

A Generic Model for Cooperative Border Security

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Abstract

This paper presents a generic model for dealing with security problems along borders between countries. It presents descriptions and characteristics of various borders and identifies the threats to border security, while emphasizing cooperative monitoring solutions.

The first section characterizes the various borders and defines three security zones as a basis for analyzing options for solving threats. Security cooperation is based on joint understandings and agreements that can prevent conflicts and diminish risks. Security cooperation is conducted as joint, low-profile combative activity. The 1994 Peace Treaty between Jordan and Israel is cited as an example of a successful agreement.

The paper emphasizes the value of agreements, advanced communication centers for obtaining information, prompt distribution of the information between the partners, and the educated use of conceptual, military, and technological solutions to create an advanced and well-coordinated response system.

Despite progress in the effort toward comprehensive peace in the Middle East, most of the countries are still struggling with border security problems. The author recommends two measures to encourage the collective resolution of border security problems:

1. Hold a Jordanian-Palestinian-Israeli meeting in a neutral venue to identify and resolve security problems along their shared borders.
2. Hold a meeting (or a series of meetings) among Middle Eastern countries in a neutral venue to identify security problems and propose options along shared borders.

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Project Background

The search for peace in the Middle East depends on many factors. One of the most important is border security. The problem of disputed and unrecognized borders in the region is slowly being resolved. Once borders are recognized, nations must achieve ongoing security. Nations face common problems with illegal immigration, smuggling, terrorism, and political infiltration. The growth of confidence between neighboring countries needed for an enduring peace is adversely affected by these illicit border intrusions. In absence of cooperation, scarce resources must be devoted to military security forces in an attempt to counter these problems.

This study is the product of the joint efforts of a Jordanian researcher and an Israeli researcher. The authors collaborated in this project because of a common interest in achieving an enduring peace in the Middle East. We believe that peace in the Middle East is inevitable. This is the first time such Israeli-Jordanian collaboration has taken place at the Cooperative Monitoring Center. The goals of this project were to 1) research options for cooperation in border security and 2) define a strategy to achieve it. Technical options exist that can significantly improve security conditions along borders, and there has been no study to date to assess how these potentially valuable tools can be used in the Middle East.

Nations around the world are beginning to think in terms of cooperative security. Unilateral or purely military actions are no longer effective. Even in the Middle East, countries are beginning to recognize that all can benefit from cooperation. The 1994 peace treaty between the Hashemite Kingdom of Jordan and the State of Israel is an important agreement to manage various security concerns shared by the two countries. This fact led us to focus on the future, and to present a general model to implement security along borders with an emphasis on cooperative security. Various ideas about the nature of threats and conditions along borders in the Middle East, particularly Israel and Jordan, served as the backdrop for this project.

The first document (A Generic Model for Cooperative Border Security, Gideon Netzer, SAND 98-0505/7) deals with the development and presentation of a generic model for border security. The second document (Cooperative Border Security for Jordan: Assessment and Options, Mazen Qojas, SAND 98-0505/8) applies the principles of generic border security to Jordan.

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Acronyms

CMC Cooperative Monitoring Center
HIC high-intensity conflict
IDF Israel Defense Forces
IR infrared
LIC low-intensity conflict
OOTW operations other than war
MIDS Mini Intrusion Detection System
WIM weigh-in-motion
NATO North Atlantic Treaty Organization
SAR synthetic aperture radar
A Generic Model for Cooperative Border Security

Executive Summary

Cooperative monitoring agreements can help neighboring countries lower security tensions along their shared borders. The creation of confidence-building measures, especially military ones, can increase stability in the countries' bilateral relations. While diminishing existing conflicts, cooperative monitoring can create an infrastructure for expanding the understanding shared by neighboring countries, and contribute to international understanding as well. The peace treaty between the Hashemite Kingdom of Jordan and the State of Israel, signed October 1994, is an example of how countries can reach agreement on shared security issues.

Cooperative security along borders relies on understandings and agreements that are based on a joint definition of the various threats and solutions. This document describes a variety of technological solutions that fit specific terrain types to respond to threats along borders.

The working assumption in this research is the understanding that it is based on a shared wish for security cooperation between the countries. This document describes an approach that emphasizes three important concepts:

1. The border area is divided into three security zones for detection, identification, and reaction. Parallel zones exist on both sides of the neighboring border.
2. The division of the border area into symmetric security zones on either side of the shared border is a method of dealing with and responding to defined threats.
3. The two security zones on both sides of the border would become, during border incidents, one protected area, with a shared early warning system, joint identification of a threat, and coordinated joint responses. The shared border area would function as a single response area, including the bilateral passage of forces.

The document defines the concept of cooperative monitoring, the framework for developing cooperative monitoring options, and the important role of information in security cooperation. The document explores the strategic concept of gathering information and disseminating it to the partners through a shared communications system.

Lastly, the document presents representative solutions to threats described by the model. Emphasis is placed on technological considerations that enable a suitable response to various threats in security cooperation to which the whole model applies. Potential recommendations include conducting a cost analysis and research on the problems of integration for a monitoring system and conducting an experiment using sensors and equipment in a sample section of the border. The establishment of a "Joint Security Center" between bordering countries could centralize information systems and could be used as a base for coordinating information collection and response.

Despite progress in the effort toward comprehensive peace in the Middle East, most of the countries are still struggling with border security problems. An incident along the border can cause deterioration in the relations between the neighboring countries. Middle Eastern countries might consider conducting intraregional research on issues of security, technology, communications, and economics in the Middle East. The author recommends two measures to encourage the collective resolution of border security problems:

1. Hold a Jordanian-Palestinian-Israeli meeting in a neutral venue to identify and resolve security problems along their shared borders. Formulating ideas for coordinated answers to future security problems along their borders could significantly advance the understanding necessary for effective solutions.
2. Hold a meeting (or a series of meetings) among Middle Eastern countries in a neutral venue to identify security problems and propose options along shared borders. Just holding such a practical

meeting would be a significant confidence-building measure in itself. A joint document could create the momentum for further developments in solving these sensitive problems in the entire region.

1. Introduction

Cooperative monitoring agreements can help neighboring countries lower security tensions along their shared borders. Relevant precedents in Europe and the Middle East prove that such agreements can be very effective. In addition, they can often result in better understanding between the countries, and increased stability along the borders and in the countries themselves.

This document develops a generic model for cooperative approaches to security problems along borders between countries. It describes the characteristics of various borders and identifies the threats to border security, while emphasizing cooperative monitoring solutions. These options can play a major strategic role in cooperative monitoring agreements that can advance security cooperation between the countries.

2. Definition of the Problem

2.1. The Need for Cooperation in Border Security

Since the end of the Cold War, the importance of regional security has increased. The United States, countries in Europe, South America, the former Soviet Union, and other regional groupings have recognized the benefit of creating joint security frameworks to increase regional and international stability. These security frameworks focus on arms control, nonproliferation, and the establishment of confidence-building measures.

Bilateral or regional cooperation permits proactive measures to be taken that help solve security problems before they result in local or regional instability. Agreements, either formal or informal, are necessary to define the context, topics, and means of cooperation. These agreements define the responsibilities of each party, actions to be taken, information to be shared, the format for coordination, and the process to resolve incidents. Examples of topics of cooperation are as follows:

1. Maintaining the balance of conventional armaments
2. Preventing the spread of nonconventional arms (nuclear, chemical, biological)
3. Controlling local or regional conflicts that have the potential to increase tension or escalate into international confrontations.
4. Maintaining the security and validity of national borders.

Examples of recent bilateral and regional security cooperation include the following:

1. The Conventional Forces in Europe Treaty (I and II)
2. The Open Skies Treaty
3. The Hungary-Romania Open Skies Treaty
4. The India-Pakistan protocols for advance notice of military exercises and movements
5. The Argentina-Brazil accord for nuclear material control and accounting
6. The USA-USSR Intermediate Range Nuclear Forces Treaty

Control of national borders is a key element in sovereignty. Disputes over the location of borders are probably the single largest contributor to international tension. A lack of respect for official borders by intruders also contributes to bilateral and regional tensions. Intruders may illicitly cross a border for many purposes: criminal, political, terror, military/intelligence, and immigration.

Conceptually, border security can be achieved through unilateral or cooperative (bilateral or multilateral) means. Unilateral methods normally rely on the use of military or police forces by the national government without regard to activities by the neighboring country. Borders become fortified zones with observation posts, defensive positions, physical barriers, and heavily armed response forces. Unilateral

actions have limits and disadvantages. Militarily based solutions to border security often have the undesirable effect of increasing tension between two neighbors. Fears of offensive military action by a neighbor can be reinforced if it conducts aggressive border security measures. Confidence, the key factor in a stable relationship, becomes difficult to build.

Cooperation requires a shift in governmental attitudes and concepts about border security. The model of cooperation means that both states will be better off — the defense of one's own borders will help the neighboring country and vice versa. To achieve such cooperation, it is necessary to take innovative measures such as creating joint control commands, appointing liaison officers for the neighboring forces, and establishing joint communications systems. Cooperation, of course, depends on the political relationship between the two countries. For example, there have been incidents along the Jordan-Israel border where cooperation between security forces proved mutually beneficial — a product of the 1994 peace treaty and supplementary agreements on security.

Cooperative border monitoring can help neutralize dangers, diminish conflicts, and reduce tension. Several agreements in the Middle East have included provisions for implementing border security. In the mid-1970s, some agreements were aimed at stabilizing the sensitive security situation along the borders of neighboring countries, the most prominent of which were the Egypt-Israel Sinai disengagement agreements (1974 and 1975) and the Syria-Israel agreement on redeployment on the Golan Heights (1974). A long-term, wide-scope peace process began in the Middle East with the signing of the peace agreement between Israel and Egypt in 1979. The peace agreement between Israel and Jordan was signed in 1994. Both treaties established official borders and protocols for securing them. The current process between Israel and the Palestinian Authority relies on working groups that create guidelines for establishing a permanent settlement. The final settlement must establish Palestinian and Israeli sovereignty respectively in the West Bank and provide for secure borders. The key task is to reach cooperative agreements and understanding, anchored in cooperative security, as part of a multilateral peace in the region.

To illustrate the utility of cooperation in solving security problems along the border, two contrasting situations are presented. In one, security along the border is a unilateral activity, and in the other, security is achieved through bilateral cooperation.

2.1.1. Example of Unilateral Security: The Lebanon-Israel border

Since the early 1980s, the Israel Defense Forces (IDF) have been struggling along the Lebanon-Israel border with ongoing clashes with terrorist organizations. The fighting is mainly guerrilla warfare and terrorist activity characterized as low-intensity conflict (LIC). (See detailed description in Appendix A.) At this point, neither party believes in the possibility of dialogue between the parties who are in a long and lasting struggle. There is no doubt that the solution along this complicated border must lean on a political solution, which is indirectly related to a future peace agreement between Syria and Israel. As long as the Syrian-Israeli relations are not resolved, and as long as Syria's status within Lebanon is not clarified, a bilateral solution is far in the future along this sensitive border. When the time comes for dialogue between the Syrian, Lebanese, and Israeli governments, other countries, such as the United States and France, would, no doubt, intervene to advance the peace. (French involvement in such an agreement is sometimes mentioned because of France's historical link to Lebanon.) This border is characterized by unilateral border security, which could lead to possible escalation of conflict.

2.1.2. Example of Cooperative Security: The Jordan-Israel border

The peace agreement signed between Jordan and Israel in October 1994 specifically defined the various components of security cooperation along the shared border between the two countries. (See Appendix B for Article 4, Security.) The agreement emphasizes that

- the shared border is characterized by cooperation between headquarters and commanders for coordinating activities to maintain the security in the protected border area, and

- the agreement relies on ongoing communication using a “hot line” for coordinating responses during an incident.

Since the signing of the peace agreement between Israel and Jordan, several security incidents have occurred along the shared border. However, instead of increasing tensions and escalating conflict, the cooperation between the commanders and the forces in the area led to improved communications and defused the potential for further violence. This is the clearest characteristic, which stresses the use of cooperative monitoring to solve security problems along the borders. Over time, the system is expected to develop into an especially efficient one.

2.2. Characterization of Border Threats

The threats battled by various security forces along borders between countries are varied. About 150 political borders exist where there are conflicts related to hostile activities such as infiltration, terrorist and guerrilla activities, drug trafficking, and hostile economic activities, such as smuggling. These threats are not comprehensive security threats, for which the response is substantially different. When countries can reach agreements regarding the need to combat mutual security problems along the border, they can begin the process for diminishing shared risks and conflicts through confidence-building measures. One of the most important factors of these agreements is the definition of threats shared by both countries. A brief description of potential threats follows.

2.2.1. Terrorism

Modern terrorism threatens many countries and is not limited to certain areas of operation. A terrorist cell may cross political borders to attack targets in neighboring countries. Fighting terrorism is a difficult and complex task. Terrorism does not pose a strategic threat to a country, but it has the power to change public opinion and thereby to influence the leadership and its activities.

Terrorism threatens many countries around the world. The successful results of terrorist activity calls for preventive activity both politically and on the military, operational front. The basic assumption in fighting terrorism is that “Terrorism has no borders.”

2.2.2. Guerrilla Warfare

Guerrillas differ from terrorists by having a paramilitary organization. Guerrilla warfare has political/military goals and some of the characteristics that exist in conventional warfare. It often occurs in rugged terrain to grant its members an advantage. As opposed to terrorism, guerrilla warfare takes place in defined areas that are well known to the warriors. Guerrilla warfare is usually characterized by continuous action taking place in the border area. Successful guerrilla operations hurt, among others, civilians, towns, and centers of social and economic activities and also can disrupt both regional and national government activities.

2.2.3. Infiltration for Subversive Activity

Infiltration takes place between hostile countries that are interested in disrupting the neighboring country's government by creating internal subversive activity. Such activity seeks to create political cells to oppose the existing regime. A state that wants to harm its neighbor for various reasons (usually diplomatic or geopolitical) will take extensive measures to advance successful subversive activity. One must take into account that border-infiltrating cells, despite their subversive designation, could also serve as fighting forces that could create conflict along the security borders between the countries. Such activity could heighten the tension between the countries and lead to a comprehensive military confrontation.

2.2.4. Drug Smuggling

The high financial value of drugs has made smuggling an attractive activity for criminals. Hostile drug-smuggling elements have developed sophisticated means to smuggle drugs across borders. A significant

portion of the effort to stop smuggling is devoted to the deployment of military and federal forces and the establishment of observation, identification, and control mechanisms along the state's borders. In addition, countries have established unilateral surveillance systems to detect drug smuggling activity, including the location of drug-harvesting land. When challenged by police or border security forces, smugglers can become violent. Anti-smuggling activities can lead to military operations that have the potential of creating tension between neighboring countries.

The struggle against drug use and smuggling has become an international battle. There is some precedent for cooperation by international organizations to minimize the damages of drug smuggling. Without cooperation between countries in the war on drugs, the battle could damage international relations between countries. It can therefore be deduced that the struggle against drug smuggling has some similarity to terrorist and guerrilla conflict.

2.2.5. Smuggling of Products for Financial Gain

The smuggling of products poses a threat to the sovereignty of the country whose borders are being crossed. Product smuggling can also adversely affect international relations. For example, a certain geopolitical situation could cause the international community to place an embargo on a certain country, dealing a direct blow to that country's economy. A neighboring country could serve as a base for smuggling by the isolated country. There are two main characteristics of economic smuggling that can be harmful to the neighboring country, as follows:

1. Extensive economic smuggling into the neighboring country could ultimately harm that country's economy.
2. Although people who smuggle products for economic gain are not necessarily violent, they might respond violently to attempts to block their intrusion. When relations between the neighboring countries are sensitive, such intrusions, if they end in violence, could worsen the situation along the border.

Security cooperation between countries along their shared border is necessary for a comprehensive battle against such intrusion. If such cooperation is impossible, every such intrusion will undoubtedly increase the tension between the countries. The threat of a conflict between countries as a result of smuggling is hard to measure. To avoid this, proper use must be made of suitable warfare and light operational units for foiling all intruders – even if they are economically driven.

2.2.6. Illegal Immigration

Illegal immigration poses a threat mainly to social and economic order. However, illegal immigration can also disrupt and shake up political systems within the state. An illegal foreign population within a state can cause political and social tension that can hurt the permanent local population and can undermine the stability of the government.

3. Concept of Cooperative Monitoring

Cooperative monitoring is the collecting, analyzing, and sharing of information among parties to an agreement. Information collection relies largely, but not completely, on monitoring technologies such as sensors. The technologies used in a monitoring system prescribed by an agreement must be sharable among all parties, and all parties must receive equal access to collected data. Since incorrect or incomplete information may be more damaging to regional relationships than no information, procedures for dealing with anomalous data or false positives must be included in a cooperative monitoring regime. If designed with consideration for local conditions, cooperative monitoring can strengthen existing agreements, build confidence, set the stage for continued progress, and lead to stability. Cooperative monitoring can be an important factor in fulfilling security agreements about borders.

Cooperative agreements may make seemingly impossible goals achievable. Historical precedents include the Intermediate Range Nuclear Forces Treaty and the Sinai disengagement agreements. Cooperative monitoring relies on the establishment of mutual trust between the partner states. A system of cooperative monitoring between two countries is characterized by the following:

- A clear understanding regarding technological cooperation, which allows for joint operation of special technological means to obtain information.
- Balance and equality between the partners in terms of the technological means for obtaining information and the ability to analyze it, as well as the output of the technological systems.
- The shared cooperative monitoring system must address and solve problems and exceptional situations, based on agreements and clear processes between the partners.

