Contributions to an on-line exchange of environmental data

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Abstract

Meanwhile in almost all countries automatic monitoring systems are installed and under operation in order to measure environmental data. Most of them are installed for local, regional, or national survey using different parameter and settings for data acquisition, transmission, evaluation, and storage. Due to the different and often non-compatible solutions scheduled transboundary data exchange is costly and up to now rarely realised.

More and more, natural risks can be restricted only by strengthening the international co-operation. Supplementary to organisational and structural measures for precaution and protection, reliable decision support and forecast becomes essential. This requires the access to environmental data close to real time as well as to historic data beyond national borderlines.

At present, financed by the Commission of the European Communities TechniData is realising an international on-line exchange of radiometeorological data and information being relevant for decision support, governmental and public information. The concept is based on the most modern data base and communication techniques using TCP/IP connections and the EURDEP file standard. The system is suitable to exchange measured data, information in form of figures and graphs, processed data, results of prediction models, and text information and operates in three modes (normal, intensive, test).

The task is designed on different levels: Interfacing of all relevant national systems to one National Data Centre and concentration and standardisation of the related information, implementation of a Regional Data Centre associated to several NDCs and exchange the collected data and information on a regular basis, making data and information available to other RDCs.

Pre-condition for the realisation of the international on-line data exchange is the multilateral agreement on standardisation and data provision.

1 Introduction

The rapid development of information technology in the last 30 years enabled authorities for the environment and civil defence to acquire, evaluate, store and archive a huge amount of measured data and to satisfy the information demands of decision makers, authorities, and the public almost in real time.

Currently, in most countries monitoring systems on a more or less automated base are installed and under operation for the measurement of environmental data (e.g. for meteorological, water, air quality and radiation parameter). Most of them are installed for local, regional, or national issues measuring different sets of parameter and using different standards and settings for data acquisition, transmission, evaluation, distribution, reporting, and storage.

In the age of globalisation new challenges are arising in the field environmental monitoring. Supplementary to organisational and structural measures for precaution and protection, reliable forecast and decision support becomes essential. This requires the access to environmental data close to real time as well as to historic long-term data beyond national borderlines.

Due to the differing and often non-compatible national and local measuring network solutions a continuous and regular automatic international data exchange is costly and is realised only in first approaches for single, neighbouring networks up to now.

2 Standard monitoring network architecture

The architecture of a state-of-the-art automatic monitoring network is quite well known. Usual, a hierarchic communication structure with a master (central station) – slave (monitoring station) operation is chosen.

Different types of sensors measure relevant parameter at the points of interest, e.g. gamma dose rate for radiation monitoring or water level and precipitation for flood early warning systems.

Every monitoring station is equipped with a control unit collecting the measured data from one or more sensors by using standard analogue or digital interfaces (e.g. 4 ... 20 mA, 0 ... 5 V, impulse, RS232, RS485, etc.). The unit controls the status of the station components and of the power supply, buffers and pre-processes the acquired data, controls alarm thresholds and exchange the data with the central station (on request or event-driven).

The central station represents the “heart” of the monitoring network. It’s main tasks are remote status control of the monitoring stations, regular request for data from the outstations (in addition, the input of manually collected data), evaluation, storage and archiving of all data, data presentation via different media (screen, printer, Internet, etc.), as well as reception and processing of spontaneous alarm messages from the stations.

Depending on the existing communication infrastructure in the concerned area different kind of channels are used for communication between the centre and the stations. The most common wired connections are analogue or digital operated telephone lines. In remote areas often wireless radio links are necessary usually requiring additional relay or repeater stations. Non-wired data communication possibilities are extended by GSM and – in future – UMTS services and the more expensive connections via satellites. In addition, small-scaled applications often uses field bus technology.

Beside this numerous communication solutions on the physical layer, there are numerous protocol standards and proprietary formats for the different applications.

Even this short survey about the possibilities shows that more or less small differences in the requirements, measurement philosophy, infrastructure, environmental conditions, administrative structures or project budget have generated and will generate big differences in the hardware and software solution (Stuffer [1]).

