Nansen Environmental and Remote Sensing Center

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Integrated Weather, Sea Ice and Ocean Service System (IWICOS)

Final Report

IWICOS Report No. 7

NERSC Technical Report No. 234

March 2003

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Contract Number: IST-1999-11129

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TITLE IWICOS - Integrated Weather, Sea Ice and Ocean Service System Final Report	**REPORT IDENTIFICATION** IWICOS Report No. 7 NERSC Technical Report No. 234
CLIENT CEC - DGINFSO Information Societies Technology Programme IST KA1	**CONTRACT** IST-1999-11129
CLIENT REFERENCE Irmgard Heiber	**AVAILABILITY** Open
INVESTIGATORS Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristján Gíslason, Jyrki Haajanen, Guðmundur Hafsteinsson, Torill Hamre, Thor Jakobsson, Ingibjörg Jonsdottir, Ville Kotovirta, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven, Ari Seinä and Renne Tergujeff	**AUTHORISATION** Bergen, March 2003 Ola M. Johannessen

Executive Summary

The overall objective of IWICOS is to develop a prototype marine information system that will provide a single-entry access to integrated meteorological, sea ice and oceanographic (met-ice-ocean) products in electronic form, and to demonstrate this prototype for a group of users working in fisheries, sea transport, exploitation of marine resources in Northern European waters, or whose work is related to sea ice monitoring on a scientific or pre-operational basis.

Results from user requirements studies, conducted before and during the project, have been used to extract and synthesise recommendations for facilities and features needed in the IWICOS System. A generic system architecture with three main subsystems: Production, Brokering and Presentation, has been defined based on these recommendations. This architecture supports a service chain where multiple producers can deliver data and information products through a common broker. Within this architecture, each producer can maintain separate (legacy) production systems, which can run on various computer platforms. Producers can also retain internal formats up to the point where products are submitted to the broker for advertisement to potential customers and to an in-house server for Internet distribution. Then, the products must be standardised. First, through adhering to a standard metadata specification, and secondly, through making the observed, derived or predicted met-ice-ocean parameters available in a standard data format.

The IWICOS metadata specification ensures that all products are described in a consistent and self-describing manner, which can be queried and processed by computer algorithms. This specification is developed using XML Schema, a widely accepted standard for metadata definition, supported by a number of public domain and commercial tools for preparation and validation of metadata. The IWICOS specification captures all relevant metadata attributes for the developed met-ice-ocean products, but is still small compared to many general-purpose standards for geographical data sets. The issue of keeping the metadata to a minimum is an important requirement, in particular for all users operating at sea and being dependent on low-bandwidth and expensive communication means.

A set of met-ice-ocean products that are suitable for electronic transmission have been developed and adapted to various regional requirements. Focus has primarily been on near-real time monitoring and forecasting products, but archived products can also be accessed by the IWICOS system. Different end-user systems were developed to retrieve, display and process met-ice-ocean products in a user-friendly way. The core elements of the IWICOS system are standardised formats (BSQ, GRIB, Shapefile and XML), a common metadata definition, a producer server, a broker and façades that allow different client software to interact with the system.

The IWICOS System prototype was developed in two main phases. First, a baseline version was implemented, providing basic and the highest priority functionality. This facilitated testing of the overall architecture and key subsystems (e.g. the Broker), and enabled initial demonstrations of data sets and products. Secondly, an extended version was constructed, elaborating the functionality and adding new features and data sets/products.

Different End-User Systems provide customised display and analysis facilities for target end-user groups, and consist of a Client and Façade subsystem. Some of these are thin clients that rely on having a server generating all data and information in a form ready for presentation. Others are thick clients, which download full (or partial) data sets and products, and contain tools for both analysis and presentation. A third category is a so-called balanced client, which include some analysis and presentation tools, but still uses a server for certain types of processing such as map drawing. The Façade may be used to tailor data to a specific client, e.g. by reducing its size by compression before transmitting it via a low-bandwidth connection, or to perform format conversion before transmission.

The extended version of the IWICOS System was used in four user demonstrations in 2002. The first of these was carried out for a scientific cruise in the Fram Strait in March. During this period the IWICOS Broker and End-User System (ViewIce client) were demonstrated to crew onboard the Finnish research vessel R/V Aranda, operating around 80ºN. Altogether about 1000 files were made available for downloading and 196 files were downloaded to the ship consisting of 66 satellite images, 73 wind forecasts, 25 pressure forecasts and 32 ice drift data files. The Iridium communication satellite was used for data transfer. The IWICOS System operated very satisfactory and the user feedback was positive.

The second onboard demonstration of the IWICOS System was done during Arina Arctica's two cruises to Greenland Waters in May-July and August-September. DMI's thick client, the MIO Viewer, was installed onboard the vessel and used operationally to display and analyse met-ice-ocean observed data and forecasts. Inmarsat-B and –C were used for communication, and a total of 185 data packages consisting of 11 satellite images, 11 ice analyses, 375 pressure forecasts, 375 wind forecasts, 300 wave forecasts, 300 swell forecasts and 13 textual weather forecasts (for Icelandic Waters) were downloaded to the ship. The IWICOS System and the MIO Viewer operated as planned, and the overall user feedback was positive.

The IWICOS project and Icelandic products and clients were demonstrated at a large exhibition in Iceland 4-7 September. The Icelandic Fisheries Exhibition 2002 had more than 18000 visitors, and about 800 exhibitors from 37 countries. During the exhibition, IMO's thin web client and Radiomidun's thick client were demonstrated, and an Icelandic IWICOS brochure distributed. Visitors marked at Captain/Owner were picked out and asked to answer a brief questionnaire. In total 95 captains/owners were interviewed at the Icelandic Fisheries Exhibition 2002.

The EMI Interactive Java client has been providing sea ice, ocean and meteorological products as a public service throughout 2002. This includes support of specific operations: Lance (March), Ocean Tiger (May) and JRC/BAS (October). Data and information has been generated for both Arctic and Antarctic areas. Users are located world-wide, and web logging mechanisms are being used to generate statistics for use.

During the IWICOS project, the following user groups have been targeted:

1. Regular users:
    - National ice and weather services (Baltic region, Greenland, Iceland)
    - Shipping companies and sea traffic administration (Baltic, Greenland, Iceland, NSR)
    - Icebreaker captains and ice pilots of ships (Baltic region, Arctic Ocean)
    - Oil companies (Greenland and Arctic Ocean)
    - Fishing vessels (Baltic region, Iceland, Greenland)
    - Coast guard (Iceland)
2. Other users who will need data on more occasional basis:
    - climate research
    - environmental monitoring and assessment
    - navy
    - insurance industry
    - tourism
    - students and teachers
    - media

During the four dedicated demonstrations, representatives from all categories of "regular users" have been exposed to the IWICOS project, products and services, although not for all of the areas listed above. In addition, many representatives from the "other users" category have been reached, both in these demonstrations and through presentations at conferences and workshops. Thus, the IWICOS project has succeeded in demonstrating a suite of met-ice-ocean products to a wide audience, accessing the information through different communication networks ranging from low bandwidth satellite communication to high-speed landbased networks. The demonstrations performed have received overall positive feedback, and many of the involved users have expressed interest in continued and enhanced met-ice-ocean services. The concrete implementations on different computer platforms have shown that the IWICOS system architecture is versatile and can easily be customised to meet the needs of specific user groups. The architecture is built on open accepted standards for metadata and data representation, system interfaces and communication protocols, which makes it well suited for future commercialisation of met-ice-ocean services. All partners will therefore continue the development of IWICOS products and services, and will also seek to promote the IWICOS metadata specification to the marine community through engagement in standardisation efforts. The IWICOS System is a contribution to operational oceanography, facilitating the access to monitoring and forecasting services delivered by multiple providers.

Contents

1 Project synopsis

The objective of IWICOS has been to develop a prototype marine information system that will provide end-users with a single-entry access to meteorological, sea ice and oceanographic data and products in electronic form for users of operational services. These include national ice and weather services, shipping companies and sea traffic administration, icebreaker captains and ice pilots of ships, oil companies and offshore industry, fishing vessels and other ships operating in harsh climate, and finally climate research, education and media. IWICOS has targeted users in the Baltic Sea, Greenland and Icelandic waters, and the Arctic Ocean.

Main tasks have been user requirements compilation and analysis, design of specifications for data and system interoperability, implementation of metadata specifications and prototype subsystems, product development, and demonstrations to selected end-users in different regions and application domains.

The user requirements analysis has relied on synthesised results from earlier projects as well as a new user survey carried out for users in Icelandic waters and a design workshop held in the beginning of the IWICOS project. Overall recommendations from this task have defined the scope of the IWICOS System, taking into account specific requirements for different types of users and differences between needs in different regions.

The design activities have lead to a generic system architecture defining the IWICOS System as a set of interoperable subsystems (Producer Server, Broker, Façade, Client) with well-defined interfaces. A metadata specification for all IWICOS data sets and products was designed and decisions on standard exchange formats made. Suitable standard technologies and available tools were also identified and selected for use in the implementation phase. This included both open source and public domain tools as well as Commercial-Off-The-Shelf (COTS) software.

Implementation of the IWICOS System prototype was carried out in two main phases. First, a baseline version was implemented, providing basic and the highest priority functionality. This facilitated testing of the overall architecture and key subsystems (e.g. the Broker), and enabled initial demonstrations of data sets and products. Secondly, an extended version was constructed, elaborating the functionality and adding new features and data sets/products.

A suite of products was developed for the IWICOS System prototype, including initial data sets (such as meteorological observations and forecasts, satellite data, ice data, etc.) to client products that are based on various presentation methods to bring essential information to the customers (e.g. text, images, graphical products, etc.). For some products, algorithms for extraction or estimation of met-ice-ocean parameters from observed and/or modelled data were developed or existing algorithms enhanced.

The extended version of the IWICOS System was used in four user demonstrations in 2002. Two of these demonstrations were carried out onboard vessels operating at sea with limited bandwidth communications, one demonstration was held at a large fisheries exhibition and the last demonstration was an ongoing web service running for most of the project period.

Main scientific and technical results from the project include the generic system architecture, the metadata specification, the various subsystems, and enhanced or new algorithms. Key subsystems of the IWICOS System have been realised by means of standard technologies, enabling them to be available on a number of computer platforms. The metadata specification was defined in XML, ensuring portability, and a high potential for widespread use and future extension. In addition, partners have established good working relationships with their target customers, which have supplied valuable feedback during the project period, and are generally interested in continued operation of services offered by a system like the IWICOS System. Finally, a market analysis has been conducted, and plans laid out for future, potential commercial, exploitation of the results from the project.

2 Targeting users in the marine community

2.1 User groups and their requirements

The background and motivation for the IWICOS project is the general requirement from a wide range of users of met-ice-ocean data to have easier access to services and data provided by meteorological offices, ice information centres and oceanographical institutes. This means that monitoring and forecasting products in digital format should become easily available on Internet and that marine communication systems should be used to send text, images and graphical products to users at sea. Ship captains have expressed a clear requirement to have more integrated information available on the bridge. Ideally, all information should be accessible in digital form via one computer system, which is easy to operate.

In previous sea ice projects, user requirements for ice information have been identified for different regions and for the main users categories such as ice-going vessels, cargo vessels, fishing boats, oil companies, shipping companies, sea transport administrations, national ice and weather centres, research activities and other marine operations under rough conditions. IWICOS has built on the main results from these projects, which covered the Baltic Sea, Greenland waters and the Northern Sea Route. These requirements have been supplemented by results from a dedicated user investigation in Iceland and a Design Workshop where invited users stated their opinion on how the IWICOS prototype should be developed.

The requirements for sea ice information are closely related to meteorological and oceanographical parameters. For example, the temporal changes in the ice conditions are always driven by atmospheric forces (winds, air temperature) or ocean forces (currents, waves, tides, ocean temperature). This means that ice data should in principle be accompanied by atmospheric and ocean data that govern the behaviour of sea ice. The requirements are related to products and their quality, time-space coverage, methods of delivery, timeliness, regularity and costs. There are different products that cover various spatial and temporal scales, for example short-term and long-term weather forecasts, ice maps for strategic or tactical operations. The cost-benefit ratio is an important factor that determines which product or service a user selects in a given situation.

The meteorological information needed by users at sea can basically be divided into three groups:

- Tactical information, consisting of observations (ground observations and satellite products), very-short-range forecasts (nowcasting, < 3 hours) and warnings, issued whenever needed.
- Strategic information where traditional weather forecasts, issued at least two times a day as text according to WMO standards (up to 24 hours) are the most important items. These forecasts may be supported by prognostic charts from numerical models, and the charts should be enhanced in such a way that they are in agreement with the worded forecast.
- Planning information is mainly based on medium range weather forecasts (up to 10 days). Such forecasts may be presented as fields but forecasts beyond day 4 should preferably be expressed in probabilistic terms, based on EPS (Ensemble Prediction System).

2.2 Recommendations from the user requirements studies

- IWICOS should recognise that the marine user community may have different needs for information, may work in different regions and have different educational background.

- The IWICOS system must be able to combine information from different sources in a flexible way. Consequently, it should be possible to construct user defined displays and combinations of information.

- IWICOS should provide an integrated system enabling users to access and display all information with one system. It is important that users do not have to worry about sources of a given information layer and formats. Today, much of the information already exists, but must be collected from different sources and may exist in different forms that obstruct easy combination of information layers from different sources.

- It is important that the IWICOS system has a user-friendly interface so difficulties with understanding and using the system will not obstruct the application and dissemination of the system. Therefore the user interface must be developed by means of known industry standards or public domain tools.

- IWICOS should aim at adopting existing standards for data presentation, e.g. standard colour coding of ice charts and standard symbols for presentation of meteorological information and ensure source independence and seamless display of data from different sources.

- IWICOS must disseminate products using standard technologies and standard data exchange formats.

- IWICOS must acknowledge the limitations of marine communication systems and the cost of using them and must adopt methods to effectively handle these problems.

- IWICOS should provide a range of products with different levels of information, aimed at different user groups. In demonstration periods a representative set of free products should be prepared and advertised through the IWICOS web site, to raise awareness of the service and allow for a wide audience to give feedback on the products and IWICOS prototypes developed.

- The cost of the met-ice-ocean products is another important aspect in the end-users' evaluation of IWICOS. Some products will require high-priced input data and/or a significant amount of processing and therefore be expensive to generate, while others may be produced by means of low-cost input data and simple, automated processing tools. Whether or not a product is to be delivered in near real-time will also have a large impact on its cost. As information needs will differ between various user groups, and also depend on the type of activity carried out, the user should be able to select and change the level of service requested to best match the current situation.

2.3 From initial data to client products

Products in this context means both met-ice-ocean data at various processing levels ranging from initial data sets (meteorological observations and forecasts, satellite data, ice data, etc.) to client products which are based on various presentation methods to bring essential information to the customers (text, images, graphical products, etc.). In this project we define initial products to be a set of met-ice-ocean data sets that are available among the partners and used to develop various methods for combination and presentation of the data sets in user-friendly ways (Figure 2.1). These presentations are defined to be the client products, and they are dependent on the client capability to transfer, display and manipulate with the data sets.

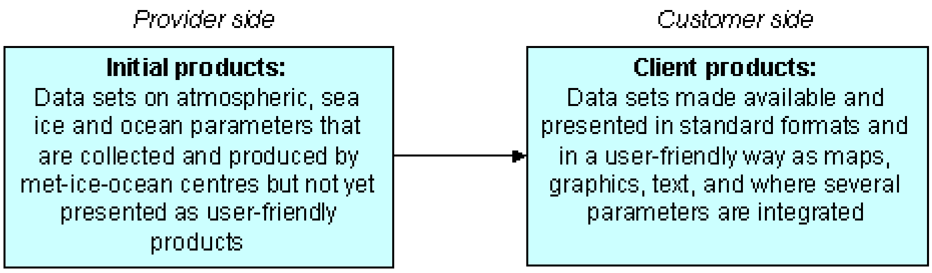


Figure 2.1 Definition of initial products and client products. Client products can either be produced by a central server on the provider side and be downloaded for display on the user's PC, or they can be produced locally after downloading initial products from a central server. The latter option makes it possible for the user to carry out own operations on the data and make his own client products provided that he has necessary software for such operations.

The partners have developed a set of initial and client products for the IWICOS System prototype. In these products data from several sources were integrated and presented, and in some cases meteorological, oceanographical or sea ice data were combined and displayed on top of each other by means of GIS technology. The client products must be tailored to the geographical regions, the communication limitations and the specific user requirements in these regions, while other products will be more or less similar in all regions. Use of GIS technology is an important element in the integration of several data types. For example, wind fields and air temperature can be used together with ice data, showing the dynamics of the ice fields. Ice kinematics algorithms can be improved by including wind forcing, and ice type classification can be made more reliable if the time series of ice data from the preceding days and weeks are made available.

The products can be divided into the following main groups:

- Near-real time products that are used for monitoring and are available on regular basis (hourly, daily, weekly, etc.)
- Forecasts of weather, ocean and ice conditions which may be supported by output from numerical prediction models,
- Archived products giving statistical information about mean and extreme conditions as well as snapshots of interesting events, and
- Experimental products

A number of products have been developed and demonstrated during the IWICOS project, e.g. SAR, AVHRR and SSM/I images and derived parameters, weather forecasts and meteorological statistics, ice charts and ice accretion forecasts (non-exhaustive list). For each product, a production chain has been set up at the producer's site, preparing the data sets and client products in a digital form suitable for distribution via the IWICOS System prototype. Figure 2.2 shows an example of such a production chain and how the developed products can be delivered to multiple customers using different client software.

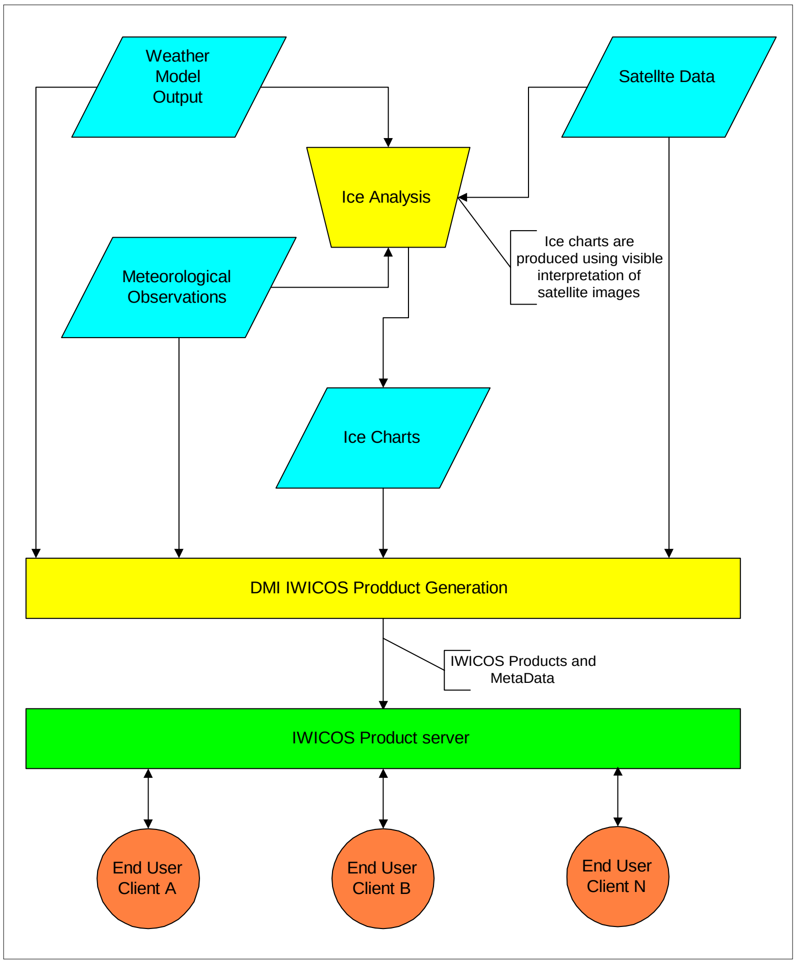


Figure 2.2 IWICOS product generation at DMI.

2.4 Enabling data and product distribution to various clients

Serving a variety of user groups through a common system necessitates standardisation of data (and metadata) exchange formats and communication protocols. A joint facility for advertisement of available data sets and products is also needed. At the end-users' sites, a client system would be needed for obtaining, displaying and (in some cases) analysing data sets and products. This lead to the development of a generic system architecture, a metadata specification standard (which also defined data format), a Broker sub-system that would manage a joint metadata repository for all IWICOS products, and a set of clients tailored to specific end-user groups. These elements have facilitated data and system interoperability, which has been a key issue in the project.

The IWICOS interoperability is based on a common description of available products and their features presented in XML. These metadata descriptions are submitted to the Broker. The customers can base their product selection on the metadata description, and then retrieve the actual products from the Producer Servers with the help of a Façade subsystem. Finally, Client Software is used to acquire a presentation of the product data (Figure 2.3).

