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Development of common tools and an information infrastructure for the shared European environment information system

Preparatory report for Reportnet

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Executive summary

A huge amount of environmental data and information is reported annually by countries in Europe to the European Community and international organisations. It is now widely accepted that a revision of this reporting is necessary in order to increase efficiency.

This report proposes the development of an environmental information structure to reduce the reporting burden and allow for better use and reuse of the information reported. Hence, this report is first and foremost about cooperation. The networks that are currently operating in international environmental reporting, such as the EEA/EIONET, the European Commission, the OECD and the various international conventions, should add a new dimension to their cooperation to attain a shared European environment information system. Under this umbrella, they should define and share a common understanding and goals, largely in the form of an information structure, which each organisation can use for its own purposes as well as to support the overall goals.

Information technology plays a key role in the development: it helps make information become available faster and increases the transparency of public administrations. Development of a shared environmental information structure would thus contribute to the goals of '*e*Europe' and 'Government online' in the environment sector.

The report describes the practical implementation of such an information infrastructure through an application suite called Reportnet. Reportnet is envisaged to include components for reporting obligations, meta-data, directory services, data repositories and process monitoring, and would be built using and contributing to IDA common tools and techniques. Most of the technology underpinning Reportnet is or will soon become available.

Reportnet is an implementation of a data collection network in a situation where data volumes vary (but are usually low) and the frequency of reporting is typically once a year, where users are widely distributed but committed to a network solution to data flows and dissemination, and where, unlike in the case of economic data, there are few, if any, examples where access to data is classified by commercial in-confidence restrictions.

Because of the complex interactions with the various stakeholders involved, new approaches to managing software engineering and organisational change during the development process are required and have been identified in the report.

1. Introduction

1.1. Who should read this and why?

This report was originally written for consideration within the EIONET and by EEA clients at the European level, in particular the Environment DG, Eurostat and the Joint Research Centre (JRC). It is, however, also of interest to policy-makers involved with legal reporting obligations in any sector as well as members of the statistical and research networks of Eurostat and the JRC.

Since 1998, the EEA has, to some extent on separate tracks, reviewed EU reporting obligations (e.g. ROD), improved and streamlined the relevance of reporting to policy evaluation (e.g. indicators) and developed electronic tools and infrastructure (CIRCA, DEMs) to facilitate more efficient reporting by countries.

Today, we know much more about the information system we would like to develop for the future and hence the IT tools and infrastructure we need in order to facilitate this development efficiently. This thinking is elaborated in the new EEA strategy (EEA, 2001), which has at its core the concept of a shared European environment information system, on which the existing e-EIONET can be expanded to what often is referred to as Reportnet (Teller et al., 2000; Norup, 2001; Saarenmaa, 2001).

This report sets out the EEA's thinking on how Reportnet should evolve. In particular, it describes how we can marry most efficiently work under way under the EEA core budget, for example streamlining data and information reporting obligations and developing indicators and assessments, with work to develop IT tools and infrastructure for the benefit of the Member States that are managed by the EEA under the auspices of the IDA programme.

Abbreviations and definitions are explained at the end of this report.

1.2. What is the challenge?

For more than a quarter of a century, EU environmental policy has developed rapidly so that there are now over 100 major pieces of legislation in place, covering the entire spectrum of environmental issues from global climate change and stratospheric ozone depletion to the protection of local biodiversity. These Community laws set the framework for a considerable part of the environmental policies of all 15 current Member States, followed by the three countries of the European Economic Area, which are also EEA members, and will soon be applied in 13 candidate countries as the Community enlarges.

What is referred to as the current reporting system is, in fact, a largely incoherent set of reporting requirements in EU environmental legislation, in EEA and Eurostat questionnaires and as part of different international environmental conventions. It is the result of three decades of development of European environment policy, whereby reporting is usually a by-product (albeit an indispensable one) rather than the main focus of the policy (Environment DG, 2002a).

To assess whether Community environment policies are working, data and information are collected by the Member States and reported and analysed at EU level. Although there are a myriad data and information reporting obligations at the international, EU and national levels — so much so that Member States often complain of 'reporting fatigue' — much of the information currently gathered is of limited use in assessing the impact of environmental measures. As the 'Bridging the Gap' conference (Anon., 1998) concluded:

'... some of the systems for monitoring and gathering information about the environment in European countries are inefficient and wasteful. They generate excessive amounts of data on subjects which do not

need it; and they fail to provide timely and relevant information on other subjects where there is an urgent policy need for better focused information, and for consistent environmental assessment and reporting.'

This message has now been fully taken on board by the European Commission and EU Member States. The common position on the proposed sixth environment action programme (6EAP) highlights the need to

'review and regularly monitor information and reporting systems with a view to a more coherent and effective system to ensure streamlined reporting of high-quality, comparable and relevant environmental data and information'

and to undertake

'*ex ante* evaluation of the possible impacts, in particular the environmental impacts, of new policies …

ex post evaluation of the effectiveness of existing measures in meeting their environmental objectives.'

So the challenges are to revise the reporting system to enable us to know more about the effects and effectiveness of the EU's environmental measures, to rebalance the reporting effort, so that only the most essential types of information need to be collected and reported, and to exploit IT developments so that we do all this in the most efficient and transparent way. This is a joint challenge for both the Member States and the EU institutions, working together and sharing ideas.

These goals are fully compatible with the larger pursuit of '*e*Europe'. The 'Government online' action aims at increasing transparency of public institutions by facilitating access to information and by developing a coordinated approach for public sector information, including at European level.

2. Current and future reporting needs

2.1. The current reporting obligations

Almost all items of EU environmental legislation require Member States to report in some way to the Commission. Currently, the information requested falls into the following five types.

1. *Legal transposition:* Details of Member States' national laws enacting EU legislation.
2. *Practical compliance:* Data on exceedances of environmental standards, limit values, national derogations, etc.
3. *Environmental data:* Data on environmental pressures and state of the environment.
4. *Descriptions of policy measures:* Plans, programmes and instruments put in place by Member States to comply with EU legislation.
5. *Policy effects and effectiveness:* The effects of these measures and the extent to which they achieve their objectives.

Most emphasis is given in the legal system to types 1, 2 and 4. All these different kinds of information are channelled from the Member States to the Legal Unit of the Environment DG through periodic, national reports on implementation. In recent years, the Commission has made progress on publishing reports evaluating implementation at the EU level, for example the standardised reporting directive reports for water and waste. However, in many cases, the information provided by countries remains non-transparent both to other countries and to users outside the policy loop, for example NGOs, and the interested general public. The Aarhus Convention will require a major change in information provision and access by all parties, and should help overcome these current shortcomings.

The system as it currently stands has grown incrementally as the Commission and the Member States have agreed reporting requirements for separate laws and sectors, in most cases independently of one another. The growth in the types of reporting requirements has therefore been organic rather than strategic. As a result, some valuable types of information are not collected at all; some officials who need access to the information that is available do not receive it, and Member States sometimes fail to report entirely in response to a growing burden of reporting obligations, the value of which may not be immediately obvious to them. The EU institutions and the Member States all suffer from this unsatisfactory situation.

In addition to legally based obligations, Member States are also required to respond to a myriad of 'moral' obligations, mainly emanating from the EEA and Eurostat in the EU, and from the OECD and international conventions at the wider international level. These obligations focus mainly on type 3 information and there are overlaps and duplication of effort across institutions. Such obligations have been defined for purposes other than those defined in EU legislation, such as for trend analysis in state-of-the-environment reports, monitoring progress under separate conventions, and, more recently, for the development of indicators to support reporting on the progress of EU environmental policy, sectoral integration and of the future sustainable development. Yet it remains difficult to obtain the types of information needed by policy-makers to assess the effects (using indicators) and effectiveness (using models etc.) of EU policies and other international commitments.

2.2. Towards a new reporting system

The review of environmental reporting, launched by the Environment DG (2002a and 2002b) as part of the sixth environment action programme, should create a more coherent and effective system for reporting data on the environment.

The EEA and EIONET, through the 'bridging the gap' process, have been considering how we could move towards a more balanced reporting system which meets policy needs and addresses the issue of reporting

fatigue in Member States. This process has yielded a number of broad and specific recommendations (Anon., 1998) that will be used to support the deliberations of the 6EAP review.

These recommendations cover the following four elements:
- developing policy-relevant frameworks for assessment based on key policy questions and relevant indicators;
- streamlining the current reporting obligations to remove redundancies and duplication;
- developing new methods for collecting, analysing, modelling and comparing data at the EU level, utilising existing and new data to fill information gaps;
- optimising institutional cooperation so that information is reported once but used by many, thus maximising efficiency.

Work on indicators is developing rapidly. However, it will be some time (5–10 years) before reporting obligations have been retuned to deliver the data, information and assessments required for policy-relevant indicators. Proposals for streamlining the current reporting obligations have evolved from analysis of the reporting obligations database (ROD) and other sources, but it will take time to unravel current legal obligations and establish new legislation (e.g. planned for 2009 under the water framework directive). For the foreseeable future, countries are likely to be required to continue to meet existing obligations.

New methods have been developed to support indicator production and policy evaluation (environmental accounting, scenarios/outlooks) and while these will ensure the better-quality information demanded by ministers, commissioners, and parliamentarians, they will in the short term add to the reporting burden.

This all indicates that most progress can be made in the area of common frameworks and approaches (e.g. indicators) and streamlined institutional cooperation. This is recognised in the new EEA strategy (EEA, 2001) and the proposals to develop a common, shared European environment information system (EEIS), on which the existing e-EIONET can be expanded, and which is often referred to as 'Reportnet'.

2.3. How can information technology help?

The principles underlying Reportnet are that:
- countries should be required to report information only once against well-defined needs based on policy objectives;
- this information is held in a well-designed repository to enable ease of access and development of a corporate memory;
- those institutions at the international level which need this information are able to access it whenever they want;
- countries share information to enhance policy learning;
- information is transparent and accessible thus enhancing participation and improving quality through use and exposure.

