CTBTO
PREPARATORY COMMISSION

# THE SECRETARIAT OF THE CTBTO PREPARATORY COMMISSION
## Looking Back Over 15 Years

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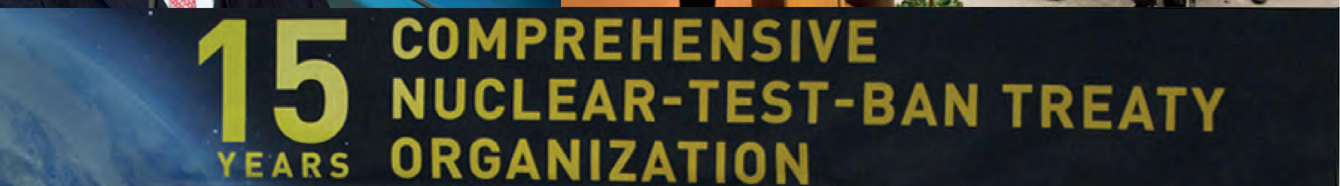
15
YEARS
COMPREHENSIVE
NUCLEAR-TEST-BAN TREATY
ORGANIZATION


MITIGATING NATURAL DISASTERS AND
ENCOURAGING SCIENTIFIC ADVANCEMENT

CTBTO PREPARATORY COMMISSION

preparatory commission for the comprehensive nuclear-test-ban treaty organization

# THE SECRETARIAT OF THE CTBTO PREPARATORY COMMISSION
# Looking Back Over 15 Years

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# Foreword

When I look back at my years with CTBTO I have an overwhelming feeling of gratitude, gratitude to the States and gratitude to the staff. I was elected to the position of Executive Secretary in 1996 and I was re-elected on a yearly basis until the end of my tenure in 2005. This procedure ensured that I had the full support of the States. In 1996 we thought that entry into force was only a couple of years away. Therefore we had to make haste. In March 1997 the Provisional Technical Secretariat started work in Vienna. At the beginning we were nine people, at the end of the year we had ten times that number.

The structure of the Provisional Technical Secretariat that was created in the beginning has basically remained the same, but it has greatly improved as far as division of labour and interdepartmental cooperation is concerned. In the early days the organization grew very fast and every single staff member had to take on a great deal of responsibility; they did so with great enthusiasm. As far as gender equality is concerned 25% of the Professional positions were filled by women, which is quite high for a technical organization, but I did not succeed in appointing a female director. Currently women represent 30% of the Professional staff and two of the five directors are female.

We have built a transparent and cost effective organization. This is not only reflected in the management of technical items but also in staff costs. All staff hold lower positions and receive less pay than staff in comparable international organizations. I see this as part of the strong support of staff.

When we started work in Vienna we received a lot of technical and administrative assistance from other organizations in the Vienna International Centre. The Austrian Government proved very helpful from the very beginning. Without the support of the States, international organizations and the scientific community, the rapid and successful growth of the organization would not have been possible.

Early on we were able to locate nuclear explosions. But very soon we were also able to explain that a certain event was not a nuclear explosion. Later we were able to contribute to tsunami warnings and could provide expert technical assistance to States Signatories.

For me personally it was very rewarding to visit former test sites on Mururoa Atoll (French Overseas Territory in the southern Pacific Ocean), in the Nevada Desert (United States of America) and Novaya Zemlya (the Russian Federation).

From the very beginning we were accepted as a fully-fledged international organization by most States and by international organizations. This was necessary in order to have the required legal framework for our endeavour. This way we were able to build a bilateral and multilateral network. Only after entry into force can the CTBTO bring its detection of a possible nuclear explosion to the attention of the United Nations. Already now States Signatories can use the data we provide to request action by the United Nations Security Council.

I am extremely satisfied that States Signatories continue to support the CTBTO with financial contributions, expertise and political involvement. I hope that entry into force will come soon. I am especially grateful to States Signatories for electing Ambassador Tibor Tóth as my successor and Mr Lassina Zerbo as his successor. Both are men of enormous knowledge and both have a forward looking attitude.

Carry on!

Wolfgang Hoffmann
Executive Secretary Emeritus
Rheinbreitbach, Germany
February 2013

# Preface

This publication is a commemoration of the first 15 years of the Provisional Technical Secretariat (PTS). It is the story of how the PTS came of age. As Ambassador Wolfgang Hoffmann, Executive Secretary Emeritus, recalls in his Foreword, the PTS had nine people when it started its work in March 1997. At the time, I was the Chair of Working Group A. We had very limited office space and almost no furniture. I remember having to place my computer and papers on carton boxes to work on the very first Programme and Budget. When I was elected Executive Secretary in 2005, the PTS was eight years old and at the time we had 80 monitoring stations. Building on the achievements of these early years, we now have 300 monitoring facilities working around the clock all over the world, a state of the art communications infrastructure, a fledging on-site inspection regime and, most importantly, some of the best experts the world has to offer. Today we have what I call a system of systems: a system that assures all States Signatories that no nuclear test explosion shall ever go undetected.

The PTS has come a long way. It is similar to when a child comes of age: it becomes more self-confident and more mature. The whole organization, not just the PTS, has matured, and so has every other layer around it. But, as we all know, for children to mature they must be challenged. The PTS has had its fair share of challenges. Ambassador Hoffmann ably steered the PTS through its eventful years of infancy. In 2006 we were faced with the need to restructure the organization, which offered new opportunities, yet involved professional and personal upheaval for staff. In addition, there was a need to implement the first round of limitation of tenure for staff. We practically had to fully rotate the professional staff of the organization, leading to a total change of staff compared to 1997. On top of that, in 2006 the first test was announced by the Democratic People's Republic of Korea. This put our political, scientific, technical and human capabilities to the test, a test which the organization passed despite the system being only 60% ready. Through continued stellar performance in 2009 and again in 2013, the second and third announced tests by the Democratic People's Republic of Korea were detected. We managed to prove beyond doubt the capabilities of the verification regime even at this stage of build-up of the monitoring system.

Through the near perfect interplay of the political process and technical/scientific achievement, the Treaty has effectively pushed the genie back in the bottle. Compared to 400–500 nuclear weapon tests carried out in each and every decade since 1945, we had a mere three in the last decade. Every single signature and ratification of the 183 States Signatories has invested political and moral capital in this arrangement.

Technically, 90% of the unprecedented monitoring system is in place. Technologies have been made to work together. The seismic, infrasound, hydroacoustic, radionuclide and noble gas technologies are supported by other technologies such as atmospheric transport modelling, information and communication. We have mastered working with each of these technologies. We have also learned how best to work them together into a system of systems, a system that not only detects nuclear test explosions but one that can contribute to disaster risk reduction and mitigation, tsunami warning and environmental and scientific research. 11 March 2011 was a tragic milestone, when the Great East Japan earthquake and tsunami were coupled with the Fukushima Dai-ichi nuclear power plant accident. Through its monitoring and verification systems, the PTS was able to provide reliable, real time, accurate and verified data which were made available to the international community to aid informed decision making.

By its very existence and through its many achievements, the Comprehensive Nuclear-Test-Ban Treaty (CTBT) created a new paradigm in the field of disarmament and non-proliferation. The CTBT has created an international joint venture of its stakeholders; an all-inclusive, multilateral and democratic, legally binding framework; a prohibition regime of equal obligations. It has a verification regime that relies on its parties and serves all of them in an equal and transparent manner. This is a new standard which goes beyond the narrow confines of non-proliferation and disarmament for security. Implications for the wider area of multilateral institutions are clear; the message is that multilateralism is very much alive. You can run, you can build, you can manage, operate and, if necessary, you can further improve a system which is as politically and technically complex as that of the PTS, with 183 countries around the table. You can run it in a smooth way technically, but you can also run it in a way where there is a cohesion of the 183 countries when there is a challenge to the norm. This type of arrangement is not a question of the past. Rather, it is the future. It gives me great pride to have been part of this landmark endeavour. I wish Mr Lassina Zerbo, the Executive Secretary Elect, every success in his new responsibilities.

Tibor Tóth
Executive Secretary
Vienna, April 2013

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# Abbreviations

| | |
|---|---|
| AG | Advisory Group |
| ATM | atmospheric transport modelling |
| CIF | Capital Investment Fund |
| CTBT | Comprehensive Nuclear-Test-Ban Treaty |
| CTBTO | Comprehensive Nuclear-Test-Ban Treaty Organization |
| DOTS | Database of the Technical Secretariat |
| ECS | Experts Communication System |
| ERP | Enterprise Resource Planning |
| GCI | Global Communications Infrastructure |
| GSETT-3 | Group of Scientific Experts Third Technical Test |
| IAEA | International Atomic Energy Agency |
| IDC | International Data Centre |
| IFE | Integrated Field Exercise |
| IMS | International Monitoring System |
| INGE | International Noble Gas Experiment |
| IPSAS | International Public Sector Accounting Standards |
| IRS | IMS Reporting System |
| ISS | International Scientific Studies |
| KPI | key performance indicator |
| NDC | National Data Centre |
| NMS | network management system |
| NPE | NDC Preparedness Exercise |
| O&M | operation and maintenance |
| OSI | on-site inspection |
| PBPR | Programme and Budget Performance Report |
| PCA | post-certification activity |
| pIDC | prototype IDC |
| PTS | Provisional Technical Secretariat |
| QMS | Quality Management System |
| RBM | results based management |
| REB | Reviewed Event Bulletin |
| S&T2011 | Science and Technology 2011 conference |
| SEL | Standard Event List |
| SOH | state of health |
| SPT1 | first system-wide performance test |
| UNEG | United Nations Evaluation Group |
| UNIDO | United Nations Industrial Development Organization |
| UNOV | United Nations Office at Vienna |
| VBO | VIC based international organization |
| vDEC | virtual Data Exploitation Centre |
| VIC | Vienna International Centre |
| VSAT | very small aperture terminal |
| WGB | Working Group B |
| WMO | World Meteorological Organization |

## TREATY

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) outlaws nuclear explosions in all environments. It seeks to constrain the development and qualitative improvement of nuclear weapons and end the development of new types of nuclear weapon. In doing so, the Treaty is an effective measure of nuclear disarmament and non-proliferation in all its aspects.

The Treaty was adopted by the United Nations General Assembly and opened for signature in New York on 24 September 1996. On that day, 71 States signed the Treaty. The first State to ratify the Treaty was Fiji on 10 October 1996. The Treaty will enter into force 180 days after it has been ratified by all 44 States listed in its Annex 2.

Under the terms and provisions of the Treaty, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is to be established in Vienna, Austria. The mandate of this international organization is to achieve the object and purpose of the Treaty, to ensure the implementation of its provisions, including those for international verification of compliance with it, and to provide a forum for cooperation and consultation among States Parties.

## PREPARATORY COMMISSION

In advance of the entry into force of the Treaty and the establishment of the CTBTO proper, a Resolution establishing the Preparatory Commission for the CTBTO was signed by the States Signatories on 19 November 1996. The Commission has two main activities: first, undertaking all necessary preparations to ensure the operationalization of the CTBT verification regime at entry into force; and second, promoting Treaty signature and ratification to achieve entry into force.

The Commission is made up of a plenary body responsible for directing policy and comprising all States Signatories, and a Provisional Technical Secretariat to assist the Commission in its duties, both technically and substantively, and carry out such functions as the Commission determines. The plenary, as the Policy Making Organ, is assisted by two Working Groups.

Working Group A deals with budgetary and administrative matters facing the organization, while Working Group B considers scientific and technical issues related to the Treaty. Both Working Groups submit proposals and recommendations for consideration and adoption by the Commission. In addition, an Advisory Group of qualified experts serves in a supporting role, advising the Commission through its Working Groups on financial budgetary and associated administrative matters.

## VERIFICATION REGIME

The CTBT provides for the establishment of a unique global verification regime that consists of an International Monitoring System (IMS), a consultation and clarification process, on-site inspections (OSIs) and confidence building measures. Data from IMS stations are to be sent via a secure global satellite network known as the Global Communications Infrastructure (GCI) to an International Data Centre (IDC) for processing and analysis, and IMS data and IDC products are to be made available to States.

## INTERNATIONAL MONITORING SYSTEM

The IMS is a global network of sensors for detecting and providing evidence of possible nuclear explosions. Upon completion, the IMS will consist of 321 monitoring stations and 16 radionuclide laboratories throughout the world in locations designated by the Treaty.

The IMS uses seismic, hydroacoustic and infrasound ('waveform') monitoring technologies to detect the energy released from an explosion or a naturally occurring event in the underground, underwater and atmospheric environments.

Radionuclide monitoring uses air samplers to collect particulate matter from the atmosphere. Samples are then analysed for evidence of physical products created by a nuclear explosion and carried through the atmosphere. The analysis of the radionuclide content can confirm whether an event recorded by the other monitoring technologies was actually a nuclear explosion. The monitoring capability of some stations is being enhanced by the addition of systems for detecting radioactive forms of noble gases that are produced by nuclear reactions.

## GLOBAL COMMUNICATIONS INFRASTRUCTURE

The GCI is designed to transport raw data from IMS facilities in near real time to the IDC in Vienna for processing and analysis. The GCI is also designed to distribute to States Signatories analysed data and reports relevant to verification of compliance with the Treaty. Digital signatures and keys are used to ensure that the transmitted data are authentic and that no one has tampered with them.

Using a combination of satellite and terrestrial communication links, this global network enables the exchange of data by IMS facilities and States in all areas of the world with the Commission.

## INTERNATIONAL DATA CENTRE

The IDC is situated at the headquarters of the CTBTO Preparatory Commission in the Vienna International Centre. The IDC is designed to collect, process, analyse and report on data received from facilities of the IMS, including the results of analyses conducted at certified radionuclide laboratories. The data and products are then made available to States Signatories for their final assessment.

## ON-SITE INSPECTION

The Treaty verification system monitors the world for evidence of a nuclear explosion. If such an event were to occur, concerns about possible non-compliance with the Treaty would be addressed through a consultation and clarification process. States could also request an OSI, which is the final verification measure under the Treaty and can be invoked only after the Treaty's entry into force.

The purpose of an OSI is to clarify whether a nuclear explosion has been carried out in violation of the Treaty and to gather those facts which might assist in identifying any possible violator.

Since an OSI can be invoked by any State Party at any time, the capability to conduct such an inspection requires development of policies and procedures and validation of inspection techniques. In addition, OSIs require adequately trained personnel, appropriate logistics and approved equipment to sustain a team of up to 40 inspectors in the field for a maximum of 130 days while enforcing the highest standards of health and safety and confidentiality.

# The Early Years

States Signatories adopt Resolution establishing the Preparatory Commission

Preparatory Commission holds its first session

PTS takes up work

IDC begins operations

Start of INGE

Relationship agreement signed with the United Nations

Preparatory Commission accedes to 1986 Vienna Convention on the Law of Treaties between States and International Organizations or between International Organizations

Cooperative arrangements established with other VBOs

Initial commissioning plans approved for the IMS and IDC

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), and the Provisional Technical Secretariat (PTS) which forms part of the Commission, occupies a special place in the history of disarmament and non-proliferation as well as in the history of international organizations. It has a number of features that distinguish it from other organizations and that have influenced the course of its history over the last 15 years. For example, there is the cost of the verification system under the Treaty, for which the PTS has responsibility, as well as its unique size and scope. The main technical task of the PTS of establishing the International Monitoring System (IMS), the International Data Centre (IDC), the Global Communications Infrastructure (GCI) as well as an On-Site Inspection (OSI) capability has been a daunting one and represents a major engineering and logistical challenge. It has involved building a unique and comprehensive verification regime driven by science and technology. The complexity of this task was clearly underestimated during the Treaty negotiations and in the early months of the existence of the PTS.

Much of the technical work of the PTS was, at least in the beginning, built on the expert work conducted during the Treaty negotiations, the work of the Group of Scientific Experts and many years of national experience in monitoring nuclear testing in all environments. However, its mandate (as set out in the Resolution establishing the Commission) was unique in scope and complexity. There was a lot of developmental

work still to be done. While some technologies such as seismic monitoring were well advanced, other technologies such as infrasound, hydroacoustic and noble gas monitoring were not as well established.

The Preparatory Commission for the CTBTO is the longest serving preparatory commission in the history of international organizations and the PTS is therefore the longest serving 'provisional' secretariat in history. This is the result of the fact that entry into force of the Treaty, upon which the PTS would become the Technical Secretariat, has taken longer than expected.

## PREPARATORY COMMISSION AS AN INTERNATIONAL ORGANIZATION

The Commission is an international organization created not by the Treaty itself but by the Resolution establishing the Commission which was adopted by the States Signatories in 1996. The mandate of the Commission is contained in this resolution. This mandate can be divided into three broad areas: tasks related to self-establishment, for example the regulations and rules to enable the Commission and the PTS to operate; the verification related tasks (IMS, IDC and preparations for an OSI); and initiation of the organizational machinery for the period after entry into force of the Treaty.

Executive Secretary Wolfgang Hoffmann meets with United Nations Secretary-General Kofi Annan.

The Commission has concluded international agreements not only with States but also with international organizations. In May 2000, it signed a relationship agreement with the United Nations, the first 'Preparatory Commission' to conclude such an agreement. This relationship agreement is based on the agreement between the International Atomic Energy Agency (IAEA) and the United Nations.

The status of the Commission within the community of international organizations was reinforced by the inclusion for the first time in 2000 of an item on cooperation between the United Nations and the Commission in the agenda of the General Assembly. Under this item, the then Executive Secretary, Wolfgang Hoffmann, addressed the General Assembly on the status of the Treaty and the work of the Commission. Since then, this item has been included on the agenda of the General Assembly on a biennial basis.

Moreover, following the example of the United Nations and other international organizations, on 11 June 2002 the Commission acceded to the 1986 Vienna Convention on the Law of Treaties between States and International Organizations or between International Organizations.

The Resolution establishing the Commission states: "The Commission shall have standing as an international organization, authority to negotiate and enter into agreements and such other legal capacity as necessary for the exercise of its functions and the fulfilment of its purposes". While the Commission's legal status is clear, its provisional or preparatory nature has caused difficulties in some areas and in some national jurisdictions, for example in relation to reimbursement of taxes and securing of GCI licences. This had an impact on the pace and cost of the build-up of the verification regime. It is an issue that continues to affect the work of the PTS as it strives to complete the IMS build-up and sustain the system.

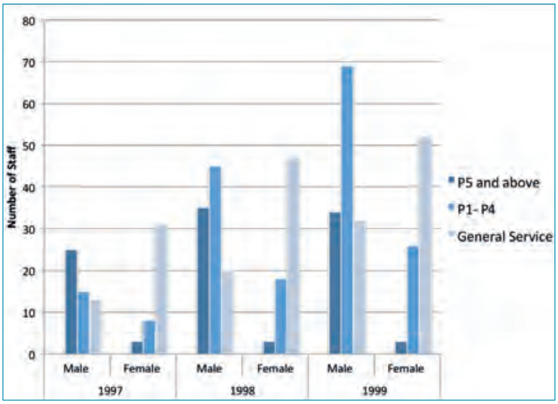
## ESTABLISHMENT OF THE PROVISIONAL TECHNICAL SECRETARIAT IN VIENNA

The choice of Vienna as the location of the Commission, as well as the decision on the basic structure of the PTS, was taken in 1996. The first session of the Commission was held in New York (20–22 November 1996) and Geneva (3–7 March 1997). The PTS started work on 17 March 1997 and with the signing of the Host Country Agreement between the Commission and the Republic of Austria on 18 March, the Commission formally established its seat in Vienna. The second session of the Commission was held in Vienna in May 1997.

The State Secretary of the Austrian Federal Ministry for Foreign Affairs, Benita Ferrero Waldner, and Executive Secretary Wolfgang Hoffmann after signing the Host Country Agreement between the Republic of Austria and the Preparatory Commission, 18 March 1997.

From 1997, the PTS immediately started to build a nucleus of personnel, which it expanded quickly into a functioning organization. Initially, staff was hired in the areas of Personnel, Finance, Conference Services, General Services and Legal and External Relations to service the Commission and its States Signatories. Later in the year, the focus shifted to staffing the three verification Divisions, IMS, IDC and OSI. By the end of 1997, the PTS was already operational with 95 staff members from 45 different States. Only nationals of States that are members of the Commission (i.e. those States that have signed the Treaty) can be recruited as staff members of the PTS.

The launch of the PTS in Vienna in March 1997 benefited greatly from the high level of optimism and enthusiasm of the staff who were recruited at the beginning. This enthusiasm stemmed not only from their commitment to and belief in the Treaty, but also from the fact that they were contributing to the establishment of a new organization, something that not all have the privilege to witness and take part in their careers. The optimism of staff was also sustained by the high level of political support and technical assistance provided by States Signatories as well as the fact that the




Number of staff at the PTS according to grade and gender, 1997–1999.

Staff of the PTS, 1997.

level of financial contributions made by States at the time was proportionately higher than in other international organizations.

Many of the individuals who played a prominent and decisive role in the early years of the PTS, as well as in Working Group B (WGB), had been involved in the negotiations of the Treaty. This included the first Executive Secretary, Wolfgang Hoffmann, whose leadership and strategic vision played a major part in the early successes of the PTS in carrying out its mandate.

From the very beginning, the PTS strove to develop cooperative arrangements with the other international organizations at the Vienna International Centre (VIC). Since being self-sufficient in all administrative areas was initially neither possible nor practical, some routine operations were outsourced. Thus the United Nations Office at Vienna (UNOV) was initially contracted to provide personnel and procurement services, and the IAEA agreed to provide financial services. To enhance cooperation with the other VIC based international organizations (VBOs), open-ended consultations were held with UNOV, the IAEA and the United Nations Industrial Development Organization (UNIDO), with the participation of States Signatories and the PTS. Overall, other organizations in the VIC were very helpful to the PTS in its efforts to establish itself.

Established as a service unit for the Commission, the functions of the PTS were conceived as twofold: verification related and administrative. At the beginning the verification Divisions were to concern themselves with the initial steps relating to the build-up of the IMS, progress in commissioning the IDC, preparations for setting up the GCI, efforts on refining proposals for guidelines and procedures for the conduct of an OSI, as well as specification of the technical evaluation programme. The non-verification Divisions were to take care of tasks such as support for the Commission and its subsidiary bodies, preparation and implementation of the budget, recruitment of staff, procurement activities, matters of cooperation with other VBOs, legal services, external relations, public information and international cooperation.

The Executive Secretary and senior PTS staff travelled to States Signatories and non-signatory States, in addition to seeking contacts with such countries in Vienna, in order to promote the Treaty and the work of the Commission as well as to facilitate the speedy build-up of the verification system.

Vienna International Centre.

## GENESIS OF IMS BUILD-UP

As already noted, a key component of the mandate of the PTS was to build up the network of IMS stations as set out in the Treaty. This was the substantive task of the IMS Division.

The first staff members of the IMS Division were hired immediately after the PTS was established in Vienna in March 1997. However, most of the technical and General Services staff joined the PTS later in the year when the work of commissioning the IMS started in earnest. By the end of 1997, the staff of the IMS Division included 18 technical staff and 5 staff members providing clerical and secretarial support.

Implementation of the IMS began in 1997 using a commissioning plan proposed by WGB and approved by the Commission at its session in May of that year. In total, the 1997 programme and the authorized budget envisaged the conduct of 32 site surveys in the four different technologies and capital investment at a number of other stations. This initial work programme for the IMS was in retrospect clearly ambitious and optimistic. It did not take into account some of the political difficulties associated with the build-up of the IMS. It already foresaw, for example, the installation of some IMS stations on the territory of countries that even today have not yet signed the Treaty.

Early work on the IMS included the elaboration of minimum requirements for station specifications. These were subsequently agreed within WGB and approved by the Commission. In addition, a questionnaire was sent to countries

Site survey at primary seismic station PS23, Makanchi, Kazakhstan, 1998.

Survey ship at the site of hydroacoustic station HA4, Crozet Islands, France, 2000.

Goods barge arriving on land near infrasound station IS18, Qaanaq, Greenland, in preparation for a site survey, 1999.

Site survey at radionuclide station RN51, Kavieng, New Ireland, Papua New Guinea, 1999.

hosting IMS stations to take an inventory of existing facilities, including their quality and specifications, in order to assess the amount and cost of necessary upgrades. Moreover, lists of suppliers of equipment and services were assembled.

In the early stages of the work, it was also necessary to establish a legal and administrative framework for the establishment of the IMS stations in the host countries. Draft IMS facility agreements were prepared and sent out to all 66 States in which IMS work was scheduled in 1997 and 1998. It was soon recognized that it would take time for these agreements to be finalized. The PTS therefore decided to begin IMS commissioning on the basis of temporary agreements in the form of an exchange of notes verbales that allowed PTS staff to enter countries to undertake the work. The support received from host countries with regard to exchanges of letters was an important contribution to the steady early progress in IMS programme and budget execution. By 1999, a sufficient exchange of letters existed in the hydroacoustic, infrasound and radionuclide technologies to enable the conclusion of the respective work programmes on a timely basis. It was only in the case of seismic stations where the lack of an exchange of letters or the lack of authorization to upgrade some of the primary seismic stations proved to be an obstacle, albeit temporary to the completion of the early work programme. Nevertheless, initial priority was given to the establishment of the IMS primary seismic network, as this was the most 'mature' technology at the time and therefore had the greatest potential for rapid deployment.


Certification visit to primary seismic station PS28, Karasjok, Norway.


Primary seismic station PS26, Torodi, Niger.

The technical staff in the IMS Division had the necessary expertise and experience to deal with the various challenges associated with installing IMS stations, including sensitive scientific instruments, in remote locations. For some of the technologies that were not so well developed at the time, however, such as infrasound and radionuclide, a collaborative effort between PTS staff and outside scientific and technical experts from national institutions was needed to do the necessary development work. The initial work of the IMS Division entailed a lot of necessary travel for PTS staff, often to remote, difficult to reach locations with harsh climatic conditions.

Judged against the milestones set out by WGB and the Commission for the IMS, the PTS achieved important progress from the beginning. This was despite the disadvantages faced by any new organization and the challenge of the technical work. This progress was achieved in all of the five areas set out in the first and second milestones of the IMS commissioning plan, namely: to undertake an inventory of IMS existing facilities; to perform the first site surveys; to start the procurement process; to begin initial installation; and to begin post-1997 planning.

Another complexity faced by the PTS in building up the IMS network was the fact that many of the coordinates of the IMS stations listed in the Treaty were incorrect. There were discussions about how to handle this legally, given that the Treaty had not yet entered into force and therefore strictly speaking its provisions could not be amended. A solution was ultimately found that enabled installation work to proceed at coordinates other than those listed in the Treaty. This involved,


Participants at the first IMS Introductory Training Programme held in Pretoria, South Africa, 1–5 December 1997.

inter alia, examination by WGB of the technical basis for any proposal from the PTS to change the coordinates of an IMS station, as well as approval by the Commission of any such changes. A more recent related issue that has not yet been resolved by the Commission is the situation where there is a proposal to change the responsibility for an IMS station from one State Signatory to another.

A programme of IMS training courses began in 1997. Introductory training courses were held in November 1997 in San Juan, Argentina, and in December 1997 in Pretoria, South Africa. In both cases, the majority of countries hosting IMS stations in these regions were able to attend. These courses provided an invaluable opportunity to establish contacts between the staff of the IMS Division and national institutions. There was also a programme of internal training for IMS Division staff to ensure that the PTS had the necessary knowledge, expertise and practical skills relevant to the specific needs of the IMS network build-up.

Following the initial progress and successes in 1997, the activities of the IMS Division during the first half of 1998 concentrated on advancing the site survey programme tasked by the Commission. This proceeded at a rapid pace. The results of the site surveys were necessary to make decisions on the type of equipment to be purchased and the technical specifications for the construction of the IMS facilities. It was imperative to make advances on the site survey programme before proceeding to the capital investment phase.

A key element at the beginning was also work on elaborating the draft operational manuals for the four IMS technologies. These manuals were the primary documents describing the IMS stations and their technical and operational requirements.

**Status of the Site Survey Programme as of 31 December 1999**

| Technology | Complete/ Not Required | Under Way | Contract Pending | Not Started |
|---|---|---|---|---|
| Primary seismic | 43 | 1 | 0 | 6 |
| Auxiliary seismic | 94 | 8 | 6 | 12 |
| Infrasound | 22 | 11 | 10 | 17 |
| Hydroacoustic | 3 | 5 | 0 | 3 |
| Radionuclide | 34 | 14 | 6 | 26 |
| **Total** | **196** | **39** | **22** | **44** |

**Status of the Station Installation Programme as of 31 December 1999**

| Technology | Complete/ Substantially Meets Specifications | Under Way | Contract Pending | Not Started |
|---|---|---|---|---|
| Primary seismic | 14 | 15 | 2 | 19 |
| Auxiliary seismic | 29 | 3 | 3 | 35 |
| Infrasound | 3 | 13 | 8 | 36 |
| Hydroacoustic | 0 | 4 | 0 | 7 |
| Radionuclide | 4 | 15 | 9 | 52 |
| **Total** | **50** | **50** | **22** | **149** |

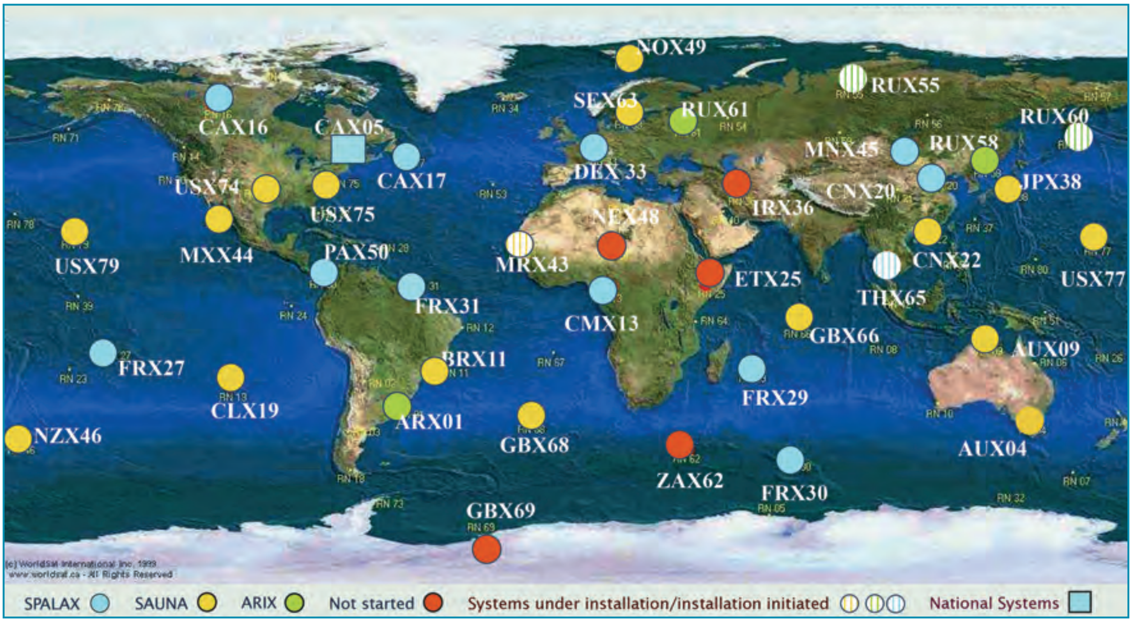
Drafting of these manuals took place formally in WGB, based on substantial input from experts in the PTS. Looking a number of years ahead, after many years of work, near final versions of the four draft IMS Operational Manuals were approved by WGB in 2009 for the waveform technologies and in 2010 for the radionuclide technology. Final versions of these operational manuals are intended to be approved after entry into force of the Treaty at the first session of the Conference of the States Parties.

Already at an early stage in 1997 and 1998 work was done within WGB, supported by the PTS, to identify the IMS radionuclide stations that should host the envisaged 40 noble gas monitoring systems. This work was based on simulations and modelling of network performance, specific proposals from various States Signatories and availability of noble gas infrastructure and expertise in various locations. The locations of the 40 noble gas systems were finalized by WGB at its Seventh Session in September 1998 and approved by the Commission in November 1998.

When the installation of IMS stations began, there was limited experience with automatic noble gas systems. There was only one system in a state of more or less advanced development at the time of Treaty negotiations.

In 1999, the Commission tasked the PTS to conduct a noble gas equipment test. The purpose of this test, which was known as the International Noble Gas Experiment (INGE), was to assess the state of the art of the radioxenon measurement technology and its capability to meet the Treaty verification requirements and goals. The INGE consisted initially of three phases, i.e. phase I: development and/or upgrade of existing equipment; phase II: intercomparison of the four noble gas systems (ARSA (USA), ARIX (Russian Federation),

State of the art of noble gas technology at the time of Treaty negotiations, Freiburg, Germany.




IMS noble gas network as of March 2012.

SAUNA (Sweden) and SPALAX (France), by parallel operation at the noble gas laboratory of the German Office for Radiation Protection, Freiburg, Germany; phase III: field and network testing.

In subsequent years the INGE made steady progress through its phases. Greater impetus was given to the development of the noble gas monitoring capability as a result of experience from the first announced nuclear test in the Democratic People's Republic of Korea in 2006. Certification requirements for noble gas systems were developed in 2008. The first certification of a noble gas system was achieved in 2010 at radionuclide station RN75, Charlottesville, VA, USA, followed soon after by two further certifications at stations in Brazil and on the island of the Tristan da Cunha (United Kingdom (UK)).

Location of radionuclide station RN68, Tristan da Cunha, UK.

Since then, the integration of noble gas monitoring into the verification system has proceeded well. A review of noble gas data in IDC operations as well as the release of the first Reviewed Radionuclide Report containing noble gas data took place for the first time in 2011.

## TRANSITION TO THE IDC IN VIENNA

During the course of 1997, the PTS made significant progress in the progressive commissioning of the IDC. This work proceeded according to ambitious plans developed originally within WGB. The cornerstone text for this work was the IDC Progressive Commissioning Plan. This plan included requirements, tasks, milestones, schedules and budgetary information for personnel

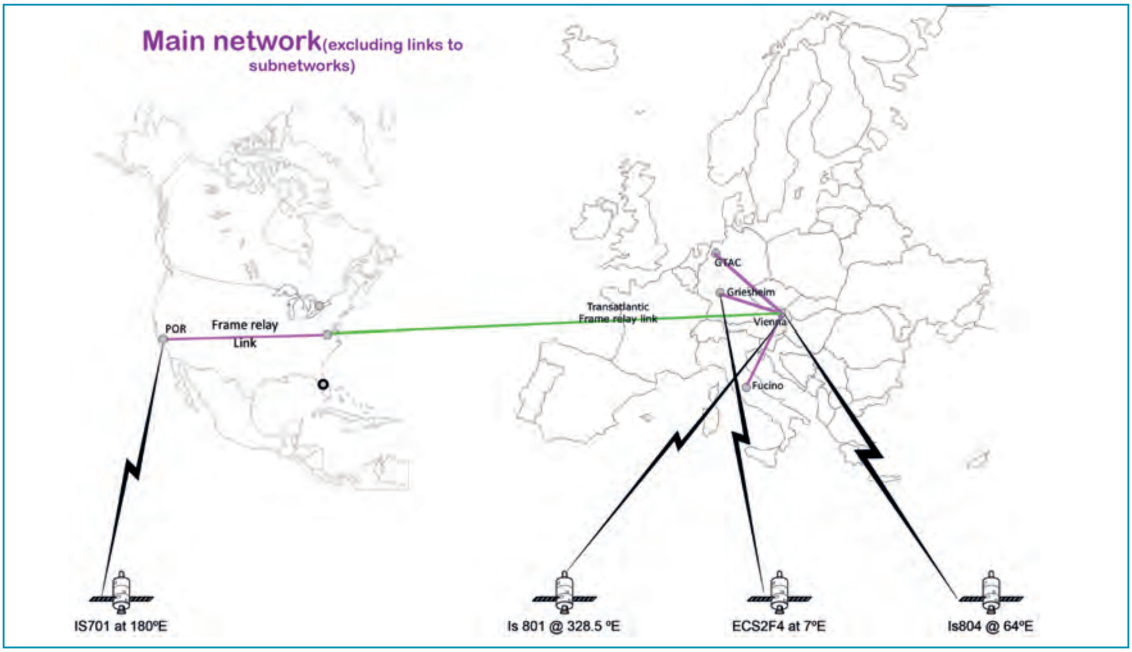
### Early Phases of IDC Progressive Commissioning Plan

| Group of Scientific Experts | | | Progressive Transition from pIDC to IDC in Vienna | | | | |
|---|---|---|---|---|---|---|---|
| 1985 GSETT-1 | 1991 GSETT-2 | 1995+ GSETT-3 | Phase: | April 97 1 | Oct 97 2 | June 98 3 | May 99 4 |
| | | | Monitoring software release: | | 1 | 2 | 2.1 / 3 |
| Experimental IDCs in Moscow, Stockholm, Washington | Experimental IDCs in Canberra, Moscow, Stockholm, Washington | Prototype IDC in Arlington | | Design & planning | Establish facilities | Establish IDC in Vienna | Initial testing of Vienna IDC |
| Growing number of National Data Centres | | | | | | | |

Location of the pIDC at the Center for Monitoring Research in Arlington, VA, USA.

Analyst reviewing seismic events during the GSETT-3 technical experiment at the pIDC.

Situation room at the pIDC.




Preliminary design of GCI VSATs (black) and terrestrial backbone networks (pink), 1998.

and systems in the IDC. The IDC Progressive Commissioning Plan specified tasks by phases and not exact dates. Therefore, exactly how much progress was expected by the end of 1997 was not specifically stated in this plan. It drew on the cumulative experience of the prototype IDC (pIDC) in Arlington, Virginia, USA. This prototype, or experimental, data centre had been set up in 1995 as part of the Group of Scientific Experts Third Technical Test (GSETT-3).

The PTS benefited extensively in the early stages from working in close cooperation with the pIDC to implement the IDC Progressive Commissioning Plan. The plan, which was subsequently reviewed and updated on a regular basis as necessary, was initially based on a number of assumptions: maximum use of previous developments and experience at the pIDC; software and documentation developed at the pIDC would form the initial basis for the IDC in Vienna; the pIDC would continue to function as required to assist in the plan to commission the IDC in Vienna; and a GCI should be established to route IMS data to the IDC in Vienna.

The first staff member in the IDC Division did not start work until the middle of 1997. By the end of 1997, the IDC Division had seven Professional staff and six General Service staff working under the Director. Despite the limited number of staff at the beginning, almost all of the 1997 milestones were accomplished along the IDC Progressive Commissioning Plan: facility preparation, infrastructure development, software development and testing, and staffing and training.

WGB concluded, for example, that all major milestones scheduled for Phase 1 had already been completed satisfactorily by September 1997.

In late 1996, the staff of the pIDC had to compile preliminary requirements for establishing the IDC facility on the fifth and sixth floors of Building E of the VIC. In March 1997, a complete draft plan was reviewed and approved by the Commission and submitted to the Internationale Amtssitz- und Konferenzzentrum Wien (IAKW-AG) AG, the Government of Austria's agent for remodelling of the VIC, as a basis for discussions. In late August 1997, the plan was refined to fully support the vision for IDC functions, staff and equipment set forth in the Treaty and in the IDC Progressive Commissioning Plan. This refined plan retained a level of flexibility to accommodate new elements of the IDC concept of operation, which might still arise in discussions within the Commission.

Operational experience gained at the pIDC over the previous years provided a realistic foundation for the assumptions underlying the remodelling plan. The plan also incorporated engineering changes recommended by the IAKW-AG that would decrease the cost both of the remodelling itself and the long term operation and maintenance (O&M) expenses for the facility. The August 1997 plan was used as a basis for the final cost estimate that was presented to the Government of Austria, and for solicitation of proposals to complete the work.

In September 1997, the Government of Austria approved funding estimated at approximately 36 million Austrian shillings for the remodelling of floors five to eight of the E building in the VIC. Three sets of problems forced minor delays relative to the original plan for preparation of the IDC facility. First, the design of the special air handling and power requirements of the IDC to support operations 24 hours per day and seven days per week took longer than expected to finalize. Second, a design to allow computer workstations for PTS technical staff on the seventh and eighth floors to be networked with the IDC systems was also more complicated than expected. Third, the fact that the goods and services necessary to complete the analysis and operations centres, for example furniture, could not be accommodated in the funding from the Government of Austria forced the procurement of these items to be delayed until early 1998. However, none of these delays had an adverse effect on the primary objectives of the IDC Progressive Commissioning Plan and did not delay the ability of the PTS to accept Release 1 of the applications software from the pIDC in 1998.

In 1997 the PTS also commenced the procurement of the minimum computer hardware and commercial software necessary to support initial IDC staff, to enable the transition and testing of Release 1 of IDC application software from the pIDC. The PTS worked closely with the staff of the pIDC and with experts in WGB to ensure that the applications software was delivered successfully, that it provided the required functionality and that it was fully transparent to all States Signatories.

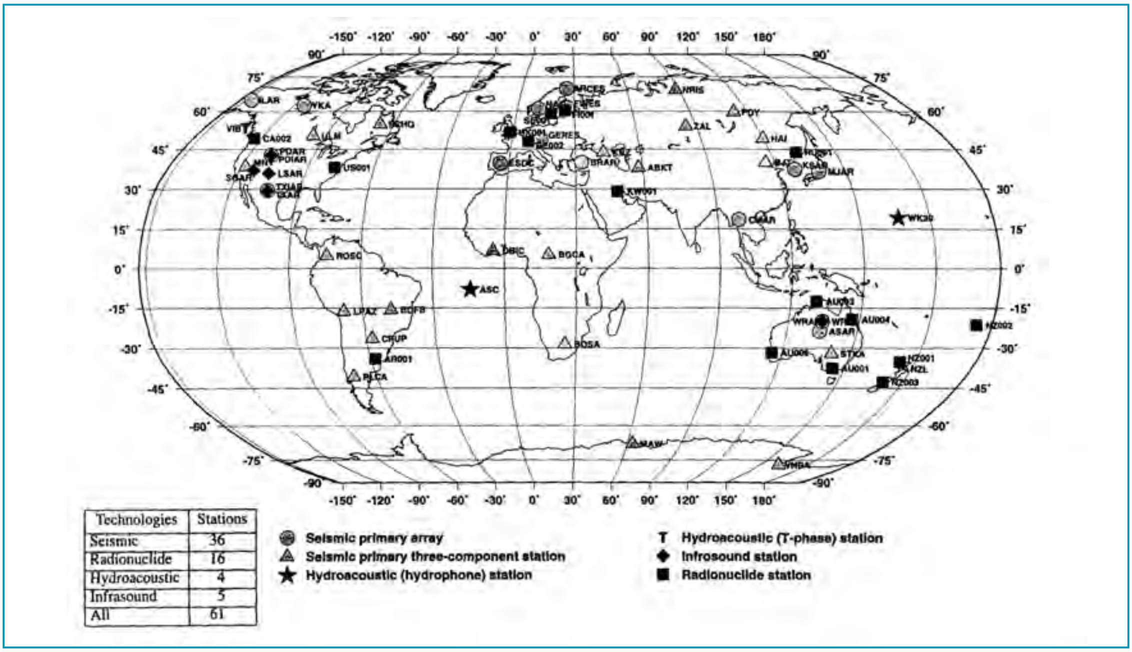
A transition plan was developed between the PTS and the staff managing the IDC software development at the pIDC. This arrangement established the overall structure, approach and contents of the complete set of software releases and deliveries to the IDC. It also covered the issues connected with having pIDC staff on the premises of the IDC in Vienna.

