United Nations
peacekeeping
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External Study

TOOLS OF THE TRADE?
Monitoring and Surveillance Technologies in UN Peacekeeping

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In 2006-07, he was on sabbatical leave when he completed the research for the current work, which included a visit to the UN operation in the Congo (MONUC). This study was commissioned by the UN Department of Peacekeeping Operations (DPKO) in response to a request from the Special Committee on Peacekeeping (the C-34). Any comments on this paper or topic can be sent to dpko-bestpractices@un.org

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DEDICATION

To the eight Guatemalan Special Forces officers who died in a pre-dawn ambush near Fataki, Eastern Democratic Republic of the Congo, on 23 January 2006, and to other soldiers and civilians who made the supreme sacrifice while serving in UN peacekeeping operations. Having served the peace, may they rest in peace. Meanwhile, it remains to us, the living, to continue to pursue the peace that they sought to secure, using all the tools at our disposal.

Executive Summary

The UN has extensive experience monitoring conflict areas using human, mostly military, observers.

The United Nations has more experience monitoring ceasefires and peace agreements than any other organization. Its peace operations have evolved considerably from early observer missions to armed forces interpositioned between belligerents to complex multidimensional operations and transitional administrations. In the process, the UN accepted increasing responsibility to inform UN Member States and the wider world about development and conditions in war-torn areas.

The human eye is very limited, especially for the expanded array of modern monitoring tasks.

The UN's operations have relied almost exclusively on human observers, both military and civilian, for monitoring. This presence on the ground is essential, but simple observation with the **human eye,** sometimes aided by binoculars, has **many limitations**. The range of vision is limited by the line-of-sight in daytime and covers only illuminated areas at night. It is difficult, if not impossible, to monitor vast territories, and to maintain a permanent presence in distant locations. The challenges of detecting arms smuggling and illegal resources-exploitation that frequently fuel conflicts are enormous, as is early warning of armed conflict in time to prevent escalations of violence. Visual observation is rarely sufficient to follow the many indicators, including the movements of armed groups in difficult terrain or to identify intruding high-flying aircraft. Furthermore, when violence escalates, it becomes more dangerous to maintain a human presence, so evacuations are often required at a time when current information is most needed for peacemaking and peace restoration. Even after atrocities have occurred, visual evidence is often hard to come by since much of it is buried and covered up.

Fortunately, technologies offer complementary means to expand the monitoring horizon, to see at night and to capture imagery for dissemination.

These devices are becoming cheaper, more accurate and more widely available commercially.

Modern monitoring technologies are tools that can solve many of these problems and dilemmas. Technologies can **increase the range, effectiveness and accuracy** of observation. They offer a means of surveillance of airspace, ground and even underground. They permit continuous (e.g., 24-hour) coverage of many areas, while decreasing intrusiveness. They can record events for further analysis and wider dissemination. They also allow observation **at a safe distance**, especially before entry of human observers, humanitarian convoys or robust forces.

Fortunately, the rapid pace of scientific and technological progress is resulting in **better, smaller, and cheaper devices** that are increasingly easier-to-use and readily available commercially. Many militaries have incorporated sophisticated devices into their standard toolkit. In fact, some prefer not to operate without the devices.

The United Nations has used ***some*** **monitoring technologies in** ***some*** **missions** but mostly in an ***ad hoc*** and ***unsystematic*** fashion. Simple digital and video cameras, often brought personally, are now providing valuable photographic evidence, but they are not yet a regular part of reporting practice. The procedures to share and analyse imagery remain primitive. The UN has yet to deploy remote-controlled video cameras to monitor potential flash points, though pioneering efforts are being made in one mission (see later). The UN owns some several hundred night-vision devices, but these are older (second generation) image intensification devices, not connected to cameras and, in any case, too few to meet the requirements. Thermal imagers, which can greatly extend the range of night-vision, are not in the UN stockpile. The United Nations has no direct experience with seismic or acoustic ground sensors. Radars are another untapped technology that permit monitoring of the sky, the ground and even underground (e.g., to detect hidden weapons or mass graves). Furthermore, the organization does not routinely deploy motion sensors, which are simple, cheap and readily available technologies that serve a useful alert function.

Aerial reconnaissance offers tremendous advantages. But the UN has little experience with observation aircraft.

The UN never deployed unmanned aerial vehicles (UAVs), which have the benefits of no risk to the lives of the crew and greater freedom of movement, especially in dangerous areas.

Deploying advanced cameras and sensors on **mobile platforms**, such as ground reconnaissance vehicles and aircraft, provides even greater benefits for speed, area coverage and safety. But the UN does not currently use these systems in its operations, with a few exceptions as examined in this study. In fact, unmanned aerial vehicles (UAVs) have yet to be deployed by the United Nations, though they were brought by a partner (EUFOR) to temporarily help one UN operation and are under consideration in new missions. Neither has the UN used tethered balloons, which provide an excellent way to observe from up high, as well as to show a UN presence and to mark strategic areas (e.g., borders).

The **new generation of peacekeeping operations (PKOs) continues to rely on old-generation tools**, mostly binoculars. Over the past decade, some militaries have become disenchanted with peacekeeping as practiced by the United Nations, in part because their soldiers were placed in harm’s way without the “full kit” deemed necessary under national standards. Needing a better situational awareness and responsive capacity, many Western nations, including former top contributors, turned to organizations more robust and more technologically capable, especially

NATO, to carry out tough peacekeeping tasks. To encourage these nations to re-engage in UN peacekeeping, more appropriate levels of technology will need to be attained, though not necessarily at the most advanced level.

The United Nations has a **responsibility** to make sure that its peacekeepers, civilian and military, from both the developed and developing world, have the tools needed to **ensure safety and effectiveness**. A **"monitoring gap"** currently exists between the assigned monitoring mandates and the means to carry them out. To narrow this gap, there are a number of ways the United Nations can make easy evolutionary progress, as described in the conclusions and recommendations section of this report and summarized here.

The gap between monitoring mandates and capabilities can be partly filled with the creative use of modern technology.

Human and technical sources of information are complementary, not competitive.

To gain experience, the United Nations could **test, deploy and evaluate sensor suites on a trial and operational basis**. Some inexpensive sensors, such as motion detectors with illuminators can be widely deployed immediately. More costly items, like UAVs, must follow a procurement process or solicitations to suitably equipped troop-contributing countries (TCCs). More generally, DPKO could identify TCCs that are capable of providing various types of monitoring equipment and expertise. DPKO should invite them to share their technological expertise and experiences, both at UN headquarters and in the field. As the Special Committee on Peacekeeping (the C-34) has requested, DPKO should engage TCCs in a dialogue, possibly through formal seminars and national technology demonstrations, in addition to informal discussions.

A policy framework is needed for the systematic introduction of monitoring technologies into UN peace operations.

To increase its technological awareness, the United Nations should **develop, update and improve its policies, doctrine and training materials** to incorporate appropriate monitoring technologies. Particularly the Contingent-Owned Equipment (COE) Manual, which provides the basis for TCC contributions, needs to be revised, clarified and expanded.

The organization should build on its recent progress with **Geographic Information Systems** (GIS). It could easily progress from paper products to user-input GIS databases, allowing data to be more easily organized, analysed and shared. The UN would benefit from the "sensor revolution" by networking sensors to GIS to provide current data about a wide range of observables to a wide range of UN agencies in real time. This would help produce better early warning of impending attacks or other escalations of violence. Data could be accessible from headquarters as well as the field, including imagery from digital video networks and web cameras.

The UN needs to **increase its in-house expertise** to select and maintain key technologies, and to apply innovative methods of technical monitoring. A small team of individuals at headquarters could be employed by the UN to gain familiarity with monitoring methods and technologies. A new **monitoring technology service** or **support office** could fill the need at UNHQ in much the same way that the communications and information technology service (CITS) does for that function.

Member States can provide key assistance by providing, loaning or leasing technologies, by helping with procurement (e.g., removal of export limitations), and with training and education programmes.

In-house expertise can be complemented by **TCC assistance and leadership**. Technologically capable Member States could identify potential contributions from their forces and devices from their industries, facilitating procurement and the much-needed export licenses, as well as sharing expertise more broadly. Those nations having limited experience with monitoring technologies could seek equipment for pre-deployment training from the UN or from donor countries. Member States could look at ways to improve the technology provisions of the **COE manual** through the COE Working Group. Finally, nations could support DPKO (or its successor departments) in its efforts to improve the technical monitoring capabilities.

A dialogue between UN Member States and with the Secretariat should help advance these issues.

The United Nations has proven its capacity to support high technology, as evidenced by its extensive communications and information technology (CIT) architecture. It should be capable of developing at least modest means of technical monitoring, including a possible technology support service.

In the information age, technology offers increased situational awareness, needed for effective threat and risk assessments and proactive operations. "Information power" is a key tool for PKOs, a vital alternative as well as a prerequisite to the use of force, which should always be a last resort. To fill the "monitoring gap" between mandates and capabilities, the United Nations can, fortunately, rely on commercial off-the-shelf technologies that are rapidly developing in capacity and decreasing in cost.

Knowledge is power and used wisely by the UN it can be a power for peace.

With the support of Member States, both technology providers and users, the level of technological advancement in PKOs can be easily enhanced for greater mission effectiveness and safety.

1. TECHNOLOGY FOR PEACE

> With regard to the use of high technology in peacekeeping operations, it was indicated that, in view of its complexity, the issue needed to be *further explored*.
>
> — 1989 Report of the Special Committee on Peacekeeping[1]

The Cold War model of UN peacekeeping needed to be modified in the 1990s as operations became more complex, dangerous and demanding. The expansion of peacekeeping tasks called for more advanced tools …

As the United Nations came out of the Cold War and peacekeeping entered a new era in 1989, the Special Committee on Peacekeeping Operations (newly named the "C-34"[2]) was aware that technology had the *potential* to enhance peacekeeping. The Committee, however, showed a reluctance to actively pursue this "complex" issue. Many nations maintained that the long-standing reliance on the human observer (UN military observer or UNMO) and infantry interposed between enemy armies would suffice for peacekeeping duties. This view proved short-sighted, as ambitious new mandates and difficult monitoring tasks quickly overwhelmed peacekeepers in places like Angola, Cambodia, Somalia, Bosnia and Rwanda. UN personnel, including an increasing number of civilians and police, were no longer stationed solely on borders between states but scattered throughout countries and large regions, carrying out a host of novel nation-building tasks while at the same time trying to prevent civil wars, massacres and all manner of violence. It quickly became evident that simply observing opposing forces with the human eye was no longer sufficient in complex multidimensional operations. There was a growing need to keep watch over potential spoilers of peace processes, to produce legal evidence of atrocities committed by rag-tag militia, as well as monitor a host of peace-building activities. Even with these new and ambitious goals, UN member states and Secretariat officials were reluctant to invest in observation technologies, for reasons to be explored later. Proposals for studies on high-tech monitoring continued to surface, but no UN studies materialized.[3] The new generation of

[1] UN Doc. A/44/301 of 9 June 1989, p.4. (emphasis added)

[2] In 1989, the Special Committee on Peacekeeping was named the "Committee of 34" or C-34 since its membership had increased by one from the previous year (1988) to 34 members. Although the C-34 currently has 124 members, the C-34 label has remained. The C-34 members are generally current or former contributing nations to UN peacekeeping operations. There are also 17 observer states associated with the C-34 at the beginning of 2007.

[3] The 1989 Report of the Special Committee on Peacekeeping contained a list of governmental "Proposals on Peacekeeping," including: "A study should be undertaken on possible uses of high technology, such as surveillance satellites, automatic sensors, radar and night-vision equipment." No such study was commissioned by the UN until

peacekeeping operations continued to rely on old generation tools (mostly binoculars).

In the late-1990s, the nations with advanced technologies shifted their military contributions to NATO operations.

Some militaries became disenchanted with peacekeeping as practiced by the United Nations, in part because their soldiers were placed in harm's way without the "full kit" deemed necessary under national standards. Needing a better situational awareness and responsive capacity, many Western nations, including former top contributors, turned to organizations more robust and more technologically capable to carry out tough peacekeeping tasks.[4]

Scientific and technological progress has been evolutionary, even revolutionary, in the communications and information technology (CIT) field. New CIT has changed the way people communicate globally and has already greatly aided UN missions.

Meanwhile, a technological "revolution" has been underway, driven by rapid scientific, technical and commercial progress. Most easily discernable are the advances in communications and information technology (IT). Global telecommunications, the Internet, personal computing, hand-held devices, wireless and digital networking have changed the way people live, move and work in the "information age"—and the United Nations has not left itself out completely. UN communications systems evolved alongside the commercial sector. But for monitoring and surveillance technologies, there was no similar progress in the United Nations, despite a commercial sensor revolution in the world. Increasingly inexpensive products such as high-zoom digital cameras, web cameras (webcams) and camcorders have become common household items. Motion detectors are in widespread use in home alarm systems (e.g., in driveways along with night illumination to alert householders to

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the present one in 2007. In 1990 and 1995, the Secretary-General's Panel of Experts (1990, 1995) on the subject of "Verification in All Its Aspects" recommended research on the use of technologies for verification in the context of peacekeeping as well as disarmament. In 1998-2000 the Department of Peacekeeping Operations (DPKO) Training Unit attempted to fund studies on the use of monitoring technologies in PKO but these proposals were not approved. In its 2005 Report, the C-34 stated that "all forms of technical monitoring and surveillance means, in particular aerial monitoring capabilities as part of United Nations missions, should be explored" and requested "the Secretary-General to provide in his next report to the Committee a comprehensive assessment in that regard and on the basis of lessons learned." (UN Doc. A/59/19/Rev.1 of 1 March 2005). When no answer was forthcoming, the request was reiterated in 2006 "for priority action." Even then, a Canadian proposal for the present study was initially rejected (summer 2006). Only with the initiative of the Military Planning Service was the study made possible in 2006-07. Meanwhile, since 1989, outside the UN, several countries, institutes and researchers have conducted relevant studies, which are listed in the Bibliography.

[4] In 1995, the developed world (as represented by OECD nations) accounted for 51% of UN uniformed peacekeepers. Ten years later, the contribution had fallen to only 8% percent (computations by the author). After 1995, NATO began to take on major peacekeeping responsibilities, starting in Bosnia and later in Kosovo. The European Union also deployed short-term forces in 2003 and 2006 to the Democratic Republic of the Congo in support of the ongoing UN-led peace process. Canada was a top contributor to peacekeeping for decades, since the first peacekeeping force was created in 1956 (at the initiative of Canadian Foreign Minister Lester Pearson). At present, Canada ranks 62nd in the list of Troop-Contributing Nations (source: Contributor by Rank, September 2007, available at www.un.org/Depts/dpko/dpko/contributors).

visitors and potential intruders), and sensors are found in sliding supermarket doors and washroom sinks, but they are not yet the tools of peacekeepers in the world's hot spots. High-resolution satellite imagery, which 20 years ago was the sole preserve of military and intelligence agencies, is now available free on personal desktops world-wide through services such as Google Earth, but the United Nations has yet to use near real-time satellite imagery in its operations. Digital video networks are making shops and streets safer in major cities (London most prominently), but the concept of closed-circuit television (CCTV) to monitor strategic locations in war-torn cities is a novelty in peacekeeping. Model airplane enthusiasts can fly small-scale airplanes equipped with miniature video cameras, but the United Nations has yet to deploy the professional equivalents (Unmanned Aerial Vehicles or UAVs) in its operations. Other organizations, like NATO and the European Union, readily adopted a wide range of advanced technologies in their peace support operations but not the United Nations.[5] Given that monitoring is a central element of every UN peacekeeping mandate, it is strange that monitoring technologies are missing from the organization's standard toolkit. It is also tragic that they are not used by the United Nations in the world's conflict zones, where detection of dangerous movements of arms and fighters could help prevent large-scale atrocities.

The sensor revolution, which includes digital imaging from remote cameras and satellites, has not made a similar impact on UN operations.

The UN is capable of incorporating new and advanced technology into its peace operations, as evidenced by its CIT progress, including the establishment of a peacekeeping intranet available to personnel both at UN Hq and in field missions.

Commercial monitoring technologies have not yet become a part of a standard toolkit for UN peace operations.

In the communications field, as mentioned, the United Nations has successfully harnessed new technologies. The UN's Department of Peacekeeping Operations (DPKO) maintains a communications system that is world-class: rapidly deployable anywhere on the globe, and capable of voice, video and data transmission at the operational level. Purposefully redundant and complementary systems (UHF, HF, cell and satellite phone networks) are deployed in most missions. New York also maintains high quality video-teleconference (VTC) links with many PKOs. DPKO's information technology architecture is also quite advanced, providing crypto-fax, email, Internet and, in 2006, Intranet access to all field

[5] In several peacekeeping missions, other organizations or governments flew UAVs but not under the UN chain of command. In Bosnia, the United States flew Predator drones in areas where the United Nations Protection Force (UNPROFOR) was stationed. Later the NATO-led Implementation Force (IFOR) and Stabilization Force (SFOR) missions used drones. Various nations deployed drones in the NATO-led Kosovo Implementation Force (KFOR). In the Democratic Republic of the Congo, the European Union (EU) flew Belgian B-Hunter UAVs, in part to support the UN Mission in the Congo (MONUC).

As monitoring technology is becoming cheaper and more widely available, it will be easier to use it in peacekeeping operations. This includes the databases and geographical information systems (GIS) that can capture information from the field in a user-friendly and readily presentable fashion.

The UN has begun to use GIS systems but it should explore the opportunities for user-input systems for real-time information and imagery sharing.

missions and most field personnel.[6] Many UN databases, containing excellent and up-to-date resources, are accessible from remote locations. For example, the Contingent-Owned Equipment (COE) database[7] is available to personnel at headquarters and in the field. Moreover, the UN's Official Document System (ODS) database, with tens of thousands of documents added yearly, has been available free to the general public since 2004.

The driving processes of globalization, digitization, miniaturization, and convergence have greatly helped the communications/IT functions of the United Nations but without direct impact on its capacity for observation. Satellites are routinely used by the United Nations for communications and IT purposes, but they are not used for timely reconnaissance. Similarly, the use of aircraft for UN transportation is impressive—for example, the UN's mission in the DRC runs the largest carrier fleet in Africa[8]—but the potential for aerial reconnaissance in peacekeeping has only begun to be explored. The UN manual that sets the standards for equipment brought to the field by national contingents (the "Contingent-Owned Equipment Manual") lists 34 types of communications technologies, but only six monitoring technologies, and even those six are not adequately defined or described.[9]

Fortunately, commercial off-the-shelf technology (COTS) for monitoring is becoming cheaper, better and lighter in virtually all categories. It is increasingly easier to procure and deploy. The microprocessor revolution—which experienced an unprecedented

[6] The UN has not yet brought data transmission to the tactical level (i.e., the individual soldier in the field), largely because communications within a contingent remain the responsibility of the contingent. Also UN personnel often complain of blackout periods, when email cannot be used, and delays in the transmission of messages across the UN networks in the field and to UN headquarters.

[7] The COE database is not available to the general public but information on the COE system can be found at www.un.org/Depts/dpko/COE/about.html.

[8] MONUC's 86 air assets are: 24 fixed wing aircraft and 62 helicopters of the following types. Military helicopters: Mi-17 (16); Mi-35 (4); Mi-25 (4); Lama/Alouette (4). Civilian air assets (Contractors): Mi-8 (30), Mi-26 (4), Hercules (6), An-24 (3); An-26 (2); An-72 (1); IL-76 (3), Beechraft-200s (3), Boeing 727 (2), HS-125 (2), Dash turbo props (2), as of 10 Jan. 2006, http://www.monuc.org/news.aspx?newsID=9576. MONUC's fleet of over 86 aircraft is greater in number than South African Airways' 63 aircraft, though the latter are mostly considerably larger (see the "South African Airways" entry in wikipedia.org). Of MONUC's annual $1.1 billion budget, almost half is spent on aircraft and fuel.

[9] The 34 types of "Major" communications equipment are listed under six the categories: VHF/UHF-FM transceivers (8 types); HF equipment (4); satellite equipment (10); telephone equipment (5); airfield communications (4); as well as miscellaneous (3, incl. underwater). The six monitoring technologies fall under two categories ("observation" and "identification"). The deficiencies of the COE Manual are described in the next chapter of this paper. The Standard Cost Manual 2005 lists 4 types of observation technology and 175 types of communications equipment.

Making these tools available to UN peace operations will provide the organization with a better ability to avoid crises or at least mitigate them.

improvement of eight orders of magnitude (a factor of a hundred million) in price-to-performance ratio over 40 years[10]—means that there has been a proliferation of "intelligent" sensors and surveillance systems. Data can now be conveniently incorporated into Geographical Information Systems (GIS) that are readily available on the commercial marketplace at a fraction of the previous price (typical price is $3,000 or licensing fees of $300 per computer annually). However, the United Nations continues to distribute only cartography products and paper maps; it has yet to make the jump to shared GIS databases which would allow direct input from users like UN police and military observers. Fortunately, this capability is likely to come soon, given the rapid progress that has been made in the DPKO's cartography/GIS units.

Technologies can play a pivotal role in early warning, conflict monitoring and verification of peace agreements and for sanctions enforcement.

Modern militaries are keenly aware of the process of technological evolution and the enormous difference new technologies can make in operations by increasing awareness, speed and precision. The terms "revolution in military affairs" (RMA) and "network-centric warfare" (NCW) are now common, if not clichés, in military circles. They convey the reality that new technologies, combined with new strategies, have substantially changed modern military operations, especially through advanced electronic networks. Many militaries have been quick to take advantage of the sensor revolution, deploying ruggedized fourth generation night-vision equipment, ground-based radars for air and ground surveillance and making much use of aerospace reconnaissance. The field of C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance)[11], with its strong emphasis on information collection and sharing, has long been viewed as an essential field of military study.

In summary, despite the rapid evolution of sensor technologies in modern militaries and society, the United Nations has been slow to apply sensors to the military or civilian domains of its peacekeeping operations. The world organization is subjecting personnel to unnecessary risks by not utilizing modern technologies that can monitor the most dangerous areas from a safe distance and help gain a broader awareness of safety and security threats.

[10] In the early 1960s, the "state-of-the-art computer" had 1 KB of "core storage" and cost over $10,000, while today a laptop with 10 GB of hard disk space can be purchased for under $1,000. This is a hundred-million-fold improvement in the price-to-performance ratio over 50 years.

[11] In the 1980s, the term C3ISR was used since computers had yet to make such a high level of impact.

Due to the lack of situational awareness, field personnel have found themselves in untenable situations. In Rwanda in 1994, the Force Commander, General Romeo Dallaire, complained of being "deaf and blind" in the field. Not being able to corroborate reports of a planned genocide or to monitor radio conversations of the genocidal militia or to track arms flows, he did not have the detailed intelligence needed for early warning nor the fighting forces required for an effective or robust response. This led to a loss of UN credibility in Rwanda and a large UN failure in the eyes of the world.

In neighbouring Democratic Republic of the Congo (DRC), an estimated 3-4 million people have perished since 1996 in widespread strife, including two civil wars—the second of which could be termed a "continental war", given the presence of opposing fighting forces from diverse African nations. At the beginning of the Congo/Zaire crisis, the United Nations proved unable even to provide accurate and consistent counts of moving refugees. Currently, large shipments of illegal armaments are routinely imported into the DRC, as vast quantities of illegal minerals are shipped out, without the United Nations being able to detect or interdict them. Rogue militia routinely carry out illegal tax collecting, looting, smuggling, kidnapping and killing in areas of the country with no real-time watch from the United Nations. Furthermore, a peacekeeper dies each month (on average) while serving in the Mission des Nations Unies en République Démocratique du Congo (MONUC).[12] Although military leaders in MONUC clearly enunciated the operational requirements for technical surveillance means, UN headquarters showed a slowness to support these requests.

When the Special Committee on Peacekeeping (C-34) requested DPKO to consider the issue of monitoring technologies in 2005 and 2006, UN field personnel and peacekeeping supporters found hope for future improvement. The 2006 C-34 report requested "priority action" from DPKO

> to examine how all forms of technical monitoring and surveillance means, in particular aerial monitoring capabilities, can be used by the United Nations to ensure the safety and security of United Nations peacekeeping personnel, particularly those peacekeepers who are deployed in volatile and dangerous conditions, and in

[12] The most dangerous current PKOs, based on fatalities per year (given in parenthesis) over the length of the mission, are: UNMIL-Liberia (28.3), UNMIS-Sudan (15), MONUC-DRC (14), UNOCI-Cote d'Ivoire (13), ONUB-Burundi (11.5) and MINUSTAH-Haiti (10).

situations too dangerous for monitoring from the ground.[13]

The UN's committee of peacekeeping contributors (the C-34) in 2006 requested a report from the Secretariat on technical monitoring.

The Special Committee recommended that DPKO "engage troop-contributing countries in a dialogue on this issue" and "reiterated yet again its request to the Secretary-General to provide the Special Committee in his next report with a comprehensive assessment in this regard."

This C-34 request for a *comprehensive* assessment is the motivation for the present study, written by an independent researcher and formally commissioned by DPKO in January 2007. An early version of this report was tabled with the C-34 in March 2007 and its conclusions were presented orally by the author. The C-34 members welcomed the study and recognized the urgent need to standardize the use of advanced technology. They requested the Secretariat to develop modalities to use such technologies and keep up a dialogue on the issue with member states.

An earlier version of the present report was presented to the C-34 in 2007. In response, C-34 members asked the UN Secretariat to standardize advanced technologies in its peacekeeping operations.