The development in recent years of the web means that IT tools and infrastructure can be designed to support implementation of the Reportnet principles. In particular, the current trends and tools in e-business, which are mainly based on applications of XML, make it feasible for organisations to interchange, share and publish data much more effectively than was the case in the past.

The rest of this report focuses on the development of the necessary IT tools to support the evolution of Reportnet towards these goals. In doing so, it addresses:
- the current situation on implementation of e-EIONET strategy;
- the explanation of the EEIS and Reportnet concepts from an IT perspective;
- design concepts for the Reportnet architecture and the underlying information infrastructure;
- evolution of the e-EIONET from 2002 onwards to deliver the needed architecture;institutional responsibilities and synergies in building a shared information system;
- conclusions.

2.4. Description of the business processes to be supported

In general terms, the current and future business processes to be supported in the development of Reportnet have been discussed above. However, a fairly detailed

description is needed so that the software's main functions can be identified. Such a description is the best guarantee that the developed systems will effectively support the stakeholders (Figure 1).

The process should ideally begin while the legislators and conventions are still deliberating the reporting needs of the forthcoming directives, regulations and laws. These are analysed by the international agencies that agree in detail in committees with the stakeholders about data elements, reporting frequency, delivery format and other relevant issues.

Countries then analyse how these requirements can be fulfilled and designate responsible persons and institutions to the tasks. They plan for the reporting work knowing the impending deadlines and availability of data. In order to facilitate data collection and assure the quality of the result, software tools and guidelines are made available by the international reporting community.

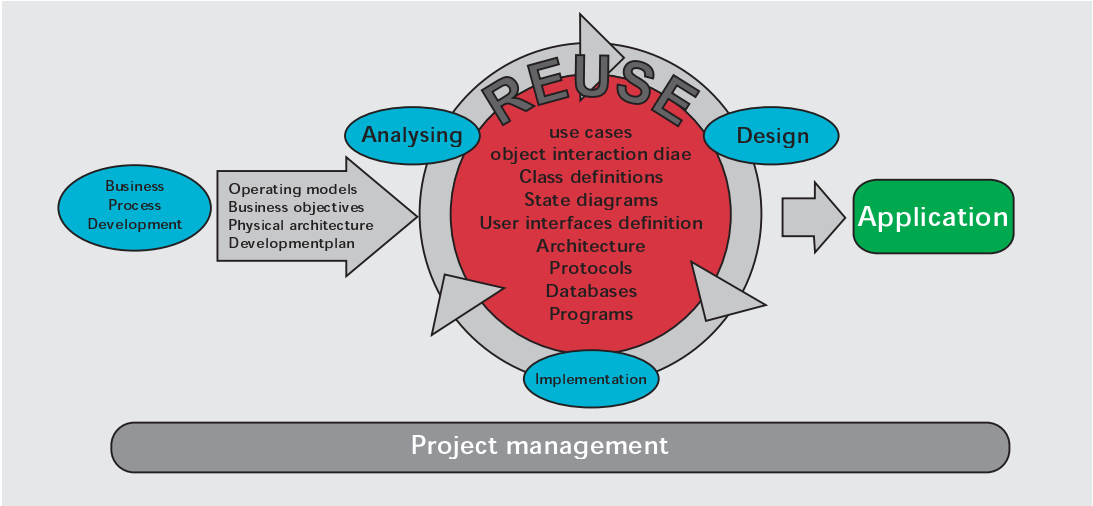
Before countries release the data to their intended recipients, they go through several steps of evaluation. Do the national data sources and international requirements match at all? Are the data which consist of aggregate values derived from other sources technically correctly calculated? Do the data fit within any existing nationally agreed limits? Can these data be made publicly available?

At the time of delivery, the authorised national department packages the data and makes them available for the international coordinator as agreed. When the international institutions receive the data, they check them and forward them to their analysts for management and production of the indicators that are needed to monitor compliance with the legal requirements and other agreed targets. These indicators are published in reports and public web services.

The above description of the basic reporting process is not overly complicated. However, there are dozens of such processes running at the same time. Since very similar requests often arrive from other members of the international reporting community, the data compiled for one reporting cycle are scrutinised, complemented where needed and packaged again for another delivery. When only one national institution is concerned in providing data to the international level, the reuse rate can be reasonably large, but often international reporting is distributed to different authorities, which complicates matters.

At the international level, integrated environmental assessment often requires data from several processes to be brought together. Information on where to locate such data and how to understand them correctly must be available.

Figure 1 **Modern software is built from reusable components each of which supports a small part of the identified business processes. Example from TietoEnator (2001)**



3. Current situation

3.1. Results of the e-EIONET and Teresa projects

In 1999–2000, the EEA produced, in collaboration with a task force from the member countries and with IDA and contractor assistance, a new strategic plan for application development in the EIONET, known as the SPADE (2000) strategy, and a related global implementation plan (see e-EIONET, 2000). Before the e-EIONET, the Teresa (1999) project had already produced several components that could later be included in the e-EIONET.

The e-EIONET global implementation plan identified several objectives relevant for reporting:

- to develop and implement for use by the EEA/EIONET the second generation of collaboration and data exchange applications;
- to achieve shorter monitoring, assessment and reporting cycles;
- to offer process owners powerful tools to manage, modify, supervise and control data and information reporting and other key processes;
- to provide a technological platform that helps remove duplication and which decreases manual work during the information gathering process and thus also unnecessary data and information reporting burdens in member countries and responsible organisations.

Moreover, five areas of application development were identified in the global implementation plan.

1. Telecommunication and hardware infrastructure of the current EIONET must be developed to a higher capacity and appropriate degree of decentralisation.
2. Collaboration services, including development of workflow management and progress monitoring tools and services, should be further developed to align better with the functions and roles within the organisational EIONET.
3. New generic and shared data management and data-flow tools are required to enable and encourage harmonisation and efficient management and collection of data so that the reporting burden is decreased in member countries.
4. In data warehousing, a new architecture is required that allows ETC databases to interchange data with the EEA data warehouse, and thereby make the data publicly available.
5. Through portal development, integration of technologies, value chains and interfaces found in the various online services can be integrated into a uniform personalised corporate portal.

Core recommendations in the global implementation plan also included descriptions of the approach. There should be no grand plan, but, instead, learning by doing using an evolutionary approach. The stable core content should be harmonised, but not content that is still evolving. A data registry should be created to provide the basis for harmonisation. National data warehouses should also be created to host the national data. The data-flow tools should be integrated with CIRCA, and XML be used as the data interchange format throughout. Where feasible, IDA common tools should be built on.

The development projects completed (or almost completed) include national data repositories in about 30 distributed CIRCA installations, a central data repository (CDR), a content registry (CR), a data dictionary (DD) including an XML schema registry, a portal toolkit (PTK), a data service for the available indicator data sets, data exchange modules (DEMs) including XML output, comprehensive directory services, a reporting obligations database (ROD), national modules for ROD, a workflow tool, and the application of these technologies in topic databases such as Waterbase, OzoneWeb and the European nature information system (EUNIS). These developments have been achieved on an annual budget of about EUR 1.5 million, most of which has been provided by the IDA programme. The majority of these components have reached the status of 'release candidate' or are already in operation. The total cost of the e-EIONET and

Teresa projects during the IDA II programme was EUR 3 033 000.

With regard to the content, 11 EIONET priority data flows have been defined. Regular progress reports are made and a list of stable indicators is still under development.

Use of a national data repository in CIRCA or a central data repository is becoming a widely accepted goal. Denmark has reorganised its international reporting activities and now publishes all the reported data on a central data repository. Air emission data flow has been implemented on top of CIRCA repositories in all countries. Country Databases on Designated Areas (CDDA) data flow is, for the most part, also handled this way. The rest of the data flows are still outside the basic e-EIONET infrastructure.

XML as the data interchange format has not yet reached operational status, although a pilot for developing Waterbase can be used to demonstrate how it works and the DEMs will soon be able to generate XML data interchange files. Obviously, XML-based data interchange will work fully only when the data dictionary and a schema registry have been completed to support it.

3.2. Problems

Although the tools are becoming available, organisational change is still slow. EIONET priority data flows are gradually being re-engineered to the recommended data-flow architecture. A large proportion of data to underpin EEA indicator production is still received from outside the regular EIONET data-flow process. However, the EEA's move towards an agreed core set of indicators by the end of 2002, to regularise its reporting activities over the next 5–10 years, will see the EIONET priority data-flow process extended to underpin the implementation of the core set.

User participation in the projects has not been very enthusiastic in all areas. Consequently, it has been difficult to get the systems beyond the prototype phase into full operational capacity and into operation. This is especially true with systems developed by outside consultants, which indicate that project management must be improved. EEA in-house developments have generally been more easily brought into production.

It has been very difficult to specify systems in advance with sufficient detail so that when they are delivered (typically the year after) they are still in line with current ideas. Users do not seem to have the time and patience to go through the several steps of requirement specification, architectural and technical design, detailed design and testing that are required by the IDA project management. The development cycle takes well over a year. After that, user needs usually have become clearer and another round of developments and enhancements is needed. This implies that prototyping must be done much faster.

