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**The Role of Unattended Ground Sensors (UGS) in Regional Confidence Building and Arms Control**

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# The role of unattended ground sensors (UGS) in regional confidence building and arms control

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## ABSTRACT

Although the Cold War has ended, the world has not become more peaceful. Without the stability provided by an international system dominated by two super-powers, local conflicts are more likely to escalate. Agreements to counter destabilizing pressures in regional conflicts can benefit from the use of cooperative monitoring. *Cooperative monitoring* is the collecting, analyzing, and sharing of information among parties to an agreement. Ground sensor technologies can contribute to the collection of relevant information. If implemented with consideration for local conditions, cooperative monitoring can build confidence, strengthen existing agreements, and set the stage for continued progress. This presentation describes two examples: the Israeli-Egyptian Sinai agreements of the 1970s and a conceptual example for the contemporary Korean Peninsula. The Sinai was a precedent for the successful use of UGS within the context of cooperative monitoring. The Korean Peninsula is the world's largest military confrontation. Future confidence building measures that address the security needs of both countries could decrease the danger of conflict and help create an environment for a peace agreement.

**Keywords:** cooperative monitoring, confidence building, treaty verification, regional arms control, ground sensors

## 1. INTRODUCTION

Now, more than ever, there is a greater emphasis on regional security. Without the stability provided by an international system dominated by two super-powers, local conflicts over resources, disputed territory, and ethnic antagonisms are more likely to escalate into violent conflict. Regional wars can have global consequences, especially when the countries involved have weapons of mass destruction (WMD). Regional agreements can be tailored to meet particular concerns of regional parties and can be negotiated at a more rapid pace than global agreements. Regional agreements do not preclude participation in global arrangements and may actually provide a necessary first step. The long term effectiveness of regional security agreements ultimately depends on the commitment and day-to-day involvement of regional parties. While external presence may play a role, a strong regional infrastructure for both the development and the implementation of region-specific options for arms control and confidence-building measures as well as the analysis of policy options and negotiations is required. Implementation of agreements will require a technical infrastructure that should include monitoring technologies, a communications network for exchanging information, data analysis capabilities, and trained inspectors. This paper will focus on the role of ground sensors as monitoring technologies to implement these agreements.

## 2. THE FRAMEWORK FOR COOPERATIVE MONITORING REGIMES

Cooperative monitoring is the collecting, analyzing, and sharing of agreed information among parties to an agreement. It provides a method of openly documenting compliance with the terms of an agreement and makes any act of noncompliance difficult to ignore. Cooperative monitoring typically relies on the use of commercially available sensor technology. When combined with techniques for data management and analysis, these technologies become powerful tools for implementing security-related agreements. Technologies incorporated into a cooperative monitoring regime must be sharable among all parties and all parties must receive equal access to the data or information acquired by the system. A cooperative monitoring regime should also include procedures for dealing with anomalous data and false positives. Such procedures are necessary for constructively resolving problems and are likely to involve human presence and activity.

The availability of standardized monitoring systems (technologies and procedures) to all parties to an agreement can remove personal bias, minimize suspicion, and balance the ability to detect and analyze relevant information. This is particularly important when parties to an agreement have differing indigenous technical capabilities.

## 2.1 Cooperative monitoring framework

For every cooperative monitoring regime, the context of the agreement, the agreement itself, the parameters defining events, and the options for monitoring technologies must be determined. Figure 1 illustrates the relationship between these factors.

**Context** - The context of the agreement determines what will be monitored and the scope of the monitoring regime. This establishes what goals the monitoring regime must meet to be a successful agreement.

**Agreement** - The actual agreement documents the objectives and provisions for monitoring regime. It defines how monitoring regimes will be established, implemented, and maintained.

**Parameters** - The parameters define what specifically will be monitored such as a vehicle of a specific type or class, troop movement, or the reuse of closed facilities. The phenomena and signatures that can acceptably be monitored constrain the technologies that can be applied.

**Monitoring Options** - Several options may be possible for the use of technology within the monitoring regime. However, the limitations of technology may also constrain what can be monitored. Export restrictions, the availability of power and communications infrastructures, and the area characteristics all influence system design. Cost and manpower considerations can also be primary drivers for selection of a monitoring regime.

