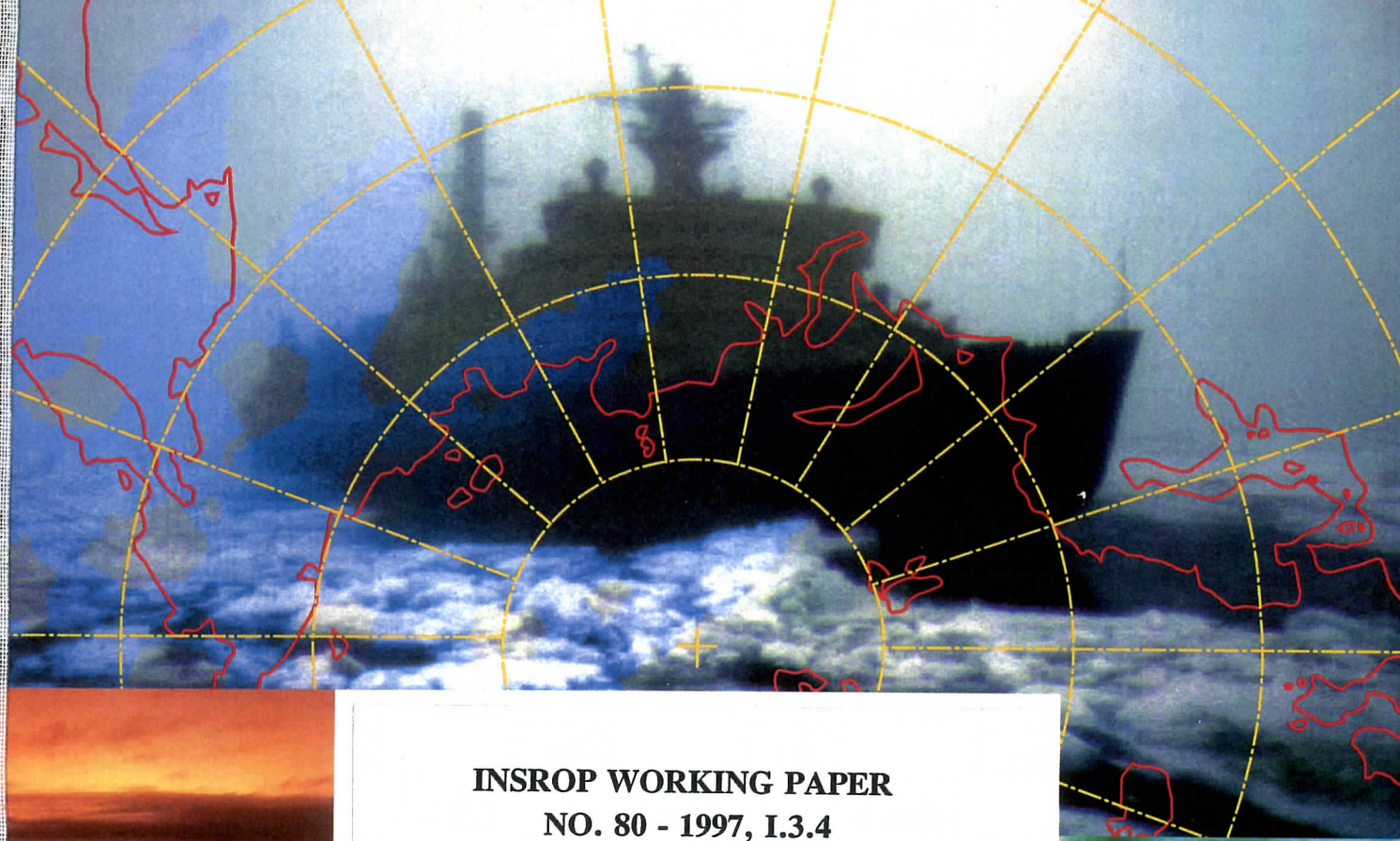

INSROP WORKING PAPER
NO. 80 - 1997, I.3.4

Design of Information System

By V. Grishchenko, E. Yakshevitch, O. Deviatayev,
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INSROP International Northern Sea Route Programme

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship and Ocean Foundation, Japan

International Northern Sea Route Programme (INSROP)

Central Marine Research & Design Institute, Russia

The Fridtjof Nansen Institute, Norway

Ship & Ocean Foundation, Japan

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Sub-programme I: Natural Conditions and Ice Navigation

Project I.3.4: Design of Information System

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Title: **Design of Information System**

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What is an INSROP Working Paper and how to handle it:

This publication forms part of a Working Paper series from the **International Northern Sea Route Programme - INSROP**. This Working Paper has been evaluated by a reviewer and can be circulated for comments both within and outside the INSROP team, as well as be published in parallel by the researching institution. A Working Paper will in some cases be the final documentation of a technical part of a project, and it can also sometimes be published as part of a more comprehensive INSROP Report. For any comments, please contact the authors of this Working Paper.

FOREWORD - INSROP WORKING PAPER

INSROP is a five-year multidisciplinary and multilateral research programme, the main phase of which commenced in June 1993. The three principal cooperating partners are **Central Marine Research & Design Institute (CNIIMF)**, St. Petersburg, Russia; **Ship and Ocean Foundation (SOF)**, Tokyo, Japan; and **Fridtjof Nansen Institute (FNI)**, Lysaker, Norway. The INSROP Secretariat is shared between CNIIMF and FNI and is located at FNI.

INSROP is split into four main projects: 1) Natural Conditions and Ice Navigation; 2) Environmental Factors; 3) Trade and Commercial Shipping Aspects of the NSR; and 4) Political, Legal and Strategic Factors. The aim of INSROP is to build up a knowledge base adequate to provide a foundation for long-term planning and decision-making by state agencies as well as private companies etc., for purposes of promoting rational decisionmaking concerning the use of the Northern Sea Route for transit and regional development.

INSROP is a direct result of the normalization of the international situation and the Murmansk initiatives of the former Soviet Union in 1987, when the readiness of the USSR to open the NSR for international shipping was officially declared. The Murmansk Initiatives enabled the continuation, expansion and intensification of traditional collaboration between the states in the Arctic, including safety and efficiency of shipping. Russia, being the successor state to the USSR, supports the Murmansk Initiatives. The initiatives stimulated contact and cooperation between CNIIMF and FNI in 1988 and resulted in a pilot study of the NSR in 1991. In 1992 SOF entered INSROP as a third partner on an equal basis with CNIIMF and FNI.

The complete series of publications may be obtained from the Fridtjof Nansen Institute.

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- Fridtjof Nansen Institute, Norway
- National Institute of Polar Research, Japan
- Ship Research Institute, Japan
- Murmansk Shipping Company, Russia
- Northern Sea Route Administration, Russia
- Arctic & Antarctic Research Institute, Russia
- ARTEC, Norway
- Norwegian Polar Research Institute
- Norwegian School of Economics and Business Administration
- SINTEF (Foundation for Scientific and Industrial Research - Civil and Environmental Engineering), Norway.

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ABSTRACT

This report presents the results of work under Project I.3.4 at the second and third stages. It has been prepared in accordance with the recommendations of the INSROP Secretariat, allowing us to show the successive character and the general direction of activities in 1994 and 1995, as regards contribution of Russia to the design of the INSROP information system.

In 1994 the main efforts of the Russian side were focused on creating and substantiating a concept for developing the INSROP information system, including the requirements to the entire system. The proposed concept is based on multiyear experience of the AARI in providing information support for shipping along the NSR. The Report takes into account the results of analyzing materials of the first stage under the projects of the Program, related topically to Project I.3.4.

In 1995 the work was aimed at developing operational technology of the hydrometeorological module of the INSROP information system and identifying the objectives of the module. The Report presents information on the structure of the information resources of the AARI and proposals for its development with a brief analysis of the options for developing the information space of the AARI. There are also proposals on the information exchange with the INSROP participants and the order of access to the information resources of the AARI.

The Report also contains proposals on the structure of the databases of the AARI meeting modern requirements and identifies telecommunication capabilities for providing transfer of hydrometeorological information between the system centers and users.

Based on the Scope of Work, major problems of planning and preparation for testing the hydrometeorological module of the INSROP information System are briefly outlined.

The authors express their appreciation to Dr. W. Weeks for his review of the report under Project I.3.4.

KEY WORDS: INSROP information system, geographical information system, GIS, GIS-technology

ACRONYMS and GLOSSARY

A

AARI	-	Arctic and Antarctic Research Institute, State Research Center of the Russian Federation
Alta 20™	-	Pinnacle Micro® magnetic-optical Jukebox
ANSI	-	American National Standards Institute
APPI	-	Russian abbreviation for the Autonomous Information Receiving Facility
ARC/INFO™	-	ESRI® Software Package for GIS
Arc/View™	-	ESRI® Software Package for GIS

B

C

IHMIC	-	Ice and Hydrometeorological Information Center
CPU	-	Central processing unit
CONTOUR	-	Russian national format for exchanging operational and archived data on sea ice

D

DB	-	Database
dBase™	-	Borland® Software Package for DBMS
DBMS	-	Database Management System

E

EPR	-	Earth's polar regions
ERDAS™	-	ERDAS® Software Package for GIS and Remote Sensing
ERS	-	European Remote-Sensing Satellite
ESRI®	-	Environmental Systems Research Institute, USA

F

FoxPro™	-	Microsoft® Software Package for DBMS
FTP	-	File Transfer Protocol

G

GIS	-	Geographical Information System

H

HMS	-	Hydrometeorological Support

I

IASNET	-	Russian Internet provider
IBM®	-	International Business Machine Inc., USA
ICN	-	Information-Communication Node
IEEE	-	Institute of Electrical and Electronics Engineers
IFIPS	-	International Federation of Information Processing Societies
Imagine Production™	-	ERDAS® Software Package for GIS and Remote Sensing