The author has adopted a broad view of UN safety and security, recognizing that the greatest threat to mission personnel is a break down of the peace process. The greatest protection for mission staff is an effective, credible mission. This holistic approach recognizes that the security of the peacekeeper is linked to the security of the "peacekept"—that human security is indivisible. Similarly, mission safety/security and mission effectiveness are inexorably linked. Threats may come from various sources, and the entire monitoring capability of a mission, including all its instruments and means, needs to be brought to bear to synthesize information from many sources for threat, risk and opportunity assessments.

Monitoring should be done "holistically" across the range of observable activities and using complimentary sources to obtain the complete picture.

With this approach in mind, this report introduces UN monitoring (Chapter 1), identifies the technology needs and gaps (2) and reviews the array of current and potential technologies (3), especially for aerial reconnaissance (4). It then assesses the strengths and weaknesses of current UN standards and procedures (5) and considers the problems and challenges for increased technology use (6), in order to arrive at a set of practical recommendations to improve the safety and effectiveness of UN peacekeeping (7).

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[13] The 2006 report of the C-34 was adopted by the General Assembly in resolution A/res/60/263 of 15 June 2006. The rest of paragraph 56 reads: "The Special Committee stresses the need for priority action by the Department of Peacekeeping Operations to examine ... [see above] … The Special Committee recommends that the Department of Peacekeeping Operations engage troop-contributing countries in a dialogue on this issue. The Special Committee reiterates yet again its request to the Secretary-General to provide the Special Committee in his next report with a comprehensive assessment in this regard." Source: http://www.un.org/Depts/dpko/dpko/ctte/6019.pdf.

2. URGENT NEEDS

The UN is required to monitor and observe an ever-increasingly diverse range of areas and activities, including: national and local borders; refugee camps; flight paths; elections; smuggling; combatants, VIPs, etc. The nature of UN activities continues to be complex and demanding. To meet the existing challenges and prepare for future needs, the UN should take advantage of commercially available technologies.

Monitoring is a basic function of all peacekeeping operations, past and present. In some cases, it is the main function. All missions have monitoring or observation or verification[14] in their mandates; almost two dozen have had the tasks in their names.[15] Peacekeeping operations (PKOs) have been required by the Security Council to observe over time (i.e., monitor) a long list of areas and activities, including:

- cease-fire lines, demilitarized zones and international/internal borders
- UN protected areas and sites (such as safe havens or refugee camps)
- strategic areas (e.g., airports), persons (protected VIPs) and groups (children)
- no-fly zones and flight bans
- arms embargoes and assistance to armed groups
- disarmament, demobilization and reintegration (DDR) of ex-combatants
- elections
- human rights
- antipersonnel mining and demining
- illegal commercial activities supporting the conflict (e.g., mineral exploitation)
- security sector reform (e.g., of armed forces, police, corrections, customs and even intelligence agencies)
- malicious acts and escalations of violence.

The UN requires additional detailed information near the UN camps and facilities.

For its own security, UN operations maintain constant awareness of conditions around UN camps and facilities, and of threats to the main supply route (MSR), roads travelled and areas visited. It must also learn much about the wider environment, such as the intentions and locations of potential spoilers, the mood of belligerent crowds/mobs, the hideouts and armaments possessed by any renegade forces, and a host of details about actual or potential threats, both natural and man-made.

For all these mandated and implied tasks, PKOs need to employ a wide set of monitoring tools and methods. Technical means can help the United Nations meet these enormous monitoring challenges. While the specific capabilities and UN experience with various technologies are

[14] For simplicity, "monitoring" can be considered "observation" over time and "verification" is monitoring to determine if an agreement (e.g., cease-fire or peace agreement) or Security Council resolution is being respected.
[15] For example, the United Nations Disengagement Observer Force (UNDOF), the United Nations Observer Mission in Georgia (UNOMIG), and the United Nations Angola Verification Mission (UNAVEM I, II and III).

Many different types of technology can help satisfy the critical needs of various PKOs.

The MONUC operation in the Dem. Rep. of the Congo is a good case study to identify the possible technological contributions to seven major goals that are common to most, if not all, PKOs.

reviewed in the next chapter, the analysis here suggests the kinds of tools that can help deal with the major recurring problems facing PKOs. This chapter also looks at some of the structures needed to process, analyse and disseminate the information within the mission, including the recently introduced Joint Operations Centre (JOC) and Joint Mission Analysis Centre (JMAC). The UN operation in the Congo (MONUC) provides a good case study to examine current capabilities and requirements for monitoring technologies (see Annexes 1 and 2). Like other missions, it faces at least seven pressing needs.

1. Protecting UN Personnel: An Essential Responsibility

The UN must have sufficient information to protect its personnel on a 24-hour basis, especially in highly volatile areas. Often there is insufficient staff to perform the necessary monitoring.

The safety and security of UN personnel should be first and foremost in the minds of UN leaders who assume a solemn responsibility for the people they send to the field. Proactive protection requires early warning and accurate *threat and risk assessments* (TRA), based on a wide range of information. Especially in highly volatile areas, where civilians might be exposed to indirect artillery/mortar fire, machine gun/rifle cross-fire, landmines/UXOs or even direct ambush or attack, the United Nations needs far more than an occasional "presence." It needs a thorough day-night watch over large areas, something few missions provide. There are rarely enough personnel to do the job. Furthermore, employing human observers presents a serious dilemma in the first place.

When hostilities flare up and UN observers are most needed, they are also at the highest risk. Technology can be used to continue observation in danger zones without risk to human life or limb.

Reliance on human observers, particularly unarmed United Nations Military Observers (UNMOs), poses a "catch 22." When conditions become dangerous or the parties become hostile, current information is most needed, requiring close observation. But at such critical times, the observers have to be withdrawn for their security, creating an information vacuum. As will be demonstrated in this paper, technologies can help answer this dilemma.

Despite the UN's caution, over 2,000 personnel have lost their lives from various causes since the beginning of UN peacekeeping in 1948. Table 2.1 looks at the fatality statistics in the DPKO Casualties Database according to three types of personnel and four types of incidents causing death. By examining how (and to whom) the fatalities have occurred, it should be possible to recommend ways and tools to help avoid them in the future.

Table 2.1. Fatalities in Peacekeeping (1948-2006) by Personnel Type and Incident Type[16]

	Incident Type				
	Accident	**Malicious Act**	**Illness**	**Other**	**Totals (%)**
Military	769	603	432	112	1,916 (89%)
International Civilian	47	27	47	8	129 (6%)
Police	50	16	37	10	113 (5%)
	866 (40%)	646 (30%)	516 (24%)	130 (6%)	2158 (100%)

Statistics reveal that international civilians are almost twice as likely to die in a peace operation than uniformed personnel.

The table shows that, over the history of peacekeeping, *accidents* have accounted for the greatest number (40%) of fatalities, followed by *malicious acts* (30%), then *illness* (24%) and a small percentage of *other* causes (6%, often undetermined). Military personnel have suffered by far the greatest number of fatalities (89%). (Only 3% of these fatalities were military observers.) The other categories are all under 7%. Since the number of military personnel serving in peacekeeping is at least ten times as many as civilian personnel,[17] a better indicator of risk is the number of fatalities per 1,000 personnel serving. For 2005, they are: 1.51 (for uniformed personnel, i.e., military and police) and 2.92 (international civilians). Surprisingly, an international civilian is almost twice as likely to die in a UN mission than a soldier![18]

Monitoring technologies can reduce fatality rates.

Many safety and protection measures can be taken to mitigate fatalities in each category. Monitoring technologies can be deployed for prevention, protection and rescue. A list of applicable technologies would include:

- For accidents: vehicle management and tracking systems (a proven example is "Carlog," see Chapter 3); better monitors of road conditions and night-vision equipment for driving on unlit roads; better weather forecasting using radars and satellite imagery;

[16] Data source: Casualties Database maintained by the DPKO Situation Centre, as provided in emails of 7 November 2006 and of 4 January 2007 to the author. The Situation Centre notes that "prior to 2006, the requirement and procedures for recording civilian fatalities were lacking, and, therefore there is a risk that for years prior to 2006 not all civilian fatalities, particularly local fatalities, were recorded" (email to the author of 30 January 2006). Because of this, fatalities of local UN staff are not included in the table. For the record, the data on fatalities of local staff (1948-2006) is: 37 by accident, 39 by malicious act, 68 by illness and 5 other, for a total of 149 deaths, which is 6% of the total. Including locals, the total number of fatalities in peacekeeping up to 31 December 2006 was 2,322.

[17] In recent years, the number of civilians (local, international and UN volunteers) serving in peacekeeping has been about 20% of the number of uniformed personnel (military and police), but for most of UN history, the military component comprised a far greater percentage.

[18] A much more detailed statistical analysis (with charts) of UN peacekeeping fatalities is available upon request to the author.

To reduce accidents, vehicle tracking systems and NVE can be used.

Many forms of technology can help monitor the threat of malicious acts, and identify hostile activities safely from a distance.

Remotely operated technological monitoring systems can act as the "eyes and ears" of the UN, even at night, without endangering the UN staff.

- For malicious acts: better threat assessments using surveillance systems to detect the presence of mines, recent military/militia activity, arms smuggling, the possibility of ambushes and many other indicators of potential violence; artillery tracking radar for incoming fire; access control/identification technologies for UN buildings and camps; convoy trackers and positioning devices (based on GPS) and, in the case of robust engagements, Identify Friend from Foe (IFF) technology;

- For illness: many medical monitoring technologies for diagnosis and prognosis (not covered in this study).

By extending the range of observation, technologies allow observers to remain away from hazardous areas while still keeping tabs on the conflict. Remote sensors can serve as the eyes and ears of the United Nations. Both ground and aerial devices can capture details of the conflict for viewing by distant observers. The range of technologies is discussed in detail in Chapters 3 and 4.

2. Protecting Civilians : Vigilance Required

Recent trends indicate that the UN is becoming more responsible for protecting local populations in strife-ridden areas.

After terrible experiences in the 1990s of massacres occurring during peacekeeping operations, the Security Council now frequently includes the protection of the local population in the mandates of PKOs.[19] Besides such explicit responsibility, many peacekeepers feel it is their moral as well as legal duty to protect the vulnerable within their areas of operation. Some countries even include this in their national Rules of Engagement (ROE) prior to deployments. Furthermore, the "Responsibility to Protect" doctrine has been adopted at the UN summit level, though it has yet to be operationalized.[20]

To achieve the ambitious civilian protection mandates in conflict zones, accurate early warning is essential. Before sending rapid response forces to prevent or mitigate tragedy, timely information/intelligence is essential. As the United Nations has readily admitted, too often it has found itself in the dark about spoiler intrigue, arms and militia movements

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[19] The Security Council's first resolution on the protection of civilians in armed conflict (Resolution 1265 of 17 September 1999) stressed the importance of including "special protection" provisions in the mandates of PKOs. MONUC is one of the current missions that has an explicit mandate to protect civilians.

[20] The Responsibility to Protect (or R2P for short) was expounded in the document "The Responsibility to Protect: Report of the International Commission on Intervention and State Sovereignty", available at www.iciss.ca. The principle was endorsed in the World Summit 2005 Outcome Document, A/60/1 of 20 September 2005.

Accurate information is needed early in order to prevent or minimize tragedies. The UN has admitted that it often lacks information to prevent tragedies.

and a host of other dangerous activities. Then it can only react to tragedies after they have occurred rather than work to prevent them in the first place.[21] UN investigations are usually conducted after violations have been committed, when the results of atrocities are plain for all to see. Even then, it may be difficult to locate hidden graves, determine the sequence of events and identify the perpetrators.

Technologies offer not only possibilities of post-conflict forensic analysis but can increase the awareness needed for conflict prevention, for instance, by monitoring both distant and proximal threats to protected or sensitive areas. Aerial reconnaissance can help detect movements of armed bands towards vulnerable civilian population centres, such as refugee camps or urban communities. Closed-circuit television (CCTV) and motion sensors can alert security forces to intruders in the offices/residences of protected VIPs and other compounds and provide a record of the events if violence does occur.

Technology can help not only to prevent tragedies but provide detailed information after tragedies have occurred for inquiries and court proceedings.

Motion sensors and video recorders can monitor sensitive areas.

The local populace could operate video cameras in some situations, though this might endanger those individuals.

A bolder proposal is to place video cameras in the hands of the local population to help identify and deter perpetrators. This, however, gives rise to a dilemma. While the potential to record violent activities may serve as a deterrent, camera-holders may also be seen as a threat to belligerents, exposing onlookers to risks of retaliation. The merits of observation equipment in local hands must be assessed in each case. For protection, cameras can be equipped with telephoto lenses for more distant viewing, ruggedized for more robust handling, and miniaturized for discreet photography. Distant or hidden cameras would be out of reach of the perpetrators. Pictures taken during conflict could constitute evidence much sought after by prosecutors from the national or international courts.

3. Night-time Awareness: Coming Out of the Dark

Nefarious activities are much more likely to be carried out under the cover of darkness, rather than in the revealing light of day.[22] So it is important for the United Nations to be able to detect and deter such actions and preparations. If fighters operate at night, then so must

[21] Secretary-General, "Report of the Secretary-General on Prevention of Armed Conflict," UN Doc. S/1999/957 of 8 September 1999.

[22] Some 41% of UN PKO fatalities have occurred at night even though there are far fewer activities carried out at night than the day. This statistic is derived by the author from fatality data collected by the DPKO Situation Centre. It includes only those fatalities for which the time of the incident has been recorded.

peacekeepers. But traditionally peacekeeping has been a "daytime job." Except for guards, scheduled peacekeeping activities were done almost entirely during daylight. Even now, UNMOs finish their work at the end of the day, typically 1700 or 1800 hrs, returning to their bases or dwellings as the sun sets. This is not only because of the dangers that might lurk in the dark and haunt patrols but also because there is little that can be seen at night with the unaided eye. This leaves the United Nations blinded for 12 hours out of 24 hours, giving the forces of violence free reign for the 12 hours.

Many distressing acts are carried out at night. The UN must become better equipped for night action with night vision equipment (NVE) in order to achieve its mandate on a continuous day/night basis.

To surmount the "darkness barrier" and claim the night back from the forces of violence, the United Nations needs to make night operations routine. This is possible thanks to the advancement of night-vision equipment, allowing troops to follow terrain by foot or drive vehicles at night, while being on the lookout for potential threats.

In 2006, MONUC's Eastern Division instigated the pioneering practice of establishing Mobile Operating Bases (MOBs) in faraway locations for four to seven days a week. The soldiers were equipped with night-vision goggles to allow them to patrol the jungle at night. And "night flash" operations cooperated with village vigilance committees that reportedly banged pots and pans in order to sound the alarm. The UN forces, with 50-70 soldiers in a group, used their night-vision equipment to help locate and confront the intruders or attackers. For larger-scale combat operations, MONUC has recently (November 2006) authorized the night-time deployment of MI-25/35 attack helicopters, equipped with advanced thermal imagers as well as image intensifiers to allow pilots to engage their targets at night.

Night-vision equipment allows UN forces to operate both more effectively and safely at night.

Night-vision goggles can allow soldiers to patrol through light jungle cover at night.

For robust operations, helicopters equipped with thermal imagers and image intensifiers allow pilots to identify friend from foe, and, if necessary, to engage

Other technologies that extend monitoring capacity at night include ground-surveillance radars and acoustic/seismic sensors. These are particularly useful to alert peacekeepers to potential threats, such as intruders into UN demilitarized or protected areas. In past cases, once peacekeepers became accustomed to operating with night-vision equipment, they asked not to patrol without them. Night-vision can also help the United Nations overcome the limitations on night flying by providing pilots with extra vision for manoeuvring and detecting nearby threats on the ground or in the air.

4. Monitoring Arms Embargoes: Detecting Illegal Trafficking in Real Time

Widespread weaponry, the bane of peacekeepers, is a frequent feature in PKO areas of operation. Conflicting parties seek to gain advantage with more and better armaments. Arms races, even on a rudimentary level, can result in massive stockpiles and great tragedies. Small arms (those which are carried and used by individuals), in particular, have caused widespread death and destruction. They have made modern conflicts more combustible and crime more extensive, feeding cultures of retribution and downward spirals of violence.

Hence, it is imperative to deal with the weapons that fuel the fires of conflict. One must frequently reduce or prohibit weapons imports, a difficult task in war-torn areas because of the typically porous borders and the high demand. The Security Council has mandated embargoes in many of the conflicts it deals with, and it has frequently asked PKOs to monitor and implement the arms embargoes. Furthermore, it has also tasked PKOs with disarmament programs to reduce weaponry overall.

But disarming unwilling parties is one of the most difficult challenges in peacekeeping. Some missions have even refused to do this job for fear of retaliation. This reluctance is understandable. Before confronting smugglers and militia forces, it is important to know what kind of weaponry they possess, to pinpoint their arms routes and timings. In this deadly "cat and mouse game," the United Nations is at a great disadvantage if it possesses inferior technology compared to smugglers who seek to evade detection. In fact, many arms smugglers are better equipped (e.g., with night-vision equipment) than the peacekeepers, allowing them to outsmart the United Nations at almost every turn.

A UN Group of Experts investigating the weapons embargo on militias in the Eastern DRC assessed MONUC's capacity. In 2004, it concluded that in order to achieve its mandate, the mission "needs to be provided with the appropriate lake patrol and air-surveillance capabilities, including appropriate nocturnal, satellite, radar and photographic assets." [23] As described in Annex 1, MONUC's leaders have continued this call.

Peacekeepers must often go searching for weapons along national borders or within nations. This is a difficult task, since weapons are

[23] The Group of Experts report is contained in UN Doc. S/2004/551 of 15 July 2004. The report was summarized for the press in a news release of 28 July 2004, available at www.monuc.org/news.aspx?newsID=3390.

Experts have concluded that marine patrol and air surveillance systems have great potential in the DRC.

Metal detectors can discover hidden & underground weapons.

X-ray machines can detect weapons being smuggled in luggage.

Maritime radars are needed on large lakes to determine where to send the fast patrol boats for interceptions.

Surveillance both of *the air and* from *the air is needed.*

Aerial surveillance can cover large areas quickly (see Chapter 4).

usually hidden until they are needed. The discovery of armaments can benefit tremendously from tools such as metal detectors and ground-penetrating radar to find buried arms caches.

X-ray machines can detect weapons smuggled through civilian luggage. At vehicle check points, mirrors are used to look under cars for explosives. While X-ray machines exist to scan entire vehicles, including tractor-trailers and sea containers, this kind of capacity would be too expensive and require too much infrastructure for the United Nations. However, X-ray machines are already used in some UN missions, as are metal detectors of the walkthrough and wand variety.

On lakes, such as the Great Lakes on the eastern border of the DRC, it is not sufficient to observe simply with the human eye. In order to maintain a wide area watch, maritime radars are required before sending the fast patrol boats to inspect or board suspicious boats. To catch weapons imports by aircraft, the United Nations must maintain surveillance over the airspace and determine where illegal flights are landing, before initiating interdictions. Surveillance *of* the air and *from* the air are both needed.

5. Aerial Surveillance: Missing Dimension of Peacekeeping

Aerial reconnaissance offers many benefits over ground reconnaissance. But only a few peacekeeping operations have made use of aircraft for observation. By ignoring the third dimension of space, the United Nations has forfeited opportunities to gain information and advantage. Since the potential is so great for speedy coverage and for areas that are large or dangerous, this topic is discussed in its own chapter (4).

6. Robust Operations: Accurate and Precise Intelligence Required

As the United Nations learned from its well-publicized past failures, PKOs need the capacity to apply force, as a last resort, to maintain the peace. This means being able to move along the force spectrum against recalcitrant groups that may have spurned previous offers of settlement, aid, rehabilitation and reintegration, etc. Often such "Chapter VII" action entails combat under the force's Rules of

Engagement (ROE) in conformity with the Security Council mandate.

To enforce a peace agreement, the UN needs to know who might be continuing (or preparing) to violate the agreement. The UN also needs to foresee attacks or ambushes on its own forces or the civilian population. On occasion, the UN must engage in combat with recalcitrant elements or spoilers of the peace process. Technology is a key "force multiplier," especially in combat situations.

Even before a mission reaches the stage of direct confrontation and combat, peacekeepers need a solid command of the information sphere in the area of operations. Such situational awareness necessitates precise information about the locations, unit structures and weaponry ("order of battle" information in traditional military terms), plus more complex factors like the level of support of the local population, the parties' intent and ability to use human shields, and the intelligence capacities of the hard-line elements.

When spoilers see that the United Nations is aware of their actions, that it has means to uncover their preparations before they strike, they will think twice about challenging the peace process. These notions of robust observation and action are being put to the test in places like the DRC.

When operating in a war zone and engaging in combat, the needed technologies include: imagers to distinguish between civilians and armed combatants (who sometimes use human shields), night-vision devices for camp protection and night operations, weapons detectors, and identify friend from foe (IFF) devices. In the attack helicopters used in the DRC, UN pilots now have the possibility of "seeing" their targets before engaging them, especially at night.

7. Analysis: Thinking Through the Data

Thanks to information technology (IT), the amount of information currently at the "finger tips" of analysts is orders of magnitude greater than before the dawn of the information age. However, the basic process of analysis has remained the same. "Raw" information from the field needs to be gathered, collated, synthesized, analysed and disseminated. Unfortunately, in today's peacekeeping operations, experts on technical monitoring are few and far between, including operators of the devices, and interpreters/compilers of the data.

Technical data and imagery often needs expert analysis to be interpreted and used effectively.

With the encouragement of the C-34, DPKO recently took a major step in the development of structures for information gathering and analysis. Joint Operations Centres (JOC) and Joint Mission Analysis Centres (JMAC) are now required components of all PKOs.[24] The

[24] Joint Operations Centres (JOC) and Joint Mission Analysis Centres (JMAC), DPKO Policy Directive, 1 July 2006.

recently created JOC and JMAC structures present an opportunity to include experts in the analysis of outputs from monitoring technologies.

The new JOC and JMAC structures provide units or structures in which to place data analysis functions for tactical, operational and strategic purposes.

Under the current concept of operations, the JOC deals with current- and near- term information while the JMAC looks to the medium- and long- term. Technical information is useful for both. Since the JOC is designed to operate 24/7 for situational awareness mission-wide and for support of current operations, it especially needs (near) real time information from in field observation assets. It also needs to know how to rapidly redeploy these assets to meet any immediate information gaps. JMAC also needs this information but not on such a short time scale.

In developing and implementing JOC and JMAC procedures in various missions, it would be important to identify the technologies that could help meet the various Mission Information Requirements (MIR), Priority Information Requirements (PIR), and urgent Requests for Information (RFI). And it would be useful to identify optimal "checkpoints and choke points," i.e., places where technical monitoring would have the most significant impact (e.g., to increase security and/or to suppress illegal/violent activities). It should be possible to direct information-gathering operations.

A robust system for information gathering incorporating feedback loops from "consumers" will help get the right information to the right people.

JOC and JMAC require specialized skill sets, including those relating to technologies:

- geographic information systems and inertial and GPS reference systems;
- digital video processing, editing and networking;
- basic interpretation of feeds from various sensors;
- relational databases and cross-referencing;
- quantitative and statistical analysis, graphing and charting using standard and advanced software;
- specialized search engines beyond those already widely used for Internet searches;
- encryption tools (e.g., private and public key) and data authentication (e.g., watermarked images).

The professional members of the JOC and JMAC need to understand the general strengths and weaknesses of the various monitoring technologies and sensor systems. Missions also need personnel with specialized expertise in order to:

- optimize technical monitoring devices;
- identify the specifications for equipment purchases;
- deal with communications bandwidth challenges;
- use artificial intelligence for digital analysis, pattern recognition,

change detection and automation software related to the monitoring technology;
- identify artifacts in imagery and other technological products;
- conduct image analyses (formerly called photo-analysts), for example, to "read" output from radar products and infrared imagers and to recognize the signatures of various armaments and vehicles;
- other specialized skills (forensic investigations, crater analysis data, etc.)

Specialized skill sets for data and image analysis are needed.

Analysts can share and compare their information amongst themselves to reach the better conclusions.

JOC and JMAC personnel should seek synergy from different information sources and methods, especially technical information that can confirm or deny human sources and day/night observations that can complement each other. JOC/JMAC analytical products should be useful for mission planning, decision making and security risk assessments. Their mandate is to support *informed* decision making across all components. Because monitoring technology is likely to be gained by a specific/dedicated units in the field, this "information hub" is valuable to "put the right information into the right hands," thereby supporting informed decision making across all components of the mission. One benefit of technology is the ability to share the "data feed" or data segments from sensors with multiple UN sections. This allows multiple inputs into the analysis.

All-source intelligence aids the corroboration of information, helping fit the pieces of the puzzle together to create the larger picture.

One important information product is the "Threat and Risk Assessment" (TRA). The TRA preparation involves, among other tasks, the compilation of risk factors and early warning indicators, and a list of developments to be monitored by specified technical and non-technical means. Optionally, the TRA can include potential responses (courses of action) and suggestions for prevention and mitigation strategies, including protection plans. From TRAs, analysts in JOC/JMAC, together with the Department of Safety and Security personnel, can determine the security levels (e.g., using the current I-V alert levels) and recommend the appropriate security postures to protect UN staff and property.

Important information products include the TRA.

Both the information-gatherers and analysts need to be aware of the moral and legal limits on technical information-gathering. There are issues of privacy, political sensitivities, and practical issues associated with technical monitoring, as will be discussed in Chapter 6.[25] During a

In the peacekeeping literature, some articles deal with the legal and ethical limitations on UN information-gathering.

[25] Two relevant publications by the author are: *The Cloak and the Blue Beret: The Limits of Intelligence Gathering in UN Peacekeeping*, Pearson Paper Number 4, Nova Scotia: Pearson Peacekeeping Centre, 1999, and "Intelligence at UN Headquarters: The Information and Research Unit and the Intervention in Eastern Zaire (1996)" in Carment, David and Martin Rudner (eds.), *Peacekeeping Intelligence: New Players, Extended Boundaries*, London: Routledge (an imprint of Taylor and Francis Group PLC), 2006.

crisis, such as one involving hostages or combat, it may be acceptable to increase the detection means to include new devices, for instance, signal interception but ordinarily this should be used with caution and sensitivity to the parties concerned.