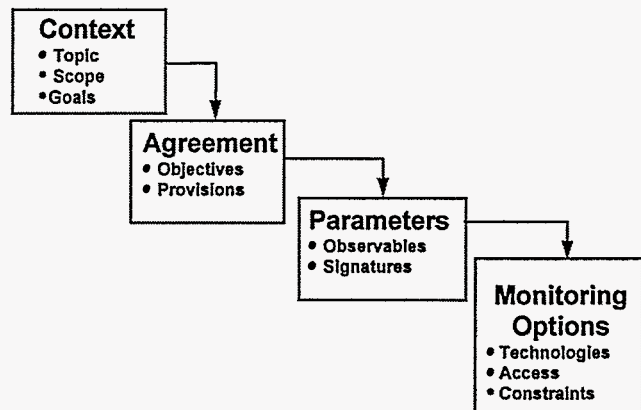


Figure 1. Framework for Cooperative Monitoring

## 2.2 Use of ground sensors

Many of the monitoring technologies originally developed for security applications are applicable to a broad spectrum of arms control and confidence building applications. Unattended ground sensor systems used for detection and assessment are an example of these monitoring technologies. Additionally, technologies for data security such as data authentication and tamper indication as well as access control technologies may also be included. When combined with data management, analysis, and integration capabilities, these technologies provide powerful tools for implementing regional security agreements. They enable parties to observe relevant activities, to measure agreed-upon parameters, to record and manage information, and to support on-site inspections.

The standardization of monitoring technologies between all parties of a regional agreement can remove personal bias, minimize suspicion, and balance the ability to detect and analyze relevant information. This is particularly important when parties to an agreement have differing indigenous technical capabilities. A thorough understanding of monitoring technologies can alleviate concerns that monitoring systems may be gathering more information than stipulated by the terms of the agreements.

## 3. HISTORICAL EXAMPLE - THE SINAI

The Sinai was the first precedent for the successful use of UGS within the context of cooperative monitoring. Multiple sensor types were used in combination with human observers. Monitoring successfully distinguished between significant and inconsequential events. When a sensor was activated, it sent a radio signal to inform

observers at nearby watch stations. If the observers concluded that the intrusion was improper, a report was sent to the Sinai Joint Commission composed of the United Nations (UN), United States (U.S.), Israel, and Egypt. The monitoring system successfully distinguished between significant and inconsequential events, despite an average of 200 sensor activations per day due to permitted activity and natural disturbances. After a period of initial suspicion, tensions stabilized and monitoring activities became almost routine. After the Peace Accord was signed, the Israelis withdrew eastward, and the monitoring system was shut down on January 25, 1980. The total cost of installing and operating the system was \$92.7 million.

### 3.1 Context

The June 1967 Arab-Israeli war ended with Israel in full control of the Egyptian Sinai peninsula up to the Suez Canal. In October 1973, an Arab coalition attacked Israel with intent of regaining occupied territory. The war ended somewhat inconclusively on the Sinai front with Israeli and Egyptian forces on both sides of the canal. A formal cease-fire was signed on Nov. 11, 1973. However, the cease-fire line was not acceptable to the Egyptians as a long-term solution. Seeking to avert further hostilities, the U.S. initiated a process whereby Israel slowly removed its troops from the region. The primary goal was to return occupied land to Egypt, while maintaining Israeli security. The process resulted in two disengagement agreements, known as Sinai I and Sinai II. Although Egypt and Israel were the only parties to the agreements, the UN and the U.S. played a major role in their negotiation and implementation. Each side felt that a direct U.S. presence was necessary as a symbol of U.S. commitment to the agreement.

### 3.2 Provisions

The first Sinai Disengagement Agreement (Sinai I) was signed on January 18, 1974 and required the Israelis to withdraw to approximately 20 km from the Suez canal. A thin buffer zone was established, and limited force zones were created on both sides of the buffer zone. The U.S. and the UN supported the agreement as third parties. The U.S. supported the UN with aerial surveillance flights.

The Sinai II agreement was signed on September 4, 1975. In Sinai II, Israel agreed to expand the buffer zone and withdraw from the strategic Giddi and Mitla passes (Figure 2) in exchange for a mix of third-party monitoring by the U.S. and the UN to provide tactical warning, combined with self-verification by Israel and Egypt. These passes are the primary avenues for large, offensive forces to move across the peninsula. The Israeli government wanted significant early warning to mobilize a defense against pending threats.