3 Data exchange between monitoring systems and standardisation

Due to increasing transnational problems (floods, pollution, radiological threats, etc.) the requirement of automatic international data exchange close to real-time is increasing. Proceeding from the isolated application of a single monitoring network to a real transboundary information system the more sophisticated problem of a data exchange between systems with non-compatible standards arises. “Real information system” in this context means on the one hand the distribution of evaluated and processed data and of data presentations to other systems, organisations, authorities, or to the public (e.g. via Internet), and on the other hand the import and processing of data and information from other systems for own purposes.

Because of the numerous existing non-standardised national and local network solutions a real automatic international data exchange is costly, restricted to the involved parties, and therefore, up to now rarely realised. Mostly, the required data exchange across boundaries takes place on a non-scheduled and/or non-standardised basis.

Nevertheless, the current software and hardware technology provides the tools to solve the related problems in a satisfying manner. Basing on an open information system as a superior data collection and exchange platform including tools for uniform data presentation basing on standard browser technology an international data exchange can be achieved in a standardised way. The main problem is the standardisation, i.e. the agreement of common rules for data acquisition, processing, and exchange on an international level.

4 Prototype system for radiometeorological data exchange

Kicked off and founded by the European Commission, the most important steps for the realisation of an Europe-wide network for radiological survey are done: a standard exchange format is agreed and a supranational exchange network is under implementation including rules for participation.

4.1 Occasion and purpose

After the Chernobyl accident monitoring networks and information systems of various kinds have been established in many European countries. In general, these systems are restricted to the area of one nation and it is not possible to exchange data between different countries quickly without implementing specific bilateral interfaces between the different systems.

It is evident that in case of a nuclear accident a quick and reliable exchange of radiological data and information between the involved countries is of great importance for an efficient emergency response. For that reason, the "Development of a Prototype System for the International On-line Exchange of Radiological Data and Information in the Event of a Nuclear Emergency" was initiated by the European Commission [2].

The main objectives of the "PDX" project are to:

- investigate the feasibility of a network for on-line exchange of radiological data, meteorological data, diffusion model results, graphical data and other information between countries in Eastern Europe and between them and the EU, which is based on existing monitoring stations, networks, data bases, prediction models, and decision support systems.
- agree on common data formats for the exchange of data and information
- define, set up, and operate a standardised interface for the exchange of data and information between the participants and with compatible systems in EU countries.

- develop software for integrating the existing national systems.
- set-up a technical system and an operational regime for fast and regular exchange of data and information between countries in Eastern Europe by providing the required hardware and software
- perform tests to demonstrate the feasibility of on-line exchange of radiological data and information between the participating countries and between them and the EU

During the prototype phase of the project the following National Data Centres (NDCs) and Regional Data Centres (RDCs) will be implemented and connected via WAN by TechniData (see figure 1):

- 3 NDCs in Russia, Belarus, and Ukraine with an associated RDC in Russia
- 1 NDC in Hungary with an associated RDC in Hungary
- 1 RDC at the Joint Research Centre of the European Commission in Ispra/Italy as well as a receiver station for the exchanged information in Germany

In total, about 20 target organisations in 6 countries – data provider, communication service provider, and end user – are involved in the realisation of the project.

