5

Aerial surveillance: Eyes in the sky

Patrols by foot, jeep and armoured personnel carriers are the norm in peacekeeping; occasionally patrols have been carried out on bicycle as well. Fixed observation posts and road checkpoints also contribute to the mission picture. Such ground-level surveillance is obviously indispensable, but there are distinct advantages to using observation from above. Aerial and ground surveillance are complementary.

The United Nations has conducted aerial reconnaissance in some of its operations. However, the use of observation aircraft has been ad hoc and unsystematized in both UN doctrine and practice. Dedicated observation aircraft were employed in ONUC (the United Nations Operation in the Congo) in 1961 after it was discovered that pilots conducting transport flights observed important activities on the ground during their voyages. This prompted ONUC to begin mandatory debriefings of these pilots and later to deploy specialized reconnaissance aircraft, including jets.[1] In Yemen (1963–1964),[2] Central America (1989–1992) and several other locations, the helicopter was a key tool for observation as well as transportation. MONUC, the United Nations mission in the Democratic Republic of the Congo (DRC), is believed to have the largest and best heliborne reconnaissance capacity in UN history.[3] However, current commanders complain that their capacity is still far from adequate for the mandated task.

There is, unfortunately, no systematic record of UN aerial observation experience or any listing of the aerial imaging equipment used in UN missions.[4] Furthermore, there are no studies or even comparisons of the

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benefits of aerial versus ground reconnaissance in peace operations. This chapter looks at the relative merits of these two important modes of observation, drawing upon selected UN operations and experiences. It also compares manned versus unmanned reconnaissance flights. The latter are increasingly used in both military and civilian applications in the developed world. The details of all such comparisons (air versus ground, manned versus unmanned) are, of course, case specific, that is, dependent in part on objectives, terrain, weather, and so on. But the broad factors outlined here point to the relative merits and the optimum configurations for effective monitoring in a wide range of environments, while also highlighting the problems of the various approaches.

Advantages of aerial reconnaissance

From the earliest days of peacekeeping, the United Nations has taken advantage of observation from altitude. Observations posts were placed on hilltops in the Middle East (Palestine, Lebanon and the Golan Heights) and Kashmir. But they provided useful views of specific fixed areas only – hilltops, unlike aircraft, are not moveable!

The "bird's eye view" is possible from aircraft, providing quicker coverage, a longer "line of sight" and a wider area of observation than on the ground. Aircraft can travel with great speed and there are generally fewer obstacles to block the view from the air. Once at the site, they can adopt the optimum observation altitude and angle for safe viewing.

Since aircraft can move faster than ground vehicles and go directly ("as the crow flies") to their destination, airborne observers can arrive at distant areas much more quickly. In addition, more territory can be covered during the observation period. Ground vehicles (for example, four-wheel-drive utility vehicles) can travel at a maximum of about 120 km/hour.[5] Under the poor road conditions typical of many conflict areas, jeeps must move slowly, perhaps 10 km/hour if at all, since many mountainous, riverine and jungle areas are impassable. By contrast, aircraft can easily overcome such terrestrial restrictions. Jets fly at typical cruise speeds of 500 km/hour, helicopters or two-seater planes at 200 km/hour, small tactical unmanned aerial vehicles (UAVs) at 100 km/hour and mini-UAVs at 50 km/hour. During an observation period, aircraft can slow down to dwell on an area, that is, circle by plane or hover by helicopter. Some gyro-stabilized cameras can "lock on" to their targets, keeping them in the centre of the picture even as the plane is moving.

During one aerial patrol (typically three to five hours duration), observers could, for instance, fly along an entire border of 500 km. Alternatively, such aircraft could cover an area of 500 km^2 or more. This could be done twice a day (or at night) for broad situational awareness and early warning. To follow the movements of the relevant actors (for example, armed bands, roving militia horsemen or smugglers along roads), the observation width ("swath") by eye or camera needs to be less than 10 km on the ground. At speeds of less than 150 km/hour and at low altitude, this would allow for detailed observation. Since low-flying aircraft (like ground vehicles) might be at risk of rifle or other fire, the optimum altitude must be determined. Fire from an AK-47 rifle, the most prevalent weapon in current conflict areas, cannot reach altitudes above 1,000 metres. And even at much higher and safer altitudes, for instance at 3,000 metres, advanced aerial observation equipment (geo-stabilized) can provide a resolution of 1 metre or better, allowing the tracking of individuals and vehicles.