The need for IDC related training was also recognized by the Commission at an early stage and at its first session a budget to begin such training in 1997 was adopted. The aim was to ensure that staff recruited by the IDC Division had the necessary knowledge and skills to carry out the various functions of the IDC. By the end of 1997, the PTS completed preparations to conduct the first IDC training course at the pIDC, and 10 trainees from 10 different States Signatories were selected.

Perhaps the most consistent cause of delays in the work of the IDC in 1997 was the fact that the number and type of personnel in the 1997 staffing plan did not quite match the type and volume of work required. A second contributor to delays was that both the PTS procedures (especially for procurement), and the personnel executing these procedures (including the IDC staff) were new in 1997. This became less of a delaying factor in 1998 and subsequent years as the procedures and staff were better established. Nevertheless, the PTS assumed a more conservative schedule for procurements to be conducted in 1998 to permit sufficient time for proper execution. The PTS would not have had the success it did in 1997 in the development of the IDC in Vienna without the help of experts from WGB and from the pIDC.

The most significant milestone accomplished within the IDC in 1998 was the successful delivery and initial testing of Release 1 of the IDC applications software. This was the first of four major releases of software from the pIDC. Extensive management planning and coordination between the two data centres preceded the delivery. The objectives of Release 1 of the IDC applications software were to familiarize IDC staff and pIDC staff with the software delivery process, to provide an initial capability for test operations and demonstrations, and to support the 1998 training programme. The installation of Release 1 took place in May 1998. Real time data from stations at 63 IMS and test sites began flowing through the pIDC to the IDC over a new high speed communications link on 15 May 1998. In June 1998, a validation test of Release 1 was conducted jointly by the staff of the IDC and the pIDC. Assessment of the test results demonstrated that the criteria set for its success were fulfilled. A report on the validation test of Release 1, and on the subsequent operational testing experience at the IDC in Vienna, was provided to WGB.

The success of the delivery of Release 1 was also dependent upon the successful preparation of the IDC infrastructure. In this regard, the PTS continued in 1998 to work closely with the Government of Austria and its contractors to complete the details of the remodelling of floors 5 and 6 of the E Building in the VIC. The new IDC Computing Centre accepted the first seven computer servers in March 1998, with all remaining hardware and commercial software procured, installed and tested in time. Additionally, the procurement of approximately 65% (by cost) of the planned 1998 purchases of the necessary additional hardware and commercial software was carried out to prepare for the receipt, installation and testing of the products in advance of the delivery of Release 2 of the IDC software in 1999.




Release 1 network, 1998.

In the first half of 1998, the PTS completed all milestones of Phase 2 of the IDC Progressive Commissioning Plan and was able to commence Phase 3 of the plan in June 1998. All milestones in Phase 3 (Establishment of Initial Operations at the IDC in Vienna) were completed at the beginning of 1999 and Phase 4 (Initial Testing of the IDC Hardware and Software) commenced in March 1999. In 1999 preparatory work also began on providing data, products and services to States Signatories on a regular basis starting in 2000.

The year 1999 marked the first year when all monitoring applications software was placed under the control of the IDC Division within a software configuration and version tracking tool.

Delivery of Release 2 of the IDC applications software from the pIDC commenced on 10 May 1999, on the basis of an implementation plan developed jointly by the IDC and pIDC staff in January 1999. This followed a three month delay during which the United States Government resolved issues related to exporting the software. The PTS ensured that the IDC infrastructure and staff were fully prepared for this delivery.

By 1999, the facilities of the IDC in Vienna were essentially complete. The first Operations Centre was available for use by the entire PTS. A service level agreement was negotiated with the UNIDO Buildings Management Services so it could assume responsibility for routine O&M of the power and environmental systems.

The first Operations Centre at the PTS.

Moreover, by 1999 substantial information technology support for the entire PTS was already under way. A computing support service (help desk) was established, with a modern problem reporting and tracking system, to attend to the hardware and software needs of the PTS. The PTS had by that time also taken over from UNOV the provision of office computing services, using a new network based on modern standards. The security of all networks had been improved through the installation and tuning of a new firewall system.

Another substantial area of work from the beginning was the development and elaboration of a draft operational manual for the IDC. This was the critical document that was to elaborate the nature of all IDC products and services, and how the IDC was to produce and provide them. This work was carried out within WGB in conjunction with work on the draft IMS Operational Manuals, again with substantial involvement and input from experts in the PTS.

## BEGINNING OF WORK ON OSI

It is now generally recognized within the Commission that development of the OSI component of the verification regime has lagged behind the other two key pillars, the IMS and the IDC. This disadvantage was evident already at the beginning of the life of the PTS. At the time, it had been considered that the immediate priority was to devote as many resources as possible to the establishment of the IMS and the IDC. In addition, OSI work always laboured under the disadvantage of being more closely linked to the prospects for entry into force of the Treaty, given that an actual OSI would not be possible until after entry into force (whereas the IMS and IDC could operate, albeit provisionally, in advance of entry into force as part of the Commission's mandate). This reality coloured perceptions about the pace of progress that should be envisaged for OSI as well as the level of resources that should be allocated to OSI related tasks.

Despite this inherent complexity associated with OSI, important work was nevertheless undertaken as of 1997, which formed the basis for the progress made in later years. Preliminary conceptual work on OSI began in early 1997 within WGB. It developed a tentative list of main subject areas as a basis for further development of guidelines and procedures for the conduct of an OSI. It also developed a tentative list of tasks and functions for OSI infrastructure to support the future OSI regime, as well as a strategy for how these infrastructure elements should evolve into final OSI infrastructure capable of supporting the OSI regime after entry into force of the Treaty. There were six basics elements as shown in the table below.

The OSI Division started work only on 14 July 1997. By the end of 1997, the Division had a total staff of six (four Professional and two General Service staff), representing less than 25% of the projected person/month staffing requirement for 1998. Under the early guidance of WGB and the Commission, the PTS worked on refined proposals for guidelines and procedures for the conduct of an OSI. It also pursued the development of a training and exercises programme, established initial OSI equipment and logistic requirements, and developed an initial outline for the draft OSI Operational Manual and proceeded with progressive compiling of the Manual.

Process of editing the draft OSI Operational Manual by the OSI Programme Coordinator and Friends and PTS staff, 2000.

In cooperation with the OSI expert group within WGB, the PTS organized the first OSI workshop on Nuclear Explosion Related Phenomenology and OSI Methodology from 30 July to 4 August 1997. The presentations at

**Infrastructure elements of OSI Major Programme in 1997**

| Programme Elements | Final Objectives |
|---|---|
| 1. Methodology & Technology Development | Establishing the methodology, developing of the detailed description of OSI technology and the concept of operations in accordance with the Treaty |
| 2. Documentation Development | Development and renewal of the Operational Manual and other OSI documentation |
| 3. Infrastructure Development | Establishing OSI infrastructure to support development and implementation of OSI part of verification regime |
| 4. Equipment & Software Provision | Acquiring or otherwise making provision for the availability of relevant inspection equipment and software |
| 5. Testing & Validation Readiness | Individual and full-scale testing and exercising, support and validation of OSI capabilities and operational readiness |
| 6. Training | Providing the different categories of experts to be involved in OSI-related activity with necessary and sufficient comprehensive training |

this workshop covered inspection issues for the initial part of an OSI. The final report of this workshop provided a valuable technical basis for the subsequent development of the draft OSI Operational Manual.

## EVALUATION AND QUALITY ASSURANCE

The Evaluation mandate was specified in the report of WGB to the Third Session of the Commission in September 1997. In particular, WGB tasked the PTS to develop the quality assurance system as an integrated part of the verification regime. The purpose of this was to ensure that continuous, reportable quality measures were implemented so as to provide the States Signatories and the Commission with the necessary confidence in its functioning and its products and services. WGB established that quality in the PTS should be verifiable and incontestable. It should lend itself to be assessed on the basis of quantitative criteria when possible, and the measures preferably have to be generated automatically, providing a tool for constant improvement.

The technical evaluation programme of the PTS was entrusted in the beginning with four main tasks. One was to review the evaluation work of the Group of Scientific Experts of the Conference on Disarmament and the performance reports prepared by the pIDC and to develop procedures for technical evaluation of the three waveform verification technologies (seismic, infrasound and hydroacoustic). The second task was to identify the various components of radionuclide operations and to develop procedures that would be used for technical evaluation of this technology. The third task was to identify the various elements of the OSI programme that could be subjected to technical evaluation and to develop procedures that would be used for these evaluations. The fourth task was to follow developments with respect to confidence building measures in both WGB and the PTS and to determine which aspects of these developments would be subject to technical evaluation.

In the beginning the quality assurance/quality control programme was divided into two tasks. The first task was to review the quality assurance systems included in the draft operational manuals that were being developed for the four technologies, for the IDC and for OSI operations. The second task was to develop a framework for the quality assurance manual for the verification regime that specified the purposes of quality assurance, the responsibilities for implementation of quality assurance, and the general framework for quality assurance that would be adapted by the verification Divisions for their particular use.

In 1998, the first evaluation workshop contributed a set of metrics to evaluate the performance of the verification system. Work on the identification, adoption, testing and refinement of such evaluation metrics has continued in the PTS, resulting in the current versions of the PTS quality policy and quality manual issued in 2006 and 2007 respectively. These put the development of metrics and key performance indicators (KPIs) at the centre of the Quality Management System (QMS). The development of the PTS Process Metrics Manual was also started, compiling and describing KPIs and their computation methods.

# Maturing of the PTS

Verification system moves towards provisional operation and sustainment

First IMS stations certified

Revalidation of performance of certified IMS stations

IDC provides data to States Signatories on a regular basis

PTS assumes responsibility for routine station management

Implementation of structural changes in the PTS

Installation of IDC applications software completed

OSI capability tested through field exercises

Substantial increase in level of data availability

A period of fifteen years is a good span of time within which to observe the development and maturing of the PTS as an organization in terms of the technical aspects of its mandate. As described in the previous chapter, in the initial years the PTS focused on rapidly building up the network of IMS stations, establishing and testing the new IDC in Vienna so that data and products could be provided to States Signatories as soon as possible, establishing the concept, mechanisms and procedures for the development of an OSI capability and putting in place the appropriate evaluation and quality management elements.

In the beginning the technical Divisions operated more as separate entities. This was natural given that their technical tasks were initially quite independent. This started to change as, for example, the IMS stations began sending data to the IDC and the completion of IMS stations required testing and certification by the IDC that the data it was receiving was of sufficient quality. Starting in 2000 there was a natural transition from build-up to provisional O&M of the verification system. This transition served to entrench the need for close cooperation between Divisions. The increasing emphasis on field exercises for OSI led to greater involvement of expertise from the IMS and IDC Divisions in OSI activities. This increasingly PTS-wide cooperation was a defining component of the maturing process of the PTS.

In the beginning, most technical expertise was provided by the States Signatories, directly and through WGB. Since then, there has been a transition of expertise from States to the PTS. While States Signatories have continued to play a vital role in providing guidance to the PTS, the capacity of the PTS to act independently according to the framework set by the Commission has increased, leading to greater effectiveness in achieving the technical outcomes. This has been another key component of the maturing of the PTS.

## MATURING OF THE IMS

In the beginning the natural focus was on the rapid installation and certification of the IMS facilities. Certification means that an IMS station meets all the requirements necessary to become a part of the IMS network. This includes meeting the technical specifications established by the Commission, ensuring that data are tamper-proof and authenticated and that data are sent in an uninterrupted stream over an official GCI link to the IDC in Vienna. Certification guidelines and a defined certification procedure forms the basic framework for this process.

In retrospect, the initial goals set for the IMS with respect to installation and certification were highly ambitious. Moreover, in the beginning, the IMS programme and budget included unrealistic objectives, deadlines and financial estimates. For example, the budgeted cost estimate for a hydrophone type of hydroacoustic station was substantially underestimated and the objective of completing the IMS network within three years was not feasible. In light of experience, the ability of the PTS to propose to the Commission more realistic programmes and budgets evolved and improved.

Measured against these initial ambitious goals, the PTS made good steady progress commensurate with the human and financial resources available and subject to the support it received from host countries. This initial progress culminated in the first certifications of IMS stations on 28 July 2000: primary seismic stations PS9 (Canada), PS27 (Norway) and PS47 (USA). The relatively higher level of maturity of the seismic technology at the time was the main reason

Primary seismic station PS9, Yellowknife, N.W.T., Canada.

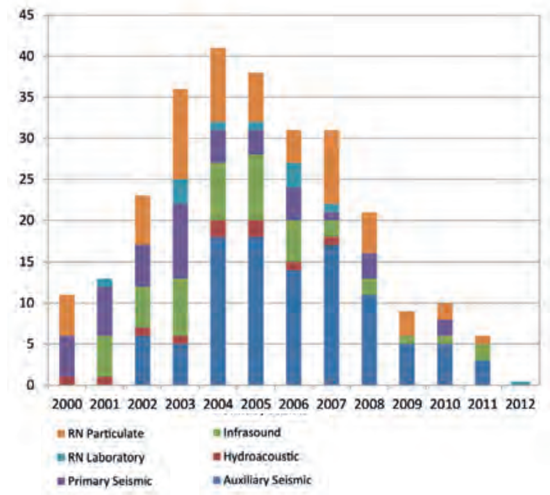
Primary seismic station PS27, Hamar, Norway.

Primary seismic station PS47, Mina, NV, USA.

that these first certifications were primary seismic stations. For the newer technologies of infrasound and radionuclide a significant amount of development work still needed to be undertaken and the number of experts in the scientific community on these technologies was limited.

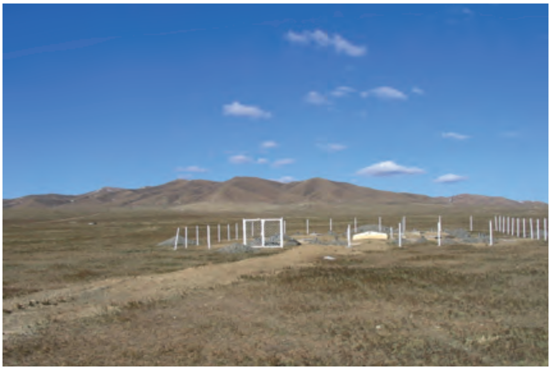
Following these first certifications, the PTS was successful in continuing the programme of installation and certification at a steady pace, taking into account resource constraints as well as technical, legal and political difficulties encountered along the way. By the beginning of 2012, a total of 294 IMS facilities (stations and laboratories) were installed, and 270 were certified.

In 2008 the concept of 'revalidation' of the technical performance of certified IMS stations became important. Revalidation involved a reassessment of the station equipment and instrumentation, associated facilities and infrastructure, as well as the station environment and operational performance against the relevant minimum technical specifications and other certification requirements approved by the Commission. This process was triggered by a range of events, including reconstruction following partial or total destruction of a station, a change of location or array geometry, a change of equipment or software due to repair, improvement, upgrade, end of life replacement, obsolescence or deterioration owing to changes in the station environment such as increased noise levels. Since many events could trigger the need to revalidate the performance of an IMS station, a definitive list was not considered practical or desirable.




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Auxiliary Seismic | 0 | 0 | 6 | 5 | 18 | 18 | 14 | 17 | 11 | 5 | 5 | 3 | 0 |
| Hydroacoustic | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Infrasound | 0 | 5 | 5 | 7 | 7 | 8 | 5 | 2 | 2 | 1 | 1 | 2 | 0 |
| Primary Seismic | 5 | 6 | 5 | 9 | 4 | 3 | 4 | 1 | 3 | 0 | 2 | 0 | 0 |
| RN Laboratory | 0 | 1 | 0 | 3 | 1 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| RN Particulate | 5 | 0 | 6 | 11 | 9 | 6 | 4 | 9 | 5 | 3 | 2 | 1 | 1 |
| **Total** | **11** | **13** | **23** | **36** | **41** | **38** | **31** | **31** | **21** | **9** | **10** | **6** | **1** |

Number of stations and laboratories certified, 2000–March 2012.

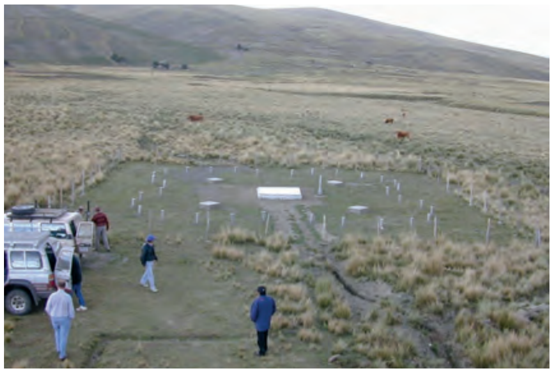


Infrasound station IS34, Songino, Mongolia.

An early example of revalidation was at infrasound station IS34 (Mongolia) after the station was upgraded.

In the beginning a significant number of IMS station installations took place under conditions of what was known as reduced assessment. This provided for work on installation of an IMS station to be undertaken by a State Signatory, using national funding that was later deducted from that State's assessed contribution for the year after the station was certified. There were advantages to this approach in ensuring rapid installation work as well as the commitment of the hosting States to complete the work. A notable disadvantage of work under reduced assessment for the system as a whole, however, was that it led to the installation of non-standard equipment (but at least with uniform functional specifications) in a large number of IMS stations. This led later on to a higher level of complexity for the IMS station maintenance programme. Examples of stations built under reduced assessment conditions are AS2 (Argentina), PS25 (France), PS43 (Turkey), IS8 (Bolivia), IS27 (Germany) and RN72 (USA).

The IMS Division was initially structured according to technology. This was self-evident at the time because it corresponded to the requirement that the PTS install as many IMS stations as possible and as quickly as possible. The concentration of expertise in a particular technology in one coherent team was a natural response to this imperative. However, as the IMS developed, such a work structure led to 'stove piping', in the sense that the four technologies were built as four quasi-independent networks and not as parts of an integrated whole. This technology



Infrasound station IS8, La Paz, Bolivia.


Auxiliary seismic station AS2, Ushuaia, Argentina.

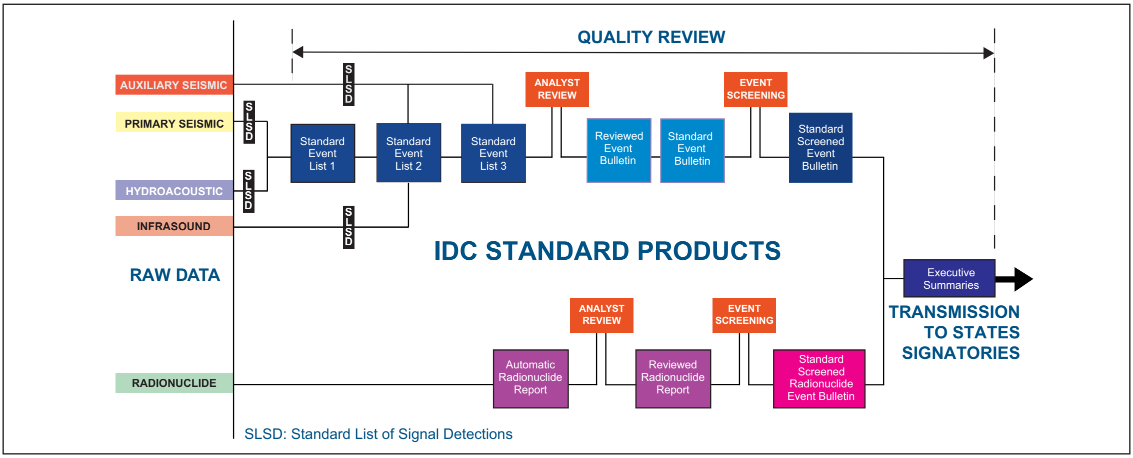
based approach evolved as it outgrew its usefulness and the focus of the PTS shifted gradually from IMS build-up to provisional O&M of the verification system as a whole.

Progress on the build-up of the IMS was also influenced by the constraints associated with working in a United Nations-like setting. This involved practices that would not normally be found in industry or in a national setting. Moreover, a lot of the IMS station installation work was and, in fact, continues to be carried out on the basis of 'sole source' contracts. These are contracts with entities that have been designated either by the PTS or the hosting country according to the Financial Regulations and Rules of the Commission without going through a competitive bidding process.

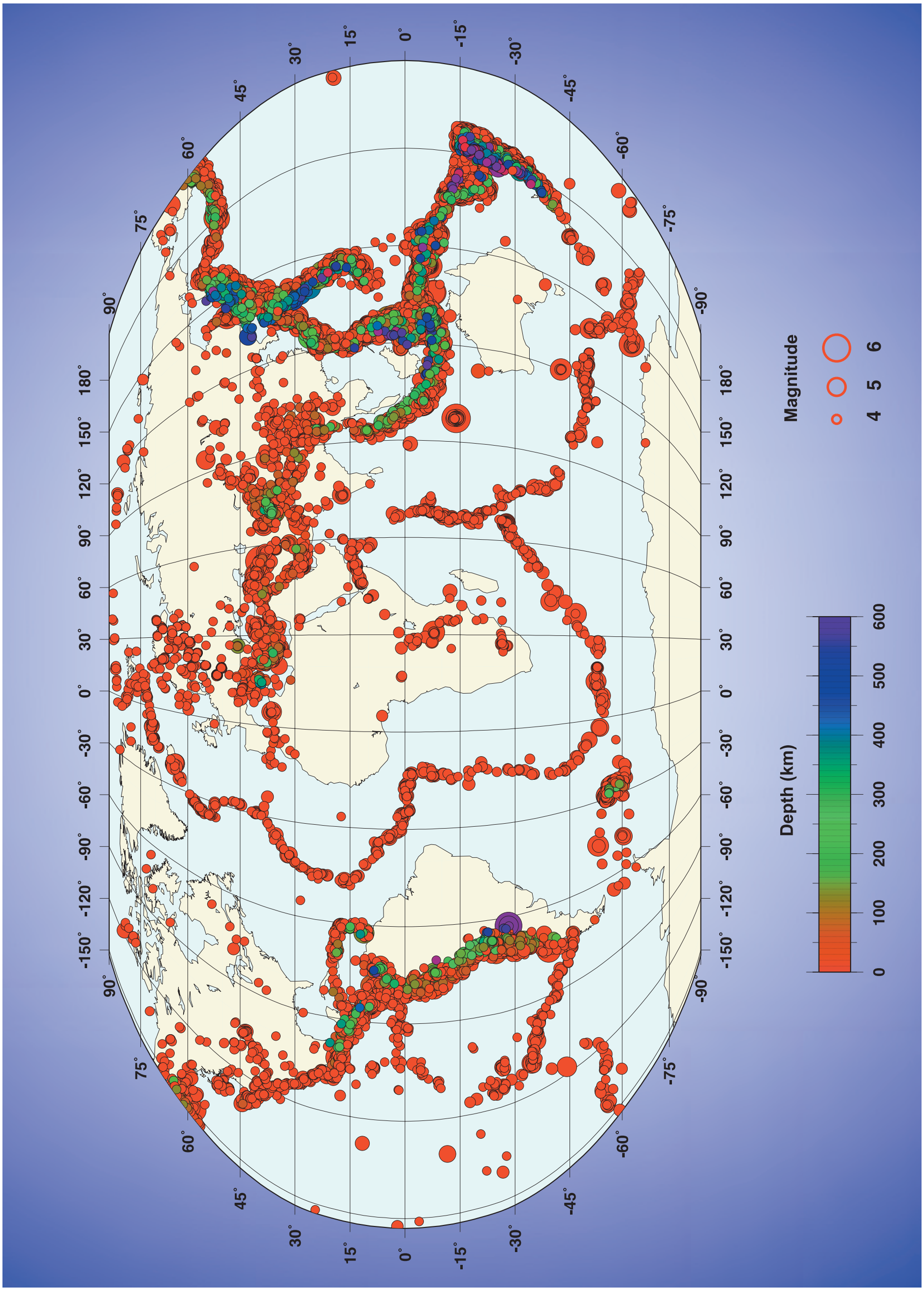
## MATURING OF THE IDC

The key element of the maturing of the IDC was its assumption of all roles and responsibilities of the pIDC and the progressive development of necessary expertise within the IDC in Vienna so that it could independently provide all States Signatories with the expected data, products and services. This was a defining moment not just for the IDC but for the PTS as a whole.

The IDC completed all milestones in Phase 4 (Initial Testing of the IDC Hardware and Software) of its Progressive Commissioning Plan in 2000. This enabled it to include data sent from IMS stations through GCI communication links into IDC operational data processing. Previously, data had been transmitted through GSETT-3 communication links via the pIDC. As of February 2000, data, products and services were provided to States Signatories on a regular basis. All IDC products underwent quality review before they were released to States Signatories. On average 52 seismoacoustic events a day were analysed in the Reviewed Event Bulletins (REBs) and 217 radionuclide spectra were processed and analysed each month. Another element of the quality assurance programme was the comparison of automatic and reviewed products




IDC standard products.




18 218 events from IDC REB under Release 2 during 2000.


Radionuclide station RN47, Kaitaia, New Zealand.


Changing a filter at radionuclide station RN10, Perth, WA, Australia.

from the IDC against those from the pIDC. The results of this comparison provided useful information for a better understanding of operational software and for the development of operational procedures.

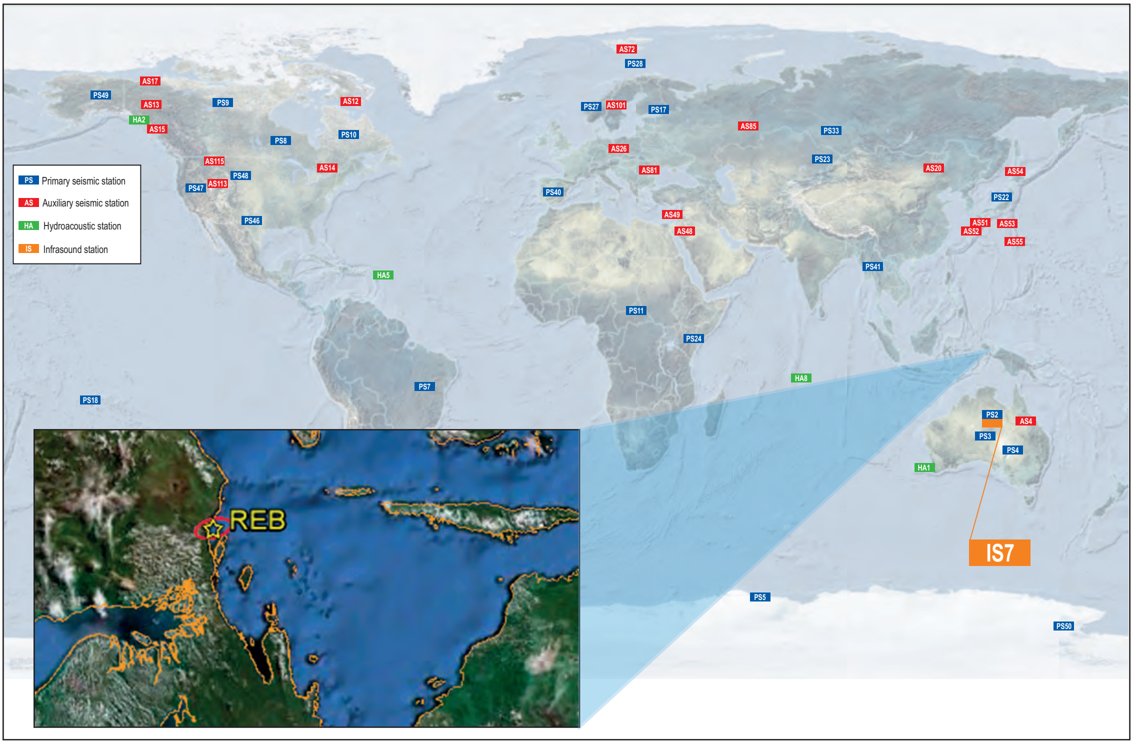
The focus shifted from assessment of the software products delivered from the pIDC to more independent management and improvement of the scientific methods employed. With the growing number of software engineering staff, the IDC assumed an increasing responsibility for software development and maintenance. In addition, a general policy for distributing software developed by the PTS to States Signatories was agreed.

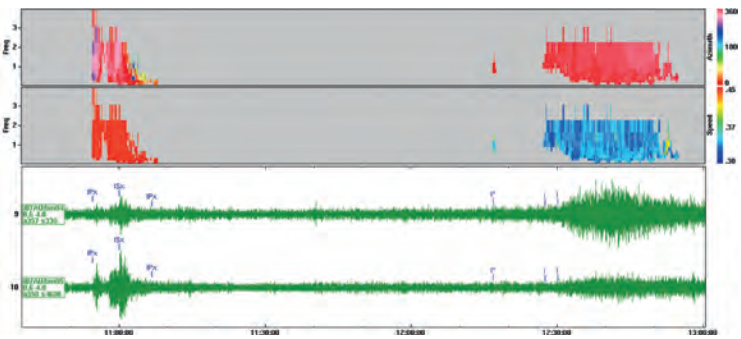
Another significant milestone in 2000 was the fact that the first five radionuclide stations established by the PTS began contributing data for the radionuclide reports (RN4 and RN10 (Australia), RN23 (Cook Islands) and RN46 and RN47 (New Zealand)). The PTS also assumed responsibility for routine station management, an activity that was previously carried out by the pIDC in the USA. It introduced an on-call duty scheme for the computer operators to ensure a 24 hours a

Radionuclide station RN23, Rarotonga, Cook Islands.

day, 7 days a week alerting mode for maintaining the technical continuity of the most critical PTS processing and information systems. This ultimately led to a fully fledged state of health (SOH) system.

In 2001, the third and last package of the IDC applications software coming from the pIDC was installed and put into operational use, allowing IMS data and high quality IDC products to be continuously provided to authorized users from States Signatories. In 2002, for the first time, all three waveform technologies contributed data towards the detection of a single event:



*Above*: Map showing the 50 IMS stations that detected the earthquake of 10 October 2002 in Indonesia. The groundshaking in West Papua as a result of the earthquake produced infrasound waves that propagated for 2020 km in the atmosphere towards infrasound station IS7 (orange), Warramunga, Australia. The detected infrasound signals show the extent of the region affected by the groundshaking.

*Left*: Upper two time versus frequency panels show the back-azimuths and trace velocity of progressive multi-channel correlation pixels while the lower panels display filtered waveforms and detections for IS7.

on 10 October of that year an earthquake of magnitude 7.3 in Indonesia was detected by 50 IMS stations, including 4 hydroacoustic stations and 1 infrasound station. Also in 2002, the IDC performance reports were redesigned with a view to making them consistent with requirements of the draft IDC Operational Manual and using them as the basis for carrying out the IDC acceptance test. These new IDC performance reports were made available to States Signatories on a monthly basis from the beginning of 2003.

## MATURING OF THE OSI

In the early years, the focus of the PTS for the OSI component of the verification regime of the Treaty was primarily conceptual, seeking to put in place the necessary framework and strategy needed for a successful OSI. As with the build-up of the IMS and the establishment and development of the IDC, there was an urgency to the work in the initial years, as at the time it was assumed that entry into force of the Treaty would happen soon and that the capability to conduct an OSI needed to be in place. Moreover, it was clear that the decision to ratify the Treaty for some States Signatories could be influenced by the state of development of the OSI regime and the procedures that would be used for OSIs after entry into force.

This conceptual work covered various elements of the OSI capability under the Treaty, including OSI guidelines and procedures, infrastructure to support the OSI regime, the specific technologies and techniques necessary for the establishment of inspection equipment, their specifications and initial requirements for equipment procurement, and progressive compiling of a draft OSI Operational Manual as well as development of other necessary OSI related documentation.

From the beginning the development of the OSI component of the verification regime was hampered by the limited financial and human resources available, in absolute terms and in comparison with the funds available for the IMS build-up and IDC development. The lack of resources was compensated partly by the motivation and dedication of the staff in the OSI Division.

Progressively the PTS matured in its approach to OSI by moving from an independent development of various separate elements of the OSI capability to developing and testing them in a more integrated fashion, including through field exercises. An early example of a field exercise was in October 1999 in Kazakhstan, when an OSI experiment was conducted at the former Semipalatinsk test site. The basis for this experiment was a 100 tonne non-nuclear explosion in an underground tunnel for calibration purposes. The inspection team consisted of 12 participants from China, France, Israel, Kazakhstan, the Russian Federation, UK, USA and the PTS. The setting of this experiment provided realistic conditions, typical of those that might be faced by an inspection team conducting an OSI after entry into force. Added realism was generated by ensuring that the inspection team was not informed about the location and other details of the explosion.

The increasing use of expertise in areas of the PTS outside the OSI Division for OSI purposes was

Inspection team and representatives of the host country during the 1999 OSI field exercise in front of the underground tunnel in Kazakhstan.

Vehicles for the field transportation of the team during the 1999 OSI field exercise in Kazakhstan.

another important element. This became evident from the planning and conduct of the Integrated Field Exercise (IFE) in Kazakhstan in 2008. This is part of the process of working towards close co-operation and coordination between all PTS Divisions that will be required after entry into force for implementation of an actual OSI, where the efforts of the entire Technical Secretariat will be called upon.

## SHIFT TOWARDS PROVISIONAL OPERATION AND MAINTENANCE AND SUSTAINMENT

The rapid build-up of the IMS and the IDC highlighted the increasing need to fulfil the demand for a high degree of data availability from all IMS stations. From an early stage the PTS recognized that, if the IMS and IDC were to achieve this goal, all aspects of O&M would have to be undertaken with an unusual degree of care and perseverance. Acting on a recommendation made at the Twelfth Session of WGB, the PTS convened the first O&M workshop in Vienna from 23 to 26 October 2000.

The progress made led to a fundamental orientation of the organization towards a structure that supported O&M and sustainment of the verification system. This necessitated looking at the verification system as a coherent whole, which would need coordinated effort across the PTS, in particular between the IMS and IDC Divisions. A key consideration was the need to protect the substantial, and constantly increasing, investment made in the verification system.

An important milestone in the history of testing and provisional O&M of the IMS was the decision of the Commission at its Nineteenth Session in November 2002 to approve guidelines to the PTS on the technical testing and provisional O&M of certified IMS stations, the GCI and the IDC. These guidelines, which have been renewed on an annual basis by the Commission, included a temporary relaxation of the station performance requirements as well as a more flexible schedule for issuance of IDC products such as the REB. Greater emphasis could then be placed

Participants of the second O&M workshop, Baden, Austria, 11–15 October 2004.

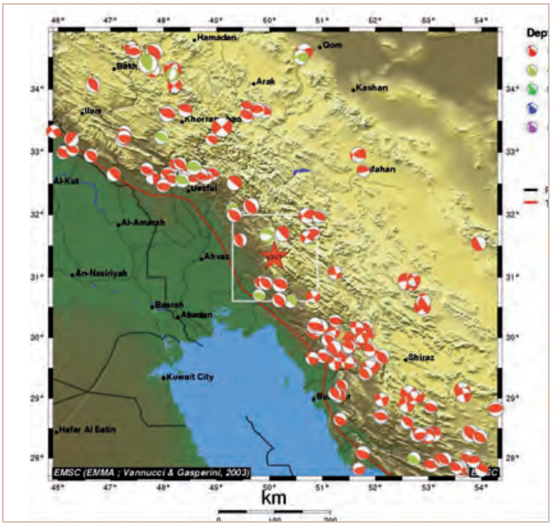
on development and testing of IDC software, procedures and processes, and on continued training of analyst staff.

The draft IMS and IDC Operational Manuals provided greater certainty and consistency in provisional O&M of the verification system and in the interaction of the PTS with IMS station operators. These manuals are a key resource for work in priority areas such as data availability, O&M of the IMS network and IDC products and services to States Signatories.


Mr Federico Guendel, Director of the IMS Division, and Mr Lassina Zerbo, Director of the IDC Division, at the third O&M workshop, Vienna, 10–14 November 2008.

Along with the shift towards testing and provisional operations, the PTS became aware of the importance of feedback from users of data and products for the continual improvement of the performance of the verification system. There was therefore a greater focus on ‘customers’.

Customers of the verification system can provide feedback at any time to the support area of the PTS. The National Data Centres (NDCs) in States Signatories host NDC Evaluation workshops which are annual customer meetings and are organized jointly with the PTS. Structured feedback is provided through the participation in annual exercises called NDC Preparedness Exercises (NPEs) the first of which took place in




Location of the NPE07 event (SEL1 on 20 June 2007). The circles containing red and green show depths of <40 km and 40–80 km respectively.

2007. NDCs also conduct comparisons between their products and PTS products. NDC recommendations are collected and analysed, and the status of implementation of these recommendations is tracked.

## Restructuring

A key management task was to ensure that the structure of the organization was optimized to carry out its mandate. With the growth of the Treaty verification system, the PTS had to adapt to manage that growth. Various adjustments to the structure of the organization were made progressively, for example the reorganization of the GCI Section in the IDC Division in 2000 and in 2002 the reorganization of the IDC structure to improve operational efficiency in the radionuclide and waveform monitoring and development areas and in the delivery of services to States Signatories. Moreover, in order to better align the technology sections in the IMS Division, the Infrasound Monitoring and Hydroacoustic Monitoring Sections were fused into the Acoustic Monitoring Section. Also, a 'coordination for provisional IMS O&M' was established under the Director of the IMS Division. In 2002, O&M coordination was strengthened further in the IMS Division and managed by an integrated group that met weekly. The senior post of O&M Coordinator in the IMS Division was filled in August 2003.

This shows that already before 2004 there was an increasing focus on O&M, demonstrating a proactive approach of the PTS to changing circumstances. In this period there was noticeably increased coordination between the IMS and IDC Divisions, including monthly meetings and the creation of ad hoc groups to resolve specific issues. In contrast to the first build-up phase, which was characterized by the parallel construction of IMS stations, of the IDC and even of OSI capacity, these increasingly coordinated activities represented the emergence of an integrated verification system.

However, it became increasingly clear that the organizational structure of the PTS no longer fully corresponded to the changed nature of the work being done and therefore needed to adapt further to the more coordinated approach taken to the build-up and sustainment of the verification regime. Therefore, in the second half of 2004 and the first half of 2005, an external review team was mandated to look at the organizational structure of the PTS. Its members, who were proposed by WGB and appointed by the Commission, were senior experts from the managerial, diplomatic and technical fields from Brazil, Canada, France, Malaysia, Mexico, the Russian Federation and South Africa, chaired by experts from Australia and Nigeria. In November 2005 the Commission adopted the final report of this external review team which, among other things, recommended structural changes to the IMS and IDC Divisions.

In response to this report, the PTS devised a plan (or 'road map') for implementing the recommended structural changes to both Divisions. The reorganization started at the end of 2005. In September 2006, the Executive Secretary formally approved changes to the organizational structures of the IMS and IDC Divisions along the lines recommended by the final report. This significant step enhanced further the coordination within the PTS in response to the increasing degree of integration of the various components of the verification system.

The approved restructuring involved redefining the functions of the technical Divisions responsible for the IMS and the IDC. The operational elements of the IMS and IDC Divisions were merged to create a Division responsible for provisional operation, testing and evaluation of the verification system (the refocused IDC Division). The technical functions that support the IMS and IDC operations were then combined into a Division responsible for engineering, development and logistical support (the refocused IMS Division).

In accordance with another recommendation in the final report of the external review team, a position of a Strategic Coordination and Planning Officer was created in the Office of the Executive Secretary. This new position serves to ensure, inter alia, that the priorities of the PTS are consistent with and contribute to the fulfillment of the strategic objectives and targets set by the Commission. It also strengthens the capacity of the organization in strategic planning.

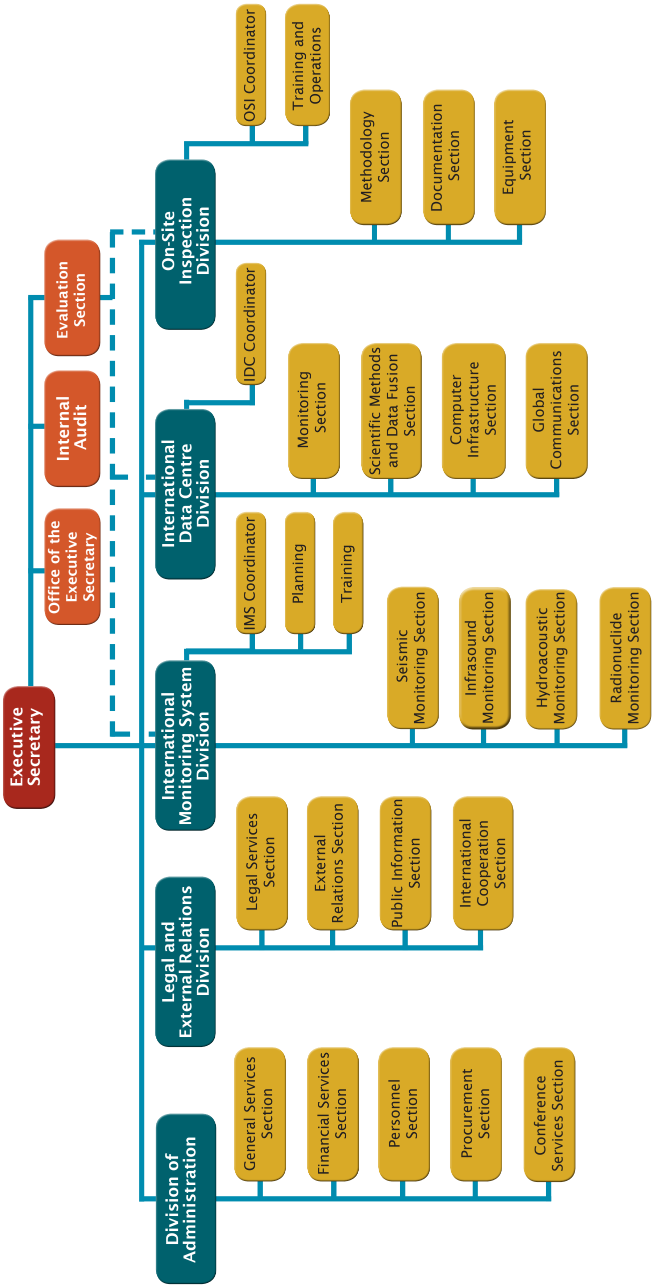
In the area of support functions, the Conference Services Section was transferred from the Division of Administration to the Legal and External Relations Division. This meant that all non-technical support services for States Signatories were concentrated in one Division for the first time.