3.1. Framework for Developing Cooperative Monitoring Options

The process of planning and designing a cooperative monitoring system must usually be linked to a political process. Technologists who are accustomed to striving for and designing “ideal” technical solutions might be frustrated by the need to balance the technical capabilities with political concerns. Four issues (see Figure 1) are critical for incorporating cooperative monitoring into a regional agreement, as follows:

1. The context of a potential accord: This includes the list of participants, consideration for the concerns and policies of the region, and understanding the ultimate goals of the accord. If the main target of the agreement is to start regional dialogue, then a rigorous monitoring regime may be premature.
2. Potential or actual provisions of the accord: Cooperative monitoring provides evidence relevant to specific agreement provisions, such as activities and declarations. General statements about the objectives of potential verification measures are also included as treaty provisions. If an agreement forbids the production of a particular item, but does not provide for a verification process, developing cooperative monitoring options will be a moot point.
3. Observable physical phenomena associated with the provisions: For determining monitoring technologies, it is necessary to understand the observable physical qualities that can be measured to assess compliance with the provisions of an agreement. Observables include items or activities that are limited by the accord, and their observable signatures.
4. Technical options for monitoring the accord: In order to design acceptable cooperative monitoring options, it is necessary to identify technologies that can detect relevant observables, weighing the tradeoffs between monitoring intrusiveness and system vulnerability, and considering other constraints, such as costs.

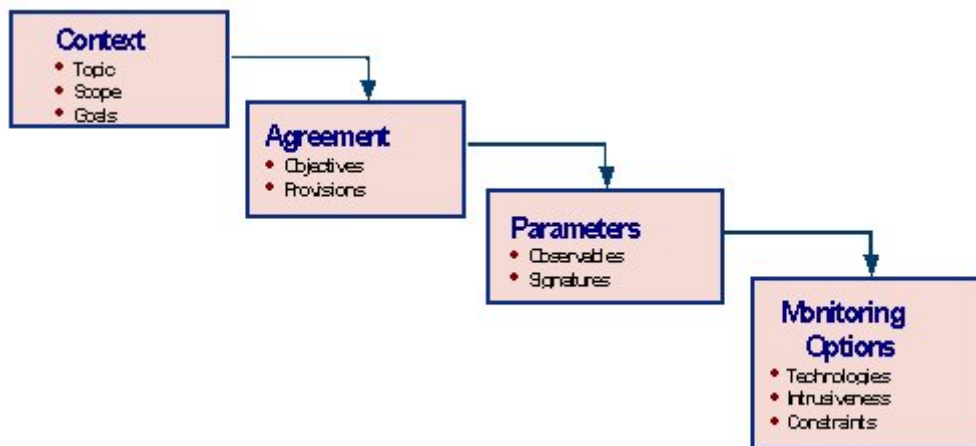


Figure 1. Framework for Cooperative Monitoring

3.2. The Role of Information in Cooperative Border Security

If cooperative security aims to diminish risks and confrontations, neutralize conflicts, and create calm along the joint border, then shared information plays an important role in reaching this goal. An agreement is necessary to define the actions by each partner to solve security problems along their borders. The agreement must answer several questions:

- Who are the partners in cooperative border security?
- In what information are the partners interested?
- What is the importance of timing in obtaining the information?

An example of a defense border is the Israel-Egypt border before the June 1967 war and in the beginning of the 1970s, before the agreements for the separation of forces and after the implementation of the agreements (1974 and 1975). Security cooperation between Israel and Egypt called for a clear definition of the threats and dangers that interested both parties. (See Appendix C for key clauses of the 1975 Israeli-Egyptian agreement regarding the plan for the separation of forces and for its implementation.) In such a reality, where the protected border area had a clear military character, with little civilian population, the partners were mainly interested in information about military movements: which units moved, their new locations, etc. Among other things, the parties dealt with the identification of and response to intruders and smugglers in the protected area, but these were naturally of lesser importance. In the background, there was the continuous fear of possible incidents or transgressions, despite the separation agreement. Cooperative security became the main method for dealing with such varying situations along the sensitive border.

Some countries share borders without military characteristics, such as the U.S.-Canada and U.S.-Mexico borders. These countries share good, neighborly relations and incidents are handled by both countries' law enforcement organizations. While terrorism or guerrilla warfare are not concerns, threats such as smuggling and illegal immigration could create problems if they did not have cooperative measures to handle incidents.

A different model of a sensitive and complex border is the border between Israel and Jordan, which has both defense and nondefense characteristics. A prevailing attribute is the multitude of civilians living adjacent to the international border of these countries. Most of the activity in this protected area is agricultural; therefore most of the traffic is comprised of civilians, who live in the security area.

The border of Jordan and Israel is defined by the leaders and politicians as a "border of peace." The security clause in the peace agreement between Israel and Jordan emphasizes the need for creating a more comfortable climate for increasing the comprehensive cooperation between the countries, especially the security cooperation. Such a border includes, inter alia, an important factor that can turn into a potential danger even when talking about security cooperation between neighboring countries, and that is the safe passage. On one hand, the passage is a significant, essential factor on the shared border, and is an expression of the developing normalization between the countries that have signed a peace agreement. At the same time, it is helpful in developing trade, economic, and tourist relations. On the other hand, it also offers a center for illegal immigration, passage of terrorists, and the terminal itself is a target for terrorist activity by those who wish to "complicate" the relations of the neighboring countries.

In order to clarify the importance of information for achieving cooperative security, it is important to emphasize how the information is used. The 1975 separation agreement between Egypt and Israel presents a positive model, which explains the organizational-technical aspect of ways to make use of bilateral information, and which played a significant role in achieving coordination and understanding and made it easier to implement the separation process.

In general, the agreement must detail and clarify who receives the information. There are various possibilities: in some cases, there can be an agreement between the parties on the transfer of the information, its analysis, understanding, and a means of response, which clearly determines who the reporting factions are. Another possibility is sorting and classifying the information according to the level of its importance and transferring it to the appropriate destination. The receivers of the information are likely to be government representatives, such as the prime ministers, the ministers of defense, senior army commanders, and commanders of the border sectors. When the agreement establishes the involvement of a neutral party, then that party might also receive the information. The information may be delivered as a periodic report – daily, weekly, or monthly – according to the cooperative security agreement.

The communication equipment and networks need to supply information quickly and efficiently to enable a speedy response by the partners. The rate of response is a central factor for resolving complicated, unexpected situations. A fast response can ensure continued stability in the protected area, and also affects the climate between the partners in the implementation of the cooperative security.

Communication methods and procedures are affected by the top leaders and statesmen who signed the cooperative security agreement, as well as the senior army officers who are usually in charge of the implementation of cooperative security agreements.

3.3. Working Assumptions in a Cooperative Border Monitoring System

The following working assumptions serve as the basis for cooperative monitoring:

1. Effective cooperative monitoring relies on the creation of a joint response system to deal with events along the border.
2. Joint operation of shared monitoring technology can create an effective information and response system.
3. A shared communication system can foster a suitable response system that will rely on a “hot line” between commanders of different levels on both sides of the border, while using the same maps and other tools for creating a common infrastructure.
4. Early detection and identification of a threat can grant time to plan and organize an effective joint response.

4. Implementation Strategy

4.1. Border Characterization

4.1.1. Introduction

Newly emerging, underdeveloped nations are particularly vulnerable to intrusion because their population is often diversified and lacking unity, which can provide a potential source of internal support for intruders. However, developed nations are not immune to intrusion. This section discusses the political, geographical, economic, and sociological considerations related to border security operations.

4.1.2. Political Background

National borders that are established purely on political grounds, with little consideration for geographical aspects or the character of the population, are subject to illicit crossings. In such areas, communication between the national government and the population may be poor, leading to a weakening of national authority and making the country vulnerable to intrusion.

4.1.3. Geographic Setting

The success of intruders depends also on the attitude of the neighboring country. If the neighboring country is also undergoing political, social, or economic problems, it cannot necessarily help curb intrusion attempts.

Border security operations are simplified when a hostile nation shares a border with the country being infiltrated, because the operations can be concentrated along that frontier. The problem is magnified if a third country allows the passage of intruders and disclaims knowledge of the use of their country to approach the target nation.

4.1.4. Economic Considerations

The type of economy (industrial or agricultural), living conditions, transportation, communication, food supply, and standard of living in both neighboring countries have a distinct bearing on the problem of intrusion.

4.1.5. Operations

The intruder can be expected to capitalize on the geographical advantages of the border. If the terrain is rugged and difficult to negotiate, features such as mountains, swamps, rain forests, or uncharted wastelands figure predominantly in the intruder's success. Conversely, the ability of border security forces to deny freedom of movement over and through such terrain reduces the enemy's effective continuation of intrusion tactics.

In jungle and mountains, foot mobility must be emphasized, while in swamps and inundated areas, watercraft may be used. Wheeled vehicles may be unsuitable for desert areas, in which case tracked vehicles or aircraft need to be used. However, based on an analysis of the actual terrain of the desert area to be controlled, it may be determined that wheeled vehicles are unsuitable for employment except on improved roads/trails. If the sole use of tracked vehicles is required, logistic planners must consider the requirement for additional petroleum, oil, and lubricants. Also, the general lack of concealment in the desert terrain, as compared with other environments, will facilitate the use of aircraft for observation.

Border security personnel must be equipped and trained as dictated by operational conditions. These terrain characteristics and population densities must be considered in planning for border security operations. Section 5.2.6 contains detailed information concerning monitoring options and terrain types.

4.2. Cooperative Security Zones in the Border Area

This section describes a model for cooperative border security. The model is based on the establishment of three monitoring zones on each side of the border that act together as a single integrated system. Each monitoring zone has a specific function (detection, identification, and reaction). Table 1 presents the three monitoring zones and general options to implement monitoring and security.

Table 1. Protection Zones and Potential Solutions

Protection Zone	Potential Solutions
Detection Zone	<p>The farthest zone from the border provides detection, which includes:</p> <ul style="list-style-type: none"> • Radar equipment • Observation means for day and night (towers, balloons, etc.) • Lighting equipment for wide scanning • Sensors • Aerial observation suitable for day and night • Optical equipment for day and night • Cameras and video cameras

	<ul style="list-style-type: none"> • Communication means
Identification Zone	<p>The center zone provides delay, in the form of:</p> <ul style="list-style-type: none"> • Fences • Ditches • Sand berms • Lighting mines (such as an intruder-triggered flare)
Reaction Zone	<p>The zone touches the border and uses the following means of reaction or response:</p> <ul style="list-style-type: none"> • Communications and computer systems for command and control • Light infantry units • Fire support units • Assault helicopters • Transport helicopters

The width of each functional zone would vary depending on local topographic, geographic, and demographic conditions. The zones would typically be equal in each country, but this could be adjusted for local circumstances. For example, one country may have less strategic depth to respond to an intrusion than the other. In these circumstances, the countries might agree to zones of unequal but proportional width. The country with greater strategic depth might define its monitoring zones to be twice the width of the other.

The design of this cooperative system is the reverse of traditional unilateral border security systems. The detection zone is the farthest from the border and is the location where intrusions are detected. Unilateral security systems associated with “defense borders” are typically focused on preventing entry into a country from the outside. Systems for detection and warning of potential intruders are placed as close to the border as possible to permit the maximum time for identification and reaction (see Figure 2-A). This system is quite logical when there is no advance warning or coordinated response from the neighboring country.

In contrast, the cooperative model associated with a “nondefense border” treats the border area as an integrated unit with shared information collection, communication, and response (see Figure 2-B). This system looks both ways: it seeks to detect and identify intrusions originating within the country itself and directed at its neighbor as well as intrusions originating from its neighbor. Because information is shared and the security response is coordinated by the two neighbors, the detection zone is moved to the outside of the border area. Security forces are moved from a position well behind the border to a deployment directly along the border. If bilateral political relations were sufficiently good, protocols could be defined that permitted security forces to cross the border in pursuit of intruders as long as they remained within the reaction zones. Alternatively, security forces might be restricted to their respective reaction zones but there would be close coordination of their actions.

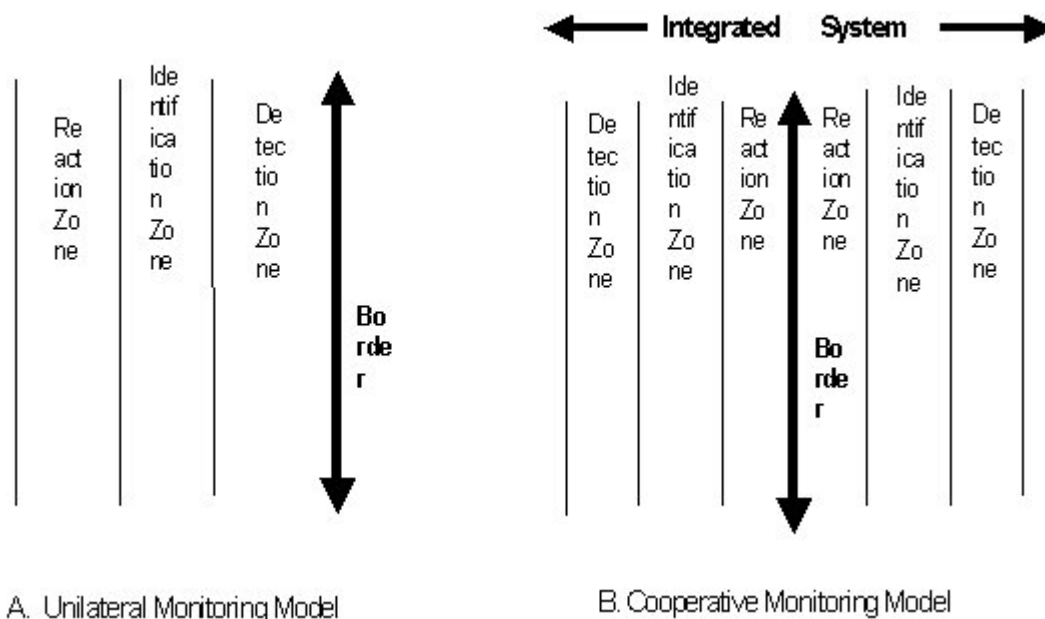


Figure 2. Contrasting Unilateral and Cooperative Monitoring Models

The implementation of this system would require meticulous communication and coordination as well as the right equipment (monitoring, communication, and security). A jointly operated monitoring center may be the most efficient and effective means to manage this system. Effective implementation of this model would provide each country with a credible assurance that all reasonable actions against common threats were being taken. In addition, it would provide significant bilateral transparency into the military and security activities of each country that maintains mutual confidence.

The cooperative border security model has its roots in actions already ongoing in the Middle East. Israel and Jordan currently exchange security information about potential intrusions. Monitoring and security responses are often coordinated. During a 1995 terrorist incident, Israeli and Jordanian forces coordinated their response and even crossed the national border.

The detection zone portion is the farthest from the border itself and should be the point where the intrusion is detected. Proper operation of all means and methods, including advanced gathering of intelligence, communication and control equipment and computers, coordination between land forces, support and air forces through high-quality control centers, and wise usage of technological means can assure positive results during a violent incident in the border area.

4.3. Strategy for Gathering and Sharing Information in Border Security Cooperation

The basis for cooperative security, as explained in the previous sections, is meant to ensure controllable situations to maintain stability along the border and in the relations between the partner countries. In examining the strategic perception of gathering and distributing information between the partners, the protected border areas are usually defined as three security zones on each side of the shared border, as described in Section 4.2, Cooperative Security Zones in the Border Area.

In practice, the three zones on each side become one geographic and security unit in which there is cooperative security against threats that have been defined by the partners. The partners determine the working rules for cooperative security for preventing operations that could harm the security of the partner countries.

These three zones are determined by the various needs of the partner countries, and therefore, each zone calls for different activity. The technological means that are to serve each zone influence the quality of the cooperative security. The central basic working assumption in cooperative security in the protected border area is that the partners share information and cooperate on the operation of means to obtain information and on the response system.

One must also take into account border areas settled by civilians, villagers, and agricultural settlements that are an inseparable part of the border area and naturally create “sensitive areas” for the response system. The situation would be even more complex in a border area characterized by LIC in which there is a permanent villager population. If terrorist activities occur, the existing situation could deteriorate and alter the relations of the neighboring countries involved in cooperative security along the border.

Due to the character of the borders and of the threats, when discussing strategies for the gathering and distribution of information, several key questions arise regarding the three defense zones on either side of the border. The partners must list, in the joint agreement, clear answers to the following questions:

- What is the purpose of each zone?
- What is needed in each zone upon the first discovery of crucial information?
- What are the main concerns of the partner countries upon receiving the information?
- How does the crucial information affect the shared response system?

4.3.1. Purpose of the Zones

The zones serve as a basis for a process that is to lead to a correct and efficient response system in cooperative security along the borders. They also clearly define the need for an organized process from the identification of the threat until the end of the response to it. Several factors in the zones influence the decision-makers and those who implement the operations in the reaction zone, as follows:

- An integration of the region’s geographic conditions (such as locating sensitive passages that might allow irregular forces to hide, for example) with the information crucial to the decision makers (based on a strong information-gathering ability)
- The right combination of technological means operated in accordance with the various threats
- The response system must involve training with high-quality combative means in order to achieve positive, swift results. The quality of the response system depends on the swiftness of the response and suitable monitoring technology.

Different terrain characteristics have advantages and disadvantages, which call for a suitable coordination between the technological means and the cooperative security along the border. (See Section 5.2.6.)

