The International Data Centre (IDC) is situated at the Headquarters of the CTBTO Preparatory Commission in the Vienna International Centre. Its function is to collect, process, analyse and report on data received from facilities of the International Monitoring System through the Global Communications Infrastructure, 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. In addition to handling the data and products, the IDC provides technical services and support to the States Signatories.

Full network redundancy has been created at the IDC to ensure high availability of its resources. A mass storage system provides archiving capacity for all verification data, currently covering more than 12 years. The software utilized in operating the IDC is mostly developed specifically for the CTBT verification regime.

**Highlights in 2012**

- More robust and flexible data and product request services
- Improvement in reviewed noble gas products by implementing a scheme that categorizes the sample spectra
- Further progress in IDC capability
**Operations**

**From Raw Data to Final Products**

The data collected by the IMS under provisional operations are processed immediately when they reach the IDC. The first automated waveform data product, known as Standard Event List 1 (SEL1), is completed within one hour after the data have been recorded at the station. This data product lists preliminary waveform events recorded by the primary seismic and hydroacoustic stations.

Requests are then made for data from the auxiliary seismic stations. These data, together with the data from the infrasound stations and any waveform data arriving late, are used to produce a more complete waveform event list, SEL2, four hours after recording the data. SEL2 is improved again after six hours have elapsed to incorporate any additional late-arriving waveform data, to produce the final automated waveform event list, SEL3.

Analysts subsequently review the waveform events recorded in SEL3 and correct the automated results as appropriate to generate the Reviewed Event Bulletin (REB). The REB for a given day contains all waveform events that meet specific quality criteria. During the current provisional operating mode of the IDC, the REB is targeted to be issued within 10 days. After the Treaty enters into force, the REB will be released within two days.

Observations from events recorded by IMS radionuclide particulate and noble gas monitoring stations typically arrive several days later than the signals from the same events recorded by the seismic, hydroacoustic and infrasound stations. Radionuclide data undergo automatic processing to produce an Automatic Radionuclide Report (ARR) and then analyst review to generate a Reviewed Radionuclide Report (RRR) for each spectrum received. The information in the REB and RRR will eventually be fused, associating seismoacoustic events with radionuclide detections through atmospheric transport modelling (ATM).
Atmospheric backtracking calculations are performed daily for each of the IMS radionuclide stations with near real time meteorological data obtained from the European Centre for Medium-Range Weather Forecasts. Using software developed by the PTS, States Signatories can combine these calculations with radionuclide detection scenarios and nuclide specific parameters to define regions in which sources of radionuclides are possibly located.

To corroborate the backtracking calculations, the Commission collaborates with the World Meteorological Organization (WMO) through a CTBTO–WMO response system. This system enables the Commission to send requests for assistance in the case of suspicious radionuclide detections to nine Regional Specialized Meteorological Centres or National Meteorological Centres of the WMO located around the world. The centres respond to these requests by submitting their computations to the Commission with a target response time of 24 hours.

After the data products are generated, they must be distributed in a timely way to the States Signatories. The IDC provides subscription- and Web-based access to a variety of products ranging from near real time data streams to event bulletins and from gamma ray spectra to atmospheric dispersion models.

New Stations in Operations

In 2012, support and build-up of the IMS continued with the testing and evaluation of data from new stations. Seven newly installed or upgraded stations and one radionuclide laboratory were introduced into IDC operations as part of the certification process. Other stations awaiting certification were installed in the IDC test bed.

Services

An NDC is an organization with technical expertise in the CTBT verification technologies.

37 435 Events from the IDC 2012 Reviewed Event Bulletin

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Its functions may include receiving data and products from the IDC, processing IMS and other data, and providing technical advice to its national authority.

The PTS continued to provide the ‘NDC in a box’ software package for use at NDCs, enabling them to receive, process and analyse IMS data. Efforts were also made to further improve the software.

A total of 123 secure signatory accounts, one for each requesting State Signatory, have been established, and close to 1400 users from these States Signatories have been authorized to access IMS data and IDC products and receive technical support.

About nine hundred requests for support were received in 2012 from NDCs and authorized users, and 90% of them were addressed. The remaining 10% involve long term issues that will take time to resolve. Upgrades to the system for managing service requests from authorized users have been installed and tested to improve the service.

**Build-Up and Enhancement**

**IDC Commissioning**

Build-up and enhancement of the IDC further the goal of commissioning the IDC, GCI and IMS. To move from phase 5a to 5b of the IDC Progressive Commissioning Plan, two steps remain: the first is to produce a draft IDC validation and acceptance test plan, and the second is to ensure that formal security measures are in place to prevent external interference or compromise of IDC operations.