This restructuring of the PTS was a major undertaking, carried out carefully and with full transparency through regular reporting on progress to States Signatories through the Commission. It was successfully completed by the beginning of 2008. The new structure quickly delivered benefits for the organization, such as promoting efficiencies and optimizing investments already made.

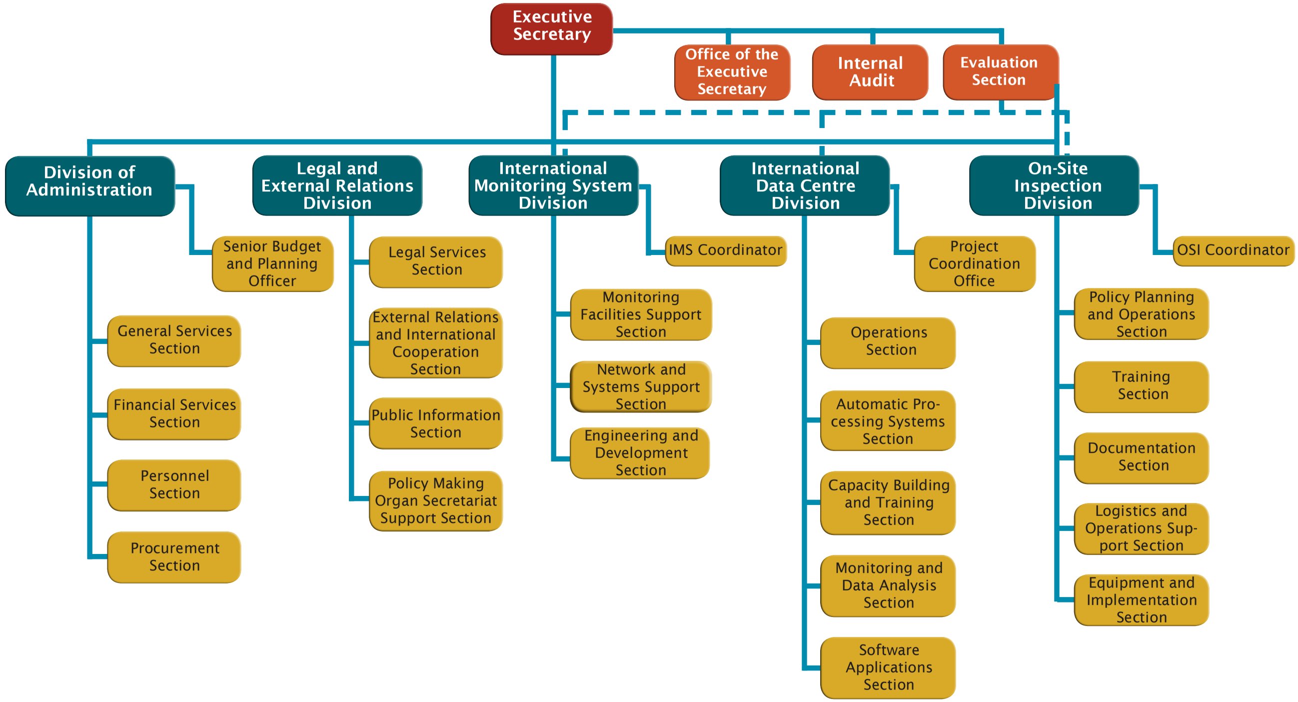
Since 2008, the structure of the organization has been kept under regular review to determine if further adjustments were required in light of changing circumstances and priorities. Examples of later adjustments are the creation of a Policy Planning Section in the OSI Division, consolidation of some functions in the Office of the IDC Director and the merging of the external relations and international cooperation functions into the one Section in the Legal and External Relations Division.

## Sustainment

The structural adjustments within the PTS following the report of the external review team




Organizational structure of the PTS, 31 December 2000.




Organizational structure of the PTS, March 2012.

**Facility Agreements or Arrangements with States Hosting IMS Facilities (up to March 2012)**

| State | Date(s) of Entry into Force | State | Date(s) of Entry into Force |
|---|---|---|---|
| Canada | 19 October 1998 (Articles 6, 8 and 9 on 1 March 2000) | Panama | 26 November 2003 |
| South Africa | 20 May 1999 | Spain | 12 December 2003 |
| Kenya | 29 October 1999 | Philippines | 8 January 2004 |
| Jordan | 11 November 1999 | Czech Republic | 29 January 2004 |
| Cook Islands | 14 April 2000 | Argentina | 2 March 2004 |
| Finland | 6 June 2000 | France | 1 May 2004 |
| Australia | 17 August 2000 | Romania | 13 October 2004 |
| Niger | 24 November 2000 | Guatemala | 2 June 2005 |
| New Zealand | 19 December 2000 | Iceland | 26 January 2006 |
| Ukraine | 20 April 2001 | Paraguay | 27 January 2006 |
| Mongolia | 25 May 2001 | Senegal | 24 March 2006 |
| Zambia | 20 October 2001 | Russian Federation | 27 December 2006 |
| Palau | 29 April 2002 | Tanzania | 10 December 2007 |
| Norway | 10 June 2002 | Kazakhstan | 5 December 2008 |
| Peru | 8 July 2002 | Namibia | 1 April 2009 |
| Mauritania | 17 September 2003 | Central African Republic | 31 December 2010 |
| | | Mexico | 20 October 2011 |

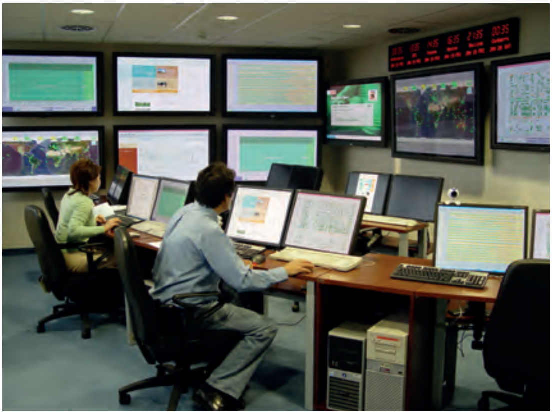
facilitated a more focused approach to those activities which are necessary to sustain, the verification system. The IMS sustainment mission was to ensure that IMS facilities continued to provide data in accordance with availability, timeliness and other requirements as specified in the draft IMS Operational Manuals, at optimal cost. Through a decision of the Commission a multiyear financial mechanism for IMS sustainment was established within the Capital Investment Fund.

Independent of the restructuring of the PTS, the O&M of the IMS came to rely progressively on a range of mutually supportive elements. These included in-house resources for technical, administrative and legal tasks; the station operators, who were increasingly taking more responsibility not only for immediate remedial action for station downtime but also longer term maintenance and other support depending on technical capability; the possible use of regional depots, workshops or stores to reduce transportation and travel time; support contracts, for example, to cover specific equipment maintenance; and support from host States pursuant to facility agreements, which address access to facilities, import and export of IMS equipment, privileges and immunities, including exemption from taxes, duties and customs restrictions, and other critical support issues.

As part of this inevitable reorientation of the priorities of the PTS, there was also an increasing emphasis on the importance of long term, integrated logistic support of IMS stations. The profile of expertise in parts of the PTS, in particular in the IMS Division, also adjusted to take this into account.

The PTS now oversees the O&M of the facilities with centralized support provided from

Vienna. A key component of this centralized support is the Operations Centre, which monitors the performance of the IMS and is the single point of contact for all station operators and personnel involved in sustaining the IMS facilities. The new state of the art Operations Centre was opened in January 2007.



New Operations Centre opened in 2007.

In 2003, a joint reporting system was introduced for logging and tracking operational problems in the IMS network. Version 2.0, which was released at the end of 2003, became the common reporting system in the PTS for issues related to all IMS network operations. All operating groups within the PTS, as well as station operators, used this system for reporting issues through a dedicated email address. The new IMS Reporting System (IRS), through which all incidents affecting the performance of the IMS network are raised, is now used as a channel of communication on issues related to the O&M of the IMS facilities.

In 2006, central management and coordination were introduced for the replenishment of spare parts necessary to keep IMS facilities operational. Since then the PTS has also taken a more coordinated approach to the training of staff for the development and sustainment of technical support capabilities.

The PTS has progressively placed greater importance on comprehensive and accurate station specific documentation. This documentation contains detailed station O&M procedures, bridging the gap between the high level IMS Operational Manuals and the specific manuals of manufacturers' equipment. In particular, this documentation at the station level describes the interaction between the PTS and the station personnel. It is intended for use by station personnel to ensure reliable operation of IMS facilities and performance that meets the technical requirements.

During 2005, an improved process for unscheduled maintenance, which covers repairs or replacements in response to unexpected malfunctioning of certified stations, was established. This included greater inter-Divisional

Maintenance engineer carrying out repairs at radionuclide station RN40, Kuwait City, Kuwait.


Views of shore facility of hydroacustic station HA3 and the central recording facility of infrasound station IS14 before (*left*) and after (*right*) they were destroyed by a tsunami in 2010.

cooperation of all parties involved, training in the procurement procedures for different categories of unscheduled maintenance and systematic monitoring of cases of unscheduled maintenance. Equipment support contracts were put in place to facilitate unscheduled maintenance as well as overall support for station equipment and software.

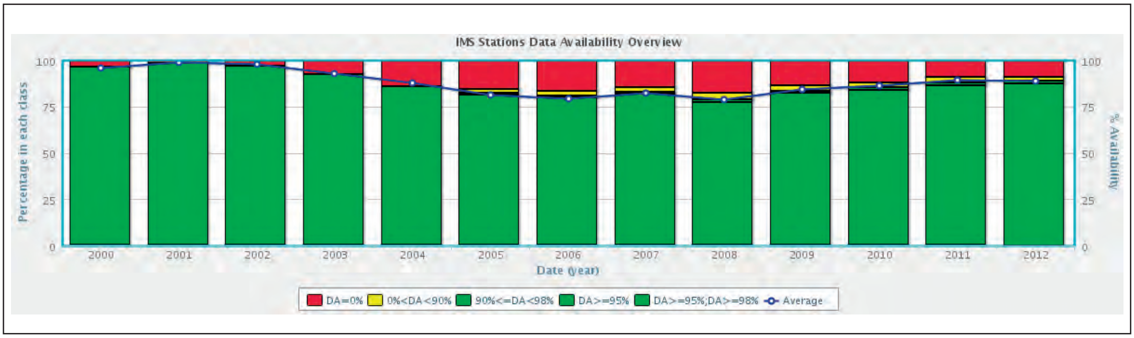
To ensure more timely corrective maintenance of IMS facilities, the Commission on two occasions, in June 2005 and November 2009, amended Financial Rule 11.5.10 to raise the procurement threshold for unscheduled maintenance activities. These amendments, which were based on proposals from the PTS, allowed these activities to be treated as a miscellaneous purchase which meant that necessary repairs and replacements could be carried out faster.

In addition to the increasing emphasis on sustainment of the IMS, the PTS has also been faced with the need to ensure appropriate recapitalization of stations, to deal, for example, with obsolescence of equipment as well as to undertake major repairs as a result of unforeseen events. An important example in this regard is the largest IMS station repair and reconstruction so far, in terms of financial investment, at the joint site of hydroacoustic station HA3 and infrasound station IS14 in the Juan Fernández Islands (Chile), which were partly destroyed by a tsunami in February 2010. This multimillion dollar project, which entails substantial technical challenges and risks, is planned to be completed in 2013. It is funded through an extrabudgetary mechanism that was approved by the Commission in 2010.

## Data Availability

One of the overarching objectives of the sustainment activities of the PTS has been to ensure an appropriate level of data availability from IMS stations by minimizing station downtime.

A key prerequisite for improved levels of data availability has been effective O&M of the IMS stations. PTS efforts have necessarily been




Overview of IMS station data availability showing an increasing trend, 2000–2012.

'multi-pronged' and have involved O&M activities, logistics and recapitalization. They have also involved finding and implementing longer term cost effective engineering solutions for IMS facilities and noble gas systems.

From the time IMS stations began to be installed and certified, data availability has consistently been a KPI for the technical work of the PTS and for the overall performance of the IMS network. There is also a clear link between data availability and other indicators related to the quality and relevance of IDC products for States Signatories.

In recent years, there has been a substantial and sustained increase in the level of data availability of certified IMS stations. Against the background of a growing but also ageing IMS network, recent efforts have been successful in reversing a decreasing trend in data availability that was observed in 2008. This was a significant achievement and became possible thanks to the joint efforts of States hosting IMS facilities, local operators and the PTS. Data availability has therefore always been a shared responsibility.

The causes of problems with data availability are not always related to O&M issues. For example, customs delays in the importation of equipment have in some cases affected data availability. So too has the absence of an appropriate facility agreement with the host State. The PTS has consistently and constructively worked with States Signatories to resolve these and other non-technical issues affecting data availability.

## RELATIONSHIP WITH WORKING GROUP B

In the beginning of its work in 1997, the PTS was undoubtedly highly dependent on WGB for technical and scientific guidance. This was to be expected since the PTS was in the process of building up and consolidating its technical staff at the time. A number of experts who in the beginning were active in WGB as experts within national delegations subsequently joined the PTS, so there was a gradual shift in expertise from one body to the other. Over the years this process has been influenced by the service limitation policy, which has led in many cases to experts moving between their national institutions and the PTS.


Fourteenth Session of WGB, Vienna, February 2001.

Even as this shift of responsibility between WGB and the PTS took place, WGB and States Signatories did retain responsibility for the key tasks of drafting the Operational Manuals for the IMS, the IDC and OSI. From the beginning the PTS has been actively involved in providing both substantive and organizational support to this work, but the formal drafting takes place within WGB itself.

This role of WGB to provide technical guidance continues to be important. However, it is clear that the balance of expertise has shifted significantly since 1997. This is not to suggest that the PTS now has a monopoly in expertise in the verification technologies or in their application in an operational context. That this is not the case is evidenced by the efforts to enhance the engagement and cooperation between the PTS and the scientific community to improve the performance and resilience of the verification regime. However, it is clear at the same time that the level, intensity and frequency of guidance required by the PTS from WGB is no longer the same, and the role of WGB has shifted more to the level of oversight and occasional guidance when needed on specific technical points.

Chair, Friends of the Chair and Task Leaders of WGB, 2012. *Left to right:* Hans Frese, Öcal Necmioğlu, Gérard Rambolamanana, Svein Mykkeltveit, Vitaliy Shchukin, Hein Haak, Frode Ringdal, Arne Bell (Secretary of WGB), Norbert Opiyo Akech, Luiz Conti, Victoria Oancea, Bernard Massinon, Jay Zucca and David McCormack.

System-wide performance test of the IMS, IDC and GCI

Small scale focused exercises

IFE08 and OSI directed exercises

Performance monitoring and testing framework established

System challenged and validated by unforeseen stress tests

# Performance and Stress Tests of the PTS

Performance monitoring and testing of the verification regime, including of OSI capability, is an integral part of the everyday work of the PTS. In the early days of the organization, the performance of the PTS was measured more in terms of how many stations had been installed and certified or whether the IDC had reached another milestone. Starting around 2004/2005 there was a shift in emphasis towards measuring and managing the overall performance of the organization as an integrated whole, including the operations of the verification system.

Specific performance monitoring and testing activities by the PTS over the years have included, for example, the first system-wide performance test of the IMS, IDC and GCI in 2004/2005, the first OSI IFE in 2008, small scale focused exercises of the IMS and IDC, IMS station certifications and use of state of health tools in day to day operations. These activities are now consolidated in an overarching performance monitoring and testing framework that covers the entire verification regime, including OSI related activities.

Testing activities across the mandate of the PTS have consistently been underpinned by the development of assessment frameworks by the Evaluation Section, with the aim of assessing the level of provisional verification readiness. This structured approach to performance testing has enabled the PTS to extract maximum benefit from the lessons learned as a result of these activities.

In addition to this ongoing testing conducted by the PTS, the capabilities of the system have been tested on a number of unforeseen external events (for example, the announced nuclear tests by the Democratic People's Republic of Korea in 2006 and 2009 and the Fukushima Dai-ichi nuclear power plant accident in 2011). These unforeseen performance tests, or perhaps more accurately stress tests, have given an insight into the state of readiness of the verification system and its ability to perform according to the expectations of States Signatories. In addition to testing the verification system


as such, these events also tested the ability of the organization to provide its States Signatories with timely, accurate and useful data and information. A qualitative comparison of the responses of the PTS and the verification system to the different stress tests has shown that the build-up of the IMS and improvements in IDC operations have continued progressively over the years. They have also assisted in identifying areas for improvement and areas that should be given priority.

## SYSTEM-WIDE PERFORMANCE TEST

By 2002, significant progress had already been made in building the separate components of the verification system: the IMS, the IDC and the GCI. At the same time, it was clear that under the Treaty these components were designed to be an integrated system, which should be tested and evaluated as a whole.

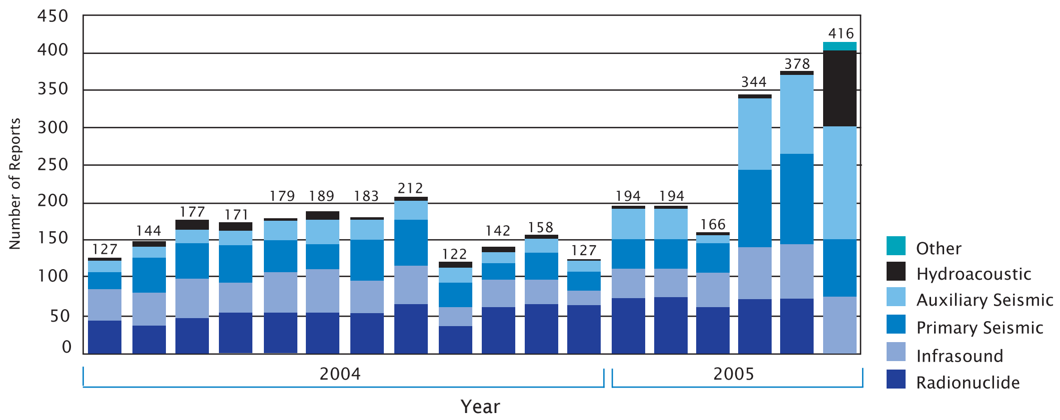
In that same year, the Commission approved the guidelines for technical testing and provisional O&M of certified IMS stations, the GCI and the IDC. At the same time WGB explicitly recognized that system-wide performance tests were essential for the development, testing and evaluation of individual components of the system. An objective of such testing was also to establish the practical and financial requirements for operations after entry into force of the Treaty.

On this basis, the PTS was proactive in developing a plan for the first system-wide performance test (SPT1). This plan envisaged that the test would be conducted in three phases: a preparatory phase in May–June 2004, a performance testing phase in April–June 2005 and an evaluation phase in the second half of 2005 and the beginning of 2006. SPT1 provided the opportunity to develop and test the basic tools to assess the performance of the overall verification system. It also served to assist the PTS in identifying which aspects of the performance of the system needed to be systematically monitored, recorded and followed up.

A number of objectives were to be fulfilled by SPT1: to identify which elements of the verification system tested met the requirements and which elements needed priority in further work; to collect information on cost in relation to performance of the system and its components; to examine established procedures of stations, communication links and IDC operations, including how the system reacted to failures; and to provide feedback for use in the development of the relevant operational manuals.

The preparatory work related to SPT1 during 2004 centred on three major issues: the ability of the PTS to collect and transmit data from the IMS, the ability to meet data processing and product delivery objectives, and the determination of the system baseline cost and cost–performance relationship. The aim was to assess the capacity of the functional elements currently in place, including the work processes supporting the achievement of performance targets, e.g. data availability and quality requirements, data processing and product and service delivery.

The preparatory phase in May–June 2004 was also developmental in nature. Its main task was to test and assess the tools and methods which would be used in the 2005 performance testing phase. This phase in 2004 already clearly demonstrated the need for more integrated operations. A PTS Operations Centre was therefore established prior to the commencement of the performance testing phase. This Operations Centre provided centralized monitoring and support functions. It enabled a more efficient resolution of incidents, including the forwarding of information on more complex incidents to the appropriate party for resolution. The Centre was staffed by personnel from various parts of the IMS and IDC Divisions.

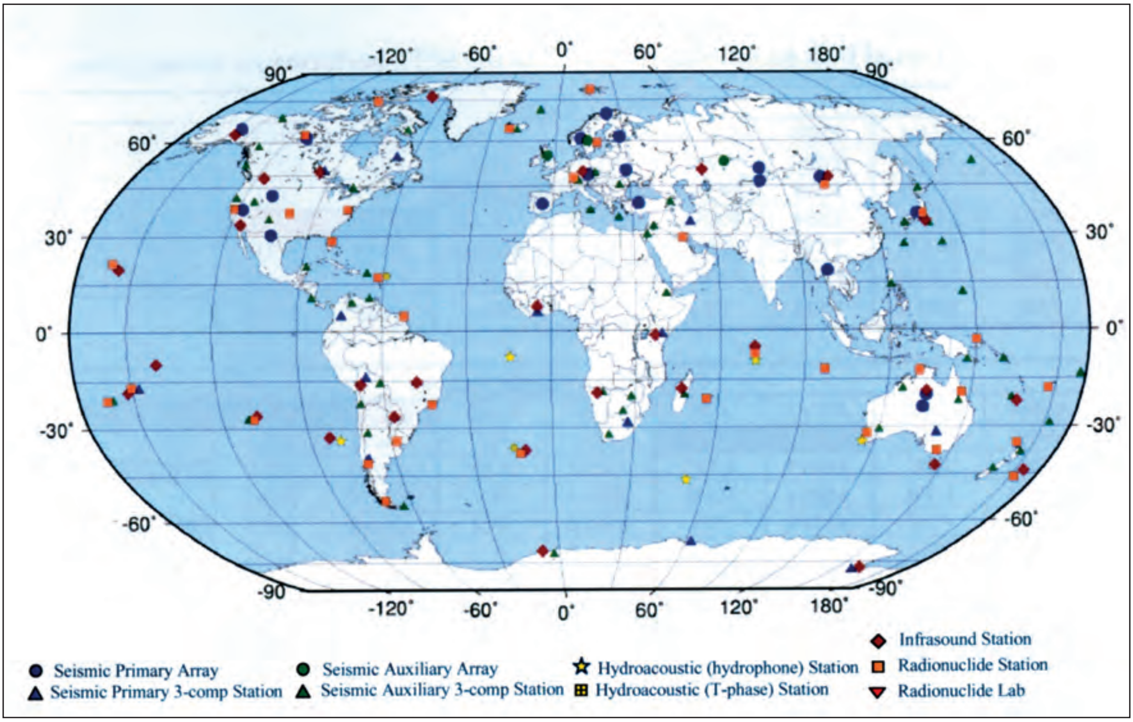



Performance of the Operations Centre in problem detection, January 2004 – June 2005.

The first two months of the performance testing phase (April–May 2005) were devoted to further testing and assessing the procedures and performance metrics and to establishing a system-wide performance baseline under the provisional O&M guidelines established by the Commission in 2002. The third month (June 2005) was used to implement 21 specific test case scenarios (e.g. station calibration and automatic and interactive seismoacoustic and radionuclide data processing) to examine either particular operational procedures or the response of the system components to the failures simulated under controlled conditions (e.g. loss of GCI links and hardware failures at the IDC).

A total of 163 IMS stations and 5 certified radionuclide laboratories participated in the performance testing phase of SPT1 in 2005. Approximately 50% of the stations from the entire IMS network provided data to the IDC during the test. During the performance testing phase, the IDC produced all 12 standard products specified in the draft IDC Operational Manual. These figures alone demonstrated the good progress made by the PTS in building up the IMS network and the IDC since 1997.

During the performance testing phase, the Operations Centre focused on the monitoring and management of incidents in the data collection process for waveform stations. It provided systematic and consistent logging of data outages longer than one hour and ensured the attribution of outages to their main cause. Although it was too late to include monitoring of the radionuclide data acquisition process in the tasks of the Operations Centre, radionuclide operations were integrated through the use of the IRS. The combination of the Operations Centre and the use of the IRS as a system-wide incident tracking tool made incident reports more focused and consistent.




Map of 163 IMS stations participating in the 2005 performance testing phase of SPT1.

SPT1 was successful both in providing information on the current state of the verification system and in illuminating various areas that required further development. It also provided essential feedback for further development of the draft IMS and IDC Operational Manuals. Lessons from the activities of SPT1 and their results gave the PTS a wealth of data which enabled it to analyse the achievements and shortcomings of the verification network as an integrated system. This led to important improvements in the following years.

On the basis of statistics and information collected during the performance testing phase of SPT1 the PTS established a system-wide performance baseline under current guidelines for provisional O&M against which future improvements could be compared.

SPT1 was a resource intensive but very useful exercise that highlighted weaknesses and areas for improvement. It fostered collaboration between the various actors in the PTS to improve existing processes and approaches.

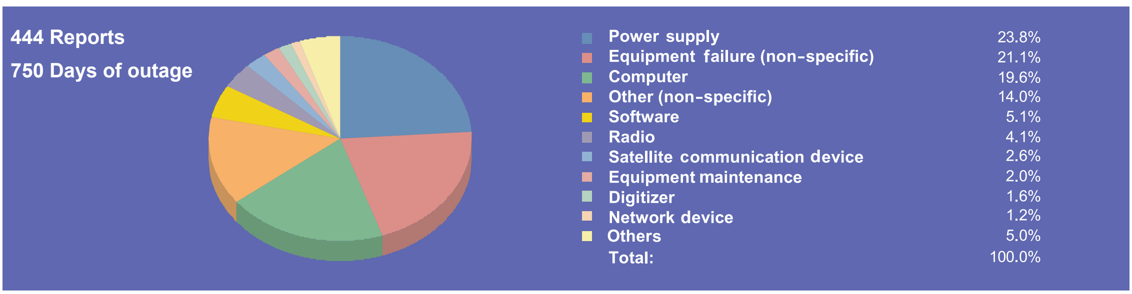
The last phase of SPT1 focused on the evaluation of and reporting on the performance tests. NDCs, IMS station operators and radionuclide laboratories played an active role in this phase. This evaluation was based on a preliminary overall framework developed by the PTS for evaluating and assessing the performance of the system and was applied on a trial basis during SPT1.

The PTS ensured that there was a high degree of transparency in the reporting of the results and conclusions drawn from SPT1. For example, initial results were already reported to States Signatories at the session of WGB in August/September 2005. Moreover, the PTS prepared a number of written reports, including a technical report on the results of the SPT1 performance testing phase that was made available on the IDC secure web site.

The results of SPT1 were also discussed during an NDC Evaluation workshop in October 2005. This workshop provided a timely opportunity for the PTS to obtain feedback from its customers. As was recognized during this workshop, in addition to the collection of important performance metrics, SPT1 increased the engagement of NDCs in the evaluation process and helped to establish good cooperation between NDCs and the PTS for evaluation activities and a high degree of engagement by NDCs in testing activities. For their part, NDCs enhanced their awareness of the need to prepare themselves for verifying compliance with the Treaty after its entry into force.

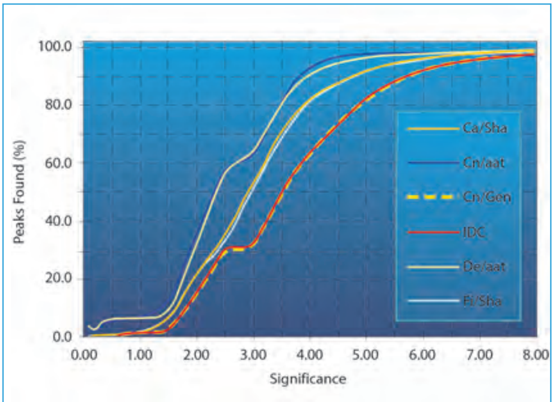
NDCs, as users of the data and products of the PTS, contributed their evaluation of system performance with respect to data collection, transport and processing. This included analyses of ground truth events and results of bulletin comparison. Through their participation in SPT1, NDCs provided an invaluable independent assessment of the performance of standard data access methods as well as of the quality of the products by comparing IDC and NDC results.

As part of this NDC involvement in SPT1, an elaborate scheme for the evaluation of radionuclide products was adopted. The PTS developed and provided 100 artificial spectra closely resembling real IMS spectra, some of which contained traces of fission products. These spectra were analysed by five NDCs and the PTS in June 2005, utilizing three software packages for interactive and reviewed analysis. The intercomparison of the radionuclide technology was supported by an evaluation infrastructure based on a Linssi database to collect and analyse the results provided by NDCs and the PTS. The results of this




Specific causes of problems at waveform stations identified during SPT1.

comparison exercise were discussed during the 2005 NDC Evaluation Workshop. It was concluded at that workshop that such exercises should become part of a regular quality assurance/quality control programme as they are an invaluable tool for benchmarking the performance capability of the whole radionuclide network.




SPT1 radionuclide intercomparison infrastructure. Peak finding probabilities for the software used by the NDCs participating in the June 2005 exercise.

In response to a request from States Signatories, the PTS set out a programme of small scale focused exercises as a follow up to SPT1. These were conducted over the ensuing 2–3 years on specific aspects of the system for which improvements were identified during SPT1. These small scale focused tests were transient in nature, performed either once, to validate a specific functionality, or at regular intervals, generally as a test for consistency and quality. Many of the test procedures initially developed under SPT1 were revisited during these focused tests.

## PERFORMANCE MONITORING AND TESTING FRAMEWORK

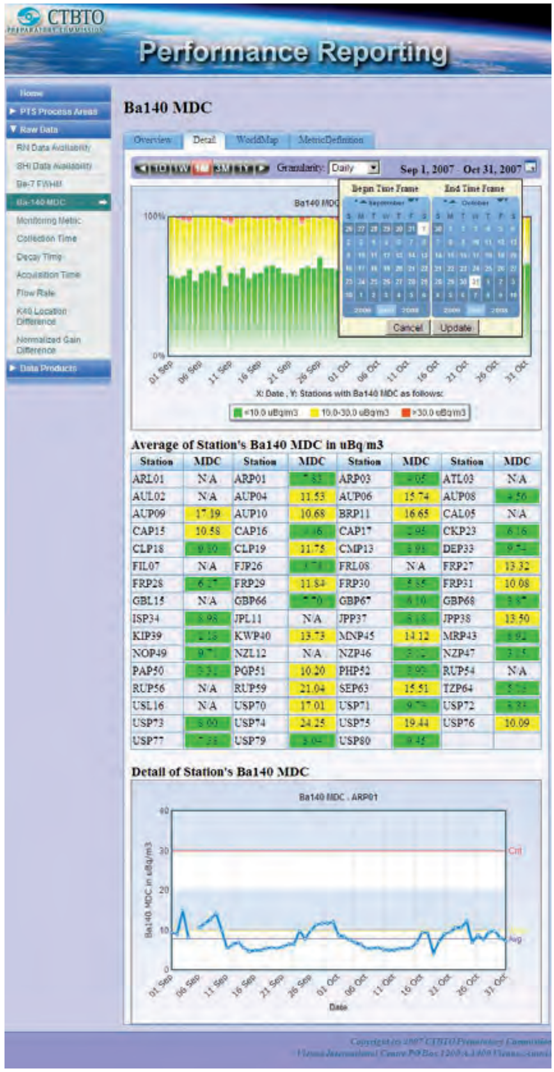
The next significant milestone in the history of performance testing in the PTS was the elucidation of a performance monitoring and testing framework to underpin the future efforts of the PTS in this area. This framework was formalized

**List of Small Scale Focused Tests Proposed for 2006–2008**

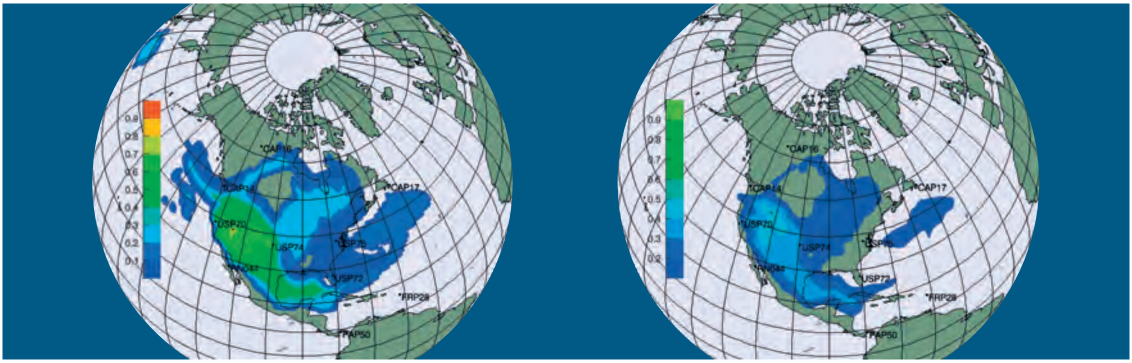
1. The PTS procedure (currently under development) to conduct remote calibration of the IMS seismic, hydroacoustic and infrasound stations
2. The PTS capability to manage different priority data transmission during abnormally heavy traffic (for example during catch-up) over different inroutes
3. The PTS capability to monitor the state of health of data flow related components
4. The ability of IDC software/hardware to verify all incoming data
5. The IDC capability to restore the system from backup tapes after simulated disc failure
6. The PTS procedure and capability to deal with temporary arrangements, e.g. substitute seismic stations
7. The consistency of IDC interactive analyses during production of the REB and Reviewed Radionuclide Reports (RRRs) under advanced operational modes including after entry into force
8. The analyses capabilities at the IDC and of the radionuclide laboratories to identify and quantify small amounts of anthropogenic nuclides added to the sample after completion of the normal collection procedure
9. The capability of IDC radionuclide analyses software and procedures using artificial spectra
10. The capacity limits at the IDC of the Automatic Data Request Manager and subscription subsystems
11. The capability of IDC hardware and software to cope with eventual (after entry into force) data flow and station processing
12. Administrative procedures for O&M and unscheduled maintenance under an enhanced mode of operation
13. Remote automatic database connection for authorized users, which requires no human intervention

in response to remarks made by the Chairperson of WGB in 2008 on the subject of validation testing. The development and implementation of the framework is in accordance with the requirements established in Article IV, paragraph 14(l), of the Treaty, Verification responsibilities of the Technical Secretariat, to "monitor, assess and report on the overall performance of the International Monitoring System and of the International Data Centre". Furthermore, consistent with the requirement of Article IV, paragraph 15, of the Treaty to elaborate "...the agreed procedures to be used by the Technical Secretariat in discharging the verification responsibilities referred to in paragraph 14...", the PTS performance monitoring and testing framework aims at further developing and validating such procedures. The set of test procedures that comes under the framework is intended to form the body of the quality assurance programme to be implemented under the QMS.

The scope of the performance monitoring and testing framework was broader than the elements of the verification system tested during SPT1. It encompassed all aspects of the verification regime including the infrastructure (e.g. IMS stations, OSI equipment, communication links and IDC equipment), the main processes (e.g. data acquisition, collection, transmission, processing, product generation, data and product distribution and storage, services to States Signatories, and OSI), and the supporting functions in the organization that ensure that the verification regime runs efficiently and effectively (e.g. procurement plays a large role in supporting the O&M of the IMS, the IDC and




The upper chart in the screenshot shows the average minimum detectable concentration (MDC) of barium-140 for the IMS radionuclide particulate network. The lower part of the screenshot shows, at the station level, the average MDC and the variation in MDC from 1 September to 31 October 2007.



Sample results of ATM in the 2010 NPE. The two figures present the calculated possible source region (shown in colour) for a fictitious release of radionuclides.

OSI). The framework gave consideration not only to the performance of the process being tested or monitored, but also to its sustainability.

Performance testing has, of course, not been the sole preserve of the PTS. States Signatories have participated in monitoring and testing of performance on many different levels. They have, for example, contributed to the planning of specific tests, participated in testing activities organized by the PTS, reviewed the results of PTS performance monitoring and testing and planned and conducted independent tests. All these tests have contributed to building State Signatory confidence that the verification system can fulfil their verification needs.

NPEs, organized and conducted independently by the NDCs themselves, have been used by States Signatories to validate whether or not the provision by the PTS of the data, products and services to States Signatories enable them to adequately verify compliance with the Treaty. The PTS has assisted these NDC activities where necessary and they have been a crucial means for the PTS to obtain feedback on its performance from external users.

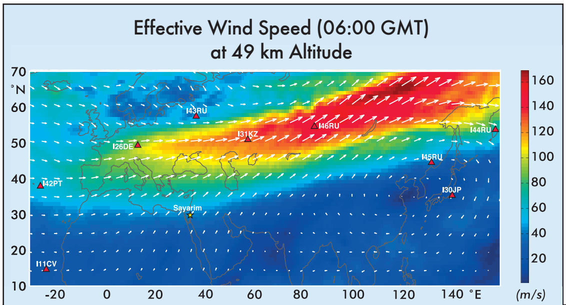
As part of the NPEs, each NDC assesses, for a selected event, the data, products and services provided to them by the PTS and how these data, products and services meet their needs to effectively conduct their verification duties. NPEs not only test the usefulness of the data, products and services provided by the PTS, they are also effective in assessing the capacity of NDCs to participate in verification related activities. The results of these tests are presented and discussed at NDC Evaluation workshops and summarized at WGB.

Performance monitoring and testing activities and results will continue to be a central element in progressively commissioning the IMS and IDC and developing OSI capabilities. They are the means through which confidence in the verification regime can be built and through which it can be demonstrated to be effective.

Drawing on past experience, the framework recognized that tests could be small scale, such as the small scale focused tests or IMS station certification processes, and concentrate on specific components of the system; or they could be large scale, such as the OSI IFE in 2008, and test a major part of the verification regime. No matter what the scale, however, the framework was designed to ensure that all testing followed the same basic methodology that included planning, execution, assessment, action and reporting.

Performance tests and performance monitoring carried out by the PTS followed this framework. They were derived from the priorities of the States Signatories and the PTS in preparation for entry into force. One of the ongoing high priorities has been ensuring that data availability and timeliness requirements are met. Performance monitoring in this area, reported in the performance reports, is done through visual displays. Another priority has been to bring the OSI regime to operational readiness.

Along with the specific tests and performance monitoring activities targeting individual processes, a wider view of the verification regime has been gained from testing broad areas, for example calibration. An infrasound calibration experiment was conducted in January 2011 in the eastern Mediterranean region. The PTS coordinated two surface explosions of 10 and 100 tonnes along with temporary infrasound sensor deployments throughout the region to observe the signals over a wide range of distances. Collaborators from 20 States Signatories deployed temporary sensors at sites in 13 countries. The meteorological conditions for the larger explosion favoured enhanced propagation to the north-east and signals were detected at three IMS infrasound stations as far as 6400 km from the explosion source.





*Left*: Map showing the stations that detected the explosion of 26 January 2011 in the eastern Mediterranean region (yellow). *Above*: The predominance of detections towards the east was influenced strongly by the direction of the stratospheric winds.

## OSI INTEGRATED FIELD EXERCISES AND OTHER EXERCISES

Performance tests have been an integral part of the work of the PTS to develop the OSI capability over the last 15 years. These have taken the form of various field exercises that have been highly successful in testing equipment, processes, methodologies and documentation essential for ensuring a functioning OSI capability upon entry into force of the Treaty.

During OSI field tests, directed exercises, build-up exercises and integrated exercises, standard operating procedures, equipment or software packages related to the inspection activities and techniques outlined in the Protocol to the Treaty were tested under realistic field conditions. The evaluation of such exercises permitted identification of those aspects that need improvement to further develop OSI capabilities and preparedness. Through the evaluation of a number of OSI field activities, evaluation methodologies were also developed and tested.

A regular series of directed exercises in various locations around the world has been a key component of this OSI testing programme. For example, there was a directed exercise in the Chernobyl Exclusion Zone in June 2007 (DE07). This exercise focused on the measurement of radioactivity levels and on the identification of radionuclides, in particular by means of gamma radiation monitoring on the ground and from the air. It also tested environmental sampling and analysis of solids, liquids and gases. The main objective during this exercise was to refine operational procedures in combination with a focused test of the OSI radiation protection regime to ensure the safety of the inspection team. Another example was a directed exercise in the Dead Sea area in Jordan in 2010 (DE10). This exercise focused on testing ground based visual observation procedures and communications during an OSI.

Concrete containment surrounding remains of the nuclear power plant unit in the Chernobyl Exclusion Zone, location of DE07.

Radioactivity check during DE07 at Chernobyl.

Using a map for orientation in the field during DE10 in Jordan.

Surrogate inspectors observing the suspicious signature during DE10 in Jordan.

### 2002 Field Experiment in Kazakhstan

In 2002 the PTS conducted a large scale OSI field experiment in a remote part of Kazakhstan. This experiment, which followed more than one year of intensive planning, built on the lessons learned during a successful earlier field experiment in Slovakia in October 2001. The 2002 experiment represented the first time that OSI techniques were performed and examined in an integrated fashion. It involved more than 25 surrogate inspectors, from 17 States Signatories and PTS staff. These inspectors performed a simulation of a range of inspection activities, including helicopter overflight, much as a real inspection team would do following entry into force of the Treaty.

The experiment began with the simulation of an illicit underground nuclear explosion. This was done by detonating 12.5 tonnes of chemical explosives about 200 m underground. To increase the realism of the experiment, several other kilogram sized chemical explosions were arranged to simulate the seismic aftershocks that would accompany an underground nuclear explosion. The inspectors deployed portable seismometers. They collected soil and air samples in search of OSI-relevant radionuclides that are relevant for an OSI. They carried out visual observation of the inspection area through helicopter overflight. There was interaction between the inspection team and a temporary Operations Support Centre.

Several hundred lessons and recommendations emerged from this field experiment and helped to guide many aspects of the future work of the PTS on OSI, for example further development of OSI equipment, the development of inspector training programmes, and future OSI field experiments and simulations.

The results of the experiment therefore greatly helped to build up the OSI regime. One of the major specific results was the recognition that field analysis of very small seismic events that follow a small underground explosion imposes requirements on the seismic equipment, processing computers and analytical software and even

Triggering event of the 2002 OSI field experiment in Kazakhstan.