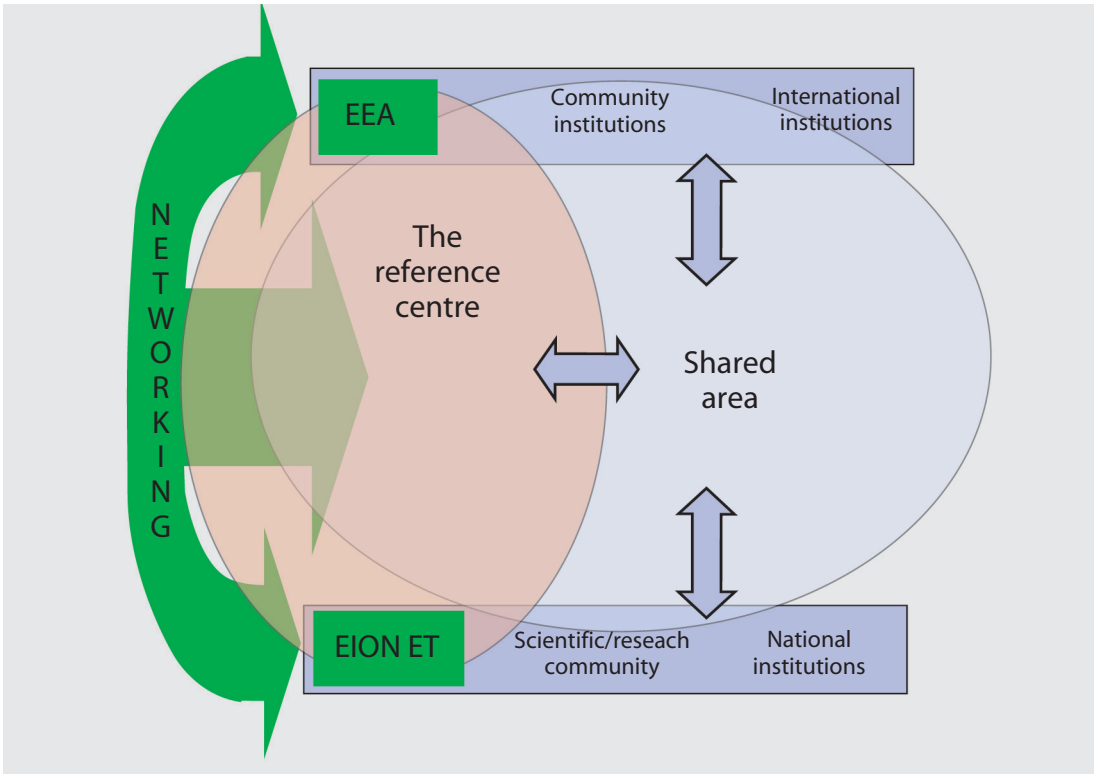
These problems make it clear that further projects must concentrate on the organisational aspects of environmental reporting.

3.3. Relationship to the existing IDA and Eurostat data collection tools

The e-EIONET and Teresa projects have produced a fairly comprehensive suite of data collection tools that could even be candidates for IDA common tools. The IDA architecture guidelines (Version 6.1) specify road maps to several kinds of model networks. These include data collection, data exchange, data dissemination, data sharing, alerts, and service process networks. In this taxonomy, Reportnet is an implementation of a data collection network in a situation where data volumes vary (but are usually low) and the frequency of reporting is typically once a year, where users are widely distributed but committed to a network solution to data flows and dissemination, and where, unlike for economic data, there are few, if any, examples where access to data is classified by commercial in-confidence restrictions. These characteristics are fairly typical for a large part of international reporting in most sectors.

For high-volume and regular data flows, IDA has available Eurostat's common tools Stadium and Statel. These have been investigated, but have been deemed too big and demanding for the current characteristics of the data flows to be supported on the EIONET. There are, however, features within these tools that could be adapted into the Reportnet tools being developed for the same purpose.

The European environment information system Figure 2



4. New framework for environmental information sharing

4.1. The wider integration proposed by the EEIS

The new EEA strategy (2001) explains the need for harmonisation of environmental data and information. In order to simplify and streamline this process, it suggests improving networking with all the members of the international reporting community involved and developing the vision of a shared European environment information system (Figure 2). The EIONET is only one network contributing to the shared information pool. The long-term vision is to get agreement between countries and international institutions (both EU and non-EU) on a common core set of indicators and underlying data flows. These would then be implemented through the EEIS so that data would be reported once by countries (e.g. through Reportnet's content repositories) and be accessible to all the institutions and networks so that they could produce, using the same data, the indicator-based assessments required under their respective institutional mandates.

This being a big ambition, it has to be based on set *principles* that will carry it forward.

- First, it is recognised that there is a wider international and European *environmental reporting community,* i.e. a network of environmental information providers. Their joint networks can be called the European environment information system. The EIONET is the EEA's network that consists of administrative and scientific institutions at national level. The community that makes up the EEIS will also consist of other networks such as that of Eurostat and its data providers and the various permanent or ad hoc networks which are built around European and national scientific organisations or NGOs. All these and related partners are providers or users of reported environmental data and should therefore share an interest in improving the related business processes.
- *Technology* nowadays helps to ease this process through the availability of an electronic infrastructure (the world wide web) that allows for distributed responsibilities and at the same time eases the integration of different web services through a common technical language (XML). To assure interoperability, the simple HTTP and SOAP protocols are used for communication. The essence of Reportnet functionality is to agree on standards on how to use XML, SOAP and related mechanisms.
- A good starting point is that the EEA — with the support of the IDA programme — has already developed a basic technical infrastructure for a network for environmental data exchange (e-EIONET). This basic infrastructure will be further extended to cover data harmonisation. This will be supported by a framework of data standards, data interchange formats, communication protocols and directories that form an *information infrastructure* enabling information sharing and interoperability of applications and tools.
- The e-EIONET has built on CIRCA as a tool and generic service since 1997. More tools are on their way and will soon form an integrated suite that covers most functions required from a data collection network. These tools and the *applications* they make will be implemented more and more in open source allowing for better exchangeability and maintenance. This is also being achieved by using modular designs that allow for adding and skipping modules if necessary.

These are the building blocks of the EEIS. Their essence and general principles shall be well understood and widely communicated. Inside the EEIS, the EEA proposes to spearhead the necessary standardisation and harmonisation efforts. The EEA not only has the mandate and the experience to go ahead, but also a strong and committed network from which to work.

4.2. Introducing Reportnet as best practice

The EEA now aims at introducing a best-practice example to be shared with other stakeholders through the development of the EEIS concept, the supporting information infrastructure and its implementation through Reportnet. While the architecture shall serve the immediate EIONET needs on one hand, it is open to interface with other networks' technical solutions on the other. This is due to the fact that national environmental data remain at the provider in a non-aggregated form. Institutions that need to aggregate such data, for example for European or international assessment purposes, can retrieve them from the provider and make use of them. If delivery of and receipt for them are legally required, these can also be provided.

The initial Reportnet functions (see Figure 4) are identified here before the technical implementation is presented in the next chapter.

- One of the abovementioned organisational aspects is that as data providers countries are interested in reducing their efforts of reporting the same or almost the same data and information to various institutions. This data shall in the future remain in repositories maintained by the countries themselves. This broader concept replaces what was called 'a national data warehouse' in the e-EIONET GIP.
- Crucial to networking is an updated directory of network partners and their roles in the network. To have this directory centralised appears advisable for reasons of better maintenance, but its content updates should be the responsibility of the countries.
- In order to determine what exactly the reporting obligations are, information about them as they stand from European legislation, conventions and other sources must be made available for other applications. Ideally, they need to be customised to the situation in the individual countries and databases to facilitate such dynamic views.
- Indicators shall be derived from the obligations and the consensus-building process among administrative and scientific interests. These shall be linked to the available data and, where data are not yet available, push to bridge this gap. The indicator part of the application shall also build on the modelling results of the network partners.
- The thorough description and quality assessment of the data exactly underpinning these indicators are tasks of a registry of parameters called a data dictionary which comes together with a registry of what data has been reported by whom and when (meta-data).
- The available data flows are referred to as the collection process. Here we will see the integration of the present data exchange modules (DEMs) based on the next generation CIRCA developments.

4.3. What is meant by an information infrastructure

There will always be many partly overlapping networks in the environment sector and the EIONET is only one of them (Figure 2). These networks have agreed and will agree to exchange data in a variety of proprietary forms. Many of them have little knowledge of existing or emerging data interchange standards. It would be wrong to assume that other organisations would join the EIONET and everything could be orchestrated by the EEA and there would be no overlapping reporting.

Therefore, another dimension of cooperation will have to be developed for more efficient and effective reporting. During the recent strategy work (EEA, 2001), this missing component was identified as a common information infrastructure. This means that multiple networks, which together make the EEIS, will share common goals. These common goals will enable them to share information efficiently. Data will be collected once by Member States and then reused by all the international reporting community.

What exactly is an infrastructure? In general, it allows people to build on one another's work. Infrastructure is often understood only as a physical, legal and financial entity, something basic that can be left to lawyers and technicians. Information infrastructure is an increasingly common notion, meaning the mechanisms and permanent structures that *enable* information sharing. These include standards, services

and support actions for representing, addressing, locating, exchanging and securing information. In broad terms, information infrastructure is everything that enables the sharing of information indirectly. Isaac Newton once wrote 'If I have seen farther than other men, it is because I have stood on the shoulders of giants'. He meant that there was an information infrastructure of science that he could build on. If there is no information infrastructure, everyone must build up his or her solutions from scratch. This is very wasteful, but it has been the usual approach due to the structure of the current international reporting system.

To be exact in computer terms, information infrastructure is an agreed set of:

- data interchange formats, such as XML;
- documented and shared data definitions, for example XML schema;
- communication protocols, such as HTTP for accessing information and SOAP for invoking remote functions;
- procedures and data need requirements, such as those documented in ROD;directories of interfaces where the data are stored, such as the Catalogue of Data Sources (CDS);
- practical tools so that the above can be deployed quickly.

All these are available now. It is just a matter of putting them together in a useful way. Building such an infrastructure does not necessarily require mega-projects and new organisations, although it is often viewed that way. A simple standardisation process is where to start.