The ability to vary the altitude of an aircraft allows the pilot to control the visibility of the plane. Aircraft can also fly above clouds for cover or find an altitude where they are nearly impossible to spot or hear. This makes it possible to monitor some illegal and clandestine activities that would otherwise be hidden as soon as the aircraft was detected. In addition, if criminal/violent elements are aware that the United Nations can operate silently, a powerful deterrent is created. Violators would fear detection, even if no aircraft were present.

If, on the other hand, a deliberate show of UN presence is desired, aircraft can fly at low altitudes. A highly visible "eye on the scene" could deter illegal activities or make them more difficult. Aircraft could even "buzz" an area at low altitudes to create a distinct impression.[6] During Operation Artemis, which aided MONUC in Ituri in the summer of 2003, a French Mirage jet on reconnaissance would deliberately break the sound barrier in the region to create a sonic boom that was clearly noticeable by all, including presumed wrongdoers. Aircraft can be painted in UN white or even with "glow colours" for greater visibility.

Flights at high altitudes offer less intrusiveness than a ground presence. At times, the United Nations must reduce its visibility either to accommodate local sensitivities or because national authorities have placed limitations on the freedom of movement of UN ground vehicles. While still observing national and international laws, UN aircraft can observe without being observed and move without attracting attention (satellites even more so). Of course, take-off and landing sites are needed, but they do not need to be near the observation area and can potentially be based in neighbouring countries. Permission to enter the airspace of a country would, of course, be required unless mandated by the Security Council.

Especially at night, aerial surveillance can provide a tremendous magnifying effect. When travel by ground is difficult and vision is limited (the range of most night-vision goggles is 500 metres or less), airborne forward-looking infrared (FLIR) and synthetic aperture radar (SAR) can alert the United Nations to illegal activities and movements of rebel fighters. Night flights for any purpose, however, are generally prohibited under UN rules because the United Nations does not possess night-time search and rescue capabilities and its aircraft are often not equipped with weather radars. In a few missions, however, contributors come well enough equipped to carry out such operations: for example, Norway and others in the former Yugoslavia, Australia in East Timor, a chartered company in Kosovo, and Russia in Sierra Leone.[7] In November 2006, MONUC was able to "break the night barrier" in the DRC after gaining permission from UN headquarters. Its Mi-35 helicopters used advanced infrared sensors to detect the movements of a renegade force advancing to attack the town of Goma. With this aerial intelligence, a combined UN–DRC force was able to halt the advance using night-flying attack helicopters.

In the future, UAVs could be used for night surveillance because the search and rescue requirement would not apply. Indeed, the European Union Force (EUFOR) did fly UAVs at night in the DRC from July to November 2006 with some remarkable successes, especially in uncovering illegal shipments of arms. For instance, the FLIR cameras were able to detect imported tanks moving by rail and small arms being transferred in small boats across the Congo River. UAV video imagery could be viewed at EUFOR headquarters in real time, so that commanders and analysts at headquarters could share a "common operating picture" and consider responses. Although there was no image feed to MONUC headquarters, recordings were shown to UN officials, for example to demonstrate illegal import activities clearly, thus allowing UN leaders to confront the violators.[8]

Reconnaissance by air is less constrained than on the ground. Host nations often insist that UN ground movements be escorted by the nation's troops or liaison officers, whose purpose is, more often than not, to keep an eye on UN personnel ("observe the observers") and prevent unauthorized detours. Air observation typically involves a lesser set of restrictions and limitations, although these may still be imposed by the host nation.