INFORMIX™	-	INFORMIX® Software Package for DBMS
INMARSAT®	-	International Mobile Satellite Organisation
IS	-	Information System
ISO	-	International Organization for Stadartization
		J
		K
		L
LAN	-	Local Area Network
		M
METEOR	-	Russian Meteorological Operational Satellite
MS Office™	-	Microsoft® Software Package
MS Windows™	-	Microsoft® Graphic Shell
		N
NetBEUI™	-	Microsoft® Network Protocol
NFS	-	Network File System
NOAA	-	National Oceanic and Atmospheric Administration, USA
NSR	-	Northern Sea Route
		O
OKEAN	-	Russian Remote-Sensing Satellite
OS	-	Operating System, Operational System
ORACLE™	-	ORACLE® Software Package for DBMS
ORACLE-Glue™	-	ORACLE® Software
		P
Paradox™	-	Corel® Software Package for DBMS
Pinnacle Micro®	-	Pinnacle Micro Inc., USA
PROGRESS™	-	Software Package for DBMS
		Q
		R
RADAR™	-	ERDAS® Additional Module for Imagine Production™
Radarsat®	-	Canadian Radar Satellite
RAM	-	Random Access Memory
Rosgidromet	-	Federal Service of Russia for Hydrometeorology and Environmental Protection
ROSPAK	-	Russian Internet provider
		S
SCANOR™	-	SCAN® satellite information receiving unit
SINTEF		Foundation for Scientific and Indastrial Research at the Norwegian Institute of Technology
SINTEF NHL	-	SINTEF Norwegian Hydrotechnical Laboratory
Solaris™	-	SUN® Operating System (UNIX)

SPARC - Scaleable Processor ARChitecture
SPRINT - Internet provider
SQL*Net™ - ORACLE® Software
SQL - Structured Query Language
SYBASE™ - SYBASE® Software Package for DBMS

T

TCP/IP - Communication Protocol (Transmission Control Protocol/Internet Protocol)
Transcend™ - SUN® Software
TRANSINFORM - Internet provider

U

V

VideoBox™ - AARI Software Package for Remote Sensing

W

WWW - World Wide Web - Graphic Shell for Internet

X

X.25 - Communication Protocol

Y

Z

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INTRODUCTION

Studies whose aim is to design the INSROP Information System are of obvious priority and govern, to a great extent, the successful implementation of the entire program. Priority is confirmed not only by the aim to fulfill the main goal of INSROP and a significant financial contribution of SINTEF NHL to Project I.3.1, but also by recognizing the need to simultaneously implement two topically close Projects I.3.1 and I.3.4.

The first stage of implementing the project "Design of Information System" included a detailed description of the Russian information system of hydrometeorological support (HMS) for traffic along the Northern Sea Route (NSR), its technical and information capabilities and structure. A brief overview of similar ice-information systems in other countries was performed and preliminary requirements to the overall INSROP information system formulated, including the functions of the Russian and the Norwegian modules of the system.

It is now clear that a common INSROP information system can be implemented only by setting up two centers, based on the Norwegian and the Russian GIS with common computer hardware and software and clearly defined functions of information support for the INSROP project. However one should remember the potential restrictions with regard to data availability:

- administrative barriers;
- obstacles regarding data confidentiality;
- time limitations;
- restrictions on data integrity and continuity;
- financial limitations.

The existing administrative-political environment can impose significant constraints on developing the system. If necessary, those legislation rules can be adopted that give institutions a right for controlling the process of data acquisition for the system and providing (exclusion of unauthorized access) of data after their input to the system. These legislative rules in the Russian Federation are stipulated by the Law on Information... (former Law on Copyright and Law on Copyright for Programs and Databases), as well as by the corresponding Rules of the Federal Service for Hydrometeorology.

It should be recognized that the work, performed at the first stage by both sides, has significantly influenced the intensive upgrading of hardware and software and the concept for creating a module of the INSROP information system at the AARI.

The Report outlines the proposed GIS design concept and the efforts, undertaken in this respect for reorganizing the AARI information system in the interests of INSROP.

1 ANALYSIS OF THE OUTCOME OF THE FIRST STAGE OF INSROP PROJECTS DIRECTLY RELATED TO DEVELOPMENT OF THE INFORMATION SYSTEM

It should be noted that practically all projects that are carried out within the framework of INSROP are connected to some extent with the main goal of the program - design of the information system for providing support for international shipping along the NSR. The system also should be capable to assimilate information and information technologies generated in separate projects and simultaneously serve as an information source for addressing the objectives of the same and other projects, providing the existence of a common information environment.

The primary purpose of the present project I.3.4 is to create an information system of hydrometeorological support aspects of (HMS) for transit international navigation along the NSR with a special emphasis on the operational HMS. Thus there is the need for a critical analysis of the outcome of the first stage under the projects I.2.1 and I.4.1. Of equal importance is the analysis of the outcome of the first stage under project I.3.1 which is directed towards creating the core of the INSROP information system based on ARC/INFO - modern commercial software for GIS technologies.

1.1 Brief Analysis of the Outcome of the First Stage under Project I.2.1.

The results of the work under project I.2.1 "Operational information about natural conditions" are presented in the general form. The authors have achieved the main objectives of their project:

- structure of the system for acquisition, processing, analysis and presentation of data on natural conditions is described;
- problems of HMS for arctic shipping and primarily for transit navigation along the NSR are formulated;
- possibilities for improving the system of operational information on natural conditions of shipping are assessed;
- diverse severe and specific environmental conditions of the Arctic influencing navigation along the NSR are described.

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The report outlines the hardware and software means for GIS design and the requirements to the local area network and communication means. The bulk of the report consists of a detailed description of the content and formats of the database that are necessary in the opinion of the authors for functioning of the information system.

However, the proposed concept of the information system does not consider the specific features of operational hydrometeorological and, in particular, ice support for navigation along the NSR, a question that was discussed at the Russian-Norwegian meeting in July 1994.

Practical use of a series of primary data, foreseen by this conceptual design (results of operational and tactical ice reconnaissance, specialized expeditions aboard research vessels and icebreakers, drifting stations, etc.) cannot be realized due to some objective reasons, governed by the legislation in force. It is also impossible at the present stage to transfer special technologies for data processing, required for operational HMS, for general use.

In our opinion, the proposed GIS option with a center in Norway can be provided with a limited data set to be transferred by the Russian side, including:

- climatic data;
- generalized operational information on ice conditions in the Arctic;
- medium- and long-range ice and hydrometeorological forecasts.

This information will enable the following functions to be fulfilled:

- to provide information-reference support for ships going to the Arctic including data on mean multiyear navigation conditions, historical traffic events, navigation support along the NSR, etc.;

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This information will enable the following functions to be fulfilled:

- to provide information-reference support for ships going to the Arctic including data on mean multiyear navigation conditions, historical traffic events, navigation support along the NSR, etc.;

- to run averaged traffic scenarios with risk assessment and recommendations to minimize it;
- marketing of international shipping along the NSR;
- early strategic planning of transit navigation along the NSR.

The facts mentioned above, govern the need for design of the operational core of the Information system, based on the Russian block. For this purpose, it is desirable to unify technical means, data formats and software.

2. DEVELOPMENT OF OPERATIONAL TECHNOLOGY OF THE HYDROMETEOROLOGICAL MODULE OF THE INSROP INFORMATION SYSTEM

2.1. Objectives of the hydrometeorological module of the INSROP information system

Analysis of the outcome of the projects related to the information system design, regulations of the Russian Federation for the use of hydrometeorological information, the existing technologies for data acquisition and processing and HMS for traffic along the NSR allow us to make a conclusion that it is necessary to create the INSROP GIS with two centers at two geographically remote locations with different functions.

The hydrometeorological module is designed by the Russian side by developing the geographic information system of the Earth's polar regions (EPR GIS) at the AARI. The EPR GIS consists of three interacting blocks (Fig. 2.1):

- operational;
- climatic;
- research.

The operational block fulfills the following functions:

- processing and analysis of the incoming data flow, construction of a composite ice chart of the Arctic Seas (the NSR), including:
- collection of hydrometeorological and ice information from a network of polar stations, icebreakers and ships;
- acquisition of specialized ice information (expeditions, visual and instrumental airborne ice reconnaissance);
- retrieval and interpretation of satellite information from national and international satellites (including information from automated drifting buoys);
- medium-range forecasting of ice situation for the Arctic Seas and the NSR (up to 10 days in advance);
- calculation of the optimal route for convoys of ships and icebreakers transiting difficult segments of the route;
- direct HMS for traffic along the NSR (specific marine operations).