4.3.2. The Role of Information

The characterization of every border, with its limitations and disadvantages for the defending force, contributes to the central problem, which is the early discovery and identification of the developing threat or danger. Early discovery and identification will speed up the situation assessment of the response system, which will certainly affect the results of the response. The technological means must be suited to each zone in order to enable early discovery of the threat in the protected border area and its identification, and the ways and means to react in the reaction zone. The model presents threats at the level of LIC that could develop in complex areas that are populated by an active civilian community. The necessary precision in the early discovery and in the identification will affect the response system and will prevent harm to innocent people. After all, illegal immigrants are not the same as members of a terrorist cell. This emphasizes the importance of the technological system with all of its elements and the communication system between the partner countries. These will have an effect on the swiftness of the information system and will expand the communications between the partner countries, allowing for better assessments that are suited to the discovered threat.

4.3.3. Main Concerns upon Receiving the Information

This analysis clarifies the importance of timing and the need for the information that is transferred to the partners. Every piece of information after the initial discovery could naturally affect the partner countries that are concerned about a violent security incident that could harm fragile bilateral relations. Therefore, the main concerns of the civilian and military organizations in the partner countries are:

- the quality of the information,
- the need for as many details as possible,
- the speed of the communication response, and
- the creation of a clear picture of the situation for the decision makers.

All of these are affected by the quality of the technology in the protected border area and they affect the quality of the response system.

4.3.4. How Information Affects the Shared Response System

A combination of all of the factors cited above yields the best response for an incident. A clear picture of the situation and a correct assessment, which depend on reliable information, will determine the appropriate response. A suitable response for every incident will increase the trust between the partners, expand the security cooperation to different options, and will create a “comfortable climate” in the bilateral political, defense, and military relations.

4.3.5. The Role of Communication in Cooperative Border Security

A key element in the development of cooperative security is communication. Security cooperation depends on an agreement to share information from the cooperative monitoring system and evaluate reports from it. The establishment of a communication system is especially important in unstable areas with high tension. Not every country may be willing to establish direct communication and grant access to its data, and this will limit the ability to implement cooperation.

4.3.5.1. The Communications Network

The communication system must be able to receive information, verify the authenticity of the information, verify the time of the information, and transfer updated information to all of the participants when needed. The communication system must also be able to organize and analyze the information in order to be a reliable, objective source of shared information as defined by the mutual agreement. Such a system increases confidence between the partners and helps to stabilize the security cooperation agreement. The network may be composed of hardware such as phone lines, hot lines, computers, fax machines, and satellite communication. Computer systems must be able to conduct fast processing and data analysis. In addition, the development and operation of the communication system serves as a confidence-building mechanism between the technological communities of the participating countries.

4.3.5.2. A Cooperative Monitoring Center – Organizational and Technical Aspects

A cooperative monitoring center embodies the cooperative monitoring method: information and analysis lead to situation assessment, which leads to an appropriate response. The center must function as the hub for communication, technological information, control and command (of joint responses), and it is the heart of the implementation of a cooperative security agreement.

The agreement between the partner countries should establish and define the functions of such a center, and it can be operated in two different ways, as follows:

- one shared center for both sides, or

- two centers, linked by the communication system, operated by each partner to the cooperative agreement in its own territory.

The separation agreements between Israel and Egypt in 1974 and 1975 are presented as a model of cooperative monitoring stations. (See Appendix C.) These centers can be viewed as a focal point of security cooperation between the commanders in the territory (relying on information, communication, and response systems) in the division command level as in the lower command levels that deal directly with routine security in the protected border area. The desired model is a product of agreements and understandings between the partners and it ensures an ability to implement cooperative monitoring in security cooperation.

A cooperative center can be a tool to resolve disputes and prevent the escalation of an incident into a crisis. Timely analysis is a key factor in effective decision making. The communications function supports stability in implementing the agreement and joint operation of the cooperative monitoring systems. The monitoring center can also aid third parties that are helping the bordering countries implement an agreement. The center may also serve as the receiving point for information from cooperative monitoring sensors.

4.3.5.3. Joint Working Groups

Experience shows that joint working groups from both sides have had a strong effect on the success of cooperative security. The composition of the working groups is determined in the comprehensive agreement, as are the activities of the technological, information, and communication systems. Routine dialogue within the working groups has been and continues to be an important basis for maintaining the cooperative monitoring ability in security cooperation. The working groups' work depends on the availability of timely and reliable information. This influences the processing of information and the presentation of solutions to the leaders, both on the political-defense level and the military level. A part of the agreement will also dictate the process of interaction between the working groups that play a part in defining the organizational structure of the cooperative center in security cooperation.

5. Representative Technological Solutions for Cooperative Monitoring

5.1. Introduction

The purpose of a cooperative monitoring system is to create confidence, reduce tension, and provide a mechanism for solving common problems. It fulfills this purpose by collecting, analyzing, and sharing agreed-upon types of data.

A border monitoring system must satisfy three requirements:

1. It must provide detection of people and vehicles approaching the border.
2. It must identify those people and vehicles to a sufficient level to determine what response, if any, must be made.
3. It must support the response by security forces with adequate data and communications.

For a border monitoring system, time is the crucial parameter. It must warn of and identify approaching subjects of interest with sufficient timeliness that an adequate response can be made. The awareness of the system should extend for a sufficient distance from the border so that this process could be concluded before the subject of interest reaches the border. The actual distance from the border covered by a monitoring system will depend upon the nature of the subject of interest and the terrain. For example, aircraft move much faster than a person on foot, so a system that must detect aircraft requires a detection capability that reaches much farther from the border than a system that must only detect people approaching on foot. Also, the process of detection, identification, and reaction is not necessarily sequential. An ideal sensor system would detect approaching subjects of interest and identify them at the same time.

5.2. Design Process

A specific design process must be followed to assure that a cooperative monitoring system will achieve its goals. Figure 3 shows the factors that must be considered during the design process for a cooperative monitoring system.

5.2.1. Step 1 — Determine the Subjects of Interest

The first step in the process is to determine the types of subjects of interest the monitoring system must address. For example, if the concern is only with large-scale armored forces crossing the border, the system may be much different than if the concern is with individuals or small groups of people crossing the border. For the purposes of this report, six subjects of interest were chosen. In order of least to greatest potential seriousness, they are casual border crossers, illegal immigrants, smugglers, subversive political agents, terrorists, and guerrillas.

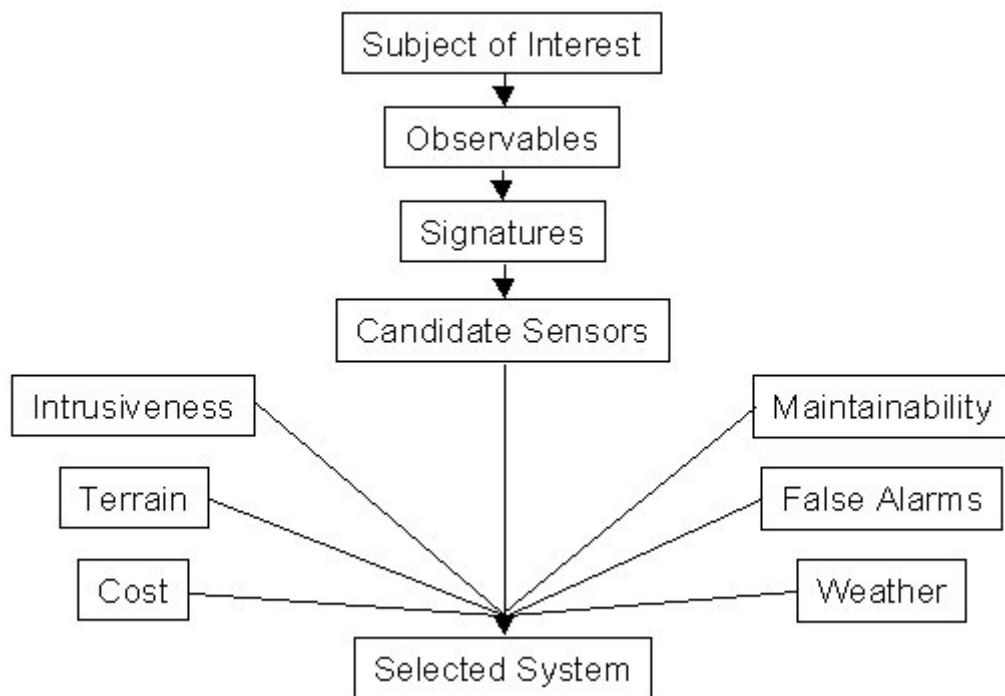


Figure 3. Design Considerations for a Monitoring System

5.2.2. Step 2 — Determine Observables and Physical Signatures

Once the subjects of interest have been determined, then the observables of these subjects must be determined. Observables are distinctive features that can be used to detect and identify the subjects of interest. For example, observables of armored forces include armored vehicles and large numbers of trucks.

From the observables, the physical signatures of the subjects must be determined. These are the actual physical characteristics of the subjects that sensors can detect or measure. An example of a signature is the weight of a vehicle.

Table 2 lists subjects of interest, their observables, and the kinds of signatures associated with those observables. The subjects of interest have many observables and signatures in common. A variety of signatures are potentially present for detection by the monitoring system.

Subject of Interest	Observables	Signatures
Casual Border Crossers	People	Seismic, acoustic, olfactory, visual, IR, radar, weight
	Animals	Seismic, acoustic, olfactory, visual, IR, radar, weight
	Vehicles	Seismic, acoustic, olfactory, visual, IR, radar, weight, magnetic
	Aircraft	Radar, visual, IR, acoustic
	Boats	Boats Radar, visual, IR, acoustic
Illegal Immigrants	All of the above observables + Tunnels, usually not aircraft	Tunnels: acoustic, magnetic, electromagnetic, radar, gravitational
Smugglers	All of the above observables + Contraband	Contraband: Visual, chemical, magnetic, X-ray
Political Agents	All of the above, usually unarmed	Same as smugglers
Terrorists	All of the above + Small Arms	Small Arms: Visual, magnetic, chemical, X-ray
	Explosives	Visual, chemical, X-ray
Guerrillas	Same as terrorists, but more numerous	All of the above

Table 2. Observables and Signatures for Border Monitoring

5.2.3. Step 3 — Select Sensors

Once the signatures have been identified, determining which sensors can detect the subject signatures for warning or identification generates a list of candidate sensors. Sensors that can detect none of the relevant signatures can be excluded from further consideration. For example, if armored forces are of concern, sensors that detect radioactivity may be of no use. The list of candidate sensors will contain sensors that are potentially capable of forming a monitoring system. Numerous sensors can be used in a border monitoring system. Table 3 matches potential sensors against those observables whose signatures they can detect. These sensors are therefore candidates for the border monitoring system. (See also Appendix D.)

A variety of sensors can be used to detect and identify the subjects of interest. The exact choice of sensors for the border monitoring system will be influenced by the other factors shown in Figure 3.

5.2.4. Step 4 — Consider Terrain

For border monitoring, the most crucial design factor, other than the subjects of interest, is the terrain at the border. Terrain determines the type, number, and placement of the sensors. Some sensors that are otherwise suitable may be ruled out because the terrain limits their effectiveness.

For this report, six types of terrain are examined. These give fairly complete coverage of the types of terrain that a border monitoring system may have to contend with and they illustrate how greatly the terrain affects design. These terrain types are:

1. Desert
2. Jungle
3. River
4. Mountain
5. Coastal
6. Crossing Point

Table 3. Candidate Sensors

Observable	Sensor
People	Cameras, radar, thermal imagers, barrier sensors, seismic, acoustic, chemical sensors, weight sensors, dogs, infrared (IR) breakbeams
Animals	Same as people
Vehicles	Cameras, radar, thermal imagers, barrier sensors, seismic, acoustic, chemical sensors, weight sensors, dogs, magnetic sensors, IR breakbeams
Aircraft	Radar, cameras, thermal imagers, acoustic sensors
Boats	Radar, cameras, thermal imagers, acoustic sensors, barrier sensors
Tunnels	Active or passive acoustic sensors, barrier sensors, magnetic sensors, electromagnetic sensors, ground penetrating radar, gravimeters
Contraband	Cameras, X-rays, chemical sensors
Small Arms	Cameras, thermal imagers, magnetic sensors, X-rays
Explosives	Cameras, chemical sensors, dogs, X-rays

5.2.5. Step 5 — Match Sensor Types with Terrain Considerations

The candidate list of sensors generated above must now be matched against each terrain type to determine which sensors are most suited to be employed in each terrain. The factors that must be considered include 1) the range of the sensors, 2) line-of-sight blockage from the terrain and terrain vegetation, and 3) false alarms from environmental factors.

The capability of each sensor must be matched against the requirements for detection, identification, and reaction. Some sensors have excellent detection capability (e.g., seismic) but little or no capability for identification. On the other hand, some sensors have great identification capability (e.g., video cameras) but must be cued by other sensors.

Table 4 shows the results of matching sensors with terrain type and sensor purpose based on the monitoring strategy using the three zones presented in Section 4.2. Each sensor is matched against each terrain type in the three roles of detection, identification, and reaction, denoted in the table by D, I, and R, respectively. A “+” sign indicates that this sensor is suitable for this role. An “L” indicates that this sensor may have a limited application for this role. A “-” sign indicates that this sensor has little or no utility for this role.

The four bottom rows of Table 4 contain devices that, while not sensors themselves, are useful adjuncts to monitoring sensors. They are included to indicate their importance and to emphasize that a monitoring system includes more components than just sensors.

Table 4. Sensor-Terrain Matrix for Border Monitoring

Means	Desert			Jungle			River			Mountain			Coastal			Crossing Point		
	D	I	R	D	I	R	D	I	R	D	I	R	D	I	R	D	I	R
Cameras	L	+	+	L	+	+	L	+	+	L	+	+	L	+	+	+	+	+
Radar	+	-	-	-	-	-	L	-	-	+	-	-	+	-	-	-	-	-
Thermal IR	+	+	+	L	+	L	-	+	L	-	+	L	+	+	+	+	+	L
Night Vision Device	+	+	+	L	+	+	+	+	+	+	+	+	+	+	+	+	+	L
Seismic	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
Acoustic	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-
Magnetic	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-
IR breakbeam	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-	+	L	-
Barrier	+	-	-	+	-	-	+	-	-	+	-	-	+	+	-	+	-	-

sensors																		
Chemical sensors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
Dogs	-	-	L	+	L	L	-	-	L	-	-	L	-	-	L	+	+	-
Explosives detectors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
X-rays	-	-		-	-		-	-		-	-		-	-		+	+	
Binoculars	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+
Rangefinders	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	-	+
GPS receivers	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+
Illumination devices	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+	+
Reaction forces	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	+

No sensor is perfect for all terrain types or roles. A mix of sensors is necessary to take into account all of the present terrain types and sensor roles. A good monitoring system combines sensors to take advantage of the strengths of individual sensor types and to compensate for their weaknesses.

Table 4 lists other components of the monitoring system that must be included. For example, illumination devices, such as pole-mounted lights, searchlights, and flares, may be needed in order for cameras and human observers to function well. While not used for detection, rangefinders and navigation devices may be necessary adjuncts to technical sensors in order to properly locate subjects of interest and to guide a response. Finally, response forces must be considered. These may range from a lone inspector to large police or military units.

The other factors shown in Figure 3 also play a part in the choice of sensors. For example, if the area experiences frequent severe weather, then all-weather sensors are preferable. Extreme heat and cold conditions can also affect sensor performance and choice. The intrusiveness of the sensor system also guides design choices. One partner may object if sensors with a very long range are proposed that might be used for intelligence gathering. In practice, a balance must be struck between the desire for an effective monitoring system and the desire to minimize the risk of disclosing important intelligence information. Initial and maintenance costs also need to be considered. Frequent maintenance requirements may rule out some sensors.

5.2.6. Monitoring Systems for Different Terrain Types

This section summarizes the general characteristics of a monitoring system for each terrain type. It includes the salient features of each terrain type that influence the design of the monitoring system. For all terrain types, there will be areas of special interest, especially those areas that contain routes that are conducive to clandestine border crossings. Examples are valleys and heavily vegetated areas that can offer concealment to crossing attempts.

5.2.6.1. Desert

Long lines of sight and little vegetation characterize desert terrain. Distances also tend to be large. Fast movement by vehicles tends to be possible. For these reasons, a monitoring system must emphasize quick detection and reaction.

Figure 4 illustrates characteristics of a notional monitoring system for desert terrain.

The detection function of a monitoring system for desert areas is characterized by long-range sensors, such as radars, thermal IR devices, night vision devices, and aided human observation. These sensors may be mounted on elevated terrain, in towers, or in aircraft to gain maximum range. Short-range

sensors, such as seismic, acoustic, magnetic, or IR breakbeam sensors, would be used to fill in gaps where the local terrain or vegetation might block the line of sight of the long-range sensors.

In order to identify detected intrusions, long-range imaging sensors such as cameras, thermal imagers, or aided human vision may be used. Some limited use can be made of short-range sensors, for example, to distinguish between vehicles and subjects on foot or animals. A major use for these sensors would be to cue a camera system that would perform the identification function.

Because movement can be quite swift over desert terrain, a fast response is necessary. Reaction units would need fast vehicles with cross-country capability. Helicopters offer very fast reaction time and are attractive for this purpose. Illumination devices may be necessary at night, especially for identification and response units.