Helicopter for overflight exercise in the 2002 OSI field experiment in Kazakhstan.

Preparation for the installation of the seismic array as one element of SAMS deployed over the inspection area of the 2007 field experiment in Sweden.

on the seismologists who interpret the data that are different from the requirements in the case of natural seismic events. This insight was important for the further development of the Seismic Aftershock Monitoring System (SAMS), which was tested and employed in later directed exercises, e.g. in Sweden in 2007.

The PTS conducted the 2002 field experiment in Kazakhstan with no health or safety incidents. It nevertheless reinforced the importance of a robust health and safety programme for OSI. To this end, following this exercise the PTS began to develop a list of appropriate health and safety standards for inspectors and for the conduct of an OSI.

## 2008 Integrated Field Exercise

The first OSI IFE was successfully conducted by the PTS in Kazakhstan from August to September 2008. This exercise was the first of its kind according to the concept of an OSI as set out in the Treaty as well as according to the time line stipulated in the Treaty and its Protocol. The IFE was a unique opportunity to try out most of the main elements of the OSI regime within a short space of time under real conditions.

As mandated by the Commission, the exercise involved a full sized inspection area and inspection team, equipped with a near full range of inspection techniques and equipment, within a compressed duration but with two distinct inspection periods (initial and continuation periods). Furthermore, the exercise was designed to be self-sustaining with regard to logistics, accommodation and amenities in an uninhabited area. As such, this exercise became the largest and most complicated OSI field exercise the PTS had conducted so far.

This IFE was an ambitious and time consuming exercise for the PTS, not just during the exercise itself but also in the years leading up to it. It involved around three years of intensive planning and preparation. This involved 11 task force groups comprising over 50 experts. These groups covered different thematic areas such as documentation, scenario development, logistics, equipment and financing. In the groups, there were PTS staff members from not only the OSI Division but also other Divisions who had the necessary expertise or experience. In this way, the preparations for the IFE represented a real collaborative effort by the PTS as a whole.

An expert advisory mechanism was also used to bring experts from States Signatories into the planning process for the exercise. Their assistance, guidance and knowledge was invaluable in ensuring that preparations for the IFE remained on the right track.

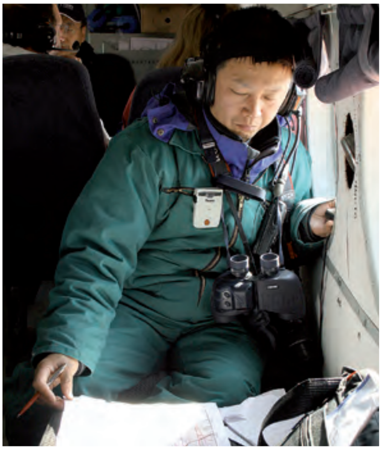
The IFE in 2008 was a significant logistical undertaking. Almost 200 participants took part in the exercise, including support staff from the host country. It involved the transportation of 50 tonnes of equipment, from Vienna to Kazakhstan. Prior to transportation on a chartered aircraft obtained with the financial assistance of the European Union, equipment needed to be collected from PTS custody as well as from States Signatories that had offered contributions in kind.

Equipment packed and stored before shipment to Kazakhstan for IFE08.

The participants had to deal with and adjust to difficult weather conditions and living arrangements in the base of operations. It therefore provided a realistic and challenging environment for the various inspection activities. The surrogate inspection team spent a total of 353 hours in various inspection activities. Its ground based activities covered a total land distance of over 4700 km. It also carried out several overflights with a total distance of over 2500 km flown.

In addition to the surrogate inspectors, there were participants carrying out the role of representatives of the inspected State Party. There were also 14 observers present at the base of operations for around a week, following the daily routines and the inspection activities.

Close interaction with civil society and media representatives during the exercise generated considerable public interest and helped craft a media strategy for real OSIs in the future. Through a dedicated web site page with articles and videos, press releases and a brochure, the media, civil society and the wider public were informed about the exercise.



Visual observation was an important technique in the initial inspection phase of IFE08.

The base of operation for IFE08 was located 150 km from the nearest town.

A ground penetrating radar unit is used to detect changes in underground structures during IFE08.

Soil samples are taken during IFE08 for further analysis in a laboratory.

Following the successful completion of the exercise, all participants and equipment were safely repatriated, on schedule and according to plan. It was clear already at that stage that the IFE had represented a major step towards OSI readiness.

During the evaluation of the IFE in 2008, emphasis was placed on sharpening up evidence based methodologies and combining qualitative and quantitative methods. At the centre of the methodology was the IFE Evaluation Framework, which provided evaluation criteria, methods and tools. Wide participation was sought in the development of the framework, through the involvement of the external evaluation team and the exercise managers and planners. The framework was finalized during a meeting in May 2008 in partnership with the United Nations System Staff College and the United Nations Evaluation Group (UNEG). This meeting combined the delivery of an introductory course on evaluation with a workshop dealing specifically with evaluation of the IFE in 2008.

The evaluation methodology for the IFE was based on an approach that emphasized the validity of and confidence in conclusions. The selected evaluation approach to data analysis consisted of examining whether the information collected by different methods and from different sources could be corroborated between data sets, i.e. a ‘triangulation method’. This was meant to reduce the impact of potential biases that could arise from using a single method or source.

Following the exercise itself, the PTS started the detailed work of sorting through the many lessons learned from the exercise, including from the evaluation report. A thorough review was conducted. Almost 900 observations were collected and analysed by PTS staff and led to the development of recommendations for subsequent implementation. As a direct follow-up to the event, a workshop for the debriefing by the participants of the IFE was organized in December 2008 in Baden, Austria.

Evaluation team members at a briefing session during IFE08.

The IFE evaluation made use of observations provided by an external evaluation team. This team was composed of experts in the various techniques tested in the exercise. Following the completion of the draft IFE Evaluation Report, which took into account the results of the surveys and interviews of participants in the IFE, a workshop was held from 2 to 5 March 2009 in Baden, Austria. The main objective of the workshop was to contribute to moving the OSI regime further towards operational readiness.

The IFE in 2008 showed that resources needed to be focused not just on the exercise but also on pre- and post-exercise activities. It also showed that such an exercise, as well as an OSI, would have to involve the whole organization, not just the OSI Division. This was a key lesson for the future.

Following the review, the PTS developed a comprehensive OSI action plan. This plan, which was approved by the Commission in 2009, described the proposed OSI ‘road map’ for developing the OSI regime further up to 2013. The action plan also addressed issues which were not tested or evaluated during the conduct of the IFE but which were considered essential for moving towards operational readiness and required development. The plan foresaw a staged approach and focused on developing inspection techniques and procedures that have a high impact on the conduct of an OSI. In addition, it concentrated on those aspects of an OSI that were assessed during the IFE as requiring most improvement.

The PTS has been implementing the various elements of this action plan since 2010. The plan

Expert meeting on inspection team functionality at the ESMF, Guntramsdorf, Austria, 18-21 October 2011.


Specially designed containers of the Intermodal Rapid Deployment System at the ESMF.

was adjusted in 2011 to take into account a new concept developed by the PTS for preparation and conduct of a second IFE in 2014 in Jordan. This concept was the result of careful analysis within the PTS as well as of an extensive consultation process with States Signatories.

The concept foresaw that the next IFE in 2014 would test the integration of aspects related to the launch, pre-inspection, inspection and post-inspection phases of an OSI. This IFE was, however, only one ingredient in a package of initiatives envisaged by the concept. Another key ingredient was a series of three core build-up exercises in 2012–2013 intended to address the different phases of an OSI. These build-up exercises were to be reinforced by a range of other activities including further tabletop exercises and field tests. In this way, there would be a phased, sequential approach to the next IFE which would ensure that core OSI components were sufficiently developed and tested in advance. Each of the smaller, more manageable build-up exercises were intended to build OSI operational capability incrementally over the time frame.

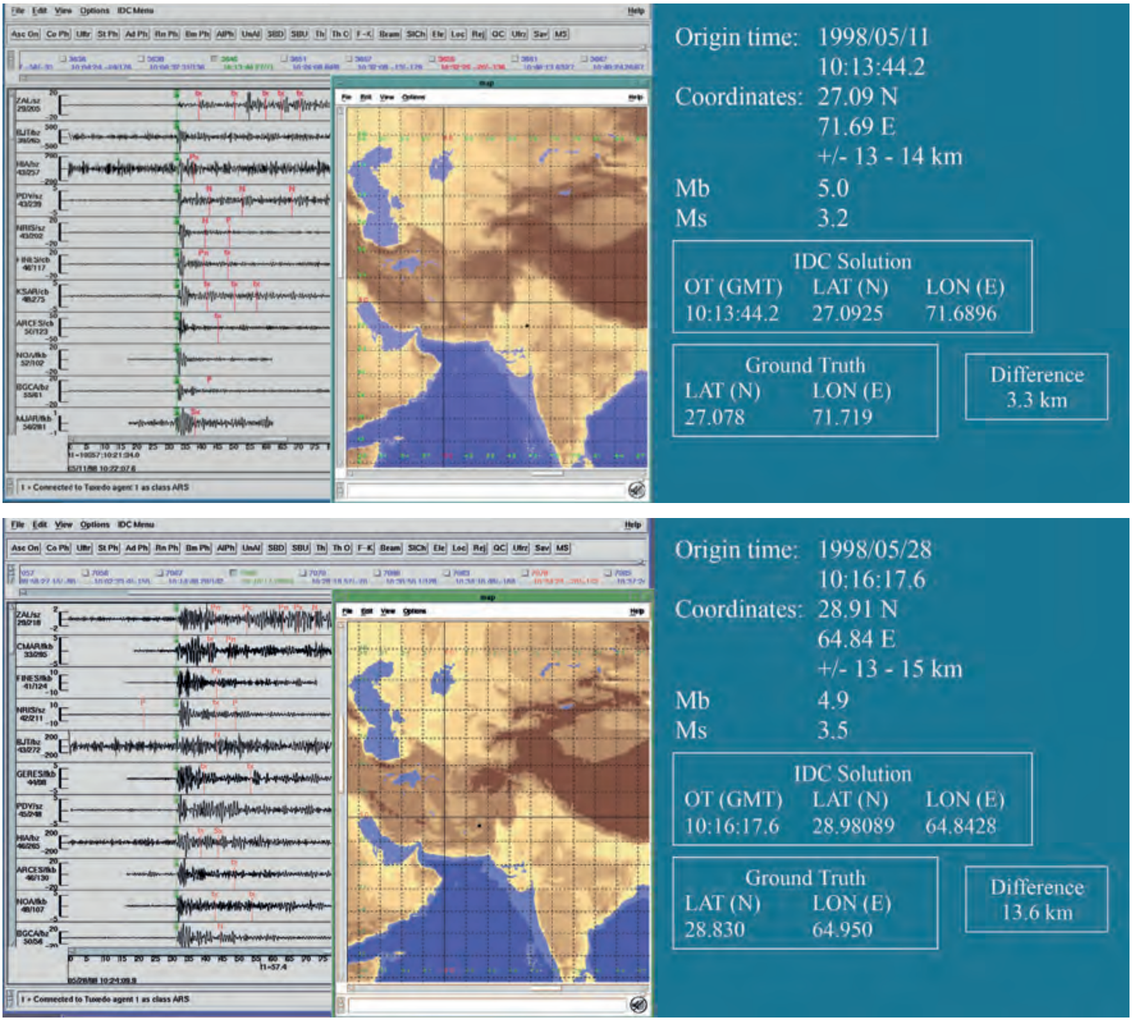
A third key ingredient of the concept for the next IFE in 2014 was the establishment of an Equipment Storage and Maintenance Facility (ESMF) in March 2011 near Vienna. This facility has provided not just a central location for storage and maintenance of OSI equipment. It also has provided the PTS with enhanced functionalities for testing, for training and, in a limited way, for exercises in the lead-up to the next IFE in 2014.

A process was also initiated to improve further the evaluation methodology in the lead-up to the next IFE in Jordan. The aim is to provide credible and evidence based information related to the progress made since the IFE in 2008 and to identify capability gaps and areas requiring further development and training.

## UNFORESEEN STRESS TESTS

### India and Pakistan Nuclear Tests

The announced nuclear tests by India on 11–13 May 1998 took place only a little more than a year after the PTS commenced work. During




Regional maps of the nuclear tests carried out by India on 11 May 1998 (*top*) and Pakistan on 28 May 1998 (*bottom*).

this period, the PTS was just beginning to install Release 1 IDC software from the pIDC. It was therefore not in a position to provide to its States Signatories real time processing of data and analysis results. However, soon after on 11 May 1998 the IDC retrieved the data for the detected Indian test for archiving and test analysis.

The situation was already slightly different by the time of the Pakistani nuclear tests, only two weeks later on 28 and 30 May 1998. Despite the fact that the IDC was just in the first days of initial test operations during installation of the Release 1 software from the pIDC, it received IMS data for both announced Pakistani nuclear explosions. Automatic processing of continuous seismic data from primary seismic stations provided reasonable first estimates of event location. For the event of 28 May 1998, data from 27 primary seismic stations were used and for the event of 30 May 1998, 23 primary seismic stations contributed.

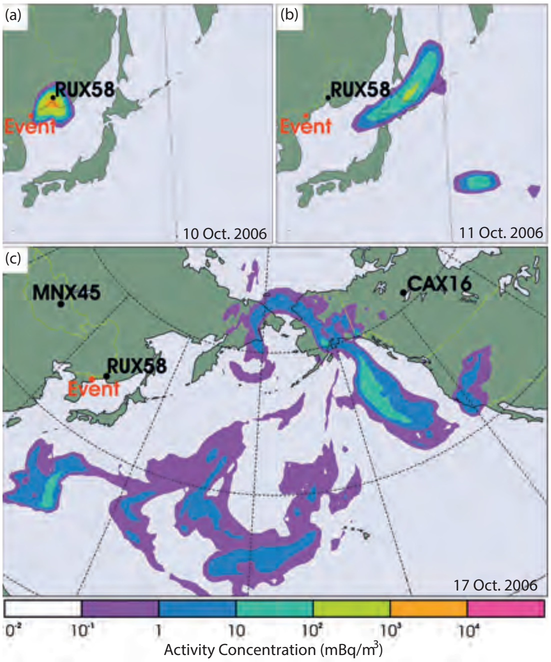
The PTS was active in providing States Signatories with information. It immediately informed States Signatories in WGB, was in session at the time, so that the response of the IMS and IDC could be assessed from a technical perspective. Executive Secretary Wolfgang Hoffmann released statements following the Indian and Pakistani nuclear tests noting that they caused “utmost concern”. Consistent with the mandate of the PTS, Mr Hoffmann also noted that it was not for the PTS to take a political position on the matter, but it was rather for the States Signatories to the Treaty to react. In this regard, the Chairperson of the Commission convened urgent meetings of States Signatories to discuss the India and Pakistani nuclear tests. On the basis of these meetings and consultations, he also released statements expressing the deep concern and regret of the Commission at the nuclear tests and calling on all non-signatory States to join the Comprehensive Nuclear-Test-Ban Treaty (CTBT) without delay.

## Announced Nuclear Tests by the Democratic People’s Republic of Korea in 2006 and 2009

The announcement by the Democratic People’s Republic of Korea that it had conducted a nuclear test on 9 October 2006 served as a trigger for the PTS to prove that its achievements since 1997 were real and worthwhile. At the same time it was the tenth anniversary of the adoption of the CTBT by the United Nations General Assembly in 1996.

The announced nuclear test in 2006 was well recorded by the IMS throughout the world. This was achieved even though less than 60% of the IMS stations envisaged under the Treaty were in use at the time. The signals originating from the event were detected at more than 10 primary seismic monitoring stations.

Less than two hours later, States Signatories received the first automated data product from the IDC, called Standard Event List 1 (SEL1). This contained preliminary information on the time, location and magnitude of the event. The IDC in Vienna expedited analysis of the seismic recordings and applied time lines for data processing and dissemination as envisaged by the Treaty. As a result, the PTS was able to distribute its primary data product, the REB, to



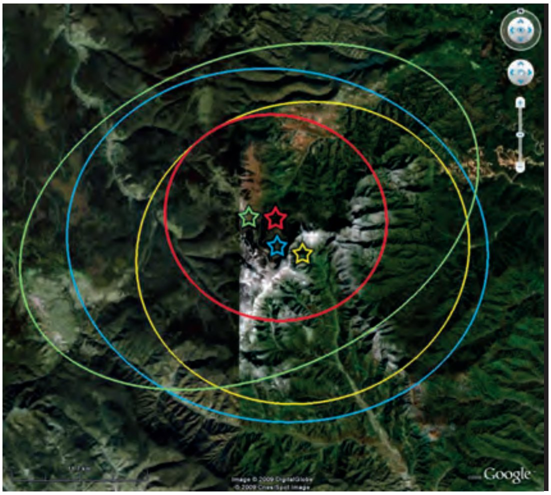

Temporal evolution of the ground level concentrations of xenon-133 at the time and coordinates of the event of 9 October 2006 (shown by the red dot).

States Signatories on 11 October 2006. The REB confirmed the validity of the event issued in SEL1 and its location and time. Moreover, the inclusion of signal detections at one additional primary seismic station and a range of well distributed auxiliary seismic stations, together with the improvements associated with analyst review, resulted in a reduced uncertainty in the location for a possible inspection area of well below 1000 square kilometres which is the maximum allowed for an OSI under the Treaty.

Two weeks after the 2006 event, the IMS radionuclide noble gas monitoring station at Yellowknife in the Northwest Territories, Canada, registered an unusually high concentration of the noble gas xenon-133. Applying atmospheric transport modelling (ATM) to backtrack the dispersion of the gas, its registration at Yellowknife was found to be consistent with a hypothesized release from the event in the Democratic People's Republic of Korea. Information related to observations made at the IMS radionuclide noble gas station at Yellowknife as part of the INGE was made available to authorized users on the IDC secure web site, and technical briefings were also given to States Signatories.

At the time of the nuclear event in the Democratic People's Republic of Korea on 9 October 2006, only 10 of the planned 40 IMS stations with noble gas monitoring technology were operating in test mode. The contribution of this technology to the analysis of the event demonstrated clearly for the first time in a practical way its significant role in the CTBT verification system. As a result, recognition of the importance of noble gas technology became even more widespread in 2007 and the installation of additional noble gas systems in the IMS was expedited.

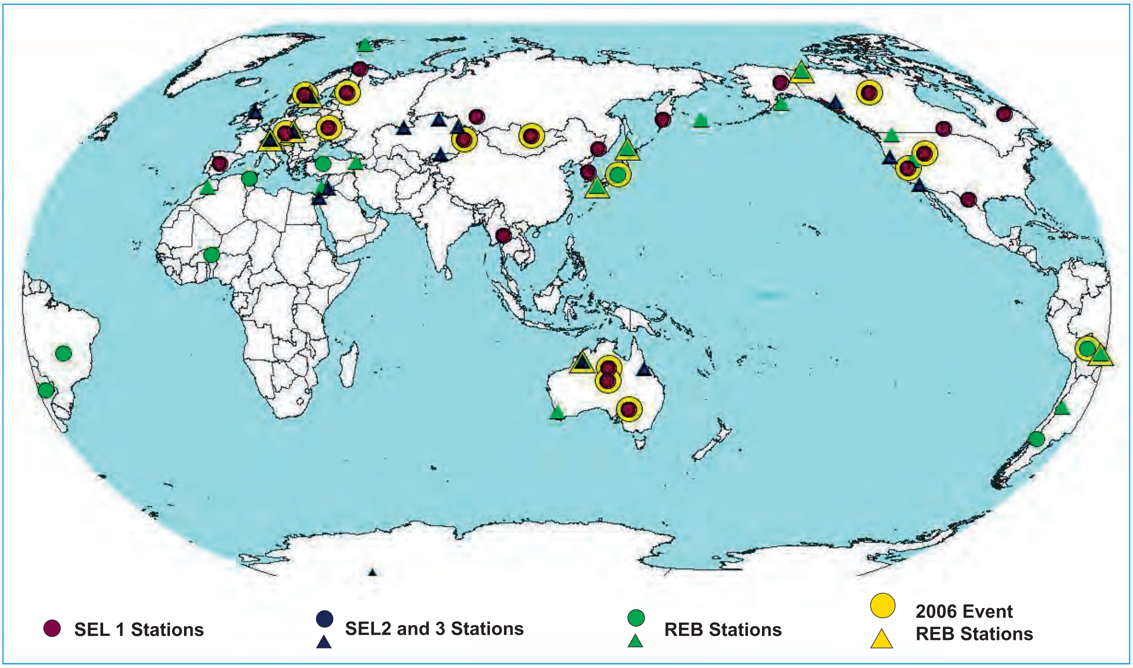
This response to the event in 2006 demonstrated that the PTS was already at that time capable of receiving and reviewing data for an event of special interest in accordance with the time lines envisaged in the Treaty and of providing States Signatories with relevant data products. Thus the challenge posed by the event provided a chance to show that, once complete, the global verification regime of the CTBT would be feasible and credible. The IMS displayed its sensitivity and effectiveness by rapidly locating, identifying and determining the very low yield in the 2006 test explosion by the Democratic People's Republic of Korea.



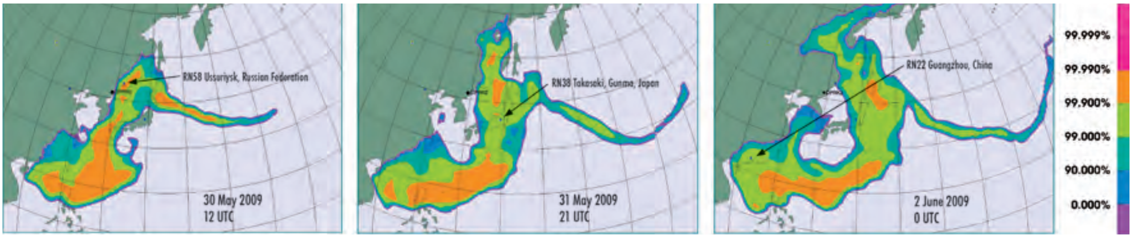
Location and uncertainty ellipses for the 2006 and 2009 events in the Democratic People's Republic of Korea determined using seismic data.

The second announced nuclear test by the Democratic People's Republic of Korea in May 2009 also presented a major challenge to the established international norm against nuclear tests. It served again as a useful stress test for the verification system. Twenty-three IMS seismic stations succeeded in detecting the event immediately. Two hours later, the first automated waveform data were made available to over 1100 secure user accounts in 110 States Signatories, in accordance with the time lines of the Treaty.

Although a substantial number of noble gas systems had been built in the region and the system's detection capability was excellent at the time of




IMS seismic stations which recorded signals from the Democratic People's Republic of Korea event of 25 May 2009. Those in red were used in the SEL1 location estimate. The estimate in SEL2 included also those in blue, and those in green were manually added by analysts for the REB. Stations with a yellow border were used in the 2006 event.




Evolution of the detectable radioactive plume from the nuclear test of 25 May 2009 in the Democratic People's Republic of Korea according to the level of containment of the assumed immediate venting.

the second nuclear test, unlike in the case of the announced nuclear test in 2006, no radioactive noble gas was measured this time. The lack of indicative radionuclide observations in the IMS noble gas network showed the importance of OSI as a component of the verification regime. Local noble gas signatures may be detectable up to four to six months after an underground nuclear test if there is venting or seepage. The 2009 announced nuclear test therefore served not only to show the capabilities of the IMS network and the IDC, but also gave new impetus and urgency to the further development of the OSI capability.

Information on the 2009 event in the Democratic People's Republic of Korea was again made available by the PTS to all States Signatories on the IDC secure web site. This was supplemented by specific and detailed technical briefings for delegations in Vienna.

The PTS did not only perform well technically. It also demonstrated its ability to communicate, devising a proactive media strategy that allowed for the rapid and reliable dissemination of all relevant information. For the 2009 event in the Democratic People's Republic of Korea, the media strategy included the immediate announcement of analysis results to journalists in a number of press briefings that were also broadcast via the public web site. These efforts resulted in unprecedented international media coverage with a large number of printed and online articles on the event acknowledging the role of the PTS.

## Tohoku Earthquake, Tsunami and Fukushima Nuclear Accident

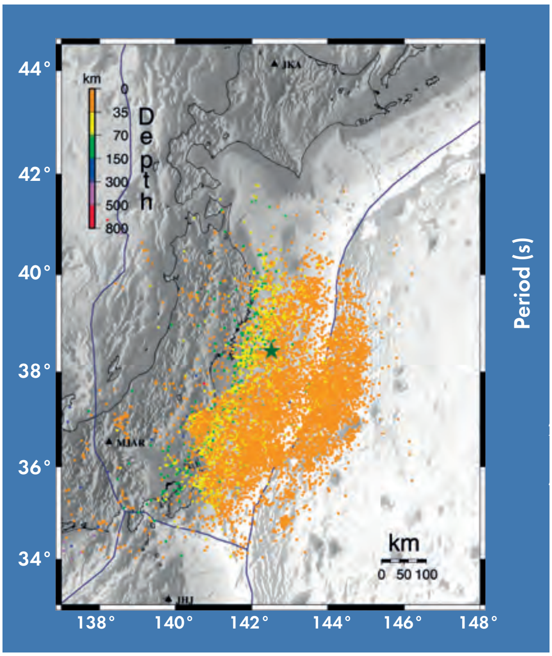
The Tohoku earthquake, the associated tsunami and the subsequent nuclear accident in Fukushima in March 2011 resulted in a demanding stress test for the entire CTBT verification system: data gathering, data processing, data distribution and provision of assistance to States Signatories.

The performance of the organization was impressive. The IMS collected the relevant data. The GCI transmitted the data and products in accordance with the standard time lines. The IDC reviewed the data and produced timely and high quality analysis.

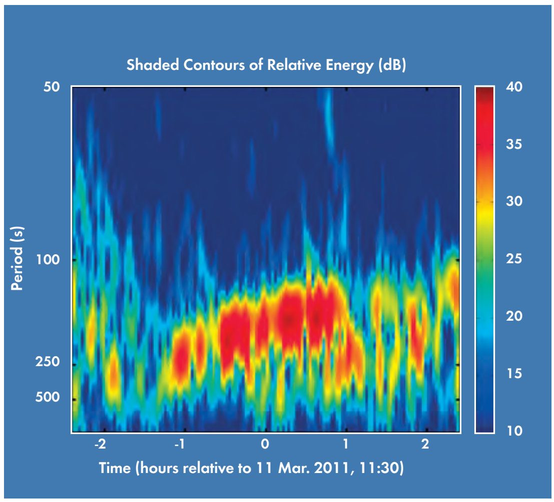
The raw data were analysed as soon as they arrived. Seismic aftershocks and radionuclide detections continued for three months after the accident. Approximately 10 000 aftershocks were detected from the earthquake and 1600 particulate samples were affected by the radiation originating from the accident. In addition, the rupture of the main earthquake was observed in the T phase signals recorded by IMS hydroacoustic stations. Infrasound stations also registered the explosions in the Fukushima Dai-ichi nuclear power plant. ATM played an important part in predicting when successive radionuclide stations were likely to detect released radionuclides. Overall, the detection system and analysis performed reliably during the whole observation period.

The IMS radionuclide system provided global coverage of the release of both radioactive noble gases and radionuclide particulates. Exceptional measures were taken to ensure the collection, analysis and assessment by PTS radionuclide experts of the samples gathered globally, to report findings in a timely manner to States Signatories and to enhance cooperation with other international organizations. In responding to the events, the PTS mobilized its resources, drawing on its advanced monitoring technologies and facilities, experience and dedicated staff.

Much diagnostic information was made available through the radionuclide detections, in




Map showing the location of the Tohoku earthquake near the east coast of Honshu, Japan, on 11 March 2011 (star) and the REB events located in the region for the three month period following the earthquake, with symbols colour coded according to calculated depth.



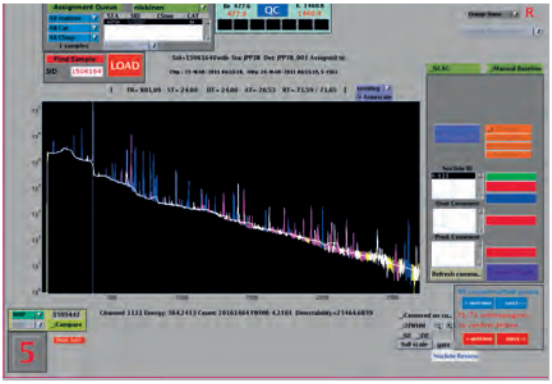

Spectrogram of signal energy as a function of time at the H11N1 hydrophone of hydroacoustic station HA11, Wake Island, USA, in the Pacific Ocean during the passage of the tsunami generated by the Tohoku earthquake. The spectrogram shows a clear tsunami signal with the dispersion of the water wave visible as a diagonal stripe of high energy, demonstrating that the long period waves arrive first, followed by the slower, shorter period waves.

particular reactor temperature, fuel burn-up, containment of heavier elements relative to gases and the change in the mixture of released materials owing to radioactive decay.

The event generated more than 400 Level 5 samples (samples with multiple anthropogenic nuclides, at least one of them being a fission product) at IMS radionuclide stations. Only a subset of them was sent for analysis to prevent bottlenecks at IMS laboratories and regional centres of World Meteorological Organization (WMO). A few samples from IMS station RN38 at Takasaki, Gunma, Japan, needed special handling at the station owing to their high activity concentration.

The good performance of the system in responding to this disaster was achieved thanks to the dedication of the PTS staff and of others around the world involved in operating the system. Station and system operators, technologists, analysts and support personnel worked day and night to run and maintain the system. Despite the pressure, they did their utmost in generating data and products and ensuring continuous real time access to what was being produced. The performance of the verification system was beyond expectations. It proved its capabilities and demonstrated its vast potential in verification as well as in the support of early warning and disaster management systems. Important lessons were learned that are being used for further improvement in equipment development, ATM, seismic monitoring, radionuclide monitoring, health and safety procedures and the delivery of data and products to users.

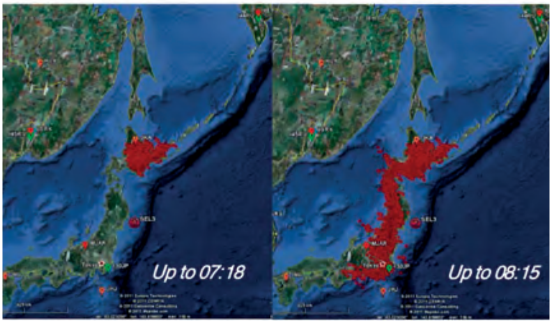
Overall, the IMS network and the IDC analysis performed well under an enhanced workload.



Typical spectrum of a sample taken at radionuclide station RN38, Takasaki, Gunma, Japan, several days after the Fukushima accident.

Taking into account that the PTS does not operate 24 hours a day 7 days a week, the event highlighted the need for special arrangements to enable staff to work under temporarily enhanced levels of operation in exceptional cases.

Additional measurements of dose rate and gamma radiation levels were carried out at several IMS radionuclide stations to provide essential information to support decision making, especially concerning health and safety aspects of station



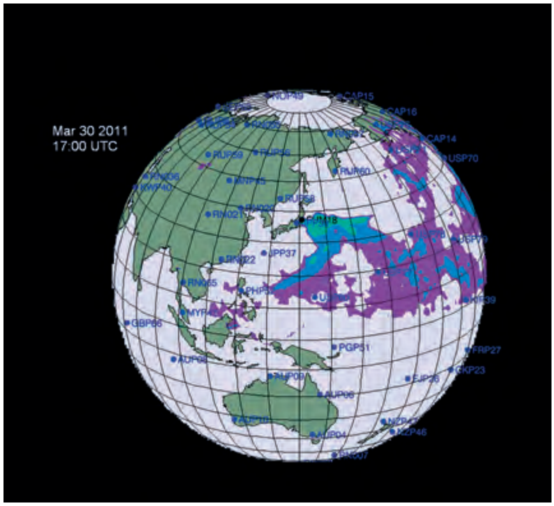
Infrasound signals generated in Japan on 11 March 2011 by an earthquake and a tsunami as recorded by infrasound station IS44, Kamchatka, Russian Federation.

operation. Prevention of cross-contamination also proved to be important at the radionuclide stations. Only two systems had traces of contamination after the incident was over. IMS stations that can be accessed remotely proved to be necessary to deliver high quality data.

Following the accident at the Fukushima Dai-ichi nuclear power plant an inter-comparison exercise among the radionuclide laboratories was carried out with real IMS station samples to assess their analytical capability. Samples containing nuclides released in the Fukushima accident were sent to the laboratories. The samples were split and sent from laboratory to laboratory for analysis. Finally, surveillance assessments were completed at four of the laboratories.

The data and analysis were shared constantly with close to 1200 authorized institutions and other users in 120 States Signatories. Throughout the Fukushima accident and its aftermath, the PTS kept States Signatories abreast of the developing situation with six technical briefings, the first of which was on 15 March 2011. Besides the formal briefings, special arrangements to keep States Signatories continuously informed included a dedicated web page with secure access, where radionuclide detections and ATM results were displayed.

The data and the data products provided by the PTS allowed States Signatories and users to monitor the dispersion of the radionuclide particulates and noble gases and prepare for any necessary contingency planning. This contributed to regional and global efforts to assess the radionuclide risks.




Atmospheric transport model of dispersion of radionuclides from the Fukushima nuclear power plant. The coloured areas show the evolution of the dispersion as of 30 March 2011 at 17:00 UTC.

At the same time, the PTS informed the media and the public about its role and contribution, thus quickly becoming a reliable source of information. Hundreds of questions were responded to, either directly or by referring to information published by States Signatories and their institutions.

As recommended by the States Signatories during the technical briefings, in-depth cooperation also started with the IAEA on 21 March 2011. Special assistance was given to the IAEA, the World Health Organization (WHO) and WMO with access to IMS data. The Commission delivered a series of technical briefings to the IAEA with a view to efficient and effective cooperation. Following consultations, the organizations immediately established a joint team of experts to make effective and strategic use of the data and data products shared.


Map showing that by mid-April 2011 all operating radionuclide stations (yellow circles) in the northern hemisphere had detected nuclides from the Fukushima Dai-ichi nuclear power plant.

On 25 March and 8 April 2011, the Executive Secretary participated in two video conferences organized by the Secretary-General of the United Nations with the heads of all international organizations involved in the response to the nuclear accident, including the IAEA, WMO, the United Nations Development Programme, WHO and the United Nations Office for Disarmament Affairs. The conferences focused on lessons learned by international organizations in relation to this event and ways to further strengthen cooperation and coordination.

The PTS also initiated and strengthened its cooperation with international organizations, including the IAEA, WHO and WMO, in the aftermath of the events in Japan in areas such as early warning, disaster management, nuclear safety, human health and the environment. For example, the PTS was invited to attend meetings of the IAEA-organized Interagency Committee on Radiological and Nuclear Emergencies. On 21 June 2011, the Executive Secretary addressed the IAEA Ministerial Conference on Nuclear Safety.

DOTS made available to station operators and Permanent Missions

Targeted training and knowledge dissemination

Public web site develops into 'one-stop shop' for information and discussion

*Spectrum* becomes key publication on nuclear disarmament

Launch of CDI

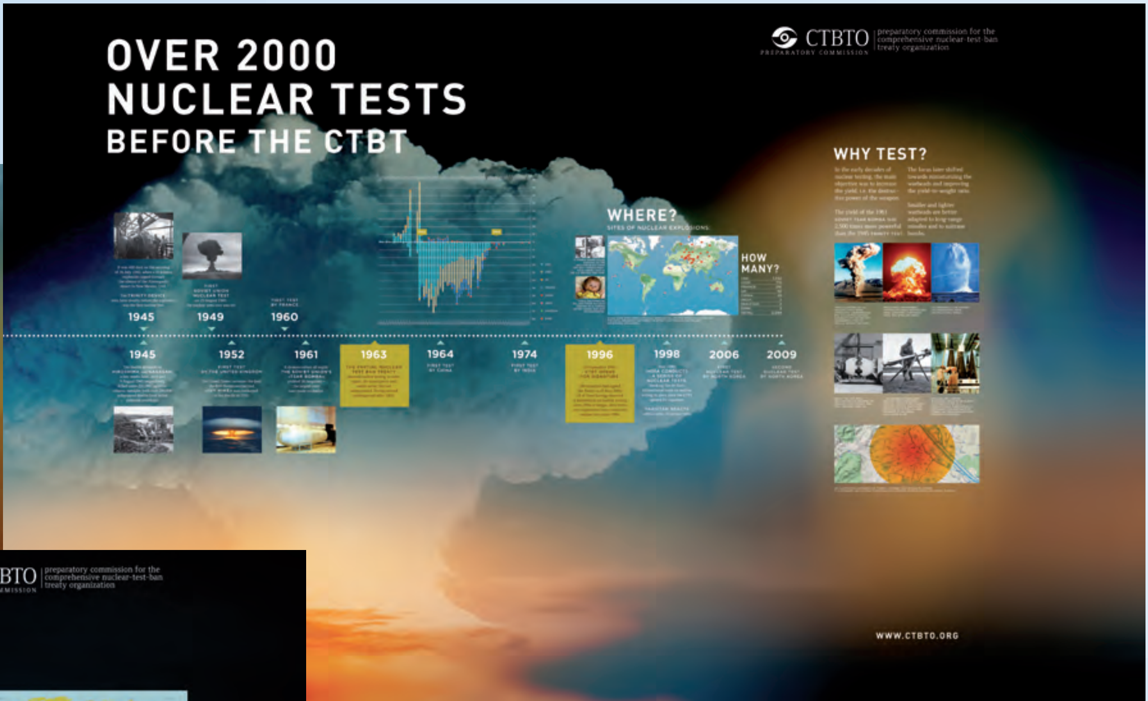
Project for participation of experts from developing countries in technical meetings implemented

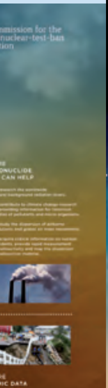
Legal assistance programme introduced for States Signatories on implementation of the Treaty

# Knowledge Organization

To be successful any organization needs to manage its knowledge effectively in order to achieve its corporate goals. This is particularly important for a knowledge based, technical organization such as the PTS. Extensive expertise and knowledge has been built up within the organization over its 15 years of operation. This knowledge needs to be managed and retained within the organization. This poses a real challenge for the PTS, particularly in light of the service limitation policy that has resulted in a regular turnover of staff. Some processes for capturing and retaining knowledge, such as knowledge transfer from departing staff members, have been put in place, but more needs to be done.


The idea of the PTS as a knowledge organization is much broader, however. It relates also to the role of the PTS as a repository and disseminator of knowledge for external stakeholders as well as a reliable resource for information on all issues, technical and non-technical, related to the Treaty and its verification technologies, including through workshops and seminars. Knowledge creation, sharing and application has therefore not been a 'closed loop' process that the PTS has been involved in alone.



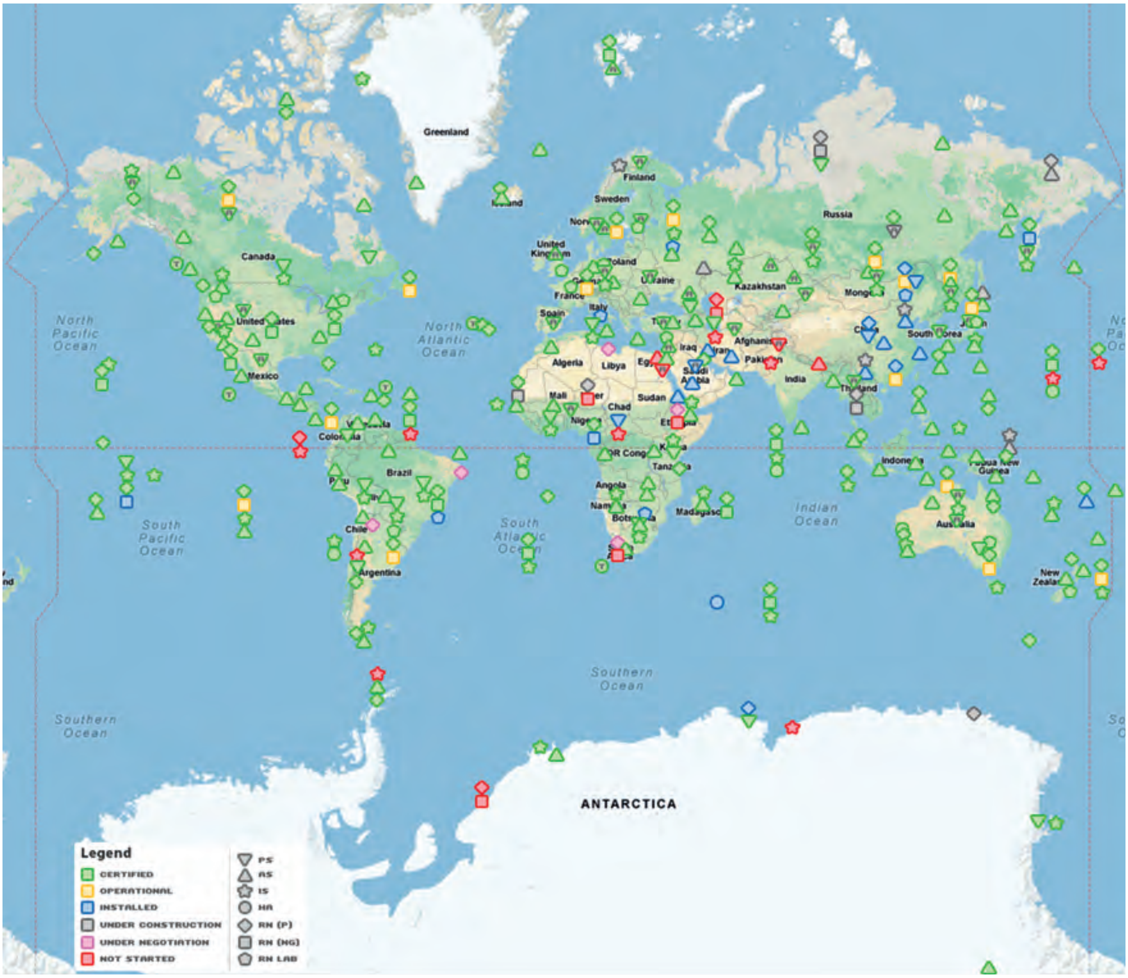




Capacity building, capacity development and training, and the dissemination of information and knowledge related to the Treaty are therefore also important elements of the concept of the PTS as a knowledge organization. For example, training of NDCs and station operators is a major component. There have been intensified efforts in capacity building (including targeting particular regions), development of e-learning as well as capacity development. It is important to engage and invest in the next generation of CTBT experts (scientists, technicians, policy makers), given that full implementation of the Treaty is still some time away. The PTS has consistently looked beyond the more traditional methods of capacity development to reach a wider audience.

