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A Model for International Border Management Systems

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International Border Management Systems

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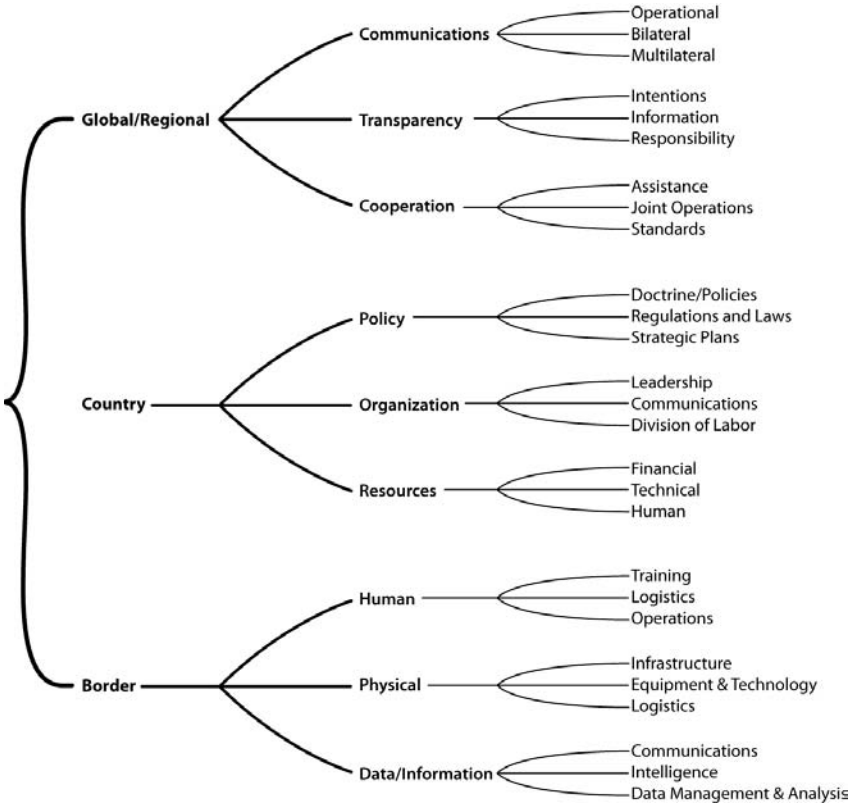
Abstract

To effectively manage the security or control of its borders, a country must understand its border management activities as a system. Using its systems engineering and security foundations as a Department of Energy National Security Laboratory, Sandia National Laboratories has developed such an approach to modeling and analyzing border management systems. This paper describes the basic model and its elements developed under Laboratory Directed Research and Development project 08-684.

Executive Summary

To effectively manage the security or control of its borders, a country must understand its border management activities as a system. Using its systems engineering and security foundations as a Department of Energy National Security Laboratory, Sandia National Laboratories has developed such an approach to modeling and analyzing border management systems. The Reference Architecture consists of three basic points of view or perspectives that can be used to characterize border management systems. Each perspective has associated facets and component elements. These are illustrated in Figure E-1 below:

Figure E-1. Border Management Systems Reference Architecture



Early exposure of this reference architecture suggests that it is broadly applicable and has the added benefit of integrating aspects of border management into a comprehensive system.

Introduction

The term "border management system" represents a relatively new concept to encompass the entirety of border enforcement, border control, and border security activities. Using the systems engineering and security foundations as a Department of Energy National Security Laboratory, Sandia National Laboratories has developed a systems approach to characterizing border management systems. It is this broad security experience that has been applied to the complex problem of border management.

- **Chapter 1** examines the definition of borders to provide common foundational terminology.

- **Chapter 2** reviews the security challenges and risks such as sovereignty, national security, economic security, and threats at the border.

- **Chapter 3** defines the three primary perspectives of Reference Border Management Architecture, the facets of each perspective, and the elements of each facet.

- **Chapter 4** concludes the paper by describing some of the common principles derived from physical, cyber, and international security applications that are also relevant to border management.

1 Border Definitions

Borders are constructed to designate a territory united by a common political/legal system. Borders define the citizenship and sovereignty of a country. They define the limits of economic regulation including currency, tariffs, and taxes. Although there appear to be definitive political boundaries between countries on large-scale geopolitical maps, it should be understood that in most circumstances, borders are essentially virtual. Efforts to demarcate borders through fences, walls, demarcation pillars, outposts, etc. have not resulted in perfect barriers to persons wishing to cross borders in either direction. In some cases, the very definition of land borders has been the cause for conflicts between countries. Land borders are distinguished by ports of entry (POE) and areas in between, hereafter referred to as frontier borders. The long distances and variability of terrain associated with land borders makes this type of border particularly challenging to manage.

While currently not globally recognized, the United Nations Convention on the Law of the Sea (UNCLOS)[1], Section 2 defines maritime borders by their distance from the land or as their distance from the Territorial Sea Baseline (TSB). Within its territorial seas and contiguous zones, a coastal country may exercise the control necessary to prevent and punish infringement of its customs, fiscal, immigration or sanitary laws, and regulations.