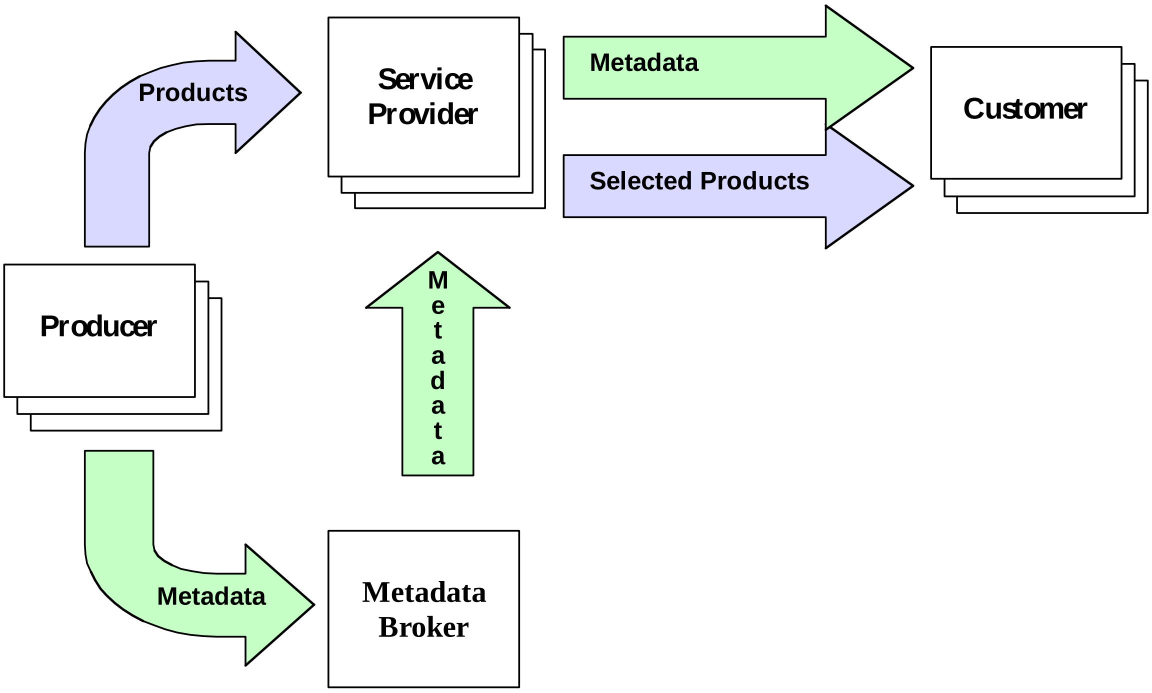


Figure 2.3 The IWICOS Service Chain.

3 Main results and achievements

3.1 Design of a generic system architecture

The logical architecture for IWICOS follows a model suitable for dynamic multi-producer GIS-systems, i.e. the system can be divided into three subsystems as shown in Figure 3.1.

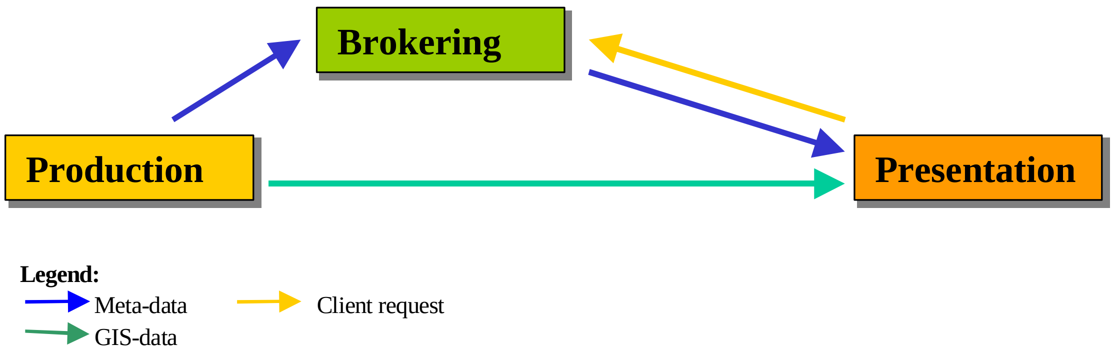


Figure 3.1 The reference architecture for IWICOS.

The main subsystems include the ***production***, ***brokering***, and ***presentation*** of GIS-products. The actual tasks in these subsystems are determined by decisions related to issues such as distribution, delivery mechanisms (push/pull) and client model (thin/thick). In the production subsystem the GIS-data is produced and packed for delivery with a metadata description of the product. The brokering subsystem receives this information (or plain metadata and GIS-data address) and the user data requirements (either a profile or a request as a query).

Production Subsystem

The Production subsystem produces the raw-data or refines it to useful products. The IWICOS architecture encompasses a set of Production Servers that register their products to the Broker using a defined protocol and describing their Products using the IWICOS Metadata format. The data itself need not be copied to the Broker.

Brokering

The main task for the Broker is to establish contact between Clients and Producers by providing a directory service for the actual products.

Presentation

The task for the client software is to present the data to the user. There are, however, two approaches to this task. The first one, called *thin-client* approach, is just to provide ready-made presentations of the data. The other one is the *thick-client* approach, which may include complicated processing of the data to gain a presentation that is customized for that particular user. Both *thin-* and *thick-client*s are supported in the IWICOS architecture, due to the heterogeneity of IWICOS users. Lately this division to *thick-* and *thin-client* systems has become a bit ambiguous, due to the Java-applet clients that have both *thick-* and *thin-client* properties. Based on this trend we define a *thick-client* to be a client that requires a separate installation process to be accomplished on the target computer before the client can be used. A *balanced-client* can be used as a term for clients having both *thin-* and *thick-client* properties.

Service chain illustration

The flow of data from the providers to customers forms a service chain that will supply both *thin clients* and *thick clients* (Figure 3.2). The initial data products are transformed into client products through different processing in production servers and client software. In this chain, the data that the user needs are produced, processed for delivery, selected and presented to the user in the form of client products. The base for identifying the useful data and the varying processing it requires is the metadata that describes the attributes of the actual data, such as its location, time, nature and origin. Extensible Markup Language (XML), XML Schema, and Resource Definition Framework (RDF) provide a good base for the definition of the metadata presentation (Karttunen 1999, Lassila 1999). In

IWICOS we used XML and XML Schema, but not RDF. The main components in the service chain are the subsystems of the reference architecture described above. However, these subsystems consist of smaller separate processes. After each processing the data is shifted to the next phase; in these interfaces the data should preferably be presented using open industry standard formats (if possible). In the service chain both client types can be served, by providing the data for client software on different levels of processing. In a *thick-client* the client software does the final processing of data and in *thin-client* this is done by the production server. Thus *thick-client*s receive a kind of 'bulk-data' and *thin-client*s receive final products.

The use of the open industry standard formats in data transfers forms natural connection points for additional processing that may be applied on some data. Such processing will actually widen the service chain concept to a *service graph*. All data is not necessarily treated similarly and value added services can be provided by external service producers that apply some specific processing on the data that is not usually available in the basic service.

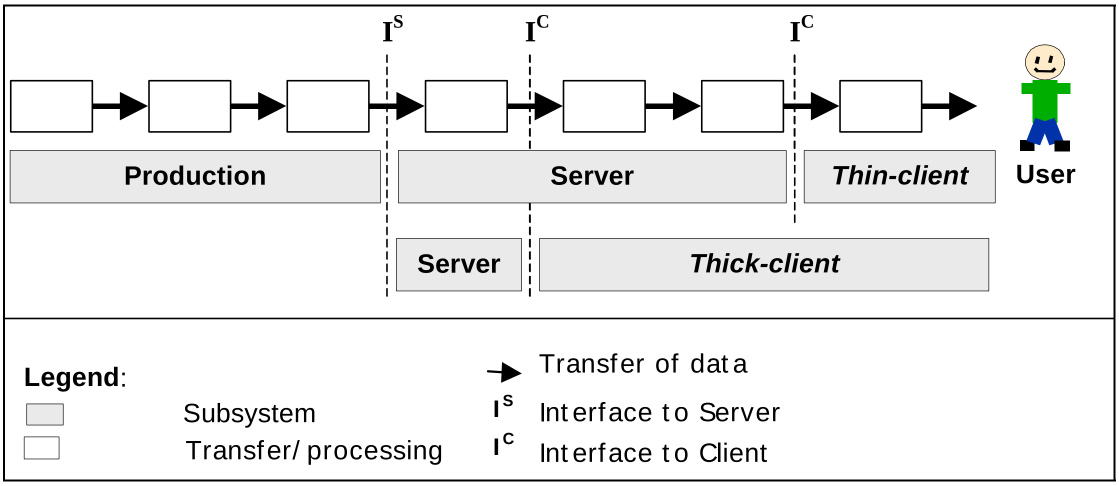


Figure 3.2 The service chain for Client-Server GIS-systems.

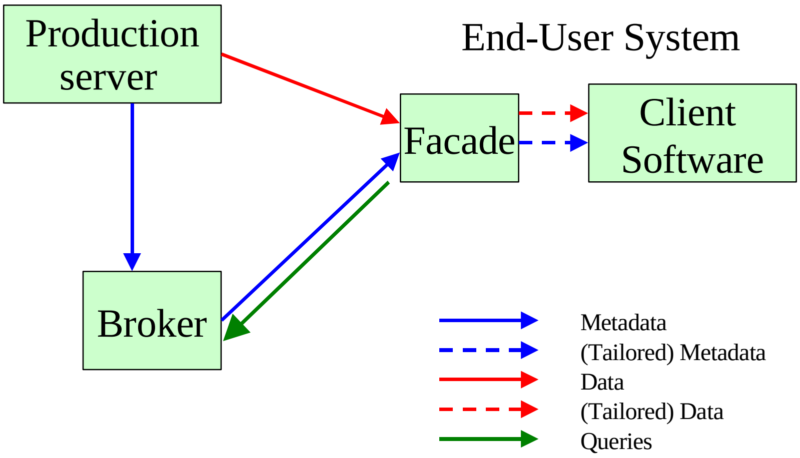


Figure 3.3 The components of the implemented IWICOS architecture.

When implementing the IWICOS architecture, a new component, the *Façade*, was introduced. The Façade can be understood as a server for the Client Software. Façade and Client Software may not be located in the same physical location, and the communication link between Client and Façade varies from high-speed Internet connection to low bandwidth cellular phone link. The Presentation was taken care of by the Client Software and the processing of the actual data was partly done by the Façade - again with large differences depending on the implementation (thin or thick client). Thus the Façade implementations can vary a lot. For a simple web-browser based client it will be closely integrated to the Client Software. On the other hand, the Façade may be a very complicated element containing reasoning of user needs based on a profile, product generation based on the products provided by the

Producer Servers, and filtering of unnecessary components of products (e.g. layers with unnecessary data content).

3.2 The IWICOS metadata specification

3.2.1 Background

The IWICOS metadata standard has been developed specifically for the IWICOS project. Several existing standards have been investigated and tested including the comprehensive ‘Standard for Digital Geospatial Metadata’ (FDGC-STD-001-1998) established by the Federal Geographic data Committee (FDGC, 2000). However, none of the existing standards fully match the IWICOS product assemblage. The varied nature of IWICOS products combined with the fact that many of the investigated existing standards consist of superfluous components when considering the IWICOS requirements urged the development of an IWICOS specific standard. Establishing an IWICOS specific standard at the same time adds flexibility to the IWICOS system, meaning that the standard continuously can be adapted and extended to meet the requirements of new IWICOS products.

3.2.2 Methods

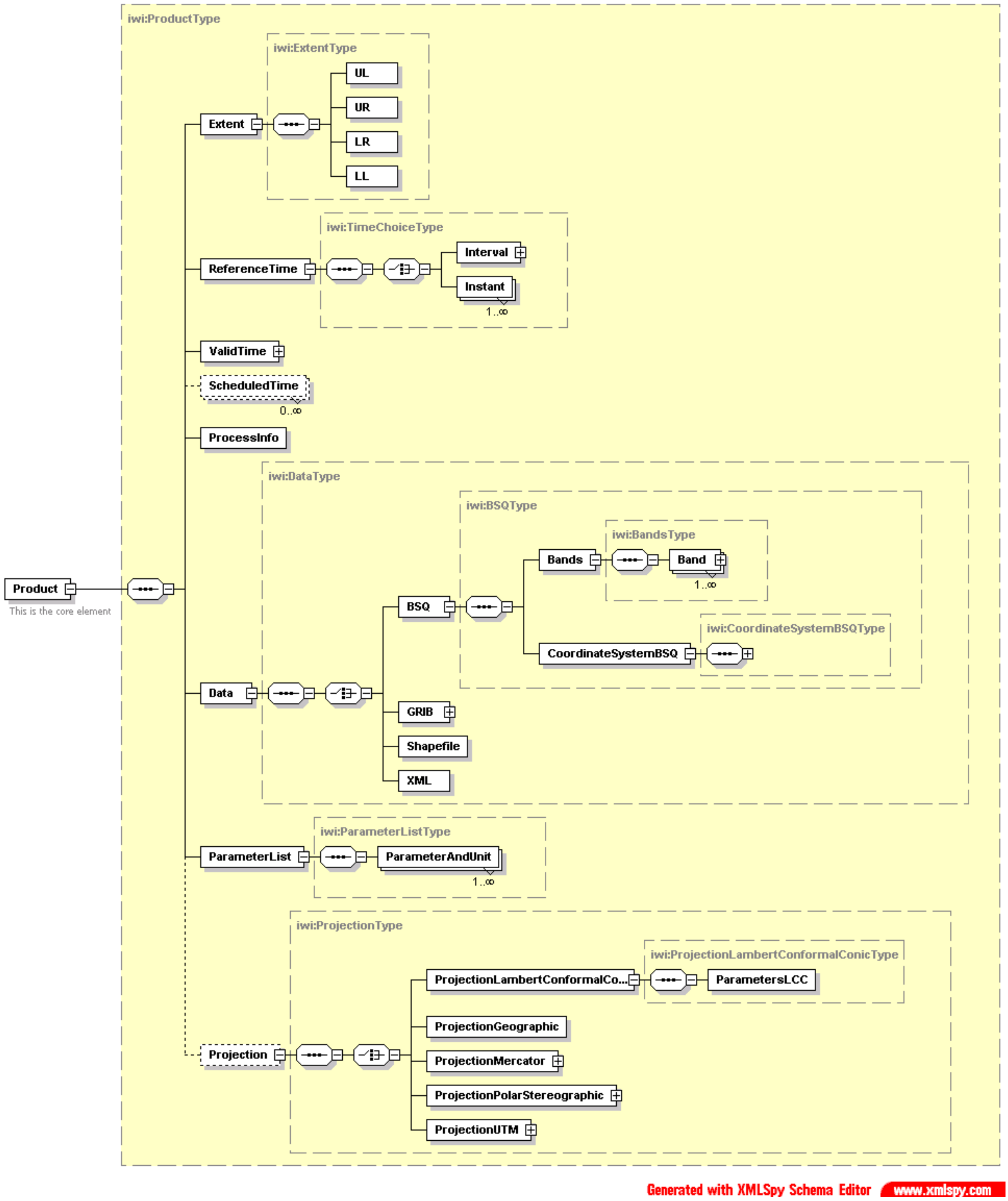
The development of the IWICOS metadata standard has been implemented using XML and XML Schema in accordance with W3C recommendations (see W3C Recommendations 2000a, 2001a, b and c). The metadata definition itself consists of XML Schemas and the metadata files are XML documents instantiated from these schemas. The XML Schema definition consists of 17 schema files connected through common namespace declarations. The division into separate schema files are made as a database-like division into themes in order to simplify the development environment and ease revision/updating. Once the core structure of the schema definition has been established the maintenance of the IWICOS metadata standard is not laborious. The implementation of new products/parameters, units, projections etc. is quite easily accomplished. Thus, the IWICOS metadata standard has been continuously updated and extended to match IWICOS product requirements. All metadata XML documents are validated against the schema definition prior to release. This ensures that metadata files are IWICOS standard compliant and can be exchanged and understood by product servers, Broker, and end-user systems.

3.2.3 Content model

The schema definition is build around a core element named ‘Product’. From this core element a tree structure emerges consisting of child elements in an element-on-element structure with each element being associated with a set of attributes. Part of the content model for the schema definition is shown in Figure 3.4.

As can be observed from Figure 3.4, the IWICOS metadata standard consists of 8 generic child elements connected to the core element ‘Product’. A short description of each generic element follows:

- **Extent:** Defines the bounding geographical coordinates of the product
- **Reference Time:** Especially used for numerical prediction products where it defines the time of analysis
- **Valid Time:** Especially used for numerical prediction products defining the valid time (analysis + prognosis)
- **Scheduled Time:** Defines the time for next similar product
- **ProcessInfo:** Comprises information concerning data origin, quality and producer information
- **Data:** Comprises the actual data information for the four IWICOS exchange formats
- **Parameter List:** Defines the parameter(s) and corresponding units
- **Projection:** Defines the data projection - a set of 5 frequently used projections have been implemented



Name	Type	Use	Value
Availability	xsd:boolean	required	
FileLocator	iwi:LocatorType	required	
FileSizeInBytes	xsd:nonNegativeInteger	required	
Compression	iwi:CompressionType	optional	

Figure 3.4 Part of the IWICOS Schema Definition content model. In the upper part of the diagram the core element 'Product' are shown together with a set of child elements. As an example, the lower part of the diagram (the table) shows the attributes related the element 'Data'.

3.3 The IWICOS Broker

The IWICOS Broker acts as a directory service for finding relevant IWICOS products. The Broker provides two interfaces for metadata operations. One is intended for the Producer Servers for managing the Broker's metadata content. The other one is the query interface for the End-User Systems through which they can access the Broker's metadata content. The Broker implementation is based on freely available components: Apache web server, Apache Tomcat servlet container, Apache SOAP implementation and MySQL database. The Broker runs on Linux OS and the service programs are written in Java. The communication is secured using SSL encrypted HTTP protocol (HTTPS).

The Broker is divided into three main components:

- Database, a storage for metadata
- Metadata Parser, that processes the metadata descriptions of new products and stores them in the Database for later access by queries
- Query Engine that interprets the queries posed in an XML format to SQL, executes them on the Database and returns the results for the caller (see Figure 3.5)

The Broker communication is implemented with the Remote Procedure Calls (RPC) implemented over the Simple Object Access Protocol (SOAP). The RPC uses a small program called a *stub* in both ends of the communication, which marshals the required parameters and returns values of the call. An example of stubs is shown in Figure 3.6.

The interfaces with the Broker are the following:

1. **Producer Server - Broker,**
2. **Façade - Broker,**
3. **Façade - Producer Server**

These are explained in more detail below.

Producer Server - Broker

In this scenario the Producer Server manages the Broker metadata content with the following operations: *newProduct*, *outdatedProduct*, and *productList*. The operations are used for informing the Broker of new and outdated products, and acquiring of a list of the producer's products that have metadata stored to Broker.

Façade - Broker

In this scenario the Façades execute queries on metadata at the Broker to gain a list of products that might be applicable for user needs. This interface contains a single operation called *query*. However, it is more complicated than the previous scenario since the parameter and reply content is more dynamic.

Façade - Producer Server

In this scenario the Façades acquire the actual product data based on the metadata retrieved in the previous scenario. The product data at the passive (web-server) part of the Producer Server is accessed using the HTTP protocol and thus is not very complicated to implement.

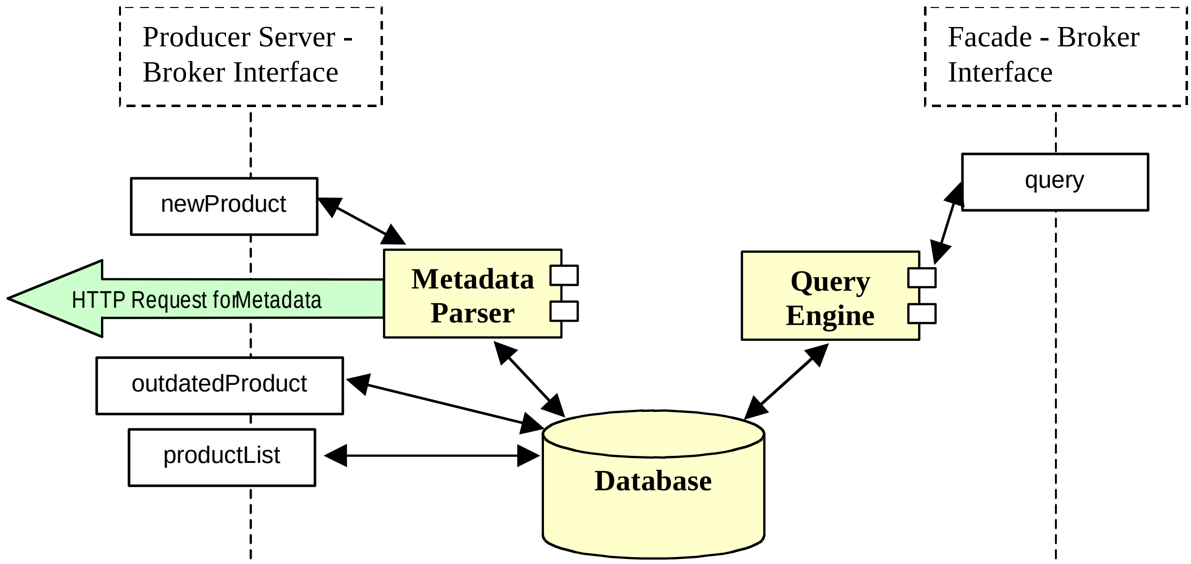


Figure 3.5 The Broker Internal Structure.