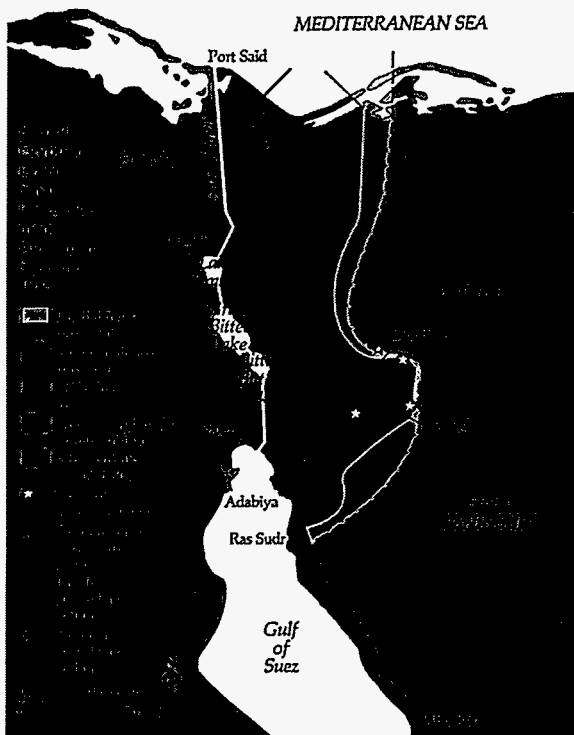
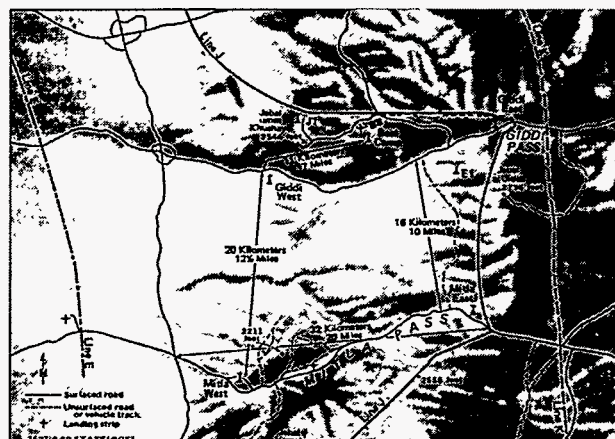


Figure 2. Sinai II Disengagement Agreement and the Monitoring of the Giddi and Mitla Passes



### 3.3 Observables

Military hardware, fortifications, and personnel were the observables associated with both of these agreements. No military equipment or personnel were allowed in the demilitarized zones, and numbers were restricted in the limited force zones.

### 3.4 Monitoring

Egypt established an electronic signal collection station in the UN buffer zone near an existing Israeli station. Both sides were permitted to fly reconnaissance missions up to the buffer zone. This activity did not constitute cooperative monitoring because they exchanged no information, but did constitute what might be called "cooperative NTM" (national technical means).

A "Joint Commission and Liaison System", with representatives from all parties and chaired by the Chief Coordinator of the UN peacekeeping mission, was established to supervise and coordinate implementation of the agreement. The UN provided 4000 peacekeeping troops to perform general observation and on-site inspections of garrisons in the limited force zones. The U.S. performed periodic oversights of the disengagement zone for tactical early warning and established the Sinai Field Mission (SFM) to monitor access to the Giddi and Mitla passes. Multiple types of sensors (Table 1) were deployed for broad area monitoring to detect activity in the region and to assist analysts in characterizing the nature of the activity. The SFM transmitted detection and characterization data simultaneously to both the Israel and Egyptian governments.

Table 1. Sensors Employed by the Sinai Field Mission

Sensor Type	Application
Seismic	The most commonly used type of sensor because of near-ideal conditions in the desert soil. The battery-powered MINISID-III could detect vehicles at 500 m and personnel at 50 m range. It transmitted the seismic signal by radio to an adjacent watch station.
Acoustic	This system was a modular addition to the MINISID-III and used its radio transmission system. A seismic activation of sufficient duration activated the unit which could detect personnel to 30 m and vehicles to 100 m range.
Magnetic	This system was also a modular addition to the MINISID-III and could detect a man with a rifle at 3-4 m and a medium truck at 15-20 m.
Strain	A strain sensitive cable was buried under roads and main trails and could be up to several hundred meters long. The compression caused by the passage of an object induced a signal proportional to weight to be generated and transmitted to a watch station.
Infrared Break-Beam	The directional infrared intrusion detector (DIRID) was also used to monitor roads and large paths. The system consisted of a transmitter and receiver for two parallel infrared beams. DIRID was mounted on tripods above ground and could monitor a space 3 to 7 m wide. Passage of an object through the beam broke the circuit and cause an activation. The order of beam breakage indicated the direction of movement.
Video	Low-light TV cameras with transmission to the base camp were used in locations beyond visual line of sight.
Imaging Infrared	A prototype system called Passive Confirming Scanner was used during 1977-78 to counter low-visibility conditions in dust and fog. The system was removed because of unacceptable reliability.

### 3.5 Performance

The system performed quite reliably, although periodic refinements were necessary. On average, there were 200 sensor activations a day, almost all of which resulted from permitted activity or natural occurrences. Activations were caused by support vehicles for the SFM and Israeli and Egyptian stations, movement of UN peacekeepers, natural seismic disturbances, low-flying aircraft, wildlife, and nomadic Bedouins. All reported violations were relatively minor, unintended, and easily resolved.