A one year image of hydroacoustic signal detections by the northern hydrophone triplet of hydroacoustic station HAS offshore of Diego Garcia in the Chagos Archipelago (British Indian Ocean Territory, BIOT) associates the signal propagation direction with possible source regions. The blue lines on the right hand map show the locations of ocean-spreading ridges (such as the Carlsberg Ridge in the Indian Ocean), which are associated with seismic activity. White indicates 10 or more signal arrivals each day. Of particular interest are the signals shown by the vertical striations. These have no obvious correlation with any source regions and, in fact, are known to be signals from whales. Because of their interest to bioacousticians, a project has begun that uses the virtual Data Exploitation Centre (vDEC), which provides a way for external researchers to collaborate with the PTS to work on topics of joint interest.
The progressive expansion of the hardware in the computer centre poses challenges to its power supply systems, cooling capabilities and other design parameters. To meet these challenges, the floor load capacity was doubled and the uninterruptible power systems were upgraded to make the power supply more robust and reliable. A power and cooling audit was carried out to reveal any potential bottlenecks in the systems. Some legacy servers were retired and others were consolidated, making the service that they provide more robust.

Software Enhancements

Data availability and performance for auxiliary seismic stations were significantly enhanced with the implementation of the GCI data repository. The repository, logically external to the IDC, receives and stores data from IMS waveform stations and handles IDC requests for auxiliary seismic data. Along with improving the timely availability of the data, the repository helps fulfil the requirement that auxiliary seismic data “shall be immediately available through on-line computer connections” (Part I, paragraph 8, of the Protocol to the Treaty), reduces data traffic on the GCI and improves resource utilization.

The new IDC message system was officially released to external users in November 2012. The system offers new noble gas products as well as a Web based delivery mechanism for data and products that is faster and more secure than the email based delivery used so far. The new message system is integrated with the
‘single sign-on’ platform and offers enhanced maintainability and robustness.

A categorization scheme for the IMS radionuclide particulate stations has been in place for years. A similar scheme for radionuclide noble gas stations was installed in 2012 and experience is being gained with this new scheme. The new scheme sorts noble gas spectra into three categories: A (no radioxenon detected), B (radioxenon typical for the sampling location detected) and C (radioxenon atypical for the sampling location detected). It is distinguishable from the scheme for particulate spectra, which uses numerical categories 1 to 5.

Activities continued to validate the new regional seismic travel time (RSTT) model provided by the USA as part of a contribution in kind. The validation performed so far included comparing the RSTT and source specific station correction values for some stations, computing travel time correction grid files of most seismic stations in North Eurasia and North America based on the RSTT model, and comparing the measured travel time of some near ground truth events with the travel time computed using the RSTT model.

The PTS continued its efforts to apply state of the art machine learning and artificial intelligence techniques to its automatic and interactive processing software for waveform data. A first version of the NET-VISA software was installed in the IDC development local area network (LAN). Waveform analysts reviewed a day of events produced by the new software and provided positive and valuable feedback. In-depth tests were conducted using the locally installed version of NET-VISA. The tests involved comparing the results and performance of NET-VISA and

A PTS portable infrasound array was deployed between August 2011 and June 2012 in the Päijänne Tavastia region of Finland, at the site of primary seismic station PS17, to monitor infrasound activity in the Scandinavian region. Infrasound waves generated by the destruction of obsolete ammunition at the Hukkakero military range, about 850 kilometres to the north, were recorded by the PTS array. This work was done in collaboration with the Finnish NDC at the University of Helsinki. The screenshot displays the IDC processing results with the IDC interactive review software (Geotool-PMCC) for signals recorded from a Hukkakero explosion. The waveforms are visible in the bottom panel. Wave parameters estimated with IDC station processing software (DPX-PMCC) are shown in the top panels.
the existing Global Association software, and evaluating and improving the computational complexity of the NET-VISA algorithm.

**International Noble Gas Experiment**

Additional noble gas systems were transferred into IDC operations during 2012. At the end of the year, a total of 31 noble gas systems were in provisional operation at IMS radionuclide stations. Data from these stations and from one national facility (Canada) are sent to the IDC and processed in the testing environment.

Today the xenon background is measured as part of the International Noble Gas Experiment (INGE) at 32 locations, but is still not understood in all cases. Medical isotope production facilities are the biggest contributor to the radioxenon background. As more medical isotope production plants are expected to start operating, this will lead to an increased number of non-CTBT-relevant detections. Also, the noble gas composition of the emissions from these plants can be similar to emissions from nuclear explosions. A good understanding of the noble gas background is thus crucial for identification of signals from nuclear explosions. Therefore the EU has funded an initiative to improve knowledge of the global xenon background.