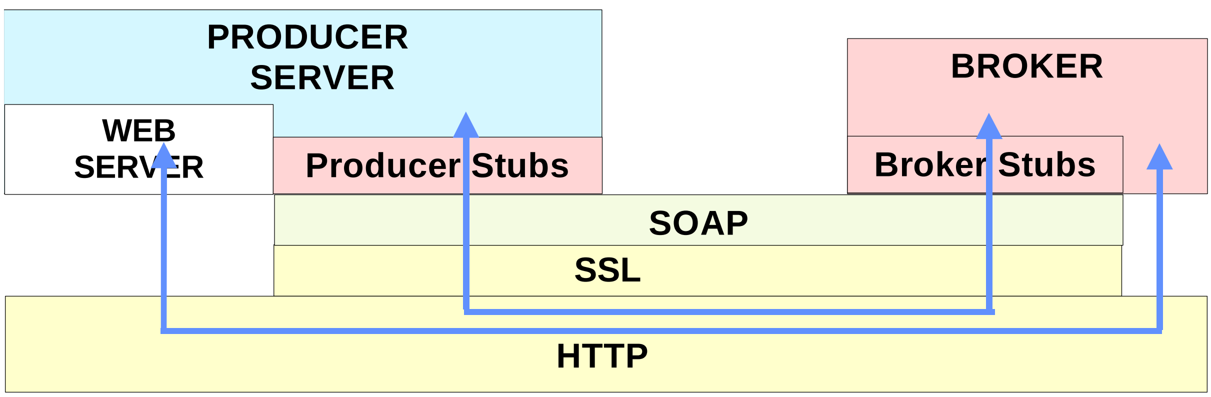


Figure 3.6 Stub Example - The IWICOS Producer Server and Broker Stubs.

4 Demonstrations

4.1 The R/V Aranda expedition in the Fram Strait

4.1.1 Introduction

One of the major bottlenecks in marine information distribution from the producers to the users at sea is a lack of suitable systems. The Fram Strait experiment in March 2002 provided a unique challenge for the IWICOS System demonstration at the area, where communication possibilities are limited and expensive to use, and the environment plays a vital role in ship's security and achieving successfully the goals of the experiment.

Due to limited communication possibilities, delivered information products and data were put into minimal. Three IWICOS partners participated in the demonstration and their roles were: VTT made available ViewIce application onboard ship, tested the communication system functionalities via the Iridium satellite system and hosted the IWICOS Façade and Broker; FIMR supported the expedition with real time or near real time RADARSAT ScanSAR Wide images and ice drift buoy data; DMI supported the expedition with meteorological forecasts making available four times a day HIRLAM forecasts for 10 m wind and surface air pressure in 3 h steps for next 48 h.

The R/V Aranda demonstration was made during the FRAMZY-2002 – Cyclones over the Fram Strait: air-ice-ocean interaction and sea ice transport field experiment, financed mainly by the German Sonderforschugsbereich (SBF 512), and it was taken place at the Fram Strait area in March 2002. Fram Strait lies between Spitsbergen (Svalbard) and Greenland around 80ºN. Participating institutes were the Finnish Institute of Marine Research, Finland and University of Hamburg, Germany, and the main purpose of the field experiment was to study decrease and redistribution of the Arctic sea ice (UH & FIMR, 2001).

The main experiment took place on 2-22 March 2002, and three platforms were used. Finnish research vessel Aranda anchored at a large ice floe, where she remained stationary during experiment. Onboard ship intensive meteorological and oceanographic observations and studies were made. German Falcon research airplane equipped with many high-tech meteorological sensors was based at the Spitsbergen, and it made several research flights over the study area. 14 ice drift buoys were installed on ice floes and ice drift was studied with these buoys.

4.1.2 System

For the first time the full IWICOS System was in full operational use. Figure 4.1 shows an overview of the system. In the Aranda demonstration the Broker received metadata from producer servers. The Façade then requested metadata from the Broker, received RADARSAT images and buoy data from FIMR, and weather data from DMI.

The operation of the Façade was controlled by user specific profiles, i.e. parameters that described the needs of the Client (Aranda). The parameters were stored in a profile database that could be edited via the Profile-UI user interface. Based on the profile, the Façade fetched the needed products and formed a password protected a web page accessible on the web. A notification was sent to the user when new products were made available. The user could then download selected products from the web page. The products were visualized with the ViewIce program.

A producer server consisted of two parts, active and passive (Haajanen and Berglund, 2001). The active part informed Broker when a new product was available or an old product was outdated. The passive part was a web server where the active part placed it's output for the Broker and the Façades to be retrieved.

The producer server informed the Broker of new and outdated products by using SOAP messages (Haajanen and Berglund, 2001). The Producer server stored the available products on a web server. The Broker parsed the contents of the metadata and extracts all elements applicable to the MSS (Minimal Searchable Set) format to its database. The Broker had the information of available products from different producers and the information of where the products could be found.

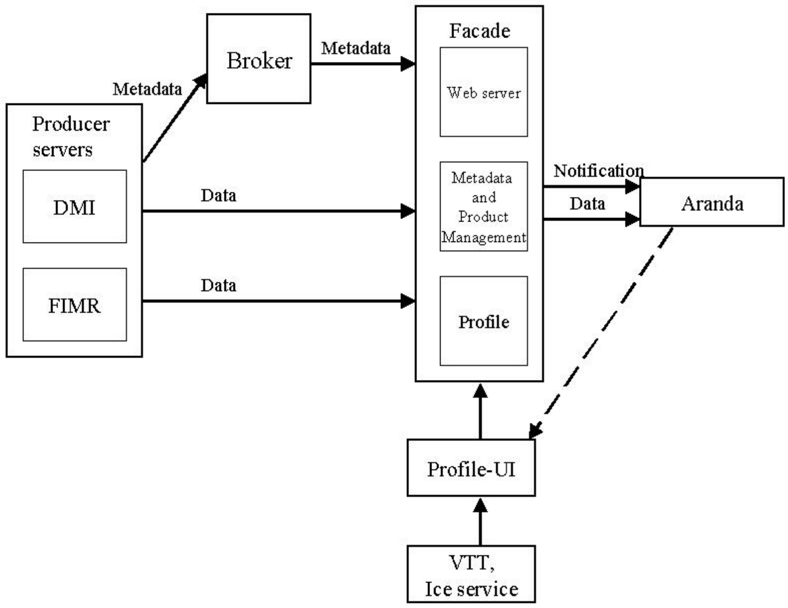


Figure 4.1 The IWICOS system in the ARANDA demonstration.

The Façade queried the Broker about available products (Haajanen & Berglund, 2001). The queries were based on XML-format and were sent as SOAP messages. The query could be posed in two modes: brief and full. In the former, the response contained only the MSS. In the latter the response contained the actual product metadata.

The Façade consisted of two main modules: Metadata & Product Manager and Profile Manager (Kotovirta, 2002). The Profile manager provided the user with a User Interface to manage profile data, i.e. parameters that described the needs of the user. The profile data was stored in a database. Metadata and Product Manager retrieved the profile data from the database and fetched the products needed from the Producer servers based on the profile. The Façade stored the retrieved products on a web page and send a notification to the user.

The Metadata and product manager was controlled by the profile (Kotovirta, 2002). It checked periodically if new data, which was interesting according to the profile, was available. When new product data was available, the Façade retrieved the data, stored it in a local file and generated a web page with links to the products. The idea was to present only relevant information to the user and when many alternatives existed, the alternatives were arranged in order of anticipated importance. Criteria for relevance could be the distance of the centre of the image with respect to the current position of the ship.

The Façade sent a notification of new products available to the user according to the profile. The notification was implemented as an e-mail, which could be relayed as text messages to Iridium using an Iridium gateway or as SMS messages to a GSM phone using an SMS gateway. A parameter, called the Quarantine time, was used to prevent the user from being flooded by messages. This parameter prohibited sending of a notification if the previous message already was sent within the quarantine time interval.

The Profile manager consisted of two parts: FaçadeDB and Profile-UI (Kotovirta 2002). The FaçadeDB was a profile parameter database. Profile-UI was the User Interface to manage profile data. The Profile-UI provided a web browser interface to edit the profile parameters. There were two versions of the user interface: a simple and a full version. The simple version was intended for the end user (Aranda) where the communication was limited. The simple version enabled the users to change the information about their current position only. The full version enabled editing of other parameters in the profile as well.

Data transfer was performed using the Iridium satellite communication system. On the client computer emulator software (called Apollo Emulator) was installed. The software took care of opening the session via the Iridium gateway to the desired Internet address.

The Apollo emulator software emulated a normal LAN connection to the applications, thus standard web browsing and e-mail software could be used. The data to be downloaded were selected and downloaded using MS Internet Explorer. The emulator software also included data compression functionality, which reduced the time to transfer ASCII files like the buoy data.

In the Aranda demonstration ViewIce (Figure 4.2) was used to display wind and pressure forecasts, RADARSAT images and buoy data. The user downloaded the images from the web page that the Façade generated according to the user's profile. The selected data was saved in a local file from where ViewIce could display it.

4.1.3 Data requirements and data to the ship

The experiment area situated around or north of 80ºN caused communication problems for data transfer to the ship. Available communication satellite systems were Inmarsat with a very slow or expensive data transfer capacity and the fact that the area was out or almost out of satellite's range, and the Iridium satellite system. In practice, the Iridium was the only available and reliable system. However, Iridium was capable to transfer only some 13 kBytes/min. This forced us to limit the data transfer to the minimum set of data needed for the scientific experiment and for the ship's safety. Under the IWICOS demonstration only satellite, weather and buoy data were delivered to R/V Aranda. The data was made available to the ship via the IWICOS Façade and Broker and consisted of the RADARSAT images, weather forecasts and ice drift buoy data.

Altogether about 1000 files were made available for downloading and the ship downloaded 196 files consisting of 66 satellite images, 73 wind forecasts, 25 pressure forecasts and 32 ice drift data files. On average 9 files was downloaded in a day, varying between 1-26 files.

The metadata information was put into the IWICOS Broker several times a day. At the R/V Aranda the data downloading started on average after 5h 00' after the message was stored in the Broker: Minimum time for starting data transfer was 0h 09', and maximum was 19h 44'.

RADARSAT ScanSAR Wide images were delivered on daily basis to R/V Aranda. ScanSAR Wide screen covers about 500*500 km area and its spatial resolution is about 100 m. A contract with the Tromso Satellite Station was made, where the TSS made available 25 screens of which 20 screens could be downloaded. At the FIMR's Finnish ice service processing and downloading took less than two hours, including data transfer to the ship no more than three hours. Downloading, reprocessing, geographical correction, land masking and format change were done before screens were available for transferring.

Because of large file sizes, two types of images were produced: a full-cover overview image in about 1 km resolution, and sub-images covering about ~ 100*100 km, where the full-resolution images were cut into 29 sub-images in a 100-200 m resolution (Figure 4.2). This put largest file sizes down smaller than 100 kBytes.

Totally 19 large images and 551 sub-images were made available on the IWICOS Façade, and 66 images were downloaded to R/V Aranda: 13 large-cover, low resolution images and 53 sub-images. On average 3.5 images were downloaded daily, varying from 0 to 11 images. Minimum compressed file size was 6.078 kBytes, average size 18.008 kBytes and maximum size was 25.106 kBytes.

Meteorological data consisted of mean sea level pressure and 10 m wind. The Danish Meteorological Institute made this data available via the IWICOS Broker four times a day.

The data consisted of 1) mean sea level pressure (3 areas, analysis every 3 h and estimated file size 11 kBytes) and 2) 10 m wind (5 areas, analysis every 3 h and estimated file size: 14.5 kBytes).

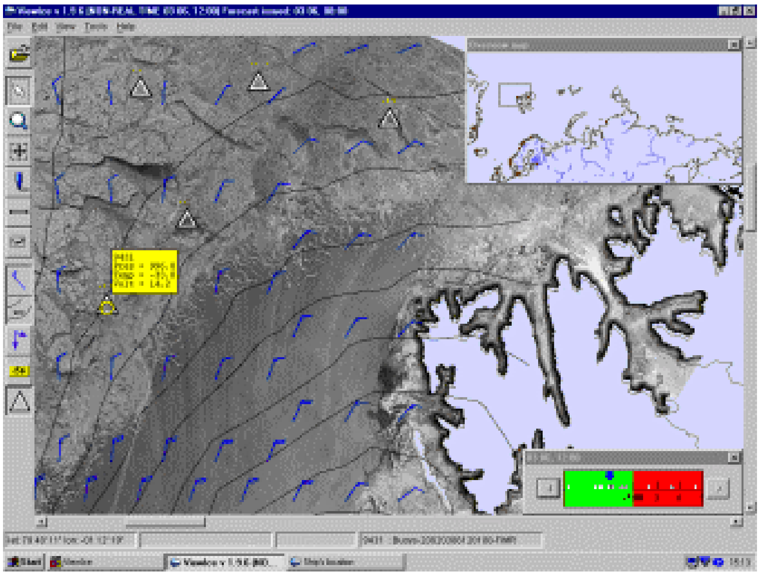


Figure 4.2 Combination of RADARSAT image, buoy positions (triangles), surface air pressure field and 10 m wind field barbs onboard ship seen over the ViewIce application.

About 80 10-m wind forecasts and 400 air pressure forecast fields were made available for transfer via the IWICOS Broker. Totally 98 meteorological forecasts were downloaded to the R/V Aranda: 73 wind forecasts and 25 air pressure forecasts. On average, 3.5 wind forecasts and 1.2 pressure forecasts were downloaded daily, varying from 0 to10 files. Minimum compressed file size for wind forecasts was 0.821 Kbytes, average was 12.146 Kbytes and maximum 13.128 kBytes.

Totally 14 Argos ice drift buoys were mounted at the area. Data of these buoys were collected via Argos at the FIMR, files transferred into XML format and made available to download via the IWICOS Façade to the ship.

Buoy position files were made available once an hour for transfer via the Façade. This was too large number to transfer via the slow communication system to the ship. Thus only 32 buoy data files were downloaded. On average 1.5 files were transferred a day, varying from 0 to 3 files. Minimum compressed file size was 3.966 kBytes), average size 7.075 kBytes and maximum size was 10.556 kBytes.

4.1.4 User comments

Onboard the ship three persons operated the System. One of them had had special introduction for the System use beforehand by the VTT. Two users filled out the straw polls and were interviewed for functionalities of the System and products.

In general the IWICOS System operated very satisfactory. The feature, where the user could choose the needed data was considered excellent. Semi-automatic features could be included in downloading procedure. Problems were found in:

- some ViewIce application functionalities,
- not possible to use Iridium and ship's intranet simultaneously, and
- usability of RADARSAT images due strong ice drift, difficulties in positioning the ship in the image, and the image interpretation was sometimes difficult, when large areas had the similar colour and / frost smoke and conditions were frost flowers were over the ice, hampered interpretation of ice conditions.

4.1.5 Conclusions

The Fram Strait field experiment provided a unique challenge for the IWICOS System demonstration in the area, where communication possibilities are limited and expensive to use, and the environment plays a vital role in ship's security and successfully achieving the goals of the experiment.

On 2-22 March 2002 the IWICOS Broker and System was demonstrated during the Finnish research vessel expedition at the Fram Strait area, around latitude 80ºN. Because of poor communication possibilities, the Iridium communication satellite system was used for data transfer, and the number and file sizes of delivered information products and data were put into minimal. This proved to function very well.

Three IWICOS partners participated the demonstration and their roles were: VTT was responsible of the Broker and the Façade (real time portal for IWICOS data), FIMR made available the RADARSAT images and ice drift buoy data, and DMI made available wind and air pressure forecasts.

Altogether about 1000 files were made available for downloading and the ship downloaded 196 files consisting of 66 satellite images, 73 wind forecasts, 25 pressure forecasts and 32 ice drift data files. On average 9 files was downloaded in a day, varying between 1-26 files.

The available data was presented to the user via a real time portal - the Façade - which used the IWICOS Broker to fetch the relevant data from the data producers. Because of lack of metadata for some of the products, part of the data was fetched directly from the producers to be presented on the web page of the Façade. The availability of new data was announced to the user as e-mails that were converted to Iridium text messages by a gateway at the satellite system provider. The automatic operation of the Façade is controlled by a set of parameters - the profile - which describes the priorities and needs of the user.

In general the IWICOS System operated very satisfactory and the user feedback was very positive. Onboard ship three persons operated the system. The feature, where the user could choose the needed data was considered excellent. Semi-automatic features could be included in downloading procedure. Better information flow between producers, system developers and users should be introduced. Also better user introduction for application handling should be made. Some reliable ways for SAR image correct positioning should be developed. Combination use of ship's radar and SAR images could be considered for better image interpretation and optimal route finding.

The full-scale demonstration of IWICOS System showed, that it could also be used in the remote areas. The System should be push up into a full operational status covering all the European sea areas. This could bring great benefits to users at sea, if they would be able to pick up and receive high resolution meteorological, sea ice and ocean data and forecasts.

4.2 The Arina Arctica demonstration

4.2.1 Executive summary

The operational demonstration of the thick client 'Met-Ice-Ocean Viewer' (in short, the MIO Viewer) took place aboard the vessel Arina Arctica during two cruises. The first cruise covered the period of May 30th - July 12th 2002. The second cruise covered the period of August 20th – September 26th 2002. Arina Arctica is owned by Royal Arctic Line and operates on the east and west coast of Greenland. The vessel is a general cargo/container carrier which operates as a supplier for the largest communities primarily at the west coast of Greenland.

In this case, the IWICOS system has been demonstrated with particular emphasis on the End-user system, i.e. the Façade and the thick client (MIO Viewer). The MIO Viewer was fed with data from three producers during the demonstration: the Danish Meteorological Institute (DMI), the European Centre for Medium-Range Weather Forecast, ECMWF (data available through DMI) and the Icelandic Meteorological Office (IMO). DMI has been responsible for supporting the MIO Viewer, adjusting the user profile and has acted as a producer of numerical predictions of meteorological parameters and of sea ice analyses and satellite imagery. ECMWF has produced numerical predictions of oceanographic data and IMO has acted as a producer of textual weather forecasts for Icelandic forecast areas.

Altogether the user at the ship downloaded 185 data packages consisting of 11 satellite images, 11 ice analyses, 375 pressure forecasts, 375 wind forecasts, 300 wave forecasts (direction and height), 300 swell forecasts (direction and height) and 13 textual weather forecasts for Icelandic waters. The provision of numerical predictions has been regular, consisting of one daily broadcast. The provision of ice information and satellite data has been irregular and data is primarily from June and the beginning of July where high concentrations of ice were found around Cape Farewell. The provision of textual forecasts for Icelandic waters were limited to the periods where the vessel operated the route across the North Atlantic Ocean, back and forth from Denmark to Greenland.

Data provision was controlled by a predefined user profile which governs the Façade data operations and the provision schedule. Data from numerical prediction models originally stored in GRIB format were converted to a client specific format through a set of Façade operations at DMI. Ice analyses and satellite images were bundled in zip files. Textual forecasts in XML format were fetched directly from an IMO web server and bundled in zip files prior to provision.

The vast majority of data were automatically pushed to a central mail server and accessed by the user through an Inmarsat-B satellite connection. At some occasions, when fast access to ice conditions were required, the crew were informed of new data through an Inmarsat-C telex connection. Finally, data was presented to the user via the MIO Viewer.

In general, the IWICOS system and the MIO Viewer operated as planned. The user feedback was positive although some recommendations can be deduced from the users response. Based on the answers to the questionnaire and discussion with crew members, following issues should be addressed when considering future development of the system:

- Better integration between existing navigational equipment and the MIO Viewer should be considered. This includes a way of obtaining a GPS input from the existing GPS receiver and the possibility of transferring waypoint information from the basic navigational system to the MIO Viewer route module. However, no integration is desired between navigational maps and weather/ocean information as it is the users point of view that such an integration would confuse more that it would ease the use of the system.

- Longer prognoses are desired for meteorological data which implies that data from models other than HIRLAM should be investigated in the future.