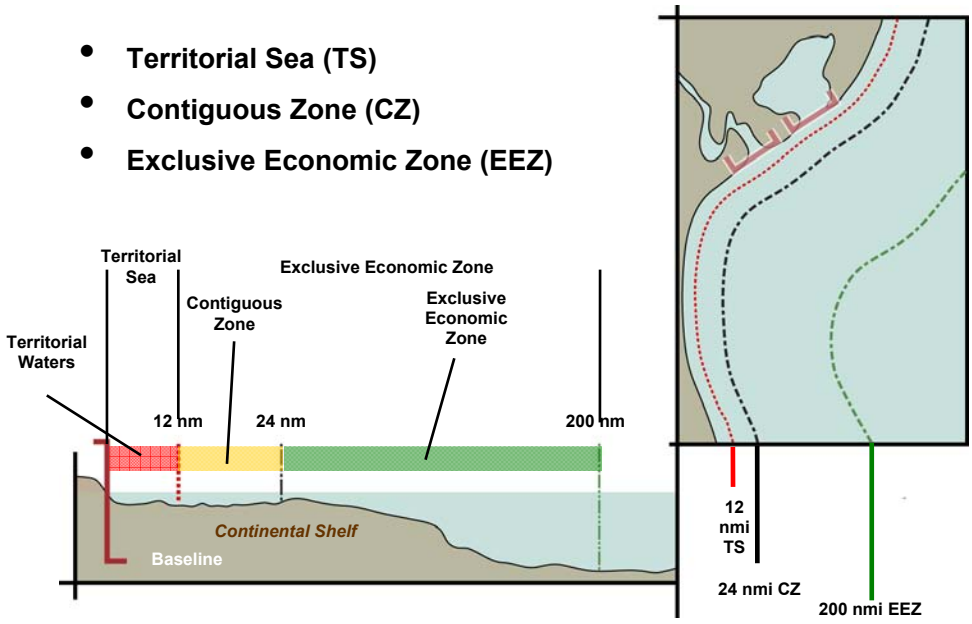


Figure 1-1. Maritime Zones of Significance

[1] United Nations Convention on the Law of the Seas, 2006, http://www.un.org/Depts/los/index.htm. Of 157 signatories, only 9 countries that are not land-locked have not signed the convention: Ecuador, Eritrea, Israel, Peru, Syria, Timor-Leste, Turkey, United States (US), and Venezuela. For a list of participating countries refer to http://www.un.org/Depts/los/reference_files/status2008.pdf .

However, if the coastal state has not developed laws and regulations to govern these waters and does not enforce those laws and regulations, then its coastal and maritime border security may be at risk when dealing with the human and commodity challenges associated with borders.

The security of maritime and coastal borders also includes the functions of policing, customs, and immigration. POEs, as well as immigration processes, are typically similar to those at land borders. However, policing of coastal borders requires naval assets and is usually under the purview of the country's navy or coast guard. To balance coverage, jurisdictions associated with fishing rights and national security should be well-defined and understood.

The airspace over a country's territory, including any territorial seas, are considered within the sovereign borders of that country.[2] The function of aerial border policing is often left to the country's military. Customs and immigration functions are typically handled at international airports. This does not necessarily prevent foreign aircraft from conducting overflights or landing at other locations within a country.

Therefore, it is important to understand how the country defines it borders and whether those borders are accepted by its neighbors. A country's border security then is dependent on its coverage and the issues associated with each zone of its border, how it manages its POEs and frontier borders in accordance with its border doctrine, and how well it performs the functions of immigration, customs, and border policing.

[2] United Nations Convention on the Law of the Seas, 2006 contains language extending sovereignty over territorial sea and airspace above the territorial sea, subject to the provisions of the Convention and other relevant rules of international law.

2. Border Management Challenges

Border management is often faced with a number of challenges. First, border management systems deal with the legal movement of people and goods. The sheer volume of this traffic can impact design and operations of ports of entry. The illicit traffic associated with people and goods must also be detected. Second, there can be political and other economic factors that also influence border management. These challenges can be broadly divided into human, commodity, political, and economic challenges.

2.1 Human Challenges

Human challenges to effective border management can take several forms, based on how routine and threatening the human traffic. We have chosen to characterize them into four categories as shown in Table 2-1. Human challenges considered to be "routine" are those that comprise much of the normal traffic seen crossing borders. "Threatening" human challenges are considered to be so because of their associated potential for violence, or other activities which may undermine the security of the state and its citizenry.

Table 2-1. Human Traffic Challenges

	Routine	Non-routine
Non-threatening	• Legitimate traders, travelers, and tourists • Cross-border nomads and tribal movement, which may or may not be legitimate depending on agreements and border management policies	The number of refugees and illegal immigrants tend to increase when natural disasters, economic disparities, and government disparities occur
Threatening	Criminals involved with smuggling and illicit trafficking that are harmful to economic security	Non-state national security threats, including insurgents terrorists, and people with communicable diseases

2.2 Commodity Challenges

The global economy is at its largest scale ever in terms of the volume of people and goods crossing national boundaries. There were over 141 million 20-foot equivalent units (TEU) shipped in 2007. Many countries can be involved with the maritime shipment of goods, functioning as source countries, destination countries, and/or transshipment countries where goods are transferred from one ship to another. Similarly, rail and truck movement of cargo can involve several countries enroute to final destination. Transshipment cargo must be considered a possible threat to each country it passes through, should it be carrying weapons of mass destruction (WMD) or other hazardous materials.

The "legitimate" global economy exists alongside a similarly profuse and expanding underground market, varying in its legality. "Black" market goods like drugs, weapons, and trafficked human beings represent clear security threats, and are particularly challenging to regulate or interdict, particularly when a steady global demand encourages suppliers to accept a high level of risk. Trading in a "gray" market (goods purchased in lower-priced markets and then sold in higher-priced markets), while less legally problematic, nonetheless creates competitive challenges for the legitimate market, while also creating trade networks that are less easily monitored and regulated. The more established illicit trafficking routes and methods become, the more likely these routes will be used for other types of undesirable trafficking, such as drugs and weapons.

Commodity challenges associated with illicit materials crossing borders include the following:

- Contraband – drugs, literature, precious gems/metals, stolen goods, etc.
- Tariff/License Avoidance Products – cigarettes, autos, counterfeit goods, etc.
- Currency – real and counterfeit
- Human Beings – voluntary (purposes of migration/employment) and involuntary (prostitution/slavery)
- Conventional Weapons – small arms, heavy weapons, explosives, etc.
- WMD – nuclear, biological, chemical, radiological, and delivery systems

These challenges require different detection technologies and inspection procedures, which can have the adverse effect of inhibiting the timely flow of goods and people across the border.

2.3 Political Challenges

Borders are in and of themselves inherently political. At the highest level, the geopolitical context influences the stability of a country's borders. Borders are generally defined according to bilateral and multilateral agreements. In many cases, the borders are established without the participation of all relevant countries, or with the expressed purpose of dividing non-consenting population groups. Stable borders are highly dependent on a country's internal political and economic stability as well as that of its neighbors. Economic sanctions against neighbors or free trade agreements with them can have profound impacts on the flow of goods across borders. Weak and failing countries where civil conflicts exist threaten neighboring countries as conflicts escalate, and often do not have a stable enough government to control its border or provide an entity for discussion of border issues. Militarized tensions between countries due to disputed boundaries can make borders themselves a military target. Ongoing hostilities, skirmishes at the border, and the appearance of opposing forces can escalate tensions and divert resources. Just as important as external politics, a country's internal politics determine how its border management doctrine will be implemented.