Advantages of integrated systems

Combining aerial and ground presences makes for a much more effective monitoring and response system. By air, large swaths of land can be reconnoitred separately or at the same time as by ground patrols. Advance surveillance flights can alert peacekeepers to dangers, locate them precisely through the Global Positioning System (GPS) and, in the future, automatically update GIS databases with the latest imagery for immediate viewing. Aerial images can help peacekeepers familiarize themselves with the terrain, their objectives and the dangers. They can assist training, planning and the operations themselves, as well as post-mission evaluation. Many hours will be saved if ground patrols can receive advance notification of roads that are impassable or bridges that are washed out, knocked out, closed or subject to militia checkpoints (or even to ambush!). Lives can be saved if potential threats are identified using aerial reconnaissance. For instance, during a MONUC battle with renegade militia leader "Cobra Matata" in the stronghold of Tchey in May 2006, heliborne spotters warned ground troops of militia fighters approaching stealthily. This allowed the UN forces to avoid a surprise attack and to respond appropriately.[9]

For UN operations to be robust they must be situationally aware and enhanced by aerial reconnaissance. Quick Reaction Forces, for instance, need to insert themselves with great accuracy at precise locations, which requires excellent geospatial awareness. This level of information, particularly about the hideouts of rogue militias or spoilers, involves advance (and advanced) surveillance, briefings for soldiers using detailed imagery and cueing from aerial assets to respond to the movements and actions of adversarial forces. Operating ahead of important convoys, aircraft can alert the convoys to potential threats in order to avoid them, for example through re-routeing. Wide-area surveillance from aircraft can make the ground action quicker, more precise and safer.

During robust peace operations, reconnaissance from above is especially valuable in the pre-dawn period because militia often move into position at night and wait for dawn to attack. For instance, in the early morning of 28 May 2006, a joint Congolese–UN force walked into an ambush near Fataki soon after they began their march to search for rebel leader Peter Karim. An attack helicopter was called to suppress militia fire during their withdrawal, but it came too late for one Nepalese soldier who lost his life in the shooting.[10]

Similarly, Guatemalan special forces carrying out reconnaissance in Garamba National Park on the Congolese border with Sudan were ambushed early in the morning of 23 January 2006. The UN peacekeepers were searching for rebel Lord's Resistance Army troops who had infiltrated from Uganda. Eight Guatemalans were killed in the fire-fight, which started shortly after 0600 hrs and lasted four hours. This was the second-deadliest attack on MONUC.[11] Aerial reconnaissance using infrared night vision could possibly have identified the fighters in waiting, and would have better prepared the joint force of MONUC and the Forces Armées de la République Démocratique du Congo (FARDC).

Adding air power to ground force allows the United Nations to better prepare its night defences and offences. In Sake, 25 km from Goma, on 26 November 2006, MONUC established a security cordon to halt the advance of renegade Congolese brigades (the 81st and 83rd). When these brigades attacked MONUC/FARDC positions at 0525 hrs, MONUC was ready. Mi-35 helicopters flew the first helicopter night flight in MONUC's experience. The UN helicopters, equipped with advanced night-vision devices, spotted the attackers in the pre-dawn, distinguished them from friendly forces and then played a major role in the ensuing fight. The militia could not use tree cover or other terrain masking to obscure themselves from the foliage-penetrating Mi-35 FLIR cameras. Furthermore, the helicopter's rocket launchers and machine guns were aimed using (or "slaved to") the pilot's helmet-mounted night-vision goggles. Shortly after, UN and Congolese government forces regained control of the town of Sake with no MONUC/FARDC casualties. The 15,000 to 20,000 inhabitants of the town began to return and the city of Goma was saved.

In the Eastern DRC, airborne reconnaissance has located many militiamen, deserting soldiers and stragglers, prior to their being apprehended and arrested or becoming part of the peace process through *brassage* (that is, merging into the national army). More about the surveillance capabilities and work of the Mi-35 attack helicopters is found in the Congo 2008 case study in Chapter 7.

In summary, ground and aerial surveillance have different but complementary effects. The air provides a grand view of the terrain, whereas ground forces have the ability to interact more closely with people. A combination of air and ground surveillance permits a more persistent and targeted presence over larger areas. Aerial reconnaissance is a force multiplier. Locations that are too distant, numerous or dangerous for UN bases are better observed by aircraft. Various types of aircraft can be considered to optimize aerial effectiveness, including cost-effectiveness.

Enter the UAV

Unmanned or uninhabited aerial vehicles have in recent years found wide-ranging commercial applications in agriculture (crop-spraying and surveys), mineral exploration (especially in desolate and hard-to-reach regions), forestry management (fighting fires), telecommunications (as mobile relay platforms, including for emergency telecommunications in disaster zones), border or coastal watch and many other areas.[12] They are particularly popular in military circles for fighting wars and recently for keeping the peace as well.

