International Data Centre
Introduction

The International Data Centre (IDC) receives, collects, processes, analyses, reports on and archives data from IMS facilities, including the results of analysis conducted at certified radionuclide laboratories. The procedures and standard event screening criteria which it uses to carry out these functions, particularly the generation of standard reporting products and the performance of a standard range of services for States Signatories, are set out in the draft IDC Operational Manual. The IDC is progressively enhancing its technical capabilities.

The data collected by the IMS are processed immediately when they reach the IDC, and the first automated products are released within two hours of the arrival of raw data. The products comprise lists of seismological and acoustic events and of radionuclides that have been detected in the IDC. Analysts subsequently review these lists in order to prepare quality-controlled bulletins. The IDC has been providing IMS data and IDC products to States Signatories through secure signatory accounts on a test basis since February 2000. The IDC gives extensive support to users designated by States Signatories, including a standard software package, training courses and technical assistance.

HIGHLIGHTS OF ACTIVITIES IN 2006

A new, state of the art Operations Centre serving the entire PTS has been built and was expected to open in January 2007.

The number of IMS stations in IDC operations reached 190 (59%) at the end of 2006.

Significant progress was made in transferring existing IDC applications software for monitoring purposes to an open source platform. A set of 103 automatic waveform processing programs, collectively called iBase, was modified so that the software can be compiled on either Solaris or Linux from the same source code.

The occurrence of an event in the Democratic People’s Republic of Korea at the beginning of October 2006 provided an opportunity to test the responsiveness of IDC operations. The exercise emphasized the importance of the synergy among Treaty verification technologies. The important contribution of noble gas data during this exercise highlighted the need to accelerate the installation of the respective IMS radionuclide monitoring stations.

The processing provided by the computer infrastructure was almost free of outages for all services. The new computer centre operated without problems and contributed greatly to the availability of all services.

DATA PROCESSING AND ANALYSIS

Waveform Data

During the year, 16 new or upgraded waveform monitoring stations were added to IDC provisional operations and thus began contributing to IDC standard products. Data from a total of 126 stations were processed continuously and contributed to Reviewed Event Bulletins (REBs).

Standard IDC products were issued for each day. On average, 122 and 76 events per day were included in the automatic Standard Event List 3 (SEL3) and the REB respectively, compared with 138 and 77 respectively during 2005. Following an event on 9 October in the Democratic People’s Republic
of Korea, the REB for that day was expedited and issued within the time line envisaged after entry into force of the Treaty (see also Special Feature 2).

The identification of software deficiencies, proposed enhancements and the testing and evaluation of software upgrades continued. The PTS continued to support the build-up of the IMS by testing and evaluating data from new stations.

The PTS continued to forward data to recognized tsunami warning organizations under the Commission decision of March 2005. In accordance with the further Commission decision of November 2006, the PTS placed the forwarding of data for this purpose under a more routine regime (see also Special Feature 3).

**Radionuclide Data**

In 2006, six radionuclide particulate stations were added to IDC provisional operations; this increased the total number of stations to 43, out of 80 foreseen in the network.

During the year, 10,368 full-sample spectra were automatically analysed, interactively reviewed and categorized. Of these, 7,393 were Level 1 spectra. Two spectra were categorized as Level 5, and these were sent for reanalysis to certified laboratories in accordance with standing procedures. In addition, six samples which were not Level 5 were sent for reanalysis to laboratories under the provisions of the draft operational manuals, following the event of 9 October in the Democratic People’s Republic of Korea.

The automated atmospheric transport modelling (ATM) system delivered ‘fields of regard’ for every Reviewed Radionuclide Report issued. Analysed global meteorological data arrived from the European Centre for Medium-Range Weather Forecasts with high reliability.