2.4 Economic Challenges

Economic factors that can affect the stability of borders and capacity of border management systems include the relative patterns of development between a country and its neighbors and the resulting concentrations of labor and capital. Not all countries have equally benefited from a globalized economy. Many remain far behind in overall economic development, with little favorable prospects in the near-term. In many cases, highly developed and highly

underdeveloped states exist in the same regional vicinity, often bordering one another. The resulting economic asymmetries sometimes generate cross-border tensions and encourage illicit market flows. Financial and industrial capital is currently overwhelmingly concentrated in the most developed economies, as well as a number of "emerging" market countries. In many cases, this concentration of capital is no longer commensurate with the labor force necessary to maintain production of goods and services. The opposite paradigm exists in many developing states, encouraging patterns of mass migration for employment that can result in political, economic, and social complications. The asymmetries associated with financial assets of black marketers versus those of border management organizations tasked to counter them favor the former. Financial constraints also limit the access of border management systems to the state-of the-art technology resources, some of which illicit traffickers might themselves be using.

3. Border Management System Architecture

One of the primary functions of a country's border management system is to detect, address, and deter breaches that might threaten national security. In addition to traditional security threats, the border management mission includes detection of:

- Illegal immigration (entry and exit)
- Smuggling of goods, narcotics, arms, and persons, as well as other transnational crime
- Diseases infectious to humans, animals, and plants
- Threats from terrorism including chemical, biological, radiological, and nuclear WMDs, as well as missile delivery systems

Border management systems must also promote and facilitate international trade, tourism, and educational exchanges, requiring a delicate balance between facilitating these activities while maintaining rigorous implementation of security goals. Balancing the two missions effectively can be a challenge for any border management system especially when implementation is often the responsibility of multiple agencies requiring close coordination in communications, procedures, jurisdictions, and response to events. Greater global access extends the flow of goods and people, which requires more consistency between countries or international standards for efficient processes.

3.1 System Architecture

The complex nature of border management systems requires us to deconstruct a system into representative elements within a multi-dimensional system architecture as shown in Figure 3-1. Border management systems can be examined using three interdependent perspectives for analysis: the border itself (defined as POEs and the areas in between referred to as frontier borders); the national or country perspective wherein the government defines its sovereign limits and border policies; and the regional/global context in which the border systems operate. Each of these perspectives can be considered as a system in and of themselves, and yet they must also be considered as an integrated, interactive whole. What happens at one level inevitably impacts and interacts with the others. This system architecture can provide a country a reference tool by which to examine different elements of the border management system toward more strategically deploying a system of personnel, physical elements, and information systems to implement border policies regulating the flow of people and goods across national boundaries and to defend against national security threats.

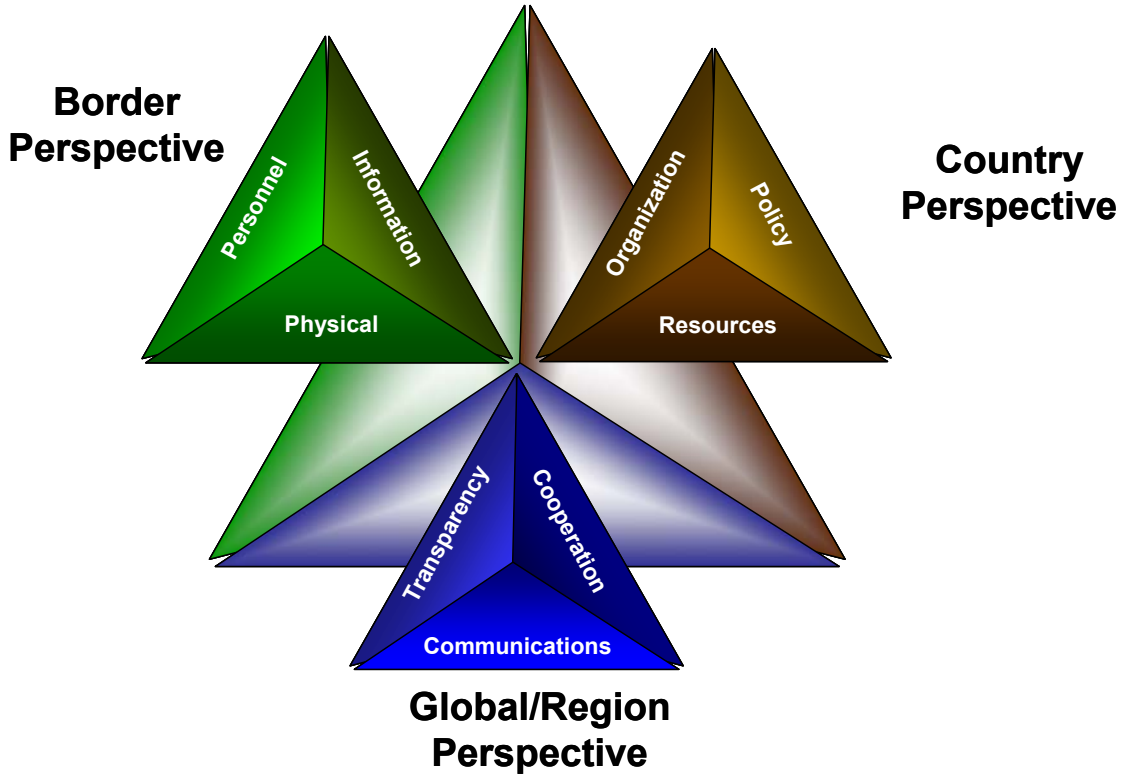


Figure 3-1. Border Management Systems Architecture

3.2 Global/Regional Perspectives

At the geopolitical level, borders define a country's sovereignty. Border management is at least the responsibility of one country. However on shared borders, all the countries involved contribute to the security associated with those borders. The fact that not all countries contribute equally to the management of shared borders can be problematic for those countries that do carry the burden. When border management on shared borders is coordinated with neighbors it can lead to more successful border management for all involved. Such coordination can include political dialogue and interaction ranging from basic communication during incidents to joint border exercises and joint border operations. Trade agreements between countries affect customs activities at borders. The freedom of cross-border-movement for persons from neighboring countries and the rights of settlement should also be discussed. Borders open for trade and the flow of people under regional cooperation can result in economic development for regional participants. A diminishment of poverty changes the characteristics of threats to the border. Ideally, mechanisms that facilitate the flow of goods and people should not also facilitate criminal and other activities that can jeopardize security and stability in the region. Close cooperation in the fields of justice and intelligence can address this concern through a common goal of information sharing and prosecution. Regional approaches toward fighting organized crime, terrorism, illegal immigration, and human and drug trafficking have been found to be more effective in dealing with these challenges. This requires countries to consider elements of transparency, cooperation, and communications associated with border management systems as shown in Figure 3-2.