Reconnaissance UAVs come in many different sizes, weights, capabilities and configurations. The payload can include many different types of sensor. Table 5.1 categorizes and characterizes the main types of UAV that could be used in UN peacekeeping.[13]

The smaller UAVs (especially mini-UAVs) are unstable in strong winds, making it hard to get steady video imagery, but sharp still images are possible using a fast shutter speed. Further, as high-resolution devices become lighter, smaller UAVs are becoming more capable. Similarly, small UAVs with less payload capacity are able to store images for download only once they have reached the ground, but the expansion of smartphone networks makes near-real-time transmission possible.

Mini-UAVs tend to run on batteries whereas the larger ones use gasoline or jet fuel. The petroleum-powered UAVs can attain a fuel efficiency of well over 200 km/litre.[14] Larger UAVs can support heavier payloads. Still, SAR payloads are of the order of 50–100 kg, so they are available only for tactical UAVs.

Ever smaller and smarter UAVs are under development. The near future might offer ultra-light or micro-UAVs (eventually possibly nano-UAVs) that are less than half a metre in wing-span and less than 2 kg in weight.[15] Autonomous take-off and landing UAVs are already available, as well as self-navigating UAVs using GPS waypoints. Generally these should be used only in a well-defined territory or air corridors where other aircraft are not present, though collision-avoidance systems are available.

The smaller UAVs have the benefit of being easier to transport (for example, by an individual), to launch (by hand or sling-shot) and to operate (for example, with joy-stick controls). They are cheaper to operate and to purchase (starting from $20,000 or less per UAV), and they usually cause less damage if they crash. On the negative side, they have limited range, endurance and payload capacity.

The deployment of "mixed packages" involving different categories of UAV allows the different advantages of each to be exploited, including cost and capacity benefits. For instance, travelling ground reconnaissance units could control mini-UAVs flying a short distance ahead, while a tactical UAV is used for more distant reconnaissance.

Manned versus unmanned aircraft

Advantages of UAVs

Unmanned flying machines are generally smaller, lighter and more fuel efficient than manned (or inhabited) aircraft. Also called remotely

Table 5.1 UAV types and characteristics

	Weight (kg)	Range (km)	Speed (km/h)[a]	Time aloft	Payload (kg)	Costs (US$)[b]	Example of functions	Sample models[c]
Mini-UAV	2–5	4–10	30–95	45 mins – 2 hrs	0.5–1.3	25,000[d]	Perimeter surveillance of UN sites and refugee camps	Desert Hawk, Dragon Eye, Raven
Sub-tactical UAV	10–20	Up to 1,000[e]	52–120	5–20 hrs	2–5.5	50,000+	Tracking humanitarian convoys; patrolling border segments	Aerosonde, Luna, Scan Eagle, Silver Fox
Tactical UAV	120–500	120–2,000[f]	90–200	3–20 hrs	3–200	1–10 million	Long border patrolling, large area surveillance, monitoring from high altitude	B Hunter, Crecerelle, CL-289, Phoenix, Shadow 200, Sperwer
Rotary-wing mini-UAV[g]	7–95	5–10	0–80	<2 hrs	4.5–30	Under 100,000	Observation in urban environments, e.g. of crowds from different angles	FFOS, STD-5 Steadicopter, SR200 VTOL, TAG M80, RMAX

Source: survey of models on the commercial market.
Notes: Micro-UAVs are also arriving on the market.
[a] Gives the range of possible speeds. Larger UAVs cannot fly as slowly as smaller ones since the "stall speed" generally increases with weight. Slow speeds can be advantageous for some observation roles, e.g. for a longer loiter time.
[b] Typical cost per UAV. For a system (including ground station with console, launcher) the cost ranges are: $60,000–300,000 (mini-UAV), $650,000–2,000,000 (sub-tactical), $2–20 million (tactical).
[c] This list emphasizes UAV models that have actually been deployed in military, forestry or other applications.
[d] For example, this is the cost for one Dragon Eye UAV; see <http://www.defense-update.com/products/d/dragoneyes.htm> (accessed 10 January 2011).
[e] For example, the producers of the Aerosonde UAV claim a range of 1,500 km with a regular payload; see <http://www.aerosonde.com/> (accessed 10 January 2011).
[f] For example, the producers of the Sperwer UAV claim a range of 200 km through direct link (line of sight), and further using relays; <http://www.sagem-ds.com/spip.php?rubrique127&lang=en> (accessed 10 January 2011).
[g] Larger (tactical) rotary-wing UAVs are also available; they are mostly converted manned helicopter models.

piloted vehicles, the greatest benefit of UAVs in peace operations is that there is no danger to pilot or other crew as none are on-board! This makes it possible to fly safely over raging conflicts.