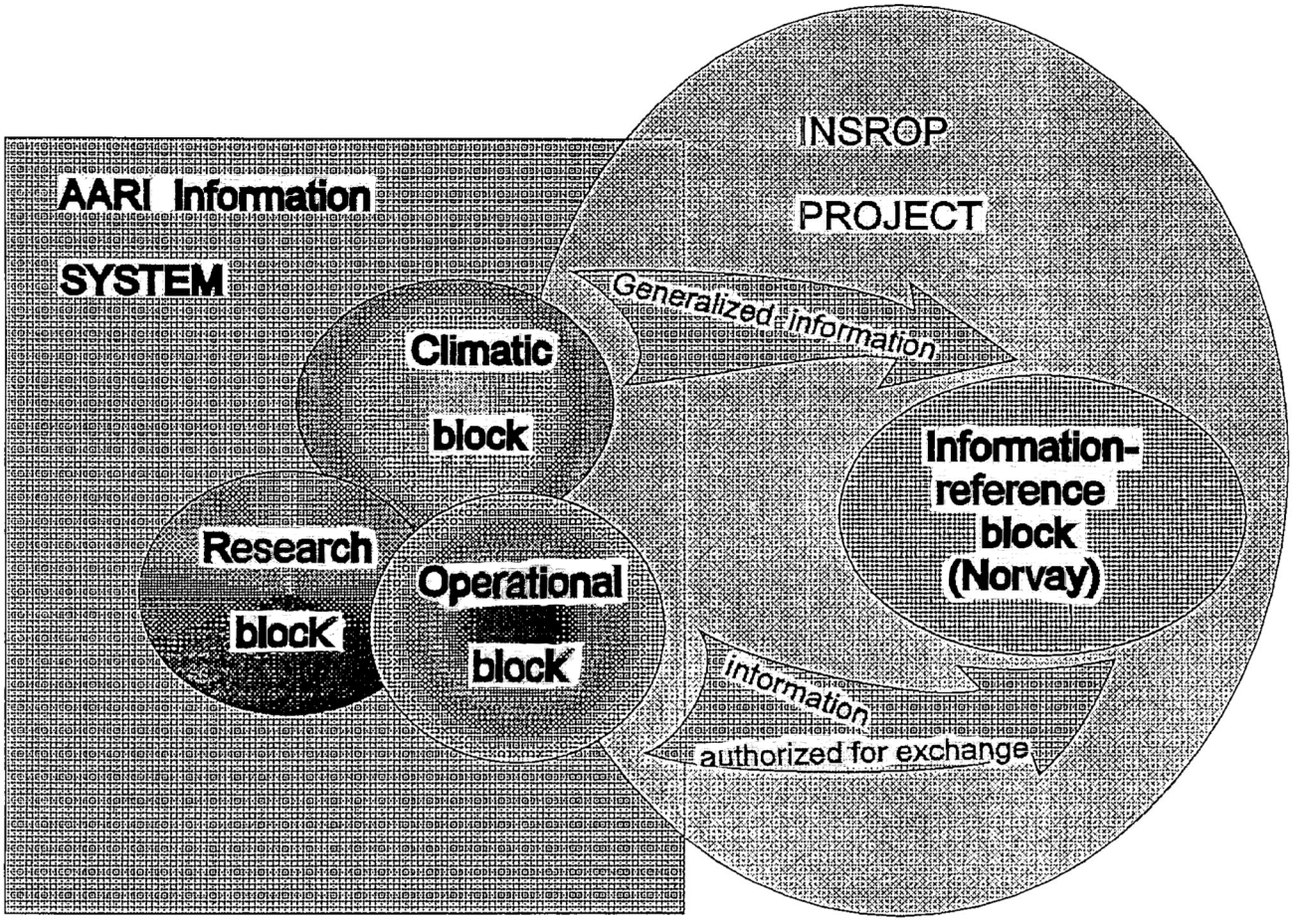

Fig. 2.1. The proposed interaction structure of the Russian and the Norwegian modules of the INSROP information system.

The climatic block fulfills the following functions:

- generalizing and complexing of hydrometeorological information reported from different sources;
- supplementing of the climatic databases, including the National and International Sea-Ice Data Banks;
- calculations of standard climatic characteristics, as well as their preparation for use in long-range forecasting;
- sampling of the information sets for research studies;
- dissemination of generalized information on request of users.

The research block fulfills the following functions:

- development of new as well as improvements of existing methods for acquisition, processing and presentation of hydrometeorological information;

- determination of future research directions with formulation of the problems and the ways for addressing them;
- organization of full-scale experiments.

Within the INSROP framework separate functions of the blocks of the hydrometeorological module, mentioned above, were developed and adapted to the goals of this program. To develop the hydrometeorological module, the following activities were outlined:

- to formulate proposals for developing the functional capabilities of the information system of the AARI to be used for INSROP purposes;
- to develop technologies for preparation of operational and climatic information for implementing the INSROP GIS with software for conversion of this information from national formats to GIS formats;
- to select the communication channels and arrange the exchange of data authorized for transfer, with the Norwegian GIS core;
- to arrange access to metadata of the EPR GIS.

2.2. Development of the Information System Structure at the AARI relative to INSROP Goals

2.2.1. The existing structure of the information resources of the AARI.

The Archive of hydrometeorological data which contains the initial observation data from a network of polar stations and expeditions is the basis of the information resources of the AARI. From the mid-1960s the AARI, based on the materials of the Archive, began to set up databases on machine media. These bases were established within the framework of separate research programs and projects and were not aimed at creating a common database on all observation elements.

Thus individual bases of oceanographic data on the Arctic Ocean and the Southern Ocean, a base of surface meteorological data on polar regions, a base of ice thickness measurement data, a base of data on discontinuities in the ice cover of the Arctic Ocean, etc. were set up. The structure of these bases and their content are described in detail in the Report under Subprogram 1.4.1 for 1994-1995.

The logical and physical level of information structuring in the existing DBs and archives does not allow us to provide the required access to the data of interest. This is governed, on the

one hand by the software difference (different OS and DBMS of FoxPro, Paradox, dBase and other types), and on the other hand by a poor development of the required communication means and the network software.

2.2.2. Proposals for developing the structure of the information resources of the AARI

The design of the information structure of the AARI should take into account a number of principal requirements whose fulfilling will provide a system solution of the main goals of the institute (including INSROP goals) and effective functioning and development of this structure. These requirements are as follows:

- a considerable remoteness of the information sources and users determines the choice for data storage, distributed by territorial and problem indications, and processing in the information system (IS) in accordance with the principle of shared responsibility for the current state of problem-oriented data subbases;
- the need for information interaction with the international programmes (INSROP, etc.) governs the orientation to use the capabilities of the State Telecommunication System of Russia;
- a long life cycle of the system requires implementation of the IS software-hardware complex in the form of open system architectures, providing modification of equipment and system software for preserving the stored information archives, applied subsystems, information technologies under conditions of its continuous operation;
- the orientation to the maximum use of the international standards in design decisions that will provide maximum adaptability to new software and hardware, as well as conjugation with the existing and developing information-communication networks and systems;
- provision of the required level of protection, reliability of information storage, modes of authorized access to the IS data archives;
- provision of the maximum full and wide set of services;
- the information system of the AARI should be introduced by efficient means to the Russian and international telecommunication networks with a full list of the information services (in particular, with services most widespread in the Internet).

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2.2.2.1. A brief analysis of the options for developing the information space of the AARI

Of utmost priority is a choice of strategy for design and development of the information space. The LAN serves as a physical basis and the DBMS (for database management and integration) - as a logical basis of the information space. There is an obvious need to formulate the problem of selecting specific technologies for updating and integrating the DBs and information archives that currently exist at the institute.

Let us define the main terms.

Integration is a capability to construct applications, capable of transparent access to different data maintained by DBMS of various producers. Since most DBMS meet SQL standards ANSI/ISO/IFIPS, such transparency of access between them is assumed from the very beginning.

Mobility is a capability to transfer applications from one net architecture to another with the use of the same base. This capability allows scaling of the hardware resources and the volume of network traffic. On the other hand, mobility enables one to design such an application which can be used with the DBMS of different producers.

Let us analyze the possible integration options and identify three idealized variants:

I. Distributed DB - data are stored on different servers, DBMS of different producers are used, part of data (currently the largest portion of data) are in the archives, i.e. they are stored in either ASCII form or as binary files.

II. Centralized DB - one allocated DB server.

III. Distributed DB with the allocated server.

Variant I actually reflects the real current situation. The question of selecting strategy for DB integration is actually the question of determining the degree of fitting into one of these three variants using technologies described above.

Let us briefly describe the advantages and disadvantages of these variants.

Variant I.

ADVANTAGES:

- minimum costs of transforming the DB themselves;
- there is no need for expensive software to organize the allocated DB server;
- no large costs are involved as regards servicing personnel, necessary for administration of large DBs.

DISADVANTAGES:

- large overhead expenses for organizing access to different DBs from different network clients (it is necessary to maintain different network interfaces and work with different formats of the DB files, etc.);
- a very low level of data integrity and preservation on the whole;
- a large volume of network traffic;
- relatively complicated communication with external users and data suppliers (in particular with INSROP participants).

Partly these disadvantages can be avoided if all DBs are transferred to the DBMS of one producer.

Variant II.

ADVANTAGES:

- a high level of data integrity and preservation, relative simplicity of management and administration of the system on the whole;
- common network interfaces of access to data;
- common means for developing applications and hence the absence of duplicating in the work of programmers;
- a possibility for scaling the hardware and system resources;

DISADVANTAGES:

- high costs of data conversion and loading to the centralized DB server;
- large material costs for implementing the allocated DB server (software and its maintenance costs, hardware costs - high-performance disk arrays, archiving systems and system maintenance).

Variant III.

Being intermediate between variants 1 and 2, it combines both their advantages and disadvantages, respectively, depending on the extent of fitting into some variant or other.

Actually, variant III is the only really feasible way for further developing the information infrastructure of the AARI where the following significant stages can be outlined:

1) Choice of the hardware platform for organizing the DB server and of a DBMS supplier.

Partly, this has already been done:

- a SPARC-architecture server was purchased (single-processor model of the SuperSPARC20 class enabling scaling of hardware and system resources - up to 4 CPU, RAM up to 512 MB, etc.);
- ARC/INFO -7 package was purchased to operate jointly with one of the relational DBMS of ORACLE, SYBASE, INFORMIX, PROGRESS class, etc.

To some extent the choice of RDBMS ORACLE depends on the following:

- existence at ORACLE of ORACLE-Glue, SQL*Net, and other products, facilitating integration with the software products of type Paradox, Microsoft Office used;
- availability of ORACLE software for preparatory work.

2) Design of DB transfer to ORACLE environment and preparation of the corresponding conversion-programmes for data transfer both to the central server and back to the local servers.

3) If possible, standardization of software on local (group) DB servers.

4) Provision of clients with the necessary means to develop applications and with necessary network interfaces.

2.2.2.2. Proposals for organizing information exchange with INSROP participants and access to the information resources of the AARI

The distributed applied information structure of the AARI is designed as a complex of interrelated information nodes and client workstations operating in the telecommunication environment in the form of a logical information subnetwork, based on the "transport system" of the information network of Rosgidromet, scientific-educational network of the north-western Russia ROCSON C3, as well as on commercial networks which have a wide user infrastructure (RELCOM, SOVAMteleport, etc.).

The architecture of the IS network is based on the industrial standards of net architectures:

- Ethernet (8802/3 ISO, 802.3 IEEE) for organizing the local network;

- Internet (TCP/IP protocols) for inter-network contacts, access to the information resources of the AARI of remote clients-INSROP participants, exit to the international networks.
- SUN protocols and software products (NFS, Solaris, Transcend);
- ORACLE software products (ORACLE-Glue, SQL*Net);
- Microsoft protocols and software products (NetBEUI, MS Windows, MS Office).

The information-communication node (ICN) serves as a system-forming component of the information system which provides exit to the external nets and combines computation and information resources of the AARI (Fig. 2.2).

The information resources are created and stored in the distributed database with an allocated server under control of ORACLE SQL*Net. Different modes of access to the information resources are provided using base technologies, developed in Internet, in the form of interrelated information servers of the ICN WWW, FTP, NEWS, etc.).

2.2.3. Implementation of the selected structure of the information resources

The actual implementation of the selected design of the information resources, based on the operational department of the AARI - the Center for Ice and Hydrometeorological Information (CIHMI) is given in Fig. 2.3.