After a period of initial suspicion, the Sinai front stabilized and monitoring activities became almost routine. Political leaders in both countries eventually praised the SFM. The right combination of technical measures and manned operation proved to be vital to the success of the operation. The increased level of confidence resulting from the Sinai monitoring and the impartial role of the U.S. and the UN were major contributors to the Egypt-Israel Peace Accord of March 1979. A phased Israeli withdrawal from the Sinai was completed in 1982. As the Israelis withdrew eastward and relations improved, there was no need for intensive monitoring of the passes and the system was shut down in January of 1980. Total cost of the SFM during its operation was \$92.7 million U.S. dollars. The Israel/Egypt border continues to be stable.

### **3.6 Conclusions from Sinai experience**

Technically-based cooperative monitoring systems provide objective data relevant to the terms of cooperative monitoring agreements, on which compliance decisions can be based. The data can also be shared with the international community, if desired, to assure other of adherence to certain agreements. Technical monitoring systems in support of cooperative monitoring agreements does not preclude the continued use of the national technical means used by individual parties as a source of information.

Technology cannot substitute for human involvement. A balanced combination of human presence, procedures, and technology is needed for successful agreements. Although technology can provide objective data humans are needed to analyze the data and to settle disputes. It is important to keep in mind that the ultimate goal of regional security agreements is reduced tension and warmer relations among participating countries. Human interactions during the implementation of agreements can contribute to this end.

Another key observation is that technical monitoring can be pursued incrementally. This incremental approach, using cost-effectiveness as a guide enables measures to be taken at a politically sensitive time.

## **4. A HYPOTHETICAL KOREAN EXAMPLE**

A hypothetical agreement was developed as part of the Korean Institute for Defense Analysis/Cooperative Monitoring Center analysis of the feasibility of monitoring a future system of military CBMs. A "Limited Force Deployment Zone Scenario" is presented as a hypothetical agreement to establish limited force deployment zones along the current demilitarized zone. This section outlines the conceptual agreement for reducing military tensions and presents a monitoring strategy for the agreement and examples of implementation using UGS. While there is no indication that the two Koreas would enter into any agreement resembling the one presented, the hypothetical agreement is consistent with the 1991 South-North Korea "Basic Agreement on Reconciliation, Nonaggression, and Exchange and Cooperation." It is also consistent with the 1996 Four-Party proposal by the Republic of Korea (ROK) and the U.S. to negotiate a permanent peace regime. None of the conceptual initiatives depends on a formal state of peace between South and North Korea.

### **4.1 Context**

Nearly 2 million North Korean, South Korean, and U.S. troops face each other along the 255-km long military demarcation line (MDL). The framework for Korean security is provided by the 1953 Armistice Agreement. A demilitarized zone (DMZ) extends 2 km into each country from the MDL. The MDL is defined by the positions of the respective military forces when the Armistice was signed. As a result, it does not follow naturally occurring physical features such as rivers or ridge lines. The overarching goal of a cooperative monitoring regime is to improve relations between the two Koreas.

### **4.2 Objectives of the hypothetical agreement**

The hypothetical agreement seeks to increase regional security in the absence of a formal peace. The agreement can support long-term conventional arms reduction and WMD arms control, but initially, the objective of the hypothetical agreement is to thin the existing military forces along the DMZ by the creation of limited force deployment zones (LDZs). The hypothetical agreement would reduce the risk of a surprise attack and permit the military alert status along the MDL to be reduced.

The agreement would be implemented in two phases:

- A. To make the military situation less dangerous, the first phase would remove all personnel and facilities from the existing 4-km wide DMZ area and make it a true demilitarized and clear zone. Both sides would remove all troops, armaments, and manned facilities (Figure 3-1) from the DMZ within 6 months after signature of the agreement. Passive defensive facilities such as tank barricades and fencing could remain. As an enhancement, heavy artillery and rockets (defined as greater than 150 mm) should be removed from hardened positions within 5 km of the DMZ.
- B. Once stabilized, the temporary military situation could be improved by reducing the possibility of surprise attack through definition and establishment of LDZs. Conventional force offensive capability could be reduced through redeployment of troops and artillery. These measures would serve to enhance the security of both capital areas. The existing military defense lines in each country were used for defining LDZs. This would result in three limited force deployment zones, including the DMZ. The suggested DMZ and LDZ deployment lines in the hypothetical agreement are shown in Figure 3.



Figure 3. Map of the Conceptual LDZ Regime on the Korean Peninsula

#### 4.2.2 Role of a "third party"

Given the lack of confidence between the two Koreas, it is unlikely that South and North Korea could successfully operate the monitoring organization by themselves. Therefore, a third party should assist by performing cooperative monitoring activities and maintaining monitoring equipment. However, it may be difficult to find an acceptable single neutral national party to perform monitoring on the Korean peninsula. Because of its relationship with the ROK, the U.S. is unlikely to perform a neutral monitoring role as in the Sinai disengagement. Monitoring of the DMZ and LDZs might be conducted by the UN as an organization (the ROK and DPRK are now both members). A regional group might also function as a monitoring organization. The U.S. could conceivably participate in multilateral organizations, particularly if China participated.