Knowledge also needs to be shared with different audiences, e.g. journalists, civil society, the general public. Knowledge can be generated and brought out by stimulating a debate about the Treaty and the work of the Commission and constructing an intellectual discussion.

## DATABASE OF THE TECHNICAL SECRETARIAT

The Database of the Technical Secretariat (DOTS) is an essential component of the management of information and knowledge in the organization. It is an integrated database with custom built Web based applications to store and manage information relevant to the activities of the PTS and the Technical Secretariat after entry into force of the Treaty. Examples of information contained in DOTS are: configuration management and IMS station baseline information, as well as general information about IMS facilities, including real time data availability and critical information necessary for IMS sustainment.




DOTS: interactive map showing status of IMS stations.

The first release of DOTS was launched in December 2002. Since then, continuing enhancements and improvements have been made, with a new version rolled out in 2009. Importantly, external access to part of the database has now been provided to station operators and some Permanent Missions of States Signatories on request.

## TECHNICAL TRAINING AND WORKSHOPS

Over the last 15 years the PTS has established itself as a key provider of training and knowledge in issues related to the verification technologies, the O&M of stations, use of IMS data and IDC products, including for staff in NDCs, as well as in issues related to OSI.

Such training and capacity building has served to enhance the real and potential technical capabilities of States Signatories as well as those of the PTS. As technologies expand and improve, so too does the knowledge and experience of designated personnel. Training courses have been held in Vienna as well as in numerous external locations with the assistance of hosting States.

This training and knowledge dissemination was carefully targeted to the actual needs of various countries and regions as well as to the needs of the organization itself. This targeted approach was underpinned by, for example, the development of country profiles and analyses for use in capacity building and training efforts for all geographic regions.

The PTS organized workshops on O&M of the IMS at regular intervals, the first of which was held in Vienna in October 2000. These workshops dealt with topics such as the roles and responsibilities of the Commission, host country, station operators, contractors and other agencies with respect to operation and support of the IMS facilities; improving the performance and sustainment of the IMS network; IMS configuration management; and data quality control parameters and procedures.

Training course for infrasound station operators held at the PTS, May 2010.

Technical training programmes for station operators and technical courses for NDC staff, to enable them to take greater advantage of the IMS data and IDC products, were organized regularly. The first introductory IMS training programme was held in San Juan, Argentina, as early as December 1997. The first IMS technical training programme was held in Vienna in October 1998.

The longest of the training courses organized by the PTS is the course for IDC analysts, which lasts three months. This is in recognition of the fact that the job of IDC analyst is a demanding one that requires a high degree of skill to sift through volumes of data and to provide an


Training for IDC analysts in Vienna, 31 August – 11 December 2009.
(Fifty per cent of the trainees are now staff members of the PTS.)

accurate account of all events that meet specific criteria. This training course has served to enhance the level of data analysis knowledge and skills in many countries and has also placed participating experts in a much stronger position to apply for analyst positions at the PTS. The first of these IDC training courses was held in January 1998 at the pIDC in Virginia, USA.

In addition to the series of quality management workshops (described in the chapter on management), NDC Evaluation workshops have been instrumental in enabling the PTS to seek feedback on the performance of the verification system from users of IMS data and IDC products as well as from States Signatories, and to exchange knowledge on the performance of the system. The implementation of recommendations from the NDC Evaluation workshops has been closely monitored and reported by the PTS.

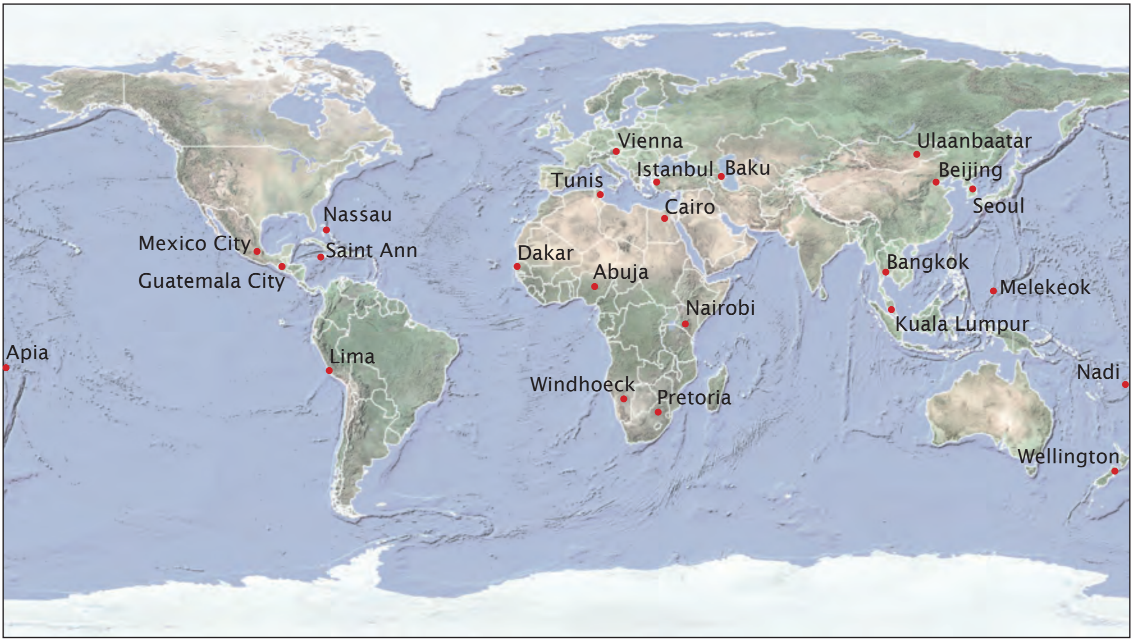
The first NDC Evaluation workshop was held in Hanover, Germany, in 1999. These workshops were hosted by the NDCs themselves. They, along with the lively online forum for NDCs, have served to promote growing cooperation among NDCs. The workshops have enjoyed strong and increasing levels of participation over the years. Since 2007, NDC Evaluation workshops have increasingly focused on testing and enhancing the preparedness of NDCs through annual exercises of increasing complexity. At the same time, they have provided the PTS with structured feedback for improving the

**List of NDC Evaluation Workshops**

| Date | Location |
|---|---|
| **1999** | Hanover, Germany |
| **2000** | Edinburgh, UK |
| **2001** | Vancouver, Canada |
| **2002** | Oslo, Norway |
| **2003** | Amman, Jordan |
| **2005** | Rome, Italy |
| **2006** | Kiev, Ukraine |
| **2008** | Baden, Austria |
| **2009** | Beijing, China |
| **2010** | Nairobi, Kenya |
| **2011** | Bucharest, Romania |


Outside view of the Ukraininan NDC (*left*) are the Chinese NDC (*right*).

Participants of the 2002 NDC Evaluation Workshop, Oslo, Norway.



Map showing the locations of the International Cooperation workshops.


Participants of the International Cooperation workshop, Cairo, Egypt, 3 June 1999.

development and testing and provisional operation of the verification system. They have also served to build confidence in the functioning of the PTS and in the data, products and services it provides.

The PTS has also undertaken a range of activities under the banner of international cooperation. In particular, it has organized a series of regular workshops in various locations around the world to promote cooperation among States Signatories to facilitate exchanges of knowledge

**List of International Cooperation Workshops**

| Location | Date | Number of participants |
|---|---|---|
| Vienna, Austria | 16–17 Nov. 1998 | 104 |
| Cairo, Egypt | 3 Jun. 1999 | 40 |
| Beijing, China | 6–8 Jun. 2000 | 48 |
| Lima, Peru | 1 Dec. 2000 | 36 |
| Wellington, New Zealand | 27–30 Mar. 2001 | 10 |
| Istanbul, Turkey | 21–24 May 2001 | 61 |
| Dakar, Senegal | 13–15 Nov. 2001 | 28 |
| Nairobi, Kenya | 18–20 Jun. 2002 | 44 |
| Saint Ann, Jamaica | 3–5 Dec. 2002 | 28 |
| Baku, Azerbaijan | 25–27 Mar. 2003 | 29 |
| Nadi, Fiji | 16–17 Jun. 2003 | 25 |
| Kuala Lumpur, Malaysia | 9–11 Dec. 2003 | 23 |
| Tunis, Tunisia | 13–15 Apr. 2004 | 35 |
| Pretoria, South Africa | 29 Nov. – 1 Dec. 2004 | 29 |
| Guatemala City, Guatemala | 19–21 Sep. 2005 | 40 |
| Seoul, Republic of Korea | 18–20 Oct. 2005 | 36 |
| Kuala Lumpur, Malaysia | 31 May–2 Jun. 2006 | 30 |
| Mexico City, Mexico | 11–13 Oct. 2006 | 40 |
| Abuja, Nigeria | 30 Nov. – 1 Dec. 2006 | 80 |
| Nassau, Bahamas | 26–28 Nov. 2007 | 20 |
| Istanbul, Turkey | 1–2 Jul. 2008 | 64 |
| Apia, Samoa | 8–9 May 2008 | 28 |
| Windhoek, Namibia | 1–2 Apr. 2009 | 16 |
| Melekeok, Palau | 21–22 May 2009 | 25 |
| Bangkok, Thailand | 23–24 Nov. 2009 | 31 |
| Ulaanbaatar, Mongolia | 15–16 Mar. 2010 | 58 |
| Istanbul, Turkey | 15–17 Nov. 2011 | 64 |

Participants of the International Cooperation workshop, Ulaanbaatar, Mongolia, 15–16 March 2010.

related to technologies used in the verification of the Treaty, as well as to support the timely establishment of the verification regime and early entry into force of the Treaty. This series of international cooperation workshops began with a workshop in Vienna, Austria, in November 1998, followed by a similar workshop in Cairo, Egypt, in June 1999. Since then the PTS has organized many international cooperation workshops in all of the geographical regions defined by the Treaty, the last of which was held in Istanbul, Turkey, in November 2011.

The PTS has also sought to reach out through various means to States in order for them to engage more actively in the work of the Commission and to provide assistance to such States as necessary. This has also included providing support for the establishment of regional cooperation centres. Moreover, the PTS has supported an information visit programme, financed partly through voluntary contributions, to bring selected government officials and experts to Vienna to learn more about the organization and the verification regime.

The PTS has also served as a repository of knowledge in the area of OSI. It has continually transmitted this knowledge through targeted training activities aimed at contributing to the build-up of OSI capability. This is important because the Treaty does not envisage the Technical Secretariat having a standing inspectorate. A key objective of the organization is therefore to ensure that the necessary knowledge and expertise exists with selected experts in the governments and institutions of States Signatories, in the form of surrogate inspectors before entry into force and as inspectors after entry into force.

For example, the PTS has held numerous OSI introductory courses. These are well balanced outreach activities that contribute to preparing a roster of trained OSI inspectors. Their aim is to familiarize experts from States Signatories with the OSI regime and its development. Some OSI introductory courses focus on the OSI process and its context, the phenomenology of nuclear explosions, OSI technologies and the rights and obligations of the inspection team and the inspected State Party. Other OSI introductory courses focus on training future inspectors in the common or generic skills required of an inspector to survive in the field and to function successfully as a team member.

These OSI introductory courses, along with other more detailed and sophisticated OSI related training activities such as directed exercises or tabletop exercises, are based on a long range plan for the training and exercise programme for future OSI inspectors. So far there have been two training cycles for this purpose.

Additional overflight performing airborne magnetic field mapping during DE06.

In recent years, the PTS has used information technology to move beyond the more traditional methods of training and knowledge dissemination for experts, station operators, NDC staff as well as those involved in OSI related activities by developing an e-learning capability that now complements face-to-face teaching. The primary objectives of this e-learning are: to increase the number of participants in PTS training activities; to prepare individuals prior to their participation in traditional classroom training and field exercises; to reduce lecture room time in favour of field activities or hands-on exercises; to provide a means for individuals to learn at their own pace where appropriate; and to broaden the base of potential candidates for employment in the PTS, thereby assisting recruitment.


CTBTO web site.

## OUTREACH AND INFORMATION SHARING

A key part of the mandate of the PTS has been to promote understanding of the objectives and principles of the Treaty, the functioning of the Commission, the verification regime, and the civil and scientific applications of the IMS technologies and data. Carrying out this mandate has been an important part of the role of the PTS as a knowledge organization. Its outreach in this regard has been done through interaction with the international community, including States, international organizations, academic institutions, non-governmental organizations, the media and the general public. Outreach activities have involved promoting signature and ratification of the Treaty, educating the general public about the work of the Commission and fostering international cooperation in the exchange of verification related technologies.

Information sharing has significantly evolved since the organization's inception. The text-heavy communiqué style dominating in the early years has given way to an intensive use of video–audio content, including verification technology animations, videos from remote monitoring stations or interactive maps. In addition, the turnaround time for publishing new developments has considerably shortened. By adopting a proactive and open stance in informing the media and the public about its role and contribution, the PTS has greatly enhanced its visibility and perception as a reliable source of information.

The public web site provides a 'one stop shop' for information and discussion related to the ban on nuclear testing. The web site aspires to be a comprehensive information resource for the CTBT and its verification regime, the history of nuclear tests and the arms control efforts undertaken to contain them, including the long phase preceding the adoption of the Treaty. Since 2008, the PTS has expanded the information provided on the history and the effects of nuclear testing, including through comprehensive web site chapters, an interactive map and a series of articles focusing on particularly 'infamous' nuclear tests. In this way, the PTS has become a knowledge portal for the wider community on issues related to the Treaty and to nuclear testing.

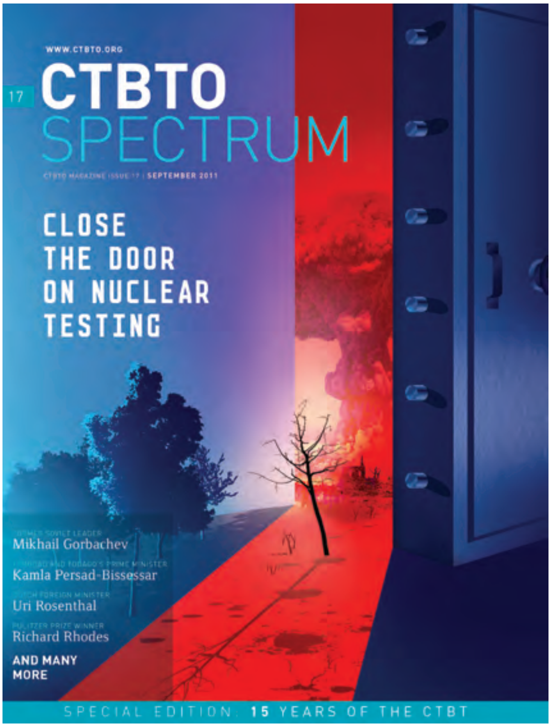
Beyond the public web site, the PTS has also been active in ensuring that it has appropriate presence in social media and through blogs with a view to broadening the scope of its information and knowledge dissemination and to creating a dialogue with the broader CTBT community. One of the most successful tools for awareness raising was the video "1945–1998" by Isao Hashimoto and promoted by the PTS, which has been viewed over three million times on YouTube.

From 2009 onwards, the PTS has developed the capacity to produce and make available broadcast quality video and audio material to broadcasters worldwide. Close cooperation with UNTV and Unifeed with their exclusive network of broadcasters worldwide has been developed to this end. Particularly successful examples were a video report about the OSI directed exercise in Jordan in November 2010 and videos about IMS stations in Argentina, Germany and Greenland.

The PTS has also expanded its visibility through exhibition panels both as a comprehensive permanent installation at the VIC, at the United Nations headquarters in New York and at the United Nations Office in Geneva, as well as for special events and other international conferences. The largest exhibition to date was installed in the central building of the VIC during the Commission's 15 years celebration in February/March 2012, which was opened by the United Nations Secretary-General.


The exhibition in the central building of the VIC installed for the 15 year anniversary of the CTBTO.

Since 2007, the biannual publication of the CTBTO *Spectrum* has evolved from a traditional organizational newsletter to a key publication in the field of nuclear disarmament and non-proliferation with the purpose of offering different perspectives and stimulating debate. It now profiles the entire spectrum of issues related to the Treaty: from policy issues, verification, the science and people behind it to the organization's role in disaster mitigation. It has featured contributions by leading international figures, foreign ministers, political analysts, scientists and members of civil society.



CTBTO *Spectrum*.

## CAPACITY DEVELOPMENT INITIATIVE

In the last several years the PTS has enhanced its effort to disseminate knowledge about the Treaty by establishing the Capacity Development Initiative (CDI), a broad based training and education programme that offers courses on the policy and legal aspects of the CTBT, as well as the science and technologies that underpin the Treaty's verification regime. The CDI approach is based on the recognition that the future of the CTBT and its multilaterally established verification system are dependent on the active and informed involvement of current and future generations of CTBT experts. The CDI courses combine live lectures in Vienna with an innovative e-learning platform that offers participants opportunities for online engagement. All courses can be followed via live stream and are archived on the e-learning platform, allowing participants to follow the courses from anywhere in the world. By training and educating a growing pool of experts in all aspects of the CTBT, the PTS has increased awareness and understanding of the Treaty with a view towards its entry into force and universalization. In 2011 an Introductory Course and an Advanced Science Course were held in Vienna and many more participants followed the courses online.

In less than three years, more than 1800 participants have registered for the CDI courses, of which nearly half have completed the necessary requirements to receive a Certificate of Successful Completion. Through massive online open educational collaboration, this approach is also seen as contributing to the enhancement of the broader non-proliferation and disarmament regime. Demonstrating its commitment to broad dissemination of disarmament and non-proliferation educational material, the PTS has also developed a robust presence on iTunes U, a


Participants of the Advanced Science Course at the closing session, Vienna, 9 December 2011.

growing online platform for free educational content. The unique presence on this platform enables wider distribution of Treaty related resources, including issue specific modules on all aspects of the CTBT and its verification regime.

## LEGAL ASSISTANCE

As part of its mandate, the Commission has also been involved in facilitating the exchange of information and knowledge between its States Signatories concerning the legal and administrative measures that will be necessary for the implementation of the CTBT upon entry into force.

Acts implementing the CTBT, laws prohibiting nuclear explosions, decrees recognizing the privileges and immunities of the organization, orders designating the National Authority to interact with the PTS and with the future CTBTO – these are some of the types of measures that States have adopted to prepare for the implementation of their obligations and to better collaborate with the activities of the organization.

The PTS has a programme of legal assistance to support States in these endeavours. It has developed a lot of information material, such as the CTBT legislation database, the guide on CTBT implementing legislation, the CTBT legislation questionnaire and other documents. The PTS also provides advice on draft legislation upon request. Model laws have been developed to serve as a reference to national drafters, while courses and workshops have been organized for legal experts in States Signatories.

Experience in some States has shown that legal preparations for the implementation of the CTBT may be a good opportunity to strengthen partnerships at the national and international levels, for the benefit of improved national capabilities in using the Treaty's verification technologies of the Treaty, including their civil and scientific applications.

For these and other policy reasons, States Signatories have shown increased interest in this subject. Over the last few years the PTS has enlarged outreach of its legal assistance activities. The first workshop on implementing legislation was held in November 2011 in Vienna. During this workshop, participating States identified the scope of national measures, including legislation which may be necessary in their countries for CTBT implementation. Draft proposals of legislative provisions were elaborated, taking into account the national legislative context, for eventual submission to the competent national authorities. Participants were enthusiastic about the results of the project and encouraged the PTS to continue conducting this kind of activities in the future.

Participants of the Pilot Workshop on Implementing Legislation for the CTBT, Vienna, 1–4 November 2011.

## SUPPORTING EXPERTS FROM DEVELOPING COUNTRIES

Since the beginning of 2007, the PTS has been implementing a project initiated by the Commission to facilitate the participation of experts from developing countries in official technical meetings of the Commission, in particular WGB, the subsidiary body responsible for scientific and technical issues. The stated aim of this project is twofold: to strengthen the universal character of the Commission and to foster capacity building in developing countries. It has proven to be an important mechanism for increasing the level of knowledge about the Treaty and the verification regime in developing countries. It has also served to strengthen the ability of those countries to take advantage of the data and products of the verification system and to contribute to the development of the OSI capability.

The project has been financed so far by over $800 000 in voluntary contributions from 19 countries (Austria, China, Finland, Hungary, Indonesia, Luxembourg, Malaysia, Morocco, the Netherlands, New Zealand, Norway, Oman, Qatar, the Republic of Korea, Slovenia, South Africa, Spain, Turkey and the United Kingdom) and from one institutional donor, the OPEC Fund for International Development. Using selection criteria approved by the Commission and following a rigorous selection process, the PTS has up to now chosen experts from 22 countries, each of which has had the opportunity to participate in official technical meetings for at least two years. These countries are: Algeria, Bolivia, Brazil, Burkina Faso, the Dominican Republic, Ethiopia, Indonesia, Jordan, Kenya, Madagascar, Mexico, Mongolia, Papua New Guinea, Paraguay, Peru, the Philippines, Samoa, South Africa, Sri Lanka, Thailand, Tunisia and Vanuatu. One measure ensuring the success of the project was the decision of the Chairperson of WGB to appoint three of the experts supported under the project as Task Leaders within WGB.

Meeting between representatives of donor countries and experts from developing countries who received support through the pilot project to attend technical meetings of the Commission, August 2008.

# Innovative Organization

Enhanced interaction with scientific community

Scientists access IMS data through vDEC

New IMS technology test facility opens in Austria

Launch of technology foresight exercise

Opening of new Operations Centre and Computer Centre

Migration of the GCI to a new technology platform

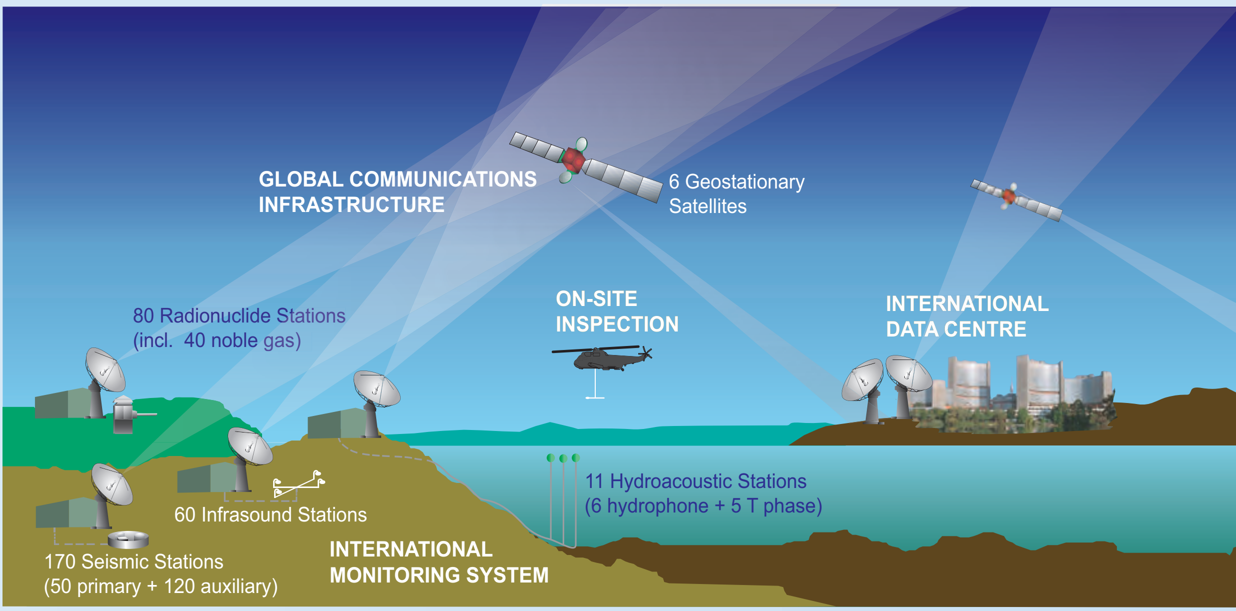
Development of OSI equipment encompassing innovative technology

Innovation is of crucial importance for the PTS as an organization responsible for establishing and operating a verification system that relies on the latest advances in science and technology. In many respects, the concept of innovation is already embedded in the Treaty, for example in the progressive development of specifications and the fact that it is a verification based Treaty.

This concept of innovation for the PTS has not been an end in itself, but a means to ensure that the verification system remains technologically relevant and as state of the art as possible within financial constraints. It is something that has permeated the work of the PTS since the beginning.

To foster innovation, it has been of strategic importance for the PTS to stay attuned to defining events in the scientific community, to benefit from new developments and to attract competent scientists to work for it. In this way, it has also been able to assess whether its activities and products meet international standards.

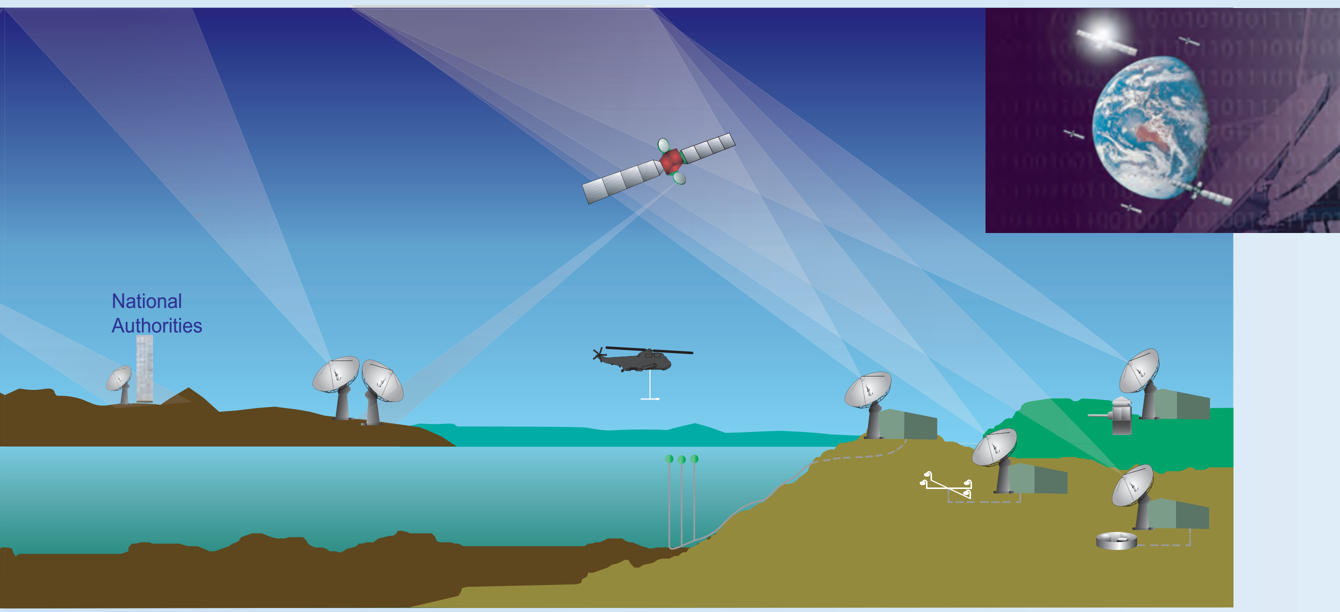
Verification of compliance with the Treaty poses challenges whose resolution depends crucially on the promotion and exploitation of scientific research and technological developments. Both the credibility of the verification system that is being established by the Commission as well as its ability to detect, locate and identify nuclear explosions rely on a continuing engagement with the specialist communities that drive advances in relevant instrumentation, processing and analysis methods. This is why



interaction with the global scientific community has been, and will continue to be, so important. The PTS has been proactive in fostering this interaction.

Part of the role of the PTS as an innovative organization is building awareness of its work and the Treaty outside the more narrow CTBT constituency. In this context, the use of the virtual Data Exploitation Centre (vDEC) to encourage a larger collaboration on scientific and technical issues as well as the CDI are vital elements. It will be important to continue to seek further opportunities to reach and engage a wider audience to stimulate innovation. An outreach and information strategy that uses innovative, state of the art electronic communications is key to this endeavour.

The challenge of dealing with a longer than expected period before entry into force also necessitates stronger engagement with a wider range of stakeholders so that the organization can make its presence felt in the outside scientific and technical environment. This includes ensuring that work within the PTS is integrated into the development programmes of other scientific players.



## ENGAGEMENT WITH THE SCIENTIFIC COMMUNITY

A prerequisite for the ability of the PTS to be an innovative organization has been its interaction with the broader scientific community. This interaction has had two main components: one involving the recruitment of scientists and technicians to provide their expertise within the PTS itself, and the other involving mechanisms to foster an exchange between the PTS and the outside scientific community.

This second element has been part of the strategy of the PTS for many years. It gained a new, more structured and more visible dimension, however, in 2006 with the organization of a scientific symposium in Vienna entitled CTBT: Synergies with Science 1996–2006 and Beyond. This symposium marked the beginning of a process of strengthening the links between the PTS and the scientific community.

The 2006 conference marked the tenth anniversary of the adoption of the Treaty and its opening for signature in September 2006. It attracted more than 300 participants, including key figures in the field of nuclear non-proliferation and disarmament and scientists from internationally renowned universities and institutions, as well as representatives of States Signatories. There was an exchange of ideas aimed at strengthening the interaction between the global scientific community and the Commission. Some of the many significant scientific developments that had taken place since 1996 and are of relevance to the


Mohamed ElBaradei, Director General, IAEA, and Executive Secretary Tibor Tóth at the opening of the 2006 symposium.

Participants of the 2006 symposium.

verification system were discussed at the symposium. These included precision seismology to improve the accuracy of event location, improved understanding of earthquake sources, new computational tools to understand wave propagation, new and improved methods and procedures for the analysis of large data volumes, and new analytical methods and procedures to increase the understanding of infrasound observations.

Scientists at the symposium highlighted the great value of CTBT data and their many long term uses in scientific research which could lead, inter alia, to improved methods of data acquisition and analysis. CTBT data could be used in studies of the earth's structure as well as in research on earthquakes, underwater explosion location and climate change monitoring. They could also be of value in efforts to improve early warning systems for tsunamis, volcanic and major chemical explosions, and tropical cyclones.

The 2006 symposium, while highly useful in its own right, was never intended to be a one-off event. As a follow-up, the International Scientific Studies (ISS) project was initiated in 2008. Like the 2006 symposium it represented a PTS-wide effort to develop long term connections and cooperation with the scientific community and to help the Commission to keep pace with the latest advances in science and technology in a cost effective manner.

The decentralized work method of the ISS project involved many different scientific groups. Some twenty senior scientists coordinated activities and contacts with the scientific community in eight fields of key importance to the PTS: system performance, seismology, hydroacoustics, infrasound, radionuclide monitoring, ATM, OSI and data mining.

The project included active participation in scientific conferences and joint studies with scientific institutions on how to apply modern analytical methods to improve the efficiency of data analysis by the PTS and the quality of its data products. A specific ISS activity begun in 2008 was to evaluate the capability and readiness of the IMS and OSI elements of the CTBT verification regime. In addition, a number of workshops and expert meetings on data mining were held in 2008 and 2009. These events addressed the methods and procedures developed within this area of science and how they could be used to improve the analysis of verification data. They proved important in boosting dialogue and cooperation between the data mining community and those engaged in developing tools for analysis of verification data.

A culmination of the ISS project was a major scientific conference in Vienna in June 2009. This was a platform for strengthening the interaction of the Commission with the scientific community. It assisted in making an independent assessment of the capabilities and readiness of the verification regime and in identifying developments that might enhance these capabilities.

This conference in June 2009 attracted over 500 scientists from about 100 countries, in addition to diplomats and journalists. The results of the conference as well as the final publication and the more than 200 scientific posters presented at the meeting were made available on the public web site. New electronic information

Executive Secretary Tibor Tóth and Wolfgang Hoffmann, Executive Secretary Emeritus, at the ISS09 conference.

Around 600 participants from 99 countries attended the ISS09 conference.


products were launched at the conference including animations on the four monitoring technologies, a film on the 2008 IFE and a slide show on the history of the CTBT and its verification regime.

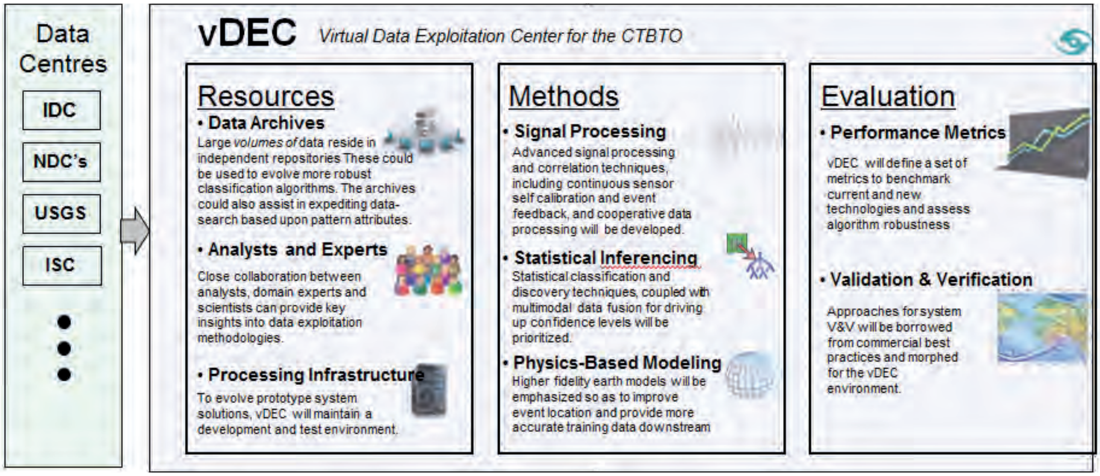
The next major step in the strengthening of links between the PTS and the scientific community was the Science and Technology 2011 (S&T2011) conference held in June 2011. This conference was a major initiative to foster further interaction with the scientific community and to seek cost effective technological improvements. It brought together around 750 participants from over 100 countries. They included scientists, academics, researchers, science administrators, technologists, State officials and representatives of the media and civil society. The conference provided a good opportunity to review the performance of the verification regime and to increase the interaction of the PTS with the scientific community in its continuous pursuit of a technological vanguard position. S&T2011 also provided a forum for discussion of advances in science and technology relevant to nuclear test ban verification and to explore civil and scientific applications of the CTBT verification infrastructure. It also fostered partnerships and knowledge exchange between the Commission and the broader scientific community.


Final reception of S&T2011.

*From left to right:* Wolfgang Hoffmann, Executive Secretary Emeritus, David Strangway, President Emeritus of the University of British Columbia, Canada, and Lassina Zerbo, Director of the IDC, at S&T2011.

Discussions at the S&T2011 conference were organized around five themes: the earth as a complex system; understanding the nuclear explosion source; advances in sensors, networks and observational technologies; advances in computing, processing and visualization for verification applications; and creating knowledge through partnerships, training and information/communication technology. A special session, including a panel discussion, on the Tohoku earthquake, the resulting tsunami and the Fukushima Dai-ichi nuclear power plant accident was organized. This session was the first public seminar of its kind. Two additional panel discussions centred on practical means to achieve cooperation with the scientific community. A dedicated web site area was created as a one stop shop for all material related to the conference, including programme, abstracts, posters, presentations, video files, articles, video interviews with scientists and video

Panel discussion on the Fukushima event. *From left to right*: Susan Watts, BBC science journalist (moderator), Roland Schenkel, former Director-General of the Joint Research Centre of the European Union, Denis Flory, Deputy Director General, Department of Nuclear Safety and Security, IAEA, Matthias Auer, IMS Radionuclide Project Manager, Wolfgang Weiss, Head, Federal Office for Radiation Protection, Germany, and Harri Toivonen, Director of Laboratory, Radiation and Nuclear Safety Authority, Finland.




vDEC for the CTBTO.

clips. A capacity building seminar for journalists was held on the margins of the conference with distinguished scientists and the Director of the IDC Division and staff.

The three major conferences organized by the PTS in 2006, 2009 and 2011 showed, in their progressively higher profile and level of accomplishment, a clear momentum in the engagement of the organization with the scientific community and in its efforts to be an innovative organization. This series will continue with a further S&T conference in 2013.

A key issue for the interaction between the PTS and the scientific community has been the possibility of access for scientists to IMS data for research purposes. This has generated a lot of discussion over the years, including among States Signatories in WGB, on the extent to which, and in what form, these data should be made available. At the end of 2009 the PTS initiated a project to establish a vDEC. Since then, this platform has become well established with a growing number of scientific teams having access to hardware, archived data and a collaborative wiki. The legal framework was in place for scientists to access data at vDEC free of charge. It is already proving to be instrumental in allowing innovative ideas to be tested on IMS data, as well as providing scientists with access to a large continuous data set from which valuable information and insight can be gathered. In this way, vDEC is another important tool for ensuring that the PTS continues to be an innovative organization.

## INNOVATION IN IMS TECHNOLOGIES

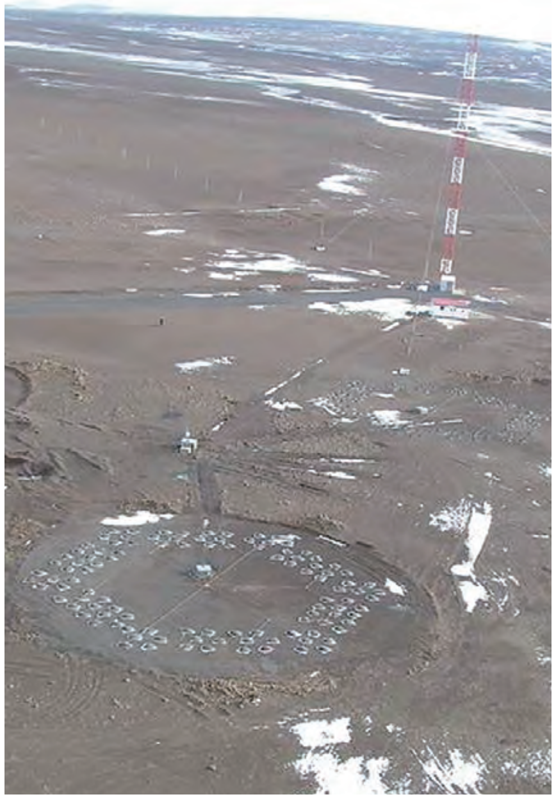
Innovation in the technologies that underpin the IMS has been vital to ensure that this system remains technologically relevant. The PTS has been the vehicle or tool for developing and preserving Treaty technologies which otherwise may not have been developed to such an extent. The PTS is where a lot of innovation in these technical areas happened and continues to happen, for example infrasound and noble gas technology (in particular its use in the field). This innovation does not, however, take place within the PTS alone, i.e. an indispensable element has been collaboration with scientists and technicians in the wider community.

One instrument used by the PTS to foster the exchange of ideas on the various technologies and to stimulate innovation is, for example, technology workshops. These workshops have been held, in many cases jointly with national scientific institutions, in various locations around the world since 2000 and have covered hydroacoustic technology, infrasound technology and radionuclide and noble gas technology.

Another important development in this regard was the establishment of a new test facility at the Conrad Observatory, Austria. This facility has proven to be useful for devising ways to improve the performance of the waveform monitoring technologies, for example infrasound portable arrays.

Outside view of the Conrad Observatory, Lower Austria, Austria.

Participants of an NDC Evaluation workshop at a borehole facility at the Conrad Observatory.



Array at infrasound station IS23, Kerguelen, France.

A good example of successful collaboration between the PTS and a State Signatory on innovation in verification technologies is the development of an improved system for infrasound stations located in areas with strong winds. This was done jointly with the Department of Analysis and Surveillance of the Environment of the French Atomic Energy Commission. This research was successfully concluded in 2005 with the innovative and tested concept of synthetic infrasound array elements to be implemented at high wind IMS station locations such as IS23 on the island of Kerguelen.

The PTS also established an engineering and development programme to develop cost effective solutions to problems arising at IMS stations and initiatives to enhance monitoring performance. The underlying philosophy was that systems engineering should be implemented throughout the IMS station life cycle, relying on open systems design through standardization of interfaces and modularity, applying end to end systems engineering and optimizing station design with processing by the IDC. For example, in 2011 this programme focused on designing, validating and implementing solutions to improve overall data availability and quality, cost effectiveness and performance.

## TECHNOLOGY FORESIGHT

As part of its commitment to cost effective innovation, the PTS recently began a technology foresight exercise. Its aim is to uphold the relevance of the technology intensive verification system as well as to ensure awareness of developments in science and technology that could enhance performance and efficiency of systems and operations. It is intended to be a continuous process whereby scientists and technologists meet, interact, debate and jointly define future courses for Treaty related research and development.

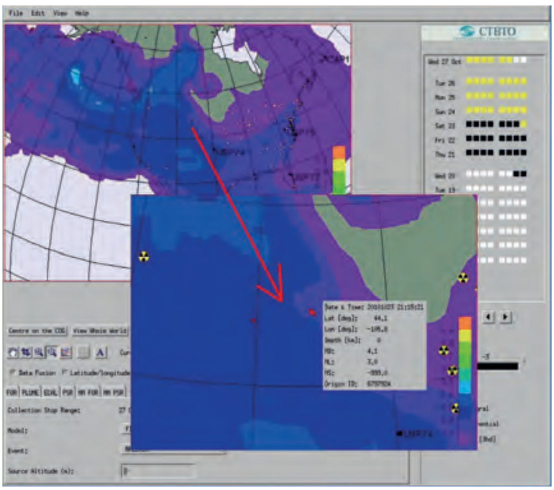
In 2011, the technology foresight exercise focused on identifying the scientific and technological developments that might affect future PTS operations. The aim of this phase was to deliver a medium to long term integrated technology forecast for the Commission. A first assessment to identify major topics and trends relevant to the CTBT technologies was released.

## INNOVATION IN THE IDC AND COMPUTER INFRASTRUCTURE

Innovation has also been a key concept within the IDC since its establishment in Vienna in 1998. It has been done through work within the PTS as well as through regular interaction between PTS staff and expert groups within WGB. The search for innovation in the IDC has been partly driven by the need to find the right balance between automatic processing and human review. In this regard assessments have shown the added value of interactive review, highlighting the recognized limitations to be expected from automatic IDC products.

Development work in the IDC has included, for example, continuous assessment of the scientific methods used in the IDC applications software for all technologies, enhancements and upgrades to IDC application software, establishment of a reference event database for hydroacoustic and infrasound technology, a seismic calibration programme for improving the location of events based on the best available regional travel time information and introduction of a Web connected graphics engine (WEB-GRAPE) as a tool for analysis of atmospheric transport calculations. The refining and improving of detection and analysis methods and algorithms for processing of data has led to a decrease in the number of 'false' (non-real) events in automatic processing compared with the number of events in the REB.