Currently, the AARI actively upgrades its technical means and purchases the hardware and software complexes for information acquisition, processing and presentation in accordance with the requirements of INSROP and other international and state projects. Technical re-equipment is carried out along the following lines:

- transfer of the active part of the metadata archive to computer-readable information media and creation on their basis of thematic databases for providing hydrometeorological information on the Earth's polar regions (EPR) to national and international users (including INSROP participants), creation in the future of the Regional archive of hydrometeorological data on the EPR;
- increased use of satellite means for acquisition of hydrometeorological information, especially on the ice cover, improvement of hard- and software of the APPI (Russian abbreviation for the Autonomous information receiving facility) - for a more complete use of available and planned specialized space platforms;

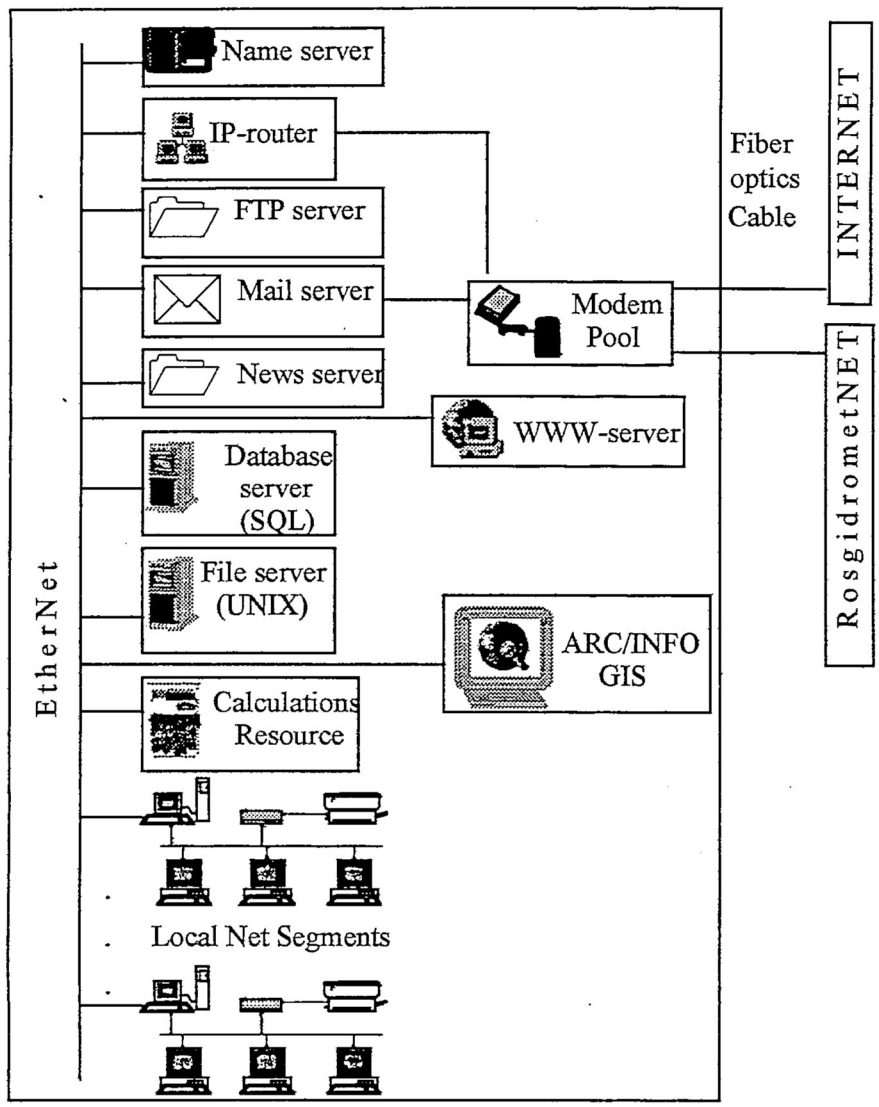

Fig. 2.2. A scheme of the information resources of the AARI.

- re-equipment of the communication unit for a more active use of modern communication means and intercomputer exchange in order to increase the operational character and quality of data acquisition, processing and presentation;
- creation of new and updating of available methodologies of HMS for commercial operations in the EPR (composite ice charts, ice forecasts, specialized forecasts for supporting decision-making, etc.), using geoinformation technologies;
- development of the local area network of the CIHMI to achieve the objectives formulated above.

The first stage of creating the operational database and the Archive on computer-readable media includes two workstations, based on IBM-compatible PCs, and a Pinnacle magnetic-optical Jukebox Alta 20. The latter allows us to provide the disk space with a capacity of 20

Gb with the access time of 19 ms (the rate of changing each of sixteen 1.2 Gb disks is 6 s). Also, this enables us to store the archive on long-lived (not less than 30 years) media.

It is proposed to use GIS METEO as software for maintaining the operational base of hydrometeorological data (except for ice information), as this software was specially developed for the institutions of Rosgidromet.

For re-equipping the APPI by the data receiving station in the decimeter range (1.7 and 8.2 GHz) that provides data receiving from Russian (METEOR and OKEAN) and other satellites (NOAA, ERS, RadarSat, etc.) the SCANOR station of the Moscow SCAN company was chosen. In the proposed configuration this station provides data receiving only from NOAA satellites in the range of 1.7 GHz, but in the future it can be upgraded to also operate in the range of 8.2 GHz.

As the main means for processing satellite information whose amount will increase by an order, it is proposed to use ERDAS software package for processing remote sensing data in the base set Imagine Production and the additional module RADAR.

ARC/IINFO, purchased earlier, will be used for complexing ice and hydrometeorological information. In the working groups operation with ARC/INFO will be arranged on PCs emulating the X-terminal. Also, main operation with the ready materials in ARC/INFO formats and data preparation are to be based on ArcView package.

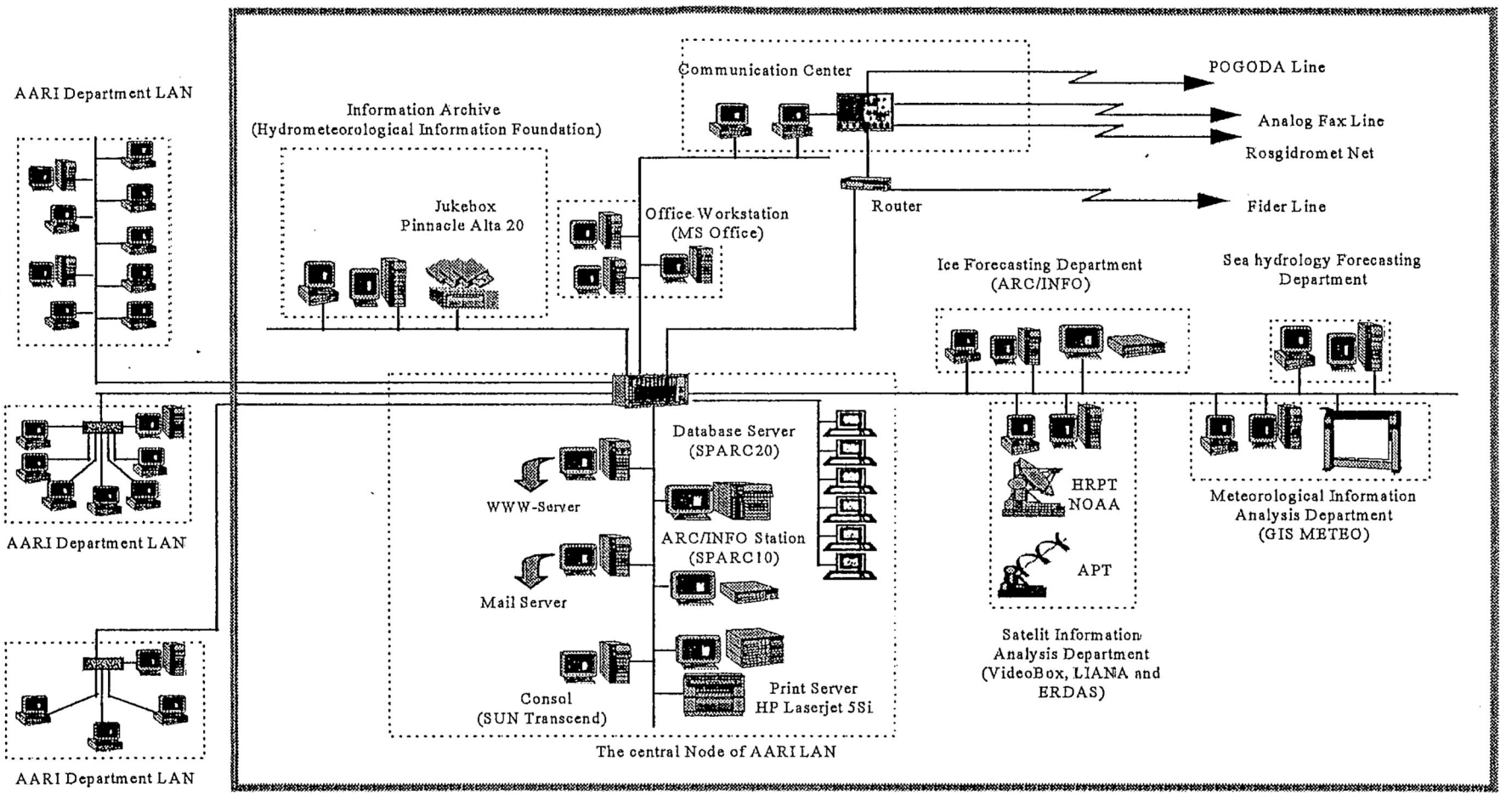

Fig. 2.3 The Structure of The Operational Core of the AARI Information System

The exit to the external networks (Internet) is currently organized through the scientific-educational network of the north-western Russia ROCSON NW. For this purpose a fiber cable connecting the AARI and the St. Petersburg Institute of Informatics (SPII) of the Russian Academy of Sciences is used. The traffic is 256 Kbit/s and after upgrading of the Central node of the optical communication it will be up to 10 Mbit/s. The data content for implementing the FTP, WWW servers and teleconferences (News) is under consideration now.

Simultaneously, the connection of Local Area Network (LAN) of the CIHMI (EtherNet) to the network of Rosgidrimet (IASNET) by X.25 protocol is organized. The intercomputer data exchange on the basis of X.25 protocol allows the AARI requirements for intercomputer exchange with the Arctic Administrations for Hydrometeorology to be met.