To control UAVs, remote pilots remain at distances of up to 100 km or even further using repeater stations (which may be on the ground or in other UAVs in the air). With satellite communications, the remote operators can be on the other side of the Earth. The controllers can vary the altitude, direction and speed of the aircraft as well as the angles and zoom of the onboard camera(s). The imaging suite can include devices to capture visible light, infrared and radar signals. Autonomous (pre-programmed) UAVs exist, but this feature is not likely to be used in peacekeeping in the near future, except possibly for take-off and landing.

For night flying, UAVs offer tremendous advantages. The United Nations generally does not allow its planes to fly at night for fear of crashes. UN aircraft are typically not equipped with weather radars, which help spot approaching rains, stormy winds or other hazards at night. Nor does the United Nations have night-time search and rescue or combat search and rescue capabilities to react properly and quickly to crashes at night-time or in heavy conflict areas. With downed UAVs, recovery is not as time sensitive so they do not have the same stringent night-flying rules. Given the current lacuna for night surveillance in peacekeeping operations, UAVs offer a powerful tool to enhance effectiveness and security after dark.

UAVs are generally harder to detect and shoot down than manned aircraft, given their smaller size and decreased noise. Battery-powered UAVs make hardly any noise at all, certainly nothing detectable above the din of battle. At higher altitudes (for example, 500 metres above ground level), some smaller UAVs can be neither seen nor heard. It should be noted, however, that a Belgian UAV was shot down by a hunter in the Congo in 2006, but this was considered a highly improbable hit.

If a UAV crash does occur, day or night, the costs are much less than for a plane, most importantly in terms of human life. Also UAVs are much less expensive to purchase or replace. A mini-UAV with its control system typically costs less than $50,000; sub-tactical UAVs are available for $500,000 or less. And costs are decreasing while capability is increasing. Requirements for licensing, clearance and flight planning are also decreasing as the technology proliferates.

Though UAVs still need remote pilots and a crew for launch, control and maintenance, the number of such support personnel is less than for manned aircraft. Typically, 5–10 soldiers are needed to form a “flight” of two or three tactical UAVs – less for mini-UAVs. UAVs also require less training. Some mini-UAVs can be flown and operated successfully with only weeks of training (like model aircraft).

UAVs can be launched from many locations. Short runways are sufficient for most UAVs and some can take off vertically. Some mini-UAVs can be hand-launched. UAVs are also easier to transport: most mini-UAVs are human-portable; that is, they can be carried in a case by a single individual. Some fit in a backpack. Sub-tactical UAVs can be transported in a minivan or on top of a utility vehicle (jeep), whereas tactical UAVs usually come with their own transport vehicle. UAVs are also easier to store, maintain and repair. All these features mean that UAVs have a "smaller operational footprint" in the field but the area coverage they provide can be as large as for manned aircraft.

UAVs also offer benefits to observers and analysts. In manned aircraft, onboard observers can easily become fatigued. Having more space and a greater ability to rotate personnel, ground-based observers at convenient locations can study monitors on large screens for longer periods of time. The endurance for human observers on a plane is typically four to six hours, and most planes need refuelling in even less time. UAVs can fly for longer periods because they are lighter and can be controlled by ground personnel on rotating shifts at a safe base to support longer flights. Any number of personnel can observe the video feed from the UAV.

Most UAVs are capable of longer loiter periods than planes, not only because they have more endurance but because they can achieve lower stall speeds, even as low as 30 km/hour (16 knots) for mini-UAVs, compared with 80 km/hour (43 knots) for small manned aircraft. Of course, rotary-wing aircraft have no stall speed. This "loiter on station" capacity is particularly useful to observe a localized activity closely for extended periods of time.