To overcome a traditional challenge facing information analysts, technology provides means to avoid "information overload and under-use" and to get "the right information into the right hands."

The dissemination of information/intelligence products in order to impact decision-making is a traditional challenge for analysts. To draw attention to their assessments, they have used prioritized reports (e.g., flash reports), as well as routine ones. Information technology (IT) has, of course, made sending the results to decision-makers and other users/clients much easier, but there is a frequent problem of "information overload and under-use." With so much information arriving electronically, it can be difficult to separate valuable timely information from the trivial, a difficulty also known as the "signal to noise problem." Search engines, file-finding tools and data-basing have helped ease this difficulty, due to their ability to locate, flag, highlight, and prioritize present information. But the challenge remains to provide the right level of detail, with proper timely analysis, for busy decision-makers.

3. SURVEY OF TECHNOLOGIES

Monitoring technology extends and complements human observation. Instead of the small "visible" portion of the electromagnetic spectrum, imaging can be done over a range many orders of magnitude larger, from X-rays to infra-red (IR) radiation to microwaves and radio waves.

Technology is a supplement to, not a substitute for, the human presence in the field. Civilian and military personnel will always be needed to build trust and understanding. But once peacekeepers are placed in complex and dangerous environments they require good situational awareness to be safe and secure, and to effectively carry out their monitoring mandates. There is much that technology can do to help, including:

- Increase the range, area coverage and accuracy of observation
- Permit continuous (e.g., 24-hour) monitoring
- Increase effectiveness (incl. cost-effectiveness in some cases)
- Decrease intrusiveness
- Record events for transmission.

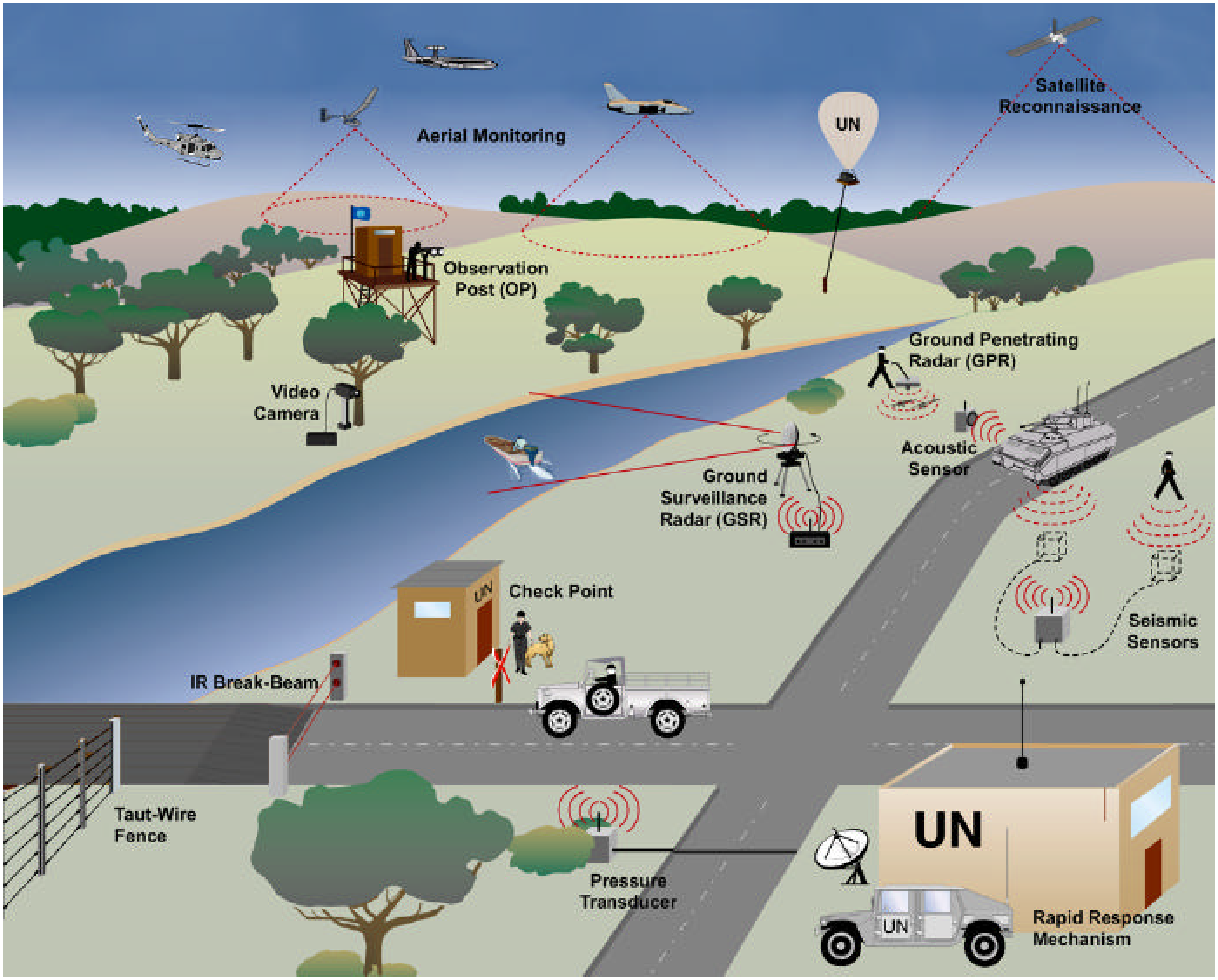
Technical information complements human observation by creating a larger and more detailed picture of the area of operation. The United Nations can easily move beyond the "Mark One Eyeball" aided by binoculars, and deploy a variety of appropriate technologies as a standard part of the peacekeeper's toolkit.

The human eye sees only a small slice of the electromagnetic spectrum (corresponding to visible light of wavelength 400 to 700 nanometres). Instruments are capable of measuring a range that is at least fifteen orders of magnitude larger, from X-rays (less than 3 nanometres in wavelength) to radio waves (centimetres to thousands of kilometres). Furthermore, the human eye has limited optical resolution[26] and no capacity for zooming. Electro-optical sensors can extend the human capacity many fold, enhancing human observation, interpretation and assessment. Sensors can also record images for dissemination.

Other forms of energy can also be measured (acoustic/seismic signals, quasi-static electric/magnetic fields), as can materials (nuclear particles, chemical/biological agents). A more detailed and comprehensive tabulation of the sensor categories is provided in Annexes 3, 4 and 5. This chapter focuses on the more useful technologies, illustrated in Figure 3.1.

[26] The resolution capacity of the human eye is typically described as "0.5 arc minutes" for a "line pair." That is, when two lines are separated by less than 1/120 of a degree from the observer, they can no longer be distinguished as separate. Given that the visible field of view is 120x120 degrees (maximum horizontal and vertical), one can estimate the number of bits of information the human eye is capable of seeing: 120x120x60x60/(0.5x0.5) which is about 300 megapixels (MP). Commercial digital cameras are typically 3-10 MP but advanced photo-reconnaissance cameras can record several orders of magnitude more information.

Figure 3.1. Composite diagram showing potential sensors and platforms for peacekeeping



The composite diagram above (Figure 3.1) depicts a wide range of useful technologies for peacekeeping. The "top to bottom" view illustrates the four possible regions to place monitoring technology: outer space, airspace, ground-level and underground. From outer space (top right), modern reconnaissance satellites can legally observe all areas of the Earth, with enough resolution to count cars and even people. In the air, helicopters, unmanned and manned aircraft (including radar-equipped planes and jet reconnaissance aircraft), and balloons (tethered, guided or free floating) permit even higher resolution surveillance of large areas.

Ground observation posts can be equipped with imaging equipment, such as video cameras attached to high-power binoculars, or night-vision devices. For open areas, as often found in buffer zones and waterways, ground surveillance radar (GSR) can be used to detect intruders or movements of persons, vehicles or boats. For smaller passageways, acoustic or seismic arrays can detect such movements, possibly to alert peacekeepers of oncoming vehicles or to initiate mobile UN checkpoints or to trigger a rapid reaction force. Similarly, pressure transducers or infrared break beams could alert the UN to vehicle movements (especially at night) on roads that have no UN checkpoints. Ground penetrating radar (GPR) can help locate buried weapons, mass graves, landmines or underground bunkers or tunnels. Areas that are UN protected or sensitive can be blocked off with taut-wire fences, which serve not only as barriers but also send signals when touched (or climbed or cut), providing the location of intruders to UN guards or forces.

A UN station (bottom right in Figure 3.1) could dispatch mobile patrols or interception forces to respond to incoming information. It could also communicate by satellite the imagery and information gained by the sensors to other nearby stations and to mission headquarters for real-time (or near real-time) viewing, forming a kind of "network-centric peacekeeping."

The United Nations has, in isolated instances, used some of these technologies. More frequently, advanced contingents have brought them to the mission as part of their National Support Element. These technologies are now covered in detail with examples. The overview permits a more thorough examination of the technological resources the United Nations could use in the future.

Satellite reconnaissance was a key tool of the superpowers during the Cold War. It helped create greater situational awareness and transparency, thus building confidence.

1. Satellite and Aerial Reconnaissance

High-resolution satellite imagery was for decades the sole preserve of the superpowers. From the very dawn of the space age, however, UN supporters have envisioned the possibility of UN satellite reconnaissance for peacekeeping and humanitarian purposes. In 1981, a UN study even recommended the creation an International Satellite Monitoring Agency

But the secrecy and high costs associated with these satellites prevented the UN from making substantial use of them. Now commercial satellites are providing the UN with high-resolution imagery at affordable prices.

Some companies and agencies can provide the UN and humanitarian organizations with special technological services. Inter-agency programmes, such as UNOSAT, offer flexible, low cost means to do mapping and strategic assessments. But the turn-around time is slow—usually two weeks or more. The UN also needs tactical information in near-real time (hours) for current operations so new arrangements need to be made.

(ISMA).[27] While dedicated UN satellites proved far too expensive, commercial industry began selling increasingly higher-resolution and better satellite imagery at affordable prices (with discounts for humanitarian agencies). Since 1999, images of one-metre resolution or better—a capability once highly classified—have been readily available on the open market.[28]

To capitalize on the host of new satellite imaging applications, European nations in 2000 led the development of an International Charter on Space and Major Disasters, to provide a "unified system of space data acquisition and delivery to those affected by natural or man-made disasters."[29] The joint endeavour of international organizations, the private sector and the scientific community allows authorized users "to request the mobilization of the space and associated ground resources ([for satellites:] ADARSAT, ERS, ENVISAT, SPOT, IRS, SAC-C, NOAA, LANDSAT, ALOS, DMC satellites and others) of the member agencies to obtain data."

One result of this initiative was the creation of the United Nations Operational Satellite Application Program (UNOSAT) to harness the possibility of inexpensive data for peacekeeping and humanitarian purposes.[30] Under the motto of "satellite imagery for all," UNOSAT operates a 24/7 Rapid Mapping Service for UN agencies and their implementation partners. An impressive example of its mapping capability was shown during the Israel-Lebanon crisis of July-August 2006. Damage assessments were provided after the conflict to assist with rebuilding a few weeks after the fighting stopped.[31]

The turn-around time for most commercial satellite imagery ordered by the United Nations is still too long, two weeks or more, for real-time use during current UN operations. The vast majority of satellite images ordered by the United Nations are used to make maps. The UN has

[27] See Walter Dorn, Peacekeeping Satellites: the Case for International Surveillance and Verification, *Peace Research Reviews*, vol. X, no. 5&6, 1987. Available at www.rmc.ca/academic/gradrech/dorn19_e.html.

[28] Ikonos, launched on 24 September 1999, was the first commercial satellite with a one-metre resolution. Since then, several other satellites were launched with a higher resolution, e.g., QuickBird 2 at 0.62 metres.

[29] "International Charter: Space and Major Disasters." Available at www.disasterscharter.org/main_e.html.

[30] UNOSAT (www.unosat.org) works on a not-for-profit basis and must be self-supporting. Therefore, images ordered by UN agencies carry a cost based on special prices negotiated with satellite image providers.

[31] The UNOSAT Lebanon images are available at unosat.web.cern.ch/unosat/asp/prod_free.asp. Another valuable website for imagery is Google Earth (earth.google.com), though the free public imagery can be three years old. The UN is an "Enterprise Client" subscriber, so it can acquire a much larger range of imagery, including recent imagery. The turn-around time is still at least two weeks, though rush orders are possible.

not moved to near real-time imagery. This would be extremely useful in countries like the DRC and Sudan to determine the recent locations and movements of militia. Some governments have this capability, but near-real-time imagery is only shared on a "need-to-know basis"— when the governments believe the United Nations needs to know, based on national security criteria. In the future, as commercial satellite technology advances, images of current operations will be possible.

Unlike satellites, aircraft can currently provide near-real-time imagery, since they can be leased and controlled directly by the United Nations. The organization has carried out aerial reconnaissance in several of its missions. Recently, for example, the UN operation in the DRC (MONUC), established an "Observation Aviation Unit" as an Eastern Division asset, with four Lama light helicopters. When street protests and mobs were a threat in Kinshasa, two of these Lamas were brought to the capital for urban monitoring. Also in the Western Congo, the United Nations had its first experience tasking Uninhabited/Unmanned Aerial Vehicles (UAVs), brought by the European Union Force (EUFOR) to help MONUC during the election period from June to November 2006. These UAVs helped spot and track illegal arms imports near the city by the two main parties. EUFOR also deployed mirage jets with photo-reconnaissance capabilities. Finally, balloons (aerostats) could serve as another useful observation platform and, when tethered to the ground, as a land mark (e.g., to mark borders), though such possibilities have not yet been explored by the United Nations. Since aerial reconnaissance is such an important topic, and there are so many varieties of aircraft, Chapter 5 is devoted to the subject.

As video cameras have become cheaper and more widespread, it would be natural to extend their employment from UN buildings and patrols to remote monitoring of conflict zones in order to keep an eye on potential violence and violations.

2. Cameras and Motion Sensors

In recent years, video cameras have found a place in peacekeeping operations just as they have in the family home. Personal hand-held camcorders are providing evidence of breaches of international law just as they are of domestic law.[32] As commercial video technology becomes increasingly better and cheaper, the UN field operations will undoubtedly benefit, particularly if ingenuity is used to find new and creative methods

[32] For example, see Barbara Crossette, "UN Report Suggests Israeli Attack Was Not a Mistake," *New York Times*, 8 May 1996.

and places for deployment.

Closed-circuit television (CCTV) is now used to monitor the perimeters and some hallways in the headquarters compounds of many UN missions.[33] Expanding this use to view conflict areas has tremendous possibilities. Remotely controlled cameras inside and outside Iraqi (non-UN) buildings were used by the United Nations Monitoring, Verification and Inspection Commission (UNMOVIC) for arms control verification in Iraq[34], but have yet to find application in UN peacekeeping. By contrast, the Organization for Security and Cooperation in Europe Mission in Kosovo (OMIK, a distinct component of the United Nations Interim Administration in Kosovo (UNMIK)) installed a network of some 130 cameras in or near its buildings, all electronically linked to its mission-wide local area network (LAN). More importantly, in the divided city of Mitrovica, two of its pan, tilt and zoom (PTZ) cameras keep a 24-hour watch on a bridge that is the site of frequent contention between ethnic communities. Any gathering of crowds can be observed remotely from the OMIK Operations Room or from any computer on the network, including at OMIK headquarters.[35] Imagery of swelling and violent crowds can then signal intervention by peacekeepers.

Technology enables new strategies for peacekeeping, including one of "concentration with mobility." Sensors can trigger rapid reaction forces in place of frequent and monotonous patrols.

The United Nations Peacekeeping Force in Cyprus (UNFICYP), which monitors the "Green Line" that separates the two main ethnic communities on the Mediterranean island, advocated an even more pioneering approach in 2004, its fortieth anniversary. Under a new concept of operation titled "concentration with mobility," UNFICYP leaders argued that the mission would be more effective with a mobile response force using monitoring technology. They advocated a shift from static observation posts to mobile teams cued by CCTV and helibourne surveillance. This approach would need fewer peacekeepers, they argued, and would bring greater operational efficiency and enhanced force

[33] The UN's CCTV security systems typically cost $10,000-20,000, including four or five cameras and a viewing/recording suite. Extra video cameras can cost from $1,000 to $3,500 each.

[34] During the UN's verification operations (UNSCOM/UNMOVIC and IAEA) in Iraq prior to 2003, in the presence or absence of inspectors, sensors transmitted imagery and data by radio and telephone landline to the Monitoring and Verification Center in Baghdad, where remote viewing was carried out. For instance, IAEA cameras were able to observe the withdrawal of equipment from one Iraqi nuclear site in January 1999 the day before US bombs destroyed the facility (and the camera as well).

[35] OMIK's two PTZ cameras, with a 100x zoom and waterproof casings, cost a total of about $3,000. Many additional features and accessories are advertised for the BioDVN suite, including a "face recognition and identification module." See www.security-lab.com.

protection, along with savings in personnel, logistics and administration.[36] A year later DPKO purchased 100 CCTV cameras for the mission.[37]

As the quality, range and resolution of commercial CCTV cameras increase and the costs decrease from current prices ($1,000 to $10,000 per camera) their appeal will inevitably improve. Furthermore, new features are being added. For instance, to alert UN peacekeepers to activities in known hot spots, the system can provide notice (sounding an alarm) when there is movement or another stimulus.

Remote video viewing and recording can be triggered automatically using motion sensors. These sensors can also turn on illuminators at night. They allow a better of view the subject and act as a deterrent.

Motion detectors can be used not only to cue cameras but also to turn on illuminators at night. They can be used to detect and deter prowlers or other intruders into UN camps or protected/monitored areas. Such detectors can be fine-tuned to go off only when people approach. Older motion detectors often had the problem of differentiating humans from dogs, cats, or even a blowing branch. Today's passive infrared sensors (or PIR) are keyed to the temperature of the heat coming from the human body: infrared (IR) radiation of wavelength between 9 and 10 micrometers. Typically a household motion detector costs only $20 to $30. They are also available in solar powered and ruggedized form ($100-$300), which means they can be left alone for long periods of time.

3. Night Vision

Peacekeeping is currently mostly a daytime job. To "take back the night from the forces of violence," it is necessary to equip UNMOs, patrols, observation posts and checkpoints with NVE.

Hostile elements most often use the cover of night to conduct their illegal activities. As mentioned in the previous chapter, these include: digging of mass graves to hide atrocities, pushing forward cease-fire lines to gain strategic advantage; raids across line of control; laying of mines; ambushes and launching of attacks; and the breaking of sanctions, such as arms smuggling.

In all such cases, *night-vision equipment* (NVE) is an invaluable tool for the peacekeeper. The most effective type, a thermal imager detects infrared (IR) radiation, particularly in the 8 to 14 micrometer or far-IR wavelength band, from warm bodies at distances over 5,000 meters and vehicles at 10,000 meters. Such devices can also peer through smoke and

[36] UN Doc. S/2004/756 of 24 September 2004.

[37] The video surveillance cameras cost $225,500 for 93 cameras (approximately $2,500 each). With the associated equipment (computer, cabling, power supplies, etc) the total equipment cost was about $400,000. For the maintenance of this CCTV system, DPKO budgeted $40,000 for 2006/07. Source: www.un.org/Depts/ptd/2007_unificyp.htm.

dust, though not so easily through fog and clouds. Thermal imagers can enable peacekeepers to spot warm bodies hiding in jungle growth or rubble (though not behind glass windows). Though many thermal devices are heavy, some can be worn as goggles, facilitating foot patrolling and night driving (for example, in aid convoys), spotting targets, as well as keeping track of other peacekeepers. Unfortunately, the United Nations has very few (if any) of these because of their high cost (over US$5,000). Rather the United Nations depends on a simpler form of night vision: image intensification.

Image intensifiers detect visible light and sometimes near-IR, but not far-IR (heat), radiation. The devices "amplify" the ambient visible light before it reaches the eye. Standard off-the-shelf intensifier tubes have a magnification factor of 25,000 or more. To be effective, there must be sufficient ambient light, either from the night sky or artificial sources. For nearby objects, illuminators in the near-IR are sometimes included in the devices. Practically speaking, image intensifiers add extra hours of vision around dawn and dusk. Under ideal conditions (e.g., a cloudless night with a full moon), a sentry using a third-generation image intensifier can spot humans at distances of up to 1,500 meters. The UN-owned equipment (UNOE) standard requires "an effective range of 250 metres," considerably less than the COE Manual standard of 1,000 metres for contingent-owned equipment. The cost of these image intensifiers varies from US$300 to $3,000 per monocular or set of goggles, depending on the generation and quality.

The NVE owned by the UN need to be modernized; at present the UN uses older generation equipment without the ability to record imagery.

The quantity and quality of NVE brought by contingents varies greatly.

The UN DPKO owns only 400 night-vision devices (mostly binoculars), almost all of which are currently deployed in missions.[38] Most PKOs possess about 20 of the UN-owned devices, with four (ONUB, UNMIL, MONUC, UNMIS) having over 50 devices each, still a small number compared with the number of personnel. The devices are all second-generation (or "Gen. 2+")[39], except for a single third-generation device, which the Property Management Unit database lists as in "fair condition."[40] Generation 2+ typically cost the United Nations just under $2,000 per binocular. Though DPKO has tried to procure third-generation devices, it has so far been denied the required US export licenses.

[38] The UN is also supplying the African Union Mission in Sudan (AMIS) with 360 night-vision goggles according to a UN-African Union Agreement. See UN Doc. S/2006/779 of 29 September 2006.
[39] Most are NVS 7-2 (Generation 2+) devices from Newcon Optik (www.newcon-optik.com).
[40] Property Management Unit database query, Logistics Support Division, DPKO, New York, 27 September 2006.

Contingents are usually requested to bring their own NVE, in accordance with the vague standards of the COE manual. The NVE usually come in the form of headgear (goggles) but they can also be found as monoculars, binoculars or weapon sights. They are mostly image-intensification systems with some near IR capability. Thermal systems are also brought by some nations (mostly developed nations) to some missions.

The United Nations does not have its own means for recording imagery from NVE. The MI-35 attack helicopters flown in the Eastern DRC are equipped with fourth-generation FLIR cameras but these are national (Indian) assets, and the digital video recordings from the cameras are not shared with the United Nations. Also, when EUFOR deployed to the DRC, its special forces brought fourth-generation devices, though these were not shared with the UN. EUFOR antitank (TOW[41]) missile launchers also came equipped with night-vision sights having an impressive range of over 4 kilometres. In earlier UN missions, peacekeepers would take the night-vision sights off TOW launchers, brought for protection, in order to use them for observation.

4. Radars

Radars can detect objects moving in the sky and on the ground or buried underground in all weather conditions, day and night. They combine well with NVE to indicate the movement persons or vehicles for further investigation.

Radars, though seldom used by the United Nations, have tremendous potential in peacekeeping, just as they have in war-fighting. Whether deployed on the ground, in the sky or in space, they can greatly increase situational awareness through imaging or tracking movements of objects on the ground, in the air or underground. *Ground surveillance radars* (GSR) can detect a moving person or vehicle at 3 to 10 kilometres within the field of view. Motion detected by the radar could then trigger investigations by patrols. The United Nations Interim Force in Lebanon (UNIFIL, 1978-), for instance, set up ground radar devices to detect infiltration along critical sections, including the Litani river, and along the Israeli border or (earlier) along Israeli controlled-areas. In spite of a large number of false alarms (due mostly to animals), the system proved valuable. The radar greatly extended the range and night-capacity of UNIFIL.

Tube-launched, Optically-tracked, and Wire-guided, describing a missile technology invented in derably improved over the decades.

Ground-surveillance radars have been used in a few PKOs (e.g., UNIFIL, UNIKOM and UNMIL) but there are no available UN reports on the experience with these devices. Anecdotal evidence indicates they proved very useful, including to monitor waterways at night.

Aerial surveillance is valuable for no-fly zones, sanctions enforcement, and detecting sovereign airspace violations, as well as for air traffic control.

NATO provided AWACS surveillance to monitor the no-fly zone in Bosnia.

Radar (SAR) in moving aircraft and satellites can yield high-resolution imagery, though expert analysis is usually needed to interpret the imagery.

Ground-based radars can also be used to identify and track mortar and artillery fire. In the United Nations Protection Force (UNPROFOR) in Bosnia, the UN obtained radar units that were able to locate the origins of mortar fire, which in some cases revealed disturbing evidence of self-inflicted atrocities.

The only Ground Surveillance Radar (GSR) units currently in UN deployment are the two AMSTAR (Advanced Man-portable Surveillance and Target Acquisition Radar) units being used in Liberia since 2003 by the Irish Quick Reaction Force. Radars were also brought by European states to Lebanon in 2006 for land, air and sea surveillance. Various naval radars were used by UN Iraq-Kuwait Observer Mission (UNIKOM, 1991-2003), along the tense maritime border, particularly to observe traffic in the seaways near Basra.[42] Unfortunately, there are no UN reports on the use or functioning of this or other UN-owned or UN-controlled radar systems.

Air surveillance radars have proven essential for accurate detection of airspace violations, which are common in war-torn areas. Already in the 1960s, the United Nations Operation in the Congo (ONUC) employed two such radar sets, but the current mission in the Congo (MONUC) has not yet used them, despite the calls from mission leaders. Only recently has UNIFIL gained the capacity for radar-based airspace surveillance, despite a long history of unauthorized aerial intrusions. In the past, airspace monitoring was done solely with the human eye: "violation reports" were issued when two UN military observers (of different nationalities), using nothing more sophisticated than binoculars, observed (and tried to identify) a plane in the sky.