The initiative funded by the EU (Joint Action III), which started in December 2008, continued in 2012 to further improve knowledge of the global xenon background. The objectives of this project are to supplement knowledge on the global radioxenon background over longer and thus more representative periods at selected sites by performing measurements for at least six months, to detect local sources, if present, and to provide empirical data for validating network performance, for testing xenon equipment and logistics, for data analysis and for training local experts.

For this purpose three systems were deployed temporarily at selected locations. These mobile systems, two owned by the PTS and one by the USA, are designed to be deployable anywhere in the world within a few days. Measurement campaigns were conducted in 2012, in cooperation with regional hosting institutions and with the Pacific Northwest National Laboratory in Richland, Washington, USA, for periods from 6 to 12 months in Kuwait City, Jakarta and the Mutsu area of Japan. Locations were selected on the basis of the noble gas background information available, the influence from medical isotope production facilities and negotiations with hosting countries, among other things. The location in Jakarta is in the immediate vicinity of a medical isotope production facility for which emission data are available, thus providing the unique opportunity to correlate emission measurements with sampling data. Through these measurements, insight into seasonal variations and general background levels could be gained in areas which are poorly covered by the current IMS stations.

**Technology Foresight**

The Commission is engaged in a technology foresight exercise in support of its commitment to uphold the relevance of its technology-intensive system, as well as to ensure awareness of developments in science and technology that could enhance the performance and efficiency of systems and operations. It is a continuous process whereby scientists and technologists meet, interact, debate and jointly define future courses for Treaty related research and development. This involves an iterative cycle of workshops on various themes, definition of pilot projects and funding of these projects from various sources.

In 2012, the technology foresight exercise continued to focus on identifying the scientific and technological developments that may affect future PTS operations. The aim of this phase is to deliver a medium- to long-term integrated technology forecast for the Commission together with a ‘taxonomy’ that enables intuitive and in-depth understanding of identified developments. The technology foresight initiative was presented and discussed at a number of specialist meetings. A range
Verification of compliance with the Treaty poses challenges whose resolution depends crucially on the promotion and exploitation of scientific research and technological developments. The credibility of the verification system being established by the Commission, and its ability to detect, locate and identify nuclear explosions both rely on a continuing engagement with the specialist communities that drive advances in relevant instrumentation, processing and analysis methods. Recognizing the strategic importance of this, initiatives taken by the Commission such as “Synergies with Science” in 2006, “International Scientific Studies” (ISS09) in 2009 and “Science and Technology 2011” (S&T2011) have provided good opportunities for the global scientific community and the Commission to interact constructively. The next conference in the series, S&T2013, was being planned for June 2013 and will be held at the Hofburg in Vienna.

The conference is expected to attract approximately four hundred oral and poster presentations by scientists worldwide, including some from non-signatory States. The presentations will be organized around three themes: the earth as a complex system; understanding the nuclear explosion source; and advances in sensors, networks and processing.

A comprehensive public information strategy has been put in place for S&T2013. A dedicated web site area was created for registration, abstract submission and materials related to the conference. The conference was being publicized through brochures, posters, booths at scientific conferences, direct emails and advertisements in scientific journals.

**Civic Activities**

**Provision of Data for Tsunami Early Warning**

In November 2006, the Commission endorsed a recommendation to provide continuous IMS data in real time to recognized 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. In 2012, an agreement was finalized with the Korea Meteorological Administration of the Republic of Korea.
of Korea. This brought to 11 the number of such agreements or arrangements that the Commission has entered into: with Australia, France, Indonesia, Japan, Malaysia, the Philippines, the Republic of Korea, Thailand, Turkey and the USA (Alaska and Hawaii). Additional agreements or arrangements were being developed with Greece and Spain.

Participation in the Inter-Agency Committee on Radiological and Nuclear Emergencies

The Commission was invited by the International Atomic Energy Agency (IAEA) to attend meetings of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE) as an observer following the Fukushima accident. The IACRNE, which is coordinated by the IAEA, gathers representatives of the European Commission, the European Police Office, the Food and Agriculture Organization of the United Nations, the IAEA, the International Civil Aviation Organization, the International Maritime Organization, the United Nations Scientific Committee on the Effects of Atomic Radiation, the International Criminal Police Organization, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, the Pan American Health Organization, the United Nations Environment Programme, the United Nations Office for the Co-ordination of Humanitarian Affairs, the United Nations Office for Outer Space Affairs, the World Health Organization (WHO) and WMO. Joint work through the IACRNE was found beneficial for all parties, and in 2012 the Commission was accepted as a participating member.