#### 4.2.3 Resolution of anomalies

The Armistice Agreement of 1953 should be reactivated and the Armistice Committee reconvened. The Joint Military Committee, called for in the 1991 South-North Agreement, should be opened and linked with the Armistice Committee for coordination, and communication to deal with DMZ issues. Representatives from both Koreas and the third-party should form a Joint Verification Committee (JVC) to resolve cooperative monitoring issues.

#### 4.3 Parameters

Military hardware and personnel are the observables associated with the hypothetical agreements. No military equipment or personnel are allowed in the demilitarized zones, and numbers are restricted in the limited force zones. For this scenario, reportable events have been defined to be detection of troops or vehicles crossing the DMZ, the reintroduction of large artillery equipment to artillery positions, and violations of terms of the cooperative monitoring agreement.



#### 4.4 A cooperative monitoring strategy for the hypothetical Korean agreement

##### 4.4.1 Phase 1: Strategy for monitoring the demilitarized zone

Large military forces moving offensively would be forced by time and logistic support requirements to move through the major natural crossings of the DMZ. The terrain along the MDL is rugged, particularly in the eastern half. Figure 4. shows the ten primary land crossings of the DMZ. Infantry can still move through the intervening hills, but without significant logistic support from vehicles, their offensive capability (both in mobility and firepower) will be much lower than mechanized forces.

The monitoring system would implement two levels of monitoring for the DMZ in order to best adapt to the physical environment and security threat:

- A. The ten strategic crossings are the most important locations and would be monitored more heavily for the movement of vehicles and personnel.
- B. The areas between the strategic crossings pose a lesser security threat because the terrain restricts movement to relatively small, non-mechanized forces. A less complex and expensive system would monitor primarily for small numbers of personnel and light vehicles.

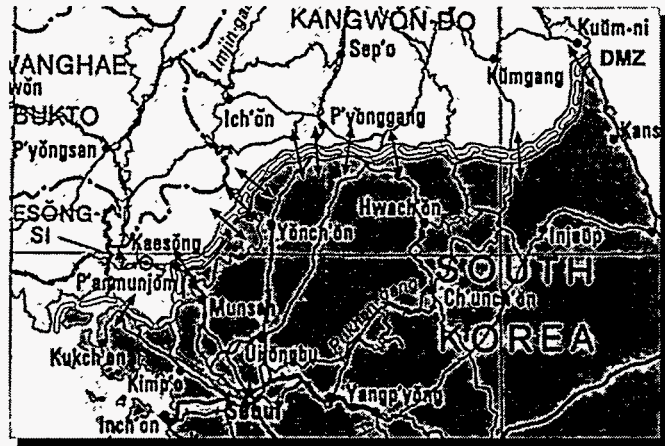


Figure 4. Strategic Routes Across the DMZ with Highlighted Sami-Ch'on Crossing

##### 4.4.1.1 Strategic DMZ crossing points

The conceptual monitoring strategy uses several layers of sensors. The layers vary in both detection phenomenologies as well as sensor placement. Sensors generally function in either a detection or assessment mode. Careful design of a monitoring system may permit some sensors to contribute to both goals.

Commercial satellite imagery was used to characterize prospective locations for installing monitoring equipment. Artificial three-dimensional images were created by using computer software to combine terrain elevation data with the SPOT satellite image. A field of view can be specified and the resulting image provides an intuitive tool to help plan and describe the monitoring system. Other geographic information, such as the DMZ lines, can be placed on the image. The sensors for the Sami-Ch'on Valley monitoring system are conceptually deployed in Figure 5.