In the former Yugoslavia in the 1990s, NATO carried out very sophisticated and effective monitoring of the no-fly zones using its AWACS (Airborne Warning and Control System) aircraft. Every second week, the UN Secretary-General circulated documents with long lists of airspace violations, totalling many thousands of violations a year. When NATO took over operations in Bosnia, the sophisticated JSTARS (Joint Surveillance and Target Attack Radar System) aircraft complemented AWACS by detecting ground movements and providing radar imagery.

Synthetic aperture radar (SAR) is of special interest to peace

[42] DPKO's Item Master Catalogue lists a "Racal UNIKOM Radar Set Ground Surveillance System S-Band" from UNIKOM as being in the possession of the UN but in the inactive category.

operations because of the ability to do imaging in all weather conditions and from high altitudes above clouds. A SAR consists of a modestly sized (but high-power) radar transmitter/receiver on an airplane or satellite. The radar achieves a high spatial resolution (a few metres) by exploiting the motion of its platform and coherently processing the return signals from the ground. The system achieves a resolution many times better than the actual physical aperture of the SAR. The resolution is limited fundamentally only by the radar wavelength. A SAR can operate day and night and in all weather conditions. SAR imagery from RADARSAT and commercial satellites has helped the United Nations to confirm large refugee movements in places like the Eastern DRC.

Combined with metal detectors, GPR can detect weapons hidden underground and spot unmarked graves.

Ground penetrating radar (GPR) would be particularly useful to detect weapons buried underground. Metal detectors can only reach a certain depth, while GPR can go deeper. In addition, for the detection of hidden graves, important for human rights work, GPR offers a strong tool. It is already in wide use for geology, archaeology and civil engineering.

The United Nations has used hand-held radar guns, normally for vehicle speed enforcement, in some of its missions. These devices, at less than $100 each, can be useful at checkpoints, in demonstrations to local traffic police, and to monitor the speed of the UN's own vehicles.

5. Radio Monitoring

Eavesdropping on radio or cellular communications raises privacy and legal issues but can be justified under certain circumstances.

In addition to visual, infrared and radar remote sensing (the extended "eyes" of the UN), peacekeepers have on occasion employed electronic "ears" (radios with frequency scanners) to listen to radio and electronic communications. This practice is not, and should not be, routinely employed in all peacekeeping operations for privacy and other reasons. However, in some circumstances, it is entirely warranted: for example, when peacekeepers are being attacked or held hostage. Such monitoring has effectively but selectively been employed in several of the UN's large PKOs and, much more extensively, in NATO operations. The first documented use was in the UN Operation in the Congo (ONUC, 1960-64), where the practice developed casually. In Northern Katanga, a battalion commander established an improvised radio interception system, using a commercial receiver and local tribesmen as translators. Later in that mission, a more sophisticated interception system with a code-breaking capability was established to stop the nefarious activities of the mercenaries.[43] But for the vast majority of operations, electronic interception has not been use. In NATO-led operations (I/SFOR and KFOR), by contrast, advanced electronic intelligence (ELINT) platforms, for example, on AWACS aircraft, are routinely used to capture messages sent by radio, even those transmitted by frequency-hopping techniques. Of course, national laws need to be respected during such undertakings.

The UN needs to be aware that its own communications are liable to be intercepted. In the Congo, EUFOR deployed secure communications systems (secure satellite phones, radios and fax), but the United Nations does not deploy this feature in its radio network. In addition, the commercial cell phones used by so many MONUC personnel were generally known to be monitored. The UN did conduct sweeps to detect bugs in some mission headquarters offices but, in general, its counter-intelligence capability is very limited.

6. Acoustic and Seismic Sensors

In addition to the detection/monitoring of the electromagnetic spectrum, sensors are available to detect acoustic (sound) and seismic waves. These vibrations propagate through both the air and the ground. Even footsteps at 10-20 metres distance can be detected with mini-seismometers. This is useful to monitor passage at night through prohibited or sensitive areas.

Acoustic sensor systems enable sound (in the audible range and beyond) to be recorded and transmitted to remote sites. For example, in UNPROFOR, one-way radios were used as improvised sensors inside weapons storage sites under UN key but which the understaffed UNPROFOR could not guard 24/7. When parties broke into the sites, which happened numerous times, the sensors captured the sounds of the heavy vehicles (for example, the starting of a tank engine). The signals, sent by radio transmission, then alerted staff in the UN's local headquarters. In some instances, the weapons were recovered.

Seismic systems monitor low-frequency waves propagating through the earth caused by either underground or surface activity, such as explosions, vehicles or even footsteps. Because ground attenuation tends to be strong, the detection ranges of geophones are typically small (10s to 100s of metres) for most kinds of surface disturbances. For explosions, the ranges can be much larger but depend on the detailed characteristics of the soil and the frequencies being sensed. Unattended ground acoustic sensors were successfully used in the Sinai Field Mission (SFM, 1976-80). The

[43] A. Walter Dorn and David J. H. Bell, "Intelligence and Peacekeeping: The UN Operation in the Congo, 1960-64," *International Peacekeeping*, Vol. 2, No. 1 (Spring 1995), p. 11.

sensors complemented remotely-operated video cameras (both visible and IR) to notify watch stations of intruders moving through the strategic Giddi and Mitla Passes. In areas where geological conditions were less favourable for seismic/acoustic detection, *strain sensitive cables* were laid across the terrain. Strain gauges then measured the deformation of the cable and nearby ground by an intruder. The SFM was created and manned by the U.S. government but closely coordinated with the United Nations Emergency Force (UNEF II). By technical means, some 90 minor violations over nearly four years of observation were detected and resolved.[44] The United Nations, even thirty years later, still has not employed ground sensors to the level used by the SFM.

Ultrasound probing involves sending high-frequency sound waves (typically 50 MHz) through an object. The attenuated or reflected signals can be used to characterize the contents of the object. Such probing was used by inspectors in Iraq to deduce whether munitions were empty or were filled with bulk or powder or liquid, something essential to know before starting to drill for testing and destruction.

7. Chemical/Biological/Nuclear Sensors

Detectors of chemical/biological and nuclear (CBN) materials are more important for arms control than for peacekeeping. But they show promise in the detection of landmines and are important in areas where dangerous CBN materials might be located.

Chemical agent monitors (CAM) or "sniffers" are widely used to detect explosives in baggage at airports. Most systems are based on *gas chromatography/mass spectrometry* (GC/MS) devices, which are becoming more compact, more transportable and more sensitive, thanks to commercial instrument development. Sensor kits for biological agents have been developed commercially for testing of air, water and soils. The large chemical/biological analytical toolbox is rapidly expanding. A number of research programmes are developing advanced chemical sensing for landmine detection, though the technology has yet to move from the prototype to the field in the form of inexpensive, widely available devices.

The UN inspection bodies in Iraq (UNSCOM, UNMOVIC and the IAEA) have had substantial experience with chemical, biological and nuclear detectors. Some UN PKOs possess hand-held narcotics and

[44] See C. William Kontos, "Lessons from the U.S. Sinai Field Mission" in *Weapons of Peace*, *ibid*. See also M. Vannoni, "Sensors in the Sinai: A Precedent for Regional Cooperative Monitoring," Cooperative Monitoring Centre Paper, Sandia National Laboratories, 1986. Available at www.cmc.sandia.gov/links/cmc-papers/sensors-sinai.

explosives detectors, used mostly on entrance ways or airports.[45] In UNSCOM, nuclear radiation detectors were essential not only to uncover the Iraqi nuclear weapons program but also for the personal safety of the inspectors, especially on visits to destroyed nuclear sites. *Geiger counters* and *gamma detectors* are the main sensing devices, though for arms control, many other sensors are invaluable.

8. "Blue Tracking"

To track UN vehicles, the majority of PKOs have successfully deployed the Carlog system. Swipe cards and associated passwords provide extra security and have reduced vehicle theft.

Route and driving information is downloaded automatically when the vehicle passes near a UN site, helping the missions achieve increased safety, fuel efficiency and better route planning.

Blue tracking, in military parlance, means following the movements of the mission's own or friendly forces. In UN peacekeeping operations, the term is appropriate, not only because of the UN's identification with the colour blue, but because the practice is much needed to enhance the safety and effectiveness of UN forces. To best protect and make use of UN personnel, it is essential to know where they are.

In one of the most successful uses of technology in modern PKOs, nine missions have deployed a vehicle-fleet management system using Carlog devices to monitor the movements of vehicles.[46] The device, permanently fastened to vehicle dashboards, automatically identifies the driver (who must swipe his license card through the Carlog reader and enter a pass code to start the engine), his location and route (thanks to an offline Global Positioning System or GPS), distances traveled, driving behaviour (such as speeding, harsh braking or over-revving) and the time (by the second). When speeding occurs, the Carlog's built-in alarm systems beeps and displays a flashing notice, often frustrating speeding drivers. After accidents, the Carlog records can be reviewed to produce a vehicle event history and to see if drivers might be fully or partly responsible. Persistent speeders may be reprimanded or even have their licenses revoked. The Carlog display reminds drivers of the next scheduled maintenance period (e.g., after every 5,000 km). Used in conjunction with FuelLog system, it keeps track of fuel and calculates gas mileage.

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[45] MONUC has purchased eight hand-held narcotics and explosive detectors, purchased at a total cost of $210,500. Other missions having explosives detectors include (number of devices in brackets): UNAMI (6), UNFICYP (2), UNMIK (1), UNMIL (11), and UNMIS (2). The UNFICYP detector is a Scintrex E3500 model, which claims nanogram limits of detection (specifications available at www.scintrextrace.com/brochures/05-25-2006/E3500.pdf).

[46] The missions currently deploying Carlog (specifically Fleet log 2) with GPS are: UNMIK, UNTSO, UNDOF, UNIFIL, ONUB, UNMIL, MONUC, MINUSTAH, MINURSO. The commercial vendor is found at www.e-drivetech.com.

The current Carlog system does not provide the real-time vehicle position, except near UN receivers. But upgrades or other systems would enable this feature, which would be useful for tracking convoys and sensitive cargo or endangered persons.

According to DPKO transportation officials[47], the proven benefits of the Carlog system are extensive: reduced accidents and injuries, reduced repair costs, improved driving performance, better fuel efficiencies, more regular vehicle maintenance (improving vehicle reliability), reduced paper work (no manual trip-tickets), a reduced number of unauthorised trips, improved vehicle security (by use of the ID pass codes and swipe cards) and better vehicle-allocation management. On top of all that, Carlog allows for route planning/analysis to determine the most efficient routes. Carlog has provided the United Nations the assurance of knowing where its vehicles have been.

The Carlog system does not transmit vehicle location information to a central data station at all times. The radio-frequency modem in the vehicles is too weak for that. It transmits the data only when the vehicle is within the range (150 meters) of a receiving antenna, usually located at UN facilities. (With an upgrade to FleetLog3 it would be possible to conduct real-time vehicle tracking.) The FleetLog2 system used in MONUC costs $514 per device.[48]

Besides Carlog, the standard HF communications system in UN vehicles (including MONUC) also has a tracking option using GPS.[49] The current location of the vehicle could be displayed automatically on a screen in the car and/or on a computer map in an operations centre. The system can also produce audible warnings when vehicles approach a user-defined exclusion zone (e.g., national borders). But this feature has not been activated in MONUC or any other mission, at least to the knowledge of the author.

Real-time vehicle tracking by a central facility, while not yet used in peacekeeping, could be particularly useful for trips out of radio contact and for retrieving stolen vehicles. In UNPROFOR, an advanced communications system with INMARSAT uplinks was run by one of the contingents to track aid and supply convoys in the mountainous region of the former Yugoslavia. Just as airplanes possess the mandatory Emergency Locator Transmitters (ELT) for use in case of crashes,

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[47] Email from Ebrima Ceesay, Officer-in-Charge, Surface Transport Section, DPKO, to the author, 21 December 2006.

[48] MONUC purchased its Carlog system with 336 units for $173,100 or $514 per unit. Source: www0.un.org/Depts/ptd/2007_monuc.htm.

[49] See www.barrett.iinet.net.au. The UN currently uses the Model 950, 125 Watt mobile transceiver.

tracking and transmitting devices in cars could be helpful for rescue or other forms of assistance.

Other tracking systems can be used for inventory control, such as RFID, which is already widely used in commercial industry.

Radio Frequency Identification (RFID) tags can permit the tracking of movement of almost any type of object from pencils to vehicles within well-defined spaces. Microwave RFID tags are already being used in the personal automobile market for long-range access control for high-end vehicles. RFID has many potential UN applications for tracking packages, equipment and even personnel (under certain conditions), for verifying disarmed weapons in storage, among other possibilities. The rapid rise of GPS, wireless technologies and online connectivity will make such innovations increasingly easier and cheaper over time.

9. Geographic Information Systems

Mapping using high-resolution satellite imagery is quite advanced in UN missions, but the creation of real-time databases, linked to the maps, is still in its infancy.

Modern GIS is a cost-effective means to share information across a wide range of peacekeeping partners. It keeps them up to date and linked through a map to imagery (still or video) and a wealth of data.

Geographic Information Systems (GIS) are databases that associate many types of data (e.g., names, images, reports and even RFID info) with geographical coordinates, i.e., points on a map. Since mapping has long been a vital part of peacekeeping, GIS is already extensively used by DPKO to prepare maps of conflict areas where up-to-date maps are unavailable. GIS offers the potential for dynamic, draggable, interactive maps[50], change detection, overlays, analytical tools and other features that are slowly beginning to be incorporated into UN mapping.

The development of GIS is a technology-intensive area where the United Nations has made substantial progress over the past decade. The commercial availability of increasingly inexpensive and more accurate commercial satellite imagery (CSI) and GPS devices, better Internet accessibility and user-friendly software (like ArcGIS) has facilitated this progress. As a result of a Brahimi Report recommendation[51], the first GIS units in the field were established in 2001 as pilot projects in MONUC, UNMEE and UNAMSIL. GIS units are currently found in ten field

[50] For an example of overlays, see maps.google.com or GoogleEarth.

[51] The "Report of the Panel on UN Peace Operations" (widely referred to as the Brahimi Report, after its chairman, Lakdhar Brahimi) made the following recommendation: "Peace operations could benefit greatly from more extensive use of geographic information systems (GIS) technology, which quickly integrates operational information with electronic maps of the mission area." Report of the Panel on United Nations Peace Operations, UN Doc. A/55/305–S/2000/809 of 21 August 2000, para. 258b.

missions, with 10 to 30 personnel in each unit, including military officers as well as civilians.[52]

The United Nations is gradually evolving from *ad hoc* GIS arrangements to standardized structures and procedures.[53] The DPKO Cartographic Section at UN headquarters is now developing GIS start-up packages for new missions as well as portable kits for GIS personnel deployed away from mission headquarters. The kits include: laptops and hand-held GIS pocket PCs (which include GPS receivers), datasets, software, laser range finders, digital cameras, portable printers and plotters.

The GIS units in the missions are providing much-used mapping services. For example, the MONUC GIS unit in Kinshasa collected the GPS coordinates for Congolese villages and towns from UN military observers across the country. From these coordinates, it created maps using geographic names common to the whole of MONUC. In addition to basic maps of DRC administrative territories, tribal regions and UN deployments[54], MONUC's GIS unit has produced more specialized maps of the many types, including:

- dangerous areas (e.g., areas of threat, including mined and unexploded ordinance (UXO) areas, and mine cleared or uncleared sectors);
- security concerns (incidents of accidents/sickness/hostile fire, potential conflict zones, evacuation routes, mustering and regrouping points, check points, security area of responsibility, liaison offices, security warden zones);
- military locations (Congolese army units, local militias, foreign armed groups, arms trafficking routes) ;
- disarmament, demobilization and reintegration locations (regroupment sites, Centres de Brassage, Centres d'orientation, special child soldier camps).[55]

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[52] GIS has become so much a part of modern engineering that the engineering branches in several missions have their own GIS sections. The Headquarters Cartographic Section also provides services to the Security Council as well as GIS support for DPKO and missions in the field.

[53] The UN has a GIS Operation Manual, templates for resource planning, budget guidelines and missions have Standard Operating Procedures (SOPs) for GIS units.

[54] This would include, for example, the locations of civilian police, military observers, national battalions, and UN Volunteers.

[55] This list is a summary of the Map Index of the MONUC GIS unit. The Index was supplied to the author in November 2006 by email. A full list of types would add the following map types: Communications (radio and cell phone network coverage, radio checkpoints); Electoral divisions (registration centres and polling stations, election risk analysis, logistics, cast votes for President and Legislative Assembly positions, spoiled ballots, alliance map, plan de ramassage, voter turnout); Humanitarian information (internally displaced persons, child protection-orientation, medical facilities**);** Natural resources (eco-regions, hydrography, national parks, riverine maps, mineral

The costs for a professional GIS service can be substantial. For a large mission, the GIS start-up package (including personnel) is of the order of $500,000. During operations, satellite imagery costs are typically: $300 per scene (low resolution); $1,000 per site (100 km^2, medium resolution, e.g., from SPOT), and $2,500 per site (100 km^2, high resolution, e.g., from Radarsat or Quickbird).[56]

The current GIS capability is quite limited compared with the great potential. The over-reliance on printed maps means that much of the data in the hands of users is out of date, inaccuracies are not easily corrected, and new data are not easily entered. The creation of a common UN GIS database, to supplement the distribution of paper maps, would allow for quicker updating and error correction, user inputs and improvements, relational linking to other databases. For instance, UNMOs could post their daily situation reports (with photos) on a common GIS system so that records could be easily accessed, shared and compared for near-real time analysis and archival purposes. Also, these reports could contain electronic links to other documents in the database for quicker referencing. Databasing allows for more detailed queries and statistical analysis to see how the pieces of reported information relate in time and geographical space. Furthermore, real-time data display from monitors would be possible if the database were integrated with automated ground sensors or cameras to provide continuous monitoring.

and mining operations); Public information (radio station coverage, including MONUC's Radio Okapi); Transportation (transportation network, aircraft landing sites, helicopter ranges, roads status, arms trafficking and trade roads) and Other purposes (locations of Quick Impact Projects).

[56] Source: "Geographic Information System: Resource Planning and Budget Guidelines for Peacekeeping Missions," Specialist Support Services, Logistics Support Division, June 2006.

4. AERIAL SURVEILLANCE: EYES IN THE SKY

The UN's use of aircraft for surveillance has been ad hoc *and unsystematic. The utility of aerial reconnaissance was discovered only "by accident" in the Congo in 1961.*

In some previous missions, aerial observation proved to be the only feasible means to cover difficult terrain. A study on the use of aerial reconnaissance in peacekeeping is long overdue.

Patrols by foot, jeep or armoured personnel carriers (APCs), as well as fixed observation posts and road checkpoints, are the norm in peacekeeping. Such ground-level surveillance is obviously indispensable, but there are distinct advantages to complementary observation from the air.

The United Nations has conducted aerial reconnaissance in some of its operations. However, the use of observation aircraft has been *ad hoc*, not systematized in UN doctrine or practice. The first dedicated observation aircraft were employed in the Congo (ONUC) in 1961 after it was discovered that pilots of transport planes observed important activities on the ground during their flights. This prompted ONUC to begin mandatory debriefings of these pilots and later to deploy specialized reconnaissance aircraft, including jets.[57] In Yemen (1963-64)[58], Central America (1989-92) and several other locations, helicopters were key tools for observation as well as transportation. The current mission in the Congo (MONUC, 1999-) is believed to have the largest and best heliborne reconnaissance capacity in UN history[59], though the overall aerial reconnaissance capability is less than an earlier mission in the Congo (ONUC, 1960-64) and 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 experiences or list of the aerial imaging equipment used in

[57] In the UN Operation in the Congo (ONUC), the UN's first air "recce" program 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. A. Walter Dorn and David J. H. Bell, "Intelligence and Peacekeeping: The UN Operation in the Congo, 1960-64," *International Peacekeeping*, Vol. 2, No. 1 (Spring 1995), p.11.

[58] 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 UN came 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.

[59] MONUC has 4 Lama (Alouette) observation helicopters, 4 MI-25, 3 MI-26 and 4 MI-35 attack helicopters equipped with advanced observation equipment. Along with the 28 transport helicopters (MI-8T, MI-8MTV, MI-17), there are a total of 43 rotary wing aircraft (as of 24 March 2005).

A comparison of the relative merits of aerial and ground-based reconnaissance shows the great benefit of an aerial component as part of an overall synergistic approach.

UN missions[60], no lessons learned or even comparisons of the benefits of aerial versus ground reconnaissance in peacekeeping. This chapter therefore looks at the relative merits of these two important modes of observation, drawing upon selected UN operations and experiences. It also compares the use of manned versus unmanned aircraft, as the latter is increasingly used in both military and civilian applications in the developed world. The details of all such comparisons (air vs. ground, manned vs. unmanned) are, of course, case-specific, i.e., dependent in part on objectives, terrain, weather, etc. But the broad factors outlined here point to relative merits and the optimum configurations for effective monitoring in a wide range of environments, while recognizing the problems of the two approaches.

1. Advantages of Aerial Reconnaissance

The benefits of gaining the "high ground" are well known in military strategy not only for defensive position, but also for increased situational awareness.

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

Observation from aircraft has many benefits, including:
- *wider view*
- *larger areas*
- *fewer obstacles*
- *faster travel.*

A "bird's-eye view" is possible from aircraft, providing faster coverage, a longer "line of sight" and wider area of observation than on the ground. There are generally fewer obstacles to block the view from the air, and aircraft can move easily to adopt optimum observation angles.

Since aircraft can move faster than ground vehicles and directly to the destination ("as the crow flies"), airborne observers can arrive at distant areas much more quickly. Also, more territory can be covered during the observation period. Ground vehicles (UN 4-wheel-drive jeeps) travel at a maximum[61] of 100 km/hr. Under the poor road conditions typical of many conflict areas, jeeps move as slowly as 10 km/hr, if at all—many mountainous, riverine and jungle areas are impassable or

[60] Air flight is one of the most regulated forms of human activity world-wide, 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 (ICAO). UN Missions also have Standard Operating Procedure (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.

[61] Most missions have speed limits for vehicle travel. For MONUC the limit was 60 km/hr, lower for certain roads. In some missions, the time to reach the destination takes up the majority of the patrol time. For instance, in MINURSO, the "base to station time" required to reach the "berm" (sand wall of separation that is UN monitored) is two hours or more for some bases.

impenetrable. By contrast, aircraft can easily overcome such terrestrial restrictions, moving at typical cruise speeds of 500 km/hr (jet), 200 km/hr (helicopter or two-seater plane), 100 km/hr (small tactical UAV), and 50 km/hr (mini-UAV). During the observation period, aircraft can slow down to dwell over an area, circling by plane or hovering by helicopter. Gyrostabilised cameras can "lock on" to the designated observation targets.

During an aerial patrol (typically three to five hours duration), observers could fly along an entire border of 500 km. Alternatively, such aircraft could cover an open area of 500 km^2 or more. This could be done twice a day (or especially at night) for broad situational awareness and early warning. To follow the movements of relevant "actors" (e.g., armed bands, roving militia horsemen or smugglers along roads), typical monitoring would be within a swath of width less than 10 km at a speed of less than 150 km/hr and at an altitude that would allow for detailed observation. Since aircraft (like ground vehicles) could 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, would not be effective at altitudes above 700 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 one metre or better.

Typically reconnaissance aircraft fly patterns to maximize coverage. They can also fly high to increase the field of view and to remain above the range of small arms fire.

This ability to fly at variable altitudes also allows for controlled visibility from the ground. Aircraft can fly above clouds for cover or find an altitude where they are nearly impossible to spot or hear. This makes it easier to monitor illegal and clandestine activities. In addition, if criminal/violent elements are aware that the United Nations can operate in silent mode, a powerful deterrent would be created. Violators would fear detection, even if no aircraft were present.

If, on the other hand, a show of UN presence is desired, aircraft can be flown at low altitudes. A visible international "eye on the scene" could help halt illegal activities. Aircraft could even "buzz" an area to create a distinct impression.[62] 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

[62] 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.

create a sonic boom that was clearly noticeable by all, including presumed wrongdoers. Aircraft can be painted in UN white or even "glow colours" (UAVs) for greater visibility.

Flights at high altitudes offer another potential advantage: less intrusiveness than a ground presence. At times, the United Nations must reduce the visibility of its presence, either to accommodate local sensitivities or because national authorities have placed limitations on freedom of movement of UN ground vehicles. While still observing national and international laws, UN aircraft can observe without being observed and move without drawing attention (satellites even more so). Of course, takeoff and landing sites are needed, but they could be far away, even in neighbouring lands.

UAVs proved useful for UN peacekeeping when the EU Force deployed them in the DRC to assist the UN.

The UN should acquire UAVs, through lease or purchase, especially for dangerous areas where on-site observers feel threatened.

Especially at night, aerial surveillance can offer a tremendous magnifying effect. When travel is difficult by ground 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 movements of rebel fighters and illegal activities. Night flights for any purpose, however, are generally prohibited under UN rules because the UN does not possess night-time search and rescue capabilities and its aircraft are not equipped with weather radars. But in a few missions, contributors come well-enough equipped (e.g., Norway and others in the former Yugoslavia, Australia in East Timor, a chartered company in Kosovo and Russia in Sierra Leone).[63] 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 on the town of Goma. With such aerial intelligence, a combined UN-DRC force was able to halt the advance.

In the future, Uninhabited/Unmanned Aerial Vehicles (UAVs) could be used for night surveillance because the search and rescue requirements 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

[63] Information provided by the Air Transport Section of DPKO, 28 February 2007.