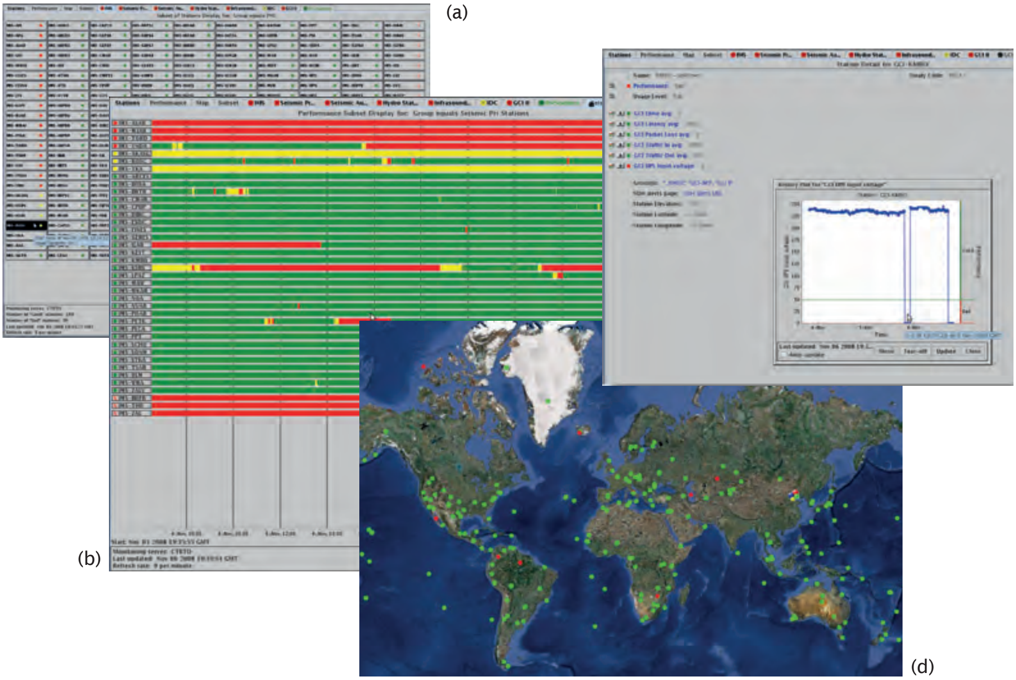
There has also been innovation in the ability of the IDC to monitor the performance of the IMS. This includes the development of unified tools and processes to record and track operational incidents in the verification system and to monitor its SOH. A new state of the art Operations Centre intended to serve the entire PTS was officially opened in January 2007. This Operations Centre, as the focal point for operational activities, has proven to be a crucial part of integrated operations. It consists of control, escalation and multimedia rooms and is equipped with state of the art technology. From there, PTS staff are provided with a real time window on the IMS. Activities of the centre include status reporting, operational incident management and GCI data, network and systems operations. A key tool is the SOH system, which was installed in the Operations Centre in 2009. This system collects and manages information on the SOH from all components of the IMS, including stations, GCI links, IDC programmes and servers and any other source of data that may be relevant to the O&M of the IMS. In 2011 a test version of a Web based SOH system was released to station operators and NDCs. Every 10 minutes the system presents the actual status of each IMS station, including the SOH parameters for components at the station and in the GCI link.




Data fusion using WEB-GRAPE.

Refreshment of computer hardware and infrastructure has also played an important part in the PTS as an innovative organization. For example, in 2003 a new technology was introduced to replace the ageing hardware purchased and installed in Vienna in 1997 and 1998. An important part of this replacement programme consisted of the purchase and installation of a storage area network that allows storage to remain unaffected by individual server failures. This process of technology refreshment has continued at regular intervals in line with the usual life cycle for information technology hardware in the PTS.

In August 2005, following an intensive planning, procurement and construction process, the new PTS computer centre became operational. Located in the basement of the




SOH showing current status of each station (a), performance of the stations over a three day period (b), details of one station (c) and map of all the stations (d).

central conference building at the VIC, this high technology facility hosts all central computer systems, networking devices and related infrastructure equipment that support the CTBT verification regime.

A defining pillar of the innovation strategy of the PTS was the implementation of the decision to migrate IDC systems to open source software, including operating systems. This has allowed more independence from vendors, more flexibility and potential long term cost saving. Open source software is software where full access to the source code is granted and distribution in source code as well as compiled form is freely allowed.

The migration to open source proceeded on the basis of a road map which was developed in 2004 by a PTS task group, comprised primarily of staff of the IDC Division, with representatives from the IMS and OSI Divisions as well as the Evaluation Section. This road map contained details on software migration and developments as well as possible hardware architecture designs necessary to achieve the migration to open source. It envisaged a gradual, phased transition over a period of five years between mid-2005 and mid-2010, comprising three phases: (1) the migration of individual applications to Linux and the creation of test suites; (2) the adaptation and redesign of the automatic waveform processing software; and (3) the adaptation and redesign of the interactive waveform processing software. This phased approach enabled the PTS to make the most of the available resources, while minimizing risk, and provided the opportunity to gradually build confidence and knowledge about the converted system. The migration was carried out using primarily in-house software developers. This kept the costs associated with this effort contained and mitigated the risks. It meant that the duration of the project was perhaps longer, but, on the other hand, it was less of a burden on the software development budget.

The migration to open source has enabled the PTS to fulfil more easily the requirements set out in the Treaty and in the draft IDC Operational Manual related to making software available to States Signatories in order to provide them with IMS data and IDC products and to assist them in the development of their own capabilities. According to a policy on distribution of software to States Signatories that was developed within WGB in 2001, all States Signatories should have appropriate access to PTS software from the IDC with the complete source code (other than for commercial off the shelf software), binaries and accompanying documentation, including algorithm descriptions. Migration to open source has made the work of the IDC Division as the focal point within the PTS for software distribution to States Signatories much easier and more efficient. Open source has significantly lowered the barrier for States Signatories that would like to use the PTS software. Prior to the migration to open source, the PTS ran software that was not available in source form and thus was not fully aware of what was contained in the libraries. Open source has introduced greater transparency for PTS staff and has enhanced its ability to resolve problems associated with software.

## GLOBAL COMMUNICATIONS INFRASTRUCTURE

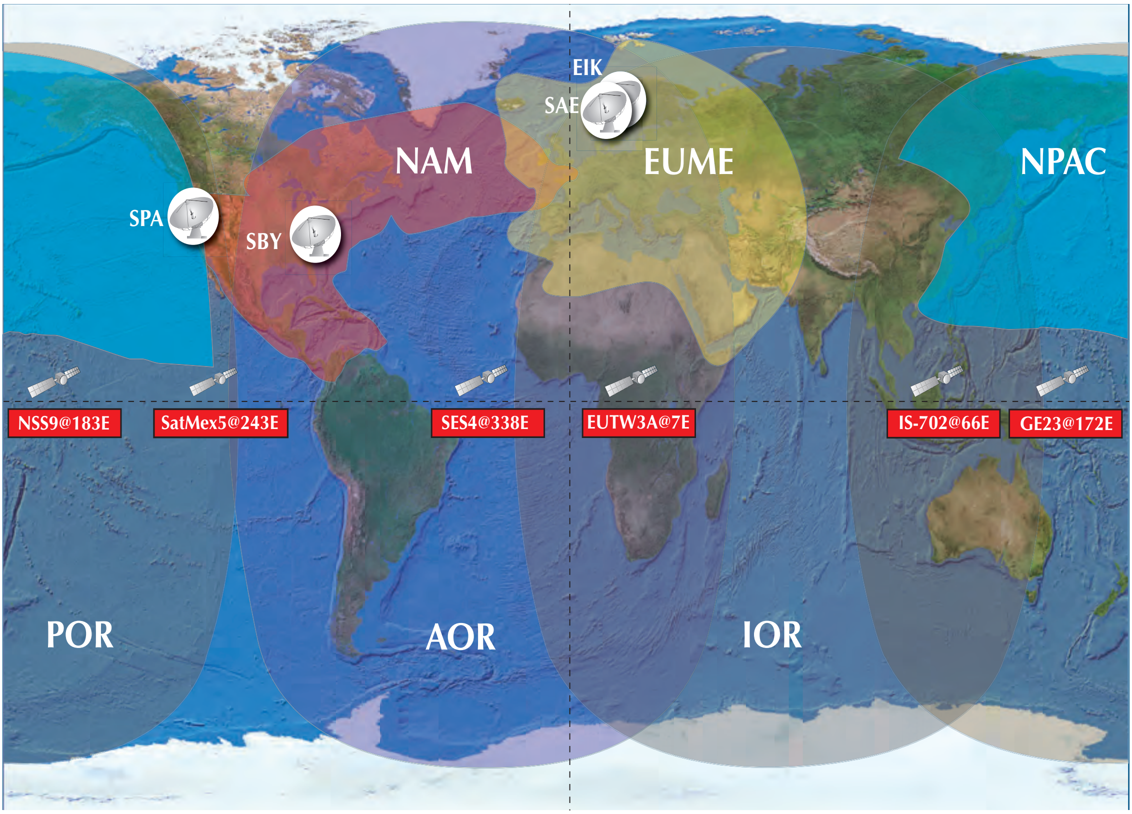
The GCI is a good example of a substantive area where innovation has played a major role in the operations of the PTS from the beginning. The GCI is the first global satellite communications network based on very small aperture terminal (VSAT) technology. It is designed to ensure raw data transmission from the IMS facilities in near real time to the IDC in Vienna. The GCI also distributes the analysed data and reports relevant to verification of compliance with the Treaty to States Signatories.

In May 1997 the Commission approved an initial plan for the acquisition and implementation of a GCI that also contained a ‘concept’ for the GCI. This concept envisioned a GCI built upon a ‘basic topology’ that routes data directly from the IMS stations to the IDC and then a standard distribution of data and products to the States Signatories. The concept also allowed for the possible inclusion of exceptions to this topology, or ‘special needs’, that might be requested by States Signatories.

The Commission tasked the PTS to issue by the end of 1997 a request for proposals to implement the GCI. To support this task two communications panels – the GCI Experts Group and GCI Committee – were convened, with nominations openly solicited from all States Signatories. The GCI Committee reviewed responses to two questionnaires sent to all States to solicit information on any special needs for routing of data from IMS stations to the IDC, and on their requirements for receipt of data and products from the IDC. The GCI Experts Group assisted the PTS in completing the request for proposals so as to accommodate both the basic communications topology and requested special needs as forwarded by the GCI Committee.

Owing to the successful collaboration between the States' experts and the PTS, a near final draft of the request for proposals was completed by 18 December 1997. After a final review by PTS legal staff and the UNIDO contracting office, the request for proposals was issued on 14 January 1998.

The priority for the PTS at the beginning was to procure the longer term GCI but at the same time to establish as quickly as possible a temporary high speed communications link between the IDC in Vienna and the pIDC in Arlington. This was done by PTS staff with the assistance of outside




Satellites and satellite hubs of the GCI.

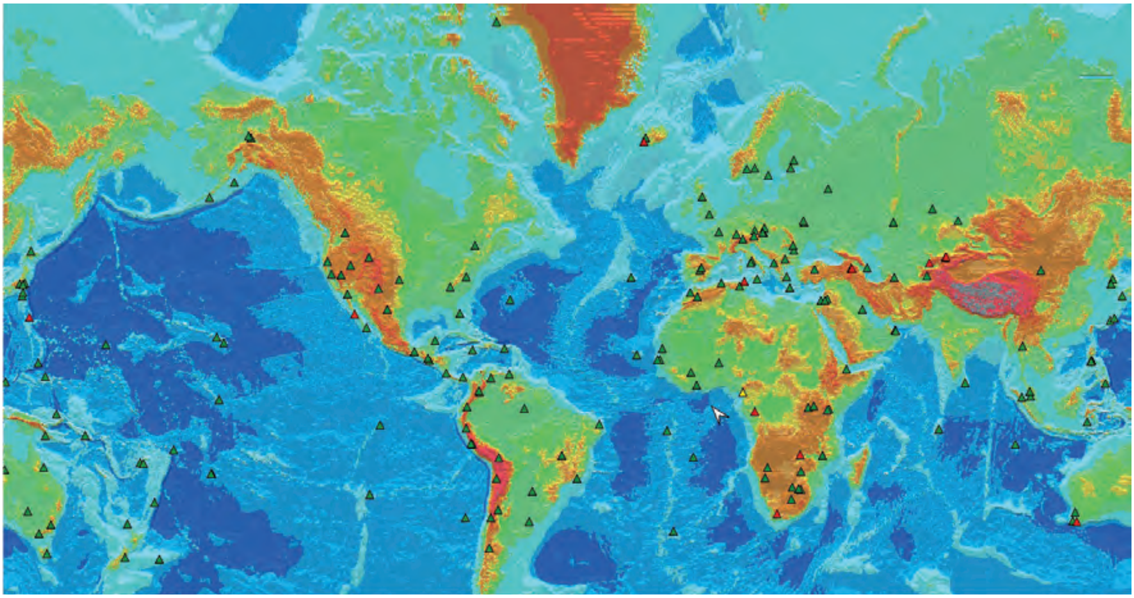
*From left to right:* GCI satellite terminals at auxiliary seismic station AS24, Rarotonga, Cook Islands; auxiliary seismic station AS78, Nana, Peru; NDC Tashkent, Uzbekistan; setting up the GCI satellite terminal at the NDC in Abuja, Nigeria.

experts. This temporary link between Vienna and the pIDC, which was put into operation in April 1998, was a major step in the development of the capacity of the IDC to operate independently. Its purpose was to provide the IDC in Vienna with rapid access to the same seismic, hydroacoustic, infrasound and radionuclide data as received at the pIDC and thus allow efficient, parallel testing of applications software at both sites. Later this same link provided the pIDC with rapid access to the same data received originally at the Vienna IDC through the GCI, once again to allow parallel testing. This link also greatly facilitated communication of software and information between the pIDC and Vienna as the applications systems were delivered, tested and improved.

There were some delays in the beginning in the procurement and deployment of the GCI as a result of a lack of sufficient staff to specify and procure communications systems and the fact that the procurement process in the PTS was still evolving. Despite these constraints, the PTS was successful in signing as early as September 1998 a $70 million contract with HOT Telecommunications Ltd. (a subsidiary of Hughes Network Systems formerly called Hughes Olivetti Telecom Ltd.) to establish the GCI. This ten year GCI contract was designed to provide turnkey services covering the design, installation, management, O&M of the complex GCI network of VSATs.

On the recommendation of the Commission, the PTS asked HOT to estimate the costs of supporting the special needs for data routing requested by several States Signatories. As a result, it was not possible to provide GCI communications for all of the first 30 IMS stations before the end of 1998. The PTS conducted a preliminary test of the first network management system (NMS) on 23 March 1999. This preliminary test verified the delivery and installation of the hardware platforms and commercial off the shelf software to be used in further developing the NMS, which provided availability and performance reports for all GCI connections.

Difficulties encountered by the PTS in licensing VSATs continued to be the biggest obstacle to the installation of new GCI sites. PTS strategies to overcome these problems included missions



Map of location of GCI VSAT and ISN sites on a global relief map, 2008.

to selected countries to accelerate the licensing process.

In 2002 the PTS continued negotiating with the GCI contractor to find savings within the GCI contract to fund additional services and to support additional sites moved from the independent subnetwork (ISN) topology to the basic topology, as well as additional NDCs that requested to be connected to the GCI via VSAT. In addition, the PTS modified the GCI service level agreement to be more compatible with the concept of provisional O&M of the IMS. Additional requirements included an enhanced NMS, a new firewall and a virtual private network as an alternative to the installation of VSATs. The new NMS provided enhanced reporting with graphical features, which were overlaid with real time global weather patterns.

There was an ongoing review of the 10 year GCI contract, including the mix of technologies used, to ensure that it continued to meet the needs of the constantly expanding IMS network and the developments in the IDC. As part of this review process, the PTS organized workshops involving experts from States Signatories. For example, GCI evaluation workshops were held in 2002 and 2003, focusing on issues related to the O&M and functionality of the GCI.

The first ten year GCI contract expired in 2008. To ensure continuity of GCI services, the PTS worked with a group of experts from States Signatories, established by WGB, to define future GCI performance requirements and technology options. The migration of the GCI to a new technology platform was completed by July 2008 without major disruptions to the data flow. The

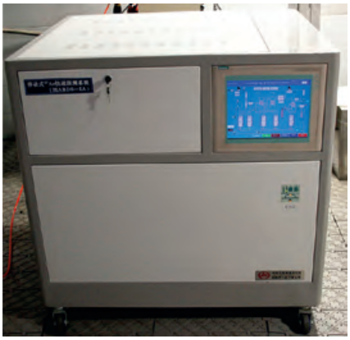
Participants of the GCI workshop held in Vienna, 20–23 October 2003.

migration was performed as part of a 10 year contract with UltiSat, Inc. which designed, implemented and commissioned a secure hybrid satellite–terrestrial network to accomplish the objectives. With support from the PTS, the new contractor completed regulatory filings, obtained host country agreements and secured operating licences for all terminals in most countries in less than 12 months. Using leased capacity on six different satellites and a multiprotocol label switching terrestrial network infrastructure, UltiSat now operates and maintains this closed and secure global network in some of the world's most remote and harsh environments. GCI II is capable of managing the performance of each link from each site, which was not possible with the previous technology. It also makes use of off the shelf rather than proprietary products for network management applications and has higher security standards than the original GCI.

## OSI EQUIPMENT DEVELOPMENT

Development of equipment for the purposes of OSI is another area where the PTS has demonstrated its status as an organization based on innovation. The mandate of the Commission requires the PTS to acquire or make provisions for the availability of relevant inspection equipment, including communications equipment, and conduct technical tests of such equipment as necessary. Core equipment collected by the PTS encompasses state of the art technology, such as instruments for high resolution geophysical surveys, gamma radiation monitoring devices and environmental sampling equipment.

Some of this equipment has been available to the PTS off the shelf through commercial providers. Because of the specificity of OSI needs, however, other equipment has not been so readily available commercially. For example, equipment for



MARDS-1A (Mobile Argon-37 Rapid Detection System), developed by the Institute of Nuclear Physics and Chemistry, China. *Left*: gas separation unit, *below*: the spectrometer unit.


measurement of the radioactive noble gases xenon and argon-37, which is highly important for OSIs conducted after entry into force, is unique and needs to be specially designed and developed. Development of a field-deployable argon-37 measurement system was undertaken by the PTS with the cooperation of China and Switzerland. Another strategy used by the PTS to acquire equipment not readily available commercially has been to seek the assistance of States Signatories to make it available on loan or lease, or as a donation to the PTS.

## INNOVATION IN MEETINGS SERVICES

The PTS has striven to be as innovative as possible in its provision of support services to States Signatories. An example of this has been the area of meeting support. The Experts Communication System (ECS), an online tool for registered experts to access documents and to take part in electronic discussions on technical issues, had its first full scale trial during a session of WGB in August–September 1998, only six months after the PTS had been established. It became fully functional soon afterwards.

The PTS has also been innovative in creating and providing a virtual working environment for those unable to attend regular meetings of the Commission and its subsidiary bodies. Starting in 2005 the proceedings of each meeting of the Commission and its subsidiary bodies have been transmitted around the globe in real time before being archived for reference purposes. In addition, documents supporting the sessions are distributed to States Signatories through the ECS, and ECS users are notified by email alerts. To complement this online distribution of material, the PTS distributes on CDs all official documents of and presentations to the Commission and its subsidiary bodies at their sessions.

Number of States Signatories with secure accounts increases

Wide distribution of ‘NDC in a box’

Development of PRTool

Cooperation agreements with WMO and other international organizations

# Open and Democratic Organization

The PTS is, by virtue of its mandate and its very nature, an open and democratic organization. All of the IMS data and IDC products for which it is responsible are available to, and more importantly belong to, all States Signatories of the Treaty, irrespective of their size or nuclear capability. Therefore from the beginning a cornerstone of the work of the PTS has been the provision of open, equal, timely and convenient access to the data, products and services outlined in the Treaty and its Protocol. Various mechanisms have been put in place to enable all States Signatories to have easy access to these data, products and IDC services.

The openness and democratic nature of the organization has not only been demonstrated as part of its ongoing business in providing IMS data and IDC products. It has also been successfully tested through the response of the PTS to the various stress tests such as the announced nuclear tests in the Democratic People's Republic of Korea and the Fukushima nuclear power plant accident. This aspect of the PTS as an open and democratic organization is described at length in the chapter on performance and stress tests. The PTS has also been an open organization in a physical sense. To familiarize visitors as well as potential users with IMS data and IDC products, tours of the technical facilities of the organization have been regularly provided.

The commitment of the organization to openness goes beyond this technical mandate. It encompasses more broadly a long standing belief in transparency of its activities and its performance and a willingness to continuously improve how it operates, based on feedback derived from this transparency of information. This openness has been demonstrated through various means, for example periodic reporting on performance such as the annual Programme and Budget Performance Report (PBPR), internal audit, greater use of KPIs in the annual Programme and Budget, financial transparency, the public and secure web sites and the various external reviews.

As a result of this commitment to openness and transparency, the PTS has proven to be an organization that can be trusted to represent all States Signatories, providing transparent services and information. Another element of the PTS as an open organization is its close cooperation and sharing of information with other international organizations. A good example of this is the close and long standing working relationship with the WMO on ATM.


USA


NAMIBIA
NIGERIA
SENEGAL
CONGO
GABON


Canada
SEMINARIO DE PROMOCIÓN EN LA REGIÓN DEL CARIBE PARA LA RATIFICACIÓN DEL TRATADO DE PROHIBICIÓN COMPLETA DE ENSAYOS NUCLEARES
CIUDAD DE MÉXICO, DEL 11 AL 13 DE OCTUBRE DE 2006.


IRAQ
IRAN (ISLAMIC REPUBLIC OF)


POLAND

## AVAILABILITY OF DATA AND PRODUCTS

The core element of the PTS as an open and democratic organization is undoubtedly the fact that access to the IMS data and IDC products produced by the organization is available to all States Signatories. The Commission is one of the few international organizations that provides equal capability to States Signatories to enjoy the full benefits of participation in the Treaty as well as to contribute to decision making in the organization. Raw IMS data are provided for potential alternative interpretation.

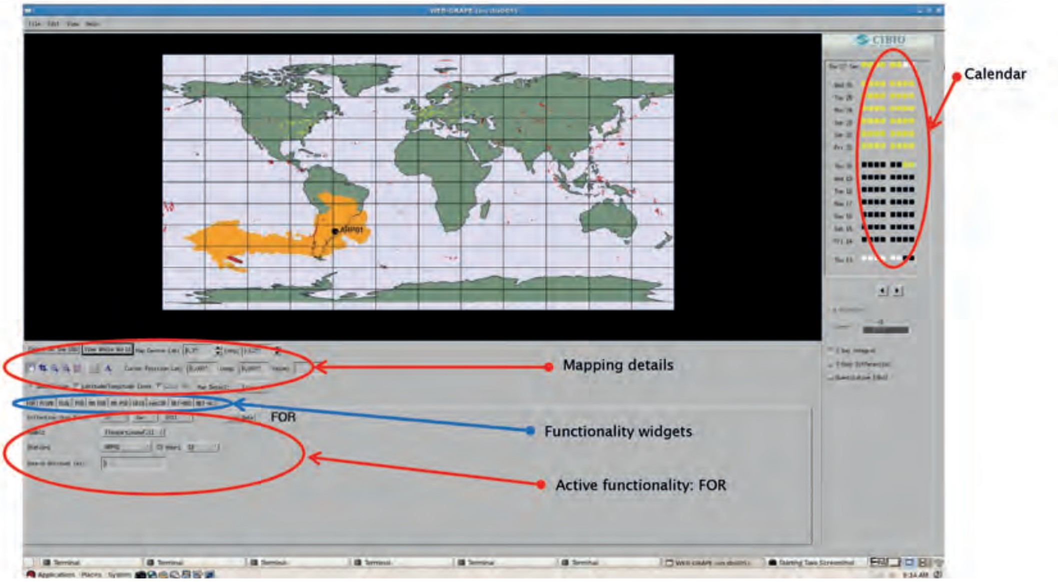
The primary mechanism developed by the PTS to provide easy access to IMS data and IDC products are secure signatory accounts. These enable each State Signatory to nominate a number of authorized users to access the data and products and to receive technical support from the IDC. The number of secure accounts and of authorized users has increased steadily over the years. By the end of 2011, there were 120 States Signatories with secure accounts and close to 1300 authorized users.

An extensive programme of capacity building and capacity development has underpinned this openness. The PTS has employed a number of tools in this regard to assist States Signatories to develop their capacity to use the IMS data and IDC products and to enhance their own expertise to verify the Treaty in preparation for its entry into force. These tools included training courses both in Vienna and at other locations around the world to enable States Signatories to take greater advantage of IMS data and the products and services of the IDC.

National seminar of the CTBT in Hanoi, Viet Nam, 16–17 December 2003.


Participants in a training course at the NDC in Accra, Ghana, November–December 2011.

The PTS has also placed emphasis on developing the NDCs in all States Signatories. This included providing 'NDC in a box' software which is available through the IDC secure web site or on CD or DVD on request. This software and associated documentation enable NDCs to review waveform data interactively and include additional software and documentation for receiving data in continuous data formats and for calculating waveform data availability. More recently, WEB-GRAPE, a software that provides NDCs with a tool to fuse waveform and radionuclide results through ATM to identify possible emission points




Screenshot showing the functionality of WEB-GRAPE.

on the globe for a detected radionuclide event, has been included as part of the 'NDC in a box' package. In addition, a more stable and reliable version of GeoTool, the software system for displaying IMS data, has been included. Radionuclide data software is also under development for eventual distribution to NDCs.

## AVAILABILITY OF ORGANIZATIONAL INFORMATION

Over the years the PTS introduced a number of tools to provide States Signatories with a high degree of transparency and a range of organizational information. These tools, which have been continuously developed, enhanced and improved, come in the form of documents as well as Web based mechanisms.

For example, the PBPR presents detailed information on programme and budget implementation for the preceding year and a full account of the activities and budgetary performance of the PTS. It provides a summary of allocation and utilization of resources by programme and subprogramme as well as actual achievements for each budget project. The achievements are measured against the expected results, with clear baselines, milestones and targets. Tables and figures are also included in order to make it easy to compare current performance with the performance in previous years.

The PBPR has been consistently recognized by the Commission, its subsidiary bodies and the Advisory Group (AG) for its high level of transparency and completeness. The AG noted in one of its recent sessions that the PBPR appeared to be without peer among other international organizations. By providing such in-depth information with a high degree of specificity, the PBPR has proven to be a valuable means for maintaining a robust and transparent interaction with the States Signatories on the performance of the organization. This interaction has helped identify areas that required further improvement. It has also assisted the Commission and its subsidiary bodies to review the progress made towards achieving the strategic goals of the organization.

Along with the PBPR, the annual Programme and Budget as well as the Accounts of the Commission are central elements of the efforts of the PTS to provide maximum transparency and accountability. This set of documents, taken as a whole, aims at giving States Signatories three main things: first, a clear and readable overview of progress by the PTS in carrying out the tasks assigned to it; second, a statement of financial management that is independently audited by the External Auditor; and third, a statement of proposed activities and priorities for the Commission for the following year. In addition to these broader documents, there is also the detailed annual report on human resource management and the annual report of Internal Audit to the Commission.



Covers of Programme and Budget and PBPR.

Over the years the PTS has demonstrated its commitment to a process of continuous improvement in its financial and programmatic reporting to the Commission as well as in its programme and budget planning. This is demonstrated by the incremental improvements that have been, and continue to be made to the various documents such as the Programme and Budget and the PBPR. These include, in particular, the addition of clearer and more focused objectives, expected results and KPIs. This results oriented approach provides a better basis for the PTS and States

Signatories to measure performance and to assess the progress of the Commission in fulfilling its mandated tasks.

To supplement these more traditional tools for reporting on organizational performance, the PTS has put a lot of effort into developing a Web based performance reporting tool, PRTool. This tool provides information on the performance of the verification system in near real time according to a range of KPIs. It therefore enables users to understand more readily how well the PTS is performing in a particular area of its work.

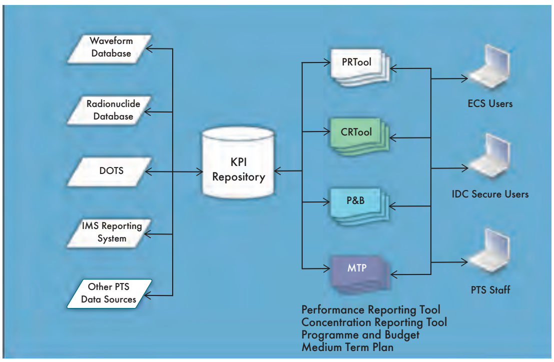


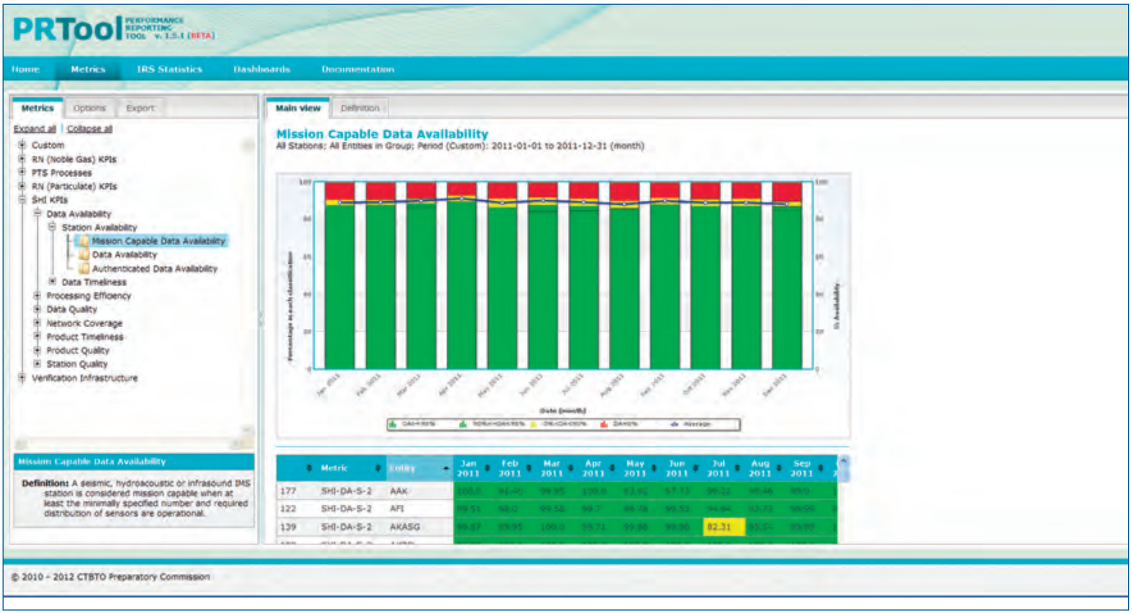

Diagram of the architecture of PRTool.

The capabilities of PRTool are being continually expanded. It is designed to enable various KPIs to be investigated by process and product and enables KPIs to be retrieved by date, geographical region or individual country, or even a specific IMS station. In other words, PRTool enables the PTS and its customers in States Signatories to assess the performance of the system at many different levels. PRTool therefore sets ambitious standards of transparency and accountability. It allows States Signatories to monitor programme implementation by the PTS, with the possibility of going back to any given year and making a judgement on the value gained for the resources invested. This interactive tool can be used to generate more than one thousand standard graphical presentations. States Signatories also have online access to performance information expressed in terms of the KPIs related to the strategic goals of the Commission.

The PRTool design proved its potential and flexibility after the Fukushima nuclear power plant accident. A new information technology application called CRTool, based on the design of PRTool and dealing with radionuclide concentrations and radioisotope ratios, was launched. Like PRTool, CRTool shows trends, histograms, maps and tables of values presented at IMS network and station levels for countries and regions. The graphical displays provided by CRTool were used during the briefings for States Signatories on developments related to the Fukushima nuclear power plant accident.

PRTool is the most tangible but by no means the only example of how the PTS has moved in recent years to providing system performance information online and in real time wherever possible. Another example is the fact that States Signatories have online access to performance information expressed in terms of the KPIs related to the strategic goals of the Commission. This access is enabled through hyperlinks in the Programme and Budget document for the respective year.

These innovative online tools are merely a continuation of the overall commitment of the PTS




Screenshot of the display produced by PRTool of the monthly average mission capable data availability for all waveform stations in operation.


Screenshot of the display produced by CRTool of the evolution of the activity of concentration of several nuclides recorded at radionuclide station RN38, Takasaki, Gunma, Japan, after the Fukushima nuclear power plant accident.

to transparency which has been evident from the beginning. Information on the status of the IMS, IDC and GCI had been available to States Signatories on the ECS at an early stage, for example information on the status of IMS station connection, GCI installation and GCI licensing. Moreover, monthly performance reports have provided States Signatories with information on over 50 performance related parameters.

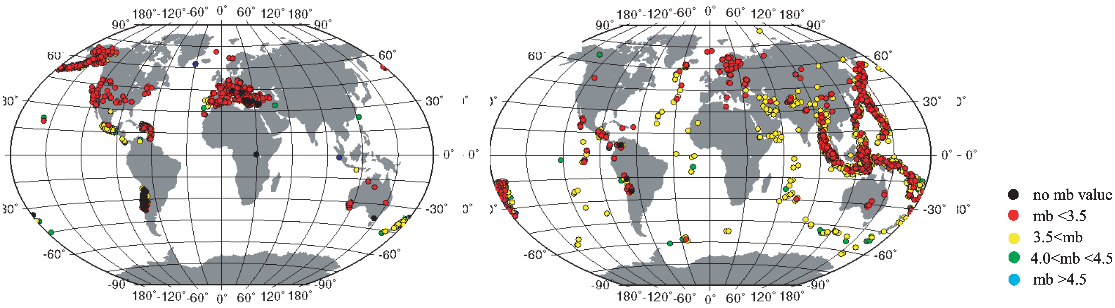
## PEER AND EXTERNAL REVIEWS

A number of peer reviews of the PTS were carried out over the last 15 years. These served to shed light on organizational performance and to identify measures to improve performance. They have therefore been a critical element in ensuring that the PTS remains an organization open to external and independent scrutiny, in addition to the more limited scrutiny provided by the External Auditor and by States Signatories as part of their usual responsibility for oversight.

Perhaps the most important peer review of the last 15 years was the review of the organizational structure of the PTS carried out in 2004/2005 by an external review team of experts from various States Signatories. Preceding this organization-wide review, there had been a number of separate peer reviews of the technical Major Programmes. In 2001, there had been an external review of the IMS Major Programme. In 2002, there had been an external review of the IDC Major Programme. In 2003, there had been an external review of the OSI Major Programme. These three external reviews produced important recommendations and suggestions for improvement and in this way had a significant influence on the further development of the PTS and how it carried out its mandate. An obvious example of this is the recommendation by the external review team looking at the OSI Major Programme that there should be a greater shift in emphasis towards a more decisive and integrated effort in OSI development, specifically towards the goal of a fully comprehensive field exercise. The outcome of this recommendation was ultimately the first IFE conducted in Kazakhstan in 2008.

Moreover, a major study of the personnel and management practices of the PTS was carried out by a consulting firm. The final report (the 'Cedar report') was released in January 2002. The PTS subsequently devoted considerable effort to addressing the issues raised in the report. Discussions involved managerial and other staff from the administration as well as from the verification Divisions. Issues addressed as a result of the Cedar report were, for example, the provisions concerning working hours and time recording, recruitment procedures, career development and the system governing performance appraisals and rewards.

In addition, a comprehensive review of the procurement related Financial Regulations and Rules of the Commission and the internal procurement procedures and practices of the PTS was carried out by an external consultant from January to April 2009. A general conclusion of this review was that the current procurement processes were too slow, lacking in flexibility for the operational requirements of the PTS and too legalistic, and that the Procurement Section was overburdened.




Comparison of NEIC bulletin and REB: overall results for April–May 2005.

The report containing the results and recommendations of this review was made available to all States Signatories were taken into account in subsequent review and improvement of procurement in the PTS. Many of the issues raised in this procurement review are still under discussion within the PTS and in the AG.

Another area where the PTS used an external review are the regular assessments of the quality of the REBs produced by the IDC through comparisons with bulletins of the International Seismological Centre and the National Earthquake Information Center (NEIC) of the United States Geological Survey. These assessments measure the accuracy and completeness of the IDC bulletin relative to the most comprehensive data sets available for global seismic event locations. Though the IMS seismic network is not yet complete, the assessments have consistently confirmed the high quality of IDC products.

## COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS

The PTS has also been an open organization in terms of its engagement from any early stage with international organizations on issues within its mandate. It has facilitated the conclusion of a range of cooperation agreements between the Commission and other international organizations.

The interaction between the PTS and the WMO is a good example of the open collaboration with other organizations that has taken place at the technical level. The agreement between the PTS and WMO entered into force in 2003. The PTS was invited to participate in a session of the WMO Nuclear Emergency Response Activities Coordination Group in Vienna in May 2006. At this meeting, the PTS proposed to create a joint CTBTO–WMO response system in the WMO Global Data Processing and Forecasting System.

Early in 2007, following a significant period of scientific and technical cooperation, the Executive Council of the WMO approved the inclusion of the CTBTO–WMO response system in its Global Data Processing and Forecasting System. In the third quarter of 2007, the PTS formally approached the WMO Secretariat to nominate Regional Specialized Meteorological Centres for atmospheric backtracking.

Since 1 September 2008, the CTBTO–WMO response system has been in provisional operation. This system has strengthened the atmospheric backtracking capabilities of the verification regime by enabling the PTS to send requests to the WMO for assistance in the case of suspicious radionuclide detections. Nine WMO Regional Specialized Meteorological Centres or National Meteorological Centres located around the world – in Beijing, China; Exeter, UK; Melbourne, Australia; Montreal, Canada; Obninsk, Russian Federation; Offenbach, Germany; Tokyo, Japan; Toulouse, France; and Vienna, Austria – respond to these requests by submitting their computations to the PTS as fast as is technically feasible with a deadline of 24 hours.

Atmospheric backtracking is the method applied by the PTS to resolve, to the best possible extent, the field of regard of Treaty-relevant (Level 5) radionuclide detections by the IMS. This method also provides the possible source regions associated with a scenario of such detections. The specialized WMO centres are the authorized external institutions that would attend to PTS requests for support in such Level 5 cases.

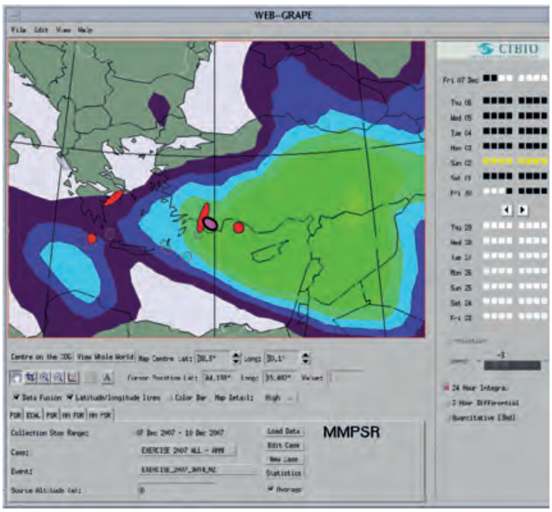
The PTS has also conducted focused exercises jointly with the WMO. For example, in December 2007, there was an exercise based on a recorded seismic event in Turkey. The exercise involved a hypothetical radionuclide release in order to test and evaluate ATM software developed in-house by the PTS. The joint venture is a prime example of how the harmonization of efforts by the PTS and WMO in this area is serving to benefit both organizations and their members.

**Relationship and Cooperation Agreements Concluded with Other International Organizations**

| International Organization | Date of Entry into Force |
|---|---|
| United Nations | 15 Jun. 2000 |
| United Nations Development Programme | 7 Dec. 2000 |
| Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean | 18 Sep. 2002 |
| World Meteorological Organization | 23 May 2003 |
| European Centre for Medium-Range Weather Forecasts | 24 Jun. 2003 |
| Association of Caribbean States | 7 Mar. 2005 |
| United Nations Educational, Scientific and Cultural Organization | 3 Feb. 2010 |
| International Computing Center | 17 May 2010 |
| World Food Programme | 2 Feb. 2012 |

Another example is the involvement of the PTS with the UNEG. This is a professional network that brings together the units responsible for evaluation in the United Nations system. It serves as the platform for United Nations agencies to discuss emerging evaluation issues as well as to produce specific deliverables that could be used by the United Nations system in their evaluation work. In 2005, UNEG adopted norms and standards for evaluation in the United Nations system, drawing from best practices of its members. They provide guidance for the establishment of the institutional framework, the management of the evaluation function, the conduct and use of evaluations and seek to ensure that evaluation entities within the United Nations follow common principles. They also provide a reference for strengthening and improving the quality of evaluation in all entities of the United Nations system.

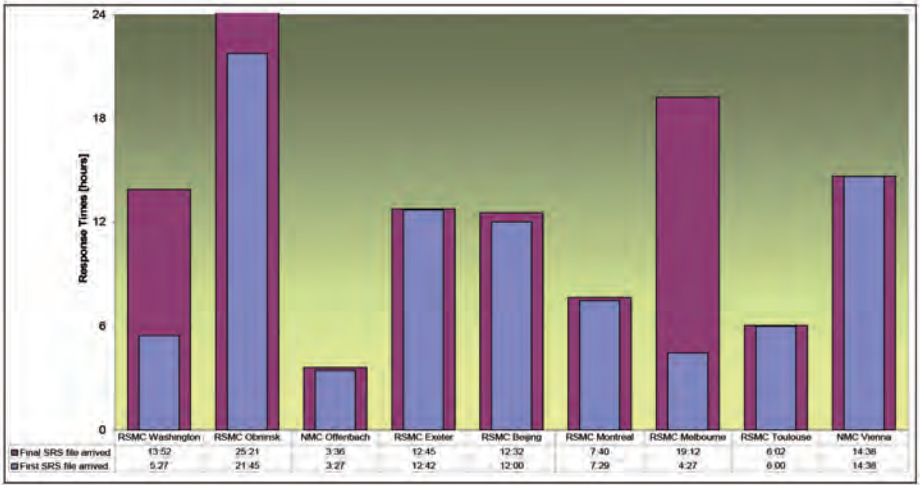

Regional Specialized Meteorological Centres that are part of the CTBTO–WMO response system.