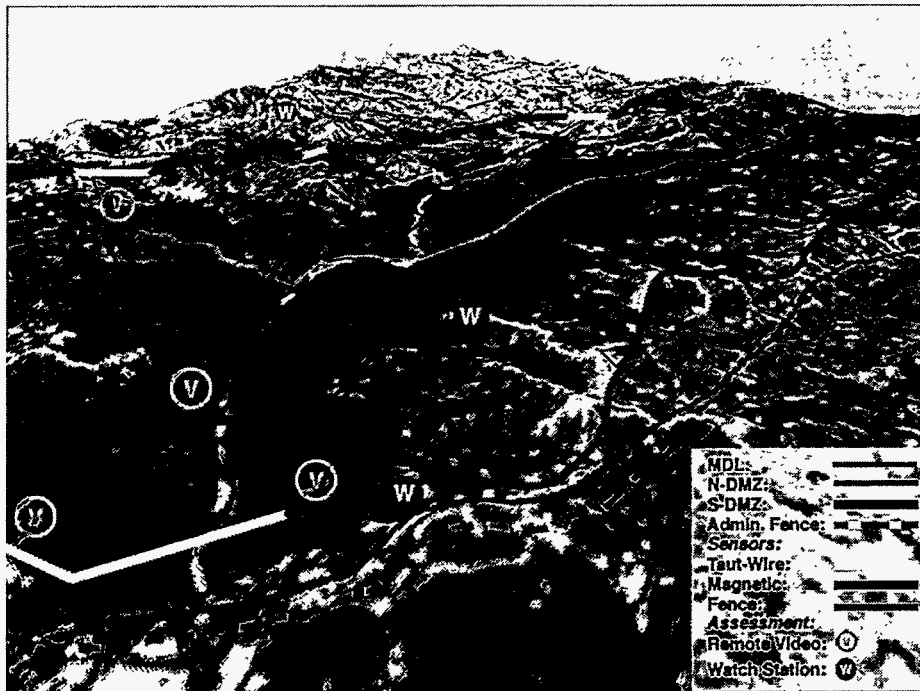


Figure 5. Sensor Locations in the Sami-Ch'on Valley Monitoring System

#### 4.4.1.2 Sensors

For maximum flexibility and reliability, the monitoring system for the DMZ crossing points would use a combination of unattended ground sensors and human observers. Ground sensors would be placed across the likely paths of movement to detect entrance into the DMZ. Different sensor detection phenomenologies would be used to gain synergies in overall performance. According to the hypothetical agreement, the DMZ would be cleared of all human activity and thus present only natural background activity (e.g., birds, wind). The sensors would be selected and arranged to detect and report the entrance of people or vehicles with a high level of selectivity. Table 2 lists the sensors proposed for the Sami-Ch'on Valley Crossing.

Table 2. Sensors Proposed for the Sami-Ch'on Valley Crossing

Sensor	Description
<b>Fence Sensors</b>	Fence sensors are suggested for first detection of personnel and vehicles because of the designated boundaries along the DMZ. Such sensors can take advantage of existing fences and serve as a highly visible symbol of the agreement as well as a deterrent to violations. Taut-wire fence system would only be placed across the most likely routes through the valley. Less expensive fiber-optic fence sensors would be used along the hilly terrain flanking these routes.
<b>Magnetic Sensors</b>	Magnetic sensors would be used to detect the metallic mass associated with vehicles and weapons. Groups of magnetic sensors should be buried in linear arrays across the north-south lines of movement through the valley. When a linear array of sensors is deployed, the mass of an object might be approximated by noting how many sensors register an activation. A moving object would activate sensors sequentially, so that the approximate direction and speed of movement through the sensor array could be estimated. When actuated, these sensors would broadcast a radio frequency transmission. These sensors would need to be battery-operated devices.
<b>Human Observers</b>	Human observers at the watch stations would use optical and night-vision devices to supplement the detection sensors and confirm sensor activations. The primary role of the observers at the watch stations would be to assess what caused the sensor activation, determine whether it is a reportable event, and transmit the report to a central Korean Monitoring Center. Assessment would be accomplished both by direct observation and interpretation of sensor reports. The observers would also initiate a patrol if they could not determine the cause of the activation from the watch station.
<b>Video</b>	Video cameras are a more definitive means of assessment. In the conceptual Sami-Ch'on monitoring system, an activation by a fence or magnetic sensor would command the activation of a video camera positioned to view the area around the detecting sensor. Two images (one pre-alarm and one post-alarm) would be transmitted to the watch station for interpretation by the observers. The video camera may also be directly activated by the observers.

#### 4.4.1.3 Areas of the DMZ between the crossing points

In the areas between the DMZ crossing points, sensors would be placed on trails or valleys that could be avenues of approach for small forces. Magnetic sensors and ground radar sensors are suggested for the interior of the DMZ because of the rugged terrain. An administrative fence along the borders could be used to keep large animals out of the sensor area and provide a limited barrier. Existing fences could be used wherever possible for the administrative fence. The fiber optic sensed fence could then be used for the first level of detection of intrusion into the DMZ.

The DMZ would also be monitored using aerial sensors. Overflight would permit the monitoring organization to survey broad areas of terrain and complement the more narrowly directed ground-based monitoring. The overflight would be performed by the cooperative use of an all-weather aircraft equipped with optical, radar, and infrared sensors. The sensors and their capabilities could be based on the 1992 Open Skies Treaty. A relatively simple aircraft would be operated by the monitoring organization and could have South and North Korean liaison officers aboard. Flights could be performed on a weekly basis and would be restricted to the 4-km wide DMZ.