EUFOR headquarters in real time, so that commanders and analysts at headquarters could share a "common operating picture" and consider responses. While there was no image feed to MONUC, recordings were shown to UN officials, for example, to clearly demonstrate the illegal import activities, allowing the UN leaders to confront the violators.[64]

Aerial observation offers controllable visibility and intrusiveness. They can remain out of sight or "buzz" wrong-doers in a show of presence.

In general, reconnaissance is freer (less constrained) by air than by ground. Host nations often insist that ground movements be escorted by their troops or liaison officers whose purpose is, more often than not, to keep an eye on the UN movements ("observe the observers") and to prevent unauthorized detours. Air observation typically involves a lesser though still substantial set of restrictions and limitations.

Aerial night observation is valuable since many illegal activities take place at night. But night flying has been restricted under UN regulations since UN aircraft are not usually equipped with the devices to detect oncoming storms and dangerous turbulence at night. Also, the UN usually lacks the capability for night-time search and rescue if an aircraft is downed. But there have been some cases of night flying in the DRC and Sierra Leone.

2. Advantages of Integrated Systems

The synthesis of an indispensable ground presence with complementary aerial observation makes for a much more effective overall monitoring system. By air, large swaths of land can be reconnoitred separately or at the same time as ground patrols. Advance surveillance flights can alert peacekeepers to dangerous events, locate such areas precisely through GPS and, in the future, automatically update GIS databases on laptops with the latest imagery. Images can help peacekeepers familiarize themselves with the terrain, objectives and dangers. They can be used for training, planning, operations themselves and for post-mission evaluation. Many hours will be saved if ground patrols can see in advance if roads are non-passable or bridges are washed out, knocked out, closed or subject to militia checkpoints (or even ambush). Most importantly, 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, helibourne spotters warned ground troops of the stealthy approach of militia fighters. This allowed the UN forces to avoid a surprise attack and respond appropriately.[65]

Aerial and ground recce are not competitive but complementary.

If peacekeeping is to be robust, it must be situationally aware and operationally mobile. Quick Reaction Forces (QRF) need to insert

[64] EUFOR offered to provide images extracted from its UAV video feeds to MONUC within 1.5 hrs (i.e., in near real-time).
[65] Interview with BGen Duma Dumisani Mdutyana, Deputy General Officer Commanding of MONUC's Eastern Division, Kisangani, 30 November 2006. The militia leader signed a peace agreement later that year.

Much time can be saved in ground patrols when aerial recce determines which roads are impassable or where threats might lie. Lives can be saved if dangers, such as ambushes, are spotted in advance from above.

themselves with great accuracy at sensitive locations, requiring excellent geospatial awareness. This level of information, particularly about the hideouts of rogue militia or spoilers, requires advance (and advanced) surveillance, briefings for soldiers using detailed imagery, and cueing from aerial assets to respond to the movements and actions of militia forces. Operating ahead of important convoys, aircraft can alert the protectors to potential threats to avoid them, for example, through re-routing. Wide-area surveillance from aircraft can make the ground action quicker, more precise and safer.

During robust PKOs, reconnaissance from above is especially valuable in the pre-dawn period, since militia often move into position at night and wait for dawn before attacking. For instance, in the early morning of 28 May 2006, a joint UN-FARDC force walked into an ambush near Fataki soon after they began their march to search for renegade leader Peter Karim. While an attack helicopter was called to suppress militia fire during the withdrawal, it came too late for a Nepali soldier who lost his life in the initial shooting.[66]

Similarly, Guatemalan special forces carrying out reconnaissance in Congo's Garamba National Park, on the border with Sudan, were ambushed early in the morning of 23 January 2006. They were looking for members of rebel Lord's Resistance Army (LRA) troops who had infiltrated from Uganda. Eight Guatemalans were killed in a firefight that started shortly after 0600 hrs and lasted four hours. This was the second deadliest attack on MONUC.[67] Aerial reconnaissance using infrared night-vision could possibly have identified fighters sitting in waiting, and better prepared the joint MONUC-FARDC force. Armed helicopters did intervene later.

Combined air and ground forces will allow the United Nations to better prepare its defences at night. 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) in an attack on Goma. When these brigades attacked MONUC/FARDC positions at 0525 hrs, MONUC was ready. MI-35 helicopters flew the first helicopter night-

[66] The helicopter provided armed protection for a group of Nepali soldiers who became dissociated from the rest of the UN force, but when it went back to refuel, these seven soldiers found themselves surrounded by more than 300 militia and were taken hostage. After 42 days of negotiations, they were finally released unharmed.
[67] Nine Bangladeshi peacekeepers died in a rebel ambush in the nearby Ituri district in February 2005. The Congo was the scene of the deadliest attack in UN history when, on 22 May 1961, 38 Ghanaians from ONUC were killed.

Aerial recce is already proving to be extremely useful in the Eastern DRC.

flight in MONUC's experience (and perhaps any current mission). 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 NVG. Soon, the UN and Congolese government forces regained control of the town of Sake with no dead or wounded from MONUC's side and the 15,000 to 20,000 inhabitants of the town began to return.

In the Eastern DRC, air recce has located many militia forces, deserting soldiers and stragglers, prior to their being apprehended and arrested or convinced to become part of the peace process through brassage (i.e., merged into the national army).

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

The proliferation of UAVs (with over 300 models already created) means that they come in many shapes and sizes, with a spectrum of capacities. They are now used commercially (e.g., for agriculture and mining) and in the public sector (e.g., for coastal and border monitoring).

3. Enter the UAV

Unmanned or Uninhabited Aerial Vehicles (UAVs) have in recent years found commercial application for agriculture (spraying crops and surveys), mineral exploration (especially desolate and hard-to-reach regions), forestry management (fighting fires), telecommunications (as mobile relay platforms, including in disaster zones for emergency telecommunications), coastal watch and other areas.[68] They are particularly popular in military circles for their potential in fighting wars and recently for keeping the peace as well.

[68] Two other commercial applications are: news broadcasting (for events that reporters cannot reach in time), ground traffic control (to monitor traffic and accidents over major highways). Source: www.list.ufl.edu/uav/UAVHstry.htm, accessed 1 January 2007.

UAVs come in many different sizes, weights, capabilities and configurations. The payload can include many different types of sensors. Table 4.1 categorizes and characterizes the main types of UAVs that could be used in UN peacekeeping.[69]

Table 4.1. Summary of UAV types, based on a survey of models on the commercial market

	Weight (kg)	Range (km)	Speed[70] (km/h)	Time aloft	Payload (kg)	Costs ($US)[71]	Sample functions	Sample models[72]
Mini-UAV	2 – 5	4 – 10	30 – 95	45 min – 2 hr	0.5 – 1.3	25,000[73]	Perimeter surveillance of UN sites and refugee camps	Desert Hawk, Dragon Eye, Raven
Sub-tactical UAV	10 – 20	Up to 1,000[74]	52 – 120	5 – 20 hr	2 – 5.5	55,000	Tracking humanitarian convoys; patrolling border segments	Aerosonde, Luna, Scan Eagle, Silver Fox
Tactical UAV	120 – 500	120 – 2,000[75]	90 – 200	3 – 20 hr	3 – 20	1 million	Long border patrolling, large area surveillance, monitoring from high altitude	B Hunter, Crecerelle, CL-289, Phoenix, Shadow 200, Sperwer
Rotary-wing mini-UAV[76]	7 – 95	5 – 10	0 – 80	Up to 2 hr	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

[69] Larger UAV systems exist, e.g., US-owned Predator and Global Hawk UAVs, but they are not appropriate for the UN. They are not commercially available, their payloads are highly classified and the cost (e.g., to the US government) is extremely high. For example, the price for a Global Hawk aircraft, which can fly at extremely high altitudes over 20,000 meters is $18-20 million.

[70] 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.

[71] Typical cost per UAV. For a system (including ground station with console, launcher) the costs range from: US$60,000–300,000 (mini-UAV), US$650,000–2 million (sub-tactical), US$2–20 million (tactical).

[72] This list emphasizes UAV models that have actually been deployed in military, forestry or other applications.

[73] For example, this is the cost for one Dragon Eye UAV (www.defense-update.com/products/d/dragoneyes.htm).

[74] For example, the producers of the Aerosonde UAV claim a range of 1,500 km with regular payload (www.aerosonde.com).

[75] For example, the producers of the Sperwer UAV claim a range of 2,000 km, www.sagem-ds.com/eng/site.php?spage=02020506.

[76] Larger (Tactical) Rotary Wing UAVs are also available. They are mostly converted manned helicopter models. A comparison of two classes of rotary UAVs is provided in Annex 5.

Small UAVs are becoming increasingly capable. Some can be launched by hand and include micro-cameras with rudimentary image stabilizers.

The smaller UAVs (especially mini-UAVs) are less stable in strong winds, making it hard to get steady video imagery, but sharp still images are quite possible (using a fast shutter speed). Mini-UAVs tend to run on batteries while the larger ones use gasoline or jet fuel. The petroleum powered UAVs can attain a fuel efficiency of over 200 kilometres per litre. Larger UAVs can support heavier payloads. But because imaging devices are becoming lighter, the smaller UAVs are increasingly capable of higher resolution imagery. Still, Synthetic Aperture Radar (SAR) payloads are of the order of 50 kilograms so they are available only for tactical UAVs.

While the EU deployed B-Hunter UAVs to support MONUC in 2006, UN PKOs have not yet deployed UAVs.

Even smaller and smarter UAVs are under development. In a future market, one might see ultra-light or micro-UAVs (eventually possibly nano-UAVs) that are less than half a metre in wing span and less than 2 kilograms in weight.[77] Autonomous take-off and landing UAVs are already available, as well as self-navigating UAVs using GPS waypoints. But these should only be used in a well-defined territory where other aircraft are not present.

Larger UAVs can carry heavier and generally better payloads but they are more costly and difficult to launch.

The smaller UAVs have the benefit of being easier to transport (e.g., by an individual), to launch (by hand or sling-shot) and to operate (e.g., with joy-stick controls). They are cheaper to purchase (starting from $15,000 per UAV) and operate, and 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 UAVs, can bring benefits from each UAV category (including cost and capacity factors). A travelling ground recce unit could control one or more mini-UAV a short distance ahead, while a tactical UAV is used for more distant recce.

4. Manned versus Unmanned Aircraft

i. Advantages of UAVs

These flying machines are generally smaller, lighter and more fuel-efficient than manned/inhabited aircraft. Also called Remotely Piloted Vehicles (RPV), their greatest benefit in peacekeeping is that there is no

[77] For an example of light-weight sensors for UAVs, see www.opticalchemy.com.

danger to pilot or crew because there are none onboard! So flying over raging conflicts is possible.

Remote pilots flying UAVs can adjust camera angles and zoom in on target areas.

To control UAVs, remote pilots remain at distances of up to 100 kilometres or even further using repeater stations (which may be on the ground or in other UAVs in the air) or satellite communications. 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 UAVs exist, but this feature is not likely to be used in peacekeeping in the near future, except possibly during the takeoff and landing periods.

Infra-red and/or radar-equipped UAVs enable night-time aerial monitoring, which is difficult and usually prohibited for manned aircraft.

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 generally not equipped with weather radars, which help spot approaching rains and other hazards at night. Nor does the United Nations have night-time search and rescue (SAR) capabilities or Combat SAR (CSAR) to react properly and quickly for crashes at night-time or in heavy conflict areas. With UAVs, their recovery is not as time-sensitive, so they are not as inhibited by night-flying rules. Given the lacuna in current PKOs for night surveillance, UAVs offer a powerful tool to enhance effectiveness and security after dark.

UAVs are cheaper to purchase, operate, store, maintain and replace than manned aircraft. They require less "crew", who can be more easily rotated and substituted since they remain on the ground.

UAVs are generally harder to detect and hit than manned aircraft, given their smaller size and decreased noise. Battery-powered UAVs hardly make any noise at all, certainly nothing detectable above the din of a battle. At higher altitudes (e.g., 1,000 metres above ground level), some smaller UAVs can neither be seen nor heard.

If a crash does occur, day or night, the costs are much less than for a plane, not only in terms of human life. UAVs are much less expensive to purchase or replace, typically 10 to 50 times less than an airplane. A mini-UAV with its control system typically costs $100,000; sub-tactical UAVs are available for $500,000 or less. Costs are decreasing while capability is increasing. Requirements for licensing, clearance and flight planning are also less.

Though UAVs still need "pilots" and a "crew" for launch, control and maintenance, the number of such support personnel is less than for manned aircraft. Typically, five to ten 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 (cf. model aircraft).

UAVs can be launched from many locations: short or no runways are required, depending on the UAV type. UAVs are also easier to transport: most mini-UAVs are man-portable, i.e., they can be carried by an individual in a case. Some fit in a backpack. Sub-tactical UAVs can be transported in a mini-van or on top of a jeep, while 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 though the area coverage is as large.

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 (large screens) for longer periods of time. The endurance for human observers on a plane is typically seven hours, and most planes need refuelling in even less time. UAVs, which can fly longer because they are lighter, can be controlled by ground personnel on shifts at base to support longer flights.

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: as low as 30 km/hr for mini-UAVs, compared to 80 km/hr for small manned aircraft. (Of course, rotary-wing aircraft have no stall speed. More features of such UAVs are found in Annex 6). This "loiter on station" capacity is particularly useful to observe a localized activity closely for extended periods of time.

ii. Advantages of Manned Aircraft

The use of manned aircraft (as opposed to UAVs) for observation has historical precedence in peacekeeping. The UN has considerable experience in practice, though little of it is recorded, described or analysed. The UN's first aerial cameras were used in the Congo as part of ONUC in the early 1960s. The successor mission in the Congo (MONUC) has, remarkably, less capacity though the need is as great: four Alouette helicopters with a "glass bubble" for visual observation and no recording equipment except still and video cameras that might be carried aboard.[78]

[78] 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

The MI-35 helicopters have considerably more capacity: variable field-of-view Low Light Television (LLTV) and FLIR recording systems, as well as a helmet-mounted sighting and display system. But being a prized (Indian) national asset, whose exact resolution is kept classified, the forth-generation FLIR video imagery is not shared with the rest of the mission: only freeze-and-crop frames are provided to highlight certain observations, though a live feed would be technically possible for remote viewing. The MI-35 FLIR cameras proved most useful during combat to spot militia, allowing the helicopter gunship to engage them with weapons systems "slaved" to the reconnaissance devices.

Manned aircraft can be multi-purpose, for transport and close-air support as well as reconnaissance, giving them a distinct advantage over UAVs.

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 doing reconnaissance during or after the transportation of personnel or materiel.

Manned aircraft are generally larger and capable of heavier payloads than UAVs.

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

Observation from a aircraft window is 3D while UAV imagery on a computer screen is 2D.

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.

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, the integrated use of UAVs and aircraft with crews can provide the advantages of both.

Radio Okapi were used to produce some higher resolution imagery. Interview with François Grignon, former JMAC chief, MONUC, Toronto, 4 February 2006.

5. Aerospace Platforms for Reconnaissance

Besides aircraft, other overhead monitoring devices, like balloons and satellites[79], offer some comparable advantages. For instance, satellites can travel freely in outer space, permitting them to observe any area on Earth legally without requiring national consent. The relative merits of each platform are presented in Table 4.2. Each platform is evaluated on eight basic characteristics, six beneficial ones, then two undesirable ones.

Table 4.2. Comparative advantages (dark green) of the means of aerospace surveillance

	Range	Endurance[80]	Speed[81]	Altitude	Manoeuv-rability	Payload Capacity	Cost ($)	Vulnerabil-ities
Fixed wing aircraft (manned)	HIGH (up to 10,000 km)	Medium (max 15 hours)	HIGH	HIGH (up to 20,000 m)	HIGH (but cannot fly as slow)	HIGH (up to 640,000 kg)	HIGH (for purchase, maintenance, fuel and personnel)	Possible fatalities, needs airfields for takeoff and landing
Rotary aircraft (manned helicopter)	Medium (300 km)	Low (typically 3 hours)	Medium (up to 350 km/h)	Medium to HIGH (up to 10,000m)	VERY HIGH (easy turns and stationary capacity)	Medium (up to 10,000 kg)	HIGH (for purchase, maintenance, fuel and personnel, inc. onboard pilots)	Possible fatalities
Unmanned aerial vehicles (UAV)[82]	Low to HIGH (from 1 km to 1,000 km)	Low to HIGH (from 15 min to 20 h)	Medium (from 40 km/h to 300 km/h)	Low to Medium (from 50 m to 5,000 m)	HIGH	Low (from 1 kg to 150 kg)	Low (much lower than manned aircraft, though dependent on type of UAV)	Can be shot down; weather dependent (esp. wind conditions)
Balloons (free or tethered)	Low (up to100 km a day)	HIGH (10 or more days)	Station-ary or very low	Medium (up to 5,000m)	Very Low (wind-dependent)	Low to Medium (up to 500kg)	Low	Easily targeted
Satellite	VERY HIGH (but has fixed trajectory)	VERY HIGH (years, but revisit time can be days)	VERY HIGH (25,000 km/h)	VERY HIGH (100 to 1,000 km)	Low (only certain types)	Medium (up to 5.000 kg)	HIGH (expensive to build and launch, imagery can be purchased cheaply[83])	Limited availability at specific time and place

[79] Also called aerostats, dirigibles, airships, or blimps.
[80] Without refuelling.
[81] Note: Ability to travel at slow speeds can be an advantage.
[82] Sub-tactical UAVs are considered.
[83] A high-resolution satellite can cost over a billion dollars to build and $50 million to launch.

Tethered balloons can be used for border marking as well as surveillance.

An integrated system, using a variety of tools tailored for specific operations and areas, offers the best solution to the monitoring challenge.

In the table, the comparative drawbacks are highlighted: the high costs of manned aircrafts, the limited payloads of unmanned aircraft and the very limited manoeuvrability of balloons and satellites. One advantage of satellites is that they are well beyond the range of weaponry found in peacekeeping areas.

For some purposes, manoeuvrability is not needed. For instance, tethered balloons are useful for observing important areas or corridors or choke points on a near-permanent basis. Cables keep the observation platforms in place and also allow for the conveyance of electrical power and data signals (via fibre optics in most modern systems). These large balloons are also of symbolic value as markers (e.g., of border lines), navigation aids, communications relays and radio-station transmitters. Of course, these very visible static objects can also be favourite targets for frustrated combatants. However, if shot down, they can be repaired or replaced quickly and cheaply. Some aerostats can be rapidly deployed 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 as part of national drug interdiction programs. Held at a typical altitude of 500 metres, the surveillance view can extend for several kilometres. In Afghanistan, the 14-metre long RAID (Rapid Aerostat Initial 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 and are equipped with an electro-optical/infrared sensor suite.[84]

Multiple information sources are needed to corroborate and probe sensitive and uncertain information. While aerospace reconnaissance provides unique advantages over ground reconnaissance, the best option is an integrated system. Even aerial systems can be multilayered and hybrid to complement each other as well as ground systems, to better detect threats and to explore opportunities.

[84] Source: www.designation-systems.net/dusrm/app4/aerostats.html

5. CURRENT UN STANDARDS: STARTING FROM NEAR ZERO

Existing UN training documents lack coverage of monitoring technologies.

There are currently no UN materials to train or prepare peacekeepers to use modern monitoring technologies. The majority of publications of the DPKO Integrated Training Service (ITS) fail to even mention, let alone describe, any monitoring technologies, leaving the false impression that these technologies have no role in peacekeeping. A few training documents make casual reference to technologies: for example, the *Selection Standards and Training Guidelines for United Nations Military Observers* (UNMOs) simply notes the use of "binoculars and night observation devices" and "specialized equipment to support monitoring."

There is only one document that suggests that some of the modern technologies should be procured and incorporated into training exercises.

Only the *United Nations Peace-Keeping Training Manual*[85] provides a rudimentary level of detail: "in addition to illumination, PKOs [peacekeeping operations] use a wide variety of NVE [Night-Vision Equipment] and ground radars." (Contrary to this statement, ground radars have rarely been used in PKOs, though NVE is now deployed in many missions.) The Training Manual briefly outlines some means to procure equipment[86] and recommends a general exercise: "the climax should be a training exercise involving day and night observation where troops/observers would be tested on their ability to observe and report on some contrived incidents."

The TOE is a natural place to list monitoring technologies. It should be updated regularly to include recent technologies.

The *Table of Organization and Equipment* (TOE), used to generate appropriate forces for PKOs, would be a natural place for a comprehensive list of potential monitoring technologies. But the published TOE (1998)[87] merely recommends that military observers be equipped with night-vision devices. It makes no mention of other technologies. A later version of the TOE (2006) is more specific on night-vision: it recommends one device for every 10 to 15 soldiers, "unless there is a requirement to increase

[85] *United Nations Peace-Keeping Training Manual*, Training and Evaluation Service, United Nations, New York (undated, but developed in 1995 from Scandinavian training materials). Available at www.un.org/depts/dpko/training/tes_publications/books/peacekeeping_training/training_manual.pdf. See, in particular, the section "Guidelines for National or Regional Training Programmes," p. 27.

[86] The *United Nations Peacekeeping Training Manual* lists the means of acquiring equipment through a Memorandum of Understanding (MOU), a Letter of Assist (LOA), or purchase as UN-owned equipment (UNOE). The Handbook does not mention provision of equipment as part of the unpaid National Support Element (NSE).

[87] www.un.org/depts/dpko/training/tes_publications/books/logistics/TOE/TOE.pdf. A later version is also available in draft: *Standby Arrangements in the Service of Peace: Tables of Organization and Equipment* (Draft TOE 2006). An update is being further developed in 2007.

The TOE specifications for GPS equipment are out of date. It is, admittedly, a challenge to keep documents up-to-date in the field of rapidly-evolving technological devices.

The COE Manual defines the standards for equipping and paying national contributors. Two of the 25 categories of self-sustainment equipment are Observation and Identification. The Manual lists, in a general way, "night observation devices", and another monitoring technology

equipage due to mission/threat level." It also suggests the use of Global Positioning System (GPS) devices together with laser range finders:, which can be used to determine the distance to faraway objects so that their positions can be determined precisely using the GPS coordinates of the observer. The draft 2006 TOE specifies that the GPS units must have an accuracy of 25 metres or better. But this figure is out of date: currently, even inexpensive commercial models ($200-300) offer a precision of 10 metres or better.

The *Contingent-Owned Equipment (COE) Manual*[88] is better in describing observation technologies but it is still deficient, especially given its importance in setting the standards for equipping contingents from troop-contributing countries (TCCs). Under COE rules, TCCs are paid according to two classes of equipment that they bring to the field: Self-sustainment and Major Equipment. The self-sustainment list is standard for almost all UN missions, though in some cases the United Nations assumes responsibility in some equipment categories for some nations. There are 25 categories of self-sustainment: from catering to tentage, from communications (within each contingent) to medical capabilities. The two COE categories of interest here are: Observation and Identification.[89] They are vaguely defined in the 2005 COE Manual as summarized in Table 5.1.

Under a well-developed inspection system, COE inspectors check equipment on arrival, quarterly thereafter and on departure to see if it meets the standards by the COE Manual. If equipment does not meet the standard, the country is not reimbursed for that particular category of equipment/capability.

[88] The 209-page COE Manual was finalized by the 2004 Working Group on Contingent-Owned Equipment on 22 December 2005 and published as UN Doc. A/C.5/60/26 of 11 January 2006. Its formal name is "Manual on Policies and Procedures Concerning the Reimbursement and Control of Contingent-Owned Equipment of Troop/Police Contributors Participating in Peacekeeping Missions." It is due to be reviewed in 2008.

[89] The COE Manual also calls for "early warning and detection systems to protect contingent premises" under the self-sustainment category of "Field Defence Stores." However, this requirement does not necessitate technology under the current UN interpretation. A single sentry would suffice to meet the COE standards.

Table 5.1. Contingent-Owned Equipment (COE) self-sustainment standards and rates (per person) for observation and identification (emphasis added in bold)

	Standard	Monthly rate[90] (US$)
Observation		
General	Provide hand-held binoculars for general observation use	1.07
Night observation	Detect/identify/categorize persons or items at **1 km** or more; and conduct night patrols	23.95
Positioning	Determine the **exact** geographical location	5.45
Identification	Conduct surveillance operations with photographic equipment, such as videotape and single lens reflex cameras; Process and edit the obtained visual information	1.06

Video and still cameras, plus GPS equipment are compensated according to the COE Manual, but the specifications are inadequate. There are no guidelines on the number of cameras, video recorders, night-vision or GPS devices needed per military unit.

The quality specifications for equipment are either undefined or under-defined.

For observation and identification, the Manual is deficient in both quantitative and qualitative terms, leading to problems and disputes between contingents and COE inspectors over what is acceptable. The Manual does not provide any formula or means, not even a rule of thumb, to determine how many night-vision devices or GPS units are needed per military unit. Nor are the types of equipment (goggles, monoculars, image intensifiers or infrared) or capabilities specified. Furthermore, the terms "identify" and "categorize objects" are not defined, so testing is necessarily subjective. Also, for the night-vision category, the COE Manual ignores any consideration of lighting conditions (starlit, moonlit, no-ambient light, etc.) for the 1-km target range. Similarly, the category labelled "Identification" (but better considered as "Recording Capability") does not specify the number or quality of cameras/videorecorders needed for each military unit.[91] In MONUC, it was decided, after many difficult experiences, to adopt a "force standard" of 4 NVE per infantry platoon (usually 20-30 soldiers) and to reduce the required range from 1,000 to 500 metres because virtually none of the contingents could meet the

[90] Monthly rates are per person. For a battalion of 800, the UN would multiply the specified rate by 800. For NVE, if the battalion meets the requirement for quantity and quality (54 NVE is the standard MONUC adopted), the UN will reimburse the TCC 800 x $23.95 or $19,160 per month for the NVE. The self-sustainment reimbursement rates are often increased by various factors (e.g., environmental, intensified operations, hostility/forced abandonment), typically 1– 5%, according to the mission conditions.

