can provide. By processing the thousands of photos of the tower using photogrammetry (files allowing 3D models presentation from flat pictures) or Light Detection and Ranging (LiDAR) – a measurement method based on laser sensors – an operator can gain fully cartommetric and very accurate 3D models and orthophotomaps (a number of pictures stitched together and fully measurable and geographically aligned). These technical outputs can then be integrated with CAD software for final analysis at a remote location. This is valuable because each cell tower must pass an annual visual inspection verifying that the condition of the tower does not threaten its operation or the safety of maintenance technicians. To help satisfy these requirements, very precise 3D models provide highly accurate information on each telecom tower state and equipment, including pinpoint measurement of the mounting height, tilt and azimuth of each antenna and any vertical deviation of the tower itself.

This technology is also useful in preparing for the installation of new antennae on the towers, by providing accurate measurements of components such as mounting brackets. Moreover, high-resolution images taken by drones make it possible to assess the technical condition of the tower's foundations, anchors and structure, antennae and transmission lines, as well as the environment surrounding the site such as fences, roadway and security. This means any malfunctions or defects such as structural damage, loose wiring, corrosion or pollution can be identified and analyzed remotely before being addressed on-site.

Complying with bird protection legislation

A further example of the higher efficiency that drones bring to maintenance inspections is the ability to detect birds nesting on or near the cell towers. Many bird species find telecoms towers the perfect location for nesting and roosting, because the top of the tower is usually above the level of the treetops and the antennae provide an ideal structure for building their nests. In many countries it is illegal to disturb nesting of any migratory or endangered bird species. This situation is good for the birds and the environment – but can be highly inconvenient for telecoms operators when the birds decide to use the tower site for nesting.

Drones help to address this problem by enabling the top of the tower to be inspected for nests, and any impacts on condition of the tower's equipment to be observed, without disturbing the potential inhabitants. This method is far more efficient and accurate than traditional observation carried out by biologists with binoculars, cutting the required time from days to minutes, and keeping protected birds, their active nests and also the telco's employees safe.

Enabling a quick, safe response in an emergency

While very useful in routine activities such as tower inspections, drone technology can often deliver its greatest value in times of emergency – when a quick but carefully-controlled response is vital to restore connectivity, while also ensuring the safety of technicians in difficult-to-reach locations. Drones provide the perfect solution for examining the network and re-establishing connectivity in the aftermath of natural disasters such as hurricanes or tropical storms. Indeed, drones have already been implemented to inspect cell sites impacted by severe flooding. These drones provide information on any damaged equipment and allow the site to be brought back into service within hours.

A further high-potential service area for drones in telecoms is supporting increasingly automated inspection processes. There are a number of technologies that have transformative potential for the application of drone

technology in the telecoms industry, and the foremost of these is machine learning. Thanks to the rapid expansion in computing power and ongoing miniaturization, credit-card sized processors are now available that enable a new generation of smart, autonomous machines capable of learning and performing analytical work on-the-go. In the very near future, it's likely that we will see drones conducting cell tower inspections without human intervention and providing real-time analytical reports, as well as delivering spare parts or even performing smaller repairs autonomously.

Drones in asset inventorying

Just as drone technology equipped with photogrammetry and image data analytics is useful in conducting maintenance inspections of telecoms sites, so operators – or tower owners – can also use it for inventorying the sites. Over the past two decades, as the telecoms infrastructure ecosystem has evolved globally, various forms of tower ownership and operation structures have been developed. But regardless of the ownership model, the common challenge for all market participants is how to keep track of the equipment installed on the towers.

This is a task to which drones fitted with high-resolution cameras are perfectly suited. They can not only read the barcodes or serial numbers on the antennae or other radio equipment, but also have the ability to enhance the management of tower space by building 3D models of the tower to analyze remotely the positioning of the antennae and radio coverage. This in turn enables the actual space in use to be identified for billing and contracting purposes.