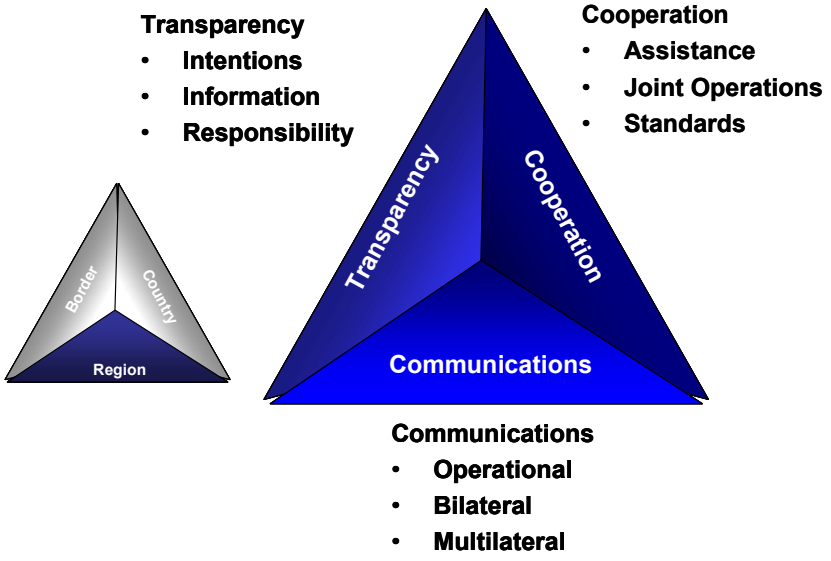


Figure 3-2. Regional Perspective Facets and Elements

Border management transparency refers to the degree to which a country shares its border management-related information with bilateral, regional, or international partners. When intentions differ between countries, transparency offers an opportunity to reach mutual understanding or find common ground for a compromise. Conversely, opacity of intentions (whether intentional or not) creates opportunities for misunderstanding that can escalate to conflict. By sharing information such as manifest data, import/export policies, immigration data, intelligence, and inspection procedures, countries can work to better facilitate the flow of goods and people while achieving more efficient security. The degree to which countries take responsibility for their borders and demonstrate efforts to achieve border management also serve as a transparency element.

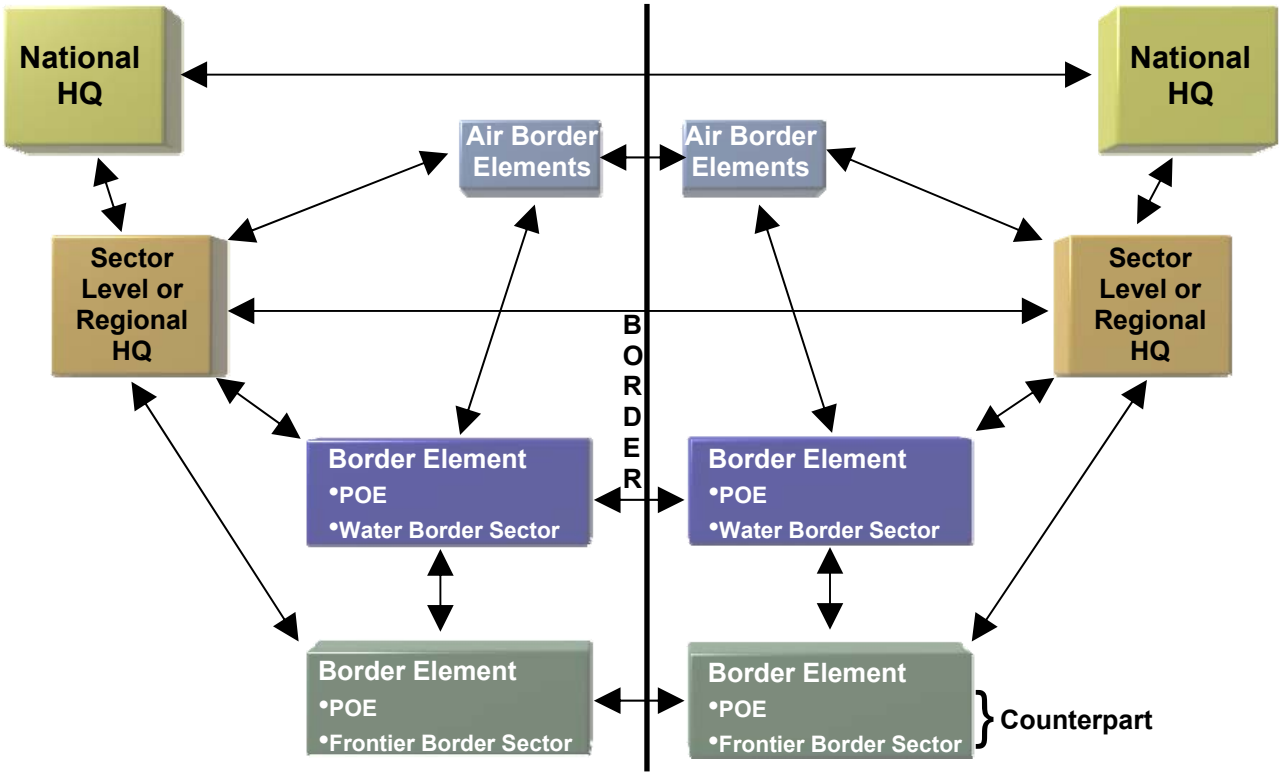
Cooperation is defined here as the degree to which a county has collaborative or cooperative border management activities with its neighbors. This may occur through assistance programs, border skills and equipment training, tour of duty exchanges, and joint operations at border POEs and frontier areas. Cooperation on jointly developed standards for border management can reduce inconsistencies and strengthen border management systems. Cooperation on intelligence and domain awareness can provide information to participating countries toward better utilization of resources. Joint operations can reduce the resource requirements and benefit both countries. Another aspect of this is the degree to which the country participates in international treaties and agreements, especially those related to border security such as:

- Compliance and report on UNSCR 1540/1810
- Membership in export control agreements such as the Zangger Committee, Nuclear Suppliers Group, Australia Group, etc.
- Participation in the conventions on human rights and against terrorism

Regional communication systems can assist with more effective border management. At the very least, operational communications with neighboring countries at POEs and monitoring posts can offer a rapid means of disseminating threat information, resolving discrepancies, and

coordinating responses. Coordination of border patrols, joint operations, and response to emergency situations, such as hot pursuits and incidents in frontier borders, can improve border management for both countries. Bilateral communication links allow perceived threats to a country to be discussed and better understood before escalating to hostilities and are necessary for agreement on the issues of delineation and demarcation of borders. Multilateral communications allow for creating regional solutions to disputes, problems, and challenges as well as facilitating trade agreements. For example, regional response to natural disasters can be planned and coordinated, especially in the response of border management to sudden large flows of population. Regional approaches to reducing transborder crime, human trafficking, smuggling, and terrorism can improve security for all participating countries. Figure 3-3 shows the possible communications linkages for operational- and strategic-level cooperation and coordination.

Figure 3-3. Multilevel Communications Linkages



Border POEs or frontier border outposts often report events to some sector level element that, in turn, reports to a national level headquarters. These headquarter units relay changes in policy to the sector that relays them to the border elements for implementation. For effective communications, it is also helpful for there to be direct communications between border elements and sectors in all domains, especially regarding changes in event statistics that might indicate shifts in smuggling or trafficking routes. In many cases, corresponding border elements exist across borders. Having established cross-border communications between these elements can reduce the potential for conflicts and can aid in interdiction. Similarly, cross-border communications between neighboring sectors can address more regional issues. For country-to-country cooperation or resolution of potential concerns, cross-border communications between

national headquarter can be useful. It is important that there be a defined protocol for whatever communication linkages exist.

3.3 Country Perspective

At the national level, it is important that a National Strategy exist for communicating the architecture of the border management system, the roles and responsibilities of border services, strategic goals, and potential courses of action that support these goals. As part of this strategy, analysis of the existing operational readiness and shortcomings at each sector should be conducted. Recommendations should be realistically achievable within the resource and environmental constraints. These sector-based objectives can then be rolled up into a national plan to be prioritized at a national level based on threat and budget priorities. Additionally, because border functions are interrelated, strategies should be coordinated to facilitate more integrated operations independent of organizational framework. These functional strategies include joint training, telecommunications, information systems, infrastructures, materials, and equipment. Figure 3-4 illustrates the elements of border management systems that must be addressed at a national level.

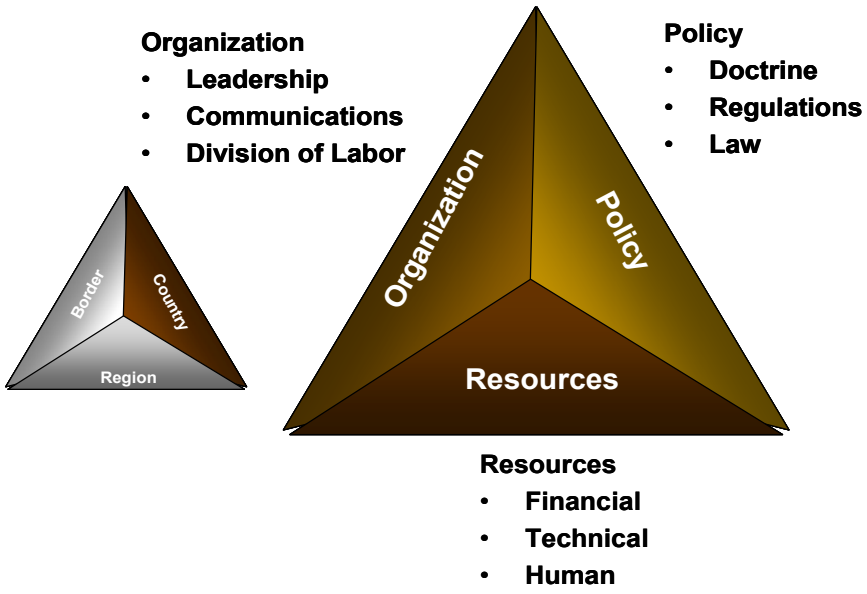


Figure 3-4. Country Perspective Facets and Elements

3.3.1 Policy

A national government generally provides a policy doctrine how its borders are to be managed. Policies for immigration dealing with the transit of persons across borders, customs policies dealing with the transit of goods across borders, and border security policies for defining border forces' mission in protecting frontier borders are all elements of overall border management policy. Prioritization among issues like terrorism, illegal immigration, and illicit trafficking should be clearly stated. Policies should also declare what constitutes the desired end-states resulting from border management. Examples of border relevant policies include:

Immigration Policies regarding the control of the flow of people in and out of a country and should include a definition of what constitutes citizenship, versus alien or immigrant status.

Customs Policies regulating the flow of goods in and out of a country. These goods include personal effects, cargo, animals, agricultural products, and even hazardous materials. Customs policies should define what goods are restricted or forbidden to pass through the border; conditions under which hazardous or potentially hazardous materials are allowed into a country; and what import/export tariffs, duties, and/or taxes are to be levied on goods.

Border Policing Policies that strengthen national security by preventing the illegal entry of people and goods into a country between ports of entry are required for controlling movement across a country's borders. POEs are generally where immigration and customs policies are enforced. Frontier border security systems are used to interdict uncontrolled border movement. These policies should make clear the security goals for border policing, the threats of concern, and the role of human rights. These policies determine to what degree borders will be demarcated, monitored, and enforced (including policies related to human rights, rules of engagement, and use of force). As transnational criminals, insurgents, and terrorists seek to bypass formal ports of entry, effective border policing increases in importance. It should be noted that border policing policies may differ at a sector level depending on the country on the other side of the border and organizational priorities.

Intelligence Policies define what information can be shared with border personnel. The more information border personnel have regarding criminals, illicit traffickers, and terrorists, the more likely they are to interdict their activities.

The effectiveness of a border management system is highly dependent on the legal foundations it is based upon. The legal infrastructure defines the rules of engagement during inspections and after arrests, dictates the disposition of persons and materials after discovery, and defines the extent to which human rights will be supported or violated under these conditions. The legal infrastructure also defines what authorities border management organizations are empowered with and the boundaries of their jurisdictions from both a procedural and geographical point of view.