[91] Payments are made per person in a military unit if the entire unit has the required capability. Payments in each category are "all or nothing." TCCs meeting the requirements in part do not receive compensation. For example, if 50 NVE are required and the contingent has only 25, the TCC is not reimbursed at all for the category.

The COE standards should be reviewed and updated.

The Major Equipment section of the COE Manual lists compensation for only a narrow set of monitoring devices.

original COE Manual standard.[92] This example highlights the need to establish appropriate, rigorous and detailed COE standards.

Under the "Major Equipment" class of the COE Manual, the United Nations *leases* expensive equipment from TCCs as the UN deems necessary. The listed equipment types are shown in Table 5.2. Here again, the inadequacy of the COE standards are manifested. Without accurate standards for equipment quality and specification of various types, the listed prices can only be considered artificial. The variety and quality of night-vision and radar equipment vary considerably across several generations of improvements, and no standards at all are specified (except the requirement for "round the-clock operability and routine calibration").

Table 5.2. Types and rates for Major Observation Equipment listed in the 2005 COE Manual

	Generic fair market value (GFMV, US$)	Monthly wet lease (US$) per person	Percentage (lease/GFMV)
Personal			
Night observation devices—tripod mounted	12,950	159	1.2
Binoculars—tripod mounted	8,094	82	1.0
Area			
Artillery locating equipment	Special case	--	--
Ground surveillance radar/system	Special case	--	--
Thermal imaging systems—aerial	132,672	1,888	1.1
Thermal imaging systems—ground	110,560	1,644	1.5

There are few details to define the operating criteria of the equipment listed.

Many technologies have been ignored in the COE Manual, or grouped together such that modern and outdated equipment are compensated equally.

For comparison, the UN pays TCCs $1,028 per soldier per month ($303 more for specialists). Thus a wet lease for the thermal imaging system would cost, according to this scheme, less than the cost of two soldiers. For "special case" equipment in the table, TCCs need to negotiate the reimbursement rate with the United Nations. The rate is then specified in the Memorandum of Understanding (MOU) between the UN and the TCC.

When the United Nations purchases its own equipment, it also uses certain guidelines. The *Standard Cost Manual 2003* lists a few (five) "observation" technologies under "Other Equipment":

- Binoculars (handheld: $350; tripod mounted: $6,500)

[92] Brig-Gen J-G Isberg (Acting Force Commander of MONUC), "Urgent Operational Equipment Upgrades—Amendment," Facsimile transmission to Military Adviser P.C. Cammaert, 7 December 2004. Even with the reduced standard, MONUC COE inspectors estimated in November 2006 that only 50% of the contingents have equipment that can satisfy the requirement.

The COE Manual also contains gross pricing inaccuracies since the cost of certain technologies has changed dramatically since 1995 when these items were priced.

- Infrared System (no details: $50,000)
- Thermal Imaging System (aerial: $120,000; ground: $72,000)

Once again, there are serious deficiencies in this list, in addition to price inconsistencies with the COE Manual and the fact that "infra-red" and "thermal" systems are the same.[93] Like the COE Manual, the Cost Manual grossly oversimplifies the wide range of available technologies, in terms of types (image intensification versus infrared), generations (e.g., night-vision equipment ranges from first to fourth-generation) and equipment quality.[94] Furthermore, the items were priced in 1995, when the costs were considerably higher—in some cases, costs are currently an order of magnitude lower (e.g., $5,000 for thermal infrared devices instead of $50,000). Finally, the Cost Manual is incomplete: it fails to cover radar systems and many other types of monitoring technologies.

Safety and Security Standards

Some of the safety and security documents are so out of date that the main technologies they refer to are walkie-talkies and telephones.

In the safety and security documentation of the United Nations, one would expect a thorough consideration of monitoring technology, since it is so prevalent in the security industry. But in the written materials for safety of UN personnel, there is a paucity of technological monitoring equipment. The outdated "Security in the Field" pamphlet (1998), meant to provide individuals going on field missions with basic tips, makes no mention of any technology except "walkie-talkies" and telephones.

The attack on the UN compound in Baghdad in 2003, when 22 UN staff members lost their lives, sparked a significant development of new standards for independent communications equipment.

After the terrorist bombing in Baghdad of 19 August 2003, in which a large section of the mission headquarters (Canal Hotel) was destroyed and 22 UN staff members lost their lives, the United Nations developed new structures, procedures and equipment lists for a more systematic approach to personnel protection. The newly created Department of Safety and Security (DSS) introduced Minimum Operating Security Standards (MOSS) for system-wide application.[95] The "baseline MOSS" provides an extensive list of telecommunications equipment, even for its lowest (phase I, precautionary) threat level: a "fully operational, independent radio network utilizing UHF, VHF and/or HF equipment" and

[93] Thermal imaging is usually done by detecting radiation in the "far" infrared part of the electromagnetic spectrum.
[94] When the UN provides night-observation equipment (NVE), its standard is much lower than the one specified for contingent-owned equipment: the NVE must have an "effective range" of only 250 metres as per the specifications of the UN Systems contract. This inconsistency should be corrected.
[95] "Minimum Operating Security Standards: Instructions for Implementation," dated 1 July 2004 (endorsed by the Inter-Agency Security Management Network in May 2004). The Security Phases are I (precautionary), II (restricted movement), III (relocation), IV (emergency operations) and V (evacuation).

Once the threat level becomes high, the MOSS standards specify that enhanced protective measures are necessary. Beyond the basic technologies, the list includes video cameras, x-ray machines, and metal detectors.

The Department of Safety and Security has begun to look at equipment in the field. A Technical Specifications Working Group was established with DPKO in 2006 to identify and procure security-related equipment necessary for PKOs.

mobile satellite telephones for each agency's country office. The MOSS also recommends the creation of a 24-hour/7-days-per-week (24/7) communications centre, in addition to an ever-present Emergency Communications System (ECS).

Under the new system, in each country, the Designated Official (DO) and the Security Management Team (SMT) must develop country-specific MOSS involving a Threat and Risk Assessment (TRA), and a table of equipment, training and structures. The only monitoring technologies listed in the template table for Phases I to III (i.e., precautionary, restricted movement, relocation phases) are digital cameras and GPS devices, both of which are "mandatory for Field Security Coordination Officers." Only when there exists a threat of terrorism, "Enhanced Protective Measures and Resources" (Annex B of the MOSS) are recommended to "supplement" the base-line MOSS. Included in the perimeter protection and access control measures are: CCTV monitoring and recording of perimeter areas by a 24/7 control room and possibly X-ray machines, metal detector archways and/or wands at visitors' entrances. In addition, a vehicle-check mirror (not high tech) is recommended for the entrance.

Thus, the DSS documentation deals solely with security equipment for UN facilities and communications systems for traveling personnel. But realizing that a more proactive approach to security means achieving better situational awareness, DSS engaged DPKO in an effort to look at equipment in the field more generally. The Technical Specifications Working Group, established in 2006 by DPKO and DSS, was mandated "to identify and procure security-related equipment necessary for DPKO-led operations."[96] The Peacekeeping Operations Support Service (POSS) unit of DSS is to maintain awareness of new equipment and recommend equipment priorities in the field. So far, the Working Group has developed specifications for only one type of type of monitoring technology: CCTV.[97]

[96] "Policy on Cooperation and Coordination between the Department of Safety and Security (DSS) and the Department of Peacekeeping Operations (DPKO)," October 2006, p. 6.

[97] The degree of detail in such specifications is not known to the author. Email requests for the specifications were not returned.

The UN does not have a comprehensive list of useful technologies available commercially for peacekeeping. Table 5.3 gives a relatively complete listing of such equipment.

This review shows the paucity of UN documentation for employing monitoring technology in PKOs. The training manuals, equipment standards and equipment lists are far from adequate for a proactive approach in the field. Many categories of technology have not even been mentioned. What, then, would a more thorough list look like? Table 5.3 is an attempt to provide an answer. It lists monitoring technologies that could and should find application in peacekeeping and be covered in UN documentation, especially the COE Manual.

Table 5.3. Summary of monitoring technologies[98]

	Types	Quantity Measured
Video monitors	- Videocameras - Web cameras (indoor/outdoor) - Closed-circuit television (CCTV) - Digital video networks (DVN) - Aerial & space-based surveillance	Visible light (electromagnetic (e.m.) radiation of wavelength 400-700 nm)
Night-vision equipment	- Image Intensifiers (II) - Thermal or Infrared (IR) Imaging	- For II: Visible light - Thermal devices: IR (e.m. radiation of wavelength 700-12,000 nm)
Motion detectors	- Automatic illuminators - Alert or alarm connections	Changes in IR or radar or light beam intensity
Radars	- Air surveillance radar (ASR) - Artillery locating radar (ALR) - Ground penetrating radar (GPR) - Ground surveillance radar (GSR) - Synthetic aperture radar (SAR) - Marine radars - Weather radars - Speed enforcement radars	Reflected radio waves*[99] - ASR: 2-30 cm - ALR: 3-50 cm - GPR: 2-10 m - GSR: 10-30 cm - SAR: - Marine: 3-15 cm - Weather: 2-15 cm - Speed enf.: 1-2 cm
X-ray machines	- Baggage and shipments - Portable	Electromagnetic radiation of wavelength 0.03-3 nm *
Acoustic sensors	- Small arms fire detection and localization - Movement of persons or vehicles	Acoustic (sound) waves in air or ground
Seismic sensors	- Geophones (for personnel/vehicle detection) - Seismic arrays (for explosion detection)	Acoustic waves produced by movements in the Earth's surface
Chemical sensors	- Explosives detector	Molecular mass or chemical binding properties
Metal detectors	- Handheld wand - Mine detector	Electric currents inducted in underground (metal) objects*
Pressure transducers	- Intrusion alarms - Road monitor	Pressure applied (converted to an electric signal)
Electronic monitors	- Signal locating equipment - Radio scanners / signal monitoring	Electromagnetic radiation (radiowaves) of wavelength > 1 mm
Positioning and tracking systems	- Global Positioning System (GPS) - Transponders and tags - Radio-frequency Identification (RFID)	Radio signals from the Global Positioning System (GPS) of satellites

[98] Other technologies, less likely to be used in peacekeeping, include: sonar, ultrasound, LIDAR, taut-wire fences, IR breakbeam detectors, seals and tags. Nuclear detectors (e.g., Geiger counters) are needed only when nuclear materials present a potential hazard.

[99] Items marked with * are "active sensors," meaning that the devices emit a wave and the reflection is measured by them. Infrared devices can be active if they are equipped with an IR emitter to invisibly "brighten" the area. Otherwise they are "passive."

6. CHALLENGES AND PROBLEMS

Appropriate technologies need to be operationally effective and easy to use. The implementation of a technology strategy involves even more: legal, political, institutional/cultural and cost considerations.

Given the current low state of technological awareness and standards in the United Nations, the first challenge is to devise criteria for the selection of *appropriate* monitoring technologies from among a wide array. This involves a range of considerations: operational (effectiveness of the devices), legal (under international and national laws), political (acceptance by a range of actors, including the major parties), institutional/cultural and financial (affordability). While examining these factors, potential problems and pitfalls can be identified.

1. Operational

Operational effectiveness means the technology is useful, practical, and durable in the robust environments of PKOs.

Technologies must, first of all, be operationally *useful*—providing increased situational awareness, for example, at night, over large areas, in important locations or of significant activities. As shown in previous sections, even the UN's limited experience—with some technologies deployed in some operations—demonstrates the utility of technologies such as night-vision goggles for night patrolling, aerial cameras to spot advancing threats, satellite imagery for mapping and tracking systems to monitor UN vehicles.

The limitations of technologies also need to be taken into account in sensor selection.

To be *practical*, the technologies have to be reliable, accurate, and easy to operate in the mission. The modern experience in UN and other (e.g., NATO) operations with many technologies has also shown that this is achievable, though special expertise and training are often required. For instance, expert analysts may be needed to recognize target signatures and to discard artefacts in imagery, especially from synthetic aperture radar. Technical expertise may also be needed to calibrate equipment and adjust threshold levels, for example, to separate background "noise" from actual "signals" (the classic "signal to noise" problem). To accommodate the extra data from sensors, the UN would also need to increase the bandwidth, speed and reliability of its electronic transmission channels (e.g., IT networks).

Technology is becoming increasingly user-friendly.

Technology is, in general, becoming increasingly *user-friendly*, especially through the use of icons and menus in computer interfaces. But even user-friendly devices require testing and practice-runs to overcome potential problems. For example, depth-perception can be a problem with night-vision equipment but to seasoned users these NVE problems are manageable. [100]

In harsh peacekeeping environments (e.g., hot climates or under rough handling), devices need to be *robust and durable*. Most military equipment is ruggedized to allow for difficult (even combat) conditions. Ruggedization may increase the cost of the equipment, but not necessarily by a large factor.[101]

For mountainous or undulating terrain, with narrow fields of view, the UN could set up an array of short-range sensors instead of long-range sensors.

Terrain type[102] and sensor range are key factors in technology selection. In flat areas where the line-of-sight is long, such as in deserts, open fields, water bodies (lakes, rivers and oceans), long-range sensors are best. These technologies include radar, high-zoom cameras (still and video), and laser range-finders, preferably on elevated towers or aerial platforms. In terrain typified by a short line-of-sight and many obstacles, as found in jungles or rapidly undulating areas or built-up urban regions, numerous short-range sensors, spaced periodically, might be needed to cover the area. Short-range devices typically include seismic, acoustic, magnetic and infrared break-beam sensors.

Some devices are greatly limited by weather (e.g., video cameras) while others are virtually weather-independent (e.g., radars).

Weather conditions also play a role in the choice of sensors. Like human eyes, cameras operating in the visible part of the electromagnetic spectrum can become virtually useless in heavy fog or rain. Other devices, like radar, are much less susceptible. Night-vision image intensifiers work better when there is more ambient light, for instance, from a full moon on a cloudless night. Infrared devices give clearest signals when the targets (warm bodies) are at greater temperature differences from the background (e.g., in colder weather). Acoustic sensors sometimes have difficulty distinguishing target sounds (e.g., rifle fire) from noise caused by thunder, rain or even wind, though automated acoustic analysis can supplement the human ear to identify the types, locations and sources of particular sounds.

[100] Night driving on roads with no street lighting (e.g., jungle roads) is possible with night-vision goggles but users should first gain experience in simpler environments. Users need to be aware that NVE can alter depth-perception, exhibit distortions like curving at the edges, and phenomena such as "blooming" (halo effects around bright lights), "scintillation" (temporary bright spots) and black spots (small but often permanent).

[101] For instance, commercial water-resistant GPS devices used for hiking and climbing expeditions can be purchased for under $500.

[102] Terrain can impose other limitations on the choice of sensors. In the open desert where there are many if not an infinite number of possible paths through the sand, point sensors are of limited value since they measure signals at one small location only. Seismic devices are rendered ineffectual in the desert because seismic waves are quickly absorbed by the sand. Similarly, in difficult mountainous terrain where vehicles are unlikely to pass, buried magnetic sensors are of limited value.

2. Legal

UN missions are legally permitted to deploy with all the equipment needed to achieve the mandate.

The host state may have to make an exception for the UN in applying its laws on monitoring of sensitive sites.

From a legal perspective, there are relatively few obstacles to the deployment of monitoring tech in UN field operations, provided the equipment serves the purpose of the mission. The UN Charter (Article 105) states that "the Organization shall enjoy in the territory of each of its Members such privileges and immunities as are necessary for the fulfilment of its purposes." The Convention on Privileges and Immunities of the United Nations further declares that "the property and assets of the United Nations, wherever located and by whomsoever held, shall be immune from search, requisition, confiscation, expropriation and any other form of interference …"[103] In the Status of Forces Agreement (SOFA), which the United Nations negotiates with the host state, the latter almost always recognizes the UN's right to import equipment as well as the state's own responsibility to promptly grant all needed authorizations and licences. The SOFA also provides reassurance to the host state:

> The United Nations peacekeeping operation and its members shall refrain from any action or activity incompatible with the impartial and international nature of their duties or inconsistent with the spirit of the present arrangement. The United Nations peacekeeping operation shall respect all local laws and regulations.[104]

Since local laws may sometimes include prohibitions on monitoring of military activities, a legal dilemma could potentially arise, but experts in the UN's Office of Legal Affairs have not encountered this problem. The UN's fulfillment of its mandate would, they say, take precedence under the legal principle of factual displacement.[105] But the issue could become a political one (see below).

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[103] Section 3 of the "Convention on Privileges and Immunities of the United Nations," United Nations, Treaty Series, vol. 1, p. 15. Also the 1994 "Convention on the Safety of United Nations and Associated Personnel" (www.un.org/law/cod/safety.htm) states that "their equipment and premises shall not be made the object of attack or of any action that prevents them from discharging their mandate."

[104] Excerpt from Article 6 of the "Draft Model Status-of-Forces Agreement for Peacekeeping Operations Between the United Nations and Host Countries" contained in UN Doc. A/45/594 of 8 October 1990. The right to import is provided in Article 15. This document also serves as the basis for Status of Mission Agreements (SOMAs) in cases where UN civilians and unarmed military observers, but not UN forces, are deployed.

[105] Interview with David Hutchinson, Senior Legal Officer, Office of Legal Affairs, United Nations, New York, 26 January 2007.

Aerial surveillance gives rise to issues of air traffic control as well as safety (air worthiness).

The UN must develop dependable procedures and systems so technical monitoring does not overstep the bounds of its mandate.

For UN aerial reconnaissance, the host states' guarantees in the SOFA of unrestricted freedom of movement would apply.[106] But the United Nations would likely develop a kind of "modalities arrangement" for purposes of air traffic control.

The United Nations respects human rights law, which includes provisions to respect individual privacy. In carrying out monitoring activities, the UN must "avoid arbitrary interference with [the] privacy, family, home or correspondence" of individuals, in accordance with the Universal Declaration of Human Rights.[107] In its monitoring work, the United Nations would uphold privacy rights except in the "non-arbitrary" cases where the actions of the targeted individuals or groups impact the peace and security mandate of the mission. The United Nations can take measures to ensure it respects privacy during its surveillance.[108] In general, legal instruments are not impediments to the UN's work but, rather, enablers of it.

3. Political: the Conflicting Parties

Since peacekeeping operations are designed primarily to achieve or contribute to a political outcome (a sustainable peace between conflicting parties), political considerations play a major role in the selection of technologies and methods to be used.

Ideally, technical monitoring, like UN observation in general, should have a confidence-building effect on the parties, creating opposition only from the individuals and groups who oppose the peace agreement or process. All committed parties would see that it is in their interests that the United Nations possess the means to identify violations and provide early warning of threats.

In reality, parties usually sign peace agreements reluctantly because they were not able to achieve their desired outcome through

[106] The Model SOFA, *ibid*., in Article 12, states (emphasis added): "The United Nations peacekeeping operation and its members shall enjoy, together with its vehicles, vessels, *aircraft* and equipment, freedom of movement throughout the [host country/territory.] The freedom shall, with respect to large movements … be coordinated with the Government."

[107] The text of the Universal Declaration of Human Rights can be found at www.un.org/Overview/rights.html. The quoted privacy rights are found in Article 12.

[108] The UN could use lower-resolution cameras so as not identify individuals (unless required) and exercise "shutter control" over the cameras and devices to ensure that the PKO was not unduly observing innocent commercial or private activities.

armed conflict (e.g., a one-sided victory). They often remain deeply suspicious, accusing each other of all manner of violations. The parties rely on the United Nations to provide objective verification of the compliance (or otherwise) of the other side, but often prepare for the possibility of renewed violence, including by hiding their weapons. They frequently push the limits of the peace agreement and test the limits of the UN's verification capability. Violations may range from marginal to substantial: from delays in implementing peace accords to political manipulation/intimidation to arms smuggling/stockpiling to inciting violence for political ends.

The conflicting parties often try to hide their weapons and violations from the UN as well as each other. So some parties may not wish the UN to deploy a comprehensive monitoring system.

For these reasons, some parties may not wish the PKO to deploy a comprehensive monitoring system that could readily detect their infractions of the peace accords. They might complain that the United Nations was interfering, infringing or "spying" on them, or accuse the UN of violating its standard of impartiality. Here, technology can both help and hinder the UN deployment. Imagery or other technical evidence of illegal activities can provide objective proof beyond the verbal or written reports from UN officers. But if parties know the UN can accomplish this level of verification, they may be less interested in bringing the organization into the peace process. In the end, the acceptance of parties to objective but intrusive monitoring is one important test of their political commitment to carry out the peace accords.

In the "cat and mouse" game, the UN needs superior monitoring technology to be effective.

In an environment of tenuous commitment, a "cat and mouse" game is often played in which the United Nations investigates wrongdoings, major or minor, which the parties try to hide or blame on each other ("the blame game"). In the end, it is the duty of the UN to establish the most rigorous verification system possible. The world organization cannot afford to be an impotent bystander in areas of violent conflict, where innocent lives are at stake. If the UN wants more than a purely symbolic presence, it must be ready and able to identify significant violators of peace accords and the perpetrators of human rights abuses. When warranted, it must be willing to "name and shame" such individuals and groups. Even more proactively, it must help locate and arrest war criminals.

The parties may also have legitimate concerns about UN monitoring. They might fear that the PKO could gain compromising

The UN should develop a better confidentiality system to minimize leaks of sensitive information. Some technological means can help create confidentiality (e.g., passwords and fire walls).

The demand from the parties for technology is now in evidence, e.g., continuous video monitoring of key weapons storage sites in Nepal.

information about them that could lead to a loss of security, especially if the information were to be obtained by the other side.[109]

The problem of information leakages have arisen in past operations when UN personnel had selective access to military, political or other information. The United Nations has dealt with the parties' fears by reassuring them that it will act impartially, in strict confidentiality and in accordance with its mandate. The UN can alleviate fears associated with new technologies by providing similar assurances and guarantees, as well as detailed explanations of the UN's methods.[110] While the methods are transparent, UN-collected information is, generally, not openly available The United Nations could also explore the concept of cooperative monitoring, in which interpreted data or even imagery is provided regularly to all the parties as a confidence-building measure.[111]

Technology is so widely recognized as a tool in modern life, that some conflicting parties have even requested the United Nations to deploy it in peace accords. For instance, the parties to the 2006 Nepalese peace agreement asked the United Nations to install cameras for 24/7 surveillance of weapons storage depots of both the Maoist insurgents and the government forces to ensure that these arms are not removed. The system includes continuous video recording of the fenced-off storage sites, a series of floodlights for illumination and a means for UN civilian observers to sound the alarm in case of unauthorized withdrawal of the weapons.[112]

[109] This has happened in a Bosnian city. As UNPROFOR soldiers observed the landing areas of mortar fire, they communicated these locations to regional headquarters by radio in the clear (non-encrypted). They did not know that Serb artillerymen were listening to the communications and using the information to correct their fire in order to make it more deadly. In such cases, encrypted communications is a must for the UN.

[110] The UN could, for instance, outline the types of information that will be sought and the general methods and devices that will be employed. Furthermore, it could provide the parties with regular reports on its monitoring activities in a way that would not threaten the parties' security. At meetings of joint commissions or other bodies that bring all parties and the United Nations together, a regular feature could be the presentation of the results of UN verification in general terms.

[111] A. Walter Dorn, *Blue Sensors: Technology and Cooperative Monitoring in UN Peace Operations*, *ibid*.

[112] "Comprehensive Peace Agreement held between Government of Nepal and Communist Party of Nepal," dated 22 November 2006, available at www.reliefweb.int/rw/RWB.NSF/db900SID/VBOL-6VSHK8?OpenDocument.

4. Political: the Contributing States

Nations contribute their military and police forces to UN PKOs for a variety of reasons: to make a contribution to international peace and security; to foster a national role and reputation in the world; to gain experience in conflict zones and/or to earn additional income.[113] Consequently, some troop contributors might not want to see a decrease in the number of peacekeepers in the field. They might possibly fear that technology could result in such reductions, just as some people feared that office automation technology would lead to empty offices. Such fears are unwarranted.

Technology would help to employ field personnel more effectively.

Technology would in most cases not result in decreasing troop numbers, but rather in their more effective employment. Most UN missions are already overstretched, with too few soldiers and civilians to carry out all the tasks the Security Council resolution has mandated and implied. Robust multidimensional operations are especially difficult to staff and support. Technology would, in most cases, take away some of the tedium of routine observation and allow PKOs to shift peacekeepers into more proactive roles, such as rapid reaction forces. By allowing greater situational awareness, including better early warning, technology would enable reaction forces to intervene in a more targeted fashion in crisis or volatile situations. Far from creating a bunker mentality, technical means can make UN peacekeepers more proactive, since they would benefit from increased knowledge of their local areas and adopt more preventive tactics when venturing into new ones.

Conceivably, "have-not" nations may resist the introduction of technology. But in practice, they are eager to gain experience and expertise with new technologies. Partnerships with developed nations can help create new capacities for the UN as well as developing nations.

Some troop contributors have little or no monitoring technology in their national inventories. Their doctrine, training and technical experience may have been limited to binoculars. Being unfamiliar with advanced technologies, these contributors might resent or envy the employment of technologies by other contingents. Technology conceivably introduces an imbalance between national contingents. One solution is to raise the capacity of these developing-nation forces by providing them with the devices and training needed to meet a standard technological level. The technology gap that exists between contributing states should not mean that the United Nations has to operate at the lowest common denominator, but rather the UN should strive to operate at the most effective level for reasonable cost and effort. The soldiers of developing nations have in the

[113] For some states, peacekeeping is revenue-generating.

past shown great eagerness to try out new tools. "Strategic partnerships" to bridge the technology gap can be adopted to address the equipment and training needs of developing nations.