What's more, all the image data gathered with drones can be processed photogrammetrically to generate geospatial products, such as densified point clouds or 3D models, and then integrated with CAD data for further analysis. This brings significant benefits for telecoms companies, who gain high-quality insights into the dimension details and tilting of the specific tower's antennae and transmitters. All of the data can also be stored in the cloud, optimizing the effectiveness of the operator's

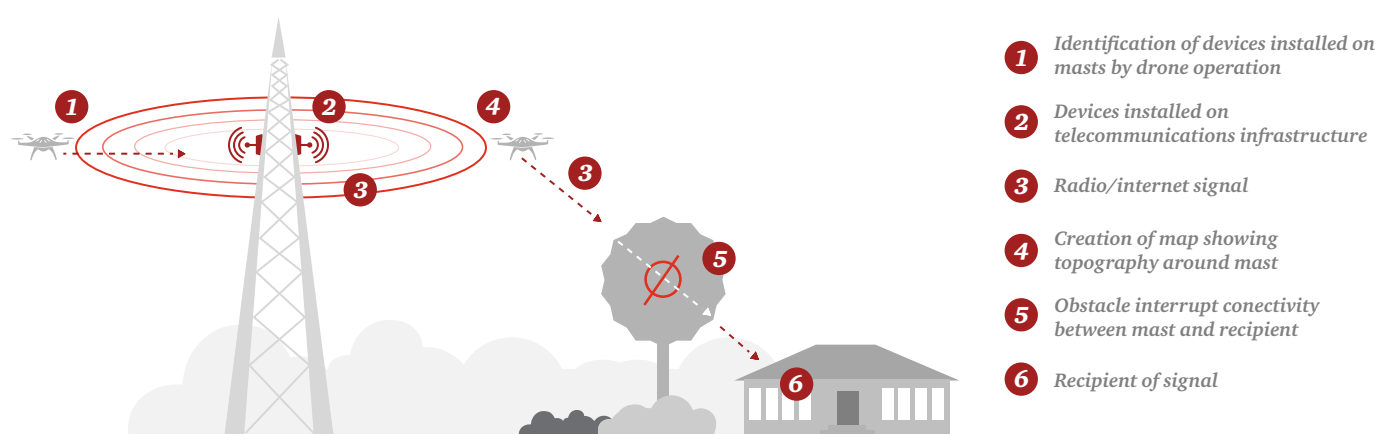digital asset management and information systems.

Drones can also reduce the cost and time involved in the sale and purchase of towers. As the tower ownership model evolves globally and gains traction in emerging markets, there are many tower transactions taking place – a trend that requires fast and reliable methods of network inventory. Drones can significantly improve this process, and the relevant data can then be implemented into operators' network inventory systems for strategic network planning and network design and build, as well as service assurance.

Drones in network planning and optimization

A further opportunity is that recent advances in drones' payload capacity and miniaturization of sensors have opened the way to new drone applications in network planning and optimization. One application that's relatively easy to implement is line-of-sight (LoS) testing between radio towers, which identifies obstructions such as trees or buildings. The results can be used as the basis for appropriate actions, such as avoiding a certain frequency affected by trees, selecting an appropriate antenna height or even changing the site location.

More advanced applications require the drones to be equipped with sensors able to detect the signal from the antennae. These enable the engineers to automatically measure the coverage area of the antennae and map their radiation pattern. This capability is especially important in mapping big venues such as sports stadiums, where every individual seat has to be analyzed in terms of coverage, upload and download speed or latency in order to ensure the perfect user experience for all spectators during sports events. In many cases the drones can help in interference detection and tracing the source of interference. The traditional way of conducting this type of analysis would involve teams of technicians walking around the stadium with the equipment in their backpacks. Using drones makes it significantly simpler and faster, potentially accelerating the process from about a week to a matter of hours.