#### 4.4.2 Phase 2: Strategy for monitoring the limited force deployment zones

Cooperatively monitoring the LDZs is technically and procedurally more complicated than monitoring the DMZ. As envisioned in the agreement, the DMZ would be a zone with very little human background activity. The LDZs, in contrast, would have high levels of background activity caused by permitted military and civilian activities. Consequently, the system must distinguish relevant activities from background noise, and permitted activities from banned ones. The problem of reliable discrimination limits the application of unattended monitoring by UGSs to points rather than zones. Likely applications in the LDZs are well-defined locations such as artillery positions, crossroads, and gates to military garrisons.

##### 4.4.2.1. Role of on-site inspection

The most widely applicable tool for monitoring the LDZs is on-site inspection. In the cooperative monitoring regime, on-site inspection would be performed by the third-party organization. The purpose of routine on-site inspections is to verify closure of facilities, observe troop movements and exercises, and verify removal of limited equipment from military bases. Special inspections could be initiated by the JVC to resolve anomalies arising from monitoring reports.

##### 4.4.2.2 Point and military facility monitoring

Continuous remote monitoring of locations and facilities may be perceived as a significant encroachment on sovereignty and would require a political commitment by the parties. Table 3 lists some options for this type of monitoring in the LDZs.

**Table 3. Point and Facility Monitoring Options in the LDZs**

Area	Option
<b>Garrisons</b>	Remote monitoring might be performed at the gates of a closed military facility. A more complex, but technically feasible, application would be to monitor the gate or perimeter of a permitted garrison in the LDZ-1 to detect if prohibited heavy weapons are reintroduced. Monitoring of facilities could be accomplished by using a combination of sensors with detection and assessment functions.
<b>Roads</b>	Given the level of background activity, it is not feasible to selectively monitor a roadway with any acceptable level of confidence. An option would be to install a video system at a key point that continually collects and transmits images to a monitoring center.
<b>Artillery Positions</b>	All heavy artillery would be removed from LDZ-1 during Phase 2. On-site inspection by the monitoring organization is used to verify that removal has occurred on schedule. Continuous remote monitoring by ground sensors would then be used to detect if artillery is reintroduced. Magnetic switches and/or loop seals would be placed on doors to detect movement. For positions without doors, magnetic or induction loop sensors placed at the entrance or under the floor could be used to detect artillery repositioning. These battery powered sensors would transmit radio signals to the nearest watch station. Periodic status reports (including indications of tampering) would be transmitted by these same sensors. Radio signal repeaters or direct satellite transmissions could be used if the distance to a watch station exceeds transmitter range. Periodic inspections could be combined with necessary battery changes. Passive seals such as a fiber-optic loop could also be used, but would require more frequent visits by inspectors to verify their condition. The sensors could also be linked to a video image system that transmits images.
<b>Broad Areas</b>	The aerial monitoring regime established during Phase 1 for monitoring the DMZ could be expanded to include the two LDZs in Phase 2. The purpose of aerial monitoring would be to detect facility construction, facility reactivation, and the re-entry of prohibited equipment into the LDZs. Commercial satellite imagery may also be incorporated when planned future enhancements in image resolution and timeliness of availability are achieved.

#### 4.5 The role of a Korean monitoring center

The conceptual monitoring system would require the establishment of a "Korean Monitoring Center" to evaluate reports from the cooperative monitoring system. The monitoring center would provide centralized data collection, assessment, communication, and data resolution. The JVC would use the Korean Monitoring Center as the site for its formal meetings. The location most likely to be acceptable for a Korean Monitoring Center is the existing Joint Services Area (JSA) in Panmunjom. An infrastructure of buildings, roads, utilities, and communications already exists in the JSA. Figure 6 shows a schematic representation of the conceptual Korean cooperative monitoring system.