Developed nations that have recently begun to re-engage in peacekeeping (e.g., European nations deployed in Lebanon) have shown that they are willing to bring in the technologies and capabilities they feel necessary, irrespective of whether the United Nations will reimburse them. The UN's MOU allows for such national support elements and equipment. Sharing various technology and expertise with developing nations would raise the standard of the mission.

5. Political: UN Member States

Technologically-advanced states should share their expertise and devices with the UN, though not necessarily the most cutting-edge technologies.

Some technologically-advanced states have continually sought to prevent the proliferation of certain monitoring technologies, fearing that these might fall into non-friendly or enemy hands. One example is the stringent US export control regime on its night-vision equipment.[114] This has prevented UN headquarters from answering calls from field commanders for third-generation NVE. Thus, the UN missions must, at present, be satisfied with the Gen 2+ equipment in UN stockpiles, though more advanced devices may still be brought to the field as contingent-owned equipment.

More generally, some states would not want the United Nations to have greater "information power" that might challenge their intelligence dominance in certain areas. This is particularly true in strategic conflict zones where economic interests are at stake and/or where covert operations are taking place. On the other hand, there are many examples where major powers have shared sensitive information with the United Nations in order to bring about a stronger peace in war-torn regions. This sharing includes imagery from satellites and overflights. When the success of a PKO is in the interests of all Member States, as PKOs most often are, support is often provided.

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[114] To export night-vision equipment from the US to the field, the UN would need an export license from the US State Department under the US Government International Traffic in Arms Regulations (ITAR) rules. The US Government allows Gen 3 technology to be exported to all NATO countries, plus Japan, South Korea, Australia, Egypt, and Israel. So far, the UN Supply section's requests for licences have all been turned down, on the basis that nations other than those listed above might gain access to the technology once it is deployed to the field. The UN currently gets most of its night-vision equipment (Gen 2+) from a Canadian company.

Nations that might possibly play host to future PKOs may harbour exaggerated fears that technology might be used to pry into their affairs, that the United Nations might slip the bounds of proper behaviour by interfering with national sovereignty and possibly engage in dubious or covert intelligence gathering. UN peacekeeping history has few incidents on record of such deviant behaviour. In practice, the United Nations has had the tendency to be overly cautious and sensitive, avoiding anything controversial. Furthermore, the UN can institute internal checks and balances to prevent the potential misuse of monitoring. As noted, the UN is obliged to observe legal prohibitions and international norms.[115]

UN civilian staff are often unaccustomed to surveillance technology. Education on technological means and capabilities is needed.

6. Institutional and Cultural

Amid the tensions of the Member States, the UN Secretariat impressively manages a large number of PKOs in difficult conflict regions of the globe, using troops and civilians from over a hundred disparate nations. With a mixed record of successes and failures in peacekeeping, DPKO struggles to provide the field with the resources needed to do the job satisfactorily, while also developing general policy, doctrine and training materials for PKOs, starting at the basic level.

Field personnel, especially from developed nations, often complain that they are deployed in UN missions without sufficient tools, especially the ones to which they have grown accustomed under national or allied arrangements. As in the case of MONUC, military commanders pleaded for modern surveillance technologies to carry out their ambitious monitoring mandates over vast territories. The UN system at headquarters, which must budget, fund and procure the technology, has often been slow or inadequate in its response. When not all UN actors sense the urgency and they face Member State demands to decrease the overall cost of peacekeeping, it has been difficult to push significant purchases of monitoring technology through the system, despite their potential or proven utility.

The military staff at UN headquarters are generally quite aware of the role that monitoring technology can play in PKOs and sympathetic to

[115] There are examples, however, where nation states have used UN peacekeeping and other operations as a cover to introduce their own intelligence personnel into the mission area. The United Nations Special Commission (UNSCOM) in Iraq, is a most likely case of this. See Scott Ritter, *Endgame: Solving the Iraq Crisis*, New York: Simon & Schuster, 2002.

the calls from the field. Soldiers are accustomed to seeking operational advantages from technology whether in war-fighting or peacekeeping. Officers with NATO experience are aware that the alliance has over a dozen agencies devoted to technology and some 20 military advisory groups and committees to deal with science and technology issues.[116] By contrast, monitoring technologies are foreign to many civilians in the UN Secretariat. Those who have never used or seen them in operation are only vaguely aware of their benefits/limitations and often exhibit a degree of "technophobia." The answer is, of course, to provide more information to raise awareness on technological options.

Some UN officials may also be concerned that Member States would complain that the United Nations was overstepping its bounds in deploying sophisticated watching devices, despite the monitoring mandates. New information gained from technologies may also pressure and raise expectations for the United Nations to respond to early warning signals, removing the option of pleading ignorance about looming threats. In the end, technical early warning signals should help the United Nations to become more proactive and responsive to the needs of Member States and the inhabitants in conflict areas.

Humanitarians speak of the need for "humanitarian space" and worry at possible over-militarization of operations. Some may not be aware that monitoring technologies can also be civilian-run. In fact, humanitarian space relies extensively on communications technologies and many life-supporting devices, such as water purification units. Using cameras instead of heavily armed soldiers can even reduce the level of military presence. The step to civilian or appropriate joint civilian-military technology should not be difficult.

7. Financial

The cost for most monitoring devices is no longer a major obstacle. Prices have plummeted in recent years due to advances in science and technology, as well as the growing commercial market. At the very-low-

[116] NATO technical bodies include: the Insensitive Munitions Information Centre (NIMIC); Military Telecommunications and Communications and Information Systems (CIS) services agencies, Naval Forces Sensor and Weapon Accuracy Check Sites (FORACS), as well as the Research & Technology Organisation (RTO) and military advisory groups and committees such as the Industrial Advisory Group (NIAG), the Science Committee, the SHAPE Technical Centre (STC), and the NATO Training Group (NTG).

The costs to purchase most devices are not prohibitive.

The costs to operate *and* maintain *"high tech" monitoring equipment can also be accommodated within most mission budgets.*

The UN would need to examine the comparative costs for (1) purchase versus (2) lease, and whether to use operators who are (3) UN personnel or (4) national (TCC) personnel or (5) contracted operators.

cost end, motion detectors/illuminators can be obtained for as little as US$20 and solar-powered versions are available at less than $90 per unit. This makes them cheap enough to use widely in refugee camps and even unattended places. Theft could be a problem, but at this low price, there is little lost.

Medium cost items, such as video cameras (typically $2,000-3,000 each) for CCTV systems and night-vision devices ($2,000 for Gen 2+ goggles) are well within normal discretionary budgets, as are hand-held metal detectors ($1,500) and acoustic/seismic systems ($1,500 for a set of a dozen sensors). Satellite imagery ($300-3,000 per image) becomes costly only when purchased in quantity or in near-real-time. Thermal (far-infrared) imaging devices are more expensive items (over $5,000) and X-ray screening machines considerably more (over $25,000), as are various ground/aerial surveillance and artillery location radars (over $30,000).

The purchase of the devices, however, is only part of the overall cost, which must cover the entire life cycle of the equipment. This includes procurement, transportation, installation, maintenance, repair, storage and disposal. Fortunately, the United Nations has become much better at equipment management over the past 10 years, including the better inventory methods and maintenance capabilities at the UN Logistics Base in Brindisi, Italy.

The most expensive types of surveillance are those involving manned aircraft (typically $1,000-2,500 per hour of flight for a wet-lease). When MONUC sought a commercial airborne surveillance service, DPKO budgeted $5 million per year, though the system has yet to be deployed. If extensive use is to be made of aerial reconnaissance in several missions over several years, it would be more cost-effective for the United Nations to procure one or more small aircraft and train its own civilian crews.

For Unmanned Aerial Vehicles (UAVs), the United Nations might, at first, rely on certain TCCs who are rapidly gaining experience in deploying UAVs to peace operations. For instance, Belgium has deployed UAVs in Bosnia and the DRC. As mini-UAV costs decrease and capabilities increase, the United Nations could consider purchasing some in the future.[117] A set of three mini-UAVs could be purchased for less than an annual dry lease for one manned aircraft.

[117] The UAV would also need a nation to certify the airworthiness of the UAVs, possibly the nation that produces the UAVs.

More challenging than equipment costs, however, can be the development of specialized *training* programmes for UN personnel to operate the more advanced equipment. As mentioned, data analysis also requires trained specialists and even relatively simple systems, such as the ones used for X-ray screening, require several weeks of training and testing.[118] This is necessary for the equipment to become part of a standing "UN capability."

The use of TCCs or wet-lease contractors allows the training to be done outside the United Nations, though the loans/leases may be more expensive than UN-owned and -operated equipment.[119] When the UNIFIL mission in Lebanon was substantially expanded and upgraded after the July-August 2006 war, the UK offered to provide high-ticket AWACS[120] surveillance aircraft, Germany deployed frigates to patrol the coastline in Mediterranean Sea and the French sent a squadron of advanced UAVs. (The full cost to lease such items would be millions of dollars a month, so the United Nations agreed to pay only a relatively small portion of the real cost.) By comparison, the cost of the UN equipment discussed above is small.

Monitoring equipment costs are currently not even 1% of UN missions costs, though monitoring is an essential if not primary function. The monitoring equipment costs are also small in comparison with the amounts the UN currently pays for aerial transport and personnel costs.[121] The United Nations is spending about $5.2 billion in 2006-07 on peacekeeping. By contrast, a substantial increase in monitoring equipment in several missions could be gained with only several million dollars. In short, the financial aspects of monitoring technology should not pose a significant obstacle.

8. Other Problems, Pitfalls and Hazards

In general, some additional problems can be associated with technical monitoring:

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[118] MONUC procured X-ray machines at a cost of over half a million dollars for baggage-handling at the MONUC-run airports in the DRC. Many months after they were installed at airport departure areas, they had not been brought into use because the local personnel had not been trained to operate them.

[119] For instance, the UN pays over $8,000 per month for two Ground Surveillance Radars used by the Quick Reaction Force (QRF) in the United Nations Mission in Liberia (UNMIL).

[120] Airborne Early Warning and Control System (AWACS) aircraft cost over $200 million each to procure and between $10,000 and $25,000 per hour to operate. Source: www.carc.org/pubs/v14no4/4.htm.

[121] It is estimated that one half of MONUC's annual budget of $1.1 billion is spent on aircraft and fuel.

– Over-reliance. If the United Nations were to become largely or uniquely dependent on technology, it could become vulnerable. If devices break down, experience a failure (e.g., of electric power) or provide false information, the United Nations could find itself in difficult situations. Thus, there is a need for constant testing, evaluation and cross-referencing with other sources, and creating natural redundancies in the system. Direct human observation must continue to play the major part in the UN's information-gathering efforts.

– Countermeasures. Some technologies are susceptible to countermeasures that parties may take to evade detection. For instance, overhead nets can be purchased to camouflage against night surveillance, and GPS signals can be jammed. The UN should be aware of these possibilities, but most of the potential adversaries are not capable of such countermeasures.

– Industrial lobbying. Already DPKO finds itself the target of lobbyists and commercial vendors who seek to promote their wares. Technologies cannot be justified for their own sake. They need to fulfil a definite purpose in peacekeeping (see Chapter 3). Commercial agents with past or present links to the organization may seek to exert undue influence on technology purchases. Given the strong defence lobby in some countries, particularly the UN's host country, it is likely that a more technological UN would find itself the object of greater lobbying. This could have the side benefit of increasing the awareness about technologies, although with some nuisance.

– "Middleman" corporations. An integral part of the defence lobby, such firms often charge substantial mark-ups for coordinating delivery of products produced by others. This sometimes results in cost inefficiencies and a lack of direct accountability.

The human dimension must always remain front and centre. Technologies are merely tools that can help peacekeepers gain situational awareness and serve more effectively.

7. CONCLUSIONS AND RECOMMENDATIONS

> The League of Nations … should be the eye of the nations to keep watch upon the common interest, an eye that does not slumber, an eye that is everywhere watchful and attentive.[122]
>
> — US President Woodrow Wilson, Paris Peace Conference, 25 January 1919

International organizations (and monitoring technologies) have come a long way since Wilson's visionary statement of 1919! The United Nations, the League's successor, has gained more experience as an official third-party monitor of peace agreements than any other organization in history. But the UN is still far from having an ever-watchful and attentive eye, even in its peacekeeping operations where it has an explicit mandate for observation and verification.

In recent decades, technological progress has also been evolutionary if not "revolutionary"—especially in the digital and information domains—offering the United Nations an array of monitoring systems that are continually increasing in capacity and decreasing in cost. This study has examined these technologies, reviewed relevant UN experience and explored the potential benefits and drawbacks of technical monitoring, including the operational, legal, political, institutional and financial challenges. From this work, four conclusions can be drawn.

Conclusion 1: There is no "technological fix" to the problem of human conflict. Technology, however, can be of immense value in monitoring, preventing and mitigating conflict, especially as a cease-fire or peace agreement is being implemented.

Conclusion 2: Technical monitoring can increase the safety and security of peacekeepers as well as the effectiveness of their mission.

Technology offers possibilities for wide-area, high-resolution and continuous surveillance to identify threats to personnel and the mission. It permits monitoring of dangerous areas, where it would be unsafe or unwise to send human observers. Aerial surveillance offers vast opportunities for rapid and remote monitoring of otherwise inaccessible areas. Night surveillance, a traditional lacuna in UN peacekeeping, is possible with modern devices. Also, imagery can be disseminated rapidly for early warning and in-depth analysis, and as evidence in future legal or other proceedings. In complex multidimensional PKOs, technologies can help fill the "monitoring gap" between UN capacities and the demanding mandates given to field operations.

[122] "Protocol of a Plenary Session of the Inter-Allied Conference for the Preliminaries of Peace, January 25, 1919" in Arthur Link, *Papers of Woodrow Wilson*, vol. 54, p. 265.

Conclusion 3: The UN currently lacks the equipment, resources, preparation/training needed for an effective and efficient use of modern monitoring technology, relying instead mainly on primitive or obsolete methods and devices.

A review of UN experience in technology shows that the organization has used *some* monitoring technologies in *some* missions but mostly in an *ad hoc* and *unsystematic* fashion. For example, ground surveillance radar is currently deployed by only one unit in only one mission.[123] The United Nations has begun to employ digital cameras in recent years but this is not regular practice or doctrine. The UN has yet to deploy remote-controlled video cameras to monitor hot spots.[124] (The parties to the 2006 Nepal peace agreement have asked for video monitoring of weapons cantonment sites.) The UN owns some four hundred image intensification systems for night viewing, but these are older (second-) generation devices, not coupled with cameras for recording and too few in number to meet the need. Thermal imagers are not in the UN stockpile. The United Nations has no direct experience with seismic or acoustic ground sensor systems. Furthermore, the organization does not routinely deploy motion sensors, a simple, cheap and readily available technology.

Deploying various sensors (e.g., infra-red and radar systems) on advanced mobile platforms, such as light reconnaissance vehicles and unmanned aerial vehicles (UAVs) offers great benefits. But the UN does not deploy these standard sensor systems in its operations. In fact, UAVs have yet to be deployed, though they were brought by a partner (EUFOR) to temporarily support the UN operation in the DRC in 2006.

More alarmingly, there is an absence of policies, doctrine, Standard Operating Procedures (SOPs) and training materials regarding high-tech monitoring equipment. For example, the UN has no policies or procedures for any type of radar use—neither for aerial or ground surveillance, nor for artillery location or underground probing. The equipment guidelines in the draft SOPs, which were written for traditional peacekeeping, are out of date by at least a decade. They have not kept up with either technological advancement or the more proactive UN approach used in some field missions.

Fortunately, a framework has been established in recent years to create, update and improve DPKO policy directives and peacekeeping doctrine. This could be of immense help as new technologies and policies are being considered, tested and deployed.

Because of the UN's "relative backwardness" in military deployments, many developed nations prefer to deploy their forces under other organizations and alliances (e.g., NATO and coalitions of the willing). In order to encourage these nations to re-engage in UN peacekeeping,

[123] The Quick Reaction Force in the United Nations Mission in Liberia (UNMIL). It is also likely to be deployed to the United Nations Interim Force in Lebanon (UNIFIL).
[124] The UN Peacekeeping Force in Cyprus is also setting up a CCTV system on the Green line.

the United Nations and its Member States should provide or permit the deployment of at least some of the advanced tools that have long been a standard part of modern militaries.[125]

Conclusion 4: The United Nations has proven capable in the past of incorporating some new and relatively advanced technologies into its operations.

The United Nations has developed a communications and information technology system that is world-class. Given the difficult environments in the field, and the urgent demands for instantaneous communications, the UN has achieved, if not set, a global standard for rapid CIT deployment to remote areas.

In monitoring technology practice, there are also several success stories. The Carlog system is deployed in many PKOs to determine where UN vehicles have been and how they have been handled, thereby reducing accidents, improving accountability and increasing efficiencies in time and fuel. (Real-time tracking is an option that could be pursued in the future for high-value or high-risk vehicles or convoys.) Similarly, the UN's capacity to use Geographic Information Systems has increased dramatically in the past half-decade, though much more can be done. High-resolution commercial satellite imagery (including that supplied through UNOSAT) is now routinely used to create more accurate and up-to-date maps. Also, aerial reconnaissance has been deployed in several missions to great effect. For instance, forward-looking infra-red devices in helicopters in the Eastern DRC and East Timor have helped save the lives of peacekeepers. UAVs and radars were brought into the United Nations Interim Force in Lebanon in 2006 by TCCs, mostly under the national support element.

More generally, the United Nations has built up extensive experience with general equipment handling and accounting in PKOs—whether UN-owned or contingent-owned. For instance, the system of inspection for contingent-owned equipment in the field is well-established and should be capable, with improvements as noted below, of handling more advanced technologies.

The present study has shown that monitoring technologies are not yet "tools of the trade," but they can and should be. To accomplish this, a conscious effort by DPKO, with the support of Member States, is needed to incorporate appropriate technologies into PKOs, and to raise technical awareness and standards generally. The following are some recommendations to expedite UN progress in this area.

[125] In Western military jargon, commonly referred to as ISTAR, "Intelligence, Surveillance, Target Acquisition and Reconnaissance."

Recommendation 1: *Update, develop and improve UN policies, doctrine and training materials to incorporate appropriate monitoring technologies.*

The generic documents used in the development and implementation of PKOs, such as the Standard Operating Procedures (SOPs) and the Table of Organization and Equipment (TOE), should be updated to include modern monitoring technologies. This would also help create a more advanced "common operating paradigm" for technical monitoring. Similarly, a discussion of technologies should be added to the Handbook on Multidimensional Peacekeeping[126]. Furthermore, a new training document could be produced to describe the range of possible technologies, including night-vision devices, radars, seismic and acoustic sensors, as well as aerospace reconnaissance.

To engage Member States in a dialogue on the issue, as the C-34 has requested, DPKO could organize seminars for both military and civilian personnel. For instance, the military and police advisers community (MPAC) is one appropriate forum for DPKO and governments to discuss possible technological contributions to specific missions and to peacekeeping in general.

To help plan specific operations, a "menu document", containing a list of technologies could be developed to supplement the TOE. From such a list, the appropriate technologies could be incorporated into the Concept of Operations and Force Requirements for specific missions.

Recommendation 2: *To gain experience, the UN should test, deploy and evaluate sensor suites on a trial and operational basis.*

To evaluate which sensors are the most appropriate and effective under various circumstances, the UN's peacekeeping department could select one or more regions in selected PKOs to incorporate a variety of technologies from different vendors. Once installed, the UN could evaluate the increase in situational awareness. For instance, video surveillance equipment and unattended ground sensors could be deployed to monitor potential hotspots. A slightly more expensive approach would include thermal imaging cameras for night activities of concern.

To better prepare UN troops, military observers, police and civilians for deployments to new or rapidly changing areas, the standard procedure should be to provide peacekeepers with ground, aerial and/or satellite images and access to a GIS database of mission information to give them a greater sense of terrain, locations, events, etc.

In the few cases where the UN has already deployed technologies in the field, assessments should be made of the impact and effectiveness of these technologies. At present, there is no program in place to systematically conduct such evaluations. The COE system

[126] *Handbook on United Nations Multidimensional Peacekeeping Operations*, New York: DPKO Peacekeeping Best Practices Unit, December 2003.

provides for inspections to verify if designated equipment is functional, not if it is being effectively used. The Peacekeeping Best Practices Unit (PBPU) of DPKO could conduct a more operational survey of current practice along with lessons to be learned. Case studies, similar to the one presented in Annex 1 (on MONUC), would help develop practical knowledge.

In missions where there is already a clearly enunciated demand for technology, such as in MONUC for aerial surveillance over the Eastern DRC, the UN could implement a trial program for a year. If successful, the capacity could be continued in subsequent years and eventually even handed over to the host state. More generally, in MONUC, DPKO should revisit and implement the recommendations of the Joint Assessment Mission (JAM) on surveillance assets.

Recommendation 3: *DPKO should identify TCCs that are capable of providing monitoring equipment and expertise. It could invite them to share some of their technological expertise and experiences.*

Some developed nations might prefer to offer specialized expertise rather than large numbers of troops to PKOs. A small number of specialists equipped with advanced technologies can make a significant impact on a mission. Such countries need to be approached and their capacities evaluated, prior to formal requests being made. DPKO could make a survey of such technologically equipped nations.

The use of contingent capacities makes more sense for larger-ticket items, where the cost to purchase and operate sophisticated monitoring systems would be prohibitive. However, when a TCC is not available, a turn-key outsource vendor could be sought.

In general, the UN has yet to move from personal equipment (e.g., night-vision goggles) to mission-operated and crew-served monitoring systems like unattended sensors and radars that offer the benefits of round-the-clock surveillance.

Recommendations 4: *Revise and update the Contingent-Owned Equipment (COE) Manual so that the requirements are clearer, more detailed and more specific.*

The important COE Manual provides the basis for the Memorandum of Understanding between the UN and TCCs. The 2005 Manual includes the most detailed treatment of monitoring technologies of any UN peacekeeping document, but there is still much to correct and improve.

In the self-sustainment category, the categories of Observation and Identification are poorly defined, leading to many uncertainties. Nations and even COE inspectors do not know what quantity or quality of equipment is required to meet the vague COE standards.[127]

[127] The COE Manual does not give any sense of the number or type of night-vision devices, and does not specify how this issue is to be resolved (e.g., through mission-specific standards). The Manual, for instance, makes no

When the 2008 review of the COE Manual is conducted by the COE Working Group, these monitoring technology sections should be re-written to provide more detail and precision to remove ambiguities. An annex should be added to these sections to list specific requirements. In the interim, UN field missions should specify and clarify their observation and identification requirements to set specific mission standards to meet the mission objectives.

Recommendation 5. *Build on recent progress in developing Geographic Information Systems (GIS).*

The Cartographic Section at UN headquarters and the GIS units in the field produce excellent-quality paper maps, using modern software and advanced (in some cases high-resolution) satellite imagery. But the UN has yet to move from cartography to geomatics, in which users in the field can access and update maps and other information through electronic databases. If users could input data directly into networked databases, a new wealth of detailed and up-to-date geospatial information would become available. For example, UN military observers (UNMOs) could submit electronic reports to a centralized database, allowing future observers and visitors to view all previous reports relating to specific villages or areas. For such types of applications, commercial GIS database software, with user-friendly interfaces for input, is now widely available.

The UN lacks a centralized database (or even a catalogue using thumbnails) of the imagery that is ordered commercially and the GIS paper products that are produced. The DPKO intranet, established in 2006, could serve as a platform for the database, providing access mission-wide and at UN headquarters. Other DPKO databases are well established.[128]

Recommendation 6: *Include imagery in UN reports, both still and links to video, and primary source data access.*

Peacekeepers are only beginning to incorporate digital (still) imagery in the reports of their patrols, visits or after-action reviews of operations. This practice is not yet used in the Situation Reports (Sitreps) that are sent to UN headquarters. In the future, imagery could be included through links to GIS databases from which analysts both in the field and at UN headquarters

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distinction between image intensifiers and thermal imagers. Similarly, the recording devices listed in the Identification category are not defined. Indeed, the section title "Identification" is a misnomer; it should really be titled "Recording" since it is about capturing images for processing and dissemination. The section could, at least, list the capability for recording night-vision images. Being the result of outdated versions, the 2005 COE Manual does not recognize the new capacities of digital cameras or the ability of computers (e.g., laptops) for storage, photo editing and databasing.

[128] The COE unit has a well developed COE database that is accessible from the field, incorporating scanned copies of all the MOU with contributing states, for consultation by COE inspectors, and the verification reports from COE inspections.

could get a clearer picture of conditions and activities in the field. Video clips could also be included, provided wider-bandwidth communications channels are available. To gain maximum benefit, experts in image analysis should be deployed to the field, particularly within the JOC and JMAC structures.

Recommendation 7: *Increase the capacity of UN headquarters to select, stockpile and maintain technologies and apply truly innovative methods of technical monitoring.*

The UN need not become self-reliant in all technologies because TCCs and contractors can help fill the gaps, but it should have a basic stockpile upon which to draw. For instance, it should increase the number of night-vision goggles (currently under 400) for quick deployment and for contingents that are not able to bring NVE that are up to mission standards (of course, losing the COE reimbursement for that category). The stockpile should include thermal imagers and third-generation image intensifiers. To procure such devices, it may be necessary to obtain export licenses from some leading manufacturing states. The Member States should be able to grant special permits to the United Nations, given that the equipment is for peacekeeping.