Figure 1: Line-of-sight testing processes enhanced with drone technology

1. Identification of devices installed on masts by drone operation
2. Devices installed on telecommunications infrastructure
3. Radio/internet signal
4. Creation of map showing topography around mast
5. Obstacle interrupt conectivity between mast and recipient
6. Recipient of signal

Overcoming network congestion

Drones can also make a valuable contribution in cases where network congestions arises during natural disasters or big events, when the available network may be not sufficient to meet the elevated demand. In order to boost the network's performance and increase data transfer or enable emergency calls in these circumstances, telecoms operators have sometimes used Cells on Wheels (COWs) – mobile cell towers positioned on top of a truck that provide additional coverage targeted at a specific area. The increasing robustness of drones mean they can also now play this role, a capability that already been tested in the field.

Drones bring a number of benefits over truck-mounted COWs. First, compared to a traditional COW, a flying COW can be easier to deploy due to its smaller size. This makes it a much more flexible solution, especially in cases of emergency or unexpected failures. Moreover, as drone COWs hover at higher altitude than mobile cell towers (up to 100m), they can cover a wider area than traditional land-based COWs. Due to the nature of the role that these drones are carrying out, the best option is to use "tethered" drones – meaning drones that are connected to a ground station via a line or cable providing power and connectivity. These robust drones have almost unlimited hovering time, can use high-speed data transfer thanks to the physical link, and can operate in difficult conditions such as high winds or heavy smoke.

Revenue stream 2: operating drone flight control systems and solutions across multiple industries

Alongside the opportunities that drones open up for revenue generation and cost savings within the telecoms industry, they also present opportunities for operators to tap into a wide range of new revenue streams at different levels of the service stack in multiple industries.

Infrastructure service revenues

Drone connectivity and data transfer services – Drones are versatile platforms that can be used across various industries to perform a wide range of tasks. Most of these tasks are related to acquisition of image data of various kinds, ranging from LiDAR datasets from oil installation inspections to live-streamed high resolution video from emergency search and rescue operations. While drones are perfectly suited to such tasks, in the process of undertaking these assignments they generate substantial amounts of data. In the course of an average single inspection with standard high-resolution camera onboard, a multirotor drone generates an average of 50 gigabytes of data. The volume of data can even be several magnitudes higher when longer-flying fixed-wing drones or other sensors such as LiDAR are being used. This data often needs to be transferred immediately to operations centers in order to provide detailed, real-time situational awareness and to enable swift responses based on up-to-date information.

As the drone technology industry continues to evolve and grow, the high-capacity data transfer services suited to use with drones will become a significant revenue stream for telecoms companies. The establishment and maintenance of reliable and sustainable data transfer services are key enablers for the development of the drone solutions market, by providing a crucial capability for the integration of data and operations within organizations. PwC's analysis suggests the provision of data transfer solutions for the drone industry may potentially generate US$2.5bn of new revenues for telecoms operators.

At the same time, telecoms operators could also benefit strongly from the development of the recreational drones market, which is currently gaining momentum on a global scale. Combining drones with the popularity of live streaming on social media could potentially increase telecom operators' revenue from data transfer by almost US$1bn.

Drone cloud storage services – A further key element of the data management process for drones is storage. Image data and analytical products generated for regulatory and operational purposes need to be archived with easy access for stakeholders. Meanwhile, for purposes such as modelling processes within the mining industry or for Building Information Modelling (BIM) in construction and infrastructure operations, the data may have to be stored on secure and accessible clouds for decades.

Given the rapid take-up and implementation of drone solutions across a wide spectrum of industries in the coming years, the rising demand for data storage may become a vital opportunity for telecoms operators. We estimate that the revenues from data storage services related to drones could reach US$1bn.