- From previous discussions with the users it is the authors point of view that not only the ‘raw’ numerical prediction output, but also derived products including visualisation of frontal systems and positions of low and high pressure zones – information which is found in more traditional weather maps are desired. In relation to this, a great challenge lies in the automation of producing such data.

- It is the authors’ point of view that more emphasis should be put on training of personnel concerning use of the client.

4.2.2 Description of the system

Figure 4.3 shows a schematic representation of the IWICOS system as it appears for the Arina Arctica demonstration. Data at producer level are stored in IWICOS exchange formats, like GRIB for numerical predictions, Shapefile for ice analyses and XML for textual weather forecasts.

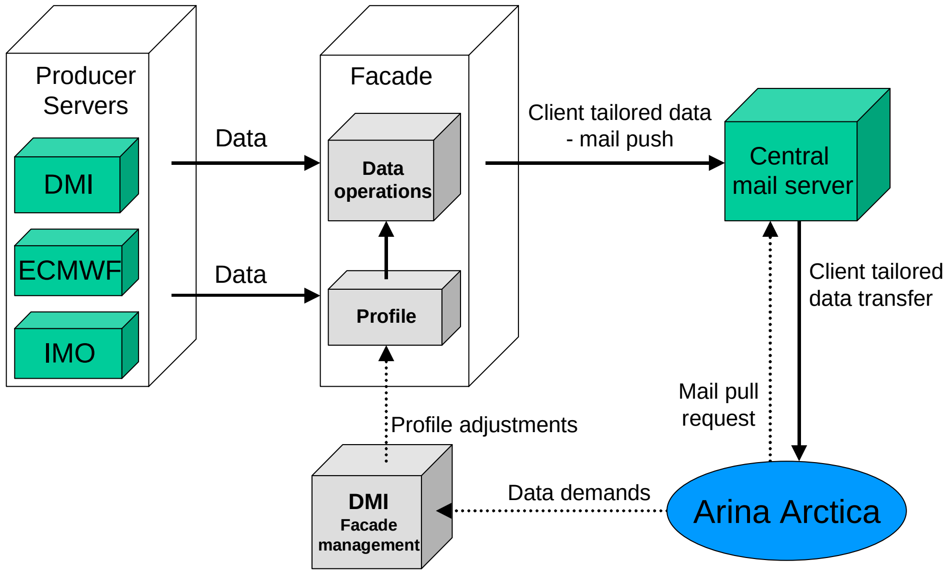


Figure 4.3 The IWICOS system as it appears in the Arina Arctica demonstration.

At Façade level, data enters a data operation module which handles production of client tailored products through data rearrangement, bundling, format conversion and compression. Also, at Façade level a user profile is established as a set of configuration files which govern the data operations and distribution to the client system. The profile is adjusted from time to time based on modified demands from the user. Profile adjustments are entirely based on mail correspondence between the user and personnel at DMI.

From the Façade level the data is pushed as mail to a central mail server according to a predefined schedule. The ship crew then pulls data from the mail server through an Inmarsat-B satellite connection. Finally, data can be displayed in the MIO Viewer application aboard the ship.

The mail system is the common way of transferring data within the Royal Arctic Line company. With the restrictions put up by the company concerning the communication system this mail solution was chosen for the demonstration.

4.2.3 Data provision

Characteristics of the data products (temporal, spatial, thematic) were related to factors like operational area, satellite data availability, ice conditions, numerical model characteristics (both temporal and spatial), communication capabilities and requirements to the provision schedule.

4.2.3.1 Communication

All transfer of data to the ship went through an Inmarsat-B connection with a bandwidth of 9600 Baud. The vessel never operated north of 70° which is the guaranteed limit for reception using Inmarsat-B. Consequently, Inmarsat was considered to fulfil the requirements regarding data reception. All data were retrieved from a central mail server as mail attachments. Table 4.1 reveals the statistics associated with the data communication. It should be pointed out that package sizes are somewhat smaller in size than the corresponding mail message size that contains the package attachment.

Table 4.1 Data package sizes of data delivered during demonstration.

PACKAGE TYPE	TOTAL NO.	MIN. SIZE (KB)	MAX. (KB)	AVG. (KB)	TOTAL (KB)
Ice analyses	11	98	416	246	2706
Meteorology (wind, pressure)	75	25	27	26	1952
Oceanography (wave, swell)	75	9	19	13	958
Satellite images	7	22	248	130	911
Weather forecasts (textual)	13	7	7	7	95

The total amount of data delivered during the demonstration was 6622 kb which is on average 86 kb pr. day. However, a major part of the large-size data from ice analyses and satellite imagery is irregularly distributed in time.

4.2.3.2 Data provision schedule

Table 4.2 expresses data characteristics, and the provision schedule for data delivered to Arina Arctica during the demonstration.

Table 4.2 Data provision schedule during demonstration. Please note that data packages comprise several parameters and several prognoses.

PARAMETER	CATEGORY	PROGNOSES (HOURS)	PROVIDER	FREQUENCY
Mean Sea Level Pressure	Meteorology	12:24:36:48:60	DMI	1/day
Wind Speed (10 meter)	Meteorology	12:24:36:48:60	DMI	1/day
Wind Direction (10 meter)	Meteorology	12:24:36:48:60	DMI	1/day
Significant Wave Height	Oceanography	24:48:72:96	DMI	1/day
Mean Wave Direction	Oceanography	24:48:72:96	DMI	1/day
Significant Height of Primary Swell	Oceanography	24:48:72:96	DMI	1/day
Mean Direction of Primary Swell	Oceanography	24:48:72:96	DMI	1/day
Ice Analysis	Sea Ice	Observation	DMI	When available
NOAA sub-images	Satellite Imagery	Observation	DMI	When available
RADARSAT sub-images	Satellite Imagery	Observation	DMI	When available
Textual weather forecasts	Met/Ocean	Varying	DMI	2/day

4.2.3.3 Spatial data coverage

The forecast/prognosis area were at all times adjusted according to ship position. Overall, data from three generic forecast areas were accessible during the demonstration (see Figure 4.4 A, B and C).

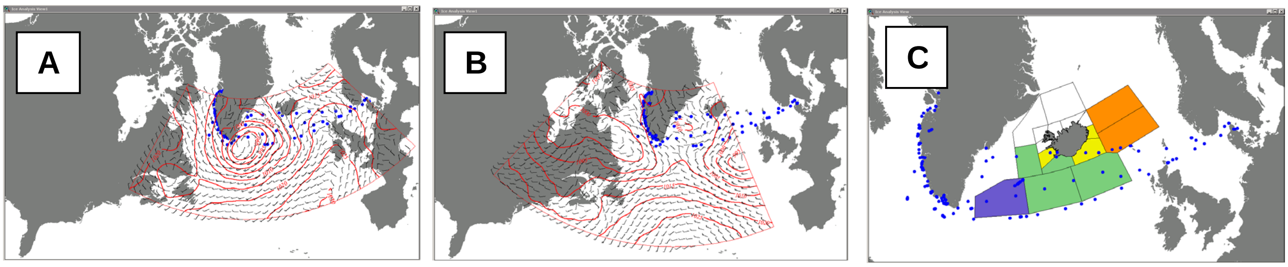


Figure 4.4 A) Forecast area for numerical predictions when the ship was located in the North Atlantic Ocean. B) Forecast area for numerical predictions when the ship was operating as feeder at the Greenland west coast. C) Forecast areas for Icelandic textual forecasts.

4.2.4 Examples of presentation

Figure 4.5 shows an example of a presentation from the MIO Viewer stand-alone client.

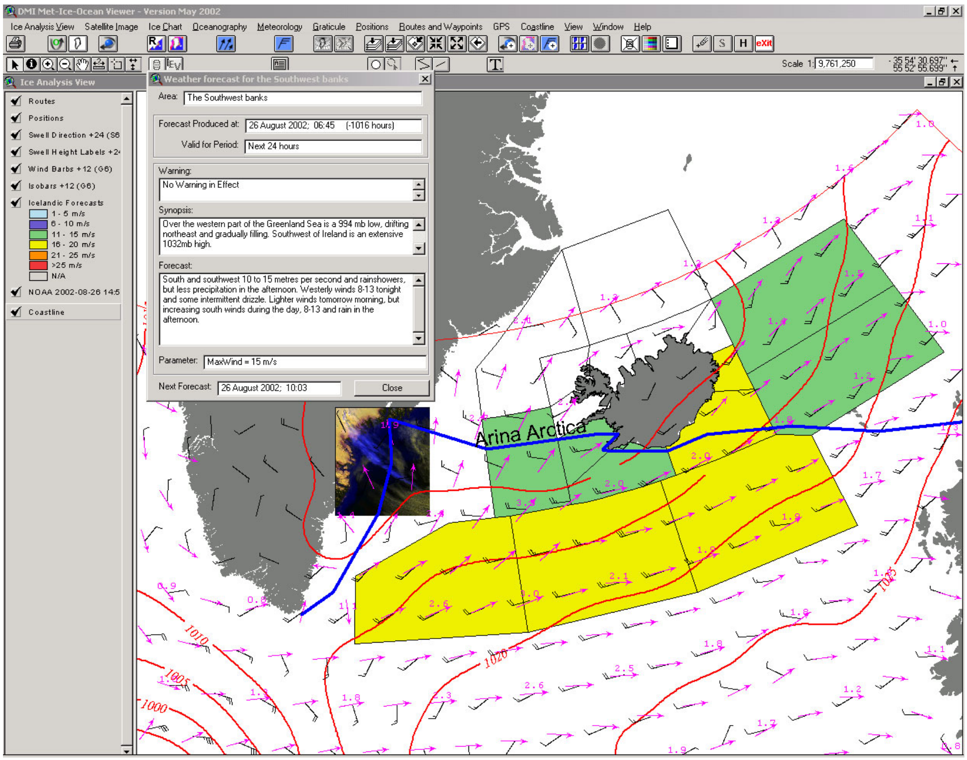


Figure 4.5 MIO Viewer presentation example for part of the eastern area for the 26th of August. MSL pressure shown as red isobars; wind barbs shown in black; swell height shown as magenta height indications; swell direction shown as magenta vectors; a textual forecast for an Icelandic area is shown in the open dialog; a NOAA sub-image in the MrSID format is shown for the area around Tasilaq; the actual route of Arina Arctica is shown in blue.

4.2.5 Conclusion

From a system management point of view the IWICOS system functioned well all the way from production to end-user system. Only minor problems in the IWICOS service chain were experienced which meant that 3% of the data packages did not reach the vessel due to server problems at DMI. The interoperability and data exchange between the IWICOS consortium participants was well functioning throughout the demonstration.

From the user side the overall response to the IWICOS system was positive and the basic capabilities for presenting and combining meteorological, oceanographic and sea ice information were widely used throughout the demonstration. Furthermore, some specialised modules were investigated for their potential concerning route planning. Traditionally users have based their route planning on hard copy weather maps. During this demonstration route planning was aided by using a digital route module within the client software – a module which the users found particularly helpful. The coupling of GPS positional information with route information and weather/ocean data enabled the users to investigate conditions along a given route based on numerical predictions of weather and ocean data. In relation to the future development of the client the implementation of automatic or semi-automatic weather routing should be investigated intensively in close connection with existing weather routing services.

Valuable experience was gained from the Arina Arctica demonstration, especially regarding current system components like the Façade and client. Additionally, experience was gained regarding production, communication, interoperability with end-users and new ideas rose for future initiatives concerning extensions to the client system.

4.3 The Icelandic Fisheries Exhibition

4.3.1 Introduction

IMO and Radiomidun demonstrated their thin and thick IWICOS clients at the Icelandic Fisheries Exhibition in Smárinn, Kópavogur, 4-7 September 2002. Captains and ship owners were selected for the demonstration and afterwards they were asked about their opinion of the clients, the products and how they would like to access them. 95 answers were obtained. The answers were generally very positive. The most wanted product was definitely the wave forecast, captains on small boats were most interested in accessing the products on a web page while captains on bigger ships did also want to have the products sent on board the ship. Many people said that they might be willing to pay a reasonable amount for such a service but very few were willing to say how much.

4.3.2 The Exhibition

Iceland depends heavily on its fishing industry and 72% of the country's export comes from fish or fish related products, making this exhibition vital not only to the Icelanders but to any international company wanting to enter this buoyant market.

The Icelandic Fisheries Exhibition has been running every three years since 1984. The Exhibition 2002 had some 17.000 visitors, and about 800 exhibitors from 37 countries. It is organised by Nexus Media Limited, are also the publishers of World Fishing Magazine. More information on The Icelandic Fisheries Exhibition can be found on the webpage www.icefish.is.

The two IWICOS clients developed by IMO and Radiomidun were demonstrated at Radiomidun's booth at the exhibition.

4.3.3 The two clients and the products

The biggest group of users of met-ice-ocean information in Icelandic waters are the fishermen. They can roughly be divided in two groups:

- Small boat owners, operating near the coast, often within range of mobile phones and arriving at the harbour daily.
- Captains/owners of bigger and better equipped vessels operating far from the coast for longer periods, out of range of mobile phones.

These two groups have similar needs for information but their possibilities to access data are quite different. Many small boat owners use the Internet most of the time while the captains of the bigger ships have to rely on satellite communication. It is therefore natural to develop two clients, thick and thin, to fulfil the needs of Icelandic fishermen for met-ice-ocean information.
The following products were demonstrated at the exhibition:

- Graphical interface to traditional text forecast where forecasting areas are coloured by maximum windspeed
- Ocean wave forecast maps, significant wave height, mean wave direction and mean wave period
- Ice accretion forecast, colour code used to indicate rate of icing
- Forecasting diagrams (meteograms) of local forecasts
- Sea ice maps, ice edge and concentration

The thin client is developed at IMO as a web site where as many as possible of the products needed by the seafarers will be made available. The target user group is mainly small boat owners and other seafarers operating relatively close to the coast. A strong emphasis is placed on avoiding "heavy stuff" in order to make it possible to use mobile phones (GSM/GPRS) to access the web and download the products. The client will also be used at home before sailing and by the seamen's families while they are out at sea.

The thick client is developed by Radiomidun and has been given the name Birtir (The Viewer). The software is installed on a PC onboard the ship. The target user group is captains of larger ships, out of reach for domestic communication. Several communication possibilities, such as Inmarsat Mini M, Iridium and Emsat can be used and the data is sent to the boat as an email attachment. The selection of met-ice-ocean products which will be made available through Birtir will be mainly the same as for the thin client but a range of other products will also be offered.

4.3.4 Implementation

A user oriented glossy brochure had been prepared and was distributed to people who showed interest in the project (Figure 4.6).

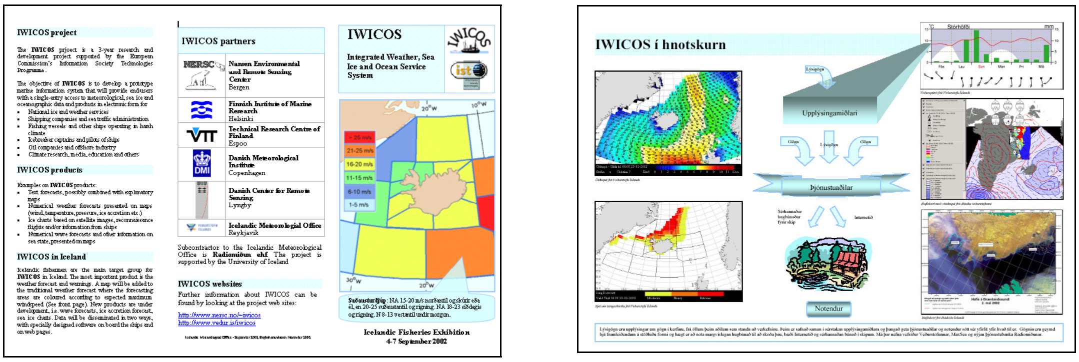


Figure 4.6 This brochure which was printed in A4 on both sides and folded into three was handed out to the persons that participated in the demonstration. A better readable picture can be found in an attachment to IWICOS D6 Demonstration and Validation Report.

All visitors to the exhibition were marked with a badge which indicated their relation to the fisheries. The target group for the demonstration was mainly captains of small and large fishing vessels. People marked as "Captain/Owner" were therefore picked out from the crowd and asked to participate in the demonstration. They received the brochure and after the demonstration they were asked a few questions about the products, the clients and how they would probably use them.

The captains showed a general interest in the demonstration and were pleased to see that research and development work was going on to improve the marine weather services. Very few declined to answer the questions. In the whole 95 captains/owners were interviewed and most of them gave answers to all the questions on the questionnaire.

To keep the questionnaire as simple and short as possible it was not asked explicitly about the size of the vessel. Sometimes however the questioner noted that the answers were given by a small boat captain/owner. These answers were also counted separately but they are also included in the whole sample. But it is very likely that some answers from small boat owners were not marked as such.

It should be noted that these interviews must be considered as an informal user survey. The answers may be biased in several ways and not strictly significant from a statistical point of view.

4.3.5 Results

As mentioned earlier 95 answers to the questionnaire were collected from "Captains/Owners" at the exhibition. Most of them gave answers to all the questions. There was not asked explicitly about the size of the ship but in 18 cases it was noted that the answers were given by a small boat owner. These 18 can be used to study the opinion of small boat owners and compare it to the whole sample even if this may not be statically significant and even if there most certainly were more small boat owners in the sample.

The answers to the first question are shown on a bar chart in Figure 4.6 (left). They show clearly that a big majority of the captains did like the graphical interface to the text forecasts, most of them said that they were very satisfied or satisfied. No significant difference could be seen between the small boat owners and the whole sample.

In the second question the captains were asked which of the other products demonstrated they found of most interest. The bar chart related to this question, Figure 4.6 (right), shows very clearly that Icelandic captains consider the wave forecast to be the most important of these products. It was mentioned in almost every answer and often given the highest priority. Sea ice charts seem to be of little interest for small boat owners since they would normally only try to avoid any ice. Some captains operating from the south coast mentioned that sea ice and ice accretion was usually not a problem in their area.

In the third question the captains were asked if they would like to have the information sent to the ship. The answers from the whole sample, shown in Figure 4.8 (left part) show a general interest for having the information sent aboard. The 18 registered small boat owners show nevertheless a quite different picture (Figure 4.8, right part). The reason given for a negative answer was usually lack of equipment or communication problems.

It was very difficult to get a definite answer to the question on the monthly amount to pay for such services. The majority gave no answer but a few gave a subjective answer as "as little as possible" or "a fair amount" (Figure 4.9, left part). Very few were willing to give any number but when it happened 5000 IKR (~60€) or even more was mentioned.

Almost everybody showed interest in having these products accessible on the web. The very few who gave a negative answer said that they didn't have a computer or could listen to everything on the radio. In the last question the captains were asked which delivery method would be most useful to them. The answers can be divided in three almost equal groups which favour the web, transmission to the ship and both methods (Figure 4.9, right part). But, as expected, the web is dominating in the answers from the 18 small boat owners.

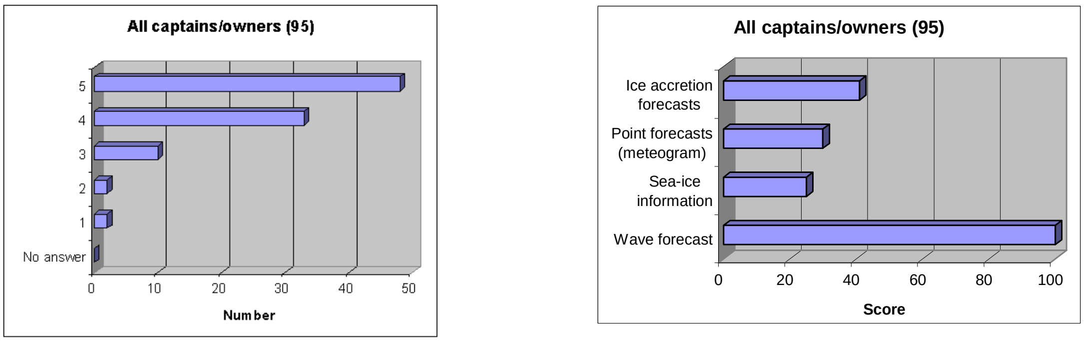


Figure 4.7 (left) How satisfied are you with the presentation of the weather forecast (textual forecast with indicated maximum wind speed on the forecast areas)? 1 (not at all) 2 3 4 5 (very satisfied). (right) What else did you find of most interest? (a) Wave forecast, (b) Sea-ice information, (c) Point forecasts (meteogram), (d) Ice accretion forecast.