A small team of individuals at headquarters could be employed by the UN to gain familiarity with monitoring methods and technologies. These could be part of a new monitoring technology service or technology support office. This resident capacity could keep abreast of recent advances in technology. The unit could fill the need at UNHQ in much the same way that the communications and information technology service (CITS) does for that function. The individuals could also become familiar with the specialized technological capacity of national contingents, so that they could advise on which nations to approach for technical contributions. For UN equipment purchases, they could develop specific selection criteria, including the principles of modularity and flexibility, so that equipment can be moved between missions, as conditions warrant.

Such a UN team of technical experts would create institutional memory on technical monitoring, so that lessons learned about equipment and techniques could be applied to future operations. The team could conduct capability/equipment performance reviews, so that better sensors could be purchased. They could also assist with technical assessments during mission start-up.

These individuals could also help UN officials and conflicting parties, when requested, to incorporate optimal technical monitoring solutions into the design and implementation of peace agreements. They could help explore cooperative monitoring, by developing protocols for regular sharing of technical results with parties.

With a host of activities to monitor, from elections to disarmament to sanctions to a myriad of threats, the world organization needs to broaden its technology base and explore innovative monitoring strategies. While technical monitoring is only one component of a UN operation, it gives the United Nations greater "information power" to keep the peace. Monitoring technologies are legitimate tools, legal under international law, which host states and conflicting parties should welcome because they allow the UN to do a more effective job as an impartial observer of commitments, thereby creating a more sustainable peace. These devices can also make the UN's civilian and military officials safer in the field. Finally, technology could help the United Nations take a more proactive approach—moving from a "culture of reaction" toward a "culture of prevention." For such proactive peacekeeping, superior situational awareness is essential. Monitoring technologies are particularly important tools of this trade. They can help the UN develop a much more watchful and attentive eye in its many operations for peace.

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Annex 1. Case Study: Technical Monitoring in the Congo from ONUC to MONUC

In 1960, the United Nations embarked on what would become its most ambitious mission of the Cold War: the Opération des Nations Unies au Congo (ONUC, 1960-64). With the goal of preventing secessionism and providing security in a country filled with mutinies and warring factions, while also helping the newly independent state to establish a foundation, it was the UN's first multidimensional operation. The ONUC leaders quickly realized the requirement for a dedicated system of information collection and analysis. In 1961, a military information branch (MIB) was created within the mission under former Scandinavian military intelligence officers to gather information using an unprecedented number of sources and methods. This included information gained on patrols and supply flights, dedicated aerial reconnaissance, wireless-message interception (including code-cracking capabilities), interrogations of captured mercenaries (conducted according to the Geneva conventions), and informants (some of them privately paid).[129] The United Nations had to relearn many of the lessons from ONUC after it became engaged once again in the Congo some thirty-five years later.

In 1999, the UN was back in the DRC under a new name, MONUC, to deal with similar problems. The problems and challenges facing MONUC exemplify modern multidimensional and robust peacekeeping in war-torn nations. MONUC is the largest and costliest of current PKOs with over 22,000 personnel including 17,300 military and a budget of over $1 billion annually.[130] MONUC must cover the huge territory of the DRC (2.3 million km^2), a central African country with little local infrastructure—less than 500 kilometres of paved roads in a territory the size of Western Europe. More importantly, it is a "flagship mission" in that it covers the spectrum of mandates and functions assumed in multidimensional peacekeeping. Its tasks have included: helping implement peace agreements, overseeing a referendum and elections (the largest elections in the history of the United Nations, with over 25 million registered voters), a large program of disarmament, demobilization and reintegration (DRR) of ex-combatants as well as repatriation of foreign combatants, human rights monitoring in a country filled with violations, demining and removal of unexploded ordnance, managing delicate political negotiations for power-sharing, security sector reform across the range of agencies and a great many other nation-building tasks. As a robust operation in dangerous areas, it also finds itself engaging in combat operations against militia that oppose the government and continue to attack towns in the Eastern DRC. This latter trend towards robustness began in earnest after the traumatic experience in Ituri.

As MONUC took an increasingly robust approach after local massacres in 2003, it managed to acquire observation and attack helicopter units from India that immediately proved their worth. They were, however, not permitted to fly at night, and were too few to cover the vast territory or fulfil the great need. The infiltration routes for arms and fighters from neighbouring countries were still not monitored.[131] While some rebel leaders had been apprehended and sent to the International Criminal Court (ICC) in 2004-06, many others were still roving the land with their bands. The United Nations was not able to keep up with their movements or prevent their

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[129] A. Walter Dorn and David H. Bell, "Intelligence and Peace-keeping: The UN Operation in the Congo 1960-64," International Peace-keeping, Vol. 2, No. 1 (Spring 1995), pp. 11-33.

[130] Figures as at 31 October 2006, found at www.un.org/Depts/dpko/dpko/bnote.htm, accessed 30 December 2006.

[131] The Security Council requested MONUC "to inspect, without notice as it deems it necessary, the cargo of aircraft and of any transport vehicle using the ports, airports, airfields, military bases and border crossings in North and South Kivu and in Ituri" and authorized the mission to seize illegal arms and related materiel (resolutions 1593 of 12 March 2004, supplementing resolution 1493 of 28 July 2003).

pillaging and human rights abuses. Many Cordon and Search Operations (CASO) proved fruitless. Over time, the mission began increasingly robust operations under Chapter VII of the Charter.

MONUC created its Eastern Division in 2005—the first time a PKO included a division-sized component—with the Security Council's support to bring more law and order to the East. Despite the large number of UN troops (13,000) in the East, MONUC's monitoring and reaction capacity was far from satisfactory in the vast and volatile territory. The leaders began to call for more technical means.

At UN Headquarters, the Military Planning Division of DPKO sought to find ways to fulfill the surveillance gap.[132] In April 2005, the Military Division sent a Joint Assessment Mission (JAM) to the DRC to identify "the exact nature of the surveillance assets" that were needed. The JAM made a candid assessment of the capacities and needs of MONUC, concluding that "the force never had any structured information collection assets other than the eyes and ears of the soldiers and military observers on the ground."[133] It recognized a "total lack of tactical mapping at all levels" and that MONUC had "no airborne *imaging* capability at all, and no night surveillance capability." The JAM suggested that "a stock of NVD [night-vision devices] could also be available for loan to the contingents that either have few or do not have such devices in national inventories to meet the operational requirements."

Neither the Government nor MONUC had resources to survey, let alone control, the country's airspace. Commercial aircraft travel in the East depended on the limited air traffic control (ATC) provided from neighbouring countries. To complicate matters, hundreds of landing strips, built in the Mobutu era, were available for arms smuggling with little chance of detection—the United Nations could not afford to place UNMOs at such a large number of landing strips. The JAM therefore recommended the acquisition of three mobile surveillance radars, with an effective range of 150-250 kilometres each, "to provide timely warning to enable airborne operations against smugglers."

To monitor and prevent the movements of militia from and to neighbouring countries, it also recommended that DPKO arrange for man-portable ground surveillance radars to supplement foot and vehicle patrols. The lakes on the eastern border (Kivu, Albert, Edward and Tanganyika) were patrolled by stretched riverine units, who were not able to detect or interdict arms smugglers. The JAM recommended mobile maritime radars and night-vision devices capable of detecting smugglers who used makeshift canoes and small motorboats.

In urban environments like Kinshasa, the JAM concluded that MONUC needed surveillance helicopters to provide warnings about dangerous crowd movements in cities. In Kinshasa, large areas were placed out of bounds to MONUC personnel, so these also called out for aerial surveillance.

Aerospace imagery was much needed since the printed maps of the DRC were old and large scale. Often MONUC staff had to draw their own maps by hand. The JAM recommended that a contributing country be approached to provide accurate (1:50,000) maps, which one country soon did. The JAM also envisioned that imagery from satellites and aircraft could help with terrain familiarization, operational planning (e.g., placement of troops in cordon and search operations), and general surveillance and oversight. Such near-real-time imagery did not become

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[132] The Military Planning Division recommended the establishment of a "Technical Assessment Mission" on 23 July 2004. The Joint Assessment Mission (JAM) visited the DRC from 11 to 19 April 2005. It was composed of representatives from DPKO and several TCCs.

[133] JAM report, *ibid*., p.2.

available to MONUC. The JAM recommendations and the current status (2007) of implementation are summarized in Table A1.1.

To punctuate the problem, MONUC suffered several deaths. Investigations showed that MONUC lacked even a basic awareness of the militia position, strength, equipment, mobility, logistical resources, commanders, organization and intents.

Engaged in robust peacekeeping without the full complement of tools, MONUC's Eastern division commander strongly supported the conclusions of the JAM. In June 2005, Eastern Division Commander General Patrick Cammaert declared a "critical shortfall in dedicated surveillance and intelligence-gathering assets with sufficient reach to provide commanders with accurate, timely and comprehensive intelligence ..."[134] He identified an urgent requirement for "an aerial surveillance platform with the ability of near real-time enhanced video, geo-coordinated reference data, thermal imagers, and compatible downlink for communications down to the tactical level." In response, UN headquarters approved a $5.8 million budget item for aerial surveillance and initiated a bidding process.[135] But, to the frustration of the mission leaders, UN headquarters could identify no compliant or suitable bids from industry.[136]

MONUC today is enjoying more capacity and has had some remarkable successes. It has engaged in extensive Cordon and Search Operations (CASO), Mobile Operating Bases (MOB), surgical operations using night-vision equipped special forces. With capabilities for night flying, its attack helicopters were able to support many ground initiatives to prevent militia atrocities. In November 2006, it was able to halt an attack on the town of Goma. Also in 2006, MONUC enabled the largest and most complex elections ever overseen by the United Nations, allowing millions of voters to go to the ballot boxes in relative peace. In the DRC, monitoring technology is already making a difference, and field commanders continue to call for more.

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[134] E-Div Commander (Cammaert) to MONUC Force Commander, "Headquarters Eastern Division Requirement," 24 June 2005.

[135] The UN budgeted $5.83 million for an "airborne surveillance system" for MONUC for 2006/07. The request was advertised by the UN Procurement Service (www0.un.org/Depts/ptd/2007_monuc.htm, accessed 29 December 2006).

[136] MONUC leaders felt the firm Airscan, which had earlier approached them to provide such a service, would have been satisfactory, but the firm was deemed non-compliant in New York because some of its services had been used by governments in South America and Africa to commit human rights abuses (see en.wikipedia.org/wiki/AirScan).

Annex 2. Surveillance Asset Requirements of MONUC: a summary of the findings and recommendations of the Joint Assessment Mission (JAM) and subsequent actions taken.[137]

	Current condition	Recommendation	Action
Mapping	"a total lack of tactical mapping at all levels throughout the Force"	"approach member states for release of existing maps or mapping data covering the East DRC ... MONUC's GIS to update it."	A Member State provided 1:50,000 maps; GIS Unit used the data
Aerial surveillance	"With the exception of one flight of Indian Alouette III helicopters, MONUC has no dedicated aerial surveillance capability. It has no airborne imaging capability at all, and no night surveillance capability."	"The provision of day and night aerial surveillance assets would have an early and positive impact ...", UAVs for local surveillance and overwatch of operations.	UAVs deployed temporarily (2006) in Western DRC by EUFOR during elections period
Airspace surveillance	MONUC needs a capability to monitor/control the airspace in eastern DRC. However, "there is no functioning airspace coordinating authority in the DRC, and MONUC does not have the resources to the control the airspace in the East."	"deploy three mobile air surveillance radars on wheels for temporary surveillance of selected airspace."	Discussions ongoing to provide airports with radar sets for dual use (transport/aerial surveillance)
Ground surveillance	"ground surveillance radars would provide some capability to monitor major infiltration routes through the border and the plains ... none of the units are equipped with adequate NVD."	provide man-portable ground surveillance radars ... a stock of NVD could also be available for loan.	No action
Lake surveillance	Illegal smuggling and movement of militia are "unquantified due to limited surveillance assets."	Provide optical surveillance and night vision devices, mobile maritime radars for lakes.	Improved equipment obtained
Urban surveillance	MONUC requires a capability for crowd warning and movement monitoring ... MONUC has no police surveillance patrols by helicopters fitted with adequate sensors.	Redeploy surveillance helicopters to Kinshasa, when required, to support crowd control operations.	Temporary redeployment of helicopters was done in 2006 during critical periods
Other	Commercial Satellite Imagery (CSI) needed at 1-15 metre resolution.	Establish structure of acquisition and distribution and funding of CSI.	GIS unit orders CSI routinely but response is not fast enough for current ops

[137] This is not a complete list. Some monitoring requirements have been omitted.

Annex 3. Possible sensing techniques for peacekeeping, categorized by type of signal detected

TECHNOLOGY	*QUANTITY MEASURED*	*EXAMPLES OF USE*
Electromagnetic Sensing (Passive)	Electromagnetic radiation, emitted or reflected, of wavelength …	
Visible light imaging (using film or charge-coupled device (CCD))	0.4–0.7 µm	Photograph or video troops, tanks, vehicles in a demilitarized zone
Infrared (IR) imaging (i.e., heat sensing)		Locate operating vehicles, warm bodies moving across cease-fire lines at night, aid to patrols
Near infrared	0.7–1.4 µm	
Short wave (SWIR)	1.4–2.0 µm	
Mid wave (MWIR)	3.0–5.0 µm	
Long wave (LWIR) of far-IR	9.0–12.0 µm	
Radiowave monitoring	>30 cm (HF: 3-30 MHz; VHF: 30-300 MHz)	Receive and monitor radio communications
Electromagnetic Sensing (Active)	Electromagnetic radiation, originating from the sensor system and reflected by object, in the wavelength range …	
LIDAR (LIght Detecting And Ranging)	0.4–1.1 µm	Determine vehicle speed, location of combatant's positions
RADAR (RAdio Detecting And Ranging)		
Ground Surveillance Radar (GSR)	10-30 cm (X-band: 10 GHz; K-band: 24 GHz; Ka band: 33-36 GHz)	Detect person entering monitored zone
Ground Penetrating Radar (GPR)	2-10 m (30-150 MHz, typically)	Find buried weapons or mass graves
Doppler Radar	0.1–100 cm	Determine vehicle speed
Synthetic Aperture Radar (SAR)	3–50 cm	Spot weapons and deployments, day and night & in all weather conditions
Aerial Surveillance Radar	3–50 cm (e.g.)	Detect planes violating no-fly zones
X-Ray detection and imaging	0.03-3 nm	Identify weapons inside metal/wooden cases or beneath personal clothing
Magnetic (and Quasi-Static Electric Field) Detection	Magnetic field perturbations due to large ferromagnetic objects	Detection of mines in fields; vehicles passing on roads
Acoustic Wave Sensing		
Seismic sensing (long-range) using a seismograph	Elastic waves traveling through Earth's interior and along its surface	Underground explosions (e.g., in explosives testing and in mining)
Seismic detection (short-range) using a geophone	Elastic waves traveling along Earth's surface	Detect vehicle or combatant intrusion into restricted areas
Sonar (SOund Navigation And Ranging) detection	Acoustic waves, in water, of wavelength 10 cm-1 km (passive) 0.1–30 cm (active)	Observe ship passage into restricted areas or presence of sea-mines
Ultrasound probing	Sound waves frequency >20 kHz	Probe artillery shells for chemical weapons' agents
Microphone	Sound waves in air of frequency 20Hz-20kHz (wavelength 1 cm-20m)	Determine which side/party fired first; provide alert if tanks are traveling along roads or removed from storage
Pressure and Strain Sensing	Pressure (or strain) applied on contact with …	
Strain sensitive cable	a cable (fiber optic or piezoelectric cable or pneumatic tube)	Detect vehicles moving on monitored roads, e.g., before or near checkpoint
Weight scale	plate	Weigh truck or tank passing atop scale for sanctions monitoring

Annex 4. Summary of the benefits of various monitoring technologies[138]

	Benefits
Video monitors - Videocameras - Web cameras - Closed-circuit Television - Digital video networks - Aerial and space-based	- Supplements observation with the human eye - Zoom capability for higher resolution - Monitor current conflict zones onsite, from air or a remote location - Spot approaching threats in daytime and illuminated areas at night (e.g., in UN compounds) - Verify commitments made in peace agreements, spot violations of human rights - Detect activities, incl. malicious acts, smuggling or sanctions evasion - Share imagery in real time or in reports - Record events for future analysis or for use as evidence in commissions or tribunals
Night-vision - Image Intensifiers - Thermal Imagers	- As above but at night - Allows for night patrols and monitoring of illegal movements of arms and personnel at night (incl. sanctions evasion and preparations for attack) - Thermal imagers can operate in complete darkness while Image Intensifiers require some ambient light (e.g., moonlight)
Motion detectors	- Detect approaching humans or vehicles, esp. at night - Activate cameras, illuminators and/or alarms
Radars - Air surveillance - Artillery locating - Ground surveillance - Ground penetrating - Synthetic aperture - Marine - Weather	- Day and night - All weather conditions - Detection and/or imaging of aircraft (ASR), ground vehicles or boats and individuals - Locating the origins of artillery fire - Discovery of buried weapons or mass graves (GPR) - Warning of oncoming storms or turbulence
X-ray machines	- Examine baggage for dangerous/prohibited items such as weapons
Acoustic sensors	- Small arms fire detection and localization - Movement of persons or vehicles
Seismic sensors	- Geophones (for personnel/vehicle detection) - Seismic arrays (for explosion detection)
Chemical sensors	- Detect explosives
Metal detectors	- Handheld wand to check for metallic weapons - Mine detector
Pressure transducers	- Intrusion alarms - Road monitor
Radiowave monitoring	- Signal locating equipment - Radio scanners / signal monitoring
Positioning and tracking systems	- Global Positioning System (GPS) to determine location of observer or of distant objects (using laser range finders) - Transponders and tags to relay position to remote monitors - Radio-frequency identification (RFID) to identify equipment (incl. stored weapons)

[138] Other technologies, less likely to be used in peacekeeping, include: sonar, ultrasound, LIDAR, taut-wire fences, IR break-beam detectors, seals and tags. Nuclear detectors (Geiger counters) are needed only when nuclear materials present a danger.

Annex 5. Summary of Current and Potential Monitoring Technology Use in UN Peacekeeping

	Types	Current UN Activities	Potential UN Activities
Video	Videocameras	- Used only in an *ad hoc* fashion in some missions - Private equipment often employed - No systematic plans, policies or guidelines for use	- Use routinely on patrols and in observation posts (OPs) - Use in an unattended fashion - Specialized cameras in aircraft - Record violations or rights abuses - Maintain database of important clips
	Closed-circuit television (CCTV)	- Used to protect UN premises	- Remote viewing of hotspots and potential flashpoints
Night-vision	- Image intensifiers	- Few possessed and deployed in insufficient numbers to missions - Inadequate COE standards	- FLIR in aircraft - Facilitate night patrols and night operations
	- Thermal imaging	- Not used, except in advanced aircraft	- Night patrols - Border control
Motion detectors	- Intrusion alarms	- Underexploited technology	- Protection of refugee/UN camps - Automatic illuminators
Radars	- Aerial surveillance radar	- Not used	- Synthetic aperture radar (SAR) for imaging from satellite and/or aircraft
	- Artillery locating radar (ALR)	- Not used	- Determine the source of artillery fire - Remove UN personnel from fire
	- Ground penetrating radar (GPR)	- Not used	- Discover underground weapons caches - Detect landmines and UXO
	- Ground surveillance radar (GSR)	- Used in one mission (UNMIL)	- Detect trespassers along line of control or demilitarized zone - Catch illegal smuggling or aggression
X-ray machines	- Baggage and shipments	- Used in entrances to some buildings and airports	- Examine cargo - Portable devices
Acoustic sensors	- Small arms fire localization - Movement of persons or vehicles	- Not used (except makeshift)	- Detect weapons being removed from cantonment - Identify source of rifle fire for early warning and response
Seismic sensors	- Geophones/ seismometers	- Not used	- Detect persons or vehicles passing over a certain area
Chemical sensors	- Explosives detector	- Not used (except perhaps in Middle East PKOs)	- Detect weapons and ammunition
Metal detectors	- Handheld wand - Mine detector	- Widely used for mine detection	- Detect weapons and mines
Electronic monitors	- Signal locating equipment - Radio scanners / signal monitoring	- Not used systematically (except in Congo 1960-64)	- For electronic counter measures, e.g., detection of bugs in UN officers or of militia signals in jungles
Positioning and tracking systems	- Global Positioning System (GPS) - Transponders and tags	- GPS used as both COE- and UN-owned equipment - Carlog used in many missions for UN vehicles	- Real time tracking of vehicles - Radio-frequency identification (RFID) used to track weapons and UN supplies
Information analysis	- Geographical Information Systems (GIS) - Databases	- GIS capabilities increasing - Used for mapping - JOC and JMAC structures developing SOPs	- Systems allowing user interaction and input

Annex 6. Characteristics of Rotary-Wing UAVs

Rotary-wing (helicopter) UAVs exist in a range from mini-UAV to tactical-UAVs. The tactical UAVs are mostly converted manned helicopter models with controls in place of the pilot's seat. Since few tactical UAVs are in existence, these are representative numbers.

	Mini-UAVs	**Tactical-UAVs**
Weight	From 7.5 to 95 kg	500 kg
Range	5-10 km	Up to 400 km
Endurance	Up to 2 hr	Up to 10 hr
Payload	From 4.5 to 25 kg	Up to 150 kg
Speed	From 0 to 80 km/h	Up to 200 Km/h
Cost	Under $100,000 per UAV	About $350,000 per UAV
Examples	SR200 VTOL UAV, STD-5 Steadicopter, TAG M80	Vigilante 502, Vigilante 496, Eagle Eye

Annex 7. Contingent-Owned Equipment (COE) Shortfalls

The equipment that contingents bring to the field is inspected upon arrival, quarterly and upon departure to see if it meets the standards described in the COE manual. A verification report (VR) is issued after each inspection. The COE database contains VR from 2001 onwards. The database shows the level of shortfalls in each of the 25 categories of equipment, revealing the percentage of contingents unable to uphold the COE standards. The categories for Observation (night vision and positioning) and Identification (recording images) technology are among the top in the shortfall list. Most night-vision shortfalls are with the developing world contingents.

Table A6.1. Equipment shortfalls (top 10 categories)

Equipment	**Shortfall**	**Rank**
Explosive Ordinance Disposal	18 %	1
Positioning	16	2
Night vision	16	3
General observation	13	4
Level 1 Medical	12	5
Tenting	11	6
Catering	9	7
TEL	8	8
HF Radio	8	9
Accommodation	7	10

For comparison the average shortfall for all equipment types is 7%. Even these 12-16% shortfalls for monitoring equipment should be considered underestimates. COE inspectors tend to give many nations the benefit of the doubt, particularly since the COE manual is vague on observation and identification standards. In addition, some missions reduced the COE standard of night vision from the COE Manual range of 1,000 metres because few contingents are able to meet it.

Annex 8. Unattended Ground Sensors: Summary of a Survey (1995)

A pioneering opinion survey on the potential use of unattended ground sensors (UGS) in UN peacekeeping was conducted by European researchers and published by the United Nations Institute for Disarmament (UNIDIR) in 1995.[139] The concept of UGS is that they could be left in the field to send their signals to peacekeepers remotely. A questionnaire was sent out to peacekeepers and to officials at defence headquarters in various countries, gaining 114 responses (out of 185 questionnaires sent). A full 90% considered ground sensors useful in principle, across the range of possible activities (cease-fire lines, buffer/demilitarized zones, enclosed areas, safe havens and portable sensors). Only 27% had actual experience with ground sensors, mostly from other military activities, as would be expected because of the very limited application in current UN operations.

A majority (68%) believed that the efficiency of a peacekeeping operation could be increased by using ground sensors, while 29% disagreed. Some 40% wanted to deploy sensors in a covert fashion, 36% in a purely overt fashion, and 16% wanted the capability for both modes of operation. Encrypted signals were preferred by 54%, while open communication was chosen by 34%, with only 7% desiring both. The respondents expected that the unattended sensors should operate for weeks (46%), as opposed to days (31%) or months (22%), before human intervention was required. The optimal detection range was 100-1000 meters for most respondents (49%), while some wanted a longer distance (25%) and the rest (9%) could settle for less. The main objects of detection were considered to be: persons (84%), trucks (75%), tanks (45%), helicopters (28%) and aircraft (28%). Most respondents desired detection within a few seconds (not minutes or hours) and were willing to accept a rate of false alarms at one per day but not five per day. A slim majority considered that an acceptable training time would be one week (51%) while some wanted only one day (35%) and others a full month (7%).

A few of the many desirable features cited for UGS were: theft-proof installation; remote on/off switching (e.g., to activate sensors at the beginning of a curfew); the capability to differentiate between animals and humans, as well as between armed and unarmed persons; and compatibility with existing computer and communications systems. Among the concerns listed (in addition to those inferred from above) were: the possibility of increased complexity in the operation; the potential need for more troops to check/guard and respond to the sensors; the need for technical expertise for operation and maintenance; the degradation of sensor capabilities due to weather, terrain and other factors; increased UN involvement necessitated as a result of increased information.

Practical suggestions included: making mention of the use of unattended sensors in the mission's mandate (or the SOFA) to lessen any fears the parties may have of unwarranted observation, and including backup systems and methods in case the sensors fail. In considering how peacekeeping expertise with sensors should be increased, most felt that cooperation among nations is the best means to develop the technologies (41%), others preferred UN ownership (30%), while the remainder preferred other means (29%).

The survey covered a more limited set of tools than the present study. The questionnaire dealt only with ground sensors—not overhead monitors or sensors inside (or on top of) buildings or on vehicles. The respondents were almost exclusively from the military component of peacekeeping missions; under-represented were the civilian members (only 5% of the respondents) of the peacekeeping community.

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[139] The results are described in the publication by Jürgen Altmann, Horst Fischer, and Henny van der Graaf (eds.), *Sensors for Peace*, Geneva: United Nations Institute for Disarmament Research (UNIDIR), 1998.