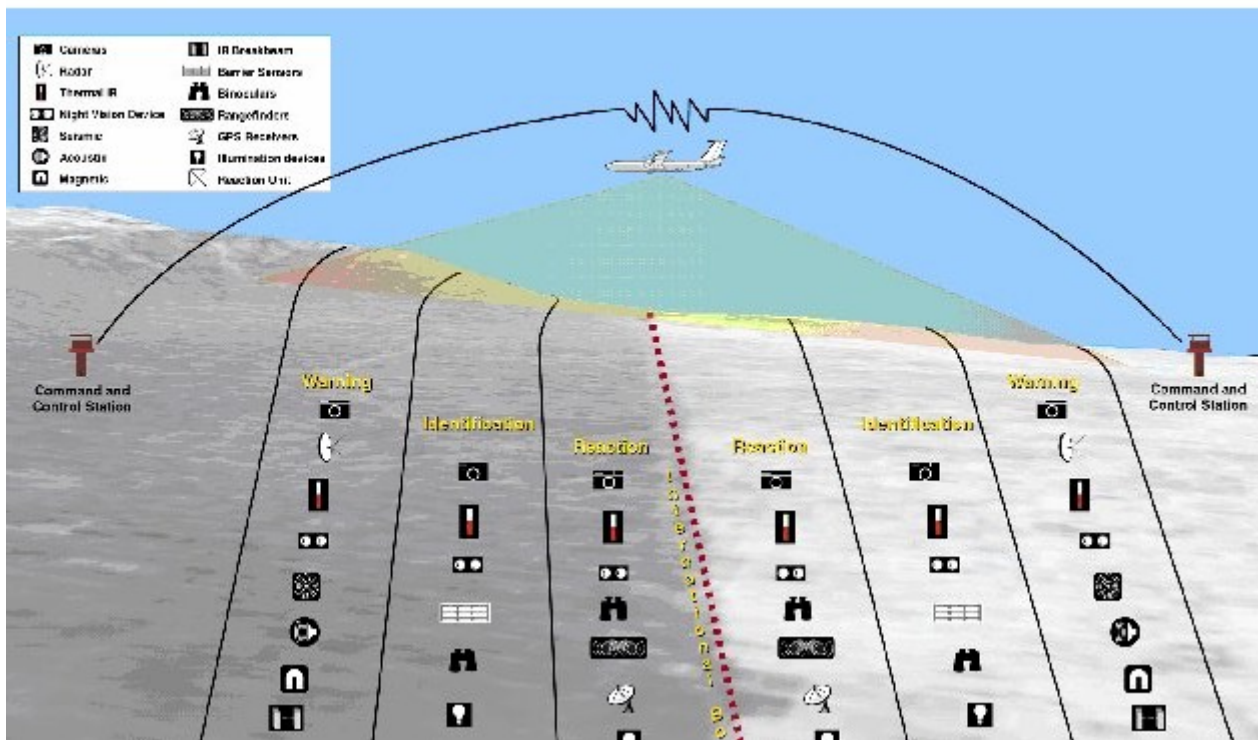


Figure 4. Notional Cooperative Monitoring System for Desert Terrain

Figure 5 shows an example of a possible crossing route in desert terrain. This sketch shows a ravine crossing a border. A possible sensor layout to cover the crossing route is also shown. While long-range sensors such as radar cover the open terrain outside the ravine, the bottom and sides of the ravine are monitored by seismic and acoustic sensors. Cameras mounted in the ravine are used to identify targets that these sensors detect. If the crossing route is relatively narrow, then a fence with barrier sensors can be used to block access to the border. Response units can be stationed outside of the ravine, where they cannot be seen by would-be border crossers.

5.2.6.2. Jungle

Short lines of sight and overgrown vegetation characterize jungle terrain. Movement tends to be slower and to be concentrated along trails or other natural or manmade breaks in the vegetation. A large animal population may be present, which could cause a high false alarm rate. Intruders may tend to use stealth, rather than speed, to escape detection.

Figure 6 shows how a notional monitoring system for jungle terrain might be laid out.

The usefulness of long-range sensors would be limited by line-of-sight blockage. Short-range seismic, acoustic, or magnetic sensors may be preferable for detection. Barrier sensors may be used for detection if costs permit. Sensors may be concentrated along the obvious lines of movement, such as trails.

Cameras may be used for identification along lines of movement or when cued by short-range or barrier sensors. Because scent is a useful signature in the jungle, dogs might be used to identify and track intruders.

Aircraft assume a special importance when monitoring jungle terrain, where most surface movement is hindered. If roads are available, wheeled vehicles could be used. Off-road mobility is severely restricted, however. Helicopters can be very useful for transporting response personnel. Aircraft can also be used to aid the navigation of ground response teams. Illumination devices are useful in jungle terrain. Potential crossing routes in a jungle might follow clearings or areas with little undergrowth. Figure 7 shows how sensors might cover a crossing route. Short-range sensors, covered by cameras, could be used to monitor this route. Aircraft could also observe the route, if it is open to the sky. Response units could be stationed relatively close to the route, as vegetation could conceal them very effectively.

5.2.6.3. River

River approaches can have the characteristics of deserts, jungles, or other terrain. The riverbanks can be an obstacle to access the river itself, and can channel the approach to the river. The river may have shallow areas where fording is possible, which would attract subjects to those areas. The line of sight down the river may be short or long, depending upon the course of the river. Finally, boats and swimmers may have relatively small signatures, which would make detection and identification more difficult.

Figure 8 illustrates a notional monitoring system for a river.

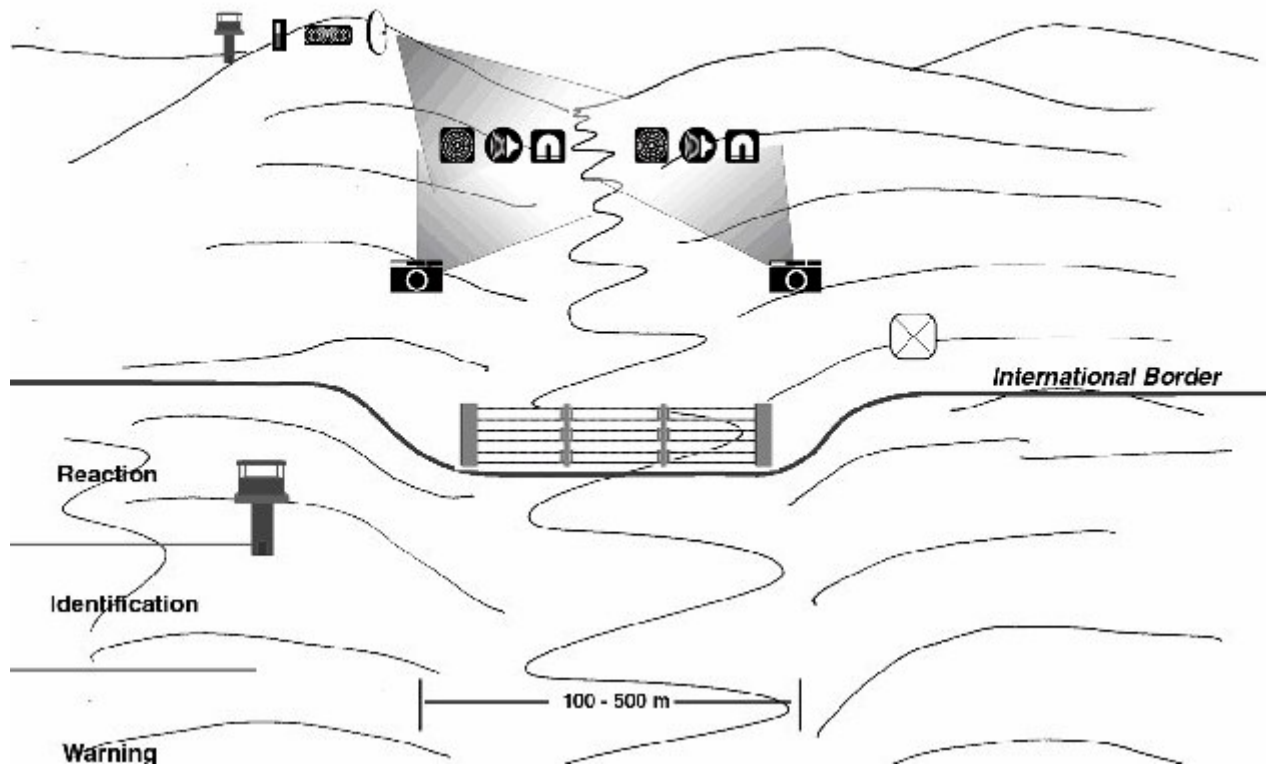


Figure 5. Desert Crossing Route

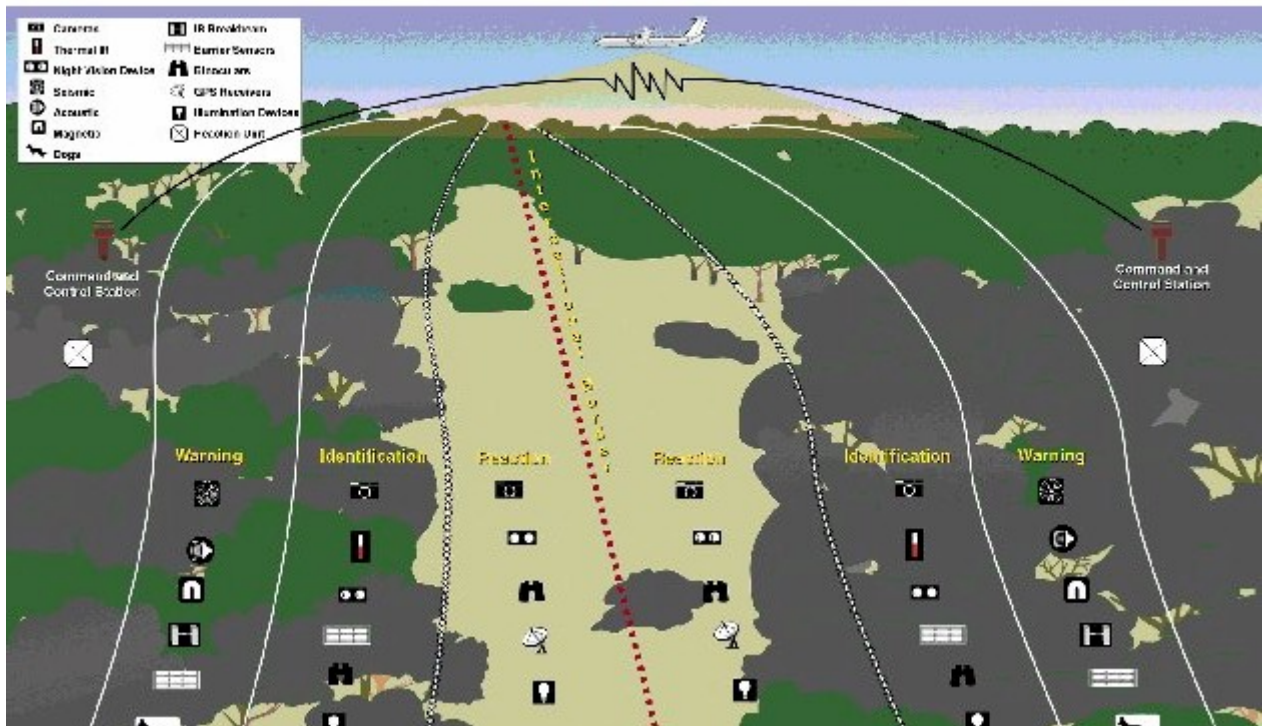


Figure 6. Notional Cooperative Monitoring System for Jungle Terrain

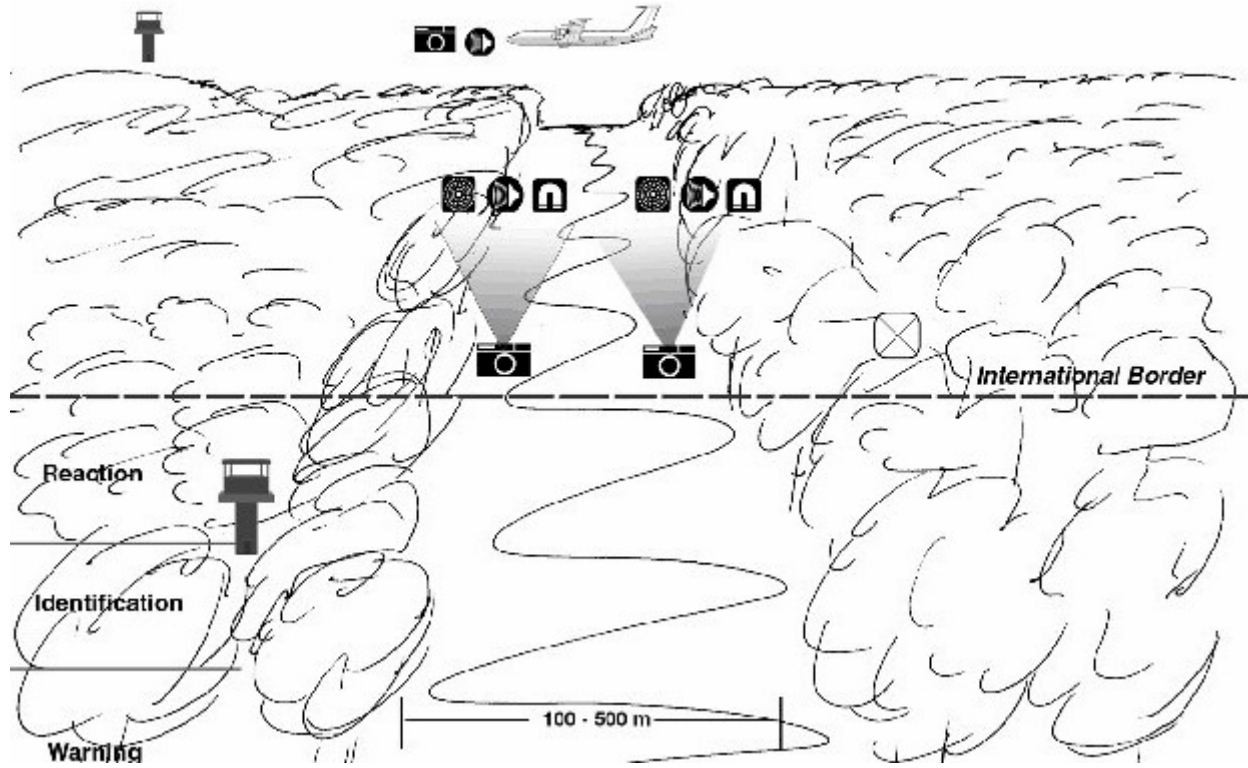


Figure 7. Notional Jungle Crossing Route

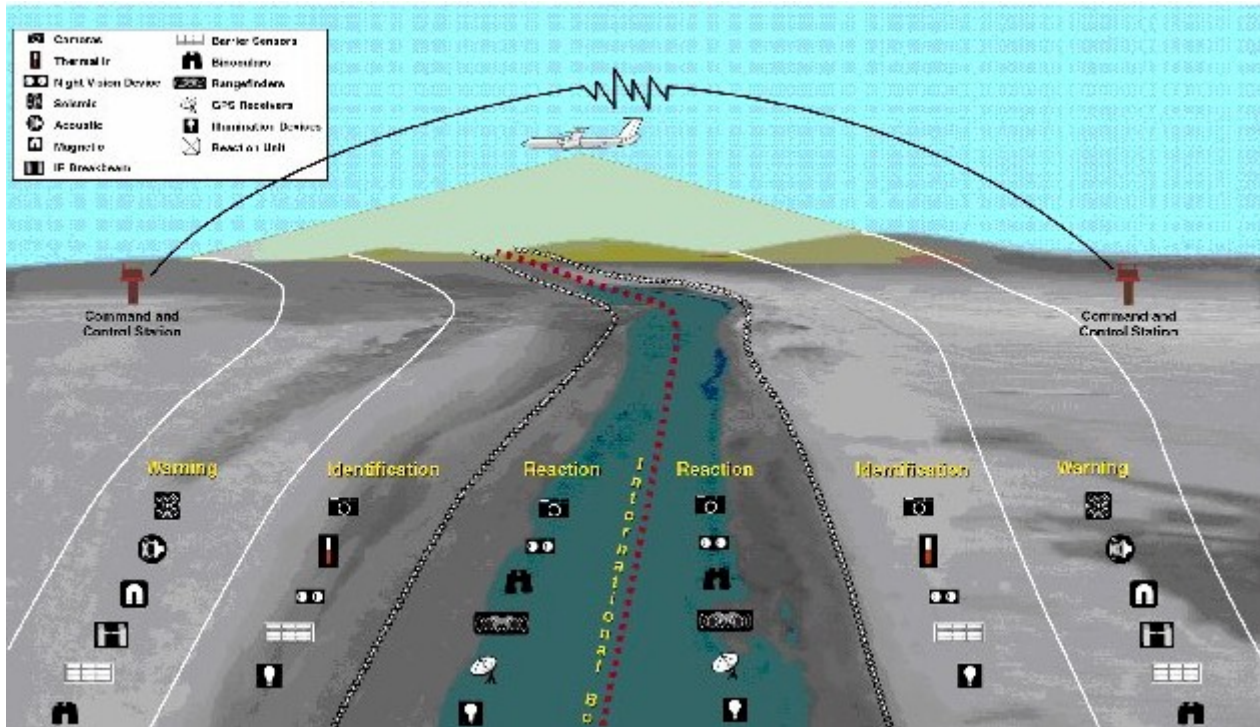


Figure 8. Notional Cooperative Monitoring System for River Terrain

A detection system monitoring the approaches to a river might have characteristics similar to those for a desert, jungle, or other terrain monitoring system, depending upon the nature of the approaches. At the river itself, short-range systems can be used on the banks, particularly where the banks permit the easiest access to the river. If the course of the river is straight, then long-range sensors aimed down the center of the river channel may be useful.

Identification can be made by cameras or other long-range sensors, if a sufficient line of sight exists. Short-range monitoring sensors can also cue cameras. Barrier sensors can be used at the banks of the river. These sensors can also cue cameras.

If the river is navigable, boats can be used to transport reaction units. Helicopters may also be used. The effectiveness of wheeled vehicles would depend upon the nature of the terrain on the approaches to the river.