The conceptual separation of computer software applications and the underlying information infrastructure is important. If you want others to build on it, then you are building infrastructure. This is characterised by the use of open, standardised interfaces (where to go) and communication protocols (what to say). Examples include IP, Z39.50, LDAP, IMAP, CORBA, SQL and POSIX. However, if you just want to get one job done, then you can build an application and perhaps hope that others can use it as it is. Popular examples include Microsoft Windows and Microsoft Access.

Mature, successful, shareable applications often migrate to infrastructure. For instance, Microsoft Office is currently found in most personal computers and one can travel with a PowerPoint file and have some confidence that the file can be opened at a remote presentation location.

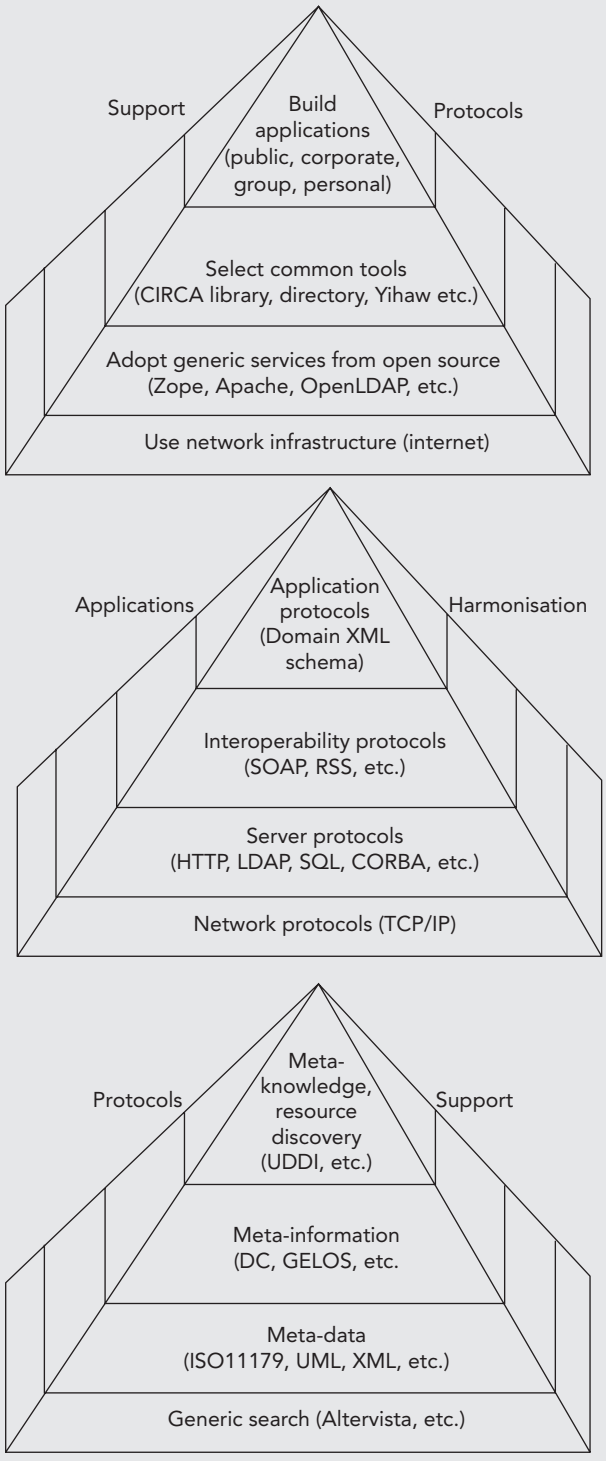
Infrastructure services are typically built using a layered approach (Figure 3) where services are built on top of one another. Interoperability is achieved when an interface at one level can connect to the next and understands a protocol, which is used to express the needs of requesters.

A simple example of infrastructure services is directory services. It is possible to use hierarchically arranged data on people, organisations and their groupings with the Lightweight Directory Access Protocol (LDAP) on connecting to an appropriate port of a directory server on the Internet. The existence of such an open interface and a related protocol makes it possible for others to build applications that use directory services. These include roles and expertise, security services and accreditation mechanisms, which can be built on. Also, e-mail applications increasingly build on directory services. Examples include people.yahoo.com and the EIONET directory[1].

1 The EIONET provides a directory service at ldap.eionet.eu.int, port 8983, at three different data roots: ou=users, o=eionet, l=Europe; ou=organisations, o=eionet, l=Europe; and ou=roles, o=eionet, l=Europe. Although currently bundled with other CIRCA tools, it really is an independent service.

Figure 3

Three sides of an interoperability pyramid depicting an application, communication and content harmonisation infrastructure, respectively. Different layers of services build on one another using standardised interfaces. Examples are given in parentheses



5. Architecture

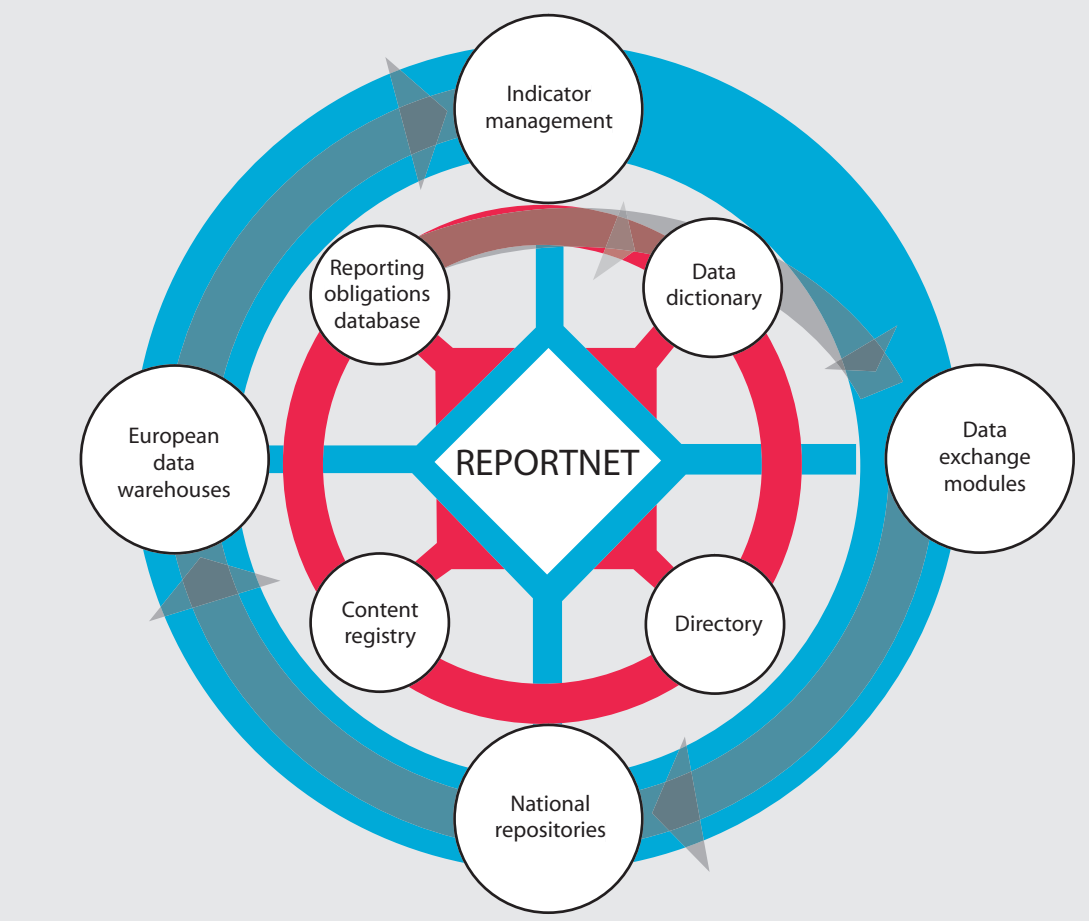
The components of Reportnet cover the functions that are needed by the input part of the EEIS. With the exception of the user interface, they are all found at the 'tools' level in the application infrastructure illustrated in Figure 4.

The components described below do not mention databases and other systems at the national level because these are different for each country. The borderline lies in the 'collection' data exchange modules. In the other direction, the Reportnet range ends when the data have been delivered as required. How these data are used for various purposes, such as to calculate various indicators, is not covered here. Figure 5 illustrates these boundaries.

Below we cover the following aspects for each component of Reportnet.

1. *Description:* Definition and purpose of the component.
2. *Functions:* What functions the component provides for users.
3. *Linkages:* What other components this one must be able to work with and how.
4. *Users:* Who is using the component and for what purpose, and who is responsible for the content.
5. *Partitioning:* Where this component is located and whether it is centralised.
6. *Technology:* How this component is built.
7. *Status:* Where we are in the implementation of this component.

Figure 4 **Components of Reportnet and the main data flow. The inner (red) circle illustrates normative and meta-data components, the outer ring the main 'real' data flow**



5.1. Network directory (ND)

1. The network directory is the database of all persons, organisations and their roles that are active with, or of interest to, the EEIS.
2. The directory provides functions that allow user authentication, security services, contact information to be obtained and routeing of workflow processes. These functions are maintained by the EEA. Contact information is accessible as required by the applicable laws and decided by the users concerned themselves.
3. The network directory is called from all the other components that need to authenticate users. There are no other user authentication sources in Reportnet. The directory also has its own user interfaces that allow contact and organisational information to be obtained. These include web browsers and use of the LDAP port for clients, such as e-mail. These interfaces are maintained by the EEA.
4. Users of the directory are all those who log on to the Reportnet applications. Also, people who are coordinating the network and who need contact information use the directory. Content is maintained by the national focal points which appoint representatives to the various roles.
5. There is one central network directory for Reportnet. In addition, there may be national directories for local user authentication. These synchronise those elements that are common.
6. The directory is built on industry standard directory services using the LDAP for communication and X509 for certification.
7. The directory has been in operation and available as part of CIRCA since release 2.5 (August 2001). It provides complete role and organisation information which can be used by other applications. Release 3.0 of CIRCA makes it possible to use any LDAP server (not only the CIRCA-bundled one) for authentication (http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/Home/central_dir_admin?fn=roles&rd=1&ud=1&od=1&act=list&v=eionet).