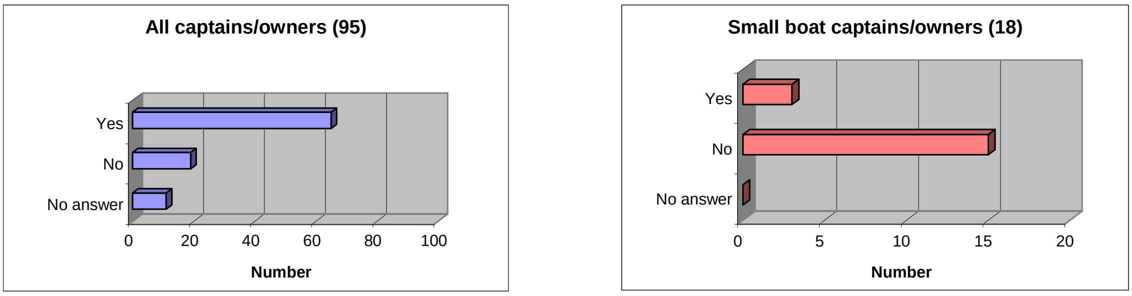


Figure 4.8 Would you like to have this information sent to you aboard the ship? If yes, what could be the monthly price for such information service? Answers from 18 small boat owners shown with red bars to the right.

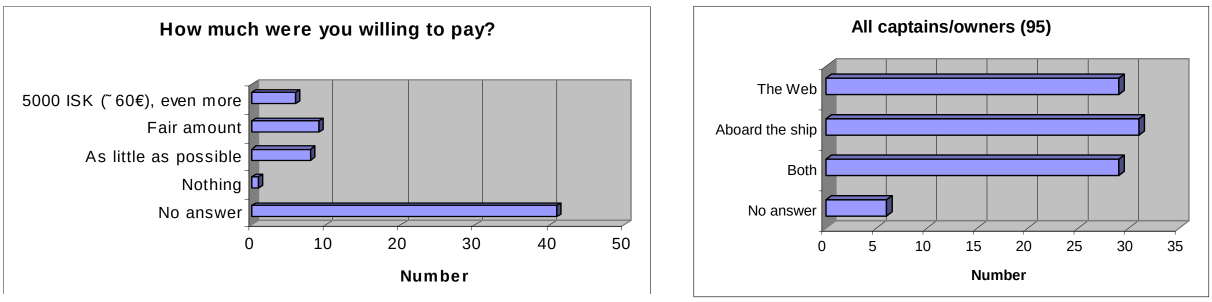


Figure 4.9 (left) What could be the monthly price for such information service? (right) Would it be most useful for you to view this information on the Web or to have it sent to you aboard the ship?

4.3.6 Conclusion

In general the reaction was very positive. The "single entry access" concept seemed to be popular; people did really like to get access to different products from one site.

There was a general interest in graphical presentation of information but it was also very clear that people did not like to loose the concise presentation of interpreted information they are used to get in traditional textual weather forecasts. Information offered to Icelandic fishermen should therefore contain products of both types which should support each other.

It was also obvious that even within this rather limited user group the needs for products and distribution means are very different. An important factor is the size of the vessel. The bigger vessels are generally well equipped and satellite transmission of data to be processed in a thick client is a feasible choice for them. The smaller vessels, which are not as well equipped, have to rely on mobile phones or Internet connections while staying at home.

Another important factor is the area of operation. Vessels operating off the north and northwest coast of Iceland may often experience arctic conditions, such as ice accretion and encounters with sea ice. In the much warmer waters off the south coast sea ice is hardly ever seen and ice accretion is generally not a problem. The south coast is on the other hand very exposed to the high waves from the open Atlantic Ocean. The interest for wave forecasts was in fact very prominent among all users but for users operating off the south coast they were definitely the most wanted product.

The answers given may be used as a valuable guideline for development of new products for seafarers in Icelandic waters, both regarding content and methods of presentation.

Weather forecasts in radio and from coastal stations have traditionally been the main source for met-ice-ocean information. Such information is by nature free of charge for the users. Icelandic fishermen are therefore not used to the idea of paying for weather information. Nevertheless considerable understanding was noticed for the fact that it might become necessary to pay for products specially developed, produced and presented to a limited user group. It seemed also acceptable that transmission costs should be paid by the receiver. Some of the "captains/owners" said that they were willing to pay "a reasonable amount" for good information but very few were willing to quantify this amount and suggest a monthly price for subscription.

4.4 A continuous web service with near real time data

4.4.1 Background

Main objectives of the demonstration were:

- Use of standard software and hardware platforms
- Platform independency (JAVA software, standard web browser)
- Provide interactivity (user can tailor view of data)
- Demonstrate a near real time service running for an extended period of time
- Use freely available satellite data
- Supplement by freely available weather and wave forecast data
- Take into account the limited bandwidth of many users

The demonstration has taken place throughout the duration of the IWICOS project (2000-2002). Both Northern and Southern hemispheres are covered.

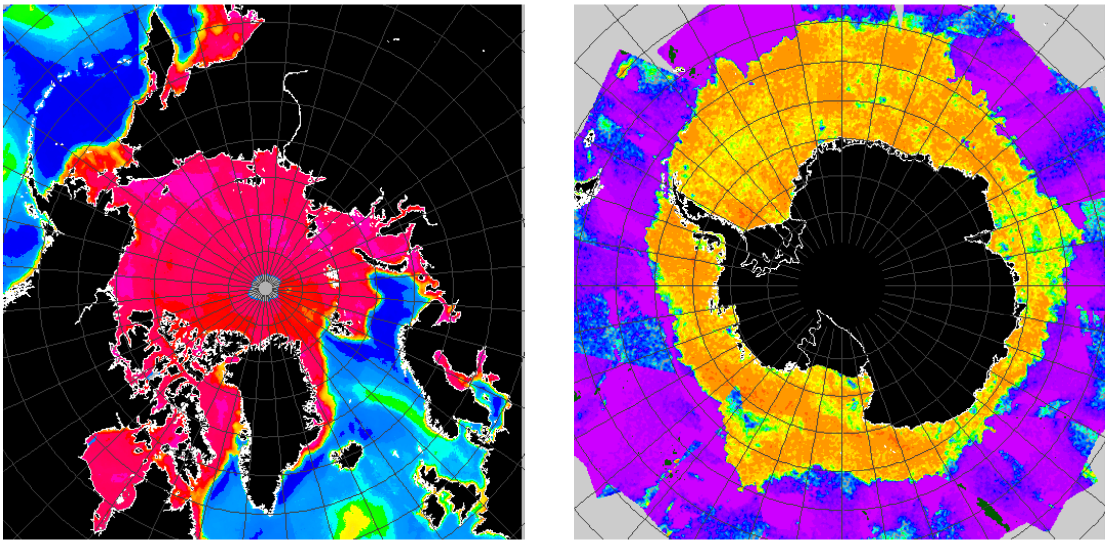


Figure 4.10 Example of SSM/I data from the Northern hemisphere and QuikSCAT data from the southern hemisphere.

4.4.2 Target user groups

The system was originally developed for internal use at DCRS. The purpose was to enable distance working, and to allow our data collection system to be supervised from remote places. Project partners and colleagues became very interested in the service, and we decided to open the system up for external use. We now see our main users as universities and other scientific institutions doing arctic research, operational ice centres, shipping companies, fisheries companies, etc. - people with a need for varied and timely information about the arctic marine environment.

Our target user group is expected to perform some interpretation of the images themselves, so we see our objectives as providing the tools to make decisions, rather than making the decisions.

4.4.3 Data Sources

All data are automatically gathered from the Internet. We are continuously looking for new data sources, to expand our coverage, to become independent of single sources, and to be able to include new facilities, higher resolution and/or more timely data.

The main sources are:

SSM/I data: The Global Hydrology Resource Center (GHRC). The GHRC is supported by NASA and is the data management and user services arm of the Global Hydrology & Climate Center (GHCC) in Huntsville, Alabama.

QuikSCAT data: Quikscat scatterometer data are provided by IWICOS partner DMI. The data are provided as ASCII files containing latitude and longitude coordinates, HH and VV backscatter as well as wind speed and direction.

AMSU data: The Cooperative Institute for Research in the Atmosphere, at Colorado State University

NOAA AVHRR data: Tromsø Satellite Station AS. TSS operates two ground stations for downloading, processing, disseminating and storing of data from polar orbiting satellites.

Sea Surface Temperature data: Top Karten. Original data from NOAA. http://www.wetterzentrale.de

Wind and Wave forecasts: The Marine Modeling and Analysis Branch, NCEP/NWS.

Digital Ice Charts: The National Ice Center (NIC), Washington DC

4.4.4 Production chain

Table 4.3 Typical daily data throughput.

Data source	Daily throughput
SSM/I	225 MB
AMSU	80 MB
QuikSCAT	20 MB
Wave & wind forecasts	9 MB
AVHRR quiklooks	15 MB

The production chain produces images for our thin client solution (plain simple gif og jpg images to be viewed in Netscape or MSIE) as well as data for the balanced JAVA applet client and for the IWICOS broker system for other IWICOS partners.

The number of individual data products per day exceeds 500 of which ca. 20 are for the thin client, and the remaining for various versions of the balanced client that allows the user to produce her own views.

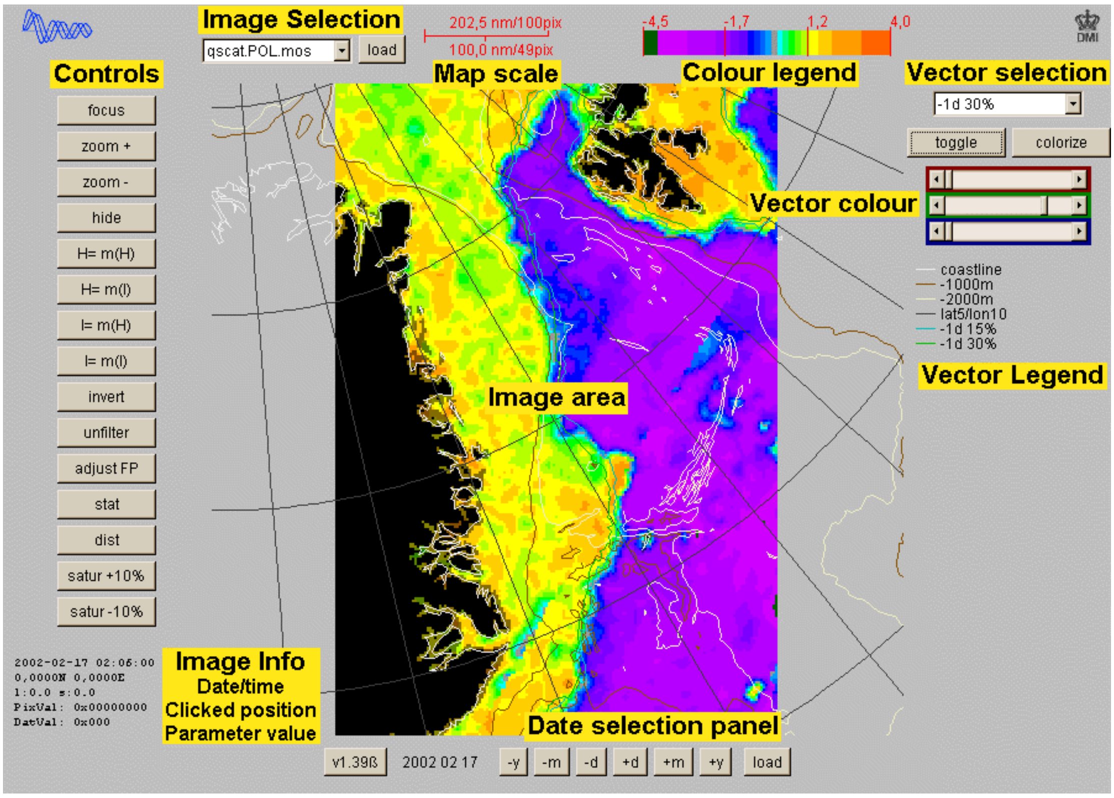


Figure 4.11 The balanced client user-interface.

The balanced client allows the user to select date and pick data from the selected date. Subsequently a list of vector overlays such as coastlines, lat/lon grids, ice concentration contours, wind and wave forecasts, ice charts etc can be selected and toggled on/of. Colours of the selected overlays can be controlled individually to suit individual needs. The user can zoom in and out, and pan around in the image.

The screen view contains information areas such as colour legend, image info (date, time) and a vector legend. The user can click inside the satellite image, and lat/lon coordinates and parameter value (e.g. ice concentration) will be displayed in the image info panel.

4.4.5 User feedback / Web statistics

Most user feedback has been in connection with the (few) down periods we have had over the past year. A number of items in the view have been introduced as a response to user feedback. Examples are:

- Colour legend
- Date selection
- Image info

Users also have complained about the many sub-areas, and the long list of images. We are therefore in the process of switching to just two databases/interfaces, one for the northern, and one for the southern hemisphere (see Figure 4.10 and Figure 4.11). We appreciate user feedback, and we use user suggestions to improve the service. The usage typically drops during weekends.

Examples of main users within the target user groups:

1. **Scientists involved in polar research**
    a. University of Iceland (IS)
    b. University of the Witwatersrand (ZA)
    c. Harvard University (US)
    d. Universite Catholique de Louvain (B)
    e. Svalbard University (N)
    f. Maritime University of Gdynia (PL)
    g. Universität Hamburg (D)
    h. Southampton University (UK)

2. **Operational ice centers**
    a. Danish Meteorological Institute
    b. Finnish Institute for Marine Research
    c. Icelandic Meteorological Office
    d. US National Ice Center
    e. Norwegian Meteorological Institute
    f. UK Met office
    g. Canadian Ice Service
    h. German Ice Service (BSH)

3. **Polar research institutions**
    a. British Antarctic Survey (UK)
    b. Arctic and Antarctic Research Institute (RU)
    c. Woods Hole Oceanographic Institution (US)
    d. Scott Polar Research Institute (UK)
    e. Institut français de recherche pour l'exploitation de la mer (IFREMER)
    f. Alfred Wegener Institute (AWI)
    g. Baltic Sea Research Institute (Warnemünde)
    h. Deutsche Klimarechenzentrum
    i. Norwegian Polar Institute
    j. Department of Fisheries and Oceans (CDN)

4. **Shipping companies**
    a. Armada Argentina
    b. Murmansk Shipping Company
    c. Princess Cruises

5. **Fisheries**
    a. Numerous Internet providers from Norway, Iceland, Greenland, Russia.
    b. Ocean Prawns A/S

6. **Insurance companies**
    a. Bergens Skibsassuranseforening (N)
    b. Unitas Gjensidige Assuranseforening (N)

7. **Oil companies etc.**
    a. Exxon
    b. British Petroleum
    c. Kolenergo Murmansk
    d. Boliden Minerals (S)
    e. Greenlands Power Supply
    f. Statoil

4.4.6 Conclusions

It has been demonstrated that a free Internet service with ice/sea/weather information can be established and it has attracted a large number of users in many fields. The system has proven valuable for internal use as well as for many external users. Running the system, we have gained considerable goodwill amongst science partners and collaborators all over the world.

5 Conclusions and plans for the future

The project has defined a generic system architecture for a met-ice-ocean service system. Three main subsystems have been identified: Production, Brokering and Presentation. These have in turn been refined as: (1) a set of data processing, analysis and forecasting subsystems that together with a Producer Server form the Production subsystem, (2) a metadata parser, a query engine, a metadata repository, communication and security subsystems as well as subsystems for interfacing with the Production and Presentation subsystems that form the Broker subsystem, and (3) a Façade and a Client subsystem that form the Presentation (or End-User) subsystem.

The IWICOS architecture supports a service chain where multiple producers can deliver data and information products through a common broker. Within this architecture, each producer can maintain separate (legacy) production systems, which can run on various computer platforms. Producers can also retain internal formats up to the point where products are submitted to the broker for advertisement to potential customers and to an in-house server for Internet distribution. Then, the products must be standardised. First, through adhering to a standard metadata specification, and secondly, through making the observed, derived or predicted met-ice-ocean parameters available in a standard data format.

Defining the subsystems and their interfaces up front and selecting standard web technologies for communications between these subsystems, allowed a great deal of flexibility in their implementation. For instance, software tools for the internal subsystems in the Broker, such as the metadata repository, could be chosen independently of the Production and Presentation subsystems. Likewise, façades and clients could be implemented in different programming languages, without affecting the other parts of the IWICOS system. The encapsulation offered by the subsystem interfaces enabled the use of both open source and public domain tools as well as Commercial-Off-The-Shelf (COTS) software in the implementation phase.

The IWICOS metadata specification ensures that all products are described in a consistent and self-describing manner, which can be queried and processed by computer algorithms. This specification is developed using XML Schema, a widely accepted standard for metadata definition, supported by a number of public domain and commercial tools for preparation and validation of metadata. The choice of XML Schema as the encoding mechanism also ensured that the metadata specification is portable across different computer platforms and that it will be easy to make extensions to cater for future products, also in other application domains, such as integrated coastal zone management.

The IWICOS specification captures all relevant metadata attributes for the developed met-ice-ocean products, but is still small compared to many general-purpose standards for geographical data sets. The issue of keeping the metadata to a minimum is an important requirement, in particular for all users operating at sea and being dependent on low-bandwidth and expensive communication means. Another advantage of basing the metadata specification on XML is that extracting a subset of the metadata defined for a product is easily implemented through the use of stylesheets (XSL), which is also a de facto standard from W3C.

A set of met-ice-ocean products that are suitable for electronic transmission have been developed and adapted to various regional requirements. Focus has primarily been on near-real time monitoring and forecasting products, but archived products can also be accessed by the IWICOS system. A variety of products were developed and integrated in the IWICOS system, ranging from observations (e.g. satellite images, buoy measurements of wave height) to predictions of met-ice-ocean conditions (e.g. weather forecasts, ocean wave, ice accretion forecasts). The metadata for all product types could be represented in the IWICOS metadata specification, indicating the flexibility of this specification and its potential for becoming a standard for a wider range of marine data and information product types.

The IWICOS Broker acts as a directory service for finding relevant met-ice-ocean products. The Broker has two interfaces for metadata operations: (1) one interface for Producer Servers submitting and managing metadata content, and (2) one interface for End-User Systems querying and retrieving metadata content. Implementation was done by means of free software components and tools, which are available for the major computer platforms. The service programs are developed in Java, and communication is secured using standard encryption mechanisms. Thus, the chosen solution should be a feasible starting point for the implementation of a future operational met-ice-ocean service.

The IWICOS System prototype was developed in two main phases. First, a baseline version was implemented, providing basic and the highest priority functionality. This facilitated testing of the overall architecture and key subsystems (e.g. the Broker), and enabled initial demonstrations of data sets and products. Secondly, an extended version was constructed, elaborating the functionality and adding new features and data sets/products. Different end-user systems were developed to retrieve, display and process met-ice-ocean products in a user-friendly way.

The different End-User Systems provide customised display and analysis facilities for target end-user groups, and consist of a Client and Façade subsystem. Some of these are thin clients that rely on having a server generating all data and information in a form ready for presentation. Others are thick clients, which download full (or partial) data sets and products, and contain tools for both analysis and presentation. A third category is a so-called balanced client, which include some analysis and presentation tools, but still uses a server for certain types of processing such as map drawing. The Façade may be used to tailor data to a specific client, e.g. by reducing its size by compression before transmitting it via a low-bandwidth connection, or to perform format conversion before transmission.

The extended version of the IWICOS System was used in four user demonstrations in 2002. The first of these was carried out for a scientific cruise in the Fram Strait in March. During this period the IWICOS Broker and End-User System (ViewIce client) were demonstrated to crew onboard the Finnish research vessel R/V Aranda, operating around 80ºN. The Fram Strait field experiment provided a unique challenge for the IWICOS System demonstration in the area, where communication possibilities are limited and expensive to use, and the environment plays a vital role in ship's security and successfully achieving the goals of the experiment.

About 1000 files were made available for downloading and the ship downloaded 196 files consisting of 66 satellite images, 73 wind forecasts, 25 pressure forecasts and 32 ice drift data files. On average 9 files was downloaded in a day, varying between 1-26 files. The available data was presented to the user via a real time portal, the Façade, which used the IWICOS Broker to fetch the relevant data from the data producers. The availability of new data was announced to the user as e-mails that were converted to Iridium text messages. A profile describing the user's priorities and needs controlled the operation of the Façade. However, because of lack of metadata for some of the products, part of the data was fetched directly from the producers to be presented on the web page of the Façade.

In general the IWICOS System operated very satisfactory and the user feedback was very positive. This full-scale demonstration of IWICOS System showed, that it could also be used in the remote areas. The System should be push up into a full operational status covering all the European sea areas. This could bring great benefits to users at sea, if they would be able to pick up and receive high resolution meteorological, sea ice and ocean data and forecasts.

The second onboard demonstration of the IWICOS System was done during Arina Arctica's two cruises to Greenland Waters in May-July and August-September. DMI's thick client, the MIO Viewer, was installed onboard the vessel and used operationally to display and analyse met-ice-ocean observed data and forecasts. Inmarsat-B and –C were used for communication, and a total of 185 data packages consisting of 11 satellite images, 11 ice analyses, 375 pressure forecasts, 375 wind forecasts, 300 wave forecasts, 300 swell forecasts and 13 textual weather forecasts (for Icelandic Waters) were downloaded to the ship.