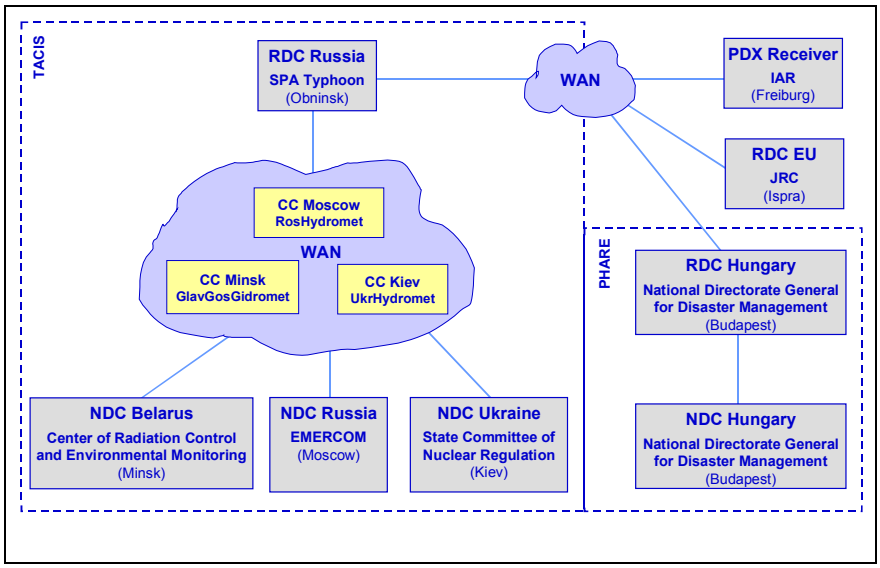

Figure 1: Participating parties in the international data exchange

4.2 System tasks and levels

The system is suitable to exchange, visualise, and store measured data, information in form of figures and graphs, processed data, results of prediction models, and text information and operates in three modes: normal mode, intensive mode in case of an emergency, and test mode for emergency training.

Most important for the project's success is that the data exchange on the transnational level (NDC – NDC, NDC – RDC, RDC – RDC) is based on the European-wide agreed EURDEP file standard (European Union Radioactivity Data Exchange Platform, de Vries et al. [3]).

The work is performed on different levels (compare figure 2):

- Connection of all relevant national monitoring networks and decision support systems to one National Data Centre (NDC) and concentration, standardisation, storage, visualisation and exchange of all relevant environmental data, information and results from the national systems
- Implementation of a Regional Data Centre (RDC) associated to several NDCs and exchange, store, and visualise data and information between the NDCs
- Data exchange between the different RDCs

In principle, the same software is running on the RDC and NDC computers including modules for unified data im- and export, for visualisation, and for data storage, but adapted and scaled to the national requirements and conditions (Stuffer et al. [4]).

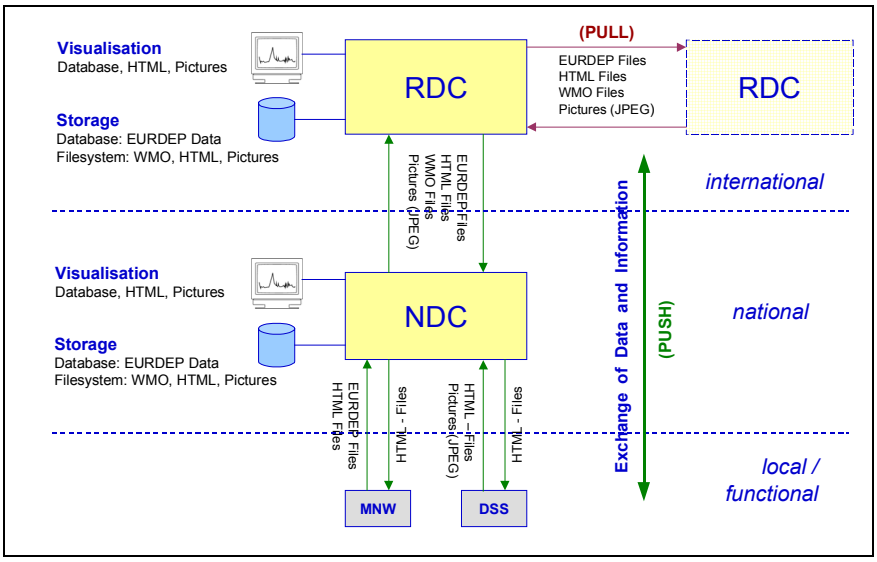

Figure 2: Data exchange system levels

4.3 Interfaces to national systems

For standardisation reasons, every national subsystem dealing with data collection and generation will be responsible for data and information export from their own data structure to the agreed standard file format (EURDEP) and for file transmission via FTP to the associate NDC file exchange system in a scheduled way (see figure 3). For file transmission each NDC acts as a FTP server and the associated national systems as FTP clients.