3.3.2 Organization

A border management system's organizational structure greatly influences its effectiveness. As noted above, there are three major functions at borders: customs, immigration, and border policing/surveillance. These functions can be run by independent agencies. The key to successful border management systems is how well the responsible agencies work within their own organizations (vertical coordination) and how well they work together and coordinate activities (horizontal). A centralized authority that integrates these functions is needed at the highest level, whether in a single individual or a governing committee, to make final decisions on doctrine, policies, budget, and resource priorities, and to resolve conflicts and jurisdiction issues. Border management systems rely on the country's organizational structure to assure coverage of the operational domains for land, water, and air, and coverage of all sectors along the border.

3.3.3 Resources

As with most systems, resources can become the empowering or limiting factor for effective border management. Financially, border management must be balanced with other national security needs as well as other internal non-security needs. A country's financial resources also have a direct bearing on the level of knowledge, skills, and abilities of human resources within the border management system. They impact the ability of a country to adequately fund the wages of border force personnel, impacting overall personnel effectiveness and the likelihood of corruption. National technical resources provide the mechanisms for test and evaluation of border technologies and its maintenance, as well as provide reachback services should technical questions arise. For example, if a sick animal is observed, access to a technical resource such as a veterinarian can provide assistance to border personnel as to whether quarantine measures are required. Similarly, reachback to a health physicist can assist with determining how to respond to discovery of a radioactive source at the border.

Often, border sectors exist in remote locations. It is necessary for border personnel to be supplied with food and water, shelter, appropriate clothing, and munitions to meet the particular challenges at each border post. The effectiveness of supply chains to these locations affects their operational effectiveness. The reliability of equipment used in border management is highly dependent on the ability to maintain and sustain equipment. Once deployed, a system of routine maintenance, calibration, and spares is needed to maintain the capability. A regularly supplied stock of associated consumables such as fuel, oil, filters, and belts for vehicles; ammunition and cleaning supplies for weaponry; and ink supplies, paper, and batteries for some technologies are needed. Maintenance support should be considered with any acquisition of equipment or technology. Having access to a test and evaluation capability or data can aid to understanding the relevance to or limitations of technology in specific operational environments.

3.4 Border Perspective

The most observable aspects of a border management system are its POEs and frontier border systems. Frontier areas may or may not be under surveillance, fenced, or demarcated. Official POEs exist where legal border crossings occur and can be located at land crossings; water crossings at rivers, seas, or oceans; and at air crossings or virtual borders legally crossed through airports. Note that the flow of people and goods across borders must be considered from both directions—entering the country and exiting the country. Frontier borders and POEs have human, physical, and information-based dimensions characterized as shown in Figure 3-6.

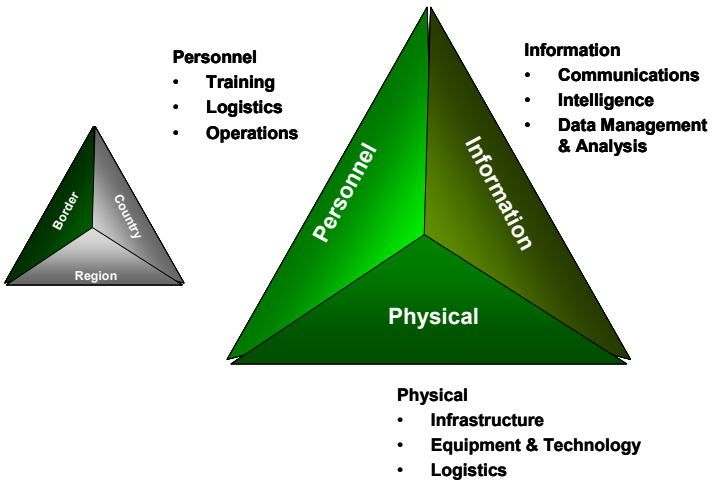


Figure 3-6. Border Element Perspective Facets and Elements

Border personnel have the responsibility to take preventative or enforcement measures at the external border of a country in order to maintain national security. This ranges from surveillance to investigations and can include the following:

- Checking the legality of persons entering or leaving the country
- Detecting and interdicting use of fraudulent documents
- Checking possessions of persons entering or leaving the country
- Preventing smuggling of goods
- Monitoring of frontier borders
- Preventing and stopping illegal crossing of the border
- Inspecting plants and animals
- Preventing entry of hazardous diseases or chemicals
- Checking goods entering or exiting the country for collection of revenues
- Preventing and interdicting illicit trade, stolen goods, drugs, weapons, explosives, and dangerous substances

The most effective security systems exercise the guiding principle of defense-in-depth or having multiple layers of detection and interdiction capability. This can include controls performed at the borders themselves, but also controls at random internal checkpoints, temporary immigrant movement monitoring, or multiple internal documentation checks in conjunction with transnational commerce.

Integration or coordination with other stakeholders as part of the system can improve the performance of border management systems. Local law enforcement and judiciary are a necessary element to ensure proper resolution of criminal activity. Railway, road, and maritime carriers and operators can assist with manifest reviews and inspections. Harbor masters, port authorities, airport authorities, and border communities can facilitate efficient information exchange, integrated security procedures, and inspection infrastructure.

It is at the border level that sectors are characterized. Choices for the personnel, physical, and information elements are determined by the following factors:

- Normal traffic, both in terms of type and volume
- Terrain including soil content, topography, and earthquake sensitivity
- Climate including weather extremes, wind, humidity, precipitation, temperature ranges
- Vegetation and wildlife, often sources of nuisance alarm equipment destruction
- Available power and communications infrastructure

Detection is an essential security capability of POEs and frontier border systems. This is sometimes accomplished using inspection regimes as the detection mechanism. In other cases, inspections represent a second level of detection to isolate or identify threats once detection has occurred. In both instances, it is important to understand the rules of engagement during inspections and the legal authorities involved with search and seizure. Depending on border management doctrines, surveillance inspections may take place at a primary location and more thorough inspections at a secondary location so as to not negatively impact legitimate traffic flows.

Another important part of the border management system is disposition of persons and materials after response has taken place. Effective deterrence is largely based on the visible ability of border management systems to interdict and prosecute violators through the country's judicial system. Effective deterrence demonstrates to potential violators the high cost of illegal activities.