Platform service revenues

Drone traffic control centers – Another potentially valuable drone-related revenue stream and source of growth for telcos comes from ensuring the safety and security of drone operations. Drones operate in airspace where they coexists with manned aircrafts. Currently

used traffic control systems are not sufficient to supervise over drones flying at low altitudes. The number of drones in use is rapidly increasing e.g. according to the Federal Aviation Administration more than 820,000 drone operators in the US have registered their aircraft since 2015.[4] As a result, Aviation Authorities around the world are looking for efficient systems to control the low altitude traffic in order to ensure safety of manned aircraft. Operators of large telecoms networks already have the infrastructure needed to enable the deployment of drone traffic control centers that monitor the traffic of drones in the airspace, significantly mitigating some of the main risks associated with the adoption of drone technologies.

The opportunity for telecoms operators to generate revenues from drone traffic control centers springs from one of the key challenges to developing a flourishing drone technology environment: the need to ensure the safety of drone operations for humans, manned air traffic and third-party property. Drone technology is often perceived as dangerous in the hands of irresponsible users. So, across the world, significant efforts are being made to develop mechanisms that can prevent potentially harmful or illegal actions.

Among the various participants in the evolving drone ecosystem, the first group to respond to this challenge were drone producers themselves, with the implementation of technologies such as geofencing to prevent drones from accessing predefined geographical locations like airports or military bases. However, these technologies cannot fully prevent the irresponsible use of drone technologies, nor enable it to be punished. This gap is soon to be filled by authorities and organizations responsible for airspace safety. Telecoms infrastructure operators' capabilities in advanced technologies mean they are ideally equipped and positioned to support these entities in deploying drone traffic control capabilities.

A fully operational drone traffic control center enables the identification and tracking of all drones operating in a particular airspace. The most advanced and effective way to achieve this is through two-way communications between the drones and a gateway built on an IoT-grade environment of LoRaWAN[5] or LTE-M[6] – two technologies that are very familiar to advanced telecoms infrastructure operators.

This means that those telecoms companies that have already implemented LoRaWAN or LTE-grade protocols within their operations are well positioned to play a pivotal role in the deployment of drone traffic control centers. By implementing new equipment within existing infrastructure such as LoRaWAN gateways on telecommunications towers, or by adjusting their infrastructure to support LTE-M – the M2M variation of the LTE protocol – telecoms companies can leverage their existing assets and technical capabilities to provide a new range of services, including drone traffic control centers.

Given the ability of drone control centers to ensure the safety and security of drone operations for humans and manned air traffic, it's hardly surprising that governments and civil authorities round the world are showing increasing interest in their deployment. Telecoms infrastructure operators can support the authorities in developing and setting up these centers by operating them for a fee, thus tapping into a significant new stream of revenues.

PwC estimates that the global addressable market for drone traffic control centers could potentially be worth US$18.7bn, with the vast majority of these new revenues coming from the deployment of the centers themselves. This new revenue stream can help to finance new investments in expanding and upgrading operators' networks, further increasing their competitive edge through more efficient use of their assets and capabilities.

Leveraging data analytics and AI to deliver predictive insights and support autonomy – A further high-potential service area for telecoms operators to build drone-based revenues is in using technologies like advanced data analytics and artificial intelligence (AI) to create predictive insights and support rising automation and autonomy. Earlier we highlighted the potentially transformational impact of these technologies in conducting automated tower inspections in the telecoms industry.

But the applications go much wider. In any sector, machine learning enables computers to solve problems without being explicitly programmed, by using AI algorithms that learn how to solve complex tasks based on provided examples of similar solutions. The trained algorithms can make very precise predictions based on data such as real-time photo or video streams, vastly increasing the quality and timeliness of decision-making by humans or machines. Drones make the task of accessing and analyzing the necessary data much faster, easier and safer.