5.2. Reporting obligations database (ROD)

1. The reporting obligations database provides descriptions of the requirements of data and information, including the legal basis why such content will have to be, or should be, provided, and periodicity.
2. This component provides functions for searching and browsing through the reporting obligations.
3. This module will point to particular roles in the *network directory* that are responsible for fulfilling the obligations. It needs to point to certain elements in the *data dictionary* that define the required content in detail. The *content registry* must be able to point to individual obligations so that it can be flagged that a certain obligation has been met. Countries may create linkages to this component that map their information holdings with regard to the obligations. It generates process definitions for *workflow*.
4. Users of this component are people who need to understand the reporting obligations and who are monitoring their fulfilment. The content is mainly derived from the Commission's EUR-Lex database of EU legislation and the reporting obligations are interpreted by the EEA so that they can be understood and responded to by countries. The EEA is also responsible for maintaining details of its own reporting obligations plus those of Eurostat in the EU and non-EU reporting institutions such as international conventions.
5. ROD maintenance is centralised because the reporting obligations are the same for all countries. So-called national extensions or country services are separate systems that, on the one hand, point to these obligations and, on the other, to national data sources.
6. This component has been built with the Java language and MySQL relational database.
7. A prototype reporting obligations database was created in 2000–01 under the Teresa project of IDA. Its content is being expanded and maintained, linkages to other systems created and functionalities gradually enhanced (http://rod2.eionet.eu.int/).

5.3. Data dictionary (DD)

1. The data dictionary will be a central registry to which other applications and projects that need data definitions can refer and where they can share their definitions.
2. The data dictionary will store definitions of data elements, their attributes, their data types, allowable values and relationships between other elements. It will be able to import and export data definitions in XML format. There will be a user interface that allows these definitions to be created, browsed and edited. The status of the elements will be documented. The data dictionary will be able to serve other tools with dynamic pick-lists of allowable values. It will also be possible to manage compound elements and provide the functions of an XML schema registry.
3. Definitions of data elements in the data dictionary must be available from the *data exchange modules* so that these can validate their input against the definitions. They must be available from the *reporting obligations database* so that obligations can be linked to the required data. The *data repository* and the *content registry* entries must point to the data definitions so that it is known what data are where. When uploading to the *data repository*, the data will be tagged with the identifiers of the contained data elements using pick-lists of allowable values. Such data are initially captured when data are uploaded to the data repository. Existing definitions from *GEMET* (general multilingual environmental thesaurus) should be used as the basis for new ones. Linkage to the network directory is needed to identify who is responsible for each definition.
4. People who formulate new reporting obligations should make reference to existing data definitions so that reusability can be maximised. Users of the data dictionary will include programmers who must reuse existing data definitions instead of reinventing their own. Other users will search data of a particular kind in the content registry using the data definitions. Maintainers of national databases may want to check the European data definitions in order to compare how closely their nationally available data correspond to these. The content will be maintained by the developers of the target systems and shall be sanctioned by a standards committee.
5. There will be one central data dictionary on Reportnet.
6. The data dictionary is being built with the Java language and MySQL database complying with the ISO11179 standard, as applicable. It will also make use of an XML server for importing and exporting definitions.
7. The data dictionary is currently being built under the framework contract between TietoEnator and the European Commission. It is expected to be available in the course of 2002.

5.4. Content registry (CR)

1. The content registry keeps track of the deliveries of data sets to the international reporting system, and also other contents, as applicable.
2. The system registers meta-information about the content of data repositories. It allows searching by meta-information fields, including data definitions, and locates the registered resources, offering a link to these whenever possible. It stores information on delivery dates so that supervising the processes is supported with simple workflow functions. It requires the harvested services to provide Dublin Core descriptions of their content in RDF format.
3. The content registry gets its information from multiple *data repositories* by harvesting them for meta-data (pull) or through notifications after upload events (push).
4. People who supervise the data reporting activities use the content registry. It allows them to search delivered data sets by data flow, country and date. It can also search documents by the Dublin Core elements. Contents are created automatically but controlled by the EIONET network management centre.
5. There is one central content registry on the Reportnet.
6. The content registry is built with the Java language, MySQL relational database and an XML server.
7. The content registry has been released as Version 1.0. Harvested resources are being added one by one (http://cr.eionet.eu.int/).

5.5. Data exchange modules (DEMs)

1. The data exchange modules are smart electronic questionnaires used to gather data from various sources in agreed formats. Optionally, such data can be delivered to agreed places.
2. DEMs provide functions for importing data in popular formats, or alternatively allow direct input, format the data technically correct, package the data, and upload or otherwise automatically deliver them. The functionality of DEMs and their maintenance are the responsibility of the EEA and its ETCs.
3. DEMs do not directly link to national data holdings, but allow import from them. They should automatically upload data to the *data repositories*. They will get the data definitions from the *data dictionary*.
4. Users of DEMs are people in national institutions and elsewhere who are responsible for producing the data for the reporting system.
5. DEMs are stand-alone applications for personal computers or in future web-based forms. Therefore, they are widely distributed. The data content within DEMs is created by the national reference centres in direct response to well-defined reporting obligations.
6. Stand-alone DEMs are produced with any PC development tools. Web-based DEMs are created with client- and server-side Java.
7. DEMs for air quality and air emissions are available at http://air-climate.eionet.eu.int/tools. There is a need to produce new ones for other topic areas, especially when framework directives that define the data needs become available.

5.6. Data repositories (DRs)

1. A data repository is the location where the deliveries of data, information and knowledge to the international reporting system are stored.
2. This component is a content management system providing functions for uploads, downloads, versioning, approvals and sealing of official data sets, packaging in virtual envelopes for delivery, and tagging with meta-information. The content of DRs is in document format.
3. A data repository is accessed by the *DEMs* when they upload content. It makes meta-information available for the *content registry* in RDF Dublin Core format. Its meta-information sets (pick-lists of allowable values) must be retrievable from external namespaces such as the *data dictionary*.
4. A data repository is accessed by the institutions to which the delivery is made. Instead of getting the delivery physically, they get a notification that their envelope is ready in a data repository. It is also used by all those needing access to the reported content, such as topic centres. Contents are created by the national focal points and national reference centres.
5. There is one central data repository (CDR) in Reportnet. In addition, one national data repository (NDR) may exist in every country.
6. The CDR is built with Zope. An NDR is implemented using CIRCA libraries.
7. The CDR is already available and entering operational service at rn2.eionet.eu.int. The NDRs are also in place on national e-EIONET servers, where no major functional changes are needed but performance on the still existing first generation national servers must be improved.

5.7. Data warehousing (DW)

1. This component provides query access to the data reported on particular topics.
2. The data warehouses (DWs) can be queried using SQL, intelligent agents or web-based forms.
3. Data to the warehouses are processed from the documents contained in *data repositories*. In some cases, *DEMs* can directly upload to the DWs. The data warehouses are accessed by *indicator management* tools for the purpose of producing assessments and scenarios.
4. Users are those creating data sets for indicators. The general public can also access the DWs using the web. Content is typically maintained by the European topic centres.
5. Each topic area should have its own data warehouse.
6. Data warehouses are created using relational database management systems.

7. Examples of existing data warehouses include Airbase, EUNIS, Wastebase and Waterbase.

5.8. Indicator management (IM)

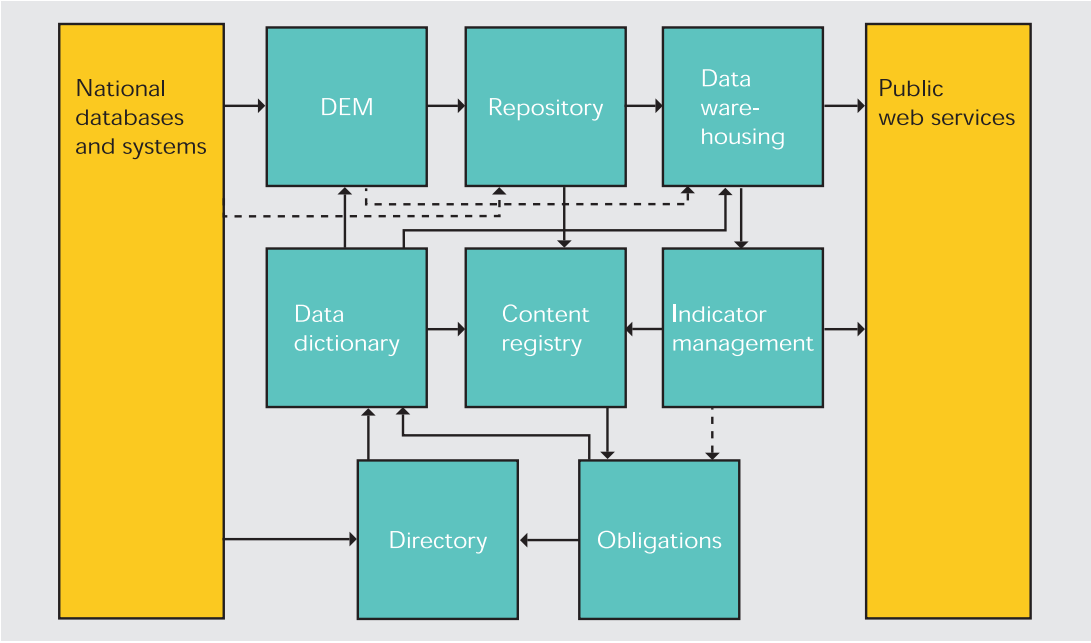
1. This component denotes the various models and other systems that are used to process the delivered data into indicators describing state, trends, and scenarios.
2. The functions include those of decision support systems, model management and operation, multimedia and web access to results.
3. The indicator management tools get their data from the *data warehouses* and *data repositories*. Working databases are also used.
4. Primary users and content managers make the assessments. Decision-makers and the general public can access the results.
5. Any.
6. Any.
7. Examples of existing indicator management tools include the EEA's data service and RIVM's DAFIA II, but this area needs to be developed.