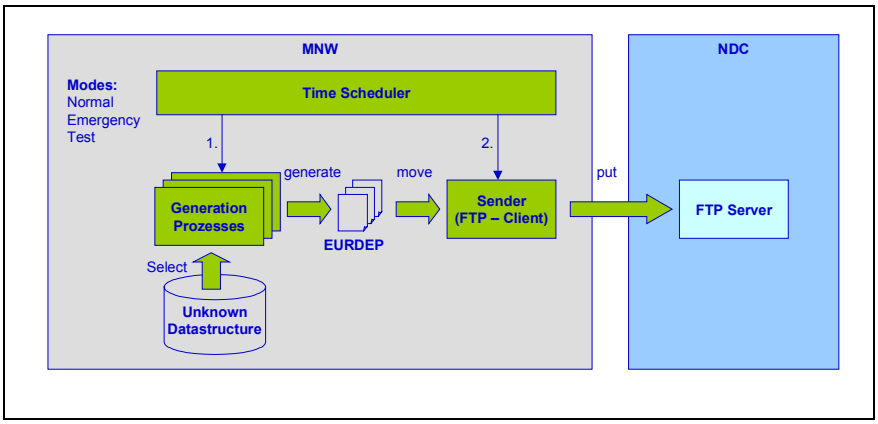

Figure 3: Basic principle for file export from the national systems

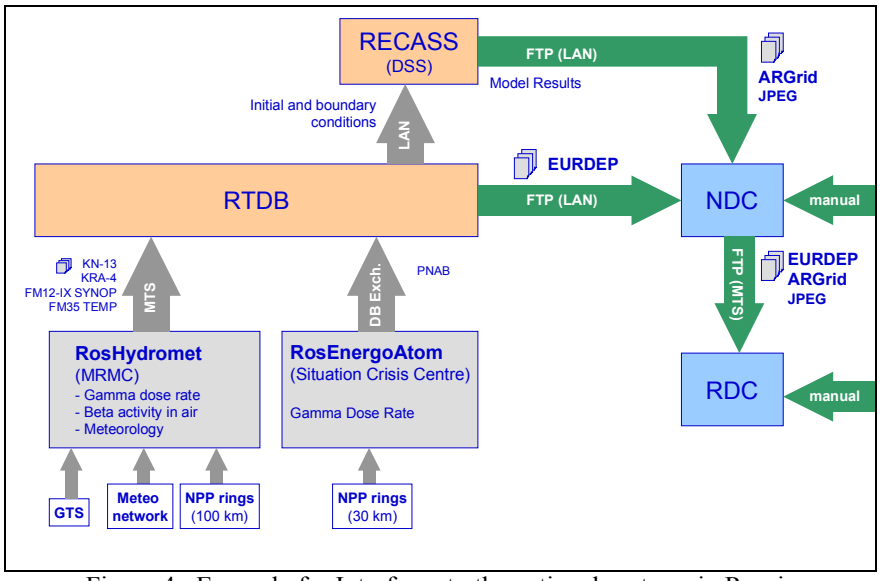

Figure 4: Example for Interfaces to the national systems in Russia

As an example, figure 4 shows the implemented interfaces to the Russian systems for monitoring and decision support.

4.4 Data Exchange

The following principles are acting on data exchange concerns:

1. Wired communication
   All data transfer is based on wired connections via local area networks as well as via dedicated and dial-up telephone lines (WAN). Depending on the data traffic the WAN lines are operated as analogue connections using V.34 standard or as digital connections with transfer rates between 64 kbps and 2 Mbps.
2. Standard file formats
   Exchange of data and information is performed via files. The allowed exchange file format for measured data within PDX is restricted to EURDEP.
3. Standard protocol
   File exchange is performed via FTP by using respective server software on each PDX node.
4. Push system on the national and regional level
   On the national and regional level (MNW/DSS ↔ NDC, NDC ↔ RDC) the respective sender is responsible for data transmission via FTP, which has to be performed in an automated, regular, and scheduled way.
5. Pull system on the inter-regional level
   For exchange of data and information between different RDCs new files will be made available on the FTP server of the RDC during a settable time interval and available files can be polled from other RDCs via FTP on demand avoiding redundant or non-required information transfer.