From a system management point of view the IWICOS system functioned well all the way from production to end-user system. Only minor problems in the IWICOS service chain were experienced which meant that 3% of the data packages did not reach the vessel due to server problems at DMI. The interoperability and data exchange between the IWICOS consortium participants was well functioning throughout the demonstration.

The overall user response to the IWICOS system was positive, and the basic capabilities for presenting and combining met-ice-ocean information were widely used throughout the demonstration. Furthermore, some specialised modules were investigated for their potential concerning route planning. During this demonstration route planning was aided by using a digital route module, which the users found particularly helpful. The coupling of GPS with route information and weather/ocean data enabled the users to study conditions along a given route based on numerical predictions of weather and ocean data. Future work on a route planning module was highly recommended.

Valuable experience was gained from the Arina Arctica demonstration, especially regarding system components like the Façade and the Client. Additionally, experience was gained regarding production, communication, interoperability with end-users and new ideas rose for future initiatives concerning extensions to the client system. On the whole, the IWICOS System and the MIO Viewer operated as planned and the overall user feedback was positive.

The IWICOS project and Icelandic products and clients were demonstrated at a large exhibition in Iceland 4-7 September. The Icelandic Fisheries Exhibition 2002 had more than 18000 visitors, and about 800 exhibitors from 37 countries. During the exhibition, IMO's thin web client and Radiomidun's thick client were demonstrated, and an Icelandic IWICOS brochure distributed. Visitors marked at Captain/Owner were picked out and asked to answer a brief questionnaire. In total 95 captains/owners were interviewed at the Icelandic Fisheries Exhibition 2002. In general the reaction was very positive, and the "single entry access" concept seemed to be popular. There was a general interest in graphical presentation of information, but it was also very clear that people did not like to loose the concise presentation of interpreted information they are used to get in traditional textual weather forecasts. A future met-ice-ocean service should thus offer both product types.

It was also obvious that even within this rather limited user group the needs for products and distribution means are very different. An important factor is the size of the vessel. The bigger vessels are generally well equipped and satellite transmission of data to be processed in a thick client is a feasible choice for them. The smaller vessels, which are not as well equipped, have to rely on mobile phones or Internet connections while staying at home. Another important factor is the area of operation. Vessels operating off the north and northwest coast of Iceland may often experience arctic conditions, such as ice accretion and encounters with sea ice. In the much warmer waters off the south coast sea ice is hardly ever seen and ice accretion is generally not a problem. Users operating in these areas were far more interested in getting wave forecasts, as the south coast of Iceland is exposed to the high waves from the open Atlantic Ocean.

The answers given may give valuable guidelines for development of new products for seafarers in Icelandic waters, both regarding content and methods of presentation. Discussions and feedback on the issue of cost of such products within a dedicated service will also be useful in future development.

The EMI Interactive Java client has been providing sea ice, ocean and meteorological products as a public service throughout 2002. This includes support of specific operations: Lance (March), Ocean Tiger (May) and JRC/BAS (October). Data and information has been generated for both Arctic and Antarctic areas. It has been demonstrated that a free Internet service with ice/sea/weather information can be established and it has attracted a large number of users in many fields. All products provided by this service have been free, escaping the potential problems related to charging users for access.

Most user feedback has been in connection with the (few) down periods that have occurred over the past years. A number of items in the graphical user interface have been introduced as a response to user feedback, e.g. colour legend, date selection and information shown for an image. Users have also complained about the many sub-areas and the long list of images. The EMI Interactive Java client will therefore be restructured to just two databases and interfaces, one for the northern and one for the southern hemisphere.

During the four dedicated demonstrations and through presentations at conferences and workshops, we have made a suite of met-ice-ocean products available to a wide audience, accessing the information through different communication networks ranging from low bandwidth satellite communication to high-speed land based networks. The demonstrations performed have received overall positive feedback, and many of the involved users have expressed interest in continued and enhanced met-ice-ocean services. The concrete implementations on different computer platforms have shown that the IWICOS system architecture is versatile and can easily be customised to meet the needs of specific user groups. The architecture is built on open accepted standards for metadata and data representation, system interfaces and communication protocols, which makes it well suited for future commercialisation of met-ice-ocean services. All partners will therefore continue the development of IWICOS products and services, and will also seek to promote the IWICOS metadata specification to the marine community through engagement in standardisation efforts. The IWICOS System is a contribution to operational oceanography, facilitating the access to monitoring and forecasting services delivered by multiple providers.

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7 Management Summary

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7.2 Executive Summary of Workpackages

7.2.1 *Main achievements*

WP200. System design and end user requirement analysis
The IWICOS metadata specification enables description of met-ice-ocean products in a consistent and self-describing manner, which can be queried and processed by computer algorithms. This specification is developed using XML Schema, a widely accepted standard for metadata definition, supported by a number of public domain and commercial tools for preparation validation of metadata. The choice of XML Schema as the encoding mechanism also ensured that the metadata specification is portable across different computer platforms and that it will be easy to make extensions to cater for future products, also in other application domains, such as integrated coastal zone management.

The IWICOS project defined a general system architecture with three main subsystems: Production, Brokering and Presentation, based on user requirements. This architecture supports a service chain where multiple producers can deliver data and information products through a common broker. Producers can retain legacy systems and formats, up to the point of delivery to the IWICOS system. Within the IWICOS system, all metadata are according the developed specification and data/products are delivered in standard formats (BSQ, GRID, Shapefiles, XML). The common broker system is a central for metadata for all available data sets and information products, and communication between this and other subsystems is done by means of standard web protocols.

WP300. Baseline product, end user and retrieval system development
The development of the baseline version of the IWICOS system enabled testing of new technologies and the initial version of the metadata specification. Experiences made and user feedback obtained from these tests, were used to revise the metadata specification and system architecture. The chosen technological solutions were found to function satisfactorily, and only minor changes needed to be made for the extended version of the system.

WP400. Test, demonstration and validation
The major demonstrations in the project were carried out in 2002, with four dedicated campaigns: (1) R/V Aranda expedition in the Fram Strait, (2) Arina Arctica cruise in Greenland waters, (3) the Icelandic Fisheries Exhibition, and (4) a continuous web service with near real time data. These campaigns validated the metadata specification and system architecture under different conditions, such as, satellite phone vs. high bandwidth connections, various types of met-ice-ocean products from multiple producers, open source and commercial technologies used in the implementation. Feedback from users were compiled and used in market analysis and business planning.

WP500: Extended product, end user and retrieval system development
The extended system enhanced the capabilities of the baseline version, and included many new features and facilities in the various subsystems. New data and information products were developed and integrated, using the final version of the metadata specification and the latest versions of web technologies. Thin, balanced and thick clients were developed and customised to deliver products to target user groups in specific geographic regions.

WP600. Evaluation and assessment
Feedback from users were compiled and used to enhance the baseline version, and for planning of future development of met-ice-ocean services based on results from the IWICOS project.

WP700. Market analysis and business plan
A market study for IWICOS products has been carried out in two of the chosen regions (Baltic Sea and Icelandic waters). The results from this study and feedback from users during demonstrations have been used to develop a plan for exploitation of project results, with a view to developing a future operational met-ice-ocean service.

WP800. Dissemination and Implementation
Project results have been widely disseminated through presentations at international conferences and workshops, literature and the project web site. Several project brochures and posters have been prepared in addition to presentations and articles.

7.3 Overview of Objectives, Milestones and Deliverables

7.3.1 Objectives

Stated objectives	*Achievement of objectives*
❑ **Design of IWICOS system**	The architecture of the IWICOS system has been defined and solutions for implementation have been proposed which can be applied in different geographical regions
❑ **Develop baseline met-ice-ocean products**	Selection and adaptation of baseline products has been completed. Specification of the metadata for each type of product has been done.
❑ **Develop baseline end-user and retrieval system**	The baseline end-user and retrieval system has been completed. The central node of the end users retrieval system is the broker, which communicates with the different product providers.
❑ **Develop extended end-user and retrieval system**	Extended Broker completed. Several clients are developed.
❑ **Demonstration of end-user and retrieval system**	Four dedicated demonstrations of the IWICOS prototype was made in 2002: (1) Aranda scientific cruise in March, (2) Arina Arctica in May- Sep, (3) Icelandic Fisheries Exhibition in September, (4) Continuous web service.

7.3.2 Milestones

Milestone	*Planned date*	*Actual date*	*Comments*
M01 – Completion of design study	16. Aug 2000	30. Sept. 00	At meeting 15-16 Aug.
M02 – Develop 50 % of the baseline system	1. Feb. 2001	15. Mar 01	Examples of products are presented in the Annual report
M03: Baseline system, ready for the first testing	1. Aug. 2001	6 – 7 Sep 01	Reviewed at Midterm meeting 6 – 7 Sep.
M04: Extended system status report	1. August 2002	November 2002	Broker completed. Work on clients ongoing.
M05: Demonstration of prototype system	Completed by end of project	December 2002	First full demonstration completed in March 02

7.3.3 Deliverables

Deliverable Code & Name	Planned delivery date	Actual delivery date	Comments
D0: Project presentation	1 March 2000	1 Mar. 2000	Accepted
D1: System design and user requirement document	1 Sept 2000	30 Sep 2000	Accepted
D2: Dissemination and use plan	1 July 2000	18 July 2000	Accepted
D3-1: Annual progress report	1 Feb 2001	15 March 01	Accepted
D-4: Baseline system report and demonstrator	1 August 2001	November 01	Accepted
D2-1: Updated Dissemination and Use Plan	1 August 2001		To be incorporated in the D8 (TIP)
D7-1: Market study report	28 Feb 2003	November 01	Accepted
D1-1: Revised system design and user requirement document	1 October 2001	January 2002	Accepted
D3-2: Annual progress report (year 2)	1 Feb 2002	May 2002	Accepted
D5: Extended System Report	1 Aug 2002	Nov 2002	Accepted
D6: Demonstration and Validation Report	1 Nov 2002	Jan 2003	Submitted
D7-2: Marketing Plan	28 Feb 2003	Jan 2003	Submitted
D8: TIP	28 Feb 2003	Mar 2003	Submitted
D9: Final Report	28 Feb 2003	Mar 2003	(This document)

7.3.4 Deviations from Plan

Causes and Description	Corrective actions
Results from the first Review meeting on 30 Jan, 01: No significant deviations were suggested, but corrective guidelines were given by the reviewers	The reviewers' comments give recommendations to the continuation of the project. The partners in general agree to the guidelines. Response to the reviewers' comments are described in the D1 Amendment document
Deviations in IMO budget	An amendment of the budget was suggested by IMO and has been accepted by IST
Results from second review meeting on 6. February 02 were positive and no significant changes in the workplan were suggested	In the 3rd year of the project it will be necessary to focus more on exploitation, marketing and plans for further implementation of the prototype.

7.4 Contractual Arrangements

No contractual changes were implemented

7.5 Project Meetings (held in 2000-02)

Title	Data and Place	Main conclusions
Kickoff meeting	20 – 21 Jan. 2000, Bergen	Action plan for the next three months
Design workshop	6 – 7 April 2000 Copenhagen	Clarification of IWICOS prototype and data formats, recommendations from users
Progress meeting	15 – 16 August 2000, Helsinki	Completion of IWICOS design document

Progress meeting	16 - 17 November 2000, Reykjavik	Action plan for baseline product and prototype development
Review meeting	30 January 2001, Brussels	Project could continue following recommendations from the reviewers
Progress meeting	14 – 15 May 2001, Copenhagen	Determined products and end user systems for the baseline system
Midterm meeting	6 – 7 September 2001, Bergen	Midterm meeting, presentation and discussion of the Baseline System
Second review meeting	6 February 2002, Brussels	Project could continue following recommendations from the reviewers
Progress meeting	14-15 May 2002, Helsinki	Status of Broker, metadata specifications and clients, Extended System and demonstrations
Progress meeting	21 – 22 October 2002, Reykjavik	Progress meeting, presentation and discussion of the Extended System
Final review meeting	27 November 2002, Brussels	Recommendations from reviewers on how to complete the project

7.6 Dissemination and Promotional Summary

7.6.1 Conferences and/or Workshops attended/organised/foreseen by the project

Date	***Title***	***Number of persons attended + other information***
4 – 5 May 2000	IST 1st Concertation meeting	S. Sandven presented the IWICOS project
29.08 - 2.9.2000	EurOCEAN 2000 conference, Hamburg	Ville Kotovirta, VTT, a presentation titled " Systems for operational use of remote sensing data in navigation in ice infested areas "
25-29 Sep. 2000	Baltic Sea Ice Meeting	A. Seina, FIMR, a 10-15 min presentation of IWICOS to about 25 Baltic Sea ice service and icebreaking experts.
26 – 28 June 2001	EOGEO 2001, Canada	Jyrki Haajanen, VTT, presented the paper "A SOAP Based Metadata Service - IWICOS Broker"
19 Oct. 2001	16th ESRI EMEA User Conference in Lisbon	Presentation of ’Met-Ice-Ocean Viewer’ a GIS Application for Integrating Meteorological, Oceanographic and Sea Ice Data’, by M. Lind, DMI.
12 – 16 Nov. 2001	IICWG, Tromso, Norway	H. Steen Andersen and A. Seina participated and presented the IWICOS project.
12 Mar. 2002	Ship operation in ice course in Rauma, Finland	A. Seina, FIMR, a short presentation of IWICOS to about 25 sea captains included in a two hour lecture.
10-11 Apr. 2002	First Danish ESRI User Conference, Copenhagen	DMI made a poster presenting the Met-Ice-Ocean Viewer and its role in the IWICOS service chain. The poster won 1st prize for ‘Best Poster’.
14-15 May 2002	EOGEO 2002, Italy	Ville Kotovirta, VTT, presented two papers: “IWICOS Broker – Connections to the Service Providers and the Query Language” and “IWICOS Façade – an Interactive Portal for Near Real-Time GIS and Remote Sensing Data”.
4-7 September	Icelandic Fisheries Exhibition	The Icelandic IWICOS-group demonstrated various aspects of the IWICOS -system and

2002		interacted with the ship owners and fishermen attending. Interviews were conducted through questionnaires.
4-6 November 2002	IST 2002 Exhibition	A. Seina, FIMR, a PowerPoint show of the Fram Strait IWICOS demonstration.
5 Dec 2002	IWICOS: Integrated weather, sea ice and ocean service system	S. Sandven, oral presentation at EuroGOOS 2002, Athens, Greece.
5 Dec 2002	Digital, high resolution weather, sea ice and ocean information to users at sea: The IWICOS demonstration during the R/V Aranda expedition in the Fram Strait	A. Seina: Oral presentation at the EuroGOOS Conference in Athens, Greece
5 Dec 2002	IWICOS Metadata	Haajanen, J., Lind M., and Toudal Petersen, L.: Poster presentation at the EuroGOOS Conference in Athens, Greece
5 Dec 2002	IWICOS Façade	Kotovirta, V., Berglund, R., Haajanen, J., Mansner, J., and Tergujeff, R.: Poster presentation at the EuroGOOS Conference in Athens, Greece
5 Dec 2002	IWICOS architecture	Haajanen, J., Berglund, R., Kotovirta, V., and Tergujeff, R.: Poster presentation at the EuroGOOS Conference in Athens, Greece

7.6.2 Articles Published, Press coverage, development web sites, etc.

Date and Type	***Details***
February 2000	Project web site http://www.nersc.no/~iwicos/
March 2000: Web-site	Web presentation of ice and weather information for North Pole Expedition http://www.tv2.no/ao2000
DCRS – IWICOS near real time ice info	http://www.dcrs.dtu.dk/sea-ice/archive.html
DCRS – IWICOS web page	http://www.emi.dtu.dk/research/DCRS/seaice/iwicos
DCRS - Antarctica pages	http://www.dcrs.dtu.dk/sea-ice/antarctica/2000/directory.html
DCRS support for Arctic cruise	http://www.dcrs.dtu.dk/sea-ice/kara/2000/08/directory.html
IWICOS brochure	To be used at conferences where the project is presented
DMI web announcement	The thick client application 'Met-Ice-Ocean Viewer' has been announced at the web at DMI's news page (http://wwwint.dmi.dk/vejr/aktuelt/200109271315/IWICOSVAERKTOEJ.HTML).
Broker web site	http://iwicos.vtt.fi
2000: Article	Karvonen, J. 2000: "A Simplified Pulse-Coupled Neural Network Based Sea-Ice Classifier with Graphical Interactive Training", Proc. IEEE International Geoscience and Remote Sensing Symposium (IGARSS'00), v II, pp 681-684, 2000.
2001: Article	J. Karvonen, J. & Simila, M. 2001: "Independent Component Analysis for Sea Ice SAR Image Classification", Proc. IEEE International Geoscience and Remote Sensing Symposium (IGARSS'01), v. III, pp. 1255-1257, 2001.
2002: Article	Makynen, M., Manninen, T., Simila, M., Karvonen, J. & Hallikainen, M. 2002: "Incidence Angle Dependence of the Mean C-Band HH-Polarization Backscattering Signatures of the Baltic Sea Ice", Proc. of the International Geoscience and Remote Sensing Symposium 2002 (IGARRS'02), 2002.

2002: Article	Karvonen, J., Simila, M. & Makynen, M. 2002: "An Iterative Incidence Angle Normalization Algorithm for Sea Ice SAR Images", Proc. of the International Geoscience and Remote Sensing Symposium 2002 (IGARRS'02), 2002.
2002: Article	Makynen, M., Manninen, T., Simila, M., Karvonen, J. &, Hallikainen, M.: "Incidence Angle Dependence of the Statistical Properties of C-Band HH-Polarization Backscattering Signatures of the Baltic Sea Ice", accepted for publication in IEEE Transactions on Geoscience and Remote Sensing.
2002: Article	Seina, A. & H. Grovall: Digital, high resolution weather, sea ice and ocean information to users at sea: The IWICOS demonstration during the R/V Aranda expedition in the Fram Strait - Abstracts, 3rd EuroGOOS Conference, 3-6 December, 2002, Athens, Greece p. 194.
2003: Article	Seina, A., Berglund, R., Haajanen, J., Kotovirta, V., Mansner, J., Terujeff, R., Launiainen, J., Eriksson, P., Johansson, M., Vainio, J., Lind, M. and Gronvall, H.: High Resolution Weather, Sea Ice and Ocean Information to Users at Sea: the IWICOS demonstration during the R/V Aranda expedition in the Fram Strait – 3rd EuroGOOS Conference Proceedings, 3-6 December, 2002, Athens, Greece (in press)
2003: Article	Haajanen, J., Berglund, R., Kotovirta, V., and Tergujeff, R.: IWICOS Architecture - Software Architecture for Marine GIS-Data Interoperability, 3rd EuroGOOS Conference Proceedings, 3-6 December, 2002, Athens, Greece (in press)
2003: Article	Kotovirta, V., Berglund, R., Haajanen, J., Mansner, J., and Tergujeff, R.: Delivering Near Real-Time Met-Ice-Ocean Observation and Forecast Data – the IWICOS Façade, 3rd EuroGOOS Conference Proceedings, 3-6 December, 2002, Athens, Greece (in press)
2003: Article	Haajanen, J., Lind M., and Toudal Petersen, L.: IWICOS Metadata - Describing Met-Ice-Ocean Information with Metadata, 3rd EuroGOOS Conference Proceedings, 3-6 December, 2002, Athens, Greece (in press)
2003: Article	Sandven, S., Hamre, T., Berglund, R., Haajanen, J., Seina, A., Lind M., Toudal Petersen, L., Saldo, R., Baldursdottir, H. B. and G. Hafsteinsson: IWICOS: Integrated Weather, Sea Ice and Ocean Service System, 3rd EuroGOOS Conference Proceedings, 3-6 December, 2002, Athens, Greece (in press)

7.7 Main Results

Description	***Details***
A design document for IWICOS	Specification of architecture, data formats, etc. for the IWICOS prototype
Several full scale demonstrations of the IWICOS prototype were successfully conducted	The full-scale IWICOS system demonstration at the Fram Strait for R/V Aranda in March 2002. The DMI thick client was demonstrated onboard the vessel Arina Arctica in two periods (May-July and August-September). Icelandic products and clients demonstrated at large fishery exhibition in September. Ongoing web demonstration of DTU/DCRS client to a wide user group.
Implementation of the Extended System completed	VTT has finished implementing the extended version Broker. All partners have completed work on Extended System End-User Systems (Façades and Clients) and extended products.

7.8 Reporting per Partner and per Workpackage

7.8.1 Nansen Environmental and Remote Sensing Center

WP100. Project Management

- NERSC has planned project meetings in co-operation with the other partners, and hosted the Kick-Off and Midterm meetings.
- Deliverables were compiled together with the partners, and sent to the Project Officer. Specific deliverables from WP100 included: project presentation (D0), annual reports (D3-1, D3-2) and the final report (D9).
- NERSC has created and maintained a project web site.
- NERSC has performed administrative and financial management.