5.9. Workflow tools and integrative services

1. The purpose of this component is to enable users to see what is going on in the network, track the processes and integrate the various tools. (This component is the central box in Figure 4.)
2. Users are provided with workflow and tracking functions. As users often jump from one component to another, the components cannot be too different from one another and tools for providing harmonised user interfaces are supplied. In the future, personalisation, groupwork support and corporate views will be provided. These integrative services also provide a technical communication platform where the other tools can exchange messages.
3. This is not a separate Reportnet component, but a set of embedded tools for active *workflow* or passive content tracking. These components talk to most of the others. The data-flow process definitions and deadlines are queried from the *reporting obligations database*. Documents are stored in *data repositories*. The *content registry* is queried for actually available documents. E-mail notifications are sent to the roles in the *network directory*.
4. Users are those involved in data flows.
5. There is one central workflow engine and various web query facilities to track the content.
6. This component links to all the others using SOAP and CIRCA API. The user interface is built with server-side Java or other dynamic application services, such as Zope.
7. A workflow tool is available and currently being tested. Country services for tracking the expected deliveries have also been prototyped.

Figure 5

Boundaries of the Reportnet components with regard to national systems and public web services. Arrows indicate primary dependencies of the tools (see table). For historical reasons, some data flows (dashed) still bypass some components, as, for instance, from national databases to the repository without the DEM and from the DEM to the data warehouse without the repository



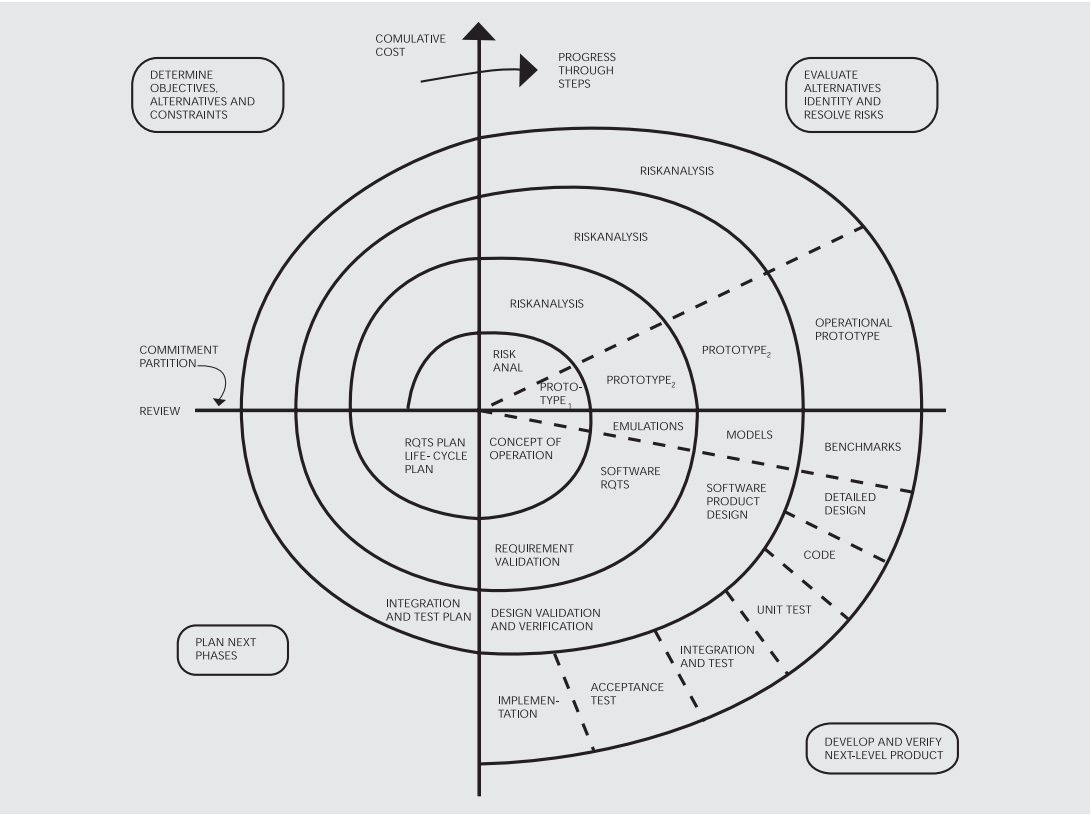
6. Approach and methodology

The development of Reportnet is not a straightforward task. Even though the main business processes are known in broad terms for all topic areas, they have only been precisely defined for air quality and air emissions. With each new framework directive, new processes are introduced. These are normally variations of the model described in Section 2.4.

It must be made clear at the outset that the development of a shared information infrastructure, Reportnet, will require some changes in organisation and responsibilities. For instance, a physical one-to-one delivery of data to the international level will be replaced by a data service at national level from where the delivery can automatically be made as legally required, but the data would also be available for other use, as appropriate. Such changes can only be agreed after there is sufficient evidence that the proposed new system will actually work. This means that Reportnet must, as a concept, prototype and demonstrator, be taken quite far before the benefits become clear.

This puts special pressure on the software engineering methodology and approach. How to design a system that has never been tried before and which users are not able to define well? That is possible with an iterative process and when the developers have a good understanding of the business processes that must be supported (see Figure 1). Another necessary ingredient in the work is IT expertise from the member countries. ITTAG was instrumental in putting together the original telematics network of the EIONET, but then pulled back to the role of network operator, while the NFP representatives participated intensively in defining and developing the initial round of Reportnet application prototypes. Now that these applications have been defined in sufficient detail, and there is a need to scale them up to operational capacity, ITTAG or a similar group should again intensify its work.

Figure 6 **The original spiral model of software development (Boehm, 1988)**



6.1. Software engineering methodology

One of the keys to the success of Reportnet is our ability to produce the right, simple software tools and identify and adjust the business processes so that they are in line with it. Experience from Teresa and e-EIONET projects shows that much more effort has to be devoted in future to adjusting the development methods to the particular constraints of the EIONET and other networks to be served. This is not something that can be left for the technologists, because extensive user involvement is required, organisational changes are foreseen and substantial budgets are at play. Therefore, the methodological approach is described here in some length[2].

So far, a methodology inherited from IDA quality assurance guidelines has been used for the EIONET. It introduces a linear approach, called the waterfall model, which goes through a series of phases such as creation of a project management plan, user requirement capture, software requirement analysis, functional design, construction, testing, and operational-service-level agreements. Such a linear approach fits well with the EU budget cycle. It comes with a set of underlying assumptions, which are as follows.

1. The requirements are *knowable in advance* of implementation.
2. The requirements have no unresolved, high-risk implications, such as cost, schedule, performance, safety, security, user interfaces and *organisational impacts.*
3. The nature of the *requirements will not change very much* either during development or evolution.
4. The requirements are compatible with *all the key stakeholders' expectations.*
5. The right architecture for implementing the requirements is well understood.
6. There is enough time to proceed sequentially.

These assumptions must be met by a project if the waterfall model is to succeed. In the working environment of the EIONET, at least assumptions 1, 2, 3 and 4 are questionable. Therefore, another development model, called the spiral model, has been chosen for future Reportnet development.

The spiral model (Figure 6) has two main distinguishing features. One is a cyclic approach for incrementally increasing a system's degree of definition and implementation while decreasing its degree of risk. The other is a set of milestones for ensuring stakeholder commitment to feasible and mutually satisfactory solutions. Under the spiral model, the answers to questions such as 'what should be done next?' and 'for how long can we let this continue?' are driven by risk considerations and vary from project to project and sometimes from one spiral cycle to the next. At the start of a cycle, all the project's success-critical stakeholders must participate concurrently in reviewing risks and choosing the next set of goals. Milestones drive the spiral to progress towards completion.

The spiral model supports incremental commitment of resources to the exploration, definition and development of the system, rather than requiring a large outlay of resources to the project before its success prospects are well understood (Boehm, 1988). Basically, the idea of evolutionary development under the spiral model is not to define in detail the entire system at first. The developers should only define the highest priority features. Define and implement those, then get feedback from users (such feedback distinguishes 'evolutionary' from 'incremental' development). With this knowledge, they should then go back to define and implement more features in smaller chunks.

However, the spiral model also has some dangers. A project cannot be started on an evolutionary development approach based on a statement such as 'we're not sure what to build, so let's throw together a prototype and evolve it until the users are satisfied'. This approach would be insensitive to several risks corresponding to the set of assumptions for successful evolutionary development. These assumptions are as follows.

1. The initial release is sufficiently satisfactory to key system stakeholders so that

2 The EIONET provides a directory service at ldap.eionet.eu.int, port 8983, at three different data roots: ou=users, o=eionet, l=Europe; ou=organisations, o=eionet, l=Europe; and ou=roles, o=eionet, l=Europe. Although currently bundled with other CIRCA tools, it really is an independent service.