IDC waveform analysts review all events that are formed by automatic processing in Standard Event List 3 and identify missed events.
SOFTWARE DEVELOPMENT

Waveform Development

Priority was given to preparing for the reintroduction of infrasound processing into IDC operations. Efforts continued to focus on the development and testing of the initial version of the interactive infrasound review tool. A database of ground truth and reference infrasound events for validating and testing purposes was established in cooperation with a group of specialists. New association criteria to enhance the network processing were tested with infrasound data. This significantly reduced the number of false events, which should be reviewed interactively. Work was also done to extend processing to lower frequencies (from 0.1 Hz to 0.02 Hz). This was made possible by the Linux hardware used in the development environment.

New source code for hydroacoustic arrival feature extraction (previously only available in binary form) was developed and installed in IDC operations. The hydroacoustic azimuth and slowness estimator was upgraded, partly to facilitate the automatic identification of seismic phases on hydrophone triplets, and its testing was begun.

The topo 8.2 bathymetry grid recommended by the expert group for hydroacoustic screening was installed in IDC operations. The minimum number of stations with surface wave measurements considered by event screening was recommended by the expert group for event screening to be increased from one to two. Work has been proceeding for one external contract concerning the refinement of the IDC event screening criterion for the magnitude ratio (mb:Ms).

The performance of the automated system for seismic processing was further analysed with the goal of enhancing the quality of the Standard Event Lists. Development work to improve signal and noise separation continued. Detection performance was improved for the large IMS array station NOA (Norway) by tuning relevant parameters.

The development of three-dimensional velocity models for eastern and southern Africa was concluded and source specific station corrections were calculated for relevant IMS stations. New potential data on ground truth events (i.e., events whose location and time of origin are known) for validation of the regional models were identified and analysed.

In the area of network processing, a scheme for computing moment magnitudes from long period P waves of large events was adapted for IDC purposes. A prediction module has been included in the global association subsystem to investigate the benefit of adding detections to existing event

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hypotheses on the basis of matching arrival times only. In both cases, preliminary tests showed promising results. The waveform event location code was improved by correcting the implementation of the underlying algorithms.

**Radionuclide Development**

Work started on the development of an automatic counterpart to the Simulation Assisted Interactive Nuclide Review Tool (SAINT), based on the existing prototype. Many of the functionalities that are currently in the interactive tool and used to correct the old Genie based automatic software will be moved to the new automatic tool and thereby further reduce the time needed for review.

The software developed in 2005 for analysing noble gas data from the United States (ARSA) and Swedish (SAUNA) systems was in regular use for the International Noble Gas Experiment. A contract was initiated for the development of software for the ARIX radioxenon analyser from the Russian Federation. For the French SPALAX radioxenon analyser a function to analyse data was developed and demonstrated in-house as a part of SAINT (Xe-SAINT).

The client software for the Web based graphics engine WEB-GRAPE to permit graphical source attribution analysis was completed with functionalities for easy access to the basic ATM results residing as source–receptor sensitivity fields on the IDC secure web site. A beta version of WEB-GRAPE was given to a number of States Signatories that requested it.

On the basis of a request from the Special Session of the Commission held after the event in the Democratic People’s Republic of Korea of 9 October 2006, enhanced ATM was performed with regard to this event. Work was done to analyse noble gas observations which appeared to be related to the event. All of these results were placed on the IDC secure web site and were presented at a special technical briefing for States Signatories in November in Vienna.

The migration of the first generation ATM software system to the new 64 bit Linux ATM server was completed. The performance gain compared with the old ATM server is by two orders of magnitude, which allows the extension of the backtracking capability from 6 to 14 days and the introduction of uncertainty analysis with regard to the daily computed ATM products. As a first step for the latter, the standard transport model, FLEXPART version 5.1, has been operated since October 2006 in two configurations with regard to the input wind fields utilized, allowing for model intercomparison.
Software Integration

Software integration work continued in the areas of software development, maintenance and configuration management. Over twenty upgrade patches of the IDC applications software were put into the operational system in 2006. A number of changes were made to improve the automatic processing capability of the software.