Crossing routes for river borders would combine ease of access to the river's edge and relatively easy crossing of the river itself. Shallow areas that might be forded would be natural crossing points. Dangerous rapids would tend to be avoided. Figure 9 illustrates sensor placement at a potential crossing point. A valley floor provides easy access to the river. This valley can be covered by short-range sensors. Long-range sensors set on high banks can monitor the river itself, as can sensors mounted on river craft. These craft can also carry the response units with them.

5.2.6.4. Mountain

Mountain terrain tends to have few practical lines of movement. Lines of sight can be short or long, depending upon the specific site. Movement tends to be slow, with the exception of airborne movements. Extreme weather conditions may prevail much of the time.

A notional monitoring system for mountain terrain is shown in Figure 10.

Where long lines of sight exist, for example, down or across a large valley, long-range sensors may be used for detection. All-weather operation is important, especially during the cold seasons. Short-range sensors can be used for detection along natural lines of movement, such as narrow valleys or passes. Identification can be made by long-range imaging sensors, or short-range sensors can cue cameras.

Off-road traffic is restricted in mountainous regions. Helicopters can be used for transport, but very high mountain regions may reduce performance of the helicopters because of the thin air. Specialized vehicles for travel over snow and ice may be necessary.

Crossing routes in mountains tend to be located in valleys, passes, or gentle slopes, which permit easy movement and concealment. A potential crossing route in a valley is shown in Figure 11. Radar sensors could monitor wide valleys, while short-range sensors and barrier sensors could monitor narrow valleys.

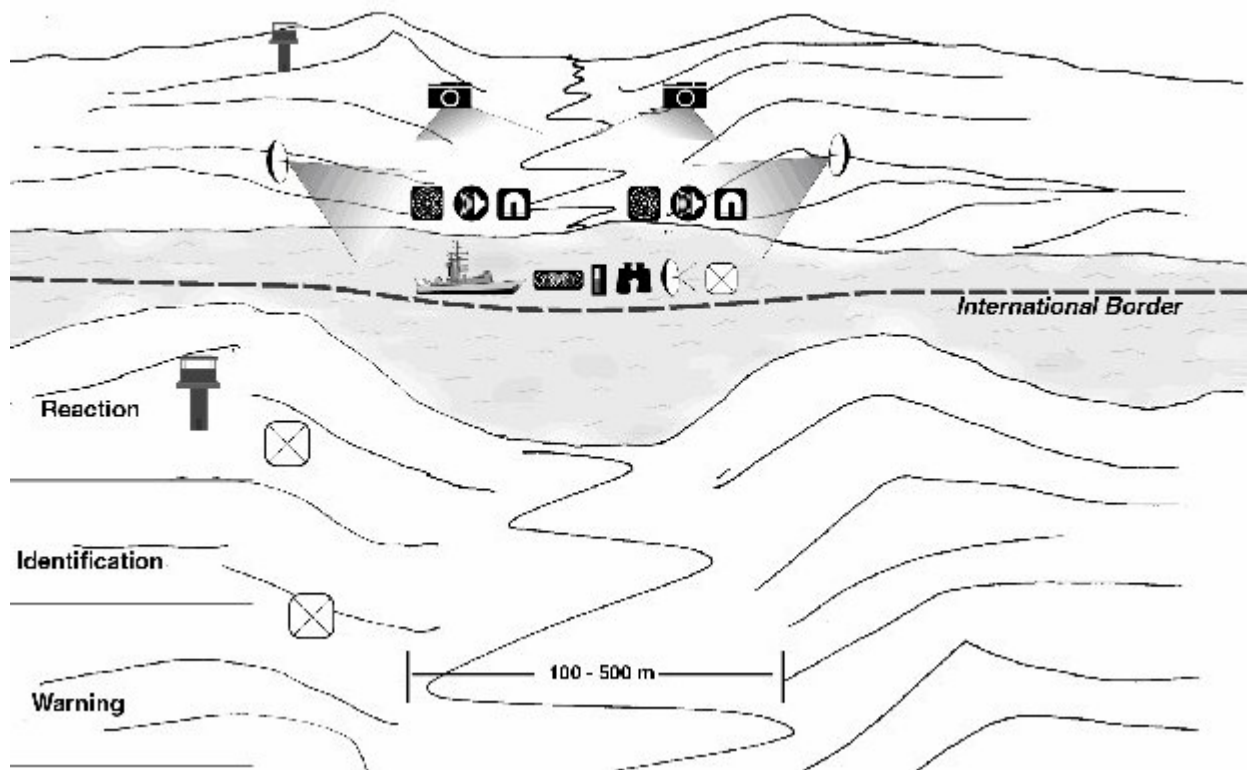


Figure 9. Sensor Placement at a Notional River Crossing Route

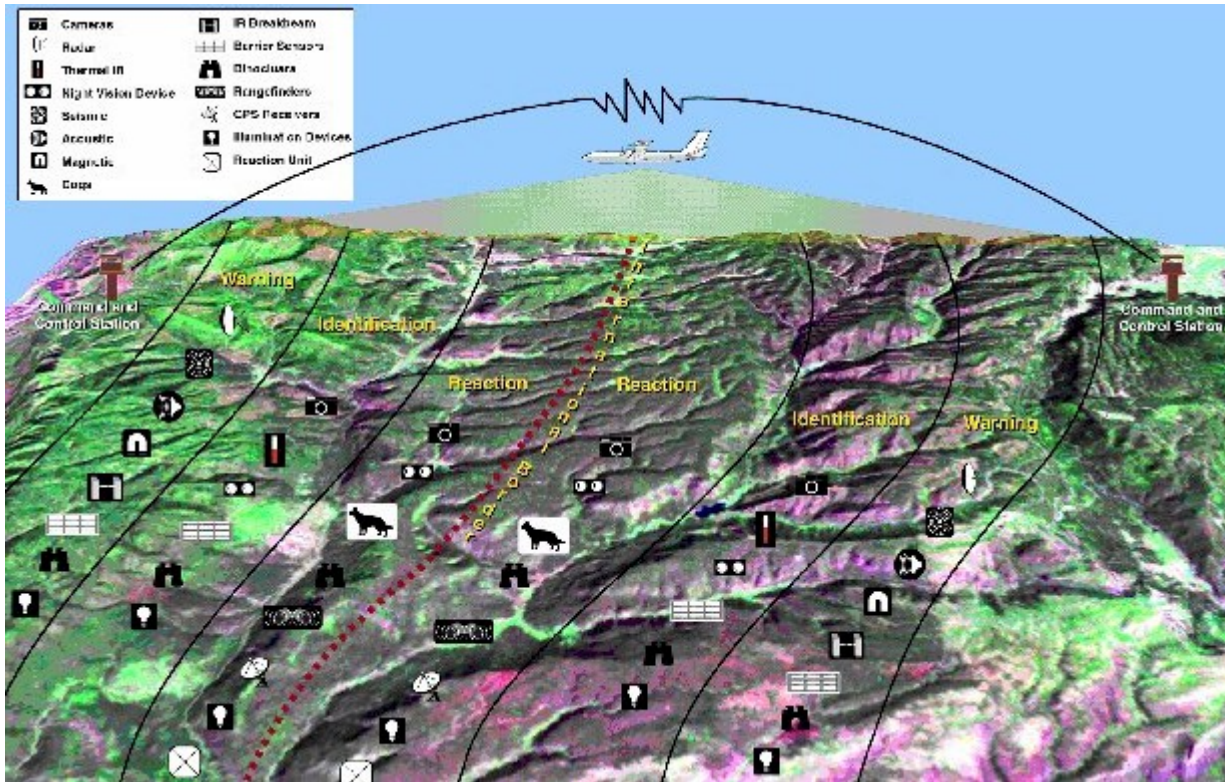


Figure 10. Notional Cooperative Monitoring System for Mountain Terrain

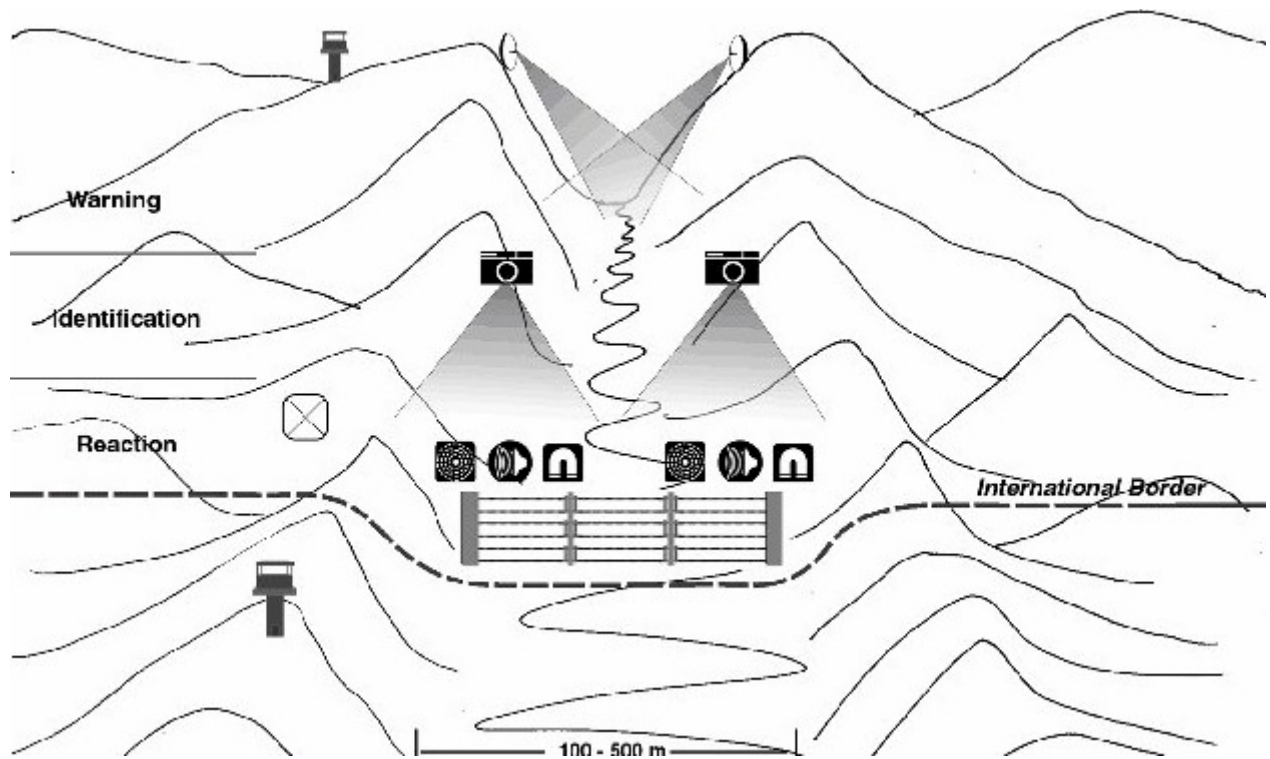


Figure 11. Notional Mountain Crossing Route

5.2.6.5. Coastal

Coastal monitoring systems may have a long line of sight looking out to sea. Limited visibility due to weather conditions may be a factor. There may or may not be long lines of sight along the shoreline, depending upon the local topography.

Figure 12 shows characteristics of a notional coastal monitoring system.

Long-range sensors may be placed to monitor the water. These sensors may be stationed on aircraft, boats, or on natural elevations or towers along the coastline. As movement can be swift on the water, maximum detection range is necessary to ensure sufficient response time. If the topography does not permit long-range sensors aimed down the shore, then lines of short-range sensors, such as seismic or magnetic sensors, may be used. Many shores have locations where access to the shore from the water is restricted, such as lines of cliffs. Sensor systems should concentrate on those areas where approach to the shore is easiest. Offshore, sensors that are compatible with a water environment such as acoustic or barrier sensors may be used to detect approaching swimmers or boats.

Identification can be made by long-range imaging sensors. If a mobile platform such as a boat or aircraft is used, then cameras may be used to identify intruders detected by other systems. Short-range sensors may be able to identify a boat or a swimmer, if the sensor is sensitive enough and sophisticated processing is used or a human is on hand to interpret the sensor information.

Depending upon the nature of the shore topography, land vehicles may or may not be used. If the terrain ashore is trafficable, then wheeled vehicles could be used for reaction units. Boats are an obvious choice for response units, as well as for sensor platforms. Aircraft, either helicopter or fixed wing, can be used to investigate detections either on land or on water.

Figure 13 shows a potential crossing route over a coastal border. The stretch of water to be crossed is relatively small. A small valley allows quick egress from the shore and concealment. Boats with sensors and long-range sensors mounted on elevated terrain can monitor the water. The valley can be monitored with short-range sensors and cameras. Acoustic sensors can be placed in the water close to the shore to detect boats and swimmers.

5.2.6.6. Border Crossing Points

Border crossing points have unique features. First, the approaches may be desert, mountain, or other types of terrain. Second, there may be a large volume of innocent traffic moving through the point, so the number of potential false alarms is great. Very short ranges characterize border crossings, so sensors that are not suitable elsewhere may be used here. Finally, access to the border crossing point itself might be the object of the subjects of interest.

In addition to short-range sensors designed to monitor traffic moving through the crossing points, all approaches to the border crossing point may need to be monitored. The terrain surrounding the crossing point will determine the type of sensors used.

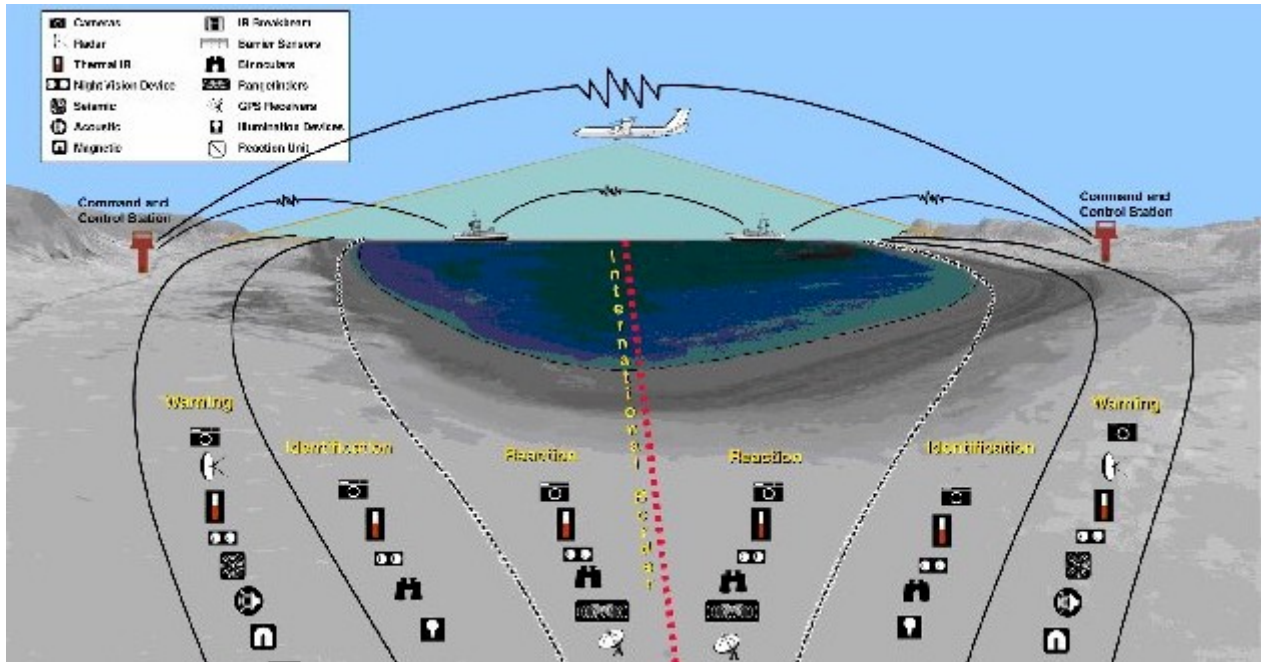


Figure 12. Notional Cooperative Monitoring System for Coastal Terrain

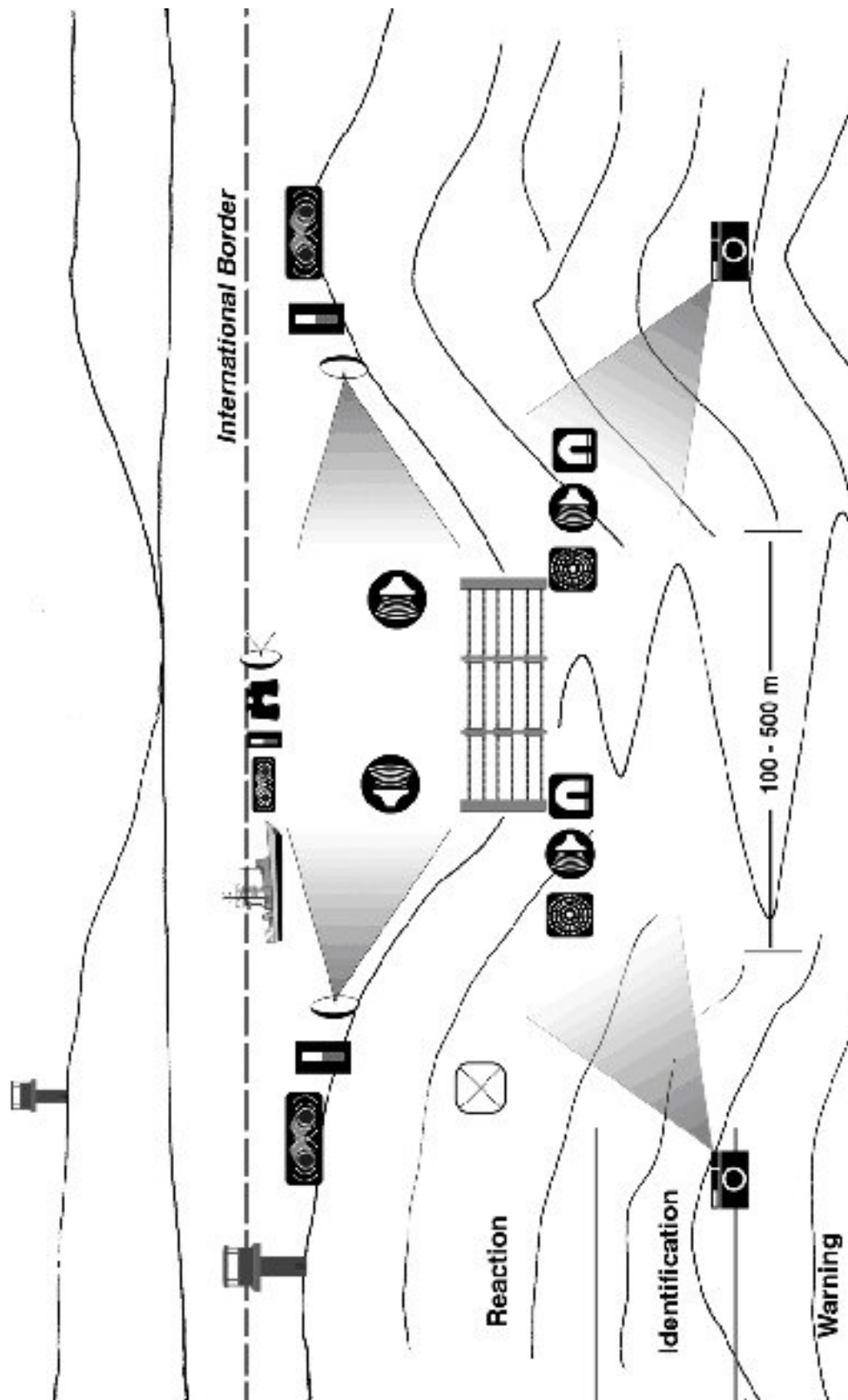


Figure 13. Potential Coastal Crossing Route for Coastal Terrain

Long-range sensors may be used in open terrain. Barrier sensors and short-range sensors may be needed for detecting approaches to the crossing point, if the crossing point is located in close terrain or in a populated area.