3.4.1 Personnel

People are the core of every good border management system, therefore, it is necessary to have effective human resource management. This begins with strategic planning, targeted recruitment and training, and continued professional development and promotion. Detailed job descriptions, procedures based on job-related skills and training, and performance measurement should be provided. Knowledge of the local language, relevant immigration laws, and local laws are necessary. Personnel assurance programs can work to ensure the reliability of border forces and detection of insider threat behaviors.

The effectiveness of operations is highly dependent on how well border forces understand what is expected of them in their jobs. Procedures document the processes and workflows and guide the actions of border forces according to the legal authorities granted to them. Operational workflows should clearly identify responsible persons and their actions for each step. Procedures should include day-to-day operations such as routine inspections, as well as event management procedures such as handling apprehended illegal immigrants (asylum or deportation), handling smuggled materials, change in custody for apprehended criminals, quarantine of animals or plants containing diseases, hazardous materials management, and emergency response.

Operations

It is necessary to understand the chain of command within the involved border management organizations and the communication links and reporting requirements among them. It is particularly important to understand who has the authority to make decisions and to understand the limits of the legal authorities granted to border management organizations and personnel.

A concept of operations document describes how the overall border management system is to operate. A roles and responsibilities document clearly defines what is required for each assigned post. These can then be reviewed collectively to minimize duplication of duties.[3] For each role and responsibility, procedures for each associated task should exist. A method for training personnel in those procedures and verifying compliance to procedures should be exercised. As a part of continuous improvement, a mechanism for review and effectiveness evaluation, changing procedures, and training of new or revised procedures should be included in the border management system. This allows procedures to be updated when actual operations are different from documented procedures or when improvements to processes can be made to reduce inspection time or improve inspection effectiveness. Resource management information can be determined from shift composition, its changes from one shift to another, and personnel assignments to shifts provide resource management information as well as, how shifts are manned, absenteeism rates, and overtime demands. A metric of operational performance of how well the rules of engagement are understood and practiced can also be evaluated.

Other factors that can affect operations include the level of pay and associated standard of living, family support, achievement recognition, growth opportunities, career advancement, knowledge preservation, and a collaborative environment. Turnover rates and their attendant drivers can be indicators of how successful border management systems are at addressing these factors. Depending on the situation within the country and at its borders, it may be necessary to consider a personnel assurance program as a means to combat bribery and corruption. This kind of program typically includes a system of background checks that may vary in depth from simple criminal background checks to more thorough background checks that examine financial status and familial relationships. The facilities associated with POEs and frontier borders may require access control and the use of credentials to provide access. Note that access control systems can range from simple lock/key-based systems to more a complex system that uses electronic badges and biometrics. Unique identifiers such as badges can be used to ensure that only authorized personnel are in restricted areas and to make it easier to identify intruders or unauthorized personnel.

Basic Skills and Training

Well-trained, organized, and adequately supported border control personnel can utilize technology to improve effectiveness of border control systems. Generally, border personnel should be expected to have some common knowledge, skills, and abilities such as those associated with basic law enforcement and first responder. Specialized knowledge of terrain, local cultures, and languages can be essential. The additional knowledge, skills, and abilities needed are based on the unique requirements of the POE or frontier border. For example, frontier border personnel should be required to be proficient in tracking, be able to identify and pursue intruders, and be versed in inspection procedures for persons or vehicles illegally crossing the border. POE personnel using equipment deployed at the POE should be proficient in its use and versed on the associated inspection procedures. Personnel required interacting with animals,

[3] Note that some duplication of duties may be required for circumstances when two people are needed to accomplish a task or function.

such as horses for mounted patrols or dogs used as drug or explosives detectors, should also be proficient in their use and care.

How personnel are trained can be as important as what they are taught. Training venues may include:

- Border security academy/training center
- Annual/periodic refresher training courses
- Annual/periodic testing or certification
- Cooperative training with international partners
- Rotations
- On-the-job inspections
- Regular field exercises
- Printed training manuals
- On-line training

Training may be *functional*, addressing topics such as weapons use and maintenance, equipment/sensor use and maintenance, navigation skills, or the use of information technology systems. Training may be *procedural*, covering specific laws or regulatory requirements, rules of engagement, and chain-of-command structures. It may be also be situation or threat-specific regarding such topics as detecting and countering terrorism, smuggling, WMD detection and disposition, trade facilitation, and response to catastrophic events. Whatever training mechanism is used, an effective training program generally reflects a continuous process as shown in Figure 4-1.

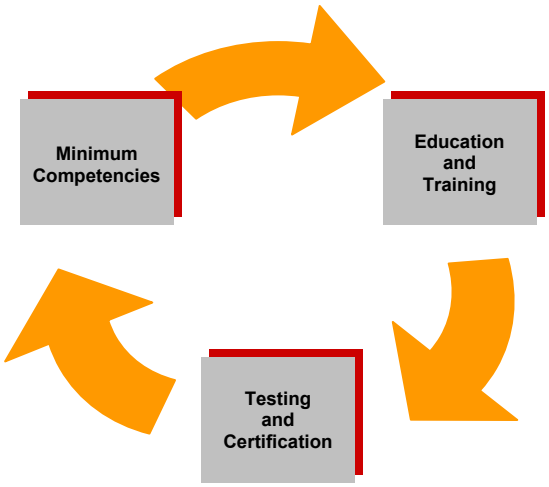


Figure 4-1 Continuous Process of Training

Logistics

To be most effective, border personnel must be logistically supported. Issues such as reliable supply of food and water (especially in remote locations), adequate clothing for the environment (particularly for hostile weather climates such as extreme cold or heat), and a dependable supply of the consumables associated with equipment and vehicles can be factors in how well border operations are performed. Another aspect of personnel logistics is the right combination of personnel on shift to cover operational, maintenance, and support functions.

3.4.2 Physical Elements

Physical elements vary from site to site and can be instrumental in the ability of border forces to perform their jobs. These elements include infrastructures, equipment, and logistics. Equipment deployed at each border element will vary depending on the function of the border element and the environment in which it resides. Equipment used to monitor frontier borders can be very different from that used at POEs to control normal traffic and detect illicit activities. However, some elements may and should be common between the two. Generally, the benefits derived

from equipment and infrastructures are dependent on the human resources managing their operations and maintenance. In the absence of a well-trained, attentive and reactive operator, sensor technologies are virtually useless. Many technologies are expensive and require regular maintenance and both must be taken into consideration in advance of purchase and deployment.