An important component for reorganizing the structure of the information resources of the AARI is to redesign the databases in accordance with the principles stated in para. 2.2.2.1. The work for conversion of the main databases from Paradox, FoxBase, dBase formats to the ORACLE 7.0 format is underway.

2.3. DEVELOPMENT OF OPERATIONAL TECHNOLOGY

Multiyear experience of providing hydrometeorological support for sea operations along the NSR shows that at their planning and implementation there are stages of addressing strategic, operational and tactical objectives. Each stage requires different ice-information support.

The objectives of strategic level are achieved by shipping companies and headquarters of sea operations consisting of selecting the routes and dates of transport operations, formation of convoys and determination of the required icebreaking support. For this purpose the review charts of the ice situation over the region of sea operations and the adjoining regions, as well as ice and weather forecasts of 7-8 to 30 days in advance are used.

The operational objective is to select the navigation variant at some segments of the route by a master of the icebreaker taking into account data of charts of the actual ice situation, short-range ice forecasts, as well as recommendations of the headquarters of sea operations and ice information centers.

The solution of tactical objectives, connected with direct motion and maneuvering of the icebreaker and the convoy in ice requires more detailed ice data. For these purposes large-scale ice charts, airborne observations and radar surveys and fragments of high resolution satellite imagery are used.

At the present time the ice situation along the NSR is analyzed and mapped based on satellite data of various resolution and range, shipborne data, and data from automated drifting stations and coastal polar stations. All this information after complexing is disseminated to users both on paper media and in the digital form (specialized CONTOUR format). The existing technology for formation and updating of composite information on ice distribution can be applied for the INSROP goals.

2.3.1 Composite ice chart

2.3.1.1 Types of coverages

Before proceeding to the description of technology for formation and updating composite information, it is necessary to identify types of coverages that provide a complete preservation of reported data.

In fact, the characteristics of distribution of any element of the ice cover can be described by a combination of polygonal, linear and point coverages.

Coverages of the polygonal type represent zones containing main characteristics of the ice cover (concentration, age categories, fast ice position) and additional characteristics (hummock and ridge concentration, snow cover amount, rafting, floe size distribution, etc.). As a rule, zones with additional characteristics are random and are formed as a result of special sampling from the main zones.

Information on the distribution of linear objects of the ice cover (cracks, leads, edge, etc.) is represented by coverages of linear type.

Coverages of point type describe objects that cannot be delineated at a chart scale (stamukhas, icebergs, etc.).

Important characteristics for each type of coverages are methods and dates of information acquisition.

2.3.1.2. Technology for formation of composite ice information

Technology for formation and updating of composite ice information is based on the "patch-work" principle when information is updated not for the entire NSR simultaneously, but old information is successively replaced by more new data for separate segments of the route.

To achieve the objective of forming composite information from separate fragments is the most important link in the entire technological chain and should be considered in more detail. We believe that most convenient for formation of composite information is to store a symbol line, describing all characteristics of the specific ice layer (concentration, age category, lead, etc.), rather than to use a by-layer storage of each of the elements describing a separate characteristic of ice distribution or its morphometric characteristics (age category, partial concentration, hummock and ridge concentration, rafting, etc.).

In this case the number of layers to be stored in the base will be considerably reduced. The more so as the governing factors for delineating zones of ice distribution are its main types (concentration, fast ice, open water, continuous cloud cover), the other characteristics being actually additional characteristics for describing a specific ice zone delineated by one of the indicators, mentioned above.

For example, the symbol line CT99SK60SI23SN12ZH12ZC10ZR12FB80 describes an ice zone with total ice concentration of 100% (CT99), partial concentration of medium first-year ice of 60% (SK60), partial concentration of thin first-year ice of 20-30% (S123), partial concentration of nilas of 10-20% (SN12), hummock and ridge concentration of 1-2 conventional units [1)] (ZC12), pressure [2)] rafting of 1-2 conventional units [3)] (ZR12), 80% of the ice forms are represented by large ice fields (FB80). This line can be presented in the form of a dendrite reference structure where the main governing parameter is type of zone and all other parameters are references to the tables containing additional information on the ice cover state.

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[1] according to the national scale of 5 conventional units

[2] according to the national scale of 3 conventional units

[3] according to the national scale of 5 conventional units

ID	Table title
ISOO	type of zone
ISO1	total concentration
IS02	age category
IS03	partial concentration
IS04	ice forms
IS05	ice surface state
IS06	ice deformation

This structure of storing information on the ice cover state requires to have only one coverage of the polygonal type - type of zone which has all necessary additional reference tables for generating new coverages of the polygonal type for any of the parameters presented in these tables. In this case there is no need to store all generated coverages in separate layers, since if necessary, it is always possible to generate them.

Separate parts of composite information have different reliability that is determined by its date and acquisition method. At the present time the technology is based on the following major stages:

- data collection from different sources;
- topical data processing using the existing software products;
- data conversion to the ARC/INFO compatible format;
- compiling of composite information based on separate fragments;
- dissemination to users.

Information on the ice cover is reported from aircraft of airborne ice reconnaissance, satellites of different resolution and region range, automated and manned drifting stations, coastal polar stations, from icebreakers and ships (data of shipborne observations and specialized expeditions). Recently, the amount of most complete information - data of airborne ice reconnaissance has dramatically reduced, satellite data becoming the main source.

Satellite imagery is processed using VideoBox software. The processing process includes:

- geographical location by orbital data and reference ground points;
- radio-brightness correction;
- interactive interpretation of the ice cover characteristics;
- preparation of a cable-message in the CONTOUR format.

Further data processing and complexing are performed in ARC/INFO medium based on the "patch-work" principle, as mentioned above. We had two problems to resolve.

i) A standard set of ARC/INFO symbols does not provide ice information presentation in accordance with the International Sea-Ice Nomenclature. Therefore we have created a base of ice symbols and software in the AML for its support.

ii) For work in ARC/INFO the elements of the digital chart of the world (DCW) at the scale 1:1 000 000 are used. In the VideoBox we use a digital chart at the scale 1:5 000 000, compiled at the AARI. For correct conversion of the results of processing satellite imagery it was necessary to reduce data to a common cartographic base. For this purpose the capability of operation with the DCW was introduced to the VideoBox.

Thus it is now possible to create a composite ice chart based on satellite data and data in the CONTOUR format, in ARC/INFO. A composite ice chart is now compiled in two variants - general purpose and complete. The general purpose chart has only one layer, containing information:

- in the summer season - on ice concentration by three gradations;
- in the winter season - on the zones of ice of different age by five gradations.

A complete chart has currently five layers:

- total ice concentration;
- partial concentration of ice of different age categories;
- discontinuities in the ice cover (cracks, leads, fractures);
- icebergs, ice islands, stamukhas;
- ice drift vectors.

The access to a complete composite ice chart is restricted.

In the near future it is planned to supplement the technology for compiling a composite ice chart with a calculation block , thus allowing compilation of an ice chart reduced to one date.

Compilation of such a chart will enable us to include the calculation (numerical) ice forecasting methods (up to 10 days in advance) to operational technology.

2.3.2 Data conversion into ARC/INFO formats

Data on computer media can be divided into three basic groups:

a) databases produced by DBMS Paradox, FoxPro, dBase III-IV;

b) databases in the text format (ASCII);

c) cartographic information in the CONTOUR format.

It was decided to convert data of the first two groups to the formats DBMS ORACLE, so that it will be possible to work with these data in ARC/INFO without special conversion.

A large amount of data on the ice cover state in the Arctic Ocean, contained in the AARI databases in the digital form are presented in the CONTOUR format.

The CONTOUR format was developed for acquisition, processing, analysis and storage of data on ice conditions in the seas and oceans at the processing points and centers of different levels and for ice information dissemination to users of all ranks. The format provides input, storage and transfer of information on all variables characterizing the ice cover state, completely preserving the precision in delineating boundaries of the zones and the position of point and ice objects.

Any ice data prepared in the CONTOUR format for transmitting via the communication lines should consist of three structural parts:

- address;
- service;
- information.

The address part is used for cable transmission via the communication lines.

The service part contains a successive description of spatial, temporal and special parameters of an ice chart.

The information part includes a data set on the boundaries of the region of data collection and the information set proper of an area or a route ice chart with the description of the ice conditions. The information set consists of the information blocks which are subdivided by their record format into the following types:

- main zones;
- zones of discontinuities in the ice cover;
- additional zones;
- linear objects;
- point objects;
- ice drift.

The description of a separate zone or an object is assumed to be the information unit. It consists of information on ice characteristics in the zone (or characteristics of the object) and information on the geographical position of a zone or an object.

The characteristics are described by the text constants, identical to the terms of the Sea-Ice Nomenclature.

The boundaries of the regions and zones of data collection, the position of the routes and linear objects are described by geographical coordinates of their turning points and the position of the point objects by their geographical coordinates. Each point is assigned two five-digit groups. The first group denotes the degrees and minutes of latitude and indication of the hemisphere of longitude, the second group denotes the degrees and minutes of longitude.

A fragment of a cable in the CONTOUR format

CONTOUR 10
Satellite SLAR ice chart 407
KARA SEA
00000801-0001080195
STEREO-5/6-1-C
BOUNDARY
74180 05400 73320 06809 72120 06647 71170 06557 69330 06437
65370 06211 66060 05232 69320 05309 69430 05310 70390 05318
74180 05400
THIN FAST ICE / 69480 05924 70030 05923 /
69490 05859 69490 05859 69400 05938 69400 05934
THIN FAST ICE / 68490 05919 68330 05839 /
69380 06005 69370 06005 69280 06011 69210 06011 69140 06015
69090 06026 69030 06037 69000 06043 68530 06039 68530 06039

68510 06032 68510 06032 68460 06029 68450 06022 68420 05957
68370 05944 68360 05940 68310 05935 68260 05936 68230 05932
68260 05916 68340 05926 68390 05928 68430 05937 68450 05934
68450 05934 68520 05923 68530 05917 68560 05905 68560 05908
CONCENTRATION 10 THIN 7-8 YOUNG 2-3 / 71210 06229 /
69470 06128 69470 06125 69540 06129 70020 06046 70150 06053
70320 06028 70330 06025 70430 06023 71000 05958 71180 06003
71260 06054 71230 06123 71320 06200 71520 06157 72020 06232
72020 06309 71550 06320 71510 06325 71460 06313 71480 06411
71350 06357 71290 06349 71250 06426 71160 06343 71020 06330
70580 06319 70490 06336 70490 06336 71000 06352 71050 06411
71020 06432 71010 06446 71070 06503 71040 06524 71150 06544
71180 06555 71170 06557
YOUNG CHANNEL
73290 05850 73200 05816 73090 05757 72570 05735 72460 05723
72360 05710 72210 05709 72060 05715 72070 05716
CONCENTRATION 10 THIN 8-9 YOUNG 1-2 / 71180 05838 /
THIN FAST ICE / 68370 05413 /
END

In accordance with the above, the format can be with some allowances referred to the type of vector topological formats. Fig. 2.4 gives a map of ice distribution with the corresponding description in the CONTOUR format.