A related revenue opportunity for telcos arising from growing adoption of drone technologies is the ability to support autonomy. Drones that will be able to undertake and complete missions autonomously are the holy grail of the drone industry and a key trigger of the "fourth industrial revolution" of the future. In order to operate autonomously and deliver data acquired in real time, these drones will have to operate beyond current Wi-Fi

4. "AUVSI Xponential", Michael Huerta, Dallas, TX. May 10, 2017 https://www.faa.gov/news/speeches/news_story.cfm?newsId=21654

5. An open-source, low-power wide-area network wireless telecommunication infrastructure created by the LoRa Alliance – see https://www.lora-alliance.org

6. Long Term Evolution (4G) for Machines, a variation of LTE protocol for machine-to-machine applications – see http://www.gsma.com/iot/long-term-evolution-machine-type-communication-lte-mtc-cat-m1/

and radio link standards – and the only solution in sight to achieve this is high-speed wireless communication. By expanding and improving the reliability of their 4G network services, operators are enabling deployment of fully autonomous drones, while also creating a significant new revenue opportunities for themselves.

Looking across all industries and technologies, aerial robotics is potentially one of the most disruptive hardware innovation to have emerged in recent years. It has transformative potential for all asset- and investment-heavy sectors as well as for a variety of other industries such as agriculture or media. Given the easy accessibility of the technology and the wide range of benefits it can provide, we are likely to see increasing numbers of commercial drones in our skies in the years to come. Telecoms operators have all the capabilities needed to take an active role in enabling this explosive growth, and to generate rising value from it.

Application and solution service revenues in vertical industries

As we mentioned earlier, in May 2016 PwC's Drone Powered Solutions center of excellence published its first report on the global drone industry – *Clarity from Above* – in which we estimated the total potential value of the drone market at US$127bn. As players from various industries seek to claim a share of this value, telecoms operators' existing strengths in technology and connectivity give them the edge, since these mean they can deploy drone solutions much more easily than most other types of business. As a result, they can enter this booming market early and leverage their existing assets and capabilities to generate new revenue streams.

The revenue opportunities include the ability to provide customers across a vast array of industries with professionally-managed drone services, extending to managing fleets of drones on behalf of customers "as a service", including providing flight control capabilities, tailored vertical solutions, and expert staff such as pilots, flight controllers and vertical industry specialists. In approaching these opportunities, the questions for telcos include how far up the service stack they should go, and what are the areas where they can compete most effectively for revenues. Having answered these questions, they need to decide which necessary capabilities they already have, which ones they can develop, and which ones they'll need to access through acquisition or partnering.

Going forward, it's highly probable that "beyond visual line of sight" (BVLOS) operations will be allowed in many countries in the next few years. Since BVLOS operations demand connectivity, telecoms operators' existing dispersed infrastructure gives them a significant advantage over other industries. When it comes to obtaining new capabilities in the drone space, telcos could take over one of the players in the drone services market. However, since the market is still immature at this stage, they should also consider building their own operations and capabilities from the scratch. One of the key issues faced by today's drone services providers is low volume of operations. Since telecom operators have their own infrastructure, the ready access to this would give an internally-developed drone services provider the opportunity to significantly accelerate its progress up the learning curve.

All of this means that telcos are well-placed to pursue drone-based revenues across a host of vertical industries. Here are some of the main opportunities, complete with PwC's assessment of their value.

The infrastructure sector – According to PwC's analysis, the infrastructure sector – at a potential value of some US$45bn – accounts for over a third of the total value of the drone solutions market, making it a key focus for development. The scope of solutions for the infrastructure industry ranges across areas including investment monitoring, maintenance and asset management of energy, manufacturing and transportation infrastructure.

Agriculture – The second biggest addressable market for drone solutions is agriculture, with an estimated potential value of US$32.4bn. Using drone technology in agriculture enables the condition of crops to be monitored from the very beginning of the growing season all the way through to planning and undertaking the harvest. Adding advanced analytics to the drone solution means ground moisture and even fertilizing requirements can also be monitored. Using similar techniques, there are further opportunities to use drones in environmental protection.