Rotary-wing (helicopter) UAVs can also range from small (mini) to large (tactical) UAVs. The latter are mostly converted manned-helicopter models with controls in place of the pilot's seat. Since few tactical rotary-wing UAVs are in existence, the numbers in Table 5.2 are only representative.

Advantages of manned aircraft

Unlike UAVs, the use of manned observation aircraft has historical precedence in peacekeeping. The United Nations has considerable experience in practice, but little of it is recorded, described or analysed. The United Nations' first aerial cameras were used in the Congo as part of ONUC in the early 1960s. The subsequent mission in the Congo (MONUC) has, remarkably, less capacity though the need is as great. MONUC has four Alouette helicopters with a "glass bubble" for visual observation and no recording equipment except still and video cameras that might be carried aboard.[16] The Mi-35 helicopters have considerably more capacity: variable field-of-view low-light television and FLIR recording systems, as

Table 5.2 Rotary-wing UAV characteristics

	Mini-UAVs	Tactical UAVs
Weight	1–100 kg	500 kg or so
Range	1–10 km	<400 km
Endurance	<2 hrs	<10 hrs
Payload	1–25 kg	<150 kg
Speed	0–80 km/hr	<200 km/hr
Cost	Under $100,000 per UAV	Above $100,000 per UAV
Examples	SR200 VTOL, STD-5 Steadicopter, TAG M80	Vigilante 502, Vigilante 496, Eagle Eye

well as a helmet-mounted sighting and display system. But, being a prized Indian national asset whose exact resolution is kept classified, the fourth-generation FLIR video imagery is as a rule not shared with the rest of the mission. Only freeze-and-crop frames are provided to highlight certain observations, although a live feed would be technically possible for remote viewing. The Mi-35 FLIR cameras proved most useful during combat in spotting militia and allowing the helicopter gunship to engage them with weapons systems slaved to the reconnaissance devices. More on these systems is provided in Chapter 7.

The greatest benefit of manned aircraft is their multi-purpose capability for transportation and combat as well as observation. Soldiers can become familiar with the terrain from the air and be dropped close to their target, particularly with helicopters. Commanders can direct ground movements from helicopters, as they have done in the Congo. This dual use of manned aircraft allows cost efficiencies such as carrying out reconnaissance during or after the transportation of personnel or materiel.

Manned aircraft generally have a longer range (because of larger fuel tanks) and can fly at higher altitudes than most commercial UAVs. A typical operational range of 1,000 km is greater than most UAVs can sustain, except American UAVs such as Global Hawk, which are well beyond the means of the United Nations. Some aircraft, such as the Cold War U-2 spy plane, are designed to fly and photograph at very high altitudes of over 20,000 metres.

Aircraft also travel at greater speeds and offer a more "commanding presence". As mentioned, UAVs can provide a modest "show of presence" but a jet aircraft can streak rapidly and impressively above conflict areas, some even breaking the sound barrier.

Pilots in manned aircraft have a better "feel" for the aircraft than for a UAV, since they benefit from direct flight sensations (such as vibrations), unlike ground-based pilots. That is one of the reasons manned aircraft have a much lower crash rate than UAVs, where the pilot's life is not at stake.

Finally, direct observation from inside aircraft has advantages over remote viewing through computer screens of UAV imagery. Onboard personnel have three-dimensional and wide-angle (panoramic) views that cannot be achieved on computer screens. In addition, onboard cameras and screens can greatly increase the capacity of the unaided human eye for closer observation and for recording.

Like ground and aerial reconnaissance, integrating the use of UAVs and manned aircraft can offer the advantages of both types. Still other aerospace platforms are available for possible integration.

Aerospace platforms for reconnaissance

Overhead imaging can also be done from balloons and satellites.[17] These offer some comparative advantages. For instance, satellites can travel freely in outer space, permitting them to observe virtually any area of the Earth legally without requiring national consent. The relative merits of each platform are presented in Table 5.3. Each platform is evaluated on eight basic characteristics: six beneficial ones, then two undesirable ones.

The table shows the comparative strengths and the drawbacks: the high costs of manned aircraft, the limited payloads of unmanned aircraft and the very limited manoeuvrability of balloons and satellites. An advantage of satellites is that they cannot be shot down, at least not by the types of weaponry found in peacekeeping areas.