The standard data flow within PDX can be outlined as shown in figure 5.

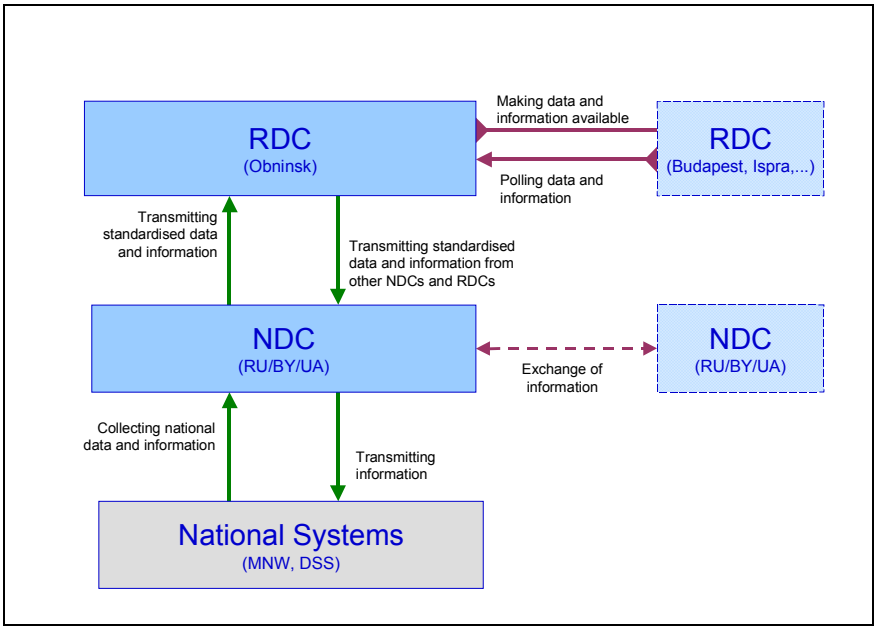

Figure 5: PDX standard data flow model

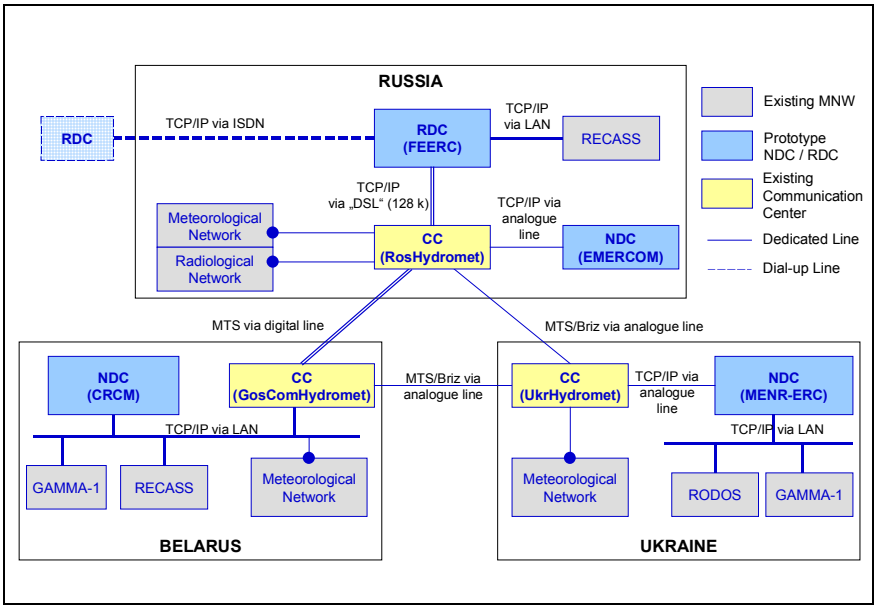

Figure 6: Physical implementation of PDX (simplified excerpt for RDC Russia)

To establish reliable and efficient communication lines according to the system requirements partly new lines has to be introduced, partly existing lines of the WMO Global Telecommunication System (GTS) will be upgraded, which has to be used together with the common WMO data stream on basis of defined priorities.