An effort was made to restructure the IDC software source code collection and to prepare for the migration of this code to the operational system by building and delivering Solaris and then Linux versions of the code from the single source code tree. This set of code, called iBase, consists of the 103 automatic waveform processing programs in use at the IDC. This major step towards open source migration of IDC applications was implemented in IDC operations in November.

Work was under way to port the remaining software, including IDC interactive processing and auxiliary software applications, to Linux, as set out in the open source ‘road map’.

The software developed by the PTS to receive and send data in CD-1.0 and CD-1.1 (continuous data) formats was improved and new versions have been moved to IDC operations. Improvements include greater speed, reduced resource usage and increased ease of use. Updated user documentation to reflect these new features was included in the release. A new testing contract was initiated for the purpose of maintaining high reliability and reducing the risk of future problems.

An improved version of the Geotool software was installed on the IDC test bed and in IDC operations.

Software problems with surface wave processing were resolved, allowing several new stations to contribute surface wave magnitudes to the bulletins. This will provide additional data for event screening.

SERVICES AND REVIEW ACTIVITIES

To ensure the continued quality of IDC products, follow-up assessments were carried out by comparing the REB with bulletins from the International Seismological Centre (ISC) for the year 2003 and the National Earthquake Information Center (NEIC) of the United States Geological Survey for the year 2004. Even though the number of events included in the REB has been steadily rising owing to the increasing number of low magnitude events being
detected by the growing PTS network, the agreement of all common solutions (in IDC and NEIC bulletins) was found to be equivalent to that of previous years. An important quality assurance activity is the evaluation of the automatic event bulletins. An assessment for 2005 demonstrated the added value of the interactive review, highlighting the recognized limitations to be expected from automatic IDC products.

Within the evaluation framework of the first system-wide performance test (SPT1), the Swedish NDC compiled a set of seismic ground truth events in Scandinavia. This data set referred to underwater explosions near Stockholm and mining explosions in central Sweden. It provided the opportunity to assess the performance of location calibration data in IDC operations. Locations obtained for the currently installed set of corrections, in comparison with the ground truth events, suggest that the average mislocation for the events is not significantly reduced and that the estimated error ellipses do not reflect the real uncertainty attached to the location solutions.

SPT1 has also shed light on other potential issues with respect to IDC analysis and processing software. In this connection, station deficiencies in seismic acoustic event screening as well as in station magnitude estimates were investigated in support of further development of the IDC applications software.

**Support for National Data Centres**

By the end of 2006, 94 secure signatory accounts (one for each requesting State Signatory) had been established and a total of 808 users from these States Signatories had been authorized to access IMS data and IDC products and receive technical support. More than 800 requests from authorized users regarding technical information were received and resolved during the year.

The ‘NDC in a box’ software had been distributed to 97 States Signatories by the end of the year. This software package, developed by the IDC for use at NDCs, gives NDCs the capability to receive, process and analyse IMS data. A new version of the software package was released and made available to States Signatories through the IDC secure web site. The new version includes CD Tools for the handling of continuous data and updates of the other software components. A limited amount of hardware was donated to NDCs by the PTS as old computers were being decommissioned.
OPERATION OF MONITORING FACILITIES

In 2006, the PTS concluded contracts for 14 new facilities for testing and evaluation and post-certification activities, making a total of 106 IMS facilities operating under such service agreements. During the year, the Operations Centre took on the task of monitoring data forwarding from the IDC to authorized users. The Operations Centre was staffed during business hours by personnel from the IMS and IDC Divisions. Despite the additional workload created by the increased number of stations in IDC operations, the Operations Centre was able to reduce the number of staff on duty each day from three to two. This was accomplished through the streamlining of procedures and improvement of the tools available.

Operation of Networks and Systems

The PTS has been preparing for an upgrade of the server infrastructure. The network preparation in the computer centre for the geographical information system (GIS) of the On-Site Inspection (OSI) Division was completed and this system was installed. New Linux servers were also installed.