Cameras and human observers can be used here for identification. Identification of contraband would be an emphasis here, so very short-range sensors such as X-rays would be needed. Because of the short ranges, very quick responses would be needed, and barriers that slow movement could be useful. Response units may be stationed at the crossing point itself, and no vehicles may be necessary in that case. If the reaction units are stationed at a different location, their transport would depend upon the intervening terrain.

6. Conclusions

Developments in the peace process in the Middle East are leading to a significant change in the region. The peace process between Israel and the Palestinian Authority and a similar process between Israel and Syria (which could bring with it a peace agreement between Israel and Lebanon) could change the Middle East from an area of confrontation to an area of economic cooperation. Even with improved relations, the sensitivity about security would remain and needs to be managed in order to preserve the comprehensive peace.

Cooperative border monitoring can help reduce tensions and promote other cooperative endeavors, such as trade, between neighboring countries. The design of a system for border monitoring is challenging, but achievable. The nature of the terrain greatly influences the design of a border monitoring system. Some types of terrain, such as deserts, are relatively easy to monitor, while jungle areas are relatively difficult.

The considerations for a cooperative system among countries fall into three categories: political/military, institutional, and technological. (Specific applications would affect how these would be implemented.)

6.1. Political/Military Conclusions

The following conclusions relate to political/military solutions:

1. The ability to resolve disputes along a shared border relies on understandings and agreements for security cooperation endorsed by the leaders of the neighboring countries.
2. Security cooperation can diminish conflicts, prevent threats, and create an infrastructure for peace in the border region.
3. Security cooperation requires countries to define shared threats to enable a suitable response at the military, the political, and technological levels. The threats (guerrillas, terrorism, infiltration for subversive activity, smuggling, and illegal immigration) can create low-intensity conflict.
4. Ongoing commitment by senior government or military leaders is necessary to develop and implement cooperative solutions.

6.2. Institutional Conclusions

The following conclusions relate to institutional considerations:

1. Successful implementation relies on a communications system that allows rapid identification of the threat and coordination of the appropriate joint response in the shared security area. Coordination of land, naval, and air security operations may be required.
2. Joint plans for coordinated efforts within the border security zones are needed to ensure the effective and efficient deployment and operation of technological monitoring tools.
3. A system of three symmetrical security zones (detection, identification, and reaction) on each side of a border can be integrated into a joint monitoring and security area. The system benefits both sides

by cooperative actions ranging from exchange of information to security forces crossing the border in a coordinated operation (such as in hot pursuit).

4. The establishment of a "Joint Security Center" would centralize information management systems and could be used as a base for coordinating response.

6.3. Technological Conclusions

The following conclusions relate to technological considerations:

1. Successful implementation of cooperative border monitoring relies on the selection of the appropriate technological means for obtaining reliable, timely information to guide a response. Resources for monitoring (such as air force aircraft) may be supplied by government organizations.
2. A border monitoring system must be applicable to intruders approaching by all credible routes (land, air, water, underwater, and underground.)
3. Auxiliary systems, such as illumination, communication, and navigation and movement routes for response teams should be considered in system design.
4. It is essential to distinguish between potentially dangerous and harmless subjects when defining the proper response.
5. Official border crossing points must be monitored.

7. Recommendations

7.1. Technical Recommendations

Several actions could build upon this study and focus on practical applications, as follows:

1. Conduct a detailed study for the generic terrain types defined in this study to analyze cost and system integration for a monitoring system.
2. Conduct a detailed study of a border monitoring system for a specific section of an international border in order to understand how the generic solutions might be implemented in an operational situation.
3. Conduct an experiment using actual sensors and communications to simulate a cooperative border monitoring system.

7.2. Institutional Recommendations

7.2.1. Establish an Intra-regional Center

A primary recommendation of this study is to encourage dialogue and new understandings between countries. Toward that end, the author recommends the establishment of an intra-regional center for joint research on issues of security, technology, communications, and economics in the Middle East.

The intra-regional center would be operated by representatives of the various Middle East countries and would promote ongoing dialogue on shared issues, which would make it possible to define development programs to advance the entire region. Working groups or committees would address regional arms control (conventional and nonconventional) and economic issues

The intra-regional center would foster the following:

1. Joint research could create a constructive climate for dialogue, which would help reduce tensions and increase understanding between the partners.
2. The center could provide additional communication channels between the partner governments, enabling joint projects to formulate regional development programs to advance and improve the welfare of the population of the entire Middle East.

The following recommendations to operate the joint research center in the Middle East are proposed:

1. Establish the main center in one of the Middle Eastern countries, based on the partners' agreement. Open branches of the center in neighboring countries that specialize in a particular topic. The most active center would likely be the security center, where military representatives and members of the academia could work together.
2. Proposals should be made to international organizations for assistance (i.e., funds, technology, and expertise) in operating the center.

The following research topics could be pursued by the center:

1. Cooperation in battling terrorism
2. Cooperation in fighting smuggling, especially drugs
3. Joint work and research teams for arms control, both conventional and nonconventional
4. Development of new water sources and distribution systems for the Middle East
5. Development of joint advanced industrial centers
6. Development of economic, agricultural, and tourism projects
7. Development of a shared intraregional infrastructure plan (roads, railroads, airports, fuel, gas, electricity, communication, and water)
8. Development of advanced communication centers
9. Development of social, health, welfare, and education facilities for the countries of the region

7.3. Conduct Intraregional Research on Middle East Border Security Problems

Despite progress in the effort toward comprehensive peace in the Middle East, most of the countries are still struggling with border security problems. An incident along the border can cause deterioration in the relations between the neighboring countries. The author recommends two measures to encourage the collective resolution of border security problems:

3. Hold a Jordanian-Palestinian-Israeli meeting in a neutral venue to identify and resolve security problems along their shared borders. Formulating ideas for coordinated answers to future security problems along their borders could significantly advance the understanding necessary for effective solutions.
4. Hold a meeting (or a series of meetings) among Middle Eastern countries in a neutral venue to identify security problems and propose options along shared borders. Just holding such a practical meeting would be a significant confidence-building measure in itself. A joint document could create the momentum for further developments in solving these sensitive problems in the entire region.

8. About the Author

Gideon Netzer is a Colonel (res.) in the Israel Defense Forces. He earned his Master's degree in Strategic (Physical) Planning from the Bar Ilan University and holds two Bachelor of Arts degrees, including one in Economics and one in History of the Middle East. From 1966 to 1996, Netzer served in a variety of military posts, including duty in infantry and paratrooper units, plus instruction and special staff assignments. His last assignment was Special Advisor in the IDF Central Command Headquarters for the Oslo-mandated military redeployment in the West Bank. He now holds a senior reserve position in a large armored formation. He participated in a strategic planning program for developing the Beit She'an valley, including a plan for Israeli-Jordanian cooperation in agriculture, industry, tourism, and joint water works. This regional development proposal was submitted by Prime Minister Shimon Peres at the first regional economic summit in Casablanca (May 1995), and later submitted to the World Bank as a regional cooperative development project.

APPENDIX A: Low-Intensity Conflict—An Analysis of Its Application to Border Security Problems

Various fundamentalist, extremist, and terrorist groups have caused violent incidents in the Middle East that require governments to respond to threats in a new way. Rather than engaging in comprehensive

wars (high-intensity conflict, or HIC), countries must deal with low-intensity conflict (LIC). LIC includes the battle against guerrilla and terrorist activities, and the ongoing fight to ensure border security.

New challenges require new solutions. LIC requires a different approach by the state than HIC. Military responses, such as selecting a suitable target or tactical operation method, are coupled with political dialogue as part of the response to LIC actions. In HIC, the aim is to destroy the systems of the opponent, whereas in LIC, the aim is to dismantle a system on one hand, but also to create a different relationship with the opponent.

Comprehensive System Perception

The collapse of the Soviet Union and the end of the Cold War presented the U.S. Army with a new situation with different threats. The U.S. Army was forced to redefine its doctrines. The logic of comprehensive war, enhanced by the nuclear threat, changed, and with it changed some comprehensive systematic military thinking patterns. During the Cold War, attention was concentrated on the possibility of a nuclear war between the superpowers, and de-emphasized other types of conflicts, such as LIC.

The Development of the Concept of Low-Intensity Conflict

However, over recent years, various armies have battled terrorism and guerrilla activities and dealt with many problems along their borders, prompting the development of military thought and clear doctrines to battle these threats, as is done for comprehensive wars (HIC). The U.S. Army, for example, has recognized that it must prepare also for operations other than war (OOTW).

Some U.S. Army publications attempted to define the concept of LIC. One author writes: "LIC is qualitatively different from war, has a different purpose and requires different methods. LIC conjures images of insurgent guerrillas in poor, tropical countries seeking to overthrow governments. In fact, that is only part of its meaning."

Another author defines LIC thus: "The generalizations of peace, LIC, and war are essentially correct in their middle regions, but the distinctions become fuzzy at the edges. That is, there are no bright line borders between them. At its upper limits, it [LIC] is distinguished from peace (or routine peaceful competition) by introducing violence into the political process."

The U.S. Army's attempt to make the transition to OOTW also indicates a lack of clarity and problems dealing with the subject of LIC. The basic assumption was that since these conflicts called for the use of force, it would be correct to use the same notions when discussing LIC as when discussing comprehensive war. The contradictions in these different situations reach all the way down to the level of the fighter: It is difficult to mold and teach the fighter to be sensitive in OOTW and daily activities, and at the same time to be determined and aggressive in comprehensive war. (The confusion regarding this understanding could explain the failure of the U.S. Army in the conflict in Somalia.) Various armies and academia are now discussing the distinctions between HIC and LIC, highlighting a change in our global understanding and perceptions.

All levels of military warfare seek to destroy the enemy. Although this continues to be the mission of the tactical levels, in the higher levels of war management, destroying the enemy and conquering the land is not identical to winning. All levels have to seek to achieve and even to define the essence of the victory. The working assumption that there is a clear division of roles between the military and the nonmilitary, in which the politicians determine the target and the army determines the achievement of the target, does not apply.

In a comprehensive, conventional war, the scope of the forces and their size indicate the importance, the level of risk, and the repercussions of the operation. In HIC, the plan dictates the moves. In LIC, the unpredictability of the conflict leads the processes, and not the preplanning. Both HIC and LIC have many interim stages. The operative program develops through interim goals, while the achievements in

each interim stage determine the plans for the next stage. The results of the campaign are discovered during the campaign.

In comprehensive war, the military is the central element for achieving operative goals, whereas in LIC, the awareness that this is a low-intensity conflict is the clear factor for achieving an operative and strategic goal. Terrorist or guerrilla activities along the border usually carry political or diplomatic messages. Therefore, these activities should be treated as an expression of wider political-strategic logic that requires suitable systematic response. The violent character of terrorist activity, guerrilla activity, or violent conflicts along state borders can be a means of applying pressure on the state. Therefore these violent activities must be dealt with and, at the same time, political dialogue must be seen as an important, complementary element, aiming to prevent the deterioration of these conflicts.

In general, combating terrorism and guerrillas and maintaining routine security borders play an important role in preparing for comprehensive war. This calls for the organization, training and equipping of forces to suit operational needs. It is important to emphasize that strategic-political concepts related to HIC cannot apply to LIC, therefore the army or any other organization must prepare to deal with this reality.

Routine Security Activity as Part of LIC

When some members of the defense establishment encounter LIC, they tend to cling to the known concepts of HIC, which may be inappropriate for low-intensity conflict. Whenever a state (the government) or army defines the national defense perception, it almost always refers to situations in which the state finds itself in comprehensive war. A nation's notion of state defense relies on the concept of comprehensive war.

Combative activities along the borders such as terrorism, guerrilla warfare, and routine security activities that lead to violent conflicts must be viewed as different threats than the threat of comprehensive war. For example, in comprehensive war, the observation post scans a wide area, noting the locations of tanks, battlements, opposing forces, and major pieces of equipment. The observation post transmits information to headquarters for their analysis and response on a large scale. In LIC, the observation post must be much more subtle, and its mission changes from a very narrow purpose (gather and transmit information) to becoming a mini-headquarters in itself, providing analysis and response in fast time frames. Amassing equipment in one area can be counter-productive in LIC: it becomes an easy target for guerrillas or terrorists. A state or army dealing with LIC must continuously redesign strategy and tactics to fit the new realities of conflict.

Summary

A political entity that has to be ready for a comprehensive war, but at the same time is busy with LIC, must prepare accordingly. Such preparation calls for a clear distinction in the methods of struggling with routine security, which is very different from struggling with comprehensive war, since this will affect the organization, training, and equipping of forces. It is important that the ongoing maintenance of security along the border will be a part of the general preparations for a comprehensive war. However, it is important also that the approach and understanding of the method will be suited to the concepts of LIC.

APPENDIX B: Key Security Sections of the Treaty of Peace between the State of Israel and the Hashemite Kingdom of Jordan

NOTE: This section is an excerpt from the 1994 peace treaty between Israel and Jordan.

ARTICLE 4 SECURITY

1.
 - a. Both Parties, acknowledging that mutual understanding and co-operation in security-related matters will form a significant part of their relations and will further enhance the security of the

region, take upon themselves to base their security relations on mutual trust, advancement of joint interests and co-operation, and to aim towards a regional framework of partnership in peace.

- b. Towards that goal the Parties recognize the achievements of the European Community and European Union in the development of the Conference on Security and Co-operation in Europe (CSCE) and commit themselves to the creation, in the Middle East, of a CSCME (Conference on Security and Co-operation in the Middle East). This commitment entails the adoption of regional models of security successfully implemented in the post World War era (along the lines of the Helsinki process) culminating in a regional zone of security and stability.
2. The obligations referred to in this Article are without prejudice to the inherent right of self-defence in accordance with the United Nations Charter.
 3. The Parties undertake, in accordance with the provisions of this Article, the following:
 - a. to refrain from the threat or use of force or weapons, conventional, non-conventional or of any other kind, against each other, or of other actions or activities that adversely affect the security of the other Party;
 - b. to refrain from organising, instigating, inciting, assisting or participating in acts or threats of belligerency, hostility, subversion or violence against the other Party;
 - c. to take necessary and effective measures to ensure that acts or threats of belligerency, hostility, subversion or violence against the other Party do not originate from, and are not committed within, through or over their territory (hereinafter the term "territory" includes the airspace and territorial waters).
 4. Consistent with the era of peace and with the efforts to build regional security and to avoid and prevent aggression and violence, the Parties further agree to refrain from the following:
 - a. joining or in any way assisting, promoting or co-operating with any coalition, organisation or alliance with a military or security character with a third party, the objectives or activities of which include launching aggression or other acts of military hostility against the other Party, in contravention of the provisions of the present Treaty.
 - b. allowing the entry, stationing and operating on their territory, or through it, of military forces, personnel or materiel of a third party, in circumstances which may adversely prejudice the security of the other Party.
 5. Both Parties will take necessary and effective measures, and will co-operate in combating terrorism of all kinds. The Parties undertake:
 - a. to take necessary and effective measures to prevent acts of terrorism, subversion or violence from being carried out from their territory or through it and to take necessary and effective measures to combat such activities and all their perpetrators.
 - b. without prejudice to the basic rights of freedom of expression and association, to take necessary and effective measures to prevent the entry, presence and co-operation in their territory of any group or organisation, and their infrastructure, which threatens the security of the other Party by the use of or incitement to the use of, violent means.
 - c. to co-operate in preventing and combating cross-boundary infiltrations.
 6. Any question as to the implementation of this Article will be dealt with through a mechanism of consultations which will include a liaison system, verification, supervision, and where necessary, other mechanisms, and higher level consultation. The details of the mechanism of consultations will

be contained in an agreement to be concluded by the Parties within 3 months of the exchange of the instruments of ratification of this Treaty.