To prepare data for entry to ARC/INFO environment, a converter was created permitting distribution of data in three files of the ASCII-format, containing respectively three types of data:

1. The file-description of the contours of ice zones.

Record format: ID, X, Y...END, where X and Y are longitude and latitude, respectively.

2. The file-description of the central points of ice zones.

Record format: ID, X, Y.

3. The file-description of the characteristics of ice zones and service information.

Record format: ID, a sequence of ASCII-symbols.

After data conversion from the CONTOUR format and creating three contextually linked files, as described above, the procedure of ice data input to ARC/INFO environment is appreciably simplified.

At the present time, the conversion of data in the CONTOUR format to the ARC/INFO formats is underway.

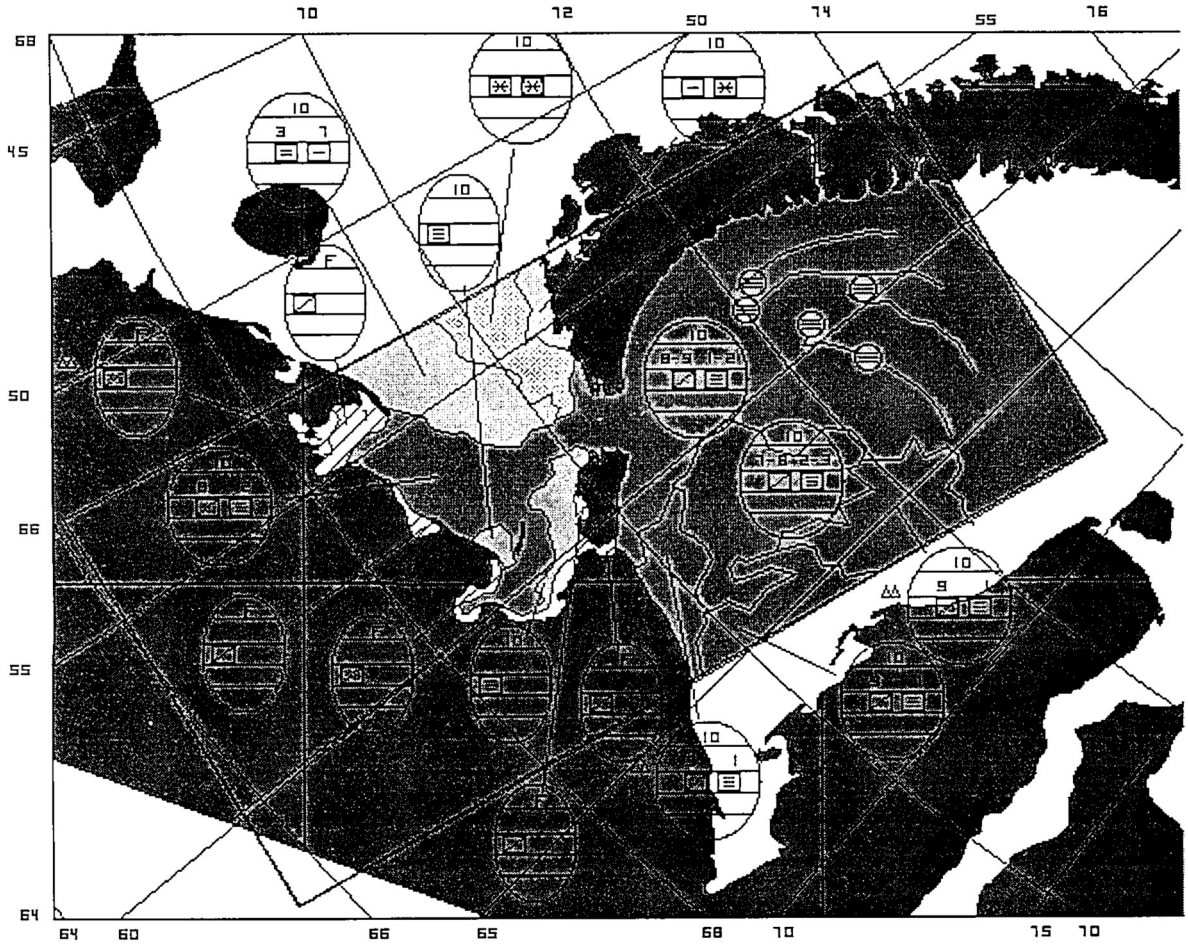

Fig. 2.4. An example of an ice chart, based on the message in the CONTOUR format

3. ORGANIZATION OF THE INFORMATION EXCHANGE BETWEEN THE INSROP HYDROMETEOROLOGICAL MODULES AND THEIR USERS

3.1. Implementation of the climatic (reference) and operational information centers of INSROP

From experience of the previous stages, this objective turned out to be most difficult in implementing both the Norwegian and the Russian centers of the INSROP information system. This was caused by initially unforeseen both political obstacles (impossibility of the Russian primary data transfer to other INSROP participants) and purely technical reasons (the databases available at the AARI were not ready for exchanging the results of statistical processing of primary data stored there). Whereas the former cause should be accepted by all INSROP participants as objective reality, not subject to change, the latter problem can be successively resolved.

As mentioned, the logical and physical information array in the existing DB and archives does not allow us an adequate level of access to data of interest. This is governed on the one hand, by different software, used by designers of individual databases (different OS and DBMS of FoxPro, Paradox, dBase type, etc. are used) and on the other hand, by the poor development of the needed communication means and the network software. Hence there is an urgent need for transfer from the individual databases to the distributed DBs with an allocated server.

3.1.1. Functional structure of the AARI databases providing a full authorized access of INSROP participants to the information resources of the AARI.

We have used as a basis the functional structure of the Information System proposed by the Norwegian side in the Outline of Project description, 1993 (Fig. 3.1). We have tried to relate it to the specific conditions of the AARI.

As mentioned above, the databases, available to date at the AARI, are not combined into any structure, the metadata block is absent and access is impossible. The only exception is the International Sea-Ice Data Bank, but even here there is no tested access structure as well.

The proposed functional scheme envisages a combination of the individual databases - oceanographic, meteorological, sea ice and others into one common distributed database RDBMS ORACLE -7. It is suggested not only to combine these bases into a large one database, but also to merge them by uniform fields. In particular, the oceanographic

databases have information on the ice thickness, snow cover depth, air temperature, etc. But such information, being of a supplementary character, is often not recorded in the main database in accordance with the adopted formats and not analyzed.

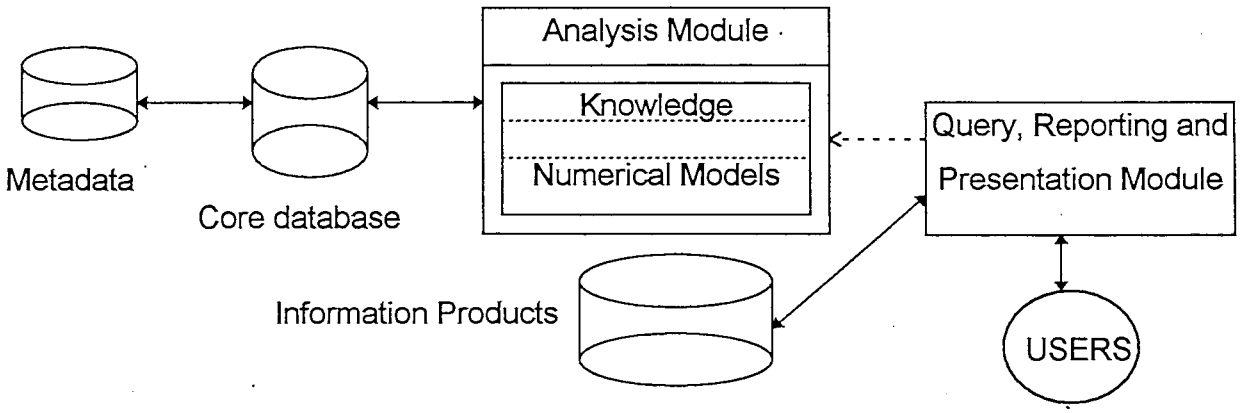

Fig. 3.1 Draft functional structure of the Information System

This work will require substantial expenditures, both in terms of finances and time. To fulfill it, well-trained specialists are needed. They will have to learn the new way of data array that will also require time. However, this is the only acceptable way and the work is already underway.

At the same time the ORACLE Toolkit will help to significantly improve the module for analysis of available information, as well as to more fully use the capabilities both for the purposes of the geographical data analysis and for presentation of data. This approach will also allow us to more actively apply the Arc/View package for preparing spatial data for ARC/INFO and for presenting the results in the form of ARC/INFO coverages to users both in the AARI and overseas.

3.1.2. Telecommunication capabilities to provide the transfer of hydrometeorological information to INSROP and recommendations for their use.

In the suggested functional scheme a great deal of attention is given for arranging access of the INSROP participants to the information resources. It is planned to provide access to such data, already ready for exchange, as reports, overviews, standard information products (for example, a composite general-purpose ice chart) by their entry to the FTP-server. As to data requiring preliminary processing in accordance with the request of users, as well as commercial data or data of restricted access, it will be entered the WWW-server. For discussing current problems by INSROP participants, a teleconference server (NEWS-server) will be implemented.

The priority problem is to arrange the information exchange between the INSROP hydrometeorological modules - the Norwegian and the Russian GIS cores. Since the information system of the AARI was unprepared for a full data exchange, the implementation of the Norwegian GIS core was connected with significant difficulties. Additional funds were used for the contract to prepare data restricted by content and amount. In case the proposed functional system is accepted, it will be necessary jointly with participants in Sub-Programme 1.3.1 to develop standard query forms to the AARI information system.