Equipment

POEs usually feature equipment designed to control the flow of persons, vehicles, and cargo. Depending on the nature of the border crossing, vehicles processed through POEs may be trains, cargo trucks, or automobiles. Operations are typically more oriented toward facilitating authorized flows of traffic, while intercepting unauthorized flows. Frontier border elements are oriented toward preventing unauthorized flows of traffic. Personnel may utilize hand-held equipment for screening and detecting metals, explosives, drugs, and/or radioactive materials. Hand-held equipment may consist of fiber-optic inspection tools, sniffers, or metal detection wands. For POEs with heavier traffic, border systems will utilize portal-based detectors to facilitate the movement of goods and people through the border. Package/cargo scanners using x-ray or neutron source technologies may also be used. Vehicle inspection sensors/portals may include x-ray, neutron source, and radioactivity-sensing technologies. For both types of border elements, the capability for documentation inspection/verification can be augmented using equipment or tools. It should be noted that canine units can be part of effective detection and response systems.

To supplement human-based patrols, frontier border systems may utilize ground sensor networks, fixed or mobile sensor platforms, sensor towers, radars, or aerial-based remote sensing. Ground sensors may include seismic, infrared, fiber-optic, magnetic, or ground radar systems. Cameras and communication equipment can also aid in surveillance of frontier borders. Patrol equipment such as aircraft, fast vessels, airplanes, helicopters, balloons, and unmanned aerial vehicles can further augment surveillance capabilities.

Environmental considerations include weather factors such as wind, precipitation, humidity, and extreme temperatures; terrain factors such as soil composition and topography; and the resident vegetation and wildlife can play a major role in sensor selection and performance. For maritime applications, tidal flows can also be a factor. There are tradeoffs to consider regarding covertness, maintenance factors, and life-cycle costs. When using sensors, the following basic specifications should be answered when considering technologies:

- Range of detection
- Detection field
- Power and communications
- Signal-to-noise ratio
- Sensitivity
- False alarm rates
- Base costs, including acquisition and installation
- Operational and maintenance requirements
- State-of-health and self-protection measures

Infrastructure
Infrastructure elements such as power, communications, and water influence the types of technologies that can be employed at border elements. Data and communications equipment often relies on a constant supply of batteries or a reliable source of electricity. In remote areas, sensor systems can also rely on battery power or alternative energy sources such as wind or solar-based systems. A reliable telecommunications infrastructure is necessary for relaying timely data and information to other decision-making organizational elements.

While the deployment may be different, there are many common infrastructure elements between POEs and frontier border systems. Both should utilize some form of delay mechanisms (usually in the form of barriers); camera and assessment systems to complement detection and response; data transmission system used to transmit information; and facilities/central alarm stations used to collect, manage, store, and communicate system information, facilities to support operations, and conveyances to assist with response.

Logistics
Logistics support of technologies is a major factor in their performance. If technologies are not routinely tested for state of health, calibrated, and maintained, their added value can be diminished. If indigenous resources for maintenance, batteries, and spare parts are not available, the equipment can be down for a significant period of time while spares are sought. If the mean time to repair is high, the mean cost to repair is high, or the mean time between failures is low, then the utility of the technology is questionable. Whatever conveyances are used, it is necessary that personnel are trained in their use and that they are well-maintained for effective patrol and response operations. Adequate fuel and spare parts are needed for vehicles to be an effective tool for personnel. Evaluation of these units should include a description of the role they play, associated procedures, and training and life-cycle issues.

3.4.3 Information Systems

Information systems include local communications, intelligence, data management, and data analysis, and are critical to the human-physical equipment interface for interpretation of what the technology is indicating. Radios and telephones may be used for local communications with security forces, data communications between sensors and control stations, and the data communicated between border elements and regional/national headquarters. The capability to receive timely intelligence can impact border personnel performance. Similarly, a country's intelligence network requires timely information from the border for data analysis and national security management. Border management organizations need data and information to assess the performance of border systems and to manage resources. Ready access to information about persons coming into the country through booking and itinerary information, visit requests, manifest data, and shipping data (such as schedules) can provide border personnel with additional information to facilitate risk assessment or to determine elevated security actions.

When an alarm is triggered, either by a sensor or visual observation by border protection force personnel, data will be generated. This data needs to be communicated, assessed, and the information shared. Detection has not occurred until the data is assessed and communicated to appropriate personnel for response. This requires the timely flow of data to personnel monitoring sensors and timely communication to personnel responding to alarms. Event data

may be shared with local or regional headquarters, national headquarters, and intelligence organizations for trends analysis and resource management. Because of the diversity of systems along the border, it is especially important to define national communication requirements and compatibility.

Communications protocols provide common understanding of events and should include how to communicate, what to communicate, and with whom to communicate. Event response plans should also include communications protocols. Communications equipment should be able to communicate reliably with local command units and have GPS capabilities. Communication modes include: direct connection by wire or fiber, telephone (wire or cellular), radio frequency (RF), wireless networks, satellite, Internet, or combinations of the above. It is valuable to have an information management system to display, record, and store data, and provide a mechanism for data analysis and for decision support.

4. Conclusions

Many border management systems are challenged trying to balance the two missions of facilitating the legitimate flow of people and goods while detecting illicit traffic. Sandia National Laboratories has over 40 years experience in the security of high consequence systems and has applied this experience to the modeling of border management systems in the architecture described in this paper. We also contend that there are universal guiding principles that can be derived from physical, cyber, and international security applications that are also relevant to border management.

- ***Command Structure Clarity*** — A clear top-down articulation of policies, postures, and priorities improves the understanding of personnel on what their job is and how it fits within the border management system.

- ***Information-Driven Operations*** — Operators should be informed by timely information and event analysis to enhance decision making. Timely intelligence can also augment border operations.

- ***Deterrence through Enforcement and Defense-in-Depth*** — Layered defensive measures provide strength to the border management system with multiple opportunities to interdict. Effective enforcement elevates the risk of illicit border activities.

- ***Technology Deployment as a Force Multiplier*** — Technology is not a substitute for human resources, but can enhance capabilities.

- ***Flexibility to Address Dynamic Challenges*** — The border management system must be able to respond and adapt to ever-growing and adapting challenges.

References

United Nations Convention on the Law of the Seas, 2006, http://www.un.org/Depts/los/

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