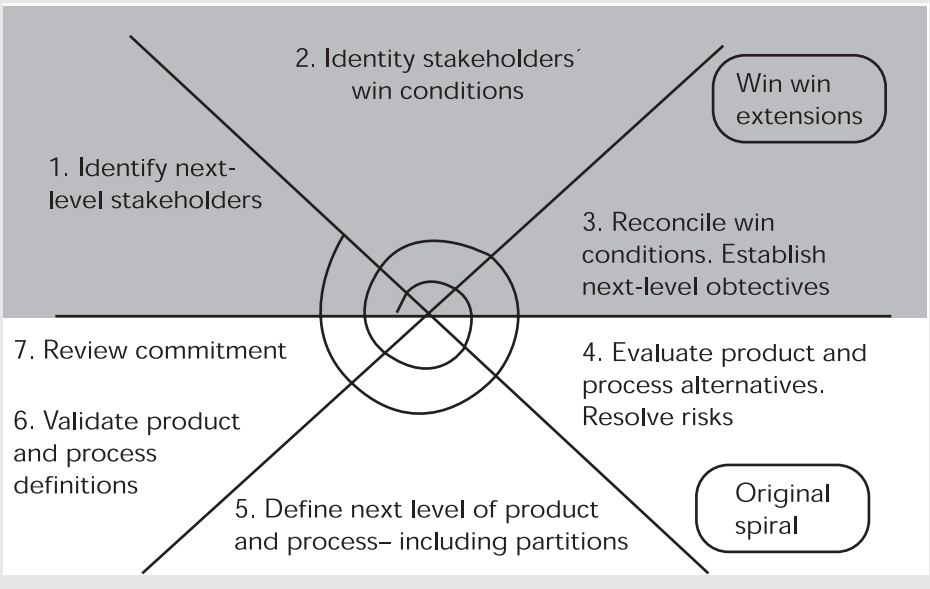
they will continue to participate in its evolution.
2. The architecture of the initial release is scalable to accommodate the full set of system life-cycle requirements (e.g. performance, safety, security, distribution to all NFPs, localisation).
3. User organisations are sufficiently flexible to adapt to the pace of system evolution.
4. The dimensions of system evolution are compatible with the dimensions of the old practice it might be replacing.
5. Stakeholders' possible overparticipation or late entry should not lead to excessive changes in direction, resulting in loss of project resources before implementation.
6. In the context of the EU budget cycle, the resources are often committed at the end of the year and cannot be redirected afterwards.

The real danger is assumption 1. Without some initial attention to user needs, and their documentation in the milestone specifications, the prototype may be so far from the user needs that they consider it a waste of time continuing with it.

The original spiral model (Boehm, 1988) began each cycle of the spiral by performing the next level of elaboration of the prospective system's objectives, constraints and alternatives. A primary difficulty in applying the spiral model has been the lack of explicit process guidance in determining these. An extended spiral model (Figure 7) uses a win-win approach to converge on a system's next-level objectives, constraints and alternatives. It involves identifying the system's stakeholders and their win conditions, and using negotiation processes to determine a mutually satisfactory set of objectives, constraints and alternatives for the stakeholders. This sounds appropriate for the case of Reportnet and its multiple stakeholders, but requires special meeting techniques so that the next-level objectives can be identified and decisions made in a timely manner.

As illustrated in Figure 7, the process translates into the following spiral model extensions.
1. *Determine objectives:* Identify the system's life-cycle stakeholders and their win conditions. Establish initial system boundaries and external interfaces.
2. *Determine constraints:* Determine the conditions under which the system would produce win-lose or lose-lose outcomes for some stakeholders.
3. *Identify and evaluate alternatives:* Solicit suggestions from stakeholders. Evaluate them with respect to stakeholders' win conditions. Synthesise and negotiate candidate win-win alternatives. Analyse, assess and resolve win-lose or lose-lose risks.

Figure 7 **An extended spiral model that supports multi-stakeholder commitments (Boehm, 2000)**



4. *Commit:* Record commitments, and areas to be left flexible, in the project's design record and life-cycle plans.

The spiral model is anchored to reality with a set of milestones: life-cycle objectives (LCOs), life-cycle architecture (LCA) and initial operational capability (IOC) (Boehm, 2000). These can be described as stakeholder commitment points in the software life cycle: an LCO is the stakeholders' commitment to support architecting; LCA is the stakeholders' commitment to support the full life cycle; IOC is the stakeholders' commitment to support operations. At the first two milestones, the stakeholders review six artefacts: operational concept description; prototyping results; requirements description; architecture description; life-cycle plan; and feasibility rationale. The feasibility rationale covers the key pass/fail question: 'If I build this product using the specified architecture and processes, will it support the operational concept, realise the prototyping results, satisfy the requirements, and finish within the budgets and schedules in the plan?' If not, the package should be reworked.

Use of the spiral model requires more intensive communication between the developers and users than the waterfall model. In the latter, specifications are produced early in the project so that the developers are able to construct an application in accordance with the specifications. In the former, the documents are mainly produced afterwards to document the systems developed. Extensive documentation is required mainly for the user commitments.

No particular development tool is identified here for any of the Reportnet components. This is deliberate, as tools and technologies come and go. They are never a good basis for IT strategic choices (Martin, 1989). Today, the various available Reportnet components are written in Java, Perl, MySQL, Netscape Directory Server and Zope. They all run on UNIX. It must be possible to replace an ageing technology in any of the components with a modern one when the time is right. This is achievable when the underlying information infrastructure is based on open standards and the system architecture is modelled after permanent business processes.

6.2. Approach to organisational change

A major issue in building Reportnet is how to combine business process re-engineering and software development. These must go hand in hand. The benefits reaped from merely automating manual procedures remain limited. Only when the work processes can be adjusted and decreased through the introduction of new software tools are true gains in productivity possible. It must be discussed whether this is a realistic goal for Reportnet, or whether simple automation is preferable. However, moving from manual one-to-one information swapping to more automated one-to-many information provision is a fundamental organisational and work process change.

The following boundary conditions with regard to organisational and work process change can be observed.

- Framework directives (i.e. fixed data requirements and business processes) do not exist for most topic areas. The situation is evolving in many areas.
- While the general requirements of data deliveries are written into legislation, the details of how the data flows are actually managed are agreed in committees and can be renegotiated when good reasons and proof of concept exist.
- Reporting obligations are based on negotiations and political compromises regarding the efforts which the international policy community is making. Positions are defended meticulously and any change in work practices has to be motivated so that all stakeholders buy in.
- Data reporting is not a full-time year-round job for most people, so complex solutions that are very different from everyday routines will not work.
- The EEA/EIONET is only one young player in the data reporting game and working with the EEA is currently voluntary.
- Network organisations where consensus is required for decisions are slow by nature. Going at the pace of the fastest or the slowest, both often having unique home conditions, should be avoided.

The recommended approach is the gradual introduction of individual Reportnet components one by one. For each component

and each data flow, agreements are made separately after the Reportnet components that could support them have become available. This has worked satisfactorily for air quality, air emissions and designated areas in the case of the repository component on CIRCA.

When a sufficient number of such examples exist, the remaining data flows will probably migrate voluntarily. Availability of support actions, reusable tools, continuous development and positive examples is crucial. It is the responsibility of the EEA to orchestrate these actions so that there are enough positive reasons for each committee and data flow to join the system. The EEA cannot directly orchestrate the EEIS but, by offering Reportnet services and by operating a strong support base and inviting all on board, it can lead the way.

In summary, Reportnet can only be built through a process of gradual convergence and provision of a strong support base.

7. Roles and responsibilities of stakeholders

Agreements on who will do what are an important part of IDA global implementation plans. Therefore it is appropriate to also cover here the suggested roles and responsibilities in Reportnet development.

7.1. Role of the EEA

- Provide most tools
- Operate the DD, CR and directory
- Provide support via the EIONET network management centre etc.
- Provide guidelines
- Use in its own data flows with ETCs
- Show best practice
- Guardian of the concept and process, promotion.

7.2. Role of member countries and NFPs

- Centralise international data and information reporting
- Operate and populate the repository
- Manage own data in the EEA and local directory.

7.3. Role of the European Commission

- Environment DG: Take Reportnet concepts into account in streamlining reporting obligations
- Environment DG: Use the concepts in own data flows and negotiations with committees
- Environment DG: Be the interface to IDA
- Eurostat: Provide some tools and standards
- Eurostat: Use the concepts in own data flows and negotiations with committees
- IDA: Provide funding and common tools
- Information Society DG: Support tools development
- JRC: Prototype and demonstrate tools
- JRC: Use the concepts in own data flows and negotiations with committees.

Status and dependencies of each Reportnet component (Figure 5).

Name of component	Status	Milestones reached	Needs data from
Reporting obligations database	Available and being populated	LCA (2)	Network directory, data dictionary
Network directory	Available in CIRCA 2.5+	IOC (3)	None (national input)
Data dictionary	Under development	LCO (1)	Reporting obligations database, network directory
Content registry	Available and being populated	IOC (3)	Data repository, data dictionary
Data exchange modules	Available only for air emissions and air quality. To be developed for other topics	IOC (3) for these two topics, otherwise none	Data dictionary (national input)
Data repository	Available in CIRCA and central data repository	IOC (3)	Data dictionary, DEM, directory (other national input)
Data warehousing	Available for air, nature, waste and water	Variable	DEM, data repository
Indicator management	Available in the EEA's data service, but not integrated with other components	LCA (2)	Data warehouses, repository
Workflow and integration	Workflow tool and country services undergoing testing	LCO (1)	All

NB: LCA = Life-cycle architecture; LCO = Life-cycle objectives; IOC = Initial operational capacity.

8. Proposed projects

8.1. Technological development

The current situation regarding the development of the various common tools for Reportnet is summarised in the table. They are all available in some form at the time of writing. The directory, repository, content registry and two DEMs have become operational on the e-EIONET, which means that they have passed the spiral model milestone IOC (initial operational capacity).

During 2002, ROD and the data dictionary will also enter the operational phase, albeit with limited content.

New DEMs will have to be created, in particular for those areas, such as waste and water, where new framework directives will soon be effective.

For support actions, the operations of the EIONET network management centre should be expanded to cover support for the components reaching the IOC milestone.

There is also the need for methodological development around the spiral model.

In summary, most of the initial development of common tools for Reportnet has already been done. Naturally, there will be a need for further enhancement of the tools as more users get involved and the requirements become more refined and expanded.