7. The Parties undertake to work as a matter of priority, and as soon as possible in the context of the Multilateral Working Group on Arms Control and Regional Security, and jointly, towards the following:
 - a. the creation in the Middle East of a region free from hostile alliances and coalitions;
 - b. the creation of a Middle East free from weapons of mass destruction, both conventional and non-conventional, in the context of a comprehensive, lasting and stable peace, characterised by the renunciation of the use of force, reconciliation and goodwill.

ARTICLE 12 COMBATING CRIME AND DRUGS

The Parties will co-operate in combating crime, with an emphasis on smuggling, and will take all necessary measures to combat and prevent such activities as the production of, as well as the trafficking in illicit drugs, and will bring to trial perpetrators of such acts. In this regard, they take note of the understandings reached between them in the above spheres, in accordance with Annex III and undertake to conclude all relevant agreements not later than 9 months from the date of the exchange of the instruments of ratification of this Treaty.

Annex III to the Israel-Jordan Peace Treaty

COMBATING CRIME AND DRUGS

A. Co-operation on Combating Dangerous Drugs

1. The two Parties shall co-operate in fighting illicit drugs according to the legal system of their countries.
2. The two Parties shall take all necessary measures to prevent drug smuggling between the two countries.
3. The two Parties shall exchange information regarding drug trafficking and dealers' activities concerning the two countries.
4. Information given by one of the Parties may not be shared with a third party without the consent of the Party which provided the information.
5. The two Parties shall exchange and share the experience of fighting against drugs, including anti-drug education, prevention, treatment, rehabilitation programs, technical means and methods of concealment.
6. In order to identify the persons involved in drug activities, the two Parties shall facilitate controlled deliveries of drugs between the two countries according to their laws
7. Drug law enforcement officers from both sides shall meet periodically to coordinate efforts pertaining to drug problems concerning the two countries.
8. The two Parties shall maintain open channels of communication such as fax, telephone and telex for liaison purposes in drug matters concerning the two countries.
9. The two Parties shall cooperate with the multilateral forums which deal with drug issues in the area.
10. The two Parties shall cooperate in investigating procedures necessary for collecting evidence and indictment in cases against drug dealers which concern either or both countries.

11. The two Parties shall exchange information regarding statistics on the type and number of drug crimes committed in each country including detailed information regarding suspected and convicted persons involved in these cases.
12. The two Parties shall exchange all relevant information regarding the narcotic drug producing laboratories if revealed in either of the two countries, including structure, working methods and technical features of the laboratory as well as the type and trademark of the product.
13. The cooperation described in this document will be carried out in accordance with the legal system of the two countries.

B. Crime

Exchange of information concerning all aspects of smuggling, theft (including art objects, vehicles, national treasures, antiquities and documents), etc. Apprehension of criminals and exchange of information including transmission of evidence in order to carry out judicial procedures in each of the two countries, subject to the relevant treaties and regulations.

General Cooperation

- Exchange of information regarding technical matters.
- Exchange of information regarding training and research.
- Joint police research projects on topics of mutual interest to both countries.

Additional Issues

- Rescue
- Unintentional border crossing, fugitives from justice.
- Notification of detention of nationals of the other country.
- Establishment of a liaison mechanism between the sides.

C. Cooperation on Forensic Science

1. The two Parties shall cooperate on the subjects of criminal identification and forensic science.
2. The two Parties shall share and exchange professional experience and training programmes, inter alia:
 - a. Use of field kits for preliminary examinations
 - b. Analysis of illicit drugs.
 - c. Analysis of poisons and toxic materials.
 - d. Forensic biology and DNA examinations.
 - e. Toolmarks and materials examinations.
 - f. Questionable documents examinations.
 - g. Analysis of voice prints.
 - h. Analysis of fire arms.
 - i. Detection of latent fingerprints.
 - j. Analysis of explosive traces.
 - k. Examination for arson in laboratories.
 - l. Identification of victims in mass disasters.
 - m. Research and development in forensic science.

APPENDIX C Sinai Interim Agreement (Sinai II)

Following are excerpts from the texts of the Agreement between Egypt and Israel, the Annex to the Egypt-Israel Agreement.

AGREEMENT BETWEEN EGYPT AND ISRAEL

The government of the Arab Republic of Egypt and the Government of Israel have agreed that:

ARTICLE I

The conflict between them and in the Middle East shall not be resolved by military force but by peaceful means.

The Agreement concluded by the Parties January 18, 1974, within the framework of the Geneva Peace Conference, constituted a first step towards a just and durable peace according to the provisions of Security Council Resolution 338 of October 22, 1973.

They are determined to reach a final and just peace settlement by means of negotiations called for by Security Council Resolution 338, this Agreement being a significant step towards that end.

ARTICLE II

The parties hereby undertake not to resort to the threat or use of force or military blockade against each other.

ARTICLE III

The Parties shall continue scrupulously to observe the cease-fire on land, sea and air and to refrain from all military or paramilitary actions against each other.

The Parties also confirm that the obligations contained in the Annex and, when concluded, the Protocol shall be an integral part of this Agreement.

ARTICLE IV

A. The Military forces of the parties shall be deployed in accordance with the following principles:

- (1) All Israeli forces shall be deployed east of the lines designated as Lines J and M on the attached map.
- (2) All Egyptian forces shall be deployed west of the line designated as Line E on the attached map.
- (3) The area between the lines designated on the attached map as Lines E and F and the area between the lines designated on the attached map as Lines J and K shall be limited in armament and forces.
- (4) The limitations on armaments and forces in the areas described by paragraph (3) above shall be agreed as described in the attached Annex.
- (5) The zone between the lines designated on the attached map as Lines E and J, will be a buffer zone. In this zone the United Nations Emergency Force will continue to perform its functions as under the Egyptian-Israeli Agreement of January 18, 1974.
- (6) In the area south from Line E and west from Line M, as defined on the attached map, there will be no military forces, as specified in the attached Annex.

B. The details concerning the new lines, the redeployment of the forces and its timing, the limitation on armaments and forces, aerial reconnaissance, the operation of the early warning and surveillance installations and the use of the roads, the United Nations functions and other arrangements will all be in accordance with the provisions of the Annex and map which are an integral part of this Agreement and of the Protocol which is to result from negotiations pursuant to the Annex and which, when concluded, shall become an integral part of this Agreement.

ARTICLE V

The United Nations Emergency Force is essential and shall continue its functions and its mandate shall be extended annually.

ARTICLE VI

The Parties hereby establish a Joint Commission for the duration of this Agreement. It will function under the aegis of the Chief Coordinator of the United Nations Peacekeeping Missions in the Middle East in order to consider any problem arising from this Agreement and to assist the United Nations Emergency Force in the execution of its mandate. The Joint Commission shall function in accordance with procedures established in the Protocol.

ARTICLE VII

Non-military cargoes destined for or coming from Israel shall be permitted through the Suez Canal.

ARTICLE VIII

This Agreement is regarded by the Parties as a significant step towards a just and lasting peace. It is not a final peace agreement.

The Parties shall continue their efforts to negotiate a final peace agreement with the framework of the Geneva Peace Conference in accordance with Security Council Resolution 338.

ANNEX TO THE AGREEMENT

Within 5 days after the signature of the Egypt-Israel Agreement, representatives of the two Parties shall meet in the Military Working Group of the Middle East Peace Conference at Geneva to begin preparation of a detailed Protocol for the implementation of the Agreement. The Working Group will complete the Protocol within 2 weeks. In order to facilitate preparation of the Protocol and implementation of the Agreement, and to assist in maintaining the scrupulous observance of the cease-fire and other elements of the Agreement, the two Parties have agreed on the following principles, which are an integral part of the Agreement, as guidelines for the Working Group.

1. Definitions of Lines and Areas

The deployment lines, Areas of Limited Forces and Armaments, Buffer Zones, the area south from Line E and west from Line M, other designated areas, road sections for common use and other features referred to in Article IV of the Agreement shall be as indicated on the attached map (1:100,000—U.S. Edition)

2. Buffer Zones

- (a) Access to the Buffer Zones will be controlled by the United Nations Emergency Force, according to procedures to be worked out by the Working Group and the United Nations Emergency Force.
- (b) Aircraft of either Party will be permitted to fly freely up to the forward line of that Party. Reconnaissance aircraft of either Party may fly up to the middle line of the Buffer Zone between Lines E and J on an agreed schedule.
- (c) In the Buffer Zone between Lines E and J, there will be established under Article IV of the Agreement an Early Warning System entrusted to United States civilian personnel as detailed in a separate proposal, which is a part of this Agreement.
- (d) Authorized personnel shall have access to the Buffer Zone for transit to and from the Early Warning System; the manner in which this is carried out shall be worked out by the Working Group and the United Nations Emergency Force.

3. Area South of Line E and West of Line M

- (a) In this area, the United Nations Emergency Force will assure that there are no military or paramilitary forces of any kind, military fortifications and military installations; it will establish checkpoint and have the freedom of movement necessary to perform this function.
- (b) Egyptian civilians and third-country civilian oil field personnel shall have the right to enter, exit from, work, and live in the above indicated area, except for Buffer Zones 2A, 2B and the United Nations Posts. Egyptian civilian police shall be allowed in the area to perform normal civil police functions among the civilian population in such numbers and with such weapons and equipment as shall be provided for in the Protocol.
- (c) Entry to and exit from the area, by land, by air or by sea, shall be only through the United Nations Emergency Force checkpoints. The United Nations Emergency Force shall also establish checkpoints along the road, the dividing line and at other points, with the precise locations and number to be included in the Protocol.
- (d) Access to the airspace and the coastal area shall be limited to unarmed Egyptian civilian vessels and unarmed civilian helicopters and transport planes involved in the civilian activities of the area as agreed by the Working Group.
- (e) Israel undertakes to leave intact all currently existing civilian installations and infrastructures.

4. Aerial Surveillance

5. Limitation of Forces and Armaments

- (a) Within the Areas of Limited Forces and Armaments (the areas between Lines J and K and Lines E and F) the major limitations shall be as follows:
 - (1) Eight (8) standard infantry battalions.
 - (2) Seventy-five (75) tanks.
 - (3) Seventy-two (72) artillery pieces, including heavy mortars (i.e., with caliber larger than 120 mm.), whose range shall not exceed twelve (12) km.
 - (4) The total number of personnel shall not exceed eight thousand (8,000).
 - (5) Both Parties agree not to station or locate in the area weapons which can reach the line of the other side
 - (6) Both Parties agree that in the areas between Lines J and K, and between they will Line A (of the Disengagement Agreement of January 18, 1974) and Line E, construct no new fortifications or installations for forces of a size greater than that agreed herein.
- (b) The major limitations beyond the Areas of Limited Forces and Armaments will be:
 - (1) Neither side will station nor locate any weapon in areas from which they can reach the other line
 - (2) The Parties will not place anti-aircraft missiles within an area of ten (10) kilometers east of Line K and west of Line F, respectively.
- (c) The United Nations Emergency Force will conduct inspections in order to ensure the maintenance of the agreed limitations within these areas.

ANNEX B

Article III

THE NORTHERN AREA

1. Buffer Zone 1

- a. The zone between the lines designated on the Map attached to the Agreement as Lines E and J will be a Buffer Zone.
 - b. UNEF will maintain checkpoints, observation posts and reconnaissance patrols along the lines of the Buffer Zone and within the area, in order to prevent any unauthorized entry into the area of any person. Access will be only through the checkpoints controlled by UNEF.
 - c. In Buffer Zone 1 there will be established an Early Warning System entrusted to United States civilian personnel.
 - d. UNEF shall have complete freedom of movement within Buffer Zone 1, except that UNEF personnel shall not enter the perimeter of the Surveillance Stations.
2. Limitation of Forces and Armaments
- a. The major limitations on Forces and Armaments are as provided for in article IV B of the Agreement and paragraph 5 of the Annex.
 - b. UNEF supervision
 - (i) UNEF will conduct inspections as follows:
 - (i) In areas between Lines E and F and Lines K and J as regards limitations of forces and armaments.
 - (ii) In the area between Line E up to ten (10) kilometers West of Line F and in the area between Line J up to ten (10) kilometers East of Line K to assure that anti-aircraft missiles are not placed in the areas.
 - (iii) UNEF shall conduct bi-weekly inspections in the areas referred to in b.(i)(a) and b.(i)(b) above in order to ensure the maintenance of the agreed limitations within these areas.
 - (iv) UNEF shall inform both Parties of the results of such inspections.
 - (v) UNEF inspection teams shall be accompanied by liaison officers of the respective Parties.
 - (vi) UNEF shall carry out additional inspections within twenty-four (24) hours after the receipt of such a request from either Party, and will promptly furnish both Parties with the results of each inspection.
3. Early Warning System
- a. The Early Warning System, based on the Agreement, the Annex and the accepted Proposal which constitutes an integral part of the Agreement, will include:
 - (i) Two (2) Surveillance Stations operated by each Party respectively.
 - (ii) Three (3) U.S. Watch Stations and four (4) unmanned electronic sensor fields.
 - b. The location of the system and the approach roads are indicated on Map 'A' attached to the Protocol.
 - c. Surveillance Stations
 - (i) General
 - (a) Each Party shall maintain a Surveillance Station in Buffer Zone 1, to provide strategic early warning.
 - (b) UNEF personnel will not enter the Surveillance Stations of each Party.
 - (c) Each Party may visit its respective Surveillance Station and may freely supply and replace personnel and equipment situated therein, in accordance with the following procedures:
 - UNEF will escort from its checkpoints to the perimeter of the Station and back.
 - From that point escort and verification will be as described in paragraph 3.d.(ii).
 - (d) Each Party will be permitted to introduce into its Station items required for the proper functioning of the Station and personnel.

(ii) The Stations

- (a) Each Surveillance Station shall be manned by not more than two hundred and fifty (250) technical and administrative personnel, equipped with small arms (revolvers, rifles, sub-machine guns, light machine guns, hand grenades and ammunition) required for their protection.
- (b) Each Party will be permitted to maintain in its respective Surveillance Station, fifteen (15) administrative vehicles, two to three (2-3) mobile engineering equipment for the maintenance of the site and the road and fire-fighting and general maintenance equipment. All vehicles shall be unarmed.

(iii) Access to and exit from the Stations

- (a) Access to and exit from the Surveillance Stations shall be as follows (as indicated on Map 'A' attached to the Protocol):
- (b) Each Party will inform UNEF at least one hour in advance of each intended movement to and from the respective Surveillance Station. UNEF will coordinate with the appropriate Watch Station.
- (c) As to escort arrangements of personnel to the Surveillance Stations, see paragraph 3.d.(ii).
- (d) Such movement to and from the respective Surveillance Stations shall take place only during daylight.
- (e) Each Party shall be entitled even during the night to evacuate sick and wounded and summon medical experts and medical teams after giving immediate notice to the nearest Watch Station and UNEF.

(iv) Maintenance of Communication Cables and Water Lines

Communication cables and water lines passing through Buffer Zone 1, to the respective Surveillance Stations, shall be inviolable. Both Parties will be permitted to carry out maintenance and repairs along the routes of the communication cable and water lines. Notification of such maintenance team shall be given four (4) hours in advance, through The UN Alpha and Bravo checkpoints respectively, to the nearest Watch Station. UNEF personnel will accompany each team in the same manner as detailed in paragraph 3.d.(ii).

(v) Communication and Coordination between UNEF and the Parties

Technical arrangements, including the laying of telephone lines, will be arranged in order to facilitate communication and coordination between the UN checkpoints, the Watch Stations and each of the Parties.

d. U.S. role in Early Warning System

- (i) The U.S. role in the Early Warning System will be as provided for in the U.S. proposal attached to the Agreement.
- (ii) The UNEF will escort Egyptian and Israeli personnel to the perimeter of each Surveillance site where U.S. civilian personnel will verify that access by the Parties is in accordance with the provisions regarding access to the Surveillance sites.
- (iii) If experience suggests changes in locations or procedures, the U.S. shall be able to work out such changes in consultation with the Parties.

Article IV

JOINT COMMISSION

1. The Joint Commission, referred to in Article VI of the Agreement between Egypt and Israel signed on the 4th September 1975, shall function in accordance with the following rules:
 - a. The Commission shall meet under the Chairmanship of the Chief Coordinator of the United Nations Peace-keeping Missions in the Middle East or his representative and shall be composed of representatives of each party.
 - b. For the duration of the Agreement, the task of the Commission is to consider any problem arising from the Agreement and to assist the United Nations Emergency Forces in the execution of its mandate.
 - c. Ordinary meetings of the Commission shall be held at agreed dates. Invitations for the meetings shall be issued by the Chief Coordinator or his representative. In the event that either Party, or the Chief Coordinator, requests a special meeting, it will be convened within 24 hours.
 - d. The Commission shall hold its meetings in the Buffer Zone under the Chairmanship of the Chief Coordinator or his representative where liaison officers of the Parties will be available.
 - e. The Parties to the Agreement shall consider problems before the Commission in order to reach agreement.
 - f. The Commission may supplement these rules as it deems necessary.
 - g. It will hold its first meeting not later than one month after the signing of the Protocol.