WP200. System design and user requirements analysis

- NERSC has compiled and prepared input to the System design and user requirements document, with focus on requirements for the Arctic Ocean including the Northern Sea Route. This work also included editing, reviewing and finalising the report (Deliverable D1).
- A document on revised system design and user requirements was compiled (D1-1).

WP300. Baseline product, end user and retrieval system development

- NERSC collected ice and weather data for the Arctic Ocean (North Pole Expedition) and demonstrated preliminary ice and met products from this expedition. Two new met/ice products combining data from several satellites have been developed and possible presentation methods investigated, using data from the Arctic (the Laptev Sea). First, ice concentration were derived from SSM/I and Radarsat SAR, and compared with each other and available in situ data. Secondly, ice kinematics in the same area were derived from time series of Radarsat SAR data, and compared with meteorological data (especially wind) from ECMWF. The production line for estimation of ice concentration from SSM/I data has been enhanced and streamlined.
- Metadata requirements for the baseline products were reviewed in co-operation with the other partners to ensure that the IWICOS metadata standard will meet the information needs in the baseline period of the project. Metadata requirements were revised after the baseline test period, and input given to refine the metadata specification for the extended system.
- NERSC has developed products and corresponding metadata for SAR ice image products, and delivered the metadata to the Broker. A metadata administration system simplifying the delivery of metadata to the Broker, and enabling display of submitted metadata from NERSC and other partners, was implemented, and the development of a thin Java-based client started.
- NERSC compiled input from the other partners and finalised the baseline system report (D4).

WP500. Extended product and system development

- Development of the metadata administration system continued, and it was updated to work with the revised metadata specification and the extended version of the IWICOS Broker. This system was developed in Java, and used open source software for XML processing (parsing, presentation).
- Development of the Java-based client, the Sea Ice Viewer, continued. A query module was developed, enabling the user to construct queries via an easy-to-use dialogue. The query module constructs the query in XML format according to broker specification, sends the query to the Broker, and receives the result as a new XML file. The result is then displayed on the screen, as text or as HTML. Open source tools were also used for GUI (graphical user interface) and GIS components.
- A web-based training module for interpretation of SAR (Synthetic Aperture Radar) images of various sea ice types was developed. This module contains background information on SAR and sea ice in polar regions, explanation of the standard WMO egg ice code, as well as numerous examples of photographs and ERS and RADARSAT SAR images of different ice conditions in different regions (e.g. Svalbard, Barents Sea, Northern Sea Route).
- A set of SAR images was prepared with interpretations and background material suitable for Internet delivery through the tutorial module. Some test data sets (SAR images) were prepared for the extended system, including accompanying metadata.
- NERSC compiled input from the other partners and finalised the extended system report (D5).

WP600. Evaluation and assessment

- Evaluation from the reviewers, and input from end users based on the testing of the baseline system (WP405) were used to focus the work to fewer products and reschedule the market analysis work.
- NERSC compiled input from the other partners and finalised the demonstration report (D6).

WP700. Market Analysis and Business plan

- A first version of the market study report was compiled based on user studies and analyses made by IMO and FIMR (D7-1).
- The market study for the Baltic Sea and Icelandic waters was revised in 2002, and augmented with partners' plans for exploitation of project results. A revised market study report and business plan was prepared in co-operation with the partners (D7).

WP 800. Dissemination and Implementation

- The dissemination and use plan was prepared (D2). This document was refined into a TIP at the end of the project (D8).
- A project presentation in PowerPoint format was prepared for presentation at the ice charting working group meeting in Tromsø in November 2001.
- An IWICOS brochure was prepared and used at several conferences (e.g. Tromsø, 2001; Copenhagen 2002).
- IWICOS was presented at the IST 2002 Exhibition in Copenhagen.
- Oral presentation of the IWICOS project at EuroGOOS 2002.

7.8.2 Finnish Institute of Marine Research (FIMR)

WP200. System design and user requirements analysis

On product design phase identification of new products from both scientist and users sides based on existing data and models related to atmospheric, sea ice and ocean conditions in the Baltic Sea was done. Input to IWICOS architecture and Design Documents was made. User requirement in the Baltic Sea was carried out in co-operation with the VTT, including personal meetings with representatives of shipping companies and the Finnish Maritime Administration. For the Baltic Sea, design of baseline and extended IWICOS information products and distribution system study and design was done in co-operation with the VTT.

Inputs were delivered to the System Design and User Requirements Study Report.

WP300. Baseline product, end user and retrieval system development

Development and adaptation work was carried out for ice drift model and wave models for IWICOS system. The ice drift model was running operationally using 18 km grid, using ECMWF +96 h wind forecast fields as inputs. Adaptation of the ice drift model was done into 5 km grid and HIRLAM forecasts. The new model is using both HIRLAM wind forecasts in 22 km grid forecasting next +24 h and ECMWF in 40 km grid forecasting reaching 112 h. The WAM wave model was adapted and tested into the IWICOS system.

The Baltic Sea end-user system was developed in co-operation with the VTT. Baseline wave and water level data in XML procedure was tested by sending it to the VTT system. The IWICOS end-user system architecture was verified. Various file exchange formats were tested.

Inputs were delivered to reports.

WP 405 Test of baseline system

PWM wave model forecasts and water level data was sent operationally to VTT's server. The IWICOS Broker was tested by sending there operationally metadata of ocean products. This procedure was automated.

Inputs were delivered to reports.

WP 420 Test, demonstration and validation

On 2-22 March 2002 the IWICOS Broker and System was demonstrated during the Finnish research vessel expedition at the Fram Strait area, around latitude 80ºN. Because of poor communication possibilities, the Iridium communication satellite system was used for data transfer, and the number and file sizes of delivered information products and data were put into minimal. This proved to function very well.

Three IWICOS partners participated the demonstration and their roles were: VTT was responsible of the Broker and the Façade (real time portal for IWICOS data), FIMR made available the RADARSAT images and ice drift buoy data, and DMI made available wind and air pressure forecasts.

Altogether about 1000 were made available for downloading and the ship downloaded 196 files consisting of 66 satellite images, 73 wind forecasts, 25 pressure forecasts and 32 ice drift data files. On average 9 files was downloaded in a day, varying between 1-26 files.

Evaluation of demonstration and user requirements were conducted and published in Demonstration report.

WP510. Extended product for the Baltic Sea
The existing operational RADARSAT image automatic classification algorithm was developed further. The texture classification algorithm based on Independent Component Analysis (ICA) for sea-ice SAR images was developed, tested and improved, partially using digitised ice charts produced by the Finnish ice service. Especially the reconstruction of image data from the ICA-produced basis vectors, and selection of visually and geophysical reasonable training set was studied.

Water level data and WAM wave forecast products were developed for the Baltic Sea users. These products were delivered operationally to the Finnish icebreakers.

WP 520 Extended end-user and retrieval system
For the R/V Aranda expedition to the Fram Strait communication system and information products were studied, planned and developed in close cooperation with other partners. The expedition was taken place in March 2002, and the expedition was supported with IWICOS information products via the IWICOS Broker in March 4-24, 2002.

WP600: Evaluation and assessment
The needs of the Baltic Sea icebreaking was evaluated and analysed inorder to find out usability of IWICOS products.

Analysis of the IWICOS demonstration to the R/V Aranda expedition at the Fram Strait was made and the functionalities of IWICOS system and products were analysed.

Overall evaluation and assessment and dissemination activities of the IWICOS project have been carried out in cooperation with other members.

WP700: Market Analysis and Business plan
A market analysis and business plan has been established for the Baltic Sea market identifying potential users including shipping, icebreaking and pleasure boating.

WP 800: Dissemination and Implementation

- Presentation of the IWICOS project to about 25 Baltic Sea ice service and icebreaking experts (representatives from Denmark, Estonia, Finland, Germany, Netherlands, Latvia, Poland, Sweden and Russia) at the Baltic Sea Ice Meeting in Riga, Latvia, 25-29 September 2000. (Ari Seina, FIMR).

- A short presentation of the IWICOS project to about 25 sea captains (from Finland, Germany and Netherlands) during Ship Operation in Ice course in Rauma, Finland, 12 March 2001. (Ari Seina, FIMR).

- A PowerPoint show of the Fram Strait IWICOS demonstration was presented at the IST 2002 Exhibition in Copenhagen, Denmark, 4-6 November 2002. (Ari Seina, FIMR).

- Oral presentation at the 3rd EuroGOOS Conference in Athens, Greece, 15 December 2002: Digital, high resolution weather, sea ice and ocean information to users at sea: The IWICOS demonstration during the R/V Aranda expedition in the Fram Strait. (Ari Seina, FIMR).

- Articles in IEEE International Geoscience and Remote Sensing Symposium (IGARSS) in 2000, 2001 and 2002, IEEE Transactions on Geoscience and Remote Sensing and 3rd Eurogoos Conference Proceedings (Juha Karvonen, Markku Simila, Ari Seina and Hannu Gronvall, FIMR).

- IWICOS has been presented during many personal meetings with many kind of users

- Inputs to the Technical Implementation Plan.

7.8.3 Technical Research Center of Finland (VTT)

WP 200 System design and user requirement study

- The IWICOS System Architecture was elaborated and documented in the IWICOS design document. A mapping of the various prototype systems by different partners to the reference architecture was done.
- XML/RDF/XML Schema formats were further studied and an example format produced for the FIMR Parametric Wave Model output.
- An IWICOS workshop and Progress meeting was held in Helsinki in August. The Design study document was revised according to the discussions in that workshop.

WP 310 Baseline product development

- A contouring package was developed to be used in the End user system. This facilitates visualisation of gridded data such as atmospheric pressure, but can also be used for displaying wave- and wind forecasts.
- Software for parsing GRIB files was developed. This is needed for interpreting forecast data in the client part of the system.
- VTT took part in the IWICOS task-force that defined the metadata format for IWICOS The format of the metadata and which part of the Metadata should be considered as a minimum searchable set, were defined. This issue is especially important when designing the Broker subsystem of IWICOS.
- A format for water level information as well as wave height information has been specified using XML. This format has been tested together with FIMR.

WP 320 Baseline and end user retrieval system

- The end-user system architecture was refined. The main task was to identify the role of the Broker subsystem and how this part should be handled. The Broker provides a common catalogue of information to the different end-user systems. VTT took the responsibility to design and implement this subsystem starting with a specification of the interface to the broker. The Broker was mainly intended to be used in the Extended System of IWICOS, but a basic version was provided already in the Baseline version.
- The Broker was designed and third party software components necessary for the Broker server were chosen. A pilot version of the Broker Server was set up on a dedicated server within VTT's internal network in 2001. The server was moved to VTT's extranet so that all consortium members could have access to the Broker.
- Visualization of the metadata contents using XSLT conversions was done. The query interface to the Broker was specified and tested.
- VTT provided consultancy help to the other consortium members in the usage of the Broker and their system integration for product development and metadata creation.
- During the period June - Sept 2001 the Broker contained metadata for 316 products and information about approximately 1700 products was inserted into the Broker.
- VTT established password-protected web-pages for the Broker to be used by the consortium members.

- Stubs for the interface between the Producer Server and the Broker were designed, documented, implemented and tested. These stubs were distributed to the partners to enable them to integrate storing of metadata information in the IWICOS Broker by their production system.
- The contouring package was integrated with the client software. A time-series tool was implemented. These tools are necessary for the functionality of the Client software.
- The visualization of wave forecast data was discussed and iterated with FIMR. Loading of weather forecast data was automated making the use of the application more user friendly. The visual appearance of the water level data was improved based on the feedback from the users.
- The communications capabilities of the potential clients of IWICOS in the Baltic were investigated by using a questionnaire.

WP 420 Test, demonstration and validation

- In May 2001 a presentation of the end-user system to icebreaker captains was performed. Comments about the weather presentation features were gathered.
- During the Aranda expedition to the Fram Strait by FIMR 2. – 22. March 2002 VTT implemented and maintained the Façade on a dedicated server in addition to the Broker. All data to Aranda was delivered through this server (iwicos.vtt.fi). DMI participated as a data producer of meteorological forecasts.

WP 510 Extended product development

- The work to apply ice field movement predictions to satellite images was done. A format for transferring forecast data from FIMR to VTT was defined. Example data was obtained to be used in the development of the "forecasted image", i.e. visualizing ice drift using a real satellite image and modifying it according to the predictions from the ice drift model. The software for image warping was finalized and integrated with the end-user system. Tests were made using real images and forecasts. The tests show that the visualization method works technically well, but that the ice drift forecasts are often not accurate enough to produce useful results for navigation purpose. The "forecasted" satellite images were therefore not included in the Extended system.
- The XML formats for gridded data was specified and elaborated in co-operation with FIMR. The format will be used for the wave forecast data.

WP 520 Extended end user and retrieval system

- The specification of the Façade subsystem was defined, implemented and tested. The goal was to use a simple version of the Façade already at the demonstration during the ARANDA expedition in March 2002.
- The implementation of the Façade subsystem proceeded with the demonstration for the Aranda expedition in mind. The Façade was implemented to use parameters stored in a profile database. The purpose is to code the needs of the End-user in a profile and then at regular intervals combine the available information as obtained via the Broker with the needs of the End-user as defined in the profile.
- The preparations for the ARANDA expedition proceeded. Communications possibilities were studied and the necessary equipment specified.
- A test of multiclient capabilities of the Façade, consisting of a version of the Façade that at regular intervals automatically produces a combined image and stores this as a web-image, was prototyped. This version can be used to produce combined data for different devices, such as handheld computers. By using existing synchronizing services for handheld devices, such as AvantGo, the implementation of a prototype service that produces up-to-date information for mobile users, is rather straightforward.
- Requirements for the Extended version of the Broker were collected. The results of the feedback can be summarized as follows:
  - The architecture works fine, no changes needed to the subsystem division and interfaces.
  - The security might be improved by taking into use the HTTPS protocol (HTTP + Secure Socket Layer (SSL))
  - The Metadata definitions require some minor changes, such as linking the product parameter to their units.
  - The Minimum Searchable Set (MSS) may need some additional fields (like URL of the actual data file).
- The extended version of the Broker was implemented. A test bench for testing of the Broker inserts and queries was developed to ensure the quality of the implementation. The necessary

tools (mainly SSL) were configured and installed in a dedicated server. The needed functional updates were implemented and testing of the whole configuration done.
- For the purpose of the Aranda demonstration, the Façade provided the Client subsystem with wind and pressure forecast information, RADARSAT images and drift buoy data. The Façade used the services of the Broker as much as possible. For items in Client specific formats, which did not use the Broker for the Metadata, the Façade generated the metadata information internally within the Façade.
- The End user retrieves the relevant data from a web page that is generated by the Façade at regular (10 min) intervals. On the web page the data is grouped according to categories and listed in order of relevance. The main relevance criterion is the distance of the center of the data to the last known position of the ship.
- A user interface for controlling the profile data (Profile-UI) using a browser was developed.
- The Client software was improved to include display of ice drift buoy positions as well as generation of routes based on the position data transferred in XML format from the Façade to the Client software.
- The wave symbol presentation in the Client software was enhanced to account for attributes based on the new data available.

WP 600 Evaluation and assessment
- Evaluation and assessment were done in cooperation with FIMR using feedback from the users onboard r/v Aranda.
- User interface features were transferred to the operational applications used onboard the icebreakers. The final evaluation will be done after the icebreaking season.

WP 800 Dissemination and implementation
- Ville Kotovirta, VTT, held a presentation titled "Systems for operational use of remote sensing data in navigation in ice infested areas" at EurOCEAN 2000 conference, Hamburg, Aug 2000.
- A paper titled "A SOAP Based Metadata Service - IWICOS Broker" was prepared and this paper was presented at the EOGEO 2001 conference in Canada, June 2001.
- A press release was issued in March 2002 together with FIMR about the Aranda expedition to the Fram Strait. This press release resulted in several articles in different newspapers.
- Jyrki Haajanen presented three posters at the EuroGOOS conference in Athens in December 2002.

7.8.4 Danish Meteorological Institute (DMI)

WP 200 System design and user requirement study
- Input from all partners has been collected, formatted and homogenised to form the design document.
- The first IWICOS workshop was arranged and executed. IWICOS workshop minutes and report were produced.
- Contribution to TIP report was made.
- A list of potential products and parameters has been compiled and the parameters which DMI will be able to provide have been documented.
- Information on standard raster and vector formats including ECDIS has been compiled to facilitate identification of a common IWICOS format list.
- The WMO standard symbol set for weather and sea ice has been collected.
- An overview of the baseline system functionality has been created.
- Baseline products and necessary components for the extended system has been identified.
- The IWICOS Metadata standard has been developed in the XML format according to W3C recommendations. Continuously the standard has been adapted in order to conform to IWICOS Baseline Products.

WP 310 Baseline product development
- A standalone (thick client) display system, Met-Ice-Ocean Viewer, has been developed. The system is capable of displaying a variety of products including sea ice charts, model fields and satellite images in single or multiple views. The system now supports following data from DMI's numerical weather model: Pressure, Temperature and Wind. Besides these products support has

been built in for wave products from the European Centre for Medium-Range Weather Forecasts (ECMWF) thus giving access to parameters like wave height, wave direction, swell height and swell direction. The client furthermore supports textual weather forecasts from the Icelandic Met Office. Different visualisation schemes have been implemented to allow for user interaction and flexibility. Focus has been on design and implementation of user-friendly dialogues which will provide an intuitive end user interface. The system design aims at presenting meteorological data according to WMO conventions using known standards for symbolisation. Fast-access to colour change and sizing of symbols is provided in order to optimise information content and aid interpretation.

- A comprehensive user manual was compiled for the use of the Met-Ice-Ocean Viewer client. Continuously the manual has been updated to reflect changes and additions to the client.

- An application has been developed which gives access to meteorological forecast data from DMI's numerical weather model and converts these from rotated longitude/latitude grid (DMI's model output) to regular longitude/latitude grids in GRIB format. Thus IWICOS partners can be provided with off line and real time meteorological data sets in IWICOS exchange format.

- A Façade module has been established acting as an interface to the client. The Façade handles filtering of data, data bundling, format conversion and compression tasks.

WP 320 Baseline and end user retrieval system

- Installation of the on-line (thin client) presentation system ArcIMS 3.0 has been completed.
- A new version of the thin client, Arc Internet Map Server (ArcIMS 3.1), has been installed and configured. ArcIMS 3.1 server- and client-side features have been tested with various meteorological, oceanographic and sea ice data. Although several bugs related to the presentation of data have been encountered in ArcIMS, the overall impression of the system performance and flexibility is promising.
- Statistical data sets have been processed from the DMI sea ice data bank and will be used for presenting ice conditions in Greenland waters using ArcIMS. Meteorological and oceanographic parameters can will be presented according to known standards, i.e. WMO standards.

WP 420 Test, demonstration and validation

- Throughout the project the merchant shipping company Royal Arctic line has acted as a test partner concerning data products and client systems. A lot of valuable feedback has been the result from this co-operation.

- From 2. – 22. March a demonstration was carried out aboard the Finnish research vessel Aranda in the Fram Strait. DMI participated as a data producer of meteorological forecasts. An automatic production of wind and pressure fields was established and data were made available 4 times a day for 6 sub-areas.

- A demonstration in Greenland and Icelandic waters was conducted at the end of may 2002. Throughout a period of app. two months the thick client (Met-Ice-Ocean Viewer) was demonstrated with data from DMI and IMO. Efforts have been spend on planning the demonstration, setting up data production and carrying out a questionnaire for users. This questionnaire was used to provide the consortium with feedback on the demonstration, the client system, data etc.

- The operational demonstration of the thick client 'Met-Ice-Ocean Viewer' (in short, the MIO Viewer) took place aboard the vessel Arina Arctica during two cruises. The first cruise covered the period of May 30th - July 12th 2002. The second cruise covered the period of August 20th – September 26th 2002. Prior to demonstration efforts has been used on preparing software for installation and preparation of GPS equipment, which, during demonstration, was connected to the client system. On the 29th of May the necessary software and GPS equipment were installed onboard the vessel. The installation was done in collaboration with crew from Arina Artica and a subsequent demonstration was carried out for users. Arina Arctica is owned by Royal Arctic Line and operates on the east and west coast of Greenland. The vessel is a general cargo/container carrier, which operates as a supplier for the largest communities primarily at the west coast of Greenland. In this case, the IWICOS system has been demonstrated with particular emphasis on the End-user system, i.e. the Façade and the thick client (MIO Viewer). The MIO Viewer was fed with data from three producers during the demonstration: the Danish Meteorological Institute (DMI), the European Centre for Medium-Range Weather Forecast, ECMWF (data available through DMI) and the Icelandic Meteorological Office (IMO). DMI has been responsible for supporting the MIO Viewer, adjusting the user profile and has acted as a producer of numerical predictions of meteorological parameters and of sea ice analyses and satellite imagery. ECMWF has produced numerical predictions of oceanographic data and IMO has acted as a producer of textual weather forecasts for Icelandic forecast areas. Altogether the user at the ship downloaded 185 data packages consisting of 11 satellite images, 11 ice analyses, 375 pressure forecasts, 375 wind forecasts, 300 wave forecasts (direction and height), 300 swell forecasts (direction and height) and 13 textual weather forecasts for Icelandic waters. The demonstration as a whole and the client performance in particular was evaluated by means of discussions with users and through answers to questionnaires. All in all the users response was positive.