Transportation – The next biggest sector of the drone market in terms of potential addressable value is transportation, at US$13bn. This offers scope for a wide variety of delivery applications. Besides the concept of parcel deliveries by drone that has attracted so much attention recently, other solutions range from delivery of urgently-needed blood or defibrillators to in-warehouse delivery of spare parts, helping to automate manufacturing processes.

Security – Drones can be also applied in a range of applications within the security sector, providing an eye-in-the-sky both for industrial users and governmental authorities. The increasing automation of drone solutions will eventually lead to deployment of fully functioning autonomous solutions providing a variety of effective surveillance and security services within certain locations. In PwC's view, the value of the addressable market of drone solutions in security could eventually reach US$10.5bn.

> *"The potential of the drone services market to develop and grow in the coming years is simply breathtaking. In all geographies and across multiple industries, drones are rapidly moving from the innovation and piloting stage to mainstream use in everyday operations. And as the adoption and usage of drones continue to grow, the related service opportunities in applications like data transfer, data storage and autonomy enablement will continue to expand. These are all opportunities that telcos are well positioned – in some cases uniquely positioned – to take advantage of. That said, in many economies – the U.S. included – the regulatory framework is struggling to keep pace with the speed of innovation. So telcos need to pay keen attention to public policy and regulatory agendas so they can proactively address potential roadblocks – which may often not come from over-regulation, but from a lack of regulation."*
>
> *- Florian Gröne, Partner at Strategy&, part of the PwC network*

Entertainment and media – One of industries where drone technology is already well established is entertainment and media, which offers an addressable drone solutions market worth US$8.8bn. Drones are now being used in the industry not only to take blockbuster-grade aerial shots, but even for low-budget promotional productions. The application of drone technology has also enabled the development of a whole new journalistic genre termed "drone journalism".

Insurance – The insurance industry comes next with an addressable market value of US$6.8bn. The applications in insurance range from risk monitoring and assessment to prevention or minimization of losses. Using drones in claims management is not only more effective than traditional methods, but is also significantly safer for staff, since they are no longer obliged to enter zones that may be dangerous.

Mining – A final major industry for the application of drone solutions is mining, with a potential market value of US$4.3bn. Drones can be employed during virtually every phase of the mine lifecycle, all the way from exploration, through construction, to operations and post-closure monitoring.

What are the enablers and challenges for telcos' drone strategies?

Three key enablers…

PwC's analysis suggests that the adoption of drone-powered solutions in the telecoms sector will be driven by three factors.

1. The opening-up of regulatory frameworks

In recent years it has become increasingly clear that drones are a key component of the digital economy. In response, the regulators in a number of countries have decided to relax the regulations for commercial drone operations while simultaneously providing guidelines and training. These moves have opened up new use cases by introducing less restrictive rules on factors such as drones' maximum altitude and minimum distance from non-participating people and structures, allowing for them to fly over populated areas. There are still regulations constraining autonomous flights and beyond visual line of sight (BVLOS) operations which, once eased, can open up further new applications of drone technology for the telecoms industry. For example, drones operating beyond visual line of sight will be able to undertake remote monitoring of telecoms operators' extensive network infrastructures, such as fiber networks or power-line communications.

2. Enhanced data processing and accessibility

Providing immediate, high-quality availability and analysis of data on any type of device is one of the key development opportunities for telcos in the drone space. For example, technicians inspecting a cell tower remotely via drones would like to know immediately about all the issues identified on and around the tower site, and to be able to conduct additional analyses in the cloud. The shorter time required to process data and enable access to information will be a key factor accelerating the implementation of drone technologies by telecoms companies.

3. Rapid technology development

Ongoing advances in technology are driving down the costs of drones or "unmanned automated vehicles" (UAVs) – contributing to growth in their mainstream usage while simultaneously helping to increase the number of drone-powered solutions available. Further developments in battery capacity through technologies such as hydrogen fuel cells, and in obstacle avoidance systems and software, will continue to expand the range of potential applications for telecoms carriers.