Article V

FLIGHTS AND AERIAL RECONNAISSANCE

1. Aircraft of either party will be permitted to fly freely up to the forward line of that Party (Lines E and J respectively).
2. Reconnaissance aircraft of either Party may fly up to the Median Line of Buffer Zone 1 (designated on Map 'D', 1/500,000, US edition, attached to the Protocol) in accordance with the following principles:
 - a. Reconnaissance flights will be carried out by planes at a height of not less than 15,000 feet and on a straight course (along the median line of Buffer Zone 1). No maneuver should occur in the Buffer Zone that may involve the crossing of lines of the other Party.
 - b. Each reconnaissance flight shall not be made by more than two (2) planes.
 - c. There shall be seven (7) reconnaissance flights every week for each Party.
 - d. For these flights each Party will have at its exclusive disposal periods of 24 hours beginning at 1215 until 1145 the following day. The Parties will alternate in the use of the allocated periods. No flights will be carried out between 1145 and 1215 daily.
 - e. Egypt will be the first to exercise the right of carrying out flights on 22nd February 1976, starting from 1215. Israel will carry out its first flight on 23rd February 1976, starting from 1215, etc.
 - f. Notice shall be given to a representative of the Chief Coordinator not less than six (6) hours before each reconnaissance flight.
 - g. For reasons of weather limitations or other technical reasons, notice of a reconnaissance flight will specify a span of four (4) hours, during which time the reconnaissance flight will take place. (For example: a reconnaissance flight will take place on _____ date, between 1000 and 1400).

APPENDIX D: Potential Technologies for a Cooperative Monitoring System

A variety of sensor technologies can be used in cooperative monitoring systems. This appendix provides a brief functional description of sensors that were considered for border monitoring. There are multiple manufacturers for most types of sensors and this section is not intended to endorse a particular brand. Different models of the same type of sensor may have different features and capabilities.

Sensors of different types may be combined into a system that performs a specific function. For example, road traffic might be monitored by a combination of different types of sensors that detect and count vehicles as well as measure certain parameters such as weight. Alarms and descriptions of vehicles that

do not meet the monitoring criterion need not be transmitted. The system design might seek to detect vehicles that try to bypass the system by leaving the road.

D-1 Unattended Ground Sensors

Unattended sensors operate without routine human intervention. Their primary purpose is to detect activity in the area they monitor. A secondary purpose is to measure characteristics of the activity (e.g., weight, magnetic properties, length, etc.) to permit identification. Sensors are powered by batteries or, if available, direct AC electric power. A number of sensors using detection and measurement phenomenologies are available commercially. A system may be assembled using sensors with different detection phenomenologies. Each sensor is assigned an identification number. When activity occurs, a sensor transmits its identification code by radio as a short digital burst. An operator at the reception station notes the identification number and cross-references to a location. Receiving stations may vary from hand-held units (costing \$550 to \$1,300) to permanent monitoring stations. A large number of sensors typically require a computer to display sensor status on a map.

D-1.1 Fence Type

The taut-wire fence sensor uses the physical property that a steel wire will act as a spring. High-tensile strength wires, usually barbed, are strung horizontally between posts and placed under tension. Each wire is connected to a sensor located in a post midway along the wires. Attempting to climb over the fence or to spread the wires activates the sensors and causes an alarm. Cutting the wire also activates the sensor. The taut-wire fence has a very low false-alarm rate and is not generally affected by weather.

There are several different manufacturers of taut-wire sensors. The principle of operation is the same for all systems, although various models use mechanical switches, piezoelectric devices, and strain gauges. A taut-wire fence is relatively expensive (approximately \$154,000 per kilometer when installed) and is thus primarily applicable to zones or facilities that are to be monitored intensely.

An alternative type of fence sensor uses fiber-optic cables to detect intrusions. The fiber-optic cables are woven through a new or existing chain-link fence. An optical communication unit continually transmits a coded signal through the cable. Disruptions to the signal caused by cutting or movement generate changes in the light pattern that are detected by a receiver. The cost of this type of system, including the fence, is about \$60,000 per kilometer.

Comments on use:

Fence sensors provide both a physical barrier and a detection sensor. The system should be designed to detect attempts to penetrate the fence by digging under it. Activations provide location information based on the sector of the fence. The smaller the sectors, the more precise the location information. Taut-wire fence sensors are highly reliable and have a low rate of false alarms. Fiber-optic fence sensors are somewhat more likely to generate false alarms than the taut-wire system but can be installed in more rugged terrain. Both systems typically use AC power but could be converted to battery systems.

D-1.2 Microwave Type

Microwave sensor technology has been used for 20 years in a variety of security protection applications. An antenna continually broadcasts microwave energy. A receiver measures the reflected microwave energy to obtain a reference level of signal strength. Intruders entering the zone cause a change in the strength of the reflected signal and generate an alarm. Microwave sensors are classified as either monostatic or bistatic, depending on the configuration of the antennas. Bistatic models have separate transmit and receive antennas located at opposite ends of the detection zone. Monostatic models have the transmission and receiver antennas located together in a single housing. Some systems can be portable and powered by batteries. Many models are available and a unit costs in the range of \$3,000 to \$5,000.

Monostatic and bistatic microwave sensors both transmit in the X (10.525-GHz) frequency band or K (24-GHz) frequency band, but bistatic systems generally have longer range. The detection zone is adjustable by the operator. Monostatic systems have a cone shape and can be set from 20 m to 125 m in length with a width of 1 m to 8 m. Bistatic systems have an oval detection zone up to 500 m long and 6 to 12 m wide. When the microwave sensor unit is carefully positioned, the detection zone can follow moderate undulations in the local terrain.

Comments on use:

Microwave sensors are most effective in open areas. Special consideration must be given to screening false alarms. Movements of animals and vegetation moved by wind can cause false alarms. Thresholds for detection can be set to counter this problem. Rain and snow can reduce operational ranges. Because of their operational characteristics, an intruder could conceivably jam these sensors using electrical transmission equipment.

D-1.3 Active Infrared Type

Infrared breakbeam sensors detect changes in the signal power of an infrared beam created between a transmitter and a receiver (referred to as an "active system"). These systems require an unobstructed optical path. When an intruder breaks the beam (not visible to the human eye), the signal strength at the receiver lens is reduced, generating an alarm. The technology has been used around buildings for security purposes for about 25 years. They can also be employed along roads, paths, or waterways that provide routes of approach into secure areas.

The typical separation of the transmitter and receiver is about 100 m but new systems can have a line-of-sight separation as far apart as 150 m. The simplest version of a breakbeam system consists of a single pair of sensors mounted on tripods. A pair of sensors costs approximately \$500 (not including the communication equipment). Such a system can be portable. Tiny, highly portable systems with more limited range (about 30 m) can be used for temporary applications.

A more complex system of multiple transmitters and receivers can be installed on poles at each end of the detection zone. The detection zone thus becomes a vertical plane and can measure the profile of an object passing through it. If parallel sets of breakbeams are used, the system can determine if an object is greater than a specified length as well as its direction of travel.

Comments on use:

Fog, rain, and dust reduce the strength of the infrared beam between transmitter and receiver. Blowing vegetation or any objects that break the beam can cause false alarms. False alarms can be reduced by the use of multiple beam system that requires a specific number of beams to be broken in order to report an intrusion.

D-1.4 Passive Infrared Type

Passive infrared detectors measure the background level of infrared radiation being reflected in its field of view. The entry of an intruder changes the strength of the reflected energy because people and vehicles are warmer than the background. A sudden change in background causes an alarm to be transmitted. Nominal detection range is 30 m for people and 50 m for vehicles. A small, portable, battery-powered sensor of a ni Intrusion Detection System (MIDS) costs about \$500, including its radio transmitter.

Comments on use:

The sun can cause false alarms during dawn and sunset. Hot summer weather can cause some objects to radiate infrared energy longer than others, causing a "hot spot" in the sensor's field of view and a false alarm. The sensor can be tuned to reduce false alarms resulting from natural activity. The sensor needs to be carefully placed to avoid looking directly at the sun during dawn or sunset.

D-1.5 Pressure (Weight) Type

In well-defined locations such as roads and paths, vehicles passing a point can be detected using a weigh-in-motion (WIM) system. A WIM system consists of two magnetic sensors and a capacitance-type sensor. The system can be calibrated to report only vehicles weighing greater than a specified weight and thus screen extraneous information. WIM systems cost approximately \$25,000.

An alternative pressure sensor uses a buried fiber-optic cable. Heavy objects passing over the cable cause it to deflect and change the path of light passing through it. An alarm is reported if the cable is deflected above some threshold. This sensor does not measure the weight of the system as the above system does. The fiber optic cables can be hundreds of meters long but only report that a disturbance has occurred within one of its defined sectors. Smaller segments should be used if more precise location information is sought.

Comments on use:

These sensors are used most effectively across roads or paths. These sensors can require significant installation effort and are not suitable for rapid or temporary installation. In open country, rocky areas may prevent their use.

D-1.6 Seismic Type

The MIDS is representative of commercially available seismic sensors (\$400-500 cost with transmitter). Figure D-1 shows the MIDS sensors. The sensors can operate for two to three months from a common 9-volt battery, depending on the level of activity in the area being monitored. An external weatherproof battery pack assembly can replace the internal battery and extend the operational life by a factor of 10. An antenna is normally attached to the sensors to provide line-of-sight radio communication (138-MHz to 153-MHz band) up to 800 m. Radio signal repeaters (approximately \$1,200) can greatly increase this range.



Figure D-1. MIDS Sensors

The nominal detection range is 10 to 30 m for people walking and 100 to 300 m for vehicles. Vibrations can travel extended distances, but the sensor detection range is limited by the ability of the soil at the local site to transmit them. Dry, hard, sandy soil typically provides the longest detection ranges. Wet soil or soil with a high proportion of chalk absorbs vibrations, reducing the detection range. Limitations in the detection range can be overcome by careful placement or by using large numbers of sensors.

Comments on use:

Seismic sensors are unable to distinguish between vibrations originated by extraneous sources from those caused by intruders. High false alarm rates caused by extraneous seismic vibrations may prevent their effective use. Common causes of false alarms are small earthquakes, vibrations caused by low-flying aircraft or bushes blown by the wind, heavy rain or hail, and rapidly flowing water. The frequency of such false alarms may be reduced by sensitivity adjustments. Seismic sensors are useful for detecting tunneling activities.

An intruder could conceivably jam radio transmissions from sensors with another transmitter. A "state of health" radio beacon can be positioned among the sensors to indicate if signals are being jammed. This transmitter broadcasts every 10 minutes to verify that the system is operating and is not being jammed.

D-1.7 Magnetic Type

These sensors detect the movement of ferrous metal at very limited ranges. The MIDS magnetic sensor has a nominal detection range of 3 m for a person with a rifle and 20 m for a medium-sized truck. The cost is about \$500 with transmitter. These devices can be effectively employed against vehicles, and they serve as confirmatory devices to other unattended ground sensors.

Comments on use:

There is no analytical system to estimate detection ranges from the sensor as a function of ferrous mass. A sensor cannot distinguish between a small ferrous mass at a short range and a large mass at a long range. Placement in the field typically requires experimentation. Magnetic sensors tend to have high false alarm rates during electrical storms. Sensitivity can be adjusted in most sensors.

D-1.8 Disturbance Type

Disturbance devices require a physical interaction or contact with the intruder. Employment should be along roads, paths, or other avenues of approach. A break-wire detector consists of a fine wire that is stretched across a potential path for intruders. When the wire is broken, an alarm is transmitted by radio. The length is selected to match local conditions. The devices are often used with other sensors.

Comments on use:

Break-wire sensors can only report once and must be restrung after their report to be used again. Thus they should only be used in areas with infrequent traffic.

D-1.9 Video Cameras

Video cameras are used primarily in combination with other sensors to determine the cause of alarms and to document events. They may also be used as part of a video motion detection system that detects changes within its field of view. When operating in an assessment mode, an interface unit interprets signals from a detection sensor, determines if an alarm condition exists, and instructs the video camera to operate. The camera takes still video images that it transmits to a remote receiving station. The receiver station displays the alarm information and provides the operator interface to the system.

Many commercial models of cameras are available at a cost between \$100 and \$3,000. A motion detection unit with adjustable sensitivity, if added, costs about \$500. A typical capability under low-light conditions is .07 lux (defined as the intensity of one candle at a distance of 1 meter). Most cameras have an automatic iris control to adjust to changing light conditions. Rugged containers permit operation in adverse climates. Extreme cold may require a heater and blower to warm circuitry and prevent condensation.

D-2 Attended Ground Sensors

These sensors require a human operator. This is usually because human vision is part of the sensor operation. Examples of attended sensors in order of increasing complexity are binoculars, night vision devices, thermal imagers and ground surveillance radars.

D-2.1 Light Intensification Devices

These devices electronically amplify ambient light in order to produce an image that the human operator can recognize. Devices that might be commercially available have detection ranges for a person of 0.4 to 1 km. Vehicles could be detected at ranges of 2 to 3 km. Commercially available devices are available in the range from \$1,400 to \$10,000. All night vision devices require an unobstructed line of sight. They are made temporarily inoperable by direct bright light sources.

D-2.2 Thermal Imagers

These use the infrared radiation emitted by targets for night operation. Detection ranges of up to 10 km against vehicle targets are reported. These devices cost from \$5,000 up to several tens of thousands of dollars.

D-2.3 Ground Surveillance Radars

These radars detect the motion of humans or vehicles. Ten to fifteen-km ranges against humans and 20+ km ranges against vehicles have been claimed. Long-range ground surveillance radars cost several tens of thousands of dollars.

General operational degradation due to inclement weather averages about 25 percent in range. Placement on elevated platforms or terrain features will increase the line of sight. Rough terrain and forest growth increase radar masking. Radar is most effective in open, smooth terrain.

D-2.4 Aerial Sensors

Sensors mounted on aircraft can monitor large expanses or border territory relatively quickly and can achieve a much higher resolution than is currently available from commercial satellites. In addition, aircraft are not limited to fixed revisit times, as are satellites. Aircraft could be dispatched at random intervals to deter evasion attempts or could be used at times when other information indicates that border crossing attempts are likely.

The Open Skies Treaty provides an example of the type of monitoring system that might be used. The treaty was originally intended to provide transparency in significant military activities and build confidence between the North Atlantic Treaty Organization (NATO) and the Warsaw Pact countries. Negotiations continued after the Warsaw Pact disbanded, and the treaty was opened to the new republics and non-NATO members. The four types of permitted Open Skies sensors and their associated resolutions are listed in Table D-1. It should be noted that better resolution is physically possible, but the resolutions shown here are the result of treaty negotiations.

Table D-1. Open Skies Treaty Aircraft-Mounted Sensors

Sensor Type	Spatial Resolution
Optical Camera	30 cm
Video Camera	30 cm
Infrared Line Scanner	50 cm
Synthetic Aperture Radar	3 m

D-2.5 Optical and Video Cameras

Large-format aerial cameras are commonly used for mapping purposes. A typical camera uses a film width of 24 cm with a film length of 120 m. A useful image area of 23 by 23 cm per frame results in 420 high-resolution images per roll. Images can be acquired at three-second intervals during flight, which permits overlapping coverage of the ground with aircraft speeds of 460 km/hr or slower at 300 m or greater altitude. Cameras are capable of shutter speeds of up to 1/10,000 of a second that produce clear images. High-resolution color video cameras can be used in daylight recording operations.

D-2.6 Infrared Line Scanner

Infrared Line Scanner is a passive thermal infrared sensor that is especially useful for nighttime assessment of heat-generating objects. Operating much like a video camera, the imager is sensitive only to thermal infrared energy. Its lens usually permits the user to select one of several levels of magnification. Data acquired are recorded with a high-resolution video recorder using the 8mm format, which captures higher frequencies and bandwidths than the conventional VHS format.

D-2.7 Synthetic Aperture Radar

Synthetic aperture radar (SAR) is imaging radar that forms images by transmitting electromagnetic energy and sensing the echoes of the reflected energy from the ground target area. This system produces high-resolution, two-dimensional images, similar in some ways to a photograph. The SAR gathers target echoes at many points along the aircraft's flight path and stores them in a digital form. The system's digital signal processor performs range and azimuth processing to create an image. The SAR can produce images during day or night operation and under adverse weather conditions, including heavy cloud cover and precipitation. As a result, radar images can be acquired when conventional photographic and video systems cannot be used.

D-2.8 Sensor Resolution

The resolution of an imaging sensor defines the smallest items detectable and refers to the size of the picture elements that comprise the image. Table D-2 shows resolution requirements in meters for a few typical targets. Note that identification of a target requires much higher resolution than just detection.

Table D-2. Typical Requirements for Resolution (in meters)

Target	Detection	General ID	Precise ID	Description	Tech. Analysis
Aircraft	4.5	1.5	1.0	0.15	0.045
Surface ships	7.5-15.0	4.5	0.6	0.3	0.045
Vehicles	1.5	0.6	0.3	0.06	0.045

D-2.9 Commercial Satellite Imagery

Commercial satellites provide wide-area monitoring and can detect construction or changes in roads, large buildings or facilities, and vegetation patterns caused by human activity. Images can be digitally processed by commercial software for analysis of features. Combining different spectral bands permits viewing of the image in false color. For example, the near-infrared spectrum shows healthy vegetation as red. Currently, images with resolutions ranging from 2 m to 30 m are available. Digital images with resolution to 1 m are scheduled to be available beginning in 1999. Cost per image varies from \$2,000 to \$5,000.

Although useful for some monitoring applications, commercial satellite images do not have enough resolution to identify the subjects of border monitoring. While 1- to 2-m resolution imagery can detect vehicles, it is not enough to identify them with precision. People and animals require even better resolution. In addition, the images are not timely enough for use in border monitoring. Acquisition of images currently takes weeks. Planned improvements may shorten the acquisition process to a few days or less. In addition, all satellites are limited by the time required to repeat the image of the same location (revisit time). This can range from 12 hours to several days.