3.2. Telecommunication Services for users of the Information System

As mentioned in the previous Report (1.3.4-93), a wide range of institutions whose activities are related to shipping support in the Arctic, are potential users of the INSROP information system. It is planned that the main user-organizations will include: shipping companies, headquarters of sea operations, search-rescue centers and services, port and pilot services, hydrographic bases, research institutes, design-exploration organizations, construction companies, marine and coastal research expeditions, educational institutions and ships.

By architecture, the system of telecommunication services to users is suggested to design on the basis of regional nodes which will provide connection of users with the INSROP GIS via the existing telecommunication resources.

The regional nodes of the system are reasonable to locate in the coastal centers Dikson, Tiksi and Pevek, as well as in Murmansk and Arkhangelsk where there are developed infrastructure of communication and access nodes to digital information webs and satellite communication means.

It is desirable to arrange the telecommunication interaction of users in the Arctic by means of ideology of open X.25 systems. This is related to the features of the existing Russian communication systems in which the X.25 protocol provides data transfer most successfully. In the future it will allow conjugation with standard computation means and systems and national and international data transfer networks without any significant adjustments On the other hand this approach will enable a by-stage increase in the number of the communication nodes and users of the system.

Each group of users will present their requirements to the user interface of the system. This will determine the necessary hardware and software for connecting with the system.

The telecommunication services should present various capabilities to access the information system.

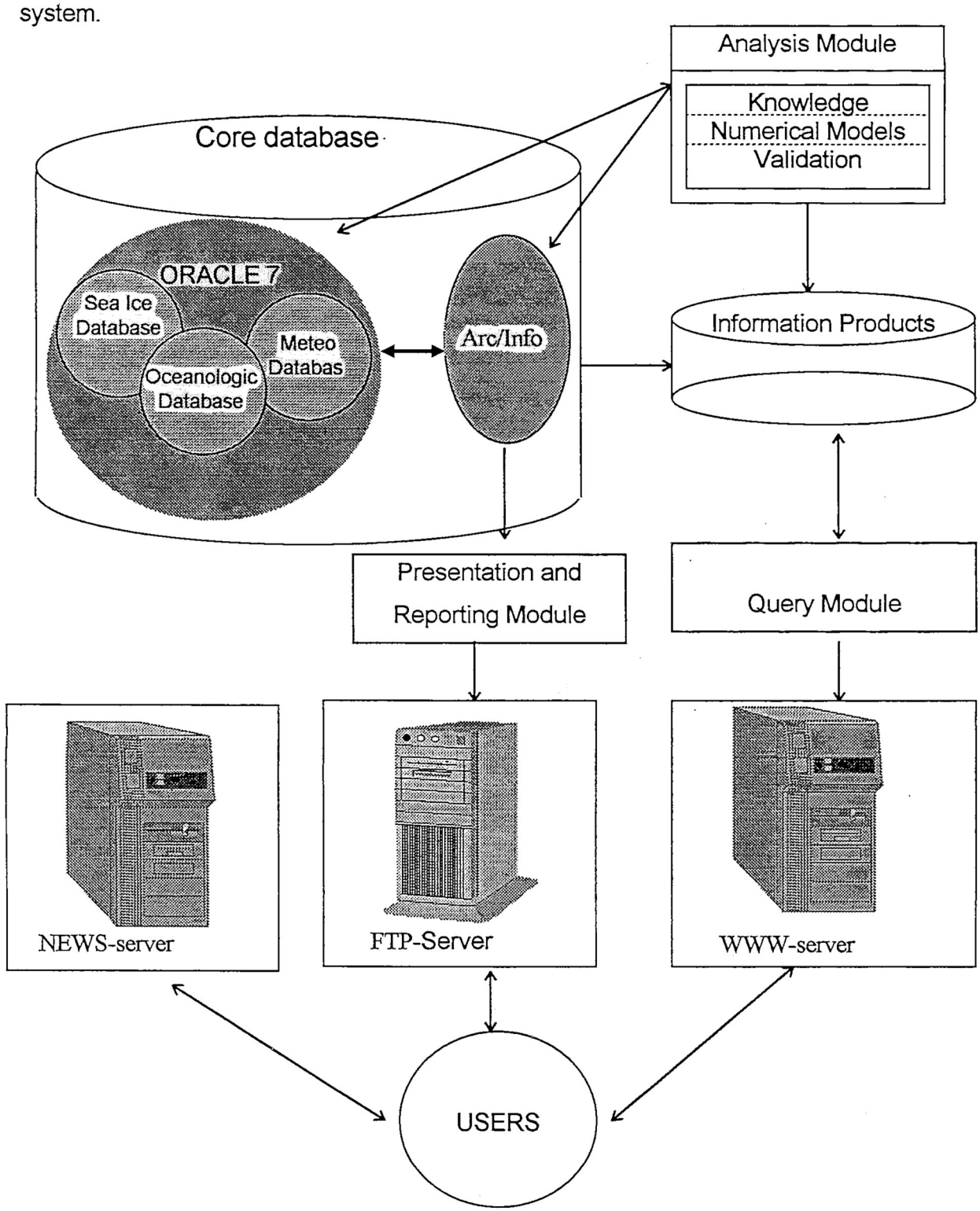

Fig. 3.2. Functional structure of the Information system of AARI

One group of users (shipping companies, shore centers, research and design institutes in large cities) have a possibility for connecting with high-speed digital communication lines. Another group (ships, users in remote locations) have restricted access capabilities, mainly by radiochannels. Thus there is a clear need for adapting the system to different users in terms of telecommunication access (Fig. 3.3).

Depending on the terminal station, the users can make connection via:

- specialized access means to the X.25 net (network adapters);
- modem;
- satellite station;
- Internet means.

The nodes of the system are combined into a common network via the existing telecommunication resources - digital communication channels, allocated channels, telephone networks, satellite communication channels, radio relay communication lines , fiber optics cable, as well as via the nets (SPRINT, ROSPAK, TRANSINFORM, etc.).

Not only access to the resources of the system databases should be implemented in the system, but also a possibility for a mutual interaction of users. For this purpose internetwork exchange and gateways to other networks should be envisaged.

An important component for GIS operation would be the possibility for ships and remote users to access the digital computer networks. Hence satellite communication is proposed to be used as the main communication means at the first stage (up to 2000). Currently intercomputer "ship-shore" exchange can be achieved via the INMARSAT system.

For communication via the composite channel (satellite channel-coastal ground station-ground communication line) it is necessary to use ground channels meeting the MKKTT.M1020 requirements by their electrical characteristics (standards for the leased channels of special quality with specially coordinated width of the frequency range). In the absence of reliable ground channels the intercomputer exchange can be in two stages in the ship-ship mode.

Later with the development of the ground communication infrastructure, the replacement of the existing radio-relay stations by digital stations, construction of Transarctic fiber cable and introduction into practice of international INMARSAT-P and national satellite systems (MARAFON, GONETS, whose characteristics are given in Projects 1.1.2.4-

94 and 1.1.2.4-95), there will be additional cost-effective access capabilities for ships and remote users to the INSROP GIS resources.

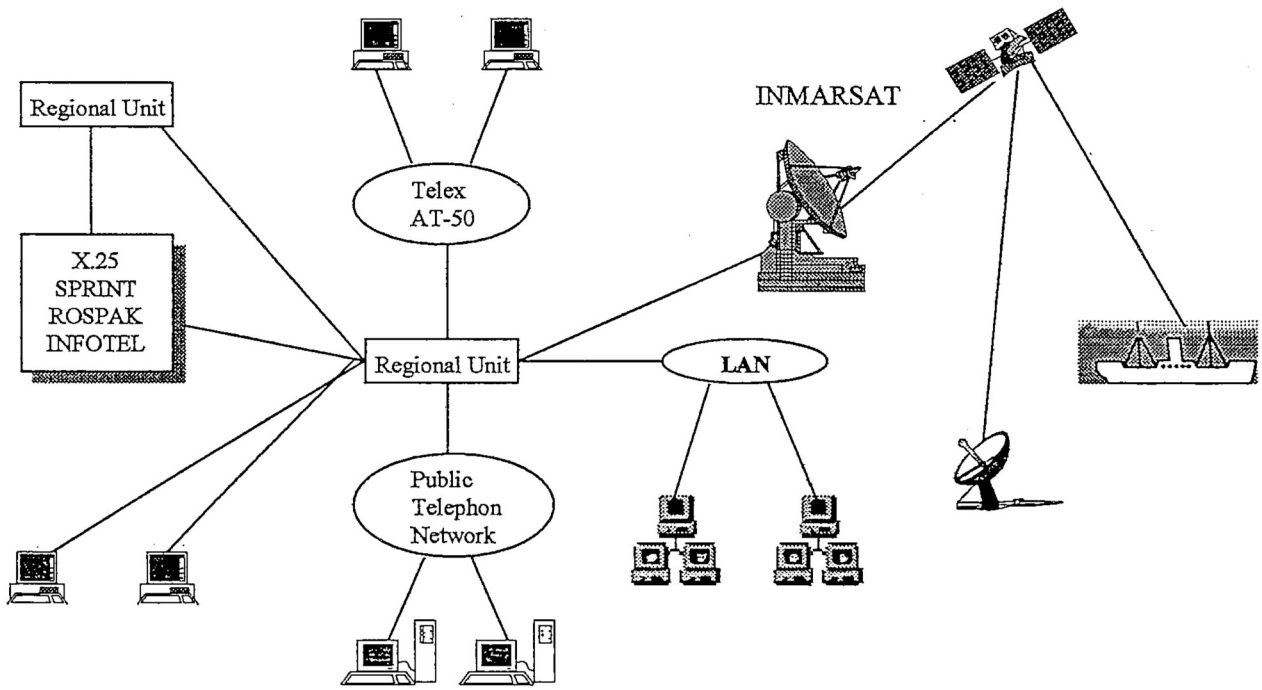

Fig.3.3. Telecommunication Interaction Scheme

4 PLANNING AND PREPARATION FOR TESTS OF THE HYDROMETEOROLOGICAL MODULE OF THE INSROP INFORMATION SYSTEM

It is clear that the hydrometeorological module of the INSROP information system that is designed at the AARI should be comprehensively tested prior to its practical use. The tests should be carried out both at the internal level of interaction of three structural blocks (operational, climatic and research), and at the external level of information exchanges with the Norwegian GIS core. Also there should be tests to exchange information that is prepared in the operational and climatic blocks, with the regional centers of the Hydrometeorological Service, Headquarters of sea operations and icebreakers supporting transportation operations. We may note that to arrange tests of the hydrometeorological module at the external level (excluding testing the information exchange with the Norwegian GIS core) will require substantial investments to hardware and software equipment of the indicated objects. In our opinion, this re-equipment can be gradual with financial returns from international shipping along the NSR.