However, it is clear that the main focus of the proposed Reportnet project will now be on the organisational change and on the data standardisation process that links the technology and business.

8.2. Standards development

Everybody loves standards. They are the essence of an information infrastructure. Reportnet and the EEIS need standards for the data elements, their allowable values, data interchange formats, message exchange protocols, etc. Today, these areas have barely been touched. Standards have been adopted from elsewhere such as conventions, and formats are often just industry standard basic file formats (read Microsoft).

The forthcoming data dictionary tool should provide the technological basis for setting up a clearing house and distribution place for standards. Experience from the EDI world and Eurostat's Gesmes project should be built on, but modern XML-based standards should be used throughout. Standards should ideally be global. Cooperation with US agencies, in particular, should be given the necessary weight here.

It is a major task for the proposed Reportnet/EEIS project to get the standardisation process off the ground.

8.3. Organisational development

Close cooperation with other European and international institutions is a necessity for Reportnet concepts to have any success beyond the EIONET. As there is nothing particularly environmental in Reportnet concepts, they should also be communicated to other sectors via the IDA programme.

The Environment DG (2002a and 2002b) is currently looking at the reporting system with possible streamlining in mind. At this point, the work is focusing on better defining the content for reporting rather than on the practical solutions. However, Reportnet concepts add an important ingredient to this discussion by showing how the streamlining and reuse of data and information might be achieved. Business process re-engineering, which is the aim of the review, can hardly be achieved at present without early consideration of IT.

During the proposed Reportnet project, an organisational structure for managing an EEIS consortium would have to be identified and established. Such a consortium

would have to have at least the following: standardisation body; topic-specific business process re-engineering teams; steering group; help desk and support action; development group; and interface to the networks and committees working in the environment sector. Such a consortium would have to be jointly supported by most of the sectoral organisations.

8.4. Costs

Support from IDA will be sought for Reportnet at the same level as the EIONET has had in the past (just under EUR 1 million/year).

9. Conclusion

In this report, a way forward in application development for environmental information handling has been proposed. It drastically updates the e-EIONET global implementation plan which is less than two years old. Such an update has been necessary because of the update of the EEA strategy in 2001 and also because some concrete experience has been gained in the first development projects.

This report has been put forward as a 'preparatory report' as required for new IDA projects. The essence of such a new project would not be technological development, but the setting-up of the standards and organisational framework for the EEIS. It will require participation of most of the major players in the sector.

For the implementation, it is very important to understand the relation between the EEIS and the underlying information infrastructure. When the EEA was established, it was mentioned in its mandate that it should avoid duplication of effort in gathering and assessing environmental information. Avoiding duplication is understood in an active way here. It is not sufficient to avoid overlap within the EEA's own work with others, but that the EEA should also seek to streamline activities elsewhere, as appropriate. It is understood that the introduction of a shared information infrastructure is the right approach towards this goal. While orchestrating the EEIS is beyond the capacity and mandate of the EEA, or any single member of the international reporting community, creating the framework and promoting the benefits of a shared information infrastructure certainly is within its reach and mandate.

Reportnet addresses some of the problems identified by the 'bridging the gap' process (Anon., 1998) by helping to avoid duplication and making sharing of information an efficient process. While it cannot directly solve the underlying political problems, it can help decision-makers to recognise the problems with overlapping data collection networks. It also simplifies the tackling of these problems by providing a framework and tools where new data flows can be anchored.

Although some figures exist on how much data has to be reported, any baseline of what reporting really costs to the member countries is currently not available. At the beginning of a Reportnet project, such a baseline would have to be established so that the required cost-benefit analysis can be made.

The Reportnet tool suite is very similar to Eurostat's Stadium central system, but is modular and also suitable for use in a distributed way and at small institutions and where workflows have not yet been fully defined. Reportnet would be such a model network, as described in the IDA architecture guidelines (IDA, 2001).

Reportnet could also be dubbed 'e-Environment'. By that we mean the implementation of *e*Europe's 'Government online' action in the environment sector. If Reportnet is created as proposed, it will increase the transparency of public administrations in an important way, because the reported data can be made publicly available without delay. Experience has shown that the best guarantee for improvement of data is exposure of the data, which also, at the same time, generates pressure for improvement of the environment.

References

Anon. (1998), 'Bridging the Gap — New needs and perspectives for environmental information', 271 pp., Proceedings of a European conference, 3 to 5 June 1998, London, Environment Agency for England and Wales.

Boehm, B. (1988), 'A spiral model of software development and enhancement', Computer 5/1988, pp. 61–72.

Boehm, B. (2000), 'Spiral development: Experience, principles, and refinements', in Hansen, W. J. (ed.), Spiral Development Workshop, 9 February 2000 (http://www.sei.cmu.edu/cbs/spiral2000/february2000/BoehmSR.html).

EEA (2001), 'The EEA strategy — Building effective and reliable environmental information for Europe', Manuscript, 8 pp. (http://org.eea.eu.int/documents/strategy/strategy.pdf).

EEA (2002), 'Shaping the Reportnet — Responses to the comments on the discussion paper and further clarifications', 11 pp. (http://www.eionet.eu.int/EIONET_Tech/sii).

e-EIONET (2000), 'Global implementation plan', 0.42 final, 25 May 2000, 37 pp. (http://www.eionet.eu.int/Best_Practice/gip/e-EIONET_GIP).

eEurope (http://europa.eu.int/information_society/e-europe/index_en.htm).

Environment DG (2002a), 'Review of environmental reporting', Discussion paper, 9 April 2002,10 pp.

Environment DG (2002b), Waste Pilot Group, Draft final report, 20 pp.

IDA (2001), 'Architecture guidelines', Version 6.1.3, 49 pp. and annexes (http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/eionet-telematics/library?l=/miscellaneous/ida/ag_version_6_zip/_EN_6.1.3_&a=i).

Jensen, S. (2001), 'Implementing a shared EEA/EIONET meta-data infrastructure', Manuscript,

Version 0.1, 7 pp., 7 September 2001 (http://eea.eionet.eu.int:8980/Members/irc/eionet-circle/eionet-telematics/library?l=/meta).

Martin, J. (1989), Information engineering — Book I: Introduction, Prentice-Hall, 178 pp.

Norup, B. (2001), 'Streamlining national environmental monitoring and international reporting. Towards Reportnet — the streamlined and transparent one-stop-shop network with validated and aggregated national data on the environment, a European environmental information and reporting system', Manuscript, 12 pp. (http://ovs.dmu.dk/4Resultater/ReportNet/reportnet_papers/streamlining).

Saarenmaa, H. (2001), 'Towards a shared European environmental information infrastructure' (Manuscript, 9 pp.) in Sustainability in the information society — Environmental Informatics 2001, 15th International Symposium on Informatics for Environmental Protection, 10 to 12 October 2001, ETH Zurich, Switzerland (in print) (http://www.eionet.eu.int/EIONET_Collaboration/ui01-eeii).

SPADE (2000), 'Strategic planning of application development in EIONET 2000–2003', 0.51 final, 24 March 2000, 33 pp. (http://www.eionet.eu.int/Best_Practice/gip/Strategic_Plan/).

Teller, A., Onclincx, F., Squilbin, M., Martin, J. and Norup, B. (2000), 'Streamlining the environmental reporting process — The reporting obligations database (ROD) and the Reportnet', EIONET News, 7, pp.1–3 (http://www.eionet.eu.int/docu/newsletter/EIONET7.pdf).

Teresa (1999), 'Transparent environmental reporting system for administrations — Global implementation plan', 18 pp., Final

draft, 9 July 1999 (http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/eionet-telematics/library?l=/miscellaneous/teresagip_rtf/_EN_1.0_&a=i).

TietoEnator (2001), 'System development methodology', Manuscript, 13 pp. (available from helpdesk@eionet.eu.int).

Glossary

European environment information system: Organisations, work processes, applications, data, indicators, agreements, and assessments that are involved in international environmental reporting in Europe

Information infrastructure: The framework of data standards, interoperability mechanisms and other permanent structures that enables information exchange and sharing within and between information systems

Information system: A system, whether automated or manual, that comprises people, machines and/or methods organised to collect, process, transmit and disseminate data that represent user information

Reportnet: Suite of IT tools optimised to support the business processes of the EEIS building on a shared information infrastructure

Abbreviations and acronyms

CIRCA: Communication and information resource centre administrator — Circle add-on for the EIONET

Circle: Centre of information resources for collaboration on environment — groupware for EU services

CDR: Central data repository — central storage option for data deliveries by countries in Reportnet

CR: Content registry — meta-data of resources in Reportnet

DD: Data dictionary — data definition and shared schemas and coding list in Reportnet

DEM: Data exchange module — electronic data exchange tools in Reportnet

DW: Data warehousing

EDI: Electronic data interchange

EEA: European Environment Agency

EEIS: European environment information system

EIONET: European Environment Information and Observation Network

e-EIONET: The electronic network that supports the functioning of the organisational EIONET

*e*Europe: Action plan to increase the usage of electronic processes in Europe

ETC: European topic centre — consortium of EEA partners for specific thematic work areas

Gesmes: Message format for the exchange of statistical data as used by Eurostat

GIP: Global implementation plan

IDA: Interchange of data between administrations

IMT: Indicator management tool — workflow tool to define and maintain data-indicator relations

IT: Information technology

ITTAG: Information Technology and Telematics Advisory Group

JRC: Joint Research Centre

NDR: National data repository — decentral storage of data deliveries on country servers in Reportnet

NFP: National focal point

NGO: Non-governmental organisation

NMC: Network management centre to support the applications used in the e-EIONET

NRC: National reference centre

OECD: Organisation for Economic Cooperation and Development

ROD: Reporting obligations database — reference database for Reportnet

Teresa: Transparent environmental data and information reporting and exchange system for administrations

XML: Extendable mark-up language

6EAP: The sixth environment action programme of the European Community from 2001 to 2010