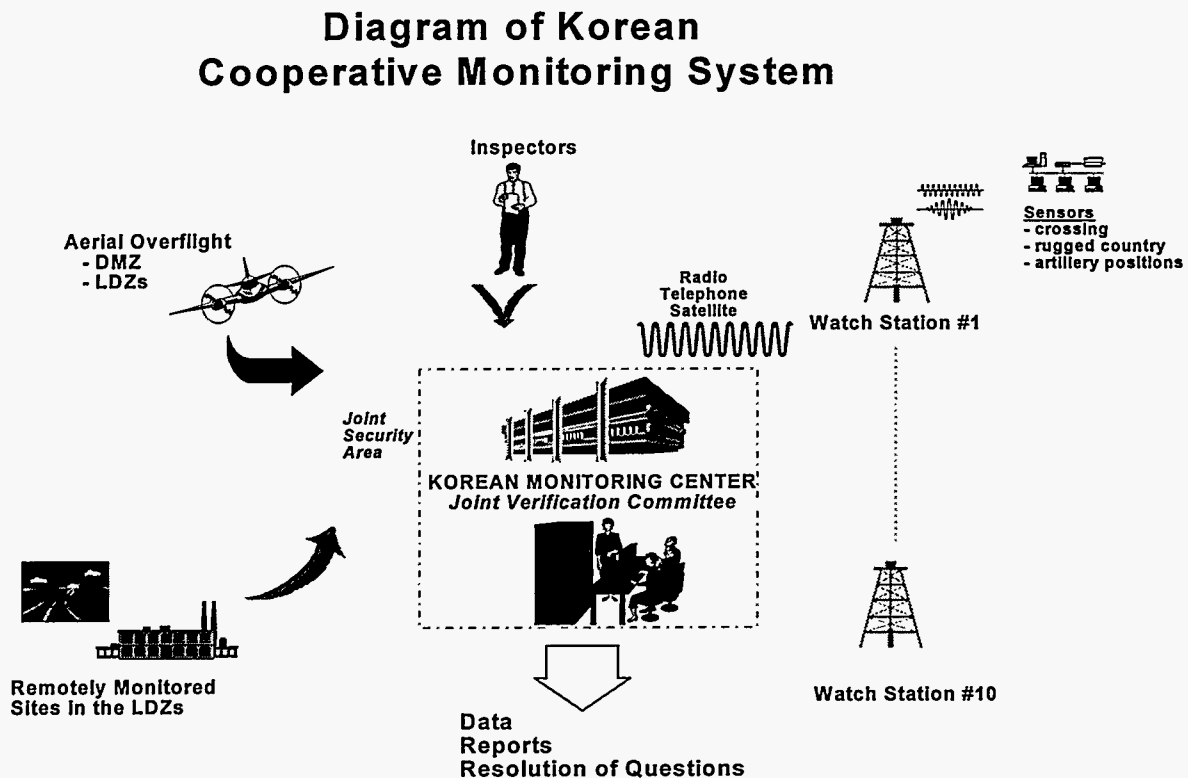


Figure 6. Schematic Representation of the Conceptual Korean Cooperative Monitoring System

Regional watch stations could be used to cover long borders requiring significant numbers of sensors. For the Korean scenario, regional monitoring stations are located in strategic locations along the ten identified crossing points positioned so that the primary routes of movement are within view. Each watch station would be used for collecting data from the local monitoring sensors. In addition, observers at the watch stations would use optical and night-vision devices to supplement the detection sensors and confirm sensor activations. The primary role of the observers at the watch stations would be to assess what caused the sensor activation, determine whether it is a reportable event, and transmit the report to the Korean Monitoring Center. This would be accomplished both by direct observation and interpretation of sensor reports. The observers would also initiate a patrol if they could not determine the cause of the activation from the watch station. These regional watch stations would then report to a Korean cooperative monitoring center located in the JSA at Panmunjom.

#### 4.6 Cost and manpower

Financial support for personnel and equipment to perform the proposed monitoring and verification activities is likely to be within South and North Korea's ability to support. A detailed cost analysis for the full conceptual system is beyond the scope of this analysis. The conceptual monitoring system for the Sami-Ch'on Valley DMZ crossing was estimated as \$1.5 million for sensor hardware and installation.

## 5. CONCLUSIONS

Historical experience from other regions (e.g., Europe, the Middle East, South Asia) indicates that CBMs are easier to initiate than formal agreements for arms reduction. Cooperative monitoring technologies and techniques offer options for implementing more effective CBMs. For example, North Korea is unlikely to accept the continuous presence of South Korean inspectors within its territory, but might accept unattended sensors maintained by a neutral third-party organization. A CBM, such as the Sinai II Agreement, that the parties see as providing a useful function truly reduces tension and provides a foundation for a future agreement addressing the root causes of the dispute.

Remote monitoring by unattended ground-based sensors is best implemented in relatively inactive environments such as the Korean DMZ and the Sinai. Remote monitoring by unattended sensors in LDZs may have limitations because of the size of the monitored area and the high level of permitted background activity. Therefore, other forms of monitoring such as aerial monitoring and commercial satellite imagery may be needed. Nontechnical forms of cooperative monitoring also play a large role in providing redundancy and enhancing political confidence.

A technical monitoring system does not have to monitor all the security concerns associated with a cooperative monitoring agreement in order to make a significant contribution to regional security. Although cooperative monitoring is intended to provide information, it is not inherently a security system or another form of intelligence collection. Shared information collected by cooperative monitoring can have great utility in discussions of compliance, but additional information also may be important. Countries that participate in cooperative monitoring arrangements usually retain the sovereign right to make compliance decisions using all available information, including that collected from purely national means. Cooperative monitoring complements, but does not replace, a country's national technical means and intelligence activities.

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