Interactive source location analysis related to the CTBTO–WMO exercise in Turkey in 2007 using WEB-GRAPE.

The PTS has worked closely with UNEG in the development of its foundation documents and has consistently sought to apply UNEG foundation documents in its evaluation work. The PTS has shared evaluation practices and experiences with counterparts from other United Nations organizations. It has also played a leading role in annual general meetings and in the development of UNEG evaluation quality standards.

The 2010 annual meeting of UNEG was held in Vienna in early May, jointly sponsored by the PTS and all United Nations VBOs. This meeting was opened by the Executive Secretary who emphasized the key role of the evaluation function in fulfilling the provisions of the CTBT, namely monitoring, assessing and reporting on the overall performance of the verification system.




Response time of the nine WMO centres during the CTBTO–WMO exercise in Turkey in 2007.

## OSI DEVELOPMENT

In view of the highly technical nature of the technologies and techniques envisaged by the Treaty for use in an OSI after entry into force, combined with the limited resources available to the PTS in-house to develop these technologies and techniques, the PTS has necessarily had to be open to using outside expertise and contributions in kind. There are many examples showing that this has proven to be a highly successful collaborative approach. For example, the programme of equipment development has benefited from contributions of equipment from States Signatories. Moreover, outside expertise was important for the planning of the IFE in 2008. An expert advisory mechanism that brought together experts from outside and within the PTS. Regular workshops dealing with specific topics, such as development and testing of OSI equipment, elaboration of the draft OSI Operational Manual and results and lessons learned from field exercises, are used successfully by the PTS to bring in the knowledge and expertise of outside experts. The first workshop involving outside experts was held in July/August 1997.

Participants of OSI Workshop-9, Hiroshima, Japan, 30 June – 4 July 2003.

## INFORMATION SECURITY

The PTS has always sought to be as open as possible, on the basis that this is a principle of its mandate. It has been mindful of its responsibility to safeguard the information within its custody from inappropriate use. Information security has therefore been a priority while at the same time pursuing maximum transparency. This manifests itself by the fact that the PTS has a dedicated Information Security Manager position within the office of the Director of the IDC Division.

The PTS has progressively put in place measures to safeguard the integrity and availability of the information from IMS stations and to protect this information against unauthorized disclosure. Work on authentication of IMS data started already in 1997. This was to ensure that data received at the IDC from IMS stations truly represented the signals recorded at the station and that they had not been deleted and replaced by fake data. Another measure is the ongoing development and deployment of a Public Key Infrastructure. There is also an adequate level of electronic information security within the administrative and technical infrastructures of the PTS. Penetration tests have been regularly conducted with the aim of identifying potential weaknesses and taking corrective actions where necessary.

Policies and procedures on confidentiality are an ongoing issue for discussion by the Commission and in particular by WGB. The PTS supports this process of discussion by preparing, for example, background papers.

# Finance, Staffing and Management

- Introduction of split currency system
- Implementation of service limitation policy
- Continuous improvement in staff diversity
- Progressive introduction of RBM
- Effective management of PCAs
- Development of planning tools
- Approval of IPSAS-compliant ERP system

One indicator of the support that an organization enjoys is the continuing willingness of its members to provide it with the necessary financial resources. In this respect, the Commission, and by extension the work of the PTS, has continued to enjoy strong support and a solid reputation for quality.

Over the last 15 years there have, however, been significant financial and staffing challenges. These have been overcome or managed by the PTS, with the assistance and support of States Signatories, through a combination of financial prudence and a proactive approach to seek innovative solutions to specific problems. It has long been recognized in the PTS that the organization's greatest asset is its staff. For this reason great care is taken to ensure that highly qualified people with the right mix of skills are recruited while at the same time ensuring that the diversity of the staffing profile reflects as far as possible the membership of the Commission.

The human resources available to the organization can be seen in a much broader context. The wider CTBT community that has been built up over the last 15 years includes station operators, NDC staff, participants in technical meetings and meetings of the Commission and its subsidiary bodies as well as scientists working on issues related to the verification technologies of the Treaty, and policy makers involved in CTBT related issues and participates in OSI related activities.

Over the last fifteen years the PTS has demonstrated its capacity to adapt to changing circumstances, to keep abreast of trends in public management and to look for and apply management solutions to deliver the technical outcomes within its mandate effectively and efficiently. The strength of the management of the PTS has been underpinned by the leadership provided by the two Executive Secretaries that the organization has had so far.

A key aspect of the evolution of management practices in the PTS has been the progressive introduction of practices consistent with results based management (RBM). The PTS prepared the ground for a transition to RBM with the restructuring of the Medium Term Plan for 2009–2013 to make this multiyear planning document more strategic and results oriented. Additionally, a strategic planning framework with seven strategic goals was formulated. Improvements have also progressively been made, starting in 2009, to the Programmes and Budgets to include essential RBM elements such as outcomes, outputs and KPIs.

## FINANCIAL ISSUES

### Getting Started

At the beginning the PTS had been confronted with a number of major financial and budgetary tasks that are typical for any new organization. A Programme and Budget had to be prepared for 1998 at a time when there was still a lot of uncertainty about verification programme implementation. This work of the PTS was assisted by the expert advice of the AG, which, through its recommendations on the 1998 Programme and Budget, strove to develop an efficient management tool for the PTS while ensuring the necessary transparency to States Signatories.

A key financial task for the PTS in 1997 was to draft the Financial Rules of the organization to complement the Financial Regulations, which had been approved by the Commission in May 1997. This was again done with the close assistance of the AG and interested States Signatories. For example, the AG and States Signatories provided suggestions on the reduced assessment system, which allowed States Signatories to perform some or all of the work associated with the installation of an IMS station and to be reimbursed through a corresponding reduction in its assessed contribution for the year following the certification of the IMS station in question.

Given the initial lack of capacity in the Financial Services Section of the PTS, it was clear that many services would have to be outsourced. It was ultimately decided, however, that the PTS should have its own capacity to perform these functions. As of the beginning of 1998, the PTS took over the implementation of accounting, payments (including payroll), treasury and reporting operations previously outsourced to the IAEA.

In 2004, the PTS entered into a collaborative agreement with the United Nations Office on Drugs and Crime to implement and maintain the financial and personnel modules of the Integrated Management Information System.

To protect the organization from the adverse effects of currency fluctuations, the PTS implemented a split currency appropriation in 2005 and assessment system (US dollars and euros) while keeping a single currency (the US dollar) as the functional currency of the Commission.

### Financial Mechanisms

When drafting the Financial Regulations and Rules of the organization, the special requirements of building a global verification regime were taken into account. An example of this was the creation of the multiyear Capital Investment Fund (CIF). This fund enabled the organization to mitigate the constraints and limitations of an annual budget for projects involving IMS station building that required expenditure over a number of years and had inherent uncertainties about the timing of when work could proceed.

More recently, the CIF has shown its flexibility by proving to be an effective mechanism for ensuring the sustainment of the system that has been built so far. In 2006, at a time when almost two hundred IMS stations were certified, an important issue that emerged was how to provide optimal funding for the sustainment of this major investment. The Commission decided to approve the establishment of a financial mechanism for IMS sustainment within the CIF by dividing it into two separate parts: one for installation and one for sustainment.

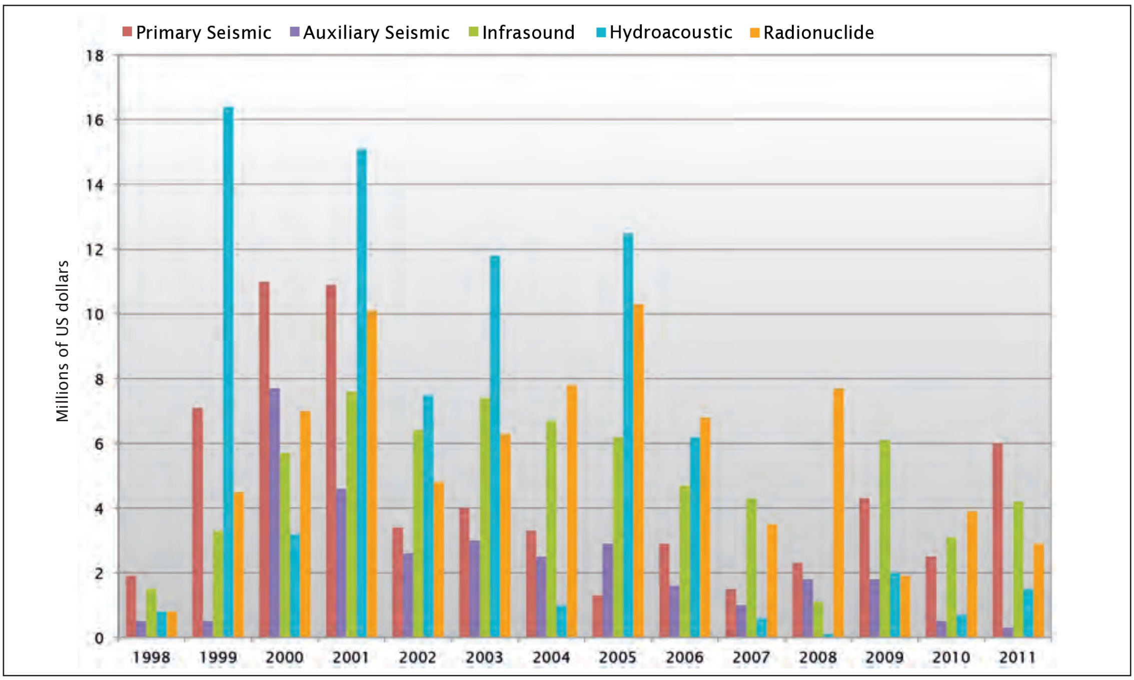
As provided for in the Financial Regulations and Rules, the PTS created special accounts to cover well defined projects that required multiyear funding but did not fall within the ambit of the CIF.

## Financial Constraints

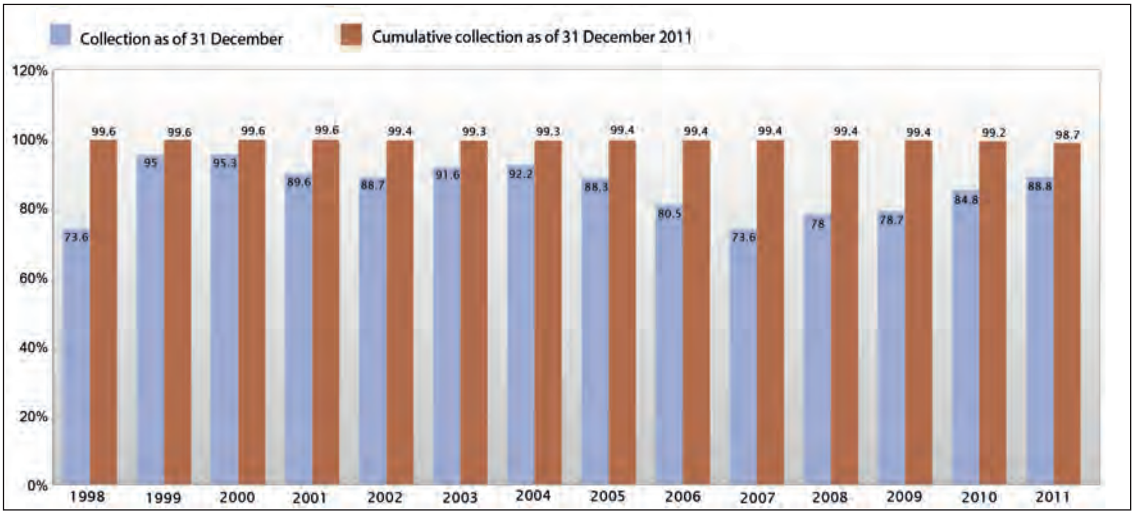
Since 2002, the PTS has been working with a zero real growth budget. This is against the background of a substantial increase in its workload. The PTS is still a growing organization, but with the same level of resources as when no IMS stations had been certified. It is an ongoing challenge to cope with the increasing demands within the mandate of provisional testing and operation and the constraints of zero real growth.

The PTS has already had to deal with difficult financial environments while continuing to deliver the expected results. An example was the period of austerity in 2007/2008 as a result of cumulative oustanding assessed contributions.

The financial difficulties encountered during this period were addressed by a continuation of the use of the contingency margin and measures to




CIF expenditure by IMS technology, 1998–2011.



Collection rates of assessed contributions in US dollar terms, 1998–2011.

improve the collection rate, and additional resources provided by States Signatories.

## Voluntary Contributions

Voluntary contributions have become an increasingly important component of the mix of financial resources available to the organization. These contributions initially represented a small fraction of the overall annual budget of the PTS but their level has continued to rise, particularly in recent years.

The PTS has consistently taken a realistic approach to voluntary contributions, never assuming that they would always be made available. It has therefore taken into account the risks involved in having core functions of the organization, such as the operation of some IMS stations, financed by voluntary contributions.

**Voluntary Contributions in US Dollars, 2005–March 2012**

| Year | Voluntary Contributions | Regular Budget | Voluntary Contributions as % of the Regular Budget |
|---|---|---|---|
| 2005 | 210 898 | 103 722 956 | 0.20 |
| 2006 | 224 566 | 106 622 493 | 0.21 |
| 2007 | 2 384 203 | 114 876 661 | 2.08 |
| 2008 | 1 727 941 | 120 033 328 | 1.44 |
| 2009 | 2 221 040 | 120 017 344 | 1.85 |
| 2010 | 3 481 790 | 119 266 308 | 2.92 |
| 2011 | 5 620 247 | 125 083 351 | 4.49 |
| 2012 | 35 948 570 | 129 372 462 | 27.79 |
| **Total** | **51 819 255** | | |

## STAFFING

### Human Resources Policies

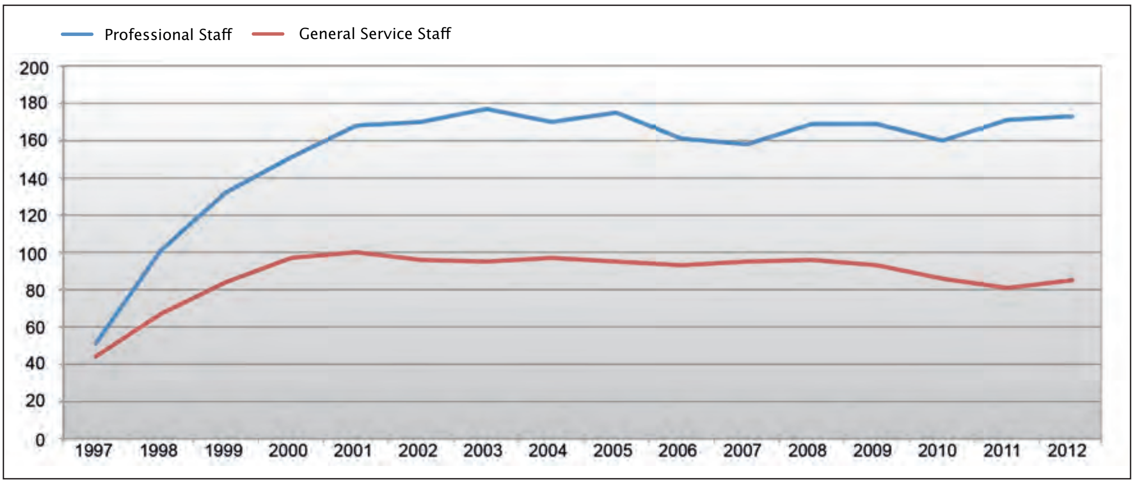
The PTS started its operations on the basis of the staffing regulations, rules and procedures of the United Nations common system. During the first three months of its existence, this was done with the administrative support of UNOV. Since the middle of 1997, however, all the personnel functions have been taken care of by the staff of the PTS. The need to adjust the regulations, rules and procedures of the United Nations common system to the requirements of the Commission caused the PTS to depart from the practice followed by other United Nations organizations in several areas. The Staff Regulations and Rules, which were considered and approved by the Commission in 1998/1999, reflected this hybrid approach.

### Recruitment

Recruitment in the PTS has been consistently based on securing the highest standard of professional expertise, experience, efficiency, competence and integrity. Due regard has been paid to the principle of equal employment opportunity and to the importance of recruiting staff on as wide a geographical basis as possible. These are the requirements set out in the Treaty.

In 1997, recruitment of qualified staff members was the major task for the Personnel Section, which was in the process of being established at the same time. This was vital to ensure that the expectations of States Signatories of a rapid start of the build-up of the verification regime could be met.

As a result of these major efforts by the Personnel Section and other PTS staff, the total number of

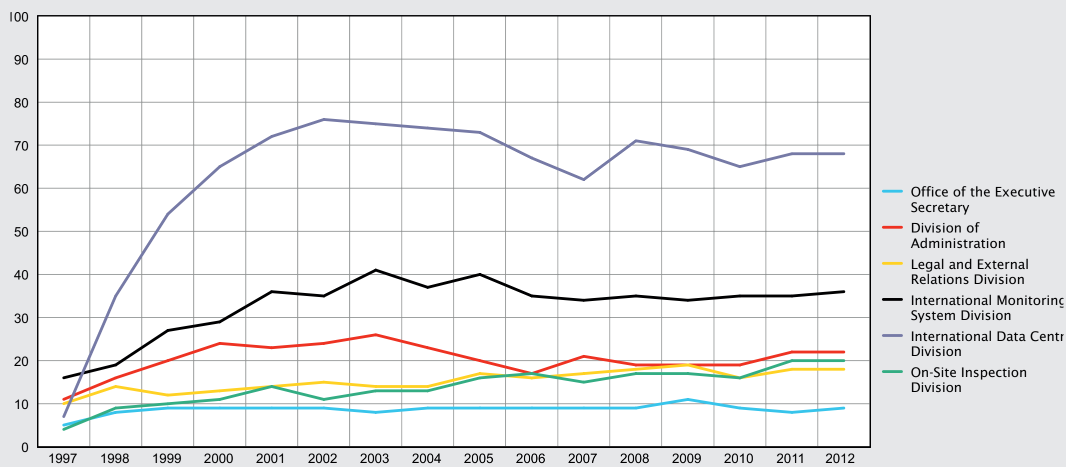



Number of Professional and General Service staff employed at the PTS, 1997–March 2012.

staff members of the PTS had reached 95 by the end of 1997, comprising 51 Professional staff and 44 General Service staff. There were also already 45 countries represented in the staffing profile.

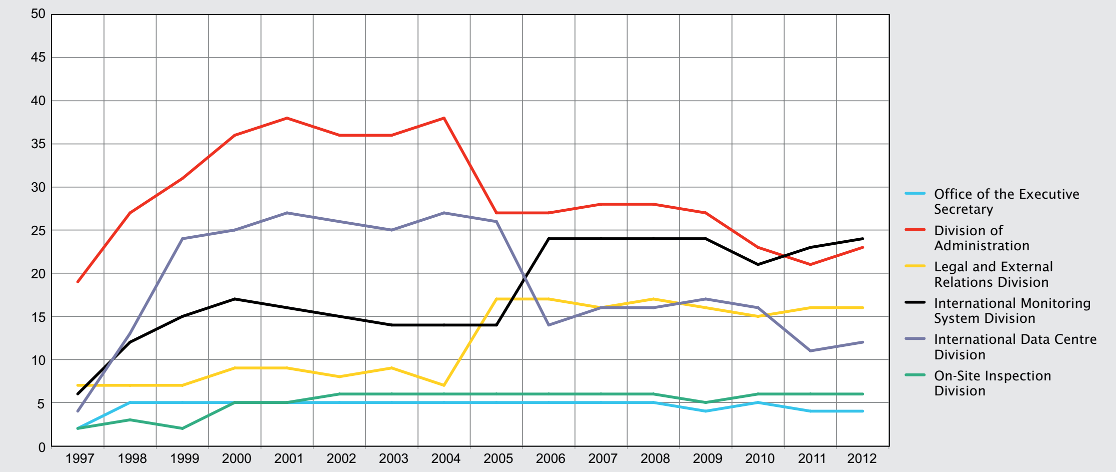
From an early stage the PTS conducted IDC training courses as a means to identify potential future PTS staff members. The objective of the IDC training courses was, and continues to be, to increase the pool and geographical distribution of possible candidates for future posts in the IDC Division. In addition to regular staff members, the PTS has brought in several experts seconded by States Signatories to perform specific tasks. This group includes cost-free experts (in 1999 there were 31) and Junior Professional Officers (JPOs). Those positions are financed by individual States Signatories for periods of one to two years. The first

| Division | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Office of the Executive Secretary | 5 | 8 | 9 | 9 | 9 | 9 | 8 | 9 | 9 | 9 | 9 | 9 | 11 | 9 | 8 | 9 |
| Division of Administration | 11 | 16 | 20 | 24 | 23 | 24 | 26 | 23 | 20 | 17 | 21 | 19 | 19 | 19 | 22 | 22 |
| Legal and External Relations Division | 10 | 14 | 12 | 13 | 14 | 15 | 14 | 14 | 17 | 16 | 17 | 18 | 19 | 16 | 18 | 18 |
| International Monitoring System Division | 16 | 19 | 27 | 29 | 36 | 35 | 41 | 37 | 40 | 35 | 34 | 35 | 34 | 35 | 35 | 36 |
| International Data Centre Division | 7 | 35 | 54 | 65 | 72 | 76 | 75 | 74 | 73 | 67 | 62 | 71 | 69 | 65 | 68 | 68 |
| On-Site Inspection Division | 4 | 9 | 10 | 11 | 14 | 11 | 13 | 13 | 16 | 17 | 15 | 17 | 17 | 16 | 20 | 20 |




Number of Professional staff members by Division, 1997–March 2012.

| Division | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Office of the Executive Secretary | 2 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4 |
| Division of Administration | 19 | 27 | 31 | 36 | 38 | 36 | 36 | 38 | 27 | 27 | 28 | 28 | 27 | 23 | 21 | 23 |
| Legal and External Relations Division | 7 | 7 | 7 | 9 | 9 | 8 | 9 | 7 | 17 | 17 | 16 | 17 | 16 | 15 | 16 | 16 |
| International Monitoring System Division | 6 | 12 | 15 | 17 | 16 | 15 | 14 | 14 | 14 | 24 | 24 | 24 | 24 | 21 | 23 | 24 |
| International Data Centre Division | 4 | 13 | 24 | 25 | 27 | 26 | 25 | 27 | 26 | 14 | 16 | 16 | 17 | 16 | 11 | 12 |
| On-Site Inspection Division | 2 | 3 | 2 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 6 |



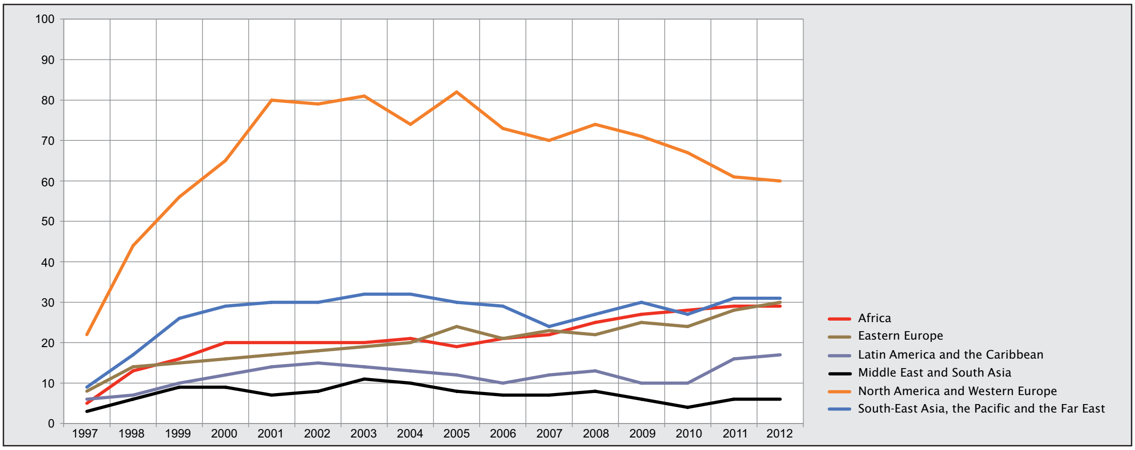

Number of General Services staff members by Division, 1997–March 2012.

such JPO, financed by the Italian Government, was appointed in 1999.

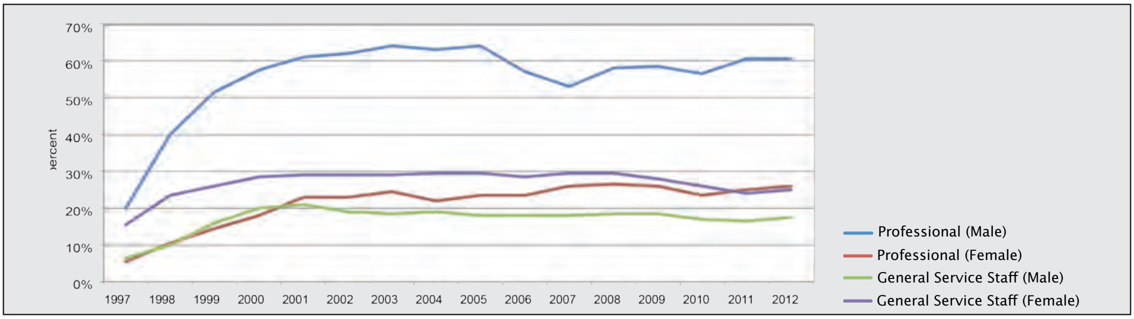
## Service Limitation Policy

The tenure policy established by the Commission sets a maximum length of service of seven years for Professional and internationally recruited General Service staff members, subject to certain exceptions.

At the beginning of the work of the PTS in 1997, little detailed thought was given to the implications of the service limitation policy introduced by the Commission because it was assumed that the Treaty would enter into force well before seven years had elapsed and that the PTS




Number of Professional staff by geographical region, 1997–March 2012.




Gender distribution at the PTS, 1997–March 2012.

would transform into the Technical Secretariat referred to in the Treaty. However, as entry into force of the Treaty did not take place as anticipated, it became clear that there was a need to find the best way to implement this policy. In 2003, the Executive Secretary made exceptions to the tenure limitation and extended beyond seven years the period of appointment of some staff members in order to retain essential expertise and memory.

Subsequently, in 2005–2006 the PTS introduced a system for implementing the policy within the framework of the Treaty, the Regulations and Rules and Administrative Directives.

Notwithstanding the authority of the Executive Secretary to make exceptions to the service limitation policy in specific cases, the high volume of rotation engendered by the service limitation policy has inevitably led to a loss of memory and expertise and to a certain degree of disruption in the ongoing work of the PTS. A major challenge for the organization has therefore been to preserve the accumulated knowledge of staff and maintain the institutional memory of the organization.

### Diversity and Gender

In the recruitment process the PTS has assiduously paid due regard to the principle of equal employment opportunity and to the importance of recruiting staff on as wide a geographical basis as possible. It has not been a simple task to ensure an adequate representation of women, particularly at the Professional level in the technical areas of the organization. To address this, discussions have been held continuously with States Signatories regarding ways to encourage female candidates to apply for vacant positions.

The PTS has a level of representation of women that compares favourably with other, comparable technical organizations. At the end of 2011, there were 50 women in Professional positions, corresponding to almost 30% of the Professional staff and there was 20% female representation at the Director (D-1) level in 2011. The latter increased to 40% in 2012.

### Staff Skills and Training

The knowledge, profiles and skills required of PTS staff have changed at the same time as the nature of the work carried out by the organization has changed. Initially, PTS staff in the technical areas were predominantly scientists. However, progressively more and more engineers and logisticians have been recruited, as the focus has gradually switched from build-up of the verification system to its provisional operation, maintenance and sustainment.

From the beginning the PTS has placed great emphasis on training of staff to continuously develop skills and competencies and to support a learning culture in the organization, including a structured programme of coaching and mentoring by managers.

### Staff Council

The Staff Council, as the entity in the organization mandated to represent the interests of staff, has played a key role in the development of staffing policies and procedures and in ensuring that the interests of staff are safeguarded in the implementation of these policies and procedures. For example, representatives of the Staff Council have been, and continue to be, consulted on the development of new policies and procedures as well as proposals for changes to the Staff Regulations and Rules. Moreover, the Staff Council is represented on every panel convened to consider whether or not a staff member who has reached the end of her/his service limit should be recommended for an exceptional extension in the event that a well qualified candidate is not identified.

## MANAGEMENT

### Planning

A significant challenge for the PTS has been the implementation of a planning process that will ensure readiness to deliver a verification regime at entry into force of the Treaty.

It was essential at an early stage to develop and present to the Commission detailed plans for the commissioning of the IMS and of the IDC. These plans formed the basis of the technical work to build up the verification system.

Another early planning tool was the Programme Options Memorandum (POM), the first of which covered the period 2000–2004. The purpose of this planning document was to present as concisely as possible a plan for the translation of the mandate of the Commission into the programmes of the PTS. The next step in the development of the approach of the PTS to planning was the Medium Term Plan, the first of which covered the period 2005–2009.

Over the years the PTS has developed a range of internal planning tools to complement the higher level planning contained in the POM, the Medium Term Plan and even the annual Programme and Budget.

In the first quarter of 2011, as part of the development of the initial draft Programme and Budget proposals for 2012, the PTS undertook for the first time an assessment of the resource requirements to carry out priority activities of the Commission.

In 2012, the PTS went one step further and initiated a process to plan and track the implementation of the 2012 Programme through detailed planning and delivery of the individual products of the organization. A new database and online tool were developed specifically for the purpose of supporting this product planning and tracking exercise.

Planning has also been a crucial component of the work of the PTS in the field of OSI. For example, an OSI strategic plan was developed by the PTS in July 2004 and was revised at the beginning of 2006.

The next key milestone in planning the work of the OSI Major Programme was the development by the PTS of an OSI action plan. This was the result of a detailed review and follow-up process that sought to derive lessons from the experience gained in the IFE conducted in Kazakhstan in 2008.

At the beginning of 2011, the PTS presented a document describing necessary adjustments to the OSI action plan in order to harmonize it with the new concept developed by the PTS for the preparation and conduct of the next IFE in 2014.

## Project Management

Various methodologies for project management at the PTS were used in the initial stages, but there was no overarching approach, philosophy or project management tool that was used consistently across the organization on technical and non-technical projects. It was not until 2003 that a standardized, coordinated approach was first introduced with the establishment of a 'project office' in the IDC Division.

Since then a more robust and professional project management culture has been introduced. In 2010, a new information technology system for project management was rolled out across the PTS.

## Evaluation and Quality Management

The work to develop evaluation and quality management within the organization began in 1997. It followed the recommendation of WGB that Evaluation provide for an ongoing evaluation of the processes, procedures and products of the verification related programmes, including IMS station performance issues and the IDC treatment of data and derivation of products, as well as for the development, implementation and maintenance of quality assurance measures for the PTS.

A first version of a Quality Manual was produced in May 2000. An important milestone in the development of the QMS of the PTS was the commitment by the Executive Secretary to a quality policy in 2006. This policy stated that the purpose of such a QMS was to ensure the implementation of continuous and reportable quality measures to provide the States Signatories and the Commission with the necessary confidence in the products and services of the verification system operated by the PTS.

A cornerstone document of the QMS is the Process Metrics Manual, which compiles a top-down structure of all processes, their outputs, associated metrics and KPIs and the methods to compute them. A number of Quality Management workshops involving PTS staff and States Signatories have been held at regular intervals. The first of these was in November 1999 in Vienna, addressing the status of the establishment of a quality assurance system for the CTBT verification regime.

## Management Cooperation with Other Organizations

In many management related areas, the PTS has cooperated closely with the other VBOs. This

Participants of the Quality Management workshop held in Vienna, 2006.

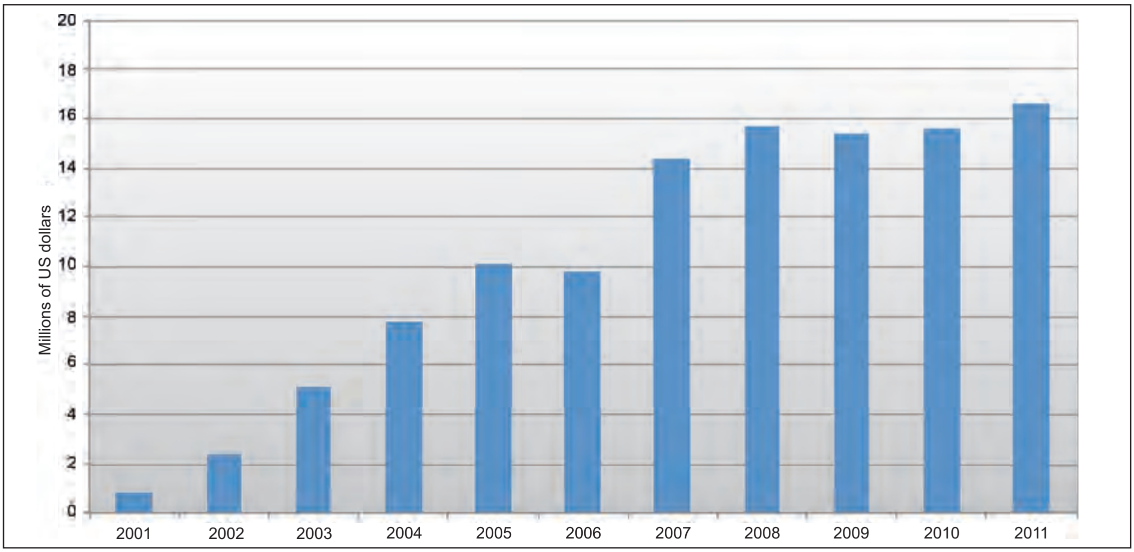
was important at the beginning of operations. In 1998, the tripartite agreement on Joint and Common Services in the VIC, which included such services as buildings management and medical services, was modified to admit the Commission as a full partner without the usual proviso of having to provide one of the services. This was an important step in ensuring that the Commission was treated as an equal by the other VBOs.

There has been good cooperation between the PTS and other VBOs in the area of management of conference facilities. An example of this cooperation was the process of building additional conference facilities. The new conference facilities were used for the first time by the PTS for a session of WGB at the beginning of 2010. This was followed by joint consideration of a draft agreement on the future use of conference facilities at the VIC.

Although the Commission has never been part of the United Nations common system, it has been involved in various United Nations bodies dealing with management related issues. For example, the PTS has been involved in the United Nations High Level Committee on Programmes and the United Nations High Level Committee on Management on issues such as security, information technology and human resources.

## Post-Certification Activities

For the PTS ensuring good management has meant not only paying attention to ensuring good internal management but also putting in place the most appropriate management structures, procedures and tools for the management of the IMS network. This has been achieved through various initiatives to improve the management of contracts for post-certification activities (PCAs).




Post-certification expenditure, 2001–2011.

PCA contracts represent the fixed cost contracts between the PTS and station operators to cover expenditure associated with the O&M of primary IMS stations after certification. Good management in this area has been essential because PCA costs represent one of the highest fixed costs within the budget of the organization and are steadily increasing. The approach taken by the PTS to PCAs has promoted consistency and objectivity in the O&M of the IMS stations.

## Enterprise Resource Planning

In 2009, the PTS made proposals to the Commission on moving to a new Enterprise Resource Planning (ERP) system. One important consideration was the proposed introduction of International Public Sector Accounting Standards (IPSAS). This proposal was based on an assessment of the advantages to the organization from the adoption of such accounting standards.

Following a lengthy process supported by the PTS, the Commission in November 2010 approved the budget for a project to develop and implement an IPSAS-compliant ERP system through partnership with an international organization. After careful analysis of various international organizations, the PTS identified the World Food Programme as the most suitable partner.

## Internal Audit and Oversight

The Office of Internal Audit in the PTS was established on 1 December 1997. Over the years the Internal Audit function has grown and been progressively empowered.

In 1998, the first PTS Internal Audit Charter was prepared setting out the terms of reference, purpose, authority and responsibility of the function. The Charter was updated in 2010 in order to clarify and strengthen its mandates and authority, and to further enhance its independence and objectivity.

Over the years, Internal Audit mandates evolved from conducting audit or assurance activities to a wider scope covering investigation and advisory services to support management in improving the performance and operations of the PTS. To further ensure its independence starting in 2005, Internal Audit has prepared annual reports to the Commission on its activities.

One way to illustrate the commitment of the PTS to strengthening oversight is the evolution of resources allocated to Internal Audit over the years. From 1998 to 2003 the annual budget was between $228 000–280 000. This figure increased to $525 000–692 000 from 2008 to 2012.

Overall, some 500 internal audit recommendations have been issued to the management of the PTS to improve its processes, internal controls, risk management and governance processes.

Since 2000, the Chief of Internal Audit has been a member of the network of the Representatives of Internal Audit Services of the United Nations Organizations.

# Civil and Scientific Applications

Relevance of IMS technologies for non-verification purposes recognized

Tsunami arrangements/ agreements signed with a number of States Signatories

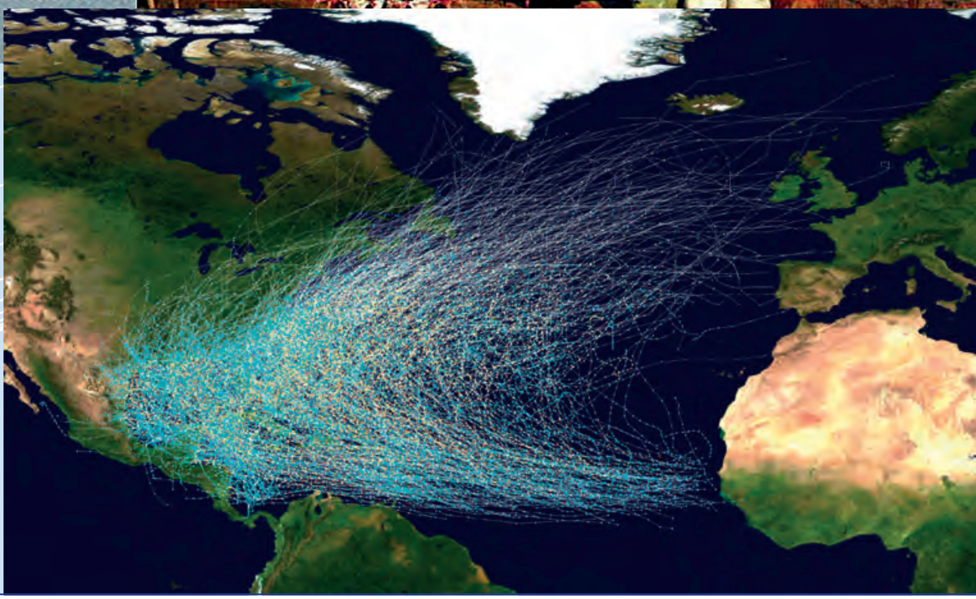
Contribution of IMS data for tsunami warning purposes

The primary purpose of the verification system is to ensure the verifiability of the Treaty. Nevertheless, the potential of the IMS and the technologies of the Treaty to be used for purposes other than verification has been recognized from an early stage. Already in 2002 there was the first of a series of experts meetings, with PTS participation, to review and explore new potential benefits for the application of verification technologies for civil and scientific uses.

CTBT verification technologies have diverse and useful civil and scientific applications that could serve human welfare and contribute to scientific research, sustainable development and civil safety. Some civil applications of the verification technologies are of particular humanitarian value mainly in the area of disaster mitigation and relief efforts.

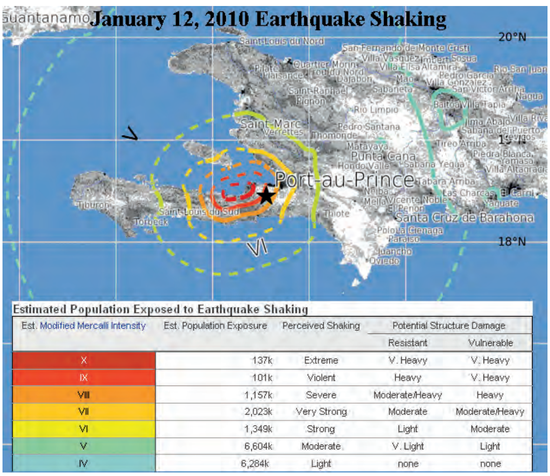
Civil and scientific applications of the Treaty technologies can serve to demonstrate to States the wider benefits to States of participating in the verification regime of the Treaty and in efforts to build it. There is therefore a relationship between this issue and efforts to secure further ratifications of the Treaty. Some countries may look at security in a wider sense and take into account the benefits of the Treaty beyond verification when deciding to join the CTBT. In this way, the civil and scientific applications of the Treaty technologies help to promote both the political and scientific acceptance of the Treaty.

Training programmes provided by the PTS in CTBT related technologies have provided a unique opportunity to build a strong national capacity in terms of human resources ranging from data analysis, station operation and NDC management to the training of OSI inspectors. There has been an ongoing debate about the use of the verification system and its data for civil and scientific purposes. This debate has centred around the potential use of all four of the Treaty technologies as outlined below. The PTS has supported, and will continue to support, States Signatories in their exploration of the extent to which the benefits of IMS data can be used beyond the area of verification.



## SEISMIC TECHNOLOGIES

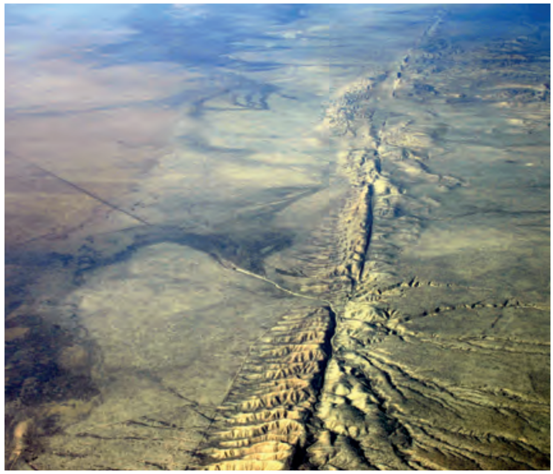
The PTS and States Signatories have recognized the potential contribution of seismic technologies under the Treaty for civil and scientific applications. For example, in the field of earthquake monitoring and response, the availability of real time IMS seismic data to national and international earthquake monitoring efforts would greatly improve the accuracy and timeliness of reports on earthquake location and magnitude. In the case of large earthquakes, these reports could be used to direct the emergency response and relief efforts. IMS seismic data could also contribute to efforts to estimate the size and frequency of aftershocks following large earthquakes. In addition, IMS seismic data could be used to produce preliminary maps of the seismicity and distribution of strong ground shaking in the area following destructive earthquakes. These shaking maps could be used to assess the scope of a disaster and plan emergency response efforts.