> *"Across the world, the drone solutions market and the regulatory approach to the industry are becoming increasingly closely aligned, as authorities come to appreciate the vital role of drones in a fully-functioning digital economy. While some restrictions remain, the overall direction of travel is clear: towards the creation of regulatory regimes that encourage and enable the development of a thriving market in drone services – to the benefit of consumers and business in all industries."*
>
> *- Mohammad Chowdhury, PwC TMT industry leader in Australia, SE Asia and New Zealand*

…and two key challenges

That said, integrating drone-powered solutions into the operational processes of infrastructure companies will face some challenges – two of which are especially significant.

1. Aviation risk

To realize the full potential of drone technologies – especially autonomous drones – it will be vital to have comprehensive air traffic management systems in place that prevent collisions between drones and other aircraft. These systems will enable drones to detect and avoid obstacles and other vehicles, and at the same time to communicate with air traffic controllers. To maintain safety, the controllers will need access to a real-time flow of information about both unmanned and manned aircraft.

2. Privacy

Along with the benefits of UAVs to the telecom industry comes a responsibility to operate them in ways that respect personal privacy. As drone operators perform flights over various types of sites, the vast amount of data they collect will sometimes include confidential or sensitive information about private property or behavior. Given this risk, there is a clear need for clear international regulations and guidelines on how companies should store the data, what types of data should not be collected, and how individuals and companies can defend their privacy rights. While US has already developed "Voluntary Best Practices for UAS Privacy, Transparency, and Accountability", in many countries there are still no guidelines or regulations properly addressing this issue. This lack of clarity on the vital issue of privacy is discouraging some companies from adopting drone-powered solutions.

A technology whose time has come for telcos

As we've described, the advent of drone technology opens up many potential benefits and revenue streams for telecoms companies. With opportunities ranging from safer, more effective and more efficient management and optimization of telecoms infrastructure, to the ability to tap into new revenues from a wide array of drone-related services and solutions, there's no question that drones represent a major breakthrough technology whose time has come for telcos.

Telecoms companies are moving to seize these opportunities, with many having already tested drone technology and several starting to embrace it. While their aim at this early stage is usually to at least break even in the short term, they are already reaping significant cost savings in terms of speed and efficiency. And they are continuing to invest in their drone initiatives, reflecting their awareness that drone-based models will become more effective over time as new opportunities and applications reveal themselves.

What's certain is that the drone opportunity will grow. Put simply, now is the time for telecoms operators to join the drone revolution – or face playing catch-up on their more forward-thinking competitors in the years to come.

About PwC Drone Powered Solutions

Drone Powered Solutions (DPS) is a global PwC center of excellence located in Europe. The team helps clients from various locations and industries to maximize the potential offered by drone technologies. Having undertaken its first project in 2013, and officially established in early 2015 in Poland, PwC DPS is the world's first professional services consulting team dedicated to industrial and business applications of drone technology. Its location in Poland is no accident: Poland was one of the first countries worldwide to adopt detailed laws regulating the industrial use of drones, having done this as early as 2013.

Since its launch, DPS has worked with clients from various industries – including telecoms – on implementing drone technology in their operations. DPS is also one of the pioneers in improving image data analytics with machine learning and artificial intelligence. Thanks to PwC's rich experience in strategic and operational planning and implementation, DPS is able to support companies not only in selecting the appropriate hardware, but also in implementing complete and comprehensive operational systems.

The scope of DPS's competencies includes strategy, process transformation, IT customization, visual data processing, and analytics. These competencies enable DPS to deliver end-to-end services to clients. DPS has also developed its own proprietary delivery software, PwC Geospatial.App, allowing for the integration, presentation and management of comprehensive data sets, thus enabling easy and instant decision-making. The DPS team already has unique experience, proprietary solutions and methodologies, but is not stopping there – and remains constantly focused on developing new ideas and technology to help clients succeed in the new drone reality.

www.dronepoweredsolutions.com

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