- The production of the *Demonstration and Validation Report* (D6) has been completed. It describes in detail the demonstration plan and system configuration including role of partners, data provision, user comments and recommendations.

- A demonstration of the Met-Ice-Ocean Viewer was conducted at the Ice Centre in Narsarsuaq, Greenland. This has lead to a continuously running operational use of the client based on numerical predictions of meteorological and oceanographic data plus ice analyses and satellite imagery on a daily basis.

WP 510 Extended product development

- Iridium satellite communication capabilities have been tested aboard the RAL vessel Kista Arctica. Thus the vessel successfully has been able to fetch ice charts from the DMI server using the Iridium data connection.

- The extended system version of the Met-Ice-Ocean Viewer has been developed. Based on user requirements improvements have been made concerning route editing and creation of new routes. Thus options have been made which enables the user to create routes based on sets of coordinates entered through a dialog. At the same time existing route files can be browsed, edited and saved to new route files. A new way of presenting meteorological and oceanographic point data has been developed. Through labelling of data points the user can define the density of point labels thus improving the way of combining several presentation methods. Meteorological and oceanographic prognoses can now be displayed in a multi-window environment. The user can select a user-defined set of prognoses where each prognosis is displayed in a separate window. Common zoom and pan options has been developed for the multi-window environment. This enables manipulation of single windows in a synchronously manner. Displaying multiple prognoses in separate windows provides a better overview of changes in weather and ocean conditions. As a response to user requests an interface for GPS has been developed which enables the user to obtain real time positioning in prognoses views/windows. At the same time parameters like vessel speed and course are obtained. A special functionality provides information on course and distance to waypoints on a predefined route. These parameters can be derived from both rhumb line and great circle calculations. Another functionality from the GPS module provides the user with ETA (estimated time of arrival) to waypoints. In relation to interpretation of weather and ocean conditions along a route, a functionality has been implemented which marks the estimated position on the route at the time of prognosis. This estimate is based on ETA to nearest waypoint and vessel speed.

WP 520 Extended end user and retrieval system

- A newer version (Version 4) of the thin client (on-line client), Arc Internet Map Server has been installed and tested with meteorological, oceanographic, sea ice data and satellite imagery. Several presentation forms have been investigated and a set of presentation examples have been established as ArcIMS map services. Following examples are established:
  - A statistical data set (currently for year 2000) for ice information around Greenland providing frequency and minimum/maximum extends of ice according to various levels of ice concentration. The data set is based on weekly ice analyses conducted at DMI.
  - Meteorological and oceanographic numerical predictions for parameters like pressure, wind, wave and swell presented as point and isoline features. Parameters are as far as possible presented according to WMO standards.

- Satellite images, e.g. from RADARSAT together with colour coded ice analyses

The Arc Internet Map Server has proven to be able to present meteorological, oceanographic and sea ice data over the http protocol. Currently the server runs test services on the DMI intranet.

WP 600 Evaluation and assessment

- At the beginning of 2002 an evaluation of clients and data products were made and plans for further development established. Users from Royal Arctic Line were contacted for preliminary feedback and evaluation of tests performed during autumn 2001 onboard the vessel Arina Arctica. Together with users, plans were made for integration of new data and development of new functionality in the Met-Ice-Ocean Viewer.

- At the end of 2002 an overall evaluation of the clients and products has been accomplished in connection with the test users.

- Overall evaluation and assessment of the project and dissemination activities has been carried out together with the other consortium members.

WP 700 Market analysis and business plan

- A business plan has been established for the Greenland market identifying potential users within merchant and passenger shipping, fisheries, navy and harbour authorities. An initial price policy has been established.

WP 800 Dissemination and implementation

- The baseline version the thick client system (Met-Ice-Ocean Viewer) was presented at the 16^{th} ESRI European, Middle-Eastern and African user conference in Lisbon 17^{th} of October 2001. The paper was named ‘A GIS Application for Integrating Meteorological, Oceanographic and Sea Ice Data’. (Morten Lind, DMI)

- Presentation of the IWICOS project at the International Ice Charting Working Group Meeting in Tromsø, Norway. (Henrik Steen Andersen, DMI)

- Presentation of the IWICOS project at the ‘Operational Oceanography and Remote Sensing Symposium’, London 5-7 March 2002. (Henrik Steen Andersen, DMI)

- DMI made a poster presenting the Met-Ice-Ocean Viewer. This poster was presented at the first Danish ESRI User Conference held in Copenhagen 10-11 April 2002. The conference targets Danish users of ESRI software in both the private and public sector. (Morten Lind, DMI)

- At the Copenhagen IST event 2002 the IWICOS project was presented and demonstrations were done of clients.

- Input compiled for the Technical Implementation Plan.

- Two articles about the ‘Met-Ice-Ocean Viewer’ in the Danish magazine ‘Vejret’ – a member magazine for the Danish Meteorological Society. No. 3 & 4, October 2002. (Morten Lind, Keld Q. Hansen, DMI)

7.8.5 Technical University of Denmark / Danish Center for Remote Sensing (DTU/DCRS)

WP 210. **Product design**

- A new sea ice information system for the Weddell Sea has been set up and is being tested in connection with a user requirement study. The work is carried out in collaboration with Scott Polar Research Institute, University of Cambridge and the Alfred Wegener Institute, Bremerhaven, Germany.
- Primary new product is ice motion derived from the daily 85 GHz passive microwave observations of the SSM/I instruments.

- The prototype works fine, and it has been decided to maintain production of data for the Weddell Sea for the time being. Project partners in other climate research project has shown great interest in using the prototype

WP 220. **Format standardisation**

- Investigations of standards for meteorological and navigational data have started. Initial software implementation started. Software for reading weather forecast and analysis data in the GRIB format has been implemented. A routine for receiving daily weather forecasts in GRIB format from the National Center for Environmental Prediction (NCEP) has been set up and tested. The system has been in operation since mid August 2000, and every morning the wind forecast from 00 UTC is downloaded, and a 0h, 6h, 12h, 18h, 24h, 36h and 48h forecast are made available through the DCRS/IWICOS archive.
- Definition of Metadata format in XML for a variety of data types.
- Definition of Metadata format in XML for a variety of data types has been reiterated and confirmed.
- The NCEP wind forecasts are now routinely (daily) being made available in all regions (Arctic, Greenland/Iceland and Antarctic).

WP 240 User requirement Study

- DCRS participation in cruises to the Greenland Sea and the Weddell Sea has been conducted in order to collect information about user requirements, and to test some new product prototypes.
- In August to October 2000, a pilot experiment was conducted in collaboration with the Russian Arctic and Antarctic Research Institute (AARI). Daily IWICOS data was transmitted to the research vessel Akademik Fedorov, navigating in the Arctic Ocean.
- Due to requests from the British Antarctic Survey, the area of coverage of the Antarctic region has been expanded to include the Bellingshausen, Amundsen and major parts of the Ross Seas. The changes have taken effect from December 25 and will be distributed to BAS colleagues throughout the first half of 2001.
- Special support for a number of scientific cruises and flights were conducted with the DCRS ice information system:British Antartctic Survey (BAS) cruise to the Bellingshausen and Ammundsen Seas in February-March 2001
- Scott Polar Research Institute (SPRI) and Alfred Wegener Institute (AWI) cruise to the Bellingshausen and Ammundsen Seas in April 2001
- 2 EC project CONVECTION cruises to the Greenland Sea in March and April 2001
- EC project CONVECTION flight to the Greenland Sea March 2001
- Norwegian cruise to the Greenland Sea in April 2001
- University of Bremen/UK-Met Office flights to the Barents Sea in March 2001
- Special support for scientific cruises and flights were conducted with the DCRS ice information system during the period:US Coast Guard Healy cruise to the Barents Sea and Arctic Ocean October 2001.

WP 310 Baseline product development

- DCRS is in the process of streamlining a cross correlation based method for ice motion tracking developed in another project, in order to be able to provide near real time ice motion data to IWICOS. The products were first generated for the Weddell Sea in connection with the above mentioned user requirement study, but has recently been extended to cover also Greenland waters, the Kara and Barents Seas and parts of the Arctic Ocean.
- A Masters thesis project on improving the algorithm for deriving ice motion from the coarse resolution microwave data has been initiated and will run until the end of April 2001.
- Software to convert digital ice charts from the National Ice Centre in Washington DC to DCRS/IWICOS format has been developed. Examples of ‘interactive ice charts’ are available through the DCRS/IWICOS sea ice information archive.
- Preliminary product: Ice concentration difference images are produced daily with time difference of 1 day, 7 days and 1 month. These products are produced for all areas from standard low resolution ice concentration images.
- A large number of older SSM/I based sea ice products were ingested into the Internet system and are now available for comparison to present day ice conditions.

WP312. Greenland and Iceland baseline products

- A routine for receiving daily weather forecasts in GRIB format from the National Center for Environmental Prediction (NCEP) has been set up and tested. The system has been in operation since mid August 2000, and every morning the wind forecast from 00 UTC is downloaded, and a 0h, 6h, 12h, 18h, 24h, 36h and 48h forecast is made available through the DCRS/IWICOS archive. We have started converting our database of ERS SAR images to a format compatible with the archive accessible via Internet.
- In October 2000, we started to produce daily QuikSCAT scatterometer images for the Greenland area. The data are received and pre-processed by DMI, and post-processed to IWICOS format by DCRS. In addition to the HH and VV polarised backscatter maps produced from the QuikSCAT data, we are now also experimentally producing maps (images) of the polarisation difference, which has proven very useful for ice/water discrimination with a sensitivity to even very thin ice.
- A number of special products were generated for the test/demonstration experiments during the Winter. This includes 'faxable' ice charts with ice concentration contours.

WP313. **Arctic baseline products**

- In connection with the above mentioned pilot project supporting the AARI cruise to the Arctic Ocean in August-October 2000, we developed a set of SSM/I based ice products that covered the region of the cruise. The products developed for supporting the AARI cruise is being continued, and we are considering expanding the area to include the rest of the ice frequented part of the Northern hemisphere.
- A new product showing multi-year concentration in the Arctic Ocean using the standard NASA Team algorithm has been implemented on request from the University of Bremen, who will be using the data for planning flights over the ice in the Barents Sea as a part of the CAATER project funded by the EC.
- QuikSCAT coverage of the Arctic Ocean expanded to include all of the Arctic Ocean.

WP320: Baseline end user and retrieval system

- The Java based end user system is currently being expanded to allow more flexibility. New tools for locally extracting and displaying parameter values such as ice concentration, backscatter coefficients and brightness temperatures directly from the compressed gif or jpg images are being implemented and tested.
- The Java based end user system is being revised to meet user requirements in terms of ease of use, easy change between dates etc. Smoother vector overlay storage and information etc. Prototype system is being tested.
- A demonstrator (CD) of a baseline system has been produced.
- Testing of Broker interface.

WP400: Test, demonstration and validation

- Testing of Broker interface and validation of first prototype XML metadata production.
- Automatic ingestion of SSM/I data into broker system during the test period in August 2001 was conducted, and is being continued.
- Special support for a scientific cruise was conducted with the DCRS ice information system: US Coast Guard Healy cruise to the Barents Sea/Arctic Ocean October-November 2001.

WP510: Extended product development

- Near real time model calculation of salt fluxes and ice type distributions were conducted for the USCG Healy cruise in October. The data were as a test distributed in near real time to a project partner in the US.
- We are experimenting with using near real time AMSU data as a supplement to the delayed SSM/I data. With AMSU data we can obtain lags of 3-5 hours rather that the 12-36 hours delay of SSM/I data. The AMSU data have poorer resolution though.
- Near real time model calculation of salt fluxes and ice type distributions were conducted for the Lance cruise in February-March 2002. The data were distributed in near real time to the ship together with the near real time AMSU data (which are now operational), QuikSCAT data and SSM/I data. With AMSU data we can obtain lags of 3-5 hours rather that the 12-36 hours delay of SSM/I data. The AMSU data have poorer resolution though. A suite of new products based on the near real time AMSU data has been developed.

- Near real time production of QuikSCAT data has been established in collaboration with DMI. Near real time production of AMSU data is now operational and the suite of new products based on the near real time AMSU are being updated several timer per day. Near real time distribution of ocean wave forecasts has been commenced.
- In support for the rescue mission for the Magdalena Oldendorff, near real time AMSU data of the Southern Ocean has been produced since early July 2002. Production chains for a number of data sources are being ported to LINUX for more flexibility.

WP520: Extended end user and retrieval system

- The prototype end-user system is being beta tested at the moment, and is performing satisfactorily.
- The On-line user's guide has been extended to match the new and more flexible user interface.
- The end-user-system is currently being updated with new features and new data are being added to the database. The latest version of the system is available at http://www.dcrs.dtu.dk/sea-ice/archive.html
- The prototype end-user system was tested during the Lance cruise to the Greenland Sea in February-March, and performed satisfactorily.
- The On-line user's guide has been extended to include the new products.
- Support for Ocean Tiger (Shrimp trawler) and Aranda (Scientific cruise) during April and May 2002.
- Thin client data were used to support the SA Agulhas during its during July 2002.
- An extended version of the JAVA browser covering the entire Arctic Ocean is being tested. The prototype can be found at http://www.dcrs.dtu.dk/sea-ice/test.
- Various tests of the extended system Broker is being carried out. Routine production of products for the extended system is expected to start in October.
- Improvement of system robustness and automation, in order to ensure continued Internet service operation after IWICOS.

WP600: Evaluation and assessment

- Analysis of web server log into categories of users.

WP700: Market analysis and business plan

- Submitted contribution to market analysis and business plan. Web server log extended.

WP800: Dissemination and implementation

- EuroGOOS presentation
- AGU/EGC presentation submitted

7.8.6 Icelandic Meteorological Office (IMO)

WP200: System design and user requirement study

The Icelandic Meteorological Office in cooperation with subcontractor Radiomidun and the University of Iceland provided during the first year of IWICOS input to the user requirement system design study for Icelandic waters, based on meetings and telephone contact with potential users representing different activities (fishing vessels, small boat owners, shipping authorities, etc.). Radiomidun had already considerable experience in specifying requirements of fishermen because the company had for some years provided commercial information service to fishing vessels and was keen on including integrated products from IWICOS in their service.

WP310: Baseline product development

IMO started work at the outset of IWICOS to develop integrated meteorological, sea ice and ocean products for Icelandic waters. The baseline system at IMO contained two product chains, forecasts in plain text written by meteorologists and model output wave forecasts for Icelandic waters. The text forecasts were prepared to be presented graphically with forecasting areas colored by forecasted maximum windspeed.

WP320: Baseline end-user and retrieval system

Work on providing Internet access to IWICOS products was performed. A dedicated web site was prepared with the aim of creating a useful part of the end-user system for the Icelandic users. Further work was performed on preparations and definitions of metadata for weather and wave forecasts in text form and work on converting text forecasts into an XML-form. A broker client was put up which could be connected to the broker server at VTT. Metadata for the baseline products could be sent to the IWICOS Broker.

WP400: Test, demonstration and validation
Work on preparing demonstration and validation of the IWICOS-system in Icelandic waters started early but was mainly done in the third year of the project. Work was put into the planning and realization of demonstrating and validating the system. In so doing, effort was made in maintaining contact with potential users among the fishing vessel fleet in Icelandic waters. The biggest demonstration event was at an international fishing and shipping exhibition in September 2002 (Icelandic Fisheries Exhibition, IFE) where captains and ship owners were selected for individual demonstration.

WP510: Extended product development
Work was started during the second year of IWICOS to prepare products as a continuation of the products shown in WP300. Extended product development work was then continued with new products like point forecasts from direct model output and ice accretion. Charting of sea ice charts was performed and interviews with potential users undertaken (University of Iceland). Further work on metadata definitions was made during this phase.

WP 520: Extended end-user and retrieval system
Work was done on the web site for the purpose of containing the Icelandic IWICOS-products and links to other IWICOS-contributions. Graphical presentation of products was improved and new products were included. Special effort was made to keep in mind the low bandwith that seafarers, specially small boat owners have to deal with when using the web site while out at sea. Work was made on a special viewer to be used by bigger wessels which are operating out of reach for domestic communication (Radiomidun). The viewer is designed to contain all IWICOS-products which are available on the web site.

WP 600: Evaluation and assessment
Evaluation and assessment was undertaken at intervals as the project work progressed. In the beginning of the last year of the project a preparatory work started for participation in IFE. The Icelandic IWICOS-group introduced various aspects of the IWICOS-system and interacted with ship owners and fishermen attending the exhibition. Carefully designed interview questionnaire was presented to a target selection of exhibition visitors where they were asked to comment on the IWICOS-system on display.

WP 700: Market analysis and business plan
A market analysis was performed, following an extensive user market survey carried out by the Icelandic IWICOS group among Icelandic seafarers. The survey was made by Gallup in February 2001 and reached all Icelandic captains. A special communication study was also made by Radiomidun where bandwith and communication equipment for seafarers was estimated for few years to come. During the last few months of the project IMO and Radiomidun developed a business plan based on their cooperation in marketing and selling, among other things, IWICOS products.

WP 800: Dissemination and implementation
From time to time during the IWICOS project an effort was made in introducing results and encouraging use of links and products constructed during the establishment of the overall IWICOS-system. An English brochure designed by all the project members was distributed at various conferences on related subjects. A special brochure written in Icelandic was designed and distributed to visitors at IFE. A poster was presented at a public exhibition in Reykjavik, organized by the Icelandic Research Council, where EU-supported projects in Iceland were introduced. Further, the Icelandic IWICOS work was presented at a meeting in Buenos Aires in October 2002 of the Expert Team on Sea Ice (ETSI) of the Joint Commission of Oceanography and Marine Meteorology (JCOMM) of WMO.

7.9 List of Deliverables

The following technical reports were produced during the IWICOS project:

Deliverable D1: **System design and user requirements study**
IWICOS Report No. 1, NERSC Technical Report No. 189, September 2000 (Availability: Rest.)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristjan Gislason, Jyrki Haajanen, Gudmundur Hafsteinsson, Torill Hamre, Thor Jakobsson, Ingibjörg Jonsdottir, Kjell Kloster, Ville Kotovirta, Morten Lind, Tor I. Olaussen, Leif T. Pedersen, Roberto Saldo, Stein Sandven, and Ari Seinä

Deliverable D4: **Baseline System Report**
IWICOS Report No. 2, NERSC Technical Report No. 204, December 2001 (Availability: Rest.)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristjan Gislason, Jyrki Haajanen, Gudmundur Hafsteinsson, Torill Hamre, Thor Jakobsson, Ingibjörg Jonsdottir, Ville Kotovirta, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven and Ari Seinä

Deliverable D1-1: **Revised system design and user requirements**
IWICOS Report No. 3, NERSC Technical Report No. 211, January 2002 (Availability: Rest.)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristjan Gislason, Jyrki Haajanen, Guðmundur Hafsteinsson, Torill Hamre, Thor Jakobsson, Ingibjörg Jonsdottir, Ville Kotovirta, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven and Ari Seinä

Deliverable D5: **Extended System Report**
IWICOS Report No. 4, NERSC Technical Report No. 221, November 2002 (Availability: Rest.)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristjan Gislason, Jyrki Haajanen, Guðmundur Hafsteinsson, Torill Hamre, Juha Karvonen, Ville Kotovirta, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven, Ari Seinä, Markku Simila and Renne Tergujeff

Deliverable D6: **Demonstration and Validation Report**
IWICOS Report No. 5, NERSC Technical Report No. 225, January 2003 (Availability: FP5)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Patrick Eriksson, Ríkharður Friðrik Friðriksson, Jyrki Haajanen, Guðmundur Hafsteinsson, Torill Hamre, Katrín Hólm Hauksdóttir, Milla Johansson, Ingibjörg Jonsdottir, Ville Kotovirta, Jouko Launiainen, Jenni Mansner, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven, Ari Seinä, Renne Tergujeff and Jouni Vainio

Deliverable D7: **Marketing and Business Plan**
IWICOS Report No. 6, January 2003 (Availability: Rest.)
Authors (in alphabetic order): Henrik Steen Andersen, Halla Björg Baldursdóttir, Robin Berglund, Kristján Gíslason, Kristján Gunnarsson, Jyrki Haajanen, Guðmundur Hafsteinsson, Torill Hamre, Magnús Jónsson, Ville Kotovirta, Morten Lind, Leif T. Pedersen, Roberto Saldo, Stein Sandven, Ari Seinä and Renne Tergujeff

Deliverable D9: **Final Report**
IWICOS Report No. 7, NERSC Technical Report No. 234, March 2003 (Availability: Public)
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