For some UN purposes, aerial manoeuvrability is not always needed. For instance, tethered balloons can be useful for observing important areas, corridors or choke points on a near-permanent basis. Cables keep the observation platforms in place and allow for the conveyance of electrical power and data signals. These large balloons can also serve as visible markers of borders or cease-fire lines, as navigation aids, as communications relays and as radio-station transmitters. Of course, these static objects might also be favourite targets for frustrated combatants. Some balloons consist of several sealed sections to reduce their vulnerability. If shot down, however, they can be repaired or replaced quickly and cheaply. Some aerostats are rapidly deployable, or redeployed, in as little as 10 minutes from the back of a ground vehicle.

Radar-equipped aerostat (balloon) systems are currently employed on several international borders (for example, US–Mexico) as part of national interdiction programmes for drugs and human trafficking. Held at a typical altitude of 500 metres, the view can extend for several kilometres. In Afghanistan, the 14-metre long RAID (Rapid Aerostat Initial

Table 5.3 Comparing different types of aerospace surveillance platform

	Range	Endurance[a]	Speed[b]	Altitude	Manoeuv-rability	Payload capacity	Cost (financial)	Vulnerabilities
Fixed-wing aircraft (manned)	HIGH (<10,000 km)	Medium (max. 15 hrs)	HIGH	HIGH (<20,000 m)	HIGH (but cannot fly as slowly)	HIGH (<250,000 kg)	HIGH (for purchase, maintenance, fuel and personnel)	Possible fatalities; needs airfields for take-off and landing
Rotary aircraft (manned helicopter)	Medium (300 km)	Low (typically 3 hrs)	Medium (<350 km/hr)	Medium to HIGH (<10,000 m)	VERY HIGH (easy turns and stationary capacity)	Medium (<10,000 kg)	HIGH (for purchase, maintenance, fuel and personnel, inc. onboard pilots)	Possible fatalities
Unmanned aerial vehicles (UAV)[c]	Low to HIGH (1–1,000 km)	Low to HIGH (15 mins to 20 hrs)	Medium (40–300 km/hr)	Low to Medium (50–5,000 m)	HIGH	Low (1–150 kg)	MEDIUM (lower than manned aircraft, though dependent on type of UAV)	Can be shot down; weather dependent (esp. wind conditions)
Balloons (free or tethered)	Low (<100 km a day)	HIGH (10+ days)	Stationary or very low	Medium (<5,000 m)	Very low (wind dependent)	Low to medium (<500kg)	Low	Easily targeted and shot down
Satellites	VERY HIGH (but has fixed trajectory)	VERY HIGH (years, but revisit time can be days)	VERY HIGH (25,000 km/hr)	VERY HIGH (100–1,000 km)	Low (only certain types)	Medium (<5,000 kg)	HIGH (expensive to build and launch; imagery can be purchased cheaply[d])	Limited availability at specific time and place

Notes:
[a] Without refuelling.
[b] Ability to travel at slow speeds can be an advantage.
[c] Sub-tactical UAVs are considered.
[d] A high-resolution satellite can cost over $1 billion to build and $50 million to launch. Satellites of much lower cost, such as micro-satellites, are now coming on the market.

Deployment) aerostats are tasked with area surveillance and force protection against small arms, mortar and rocket attacks. They can stay aloft for over five days (Parsch 2005).

In addition to working with ground systems, aerial systems can be multilayered and hybrid to complement each other. Although aerospace reconnaissance provides unique advantages over ground reconnaissance, the best option is an integrated system to better detect threats and explore opportunities for peace and stability. Multiple information sources are needed to corroborate and probe sensitive and uncertain information in the dangerous environments found in many peacekeeping operations, past and present.