Estimated Population Exposed to Earthquake Shaking

| Est. Modified Mercalli Intensity | Est. Population Exposure | Perceived Shaking | Potential Structure Damage: Resistant | Potential Structure Damage: Vulnerable |
|---|---|---|---|---|
| X | 137k | Extreme | V. Heavy | V. Heavy |
| IX | 101k | Violent | Heavy | V. Heavy |
| VIII | 1,157k | Severe | Moderate/Heavy | Heavy |
| VII | 2,023k | Very Strong | Moderate | Moderate/Heavy |
| VI | 1,349k | Strong | Light | Moderate |
| V | 6,604k | Moderate | V. Light | Light |
| IV | 6,284k | Light | none | none |

Shaking map of Haiti produced after the earthquake of 10 January 2010 (USGS).



San Andreas fault, California, USA.

The seismic technology of the Treaty and IMS seismic data could be used for the assessment of earthquake hazards on a global and regional scale by providing information on the location and magnitude of earthquakes. These assessments could provide maps of expected strong ground shaking during various exposure times (50, 100, 250 years). These estimates could be used in building codes and in the development of earthquake resistant design and construction practices.

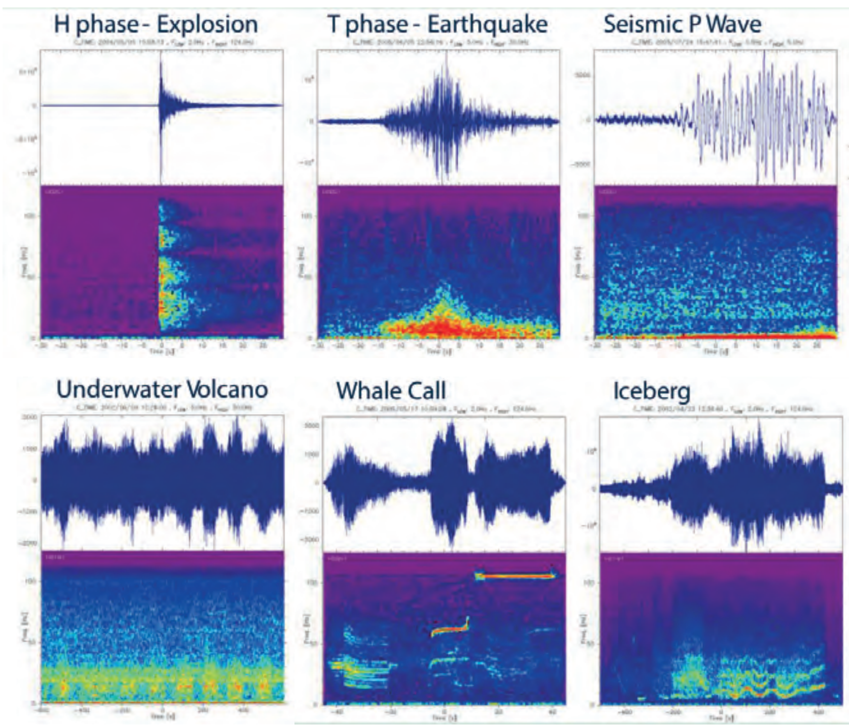
Finally, data from the network of IMS seismic stations could be used in scientific research on the internal structure and properties of the earth. IMS data could also be used to study the earthquake processes, the distribution of stress active at the earthquake source, the geometry and orientation of the causal fault, and the physics of fault breakage or rupture. In addition, the accurate determination of the location of earthquakes by the IDC could be used to identify and outline the active tectonic features of a region. Although these are general topics of research, the results of this research could be used to improve earthquake hazard assessments and the capabilities of the IDC itself.

## HYDROACOUSTIC TECHNOLOGIES

The 11 stations comprising the IMS hydroacoustic network could also potentially contribute to a range of civil and scientific goals. The scarcity of other facilities similar to the IMS hydroacoustic stations makes their data especially valuable.

For example, an IMS hydroacoustic station could be used to monitor the interior of the ocean. This could lead to improved understanding of ocean processes, such as ocean currents and temperature changes. The improved understanding of ocean processes could then lead to civil benefits in such areas as weather prediction and climate change. Data from the highly sensitive hydrophone based IMS stations could also contribute to an improved understanding of the seismicity of mid-ocean ridges and underwater volcanoes in general.

The background noise of the ocean could also be studied using data from hydrophone based IMS stations. Benefits include the scientific understanding of ocean noise and how it changes over time, for example with the changes in




Acoustic spectra of specific sounds produced by different phenomena.

shipping patterns. This measurement is of environmental relevance as the background noise of the ocean has implications for the use of ocean sound by marine species. The noise made by whales can be monitored by the stations at large distances. The benefits here include monitoring of the size of whale populations.

The T-phase stations can be useful in developing a better scientific understanding of the process of conversion of hydroacoustic energy to seismic energy at the interface between the ocean and land. A T-phase is an acoustic wave resulting from an earthquake that travels through the ocean. T stands for tertiary because these waves travel slowest and arrive third (after the P, primary waves, and the S, secondary waves). This is a process that is not yet well understood at present.

This is by no means an exhaustive list of possible uses of this technology for civil and scientific purposes. Various other possibilities for using the data from the IMS hydroacoustic stations could be explored, such as tracking the position and intensity of distant storms and monitoring iceberg activity.

## INFRASOUND TECHNOLOGIES

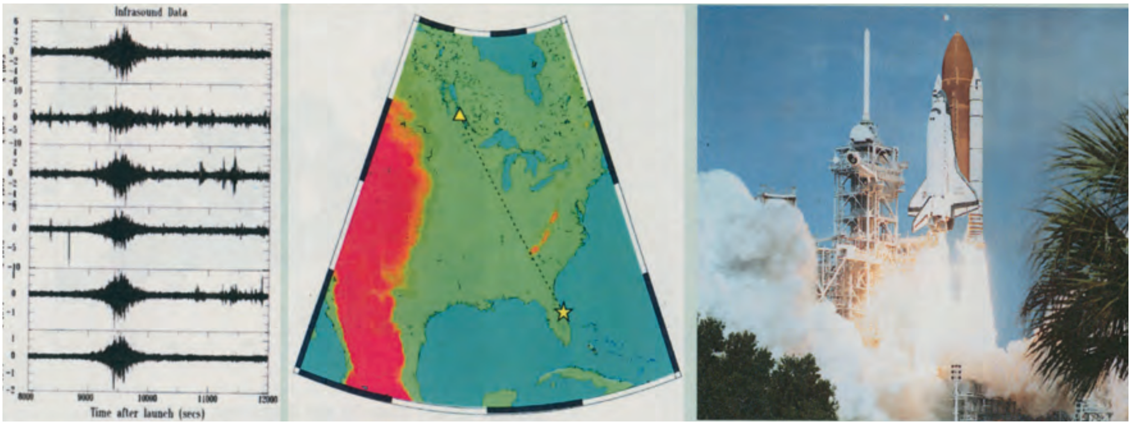
The IMS infrasound network detects on a regular basis sources of infrasound waves, among them meteor impacts, volcanic eruptions and supersonic aircraft, including space shuttle re-entries and rocket launches, chemical and nuclear explosions, helicopters, city hum, earthquakes, microbaroms, severe storm systems, auroras, sprites and mountain waves.

An example of a civil application of the IMS infrasound network is the detection of volcanic explosions. This information could assist aviation in their routeing to avoid volcanic ash in jet engines.

There is also a range of scientific applications of the infrasound technologies and the data from the IMS infrasound stations. For example, since the atmosphere is the medium of transport for infrasonic waves, data indicating their propagation path could lead to new knowledge in the area of meteorology through a better understanding of the dynamic processes in the high atmosphere where measurements are scarce. This relationship between IMS infrasound technology and meteorology is also potentially a two way process for scientific study. The knowledge of the atmosphere will make travel times and yield estimation more accurate in the use of infrasound for Treaty monitoring purposes.

The archive in the IDC in Vienna will also progressively become more valuable for scientific

Ash plumes from the Cleveland volcano on the Aleutian Islands on 23 May 2006. The event was short-lived; 2 hours later the plume had completely detached from the volcano. A major eruption could have caused great problems for aviation.




Unusual large amplitude signal observed at infrasound station IS10, Lac du Bonnet, Canada, on 27 May 1999 at a distance of 2600 km from the launch of the space shuttle Discovery.

research as a reliable high quality worldwide database of infrasound data.

## RADIONUCLIDE TECHNOLOGIES

Looking back at the Fukushima nuclear power plant accident in 2011, earlier discussions among experts about the civil and scientific applications of the CTBT radionuclide technologies appear prescient. It was noted early on that the CTBT radionuclide network would be able to significantly contribute to the collection of information after small, medium size or catastrophic nuclear accidents. It was also recognized that, while the IMS radionuclide network was not designed to be a tool for emergency response activities, the radionuclide measurement data could be useful for the validation of the dispersion modelling issued by regional specialized meteorological centres of the WMO that have a recognized mandate for 'around the clock' operational response to accidental releases of potentially hazardous material. This support in terms of global mapping of radioactive material dispersion is particularly important in regions where the IMS network provides the only monitoring capability and where even its meteorological measurements have the potential to improve weather forecasting.

The radionuclide network that is being developed by the PTS could also make significant scientific contributions. For example, it is leading to a better understanding of background radionuclide levels in general and especially in very remote areas of the world. The large and constantly growing archive of radionuclide filter samples from IMS stations could be important for scientific institutions doing research on worldwide background radioactivity levels, climate diagnostics or the long range transport of pollutants or biochemical agents. It also raises possibilities to study changes over time in minute biological species collected on the filters. Atmospheric and meteorological sciences could benefit, for example, by providing experience for pollution research and contributing to benchmarking atmospheric transport models.


Examples of remotely located radionuclide stations. *Left*: RN77, Wake Island, USA. *Above*: RN56, Peleduy, Russian Federation.

Ground penetrating radar being used to search for underground objects at an archeological site.

The IMS network will also continue to pioneer sampling and analysis methods.

## OSI TECHNOLOGIES

Actual OSIs can, of course, be conducted only after the entry into force of the Treaty. They are expected to be rare events, politically sensitive and conducted under strict constraints. For this reason, their scientific and civil applications as such would be marginal. On the other hand, an OSI is based on a broad range of technologies widely used for various scientific and civil purposes. Improvements in technologies and equipment required for OSI purposes could therefore be utilized for enhancing their applications in areas not directly related to OSI. Examples of areas where OSI related technologies and techniques could have civil applications include exploration of natural resources, e.g. oil, mineral deposits, water resources; geological survey for the purposes of building and industrial construction, mining and other industrial purposes; the survey and study of mines and underground structures to support their safe functioning; and the search for small underground buried objects of unknown location, e.g. pipelines.

The scientific applications of OSI related equipment and techniques include geophysical survey and acquisition of data about the structure and properties of the upper layers of the Earth's crust and physical processes within these layers.

## 2004 SUMATRA EARTHQUAKE AND RESULTING TSUNAMI

The use of IMS data to mitigate the catastrophic consequences of tsunamis is an example of the potential civil and scientific applications for which these data could be used.

The defining event in this regard was the earthquake off the coast of Sumatra in December 2004 and the resulting tsunami in the Indian Ocean. This tragedy, which killed hundreds of thousands, triggered intensive discussions on whether the Commission could contribute to the prevention or mitigation of such disasters. The PTS was active in supporting these discussions. In March 2005, at a special session, the Commission tasked the PTS to explore and assess which IMS data and IDC products might be useful and could be provided for tsunami warning purposes. At the same time it expressed its willingness to contribute to a tsunami warning system. Thereafter, the PTS began forwarding data on a test basis to tsunami warning centres in Japan and Hawaii.

During this test phase, which lasted over a year, a number of tsunami warning institutions received IMS data in near real time. These tsunami warning centres confirmed the usefulness of IMS data. In comparison with data from other existing monitoring networks, IMS data were found to arrive at these tsunami warning centres with less delay and higher reliability. This provided potentially vital additional warning time in which to activate alerts in the event of a possible tsunami threat.

Following the test phase conducted by the PTS, the Commission took a decision in November 2006 to provide real time and continuous data


Executive Secretary TIbor Tóth and Irina Bokova, Director-General of UNESCO, after signing an agreement to enhance cooperation between the two organizations, especially for tsunami warnings.

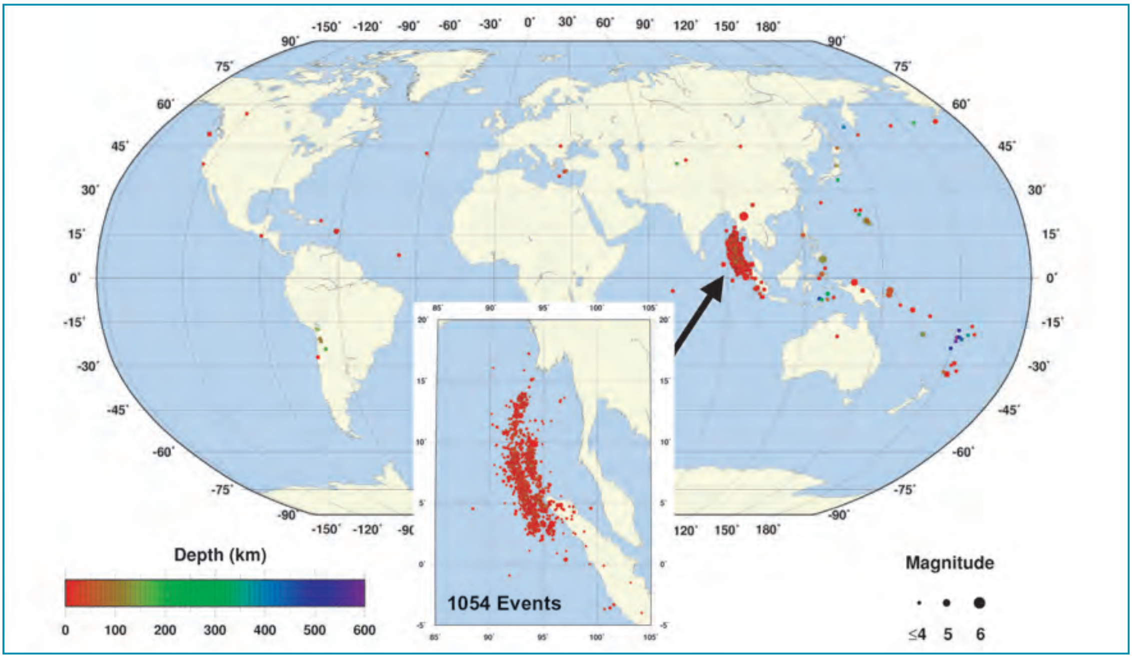
to relevant tsunami warning organizations. The Commission subsequently entered into agreements or arrangements with a number of tsunami warning centres approved by the United Nations Educational, Scientific and Cultural Organization (UNESCO) to provide data for tsunami warning purposes. The first arrangement was concluded with Japan, where IMS data were used during the March 2011 Tohoku earthquake and tsunami. The decision to provide IMS data for tsunami warning purposes was a significant step for the Commission. The long and sometimes difficult discussions that led to this decision showed clearly the fine balance between promoting the primary purpose of the verification system while at the same time responding to a clear humanitarian need. It has enabled the PTS to demonstrate to States Signatories and to the broader community both the relevance of the IMS network for non-verification purposes as well as the ability of the system to perform.


Signing of a tsunami warning agreement between the CTBTO Preparatory Commission and Japan on 11 August 2008 in Vienna: Ambassador Yukiya Amano, Permanent Representative of Japan to the International Organizations in Vienna, and Executive Secretary Tibor Tóth.

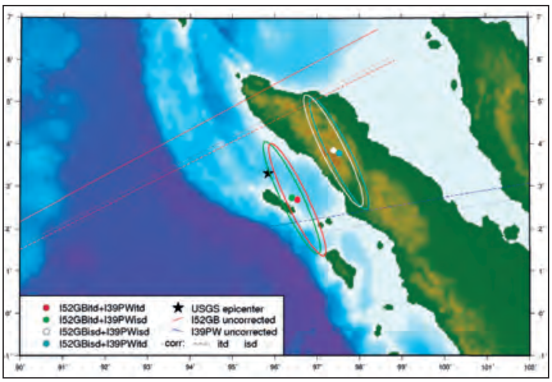
**Tsunami Arrangement/Agreements with States Signatories (as of 17 March 2012)**

| State | Date(s) of Signature | Date(s) of Entry in to Force |
|---|---|---|
| Japan | 11 Aug. 2008 | 11 Aug. 2008 |
| Australia | 12 Sep. 2008 | 12 Sep. 2008 |
| Philippines | 12 Sep. 2008 | 12 Sep. 2008 |
| USA (Alaska) | 8 Oct. 2008 | |
| | 22 Oct. 2008 | 22 Oct. 2008 |
| Indonesia | 10 Nov. 2008 | 10 Nov. 2008 |
| USA (Hawaii) | | 13 Mar. 2009 |
| Thailand | 9 Apr. 2009 | 27 April 2009 |
| | 27 Apr. 2009 | |
| France | 18 Nov. 2010 | 1 Apr. 2011 |
| Turkey | 3 Mar. 2011 | (Pending) |
| Malaysia | 17 Jun. 2011 | |
| | 18 Aug. 2011 | 18 Aug. 2011 |

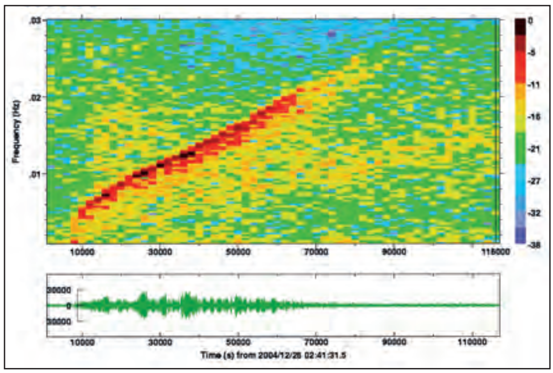
The Sumatra earthquake also represented a stress test of the IMS seismic network and of IDC processing. Some 2000 aftershocks of this earthquake tested the automatic and interactive processing of data in the IDC under stress. The way the IDC dealt with this large number of aftershocks provided a basis for a review of options to deal with future exceptional levels of seismicity.




The IDC REBs of 26 and 27 December 2004 include 11 137 events of which 1054 events (insert) were aftershocks of the Sumatra tsunamigenic earthquake.




Infrasonic locations for the 26 December 2004 Sumatra earthquake using IS39 and IS52 detections with and without atmospheric corrections. (Reprinted with permission of M. Garcés.)




Spectrogram of the 26 December 2004 tsunami recorded at hydroacoustic station HA8 (BIOT/Chagos Archipelago, UK) between 3 and 18 hours after the earthquake, showing with unprecedented clarity the highly dispersed nature of the wave.

# Entry into Force and Universality

Ratification by 36 out of the 44 Annex 2 States

Regular consultations with States that have not yet signed or ratified

Cooperation with international organizations at the global, regional and subregional levels

ISHTAR tracking tool introduced

Biannual Article XIV conferences and Ministerial Meetings to promote entry into force of the Treaty

The primary responsibility for promoting ratification of the Treaty and for securing its entry into force ultimately lies with the States themselves. At the same time, the PTS has played a key role over the last 15 years in supporting these efforts. The activities of the PTS in this area have been manifold and focused not only on proactive ways to promote the Treaty and the urgency of its entry into force and universality. but have also sought to provide a forum to assist States in their consideration of the CTBT. At times, these efforts may be difficult to quantify in terms of their impact on the overall number of signatures and ratifications of the Treaty.


This work has had to be sustained for a period much longer than envisaged when the PTS started work in 1997. At that time, the general view was that the CTBT would enter into force within a few years. Entry into force has been significantly delayed as a result of the complicated provisions for entry into force contained in Article XIV of the Treaty. The PTS has therefore had to deal in its planning with the uncertainty of the timing of entry into force, and to ensure that the momentum in building the verification regime continued despite this uncertainty.

The decision of the United States Senate in 1999 not to approve ratification of the Treaty dampened the expectations for early entry into force. It also had important consequences for the process of securing other Annex 2 ratifications and, following this decision, it became more difficult to maintain the momentum towards entry into force and universality of the Treaty. A sense of renewed optimism followed the election of President Obama in 2008, particularly after he delivered a speech in Prague in April 2009 in which he articulated the United States' commitment to "immediately and aggressively" pursue ratification.

At the same time, high level consultations and working level contacts were maintained with other Annex 2 States and, as a result of these efforts, 36 out of the 44 Annex 2 States whose ratifications are required for the CTBT to enter into force have ratified the Treaty, the latest of which was Indonesia in February 2012. With regard to those who have yet to sign or ratify the Treaty, outreach activities are supported and complemented by initiatives taken by the ratifying States themselves.


CTBTO


BURUNDI
CAMBODIA


CTBTO
Conference on Facilitating the
Entry into Force of the Comprehensive
Nuclear-Test-Ban Treaty
Vienna
17–18 September 2007

## SECURING RATIFICATIONS AND PROMOTING UNIVERSALITY

A key task of the PTS over the last 15 years has been to promote understanding of the objectives and principles of the Treaty. Essentially, this has been done through interaction with the international community, including States, international organizations, academic institutions, non-governmental organizations (NGOs) and the media.

At the political level, the PTS has maintained a close dialogue with States through a number of activities, such as participation in national seminars on the CTBT and country visits. Contacts have also been made and strengthened at multilateral fora at the global, regional and subregional levels. Both the former and the current Executive Secretary undertook missions to key countries to promote the Treaty, its verification regime and the work of the PTS. Senior officials of many non-ratifying States have attended briefings in Vienna and gained an enhanced understanding of the Treaty and its role in international security. PTS efforts to promote the CTBT have redoubled in recent years as entire regions edged closer to full ratification.

In order to encourage the remaining non-ratifying States to adhere to the CTBT, consultations have been held each year with virtually all States that have not yet signed or ratified the Treaty. Similarly, the PTS has also engaged with a number of international organizations that interact on a regular basis with the States concerned.

Cooperation has also been initiated and strengthened with international organizations at the global, regional and subregional levels. In many cases, such cooperation has been facilitated through existing agreements with the Commission.

In addition, the PTS has been assiduous in providing education about the activities of the Commission, fostering international cooperation in the exchange of verification related technologies and assisting States Signatories on

Executive Secretary Wolfgang Hoffmann attending a subregional workshop for States from West Africa, Dakar, Senegal, 2001.

Executive Secretary Tibor Tóth attending an International Cooperation workshop for States from South-East Asia, Kuala Lumpur, Malaysia, 2006.

issues related to national implementation of the Treaty.

The PTS has sought from the beginning to engage civil society in the promotion of the Treaty, its verification regime and the work of the Commission. This effort has intensified in recent years. As an integral part of its outreach efforts, the PTS has engaged in both general and targeted dissemination of information to the media, civil society and the public; involvement of journalists and NGOs in PTS activities; closer liaison with the NGO community; and use of multimedia, social media and audio–visual products.

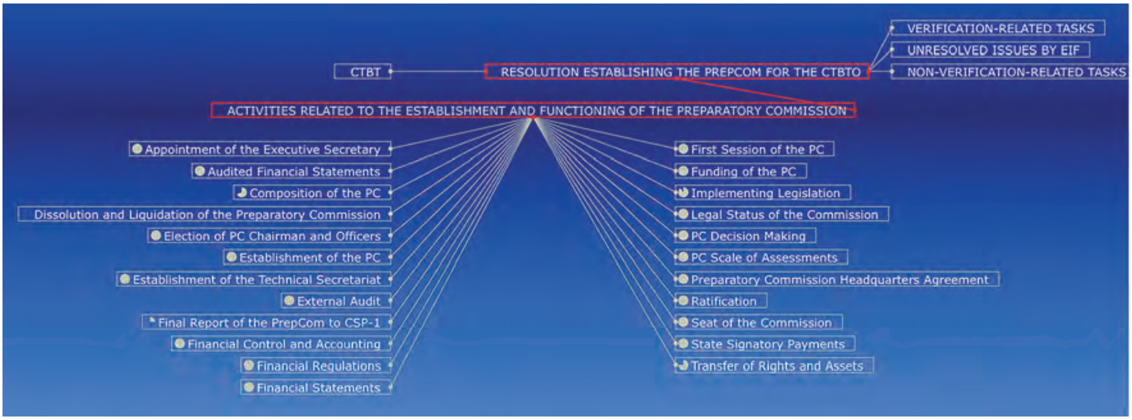
In recent years, political support for the Treaty has been expressed repeatedly through editorials in major newspapers and in leading regional newspapers. Op-eds expressing support for the Treaty by leading international personalities, foreign ministers and by the Executive Secretary were placed in prominent international and regional newspapers and web sites to help build political momentum for the Treaty.

One of the most prominent advocates and 'force multipliers' for the CTBT is the United Nations Messenger for Peace, Michael Douglas. He has spoken out for the Treaty – and in particular for US ratification – at numerous conferences, meetings and media articles and recently in a public service announcement distributed to print media and TV channels worldwide.

Over the past years, outreach efforts have also become tailored to reach certain countries, regions or audiences of particular interest. For example, the press release on the ratification by Indonesia, the most recent Annex 2 State to deposit its instruments of ratification, was translated into eight languages. Around 600 media articles reported on the event, in particular in Asia and the Middle East. This new approach includes print brochures for specific regions such as Asia, Africa and Latin America and the Caribbean, or for specific political or scientific audiences.

Members of the Indonesian parliament congratulating each other after the decision to ratify the CTBT was taken, 6 December 2011.

These activities have had the indirect goal of promoting further signature and ratification of the Treaty by States. This indirect goal has been furthered by the work of the PTS in ensuring the quality of its technical work, given that the robustness and reliability of the verification regime would be a contributing factor for many States Signatories or non-signatory States in their decision to ratify the Treaty. Although in this context the notion of cause and effect is a difficult one, the momentum of the technical accomplishments of the PTS, including in the area of civil and scientific benefits of the Treaty technologies, has been a factor in some cases in the corresponding momentum of the number of signatures and ratifications.




Screenshot of ISHTAR showing the degree of completion (indicated by partial or complete circles) of activities in one of the main categories of tasks.

The PTS also developed an online tool (Information System with Hyperlinks on Tasks Assigned by the Resolution Establishing the Preparatory Commission (ISHTAR)) that tracks the progress made by the PTS in the completion of the various technical and non-technical tasks set out in the Resolution establishing the Commission. Using hyperlinks to the official documentation of the Commission as its basis, ISHTAR is designed to enable the Commission to determine which tasks remain to be completed in preparation for the establishment of the CTBTO at entry into force.

## ARTICLE XIV CONFERENCES

Article XIV of the CTBT states that, if the Treaty has not entered into force three years after the date of the anniversary of its opening for signature, a conference of States that have ratified the Treaty should be convened to consider and decide by consensus what measures consistent with international law may be undertaken to accelerate the ratification process in order to facilitate the early entry into force of the Treaty. The Treaty also states that these conferences should be repeated at subsequent anniversaries of the opening for signature of the Treaty, until its entry into force.

The first of these Article XIV conferences was held in New York in 1999. This conference was a particular challenge since there was little detail in the Treaty itself about the format of such a conference. This first Article XIV conference also had a complex political dynamic since it coincided with the consideration of the Treaty by the US Senate. Since


2003 Article XIV conference presided over by Erkki Tuomioja, Minister for Foreign Affairs of Finland (*centre*).

1999, Article XIV conferences have been held every two years either in New York or Vienna.

The PTS works closely with the co-coordinators of the Article XIV process, who are selected for a two year period in between conferences to promote the CTBT among those States that have yet to sign or ratify the Treaty. At the same time, the PTS has also played a key role in supporting the Article XIV process through conference support, support for informal consultations in the lead-up to each conference and support related to outreach and public information activities.

The PTS has also used these Article XIV conferences to promote the Treaty and the work of the Commission. For example, the Executive Secretary has met with many Foreign Ministers and other senior representatives from States participating in the conferences, and bilateral consultations have been held at the working level to advance signature and ratification procedures. The PTS has offered extensive support to the press in various forms during the conferences, through targeted media outreach, information material, press briefings and

*From left to right:* Executive Secretary Tibor Tóth, the President of the 2005 Article XIV conference Alexander Downer, Minister of Foreign Affairs of Australia, and Kofi Annan, Secretary-General of the United Nations.


The Foreign Ministers of Costa Rica and Austria, Mr Bruno Stagno Ugarte and Ms Ursula Plassnik, shared the presidency of the 2007 Article XIV conference.


Ms Hillary Clinton, US Secretary of State, advocating the early entry into force of the Treaty at the 2009 Article XIV conference.


Patricia Espinosa Cantellano, Secretary of Foreign Affairs of Mexico (*left*), and Carl Bildt, Minister of Foreign Affairs of Sweden (*right*), shared the presidency of the 2011 conference. *Centre:* Sergio Duarte, the United Nations Under-Secretary-General and High Representative for Disarmament Affairs.

interviews. All conference related information is made available on the public web site.

## MINISTERIAL MEETINGS TO PROMOTE ENTRY INTO FORCE OF THE TREATY

In the years between the Article XIV conferences, foreign ministers from States Signatories particularly dedicated to entry into force of the CTBT meet on the margins of the United Nations General Assembly in New York in September. The aim of these meetings is to sustain and generate further political momentum as well as public attention for the entry into force of the Treaty. The initiative for these meetings was taken by Japan in cooperation with Australia and the Netherlands, who organized the first "Friends of the CTBT" meeting. The Fifth Ministerial Meeting took place in September 2010 and was convened by Australia, Canada, Finland, France, Japan, Morocco and the Netherlands. More than seventy countries participated in the meeting, of which 24 were represented at the ministerial level. In a Joint Ministerial Statement released at the meeting, foreign ministers committed themselves to making the Treaty a focus of attention at the highest political level and implementing measures to facilitate the signature and ratification process as recommended in the Final Document of the 2010 NPT Review Conference. More than seventy countries officially endorsed the Joint Ministerial Statement.


United Nations Secretary-General Ban Ki-moon addresses the opening of the Fifth Ministerial Meeting in 2010. *Left*: Seiji Maehara, Minister of Foreign Affairs of Japan; *right*: Kevin Rudd, Minister for Foreign Affairs of Australia and Chairperson of the Meeting. (Photo Credit: UN Photo/Garten.)

## CURRENT STATUS

As of March 2012, the total number of certified IMS facilities (stations and laboratories) was 271 and the Treaty had been signed by 182 States and ratified by 157 States, including 36 of the 44 States listed in Annex 2 to the Treaty, whose ratification is required for the entry into force of the Treaty.

An examination of past events and achievements over the last 15 years shows that the PTS has come a long way in carrying out the tasks, both technical and non-technical, entrusted to it by the Commission. Owing to the efforts of the PTS and States Signatories, the verification regime (IMS, IDC and OSI) is generally recognized to be in good shape.

With the Commission in a mode of provisional operation for testing and evaluation purposes according to its mandate, the operational capabilities of the IMS and the PTS have been amply demonstrated through the response to the two announced nuclear tests in the Democratic People's Republic of Korea in 2006 and 2009 as well as to the Tohoku earthquake, the subsequent tsunami and the Fukushima Dai-ichi nuclear power plant accident in 2011. The IMS network provides virtually global coverage and there is open access to data for States Signatories and to the scientific community for defined research purposes. As a result of the remarkable progress in monitoring technologies since 1997, the IMS is already performing better than envisaged for the complete system by the negotiators of the Treaty.

Moreover, OSI is now on a faster track for development. The IFE in 2008 importantly demonstrated that the conduct of an OSI was 'doable' after entry into force. This is expected to be reinforced through the next IFE in Jordan in 2014.

**Ratification Dates of the 44 States Listed in Annex 2 to the Treaty**

| Country | Date of Ratification | Country | Date of Ratification |
|---|---|---|---|
| Algeria | 11 Jul. 2003 | Iran (Islamic Republic of) | |
| Argentina | 4 Dec. 1998 | Israel | |
| Australia | 9 Jul. 1998 | Italy | 1 Feb. 1999 |
| Austria | 13 Mar. 1998 | Japan | 8 Jul. 1997 |
| Bangladesh | 8 Mar. 2000 | Mexico | 5 Oct. 1999 |
| Belgium | 29 Jun. 1999 | Netherlands | 23 Mar. 1999 |
| Brazil | 24 Jul. 1998 | Norway | 15 Jul. 1999 |
| Bulgaria | 29 Sep. 1999 | Pakistan | |
| Canada | 18 Dec. 1998 | Peru | 12 Nov. 1997 |
| Chile | 12 Jul. 2000 | Poland | 25 May 1999 |
| China | | Republic of Korea | 24 Sep. 1999 |
| Colombia | 29 Jan. 2008 | Romania | 5 Oct. 1999 |
| Democratic People's Republic of Korea | | Russian Federation | 30 Jun. 2000 |
| | | Slovakia | 3 Mar. 1998 |
| Democratic Republic of the Congo | 28 Sep. 2004 | South Africa | 30 Mar. 1999 |
| | | Spain | 31 Jul. 1998 |
| Egypt | | Sweden | 2 Dec. 1998 |
| Finland | 15 Jan. 1999 | Switzerland | 1 Oct. 1999 |
| France | 6 Apr. 1998 | Turkey | 16 Feb. 2000 |
| Germany | 20 Aug. 1998 | Ukraine | 23 Feb. 2001 |
| Hungary | 13 Jul. 1999 | United Kingdom | 6 Apr. 1998 |
| India | | United States of America | |
| Indonesia | 6 Feb. 2012 | Viet Nam | 10 Mar. 2006 |

## Middle East and South Asia (26 States)

**21** Signatories
**15** Ratifiers


## South-East Asia, the Pacific and the Far East (32 States)

**28** Signatories
**20** Ratifiers


## North America and Western Europe (28 States)

**28** Signatories
**27** Ratifiers

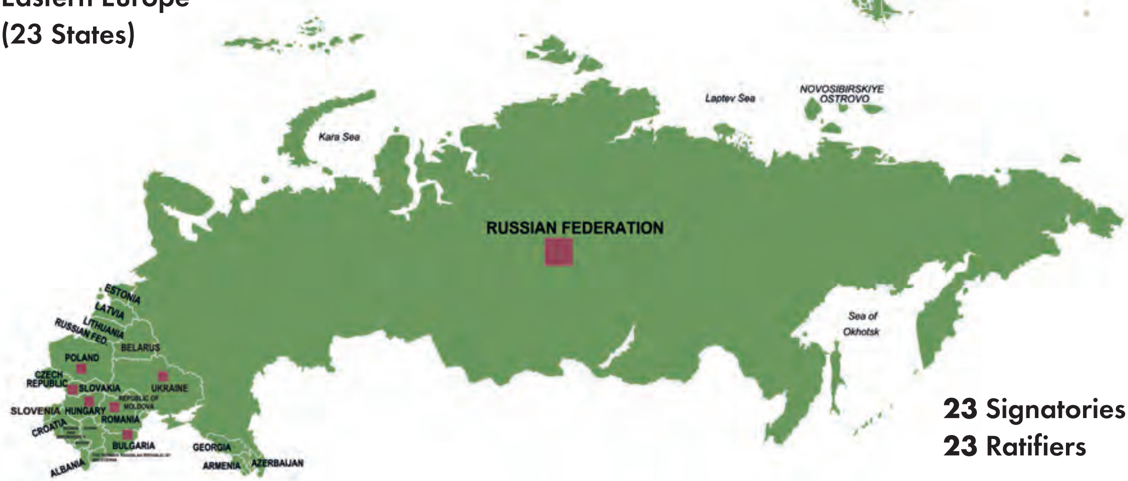
## Africa
## (54 States)


**51** Signatories
**40** Ratifiers

## Latin America and Caribbean
## (33 States)


**31** Signatories
**30** Ratifiers

## Eastern Europe
## (23 States)




**23** Signatories
**23** Ratifiers

■ Ratifying States ■ Signatory States ■ Non-Signatory States ■ States whose ratification is required for the Treaty to enter into force

# Comprehensive Nuclear-Test-Ban Treaty
# International Monitoring System
# (337 facilities worldwide)

CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization


50 primary seismic stations (PS20: details to be determined)
- PS Primary seismic array station
- PS Primary seismic three component station

120 auxiliary seismic stations (AS39: details to be determined)
- AS Auxiliary seismic array station
- AS Auxiliary seismic three component station

11 hydroacoustic stations
- HA Hydroacoustic (T phase) station
- HA Hydroacoustic (hydrophone) station

60 infrasound stations (IS28: details to be determined)
- IS Infrasound station

80 radionuclide stations (RN35: details to be determined)
- RN Radionuclide particulate station
- RN Radionuclide particulate and noble gas station

16 radionuclide laboratories
- RL Radionuclide laboratory

# Postscript

The past achievements of the PTS are well documented, and many of them are described in this report. The future, of course, cannot be documented. Rather, we must prepare and plan for it. I am certain that the PTS will continue its successful journey in the years to come, leading to the entry into force of the Treaty. Needless to say, the continued commitment and support of States Signatories will be essential.

On the technical front there is a substantial list of tasks that remain to be done in order to approach full Treaty-compliant functionality prior to entry into force. For example, there is still a significant list of IMS facilities not yet installed or not sending data to the IDC. There is a wide range of challenges which must be resolved in completing the IMS and we will continue to explore every avenue towards the goal of a full IMS network as prescribed in the Treaty.

The current functionality of the IDC needs to be supplemented by some key elements, such as support for 'special data management'. This includes the management of data acquired under the Treaty provisions for confidence building measures, consultation and clarification, Cooperating National Facilities, OSI operations, and incorporating data from States Parties. Two other major items to be fully addressed are information security infrastructure and methodologies for expert technical analysis.

Much has been mentioned already about the OSI regime and the need to complete a credible OSI regime that matches the capabilities of the IMS and IDC. There is now an increased focus on this important pillar of the verification regime. A recent PTS activity to develop a 'must do list' of tasks to be performed before entry into force was a valuable exercise in reviewing where we stand on all the above issues and more.

The development of Treaty-compliant capability throughout the verification regime, though essential, is perhaps less demanding in the long term than sustaining this capability. IMS facilities must be repaired in a timely way and recapitalized at the end of their useful life. Data quality must be made durable and the turnover of highly trained and specialized staff must be accommodated. OSI equipment will need to be kept ever-ready for deployment and a full cadre of trained inspectors maintained.

But this is not all on the technical front. The Treaty requires us (and it is in any case essential for our credibility) to embrace new technologies and keep the verification system abreast of new scientific and technological developments. Our engagement with the broader scientific community, as promoted by the CTBT science and technology conference series, is an important enabling step to meet this challenge. In some respects, the rate at which technology develops is formidable. In a report on the 2009 International Scientific Studies Conference, it was pointed out that the cost of data transmission bandwidth has decreased tenfold every five years since 1998 and that the price of data storage on hard disk has decreased by a hundredfold every eight years since 1980. Such transformations offer great opportunities but also create major challenges. They have fundamental consequences for the cost effective, reliable and secure transmission of IMS data. They also have a major impact on the optimum way of processing IMS data in the IDC, and on optimizing the design of an OSI. If one were designing the verification regime today – merely two decades after the design was actually developed, it is likely that the trends in data transmission cost and data storage cost alone would have resulted in a radically different framework for IMS data transmission, processing and storage than that which became enshrined in the Treaty.

A further point to remember is that the PTS is in provisional operations; prior to entry into force of the Treaty the staffing levels, data processing time lines and technical services to States Signatories will need to be ramped up to full operations. The IDC Commissioning Plan sets out a pathway for this, and it provides for a validation and acceptance test, the first draft plan of which has already been prepared.

On the political front we are ever conscious of the fact that entry into force requires the ratification of the Treaty by the eight remaining Annexe 2 States, three of which have not yet signed. The PTS has a role in supporting those States on their path towards signature/ratification. By ensuring that States are provided with well informed and factual information relating to the technical capabilities of the CTBT verification regime, the PTS can pave the way for their ratification processes. The credibility of the Treaty is strongly dependent upon the credibility of the PTS, and this in turn relies on the professionalism and integrity of its staff.

In order to maintain the present momentum and ensure early and successful signature/ratification processes in the remaining Annex 2 States, I have engaged with a number of eminent personalities of political standing and internationally recognized experts to establish a Group of Advocates of the CTBT (CTBT Advocacy Group). The Group will complement ongoing efforts through their advice and recommendations as well as ensure that decision makers at the highest level in the holdout States are fully apprised of the Treaty and its contribution to international peace and security.

But despite our best efforts and high hopes, it is possible that we may face a situation in which the prospects for entry into force may remain static for a significant period. This delayed entry into force poses challenges because the continued commitment of States Signatories will be required in order to ensure that previous investment is not compromised, and that PTS provisional operations can continue to evolve. In this context we are reminded of the many potential civil and scientific uses to which IMS data can be put, while still fulfilling the mandate of CTBT verification.

When I look back to the Second Session of the Preparatory Commission in May 1997, I see that great visionary steps were made then in formulating the work priorities for the PTS. The specifications for IMS stations were set out; the framework for the GCI was laid down, the IDC Progressive Commissioning Plan was approved, and comprehensive training programmes were instigated. Yet we must take note that in some respects that early enthusiasm resulted in overambition. The Third Session of the Preparatory Commission in September 1997 set forth plans to certify 38 IMS stations during 1998. In fact the first 11 IMS stations were certified in 2000. This testifies to the complexity of assembling all the skills and infrastructure needed to build up a sophisticated global monitoring system. Expectations of performance can only be set against a benchmark. It is a stark reality that for the installation of a global system to monitor nuclear tests there was no benchmark in 1997. The verification system which the Preparatory Commission and its PTS are mandated to establish is unique.

Although planned tests of the verification system are an essential component of establishing technological readiness, it is perhaps the unplanned tests that provide the most convincing demonstration of the verification regime's ability to perform its task. Three announced nuclear tests by the Democratic People's Republic of Korea have been well recorded globally by IMS seismic stations, with high quality products made available to States Signatories according to post-entry-into-force time lines. The stress placed upon all aspects of the IMS and IDC by the 11 March 2011 Tohoku earthquake and the associated Fukushima nuclear accident was unprecedented, but all aspects continued to function without interruption. At the same time these unplanned tests provided lessons upon which improvements can be based. It should be remembered that successes such as these were achieved with an incomplete verification regime operating in a provisional mode.

As we move into the sixteenth year of the PTS, the foundations laid during its past 15 years make me confident that the verification system currently in place provides a robust monitoring and verification capability and that this capability will improve further as we move towards final readiness. States Signatories have provided strong support to our endeavours over the past 15 years, and I am likewise confident that, as the continued effectiveness of the PTS is demonstrated, this support will continue.

Lassina Zerbo
Executive Secretary Elect
Vienna, April 2013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