Operational Tools

The Web portal for the GCI unified reporting interface was upgraded to improve performance and incorporate new reporting features that were then made available to States Signatories and station operators. The network management system was integrated with the PTS trouble ticket system as part of the evolution towards integrated operations of the IMS.

Internet Communication

The performance of the Internet links was consistent during 2006, with an availability of greater than 99.9%. The two links share the normal Internet traffic as well as the traffic carried by the virtual private networks for the GCI. During 2006, the capacity of one of the Internet links was increased from 4 to 10 megabits per second. The other link was scheduled for a similar upgrade in the first quarter of 2007. The links ably supported several trials in video streaming of various meetings of the Commission, including the tenth anniversary symposium (see Special Feature 1).
MANAGEMENT AND COORDINATION

Information Security

In 2006, the PTS Information Security Working Group was commissioned. Its objectives are to assemble the information security expertise from the PTS to draft information security policies and guidelines, to streamline the cross-Divisional acceptance of such policies and guidelines by actively involving information security representatives from all Divisions early in the drafting process, and to establish a security forum capable of discussing security matters and advising the PTS senior management.

Throughout the year, the PTS information security personnel provided engineering support to data and system owners to improve the security of their information systems. In particular, considerable efforts were invested in the project for the next GCI to ensure that the necessary security controls are adequate to protect the integrity, confidentiality and availability of data, and to ensure the security and integrity of all the independent networks connected via the GCI.

Two series of penetration tests were conducted in 2006 with the aim of identifying potential weaknesses in the security measures implemented to protect CTBT information assets. Corrective actions were taken to rectify the deficiencies noted from the test reports.

Workshop

The PTS maintained a high level of technical coordination with States Signatories. NDCs were invited to the Network and Data Operations Workshop, held in Vienna from 20 to 24 November 2006, to share their views regarding the further development of the provisional operation of the monitoring system and the cost effectiveness and efficiency of the end to end data flow. The workshop provided an opportunity to participants to bring directly to the attention of the PTS the problems that they were facing at their NDCs or at their stations. Around fifty NDC staff and station operators actively participated. The workshop was an example of PTS support of efforts of States Signatories in building or improving tsunami warning centres.

Cooperation with World Meteorological Organization

The PTS was invited to participate at 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 ATM by 2007. Such a system would allow the PTS, in the case of a Treaty-relevant radionuclide detection, to request, in near real time, ATM products from WMO centres to supplement its own computations. This would constitute the first near-real-time backtracking response system worldwide. The group noted the successful collaboration between the PTS and the WMO during the last decade, and recommended to formally include the CTBTO–WMO response system in the WMO Global Data Processing and Forecasting System (GDPFS).

The PTS furthermore participated at the Extraordinary Session of the WMO Commission for Basic Systems (CBS) in Seoul from 9 to 16 November 2006. There, the PTS gave a plenary presentation on the CTBTO–WMO cooperation. The CBS agreed to establish the new arrangements regarding the CTBTO–WMO backtracking response system. It recommended that these arrangements be formally included in the manual on the GDPFS. The matter was forwarded to the WMO Executive Council for final approval.

RESTRUCTURING OF IDC DIVISION

As a result of restructuring in the PTS in 2006, the activities of the former Computer Infrastructure and Network Services Sections were split between maintenance (and moved to the IMS Division) and operations (and transferred to a new Section of the IDC Division). The Waveform Monitoring Section was reorganized as the Monitoring and Data Analysis Section to integrate the radionuclide aspects of data analysis. The operational aspects were moved to the newly created Network and Data Systems Operations Section, which comprises the Monitoring Facilities Operations Unit and the Network and Systems Operations Unit. The Monitoring Facilities Operations Unit supervises and coordinates the operations and the first level support of the IMS facilities, which includes the management of the Operations Centre. The Network and Systems Operations Unit is responsible for all operational aspects of IDC applications software and the GCI and related computer hardware, as well as for the release of reviewed standard IDC products. The new Software Applications Section integrates all aspects related to radionuclide technologies as well as data fusion.