At the end, numerous communication standards, protocols, and formats on the sub-national level will be handled by one single superior platform and a standardised and regular data exchange on the inter-national level will be achieved, even for complicate communication infrastructures as shown in figure 6.

4.5 Perspective

After shown the "feasibility", the system will be extended to other European countries and connected to further data sources. Data dissemination to other authorities and organisations as well as to the public via Internet is optional. In order to handle the transferred data volume by avoiding non-required data a switch from a push to a pull system on the national level is intended after respective bilateral agreements.

The exchanged data are basis for the common European forecast and decision support system called RODOS being implemented step by step in all European countries, which supports disaster management authorities in the event of a nuclear emergency.

Final objective is to come to a standardised and comparable reporting and decision support, which will relieve decision makers and disaster management, and will strengthen the cooperation between national task forces in case of transnational emergencies.

Besides the technical aspects, main emphasise has to be put to the political implementation, i.e. the involvement of different responsible national institutes, organisations, and ministries in order to achieve an agreement for a guaranteed data content to be exchanged in case of an emergency.

5 Conclusion

Growing with technical progress and ecological awareness, there are European-wide attempts to facilitate the exchange of important environmental data internationally in order to solve increasing "globalised" environmental problems and to satisfy increasing reporting obligations to international organisations like the EU.

It can be asserted that current information technology is appropriate to fit the modern challenges for transnational environmental monitoring and decision support by integrating the existing national and sub-national systems without disturbing their operation. But prerequisite for an automatic multilateral exchange of real-time data is the agreement of an international exchange standard.

Partially, there are already successful agreements, e.g. for exchanging radiometeorological data and information by using the EURDEP standard. But in general, standardisation of environmental management issues in Europe is at its beginning. Most of the numerous national, bilateral, and multilateral efforts to agree on common standards, e.g. in the fields of water or air quality monitoring, are isolated projects up to now.

Therefore, more “political” support is required in order to carry on standardisation in the field of environmental monitoring, which means introduction of standards in data acquisition (measuring methods, measuring accuracy, mean value generation, measuring frequency, etc.) and introduction of standards in data exchange (protocols, formats, regularity, security, reliability, operation modes, etc.).

Abbreviations

CC	=	Communication Centre
DSS	=	Decision Support System
EURDEP	=	European Union Radioactivity Data Exchange Platform
FTP	=	File Transfer Protocol
GTS	=	Global Telecommunication System of WMO
JRC	=	Joint Research Centre, Ispra (VA), Italy
LAN	=	Local Area Network
MNW	=	Monitoring NetWork
NDC	=	National Data Centre
PDX	=	Prototype system for the international on-line Data eXchange
RDC	=	Regional Data Centre
TCP/IP	=	Transmission Control Protocol / Internet Protocol
WAN	=	Wide Area Network
WMO	=	World Meteorological Organisation

References

[1] Stuffer, S., Recent Aspects in the Development of Integrated International Information Systems. *Hydrological Challenges in Transboundary Water Resources Management,* ed. Deutsches IHP/OHP-Nationalkomitee, Koblenz, pp. 189-199, 2001

[2] European Commission (ed.), *Terms of Reference for the Development of a Prototype System for the International On-line Exchange of Radiological Data and Information in the Event of a Nuclear Emergency*, 1998

[3] de Vries, G., de Cort, M., Giuliano, S., Fontana, F., Gatti, S. *Concept and development of an exchange format for European radioactivity data, version 1.3.2*; Environment Institute of the Joint Research Centre: Ispra, 1999

[4] Stuffer, S. & Walter, F. *Inception Report and Detailed Design for the Prototype System for the International On-line Exchange of Radiological Data and Information in the Event of a Nuclear Emergency*, TechniData: Markdorf, 2001