4.1 Goal and Aims of testing the Module of Hydrometeorological Support in INSROP

The main goal of testing the hydrometeorological module of the INSROP information system is to determine its viability in providing information support for the research objectives of INSROP and real international transit navigation along the NSR.

The main goal includes the following objectives of test exercises.

Operational block:

- checking for quality and completeness of operational hydrometeorological information reported to the Center for Ice and Hydrometeorological Information of the AARI from the national and international acquisition networks;
- determination of its suitability for INSROP information support;
- development of additional requirements for improving technical means for data collection and transfer;
- testing of technologies, existing at the AARI, for constructing composite ice charts based on data of multi-channel satellite and contact measurements using the base of knowledge formalized in the climatic block;

- testing of quality of medium-range forecasts of ice conditions along the NSR and in the Arctic Seas;
- formulation of proposals for improving the prognostic schemes taking into account the specific features of international transit navigation;
- checking of correctness of the existing calculation schemes of the optimal route of convoys of ships and icebreakers in the complicated segments of the route.

Climatic block:

- checking of the methods and technologies for generalizing and compiling of hydrometeorological information that is reported to the climatic block;
- checking of technology for information interaction with the national and international sea-ice data banks;
- approbation of the calculation schemes of long-range forecasting of the ice situation along the NSR;
- operations for sampling of test information sets and their transfer to the user.

The objectives of testing the research block are governed by its functions. They will include determination of reliability of the methods both employed and under development, for acquisition, processing and presentation of hydrometeorological information in the interests of international transit navigation along the NSR.

4.2 Participants in the Test Exercises and a Scheme of their interaction

The tests of the hydrometeorological module at its internal level will involve structural divisions of the Center for Ice and Hydrometeorological Information and of the research departments of the AARI, currently responsible for a number of thematical functions of HMS for navigation along the NSR. For detailed information about these structural divisions, see the Report under Project 1.3.4 for 1993. The tests of the hydrometeorological module will employ modern computer means and the local computation network of the AARI.

All structural blocks of the Russian ice information system together with the Norwegian INSROP GIS core, developed at SINTEF NHL, are to participate in testing the hydrometeorological module at the external level.

4.3 Plans for the Test Exercises

Two stage of testing the hydrometeorological module of the INSROP information system are proposed.

At the first stage the hydrometeorological module is tested at the national level with a full complex of HMS for transport operations of the Murmansk shipping company. At the same time there will be an Internet exchange of the test information sets with the Norwegian INSROP GIS core in order to determine the viability of the selected exchange scheme and probably to develop additional requirements for its improvement. The suggested time frame presents the dates of the beginning of summer navigation which will allow us to assess the operation quality of the hydrometeorological module for supporting real transport operations.

The dates of the second stage of test exercises of the hydrometeorological module of the INSROP information system will be determined additionally in accordance with the decisions of the INSROP JRC about participation of the Russian side in the second phase of the Program. These tests can be performed prior to the beginning of regular international transit navigation along the NSR and be based on various scenarios of sea operations.

CONCLUSION

The results of activities under Project 1.3.4 in 1994-1995 allow the following conclusions to be made:

- the INSROP information system should be based on two territorially remote modules - Russian and Norwegian with corresponding sharing of functions:
  i) the main aim of the Russian module of the INSROP information system is to provide hydrometeorological support for shipping along the Northern Sea Route on an operational basis;

  ii) the main aim of the Norwegian GIS core is information-reference provision for marketing and research studies of navigation conditions along the NSR;
- it is necessary to continue input of data available at the AARI to the GIS and arrange a real information exchange between the Russian and the Norwegian modules;
- the AARI designs a hydrometeorological module (technologies and hardware and software) for the operational use of the information system of the Institute in the INSROP interests;
- software for converting ice information from the national formats to the ARC/INFO formats was created within Project 1.3.4;
- a basis for continuation of activities under Project 1.3.4 in the second phase of INSROP was created.

PROPOSALS FOR DIRECTIONS OF ACTIVITIES IN PHASE II OF INSROP

1. Reorganization of infrastructure of databases of the information system of the AARI for its use in the interests of INSROP.

2. Continuation of the information input to the INSROP GIS.

3. Organization of access to the information resources of the AARI for INSROP participants.

4. Development of proposals for introducing the developed geoinformation technologies into practice of real support for international transit shipping along the NSR.

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Claes Lykke Ragner
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5 February 1997

Dear Mr. Ragner:

The following are my comments on the revised report that you sent me to review ["Design of Information System" by Deviatayev, Grischenko, Shcherbakov, Smirnov, Shigabutdinov and Yakshevich].

I believe that the current version of the paper is a very significant improvement over the previous version that I reviewed. I also believe that the authors have made a very serious effort to implement the suggestions that I made concerning improving the earlier version. I believe that the report is ready for you to publish once your editor has carried out some additional linguistic polishing. I have done a bit of this on the paper copy of the report that I will be mailing to you tomorrow but a bit more work is needed. Fortunately this shouldn't take very long.

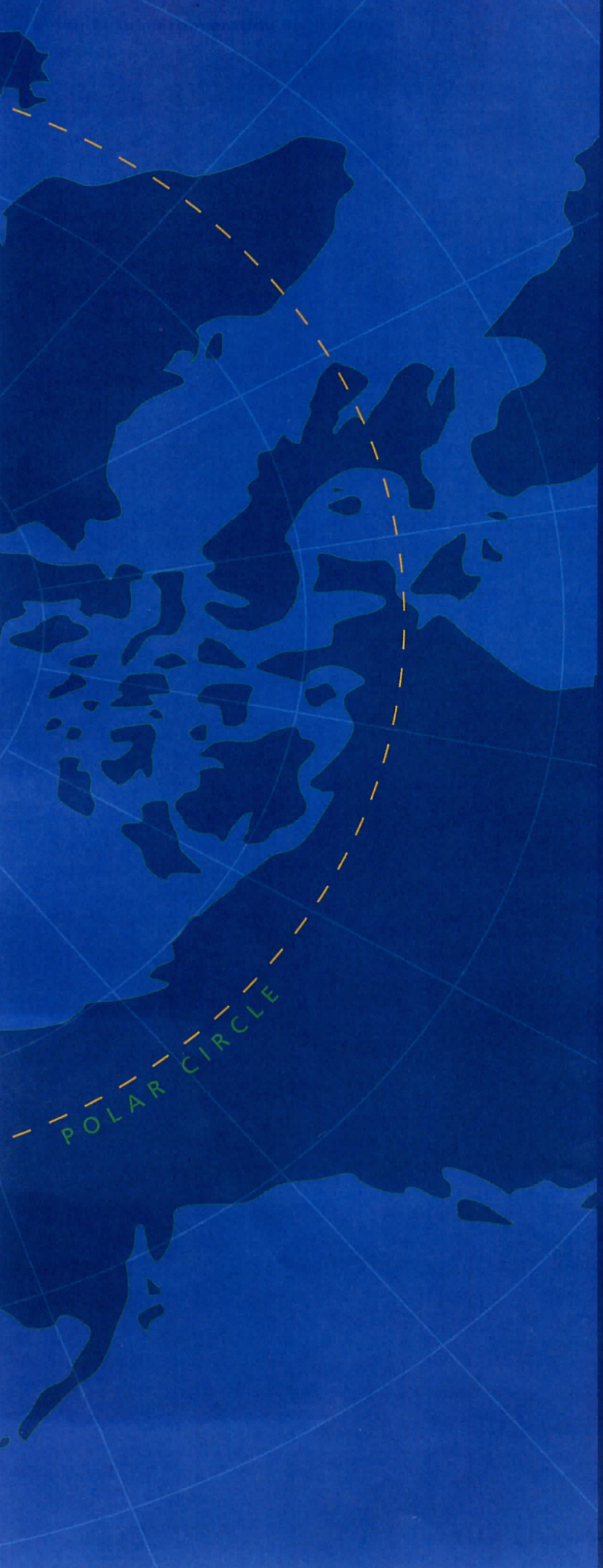
I also suggest that as the paper is being edited, your editor should attempt to prepare a terminology glossary that would appear between the Table of Contants and the Introduction. Although most of the acronyms are defined somewhere in the text, it would be nice to have one place to look when you forget exactly what expressions such as CIHMI mean. The explanations do not have to be very involved. For instance

ARC/INFO—a specific Geographic Information System (GIS)
GIS — Geographic Information System
ORACLE—a S/W company specializing in data bases
etc.

When the editor is finished with that, the report can be sent back to St. Petersburg to AARI so that the Russian authors can complete a final check and when it is returned to you, you can turn on the printing presses. I do not need to see the report again.

Sincerely,

W. F. Weeks
Consulting Glaciologist



The three main cooperating institutions of INSROP

Ship & Ocean Foundation (SOF), Tokyo, Japan.
SOF was established in 1975 as a non-profit organization to advance modernization and rationalization of Japan's shipbuilding and related industries, and to give assistance to non-profit organizations associated with these industries. SOF is provided with operation funds by the Sasakawa Foundation, the world's largest foundation operated with revenue from motorboat racing. An integral part of SOF, the Tsukuba Institute, carries out experimental research into ocean environment protection and ocean development.

Central Marine Research & Design Institute (CNIIMF), St. Petersburg, Russia.
CNIIMF was founded in 1929. The institute's research focus is applied and technological with four main goals: the improvment of merchant fleet efficiency; shipping safety; technical development of the merchant fleet; and design support for future fleet development. CNIIMF was a Russian state institution up to 1993, when it was converted into a stock-holding company.

The Fridtjof Nansen Institute (FNI), Lysaker, Norway.
FNI was founded in 1958 and is based at Polhøgda, the home of Fridtjof Nansen, famous Norwegian polar explorer, scientist, humanist and statesman. The institute spesializes in applied social science research, with special focus on international resource and environmental management. In addition to INSROP, the research is organized in six integrated programmes. Typical of FNI research is a multi-disciplinary approach, entailing extensive cooperation with other research institutions both at home and abroad. The INSROP Secretariat is located at FNI.