Notes

1. In ONUC, the United Nations' first air "recce" programme was begun one-and-a-half years after the operation was established in July 1960. Two Indian Canberra aircraft were designated for aerial reconnaissance. However, these planes proved to be inadequate, since they could take only vertical photographs because the window was designed for photographing bombing results. Later, Sweden provided two Saab 29C aircraft and a photo-interpretation detachment, which resulted in a substantial increase in intelligence on Katangese ammunition stockpiling and disproved many false reports of Katangese anti-aircraft batteries and underground aircraft shelters. See Dorn and Bell (1995: 11).
2. The United Nations Yemen Observation Mission (UNYOM) was mandated to observe an agreed disengagement between forces of Saudi Arabia, Egypt and Yemen. Air patrols, carried out by a Canadian unit with a dozen or so planes and helicopters, were essential in the mountainous border region, where foot patrols could cover only very limited ground. But, as in Lebanon in 1958, the United Nations came up against two limitations on UN patrols: traffic monitoring could be done only during daylight, and the ground inspection of various cargoes in moving caravans was difficult.
3. MONUC has 4 Lama (Alouette) observation helicopters and 4 Mi-25 and 4 Mi-35 attack helicopters equipped with advanced observation equipment. Along with the 28 transport helicopters (Mi-8T, Mi-8MTV, Mi-17, Mi-26), there are a total of 43 rotary-wing aircraft (data as of 24 March 2005).
4. Air flight is one of the most regulated forms of human activity worldwide, with detailed standards and specifications for safety and flight-worthiness. The United Nations generally abides by the standards set by the International Civil Aviation Organization. UN missions also have Standard Operating Procedures (SOPs) for flights and an Air Operations Manual. By contrast, the sub-activity of aerial reconnaissance is not well documented and only briefly mentioned in the SOPs.
5. Most missions have speed limits for vehicle travel. For MONUC, the limit was 60 km/hour, lower for certain roads. In some missions, the time to reach the destination takes up the majority of the patrol time. For instance, in the United Nations Mission for the Referendum in Western Sahara, the "base to station time" required to reach the "berm" (the UN-monitored sand wall of separation) is two hours or more for some bases.

6. Even the sound of approaching aircraft can be intimidating, stimulating or warning (depending on the context). In the Eastern DRC, the mere sound of an approaching Mi-25/35 helicopter gunship caused militia forces to break up and flee.
7. Information provided by the Air Transport Section of the Department of Peacekeeping Operations, 28 February 2007.
8. EUFOR offered to provide images extracted from its UAV video feeds to MONUC within about 1–2 hours (i.e. in near real-time).
9. Personal interview with Brigadier General Duma Dumisani Mdutyana (Deputy General Officer Commanding of MONUC's Eastern Division), Kisangani, DRC, 30 November 2006. The militia leader signed a peace agreement later that year.
10. The helicopter provided armed protection for a group of seven Nepalese soldiers who became separated from the rest of the UN force (MONUC) but, when the helicopter went back to refuel, the soldiers found themselves surrounded by more than 300 militia and were taken hostage. After 42 days of negotiations, they were finally released unharmed.
11. Nine Bangladeshi peacekeepers died in a rebel ambush in the nearby Ituri district in February 2005. The DRC was the scene of the deadliest attack in UN history when, on 22 May 1961, 38 Ghanaians from ONUC were killed.
12. Two other commercial applications are: news gathering (for events that reporters cannot reach in time) and ground traffic reporting (to monitor traffic and accidents over major highways). See University of Florida's LIST Lab, "Brief History of UAVs", <http://www.list.ufl.edu/uav/UAVHstry.htm> (accessed 10 January 2011).
13. Larger UAV systems exist, e.g. US-manufactured Global Hawk UAVs, but they are not appropriate for the United Nations. They are not generally commercially available, their payloads are highly classified and the cost is extremely high. For example, the price of a Global Hawk aircraft, which can fly at extremely high altitudes over 20,000 metres, is $18–20 million.
14. The first UAV to fly autonomously across the Atlantic Ocean, Aerosonde *Laima* (13 kg), did so on a single tank of fuel with the benefit of supportive air currents (McGeer 1999).
15. For an example of light-weight sensors for UAVs, see Optical Alchemy's website at <http://www.opticalchemy.com> (accessed 10 January 2011).
16. Given the lack of permanent observation equipment onboard, when the Lama helicopters were deployed in Kinshasa in 2006 to observe crowd movements, the television cameras from MONUC's public TV unit and from Radio Okapi were used to produce some higher-resolution imagery. Personal interview with François Grignon (former chief of Joint Mission Analysis Centre, MONUC), Toronto, Canada, 4 February.
17. Also called aerostats, dirigibles, airships or blimps.