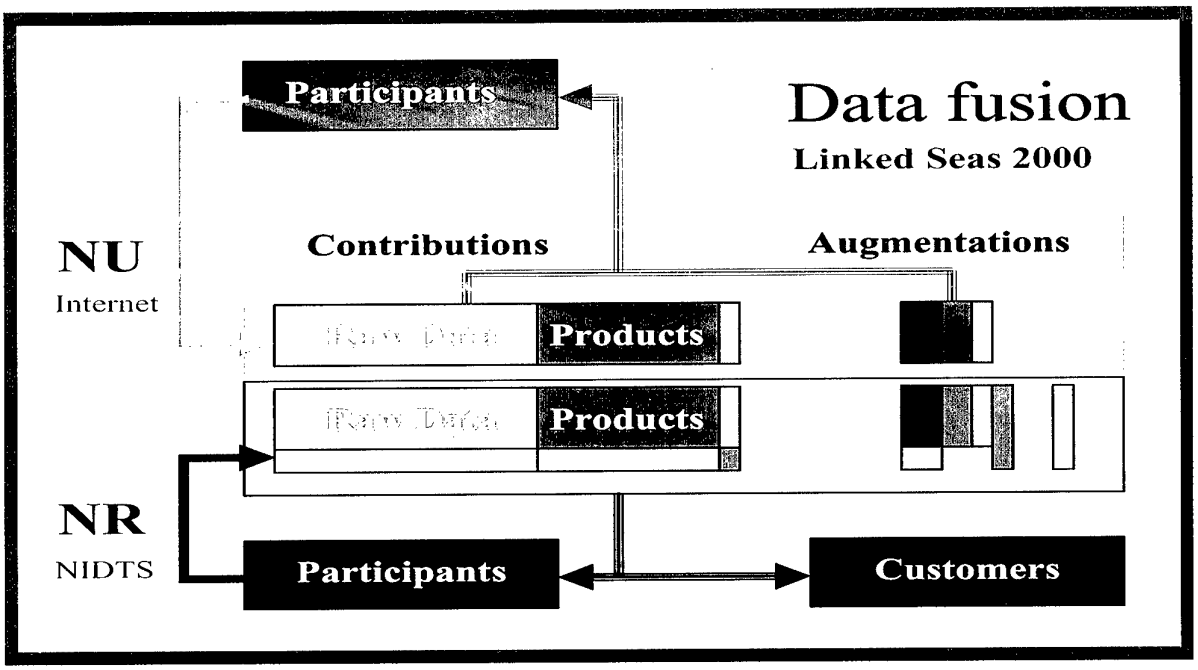
SACLANTCEN REPORT
serial no: SR- 336

# SACLANT UNDERSEA RESEARCH CENTRE REPORT






NORTH ATLANTIC TREATY ORGANIZATION ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

# Fusion centre operations for maritime rapid environmental assessment

J. Sellschopp

The content of this document pertains to work performed under Project 01-A of the SACLANTCEN Programme of Work. The document has been approved for release by The Director, SACLANTCEN.

Jan L. Spoelstra
Director

intentionally blank page

**Fusion centre operations for maritime rapid environmental assessment**

J. Sellschopp

**Executive Summary:** By action item from the 35th meeting of the MILOC Group, SACLANTCEN was requested "to provide a report to HQ SACLANT by 1 Sep 2000 detailing the operations of a NATO REA Fusion Centre, which can be provided to nations and commands developing this capability in the future. The report should be based on experiences in 96-00 exercises and recommend changes to the maritime REA CONOPS, including procedures, manpower and equipment."

Rapid environmental assessment (REA) as a new method in support of naval operations was brought to life in 1996. It has since then been developed from experimental to operational. Fastest progress was achievable in REA data communications and data fusion, while the development of tailored data acquisition systems and the science of new fast assessment methods takes more time.

Between 1996 and 2000, REA experiments have been carried out in military oceanography (MILOC) prior to four NATO exercises. Data fusion has in all cases been with SACLANTCEN. Conceptual shortfalls were progressively eliminated reaching a minimum for the last exercise, Linked Seas 2000. Digital compact disks (CD-ROMs) have been published with the data sets of all REA exercises. Their inspection would demonstrate the advancement in the data fusion concept and operator skills. It is highly recommended to use the CD-ROM "Linked Seas 2000, the complete REA data set" in conjunction with this report. All examples are taken from that disk. Looking at its realization, the reader will easier understand the data fusion concept.

Data fusion is closely linked to data acquisition during REA surveys and to REA product distribution. It is recommended to streamline the whole process by merging responsibilities at the REA command and data fusion centres.

intentionally blank page

**Fusion centre operations for rapid environmental assessment**

J. Sellschopp

**Abstract:** A capability for data fusion in rapid environmental assessment (REA) operations has been developed and practiced. The concept and the steps for its realization are described in enough detail to be used as a guide to similar exercises in the future. Examples are taken from Linked Seas 2000 data fusion, the most recent, most advanced and most complex data fusion activity for military oceanography. All functions of a data fusion centre are described, from data collection over data base organization, administration, maintenance, conversion, visualization and search to placement on one or more networks. Platform independent Internet technology is used with standard software for servers and clients. An html-version of this report is included on the SACLANTCEN CD-40 with active links to the respective examples.

**Keywords**: military oceanography, rapid environmental assessment, data fusion, Internet

# Contents

# 1 Introduction

Rapid environmental assessment (REA) as a method for improved oceanographic support for naval operations is a young discipline. Until five years ago, military oceanography (MILOC) surveys had aimed at environmental data collection in specific ocean areas with extensive and time consuming postprocessing and reporting. Since the move to REA was made, experience was gained during four MILOC surveys of the new type: Rapid Response 96, 97 and 98 and Linked Seas 2000. Scientists and operational experts have developed new concepts and published first results. Special conferences [1] or sessions on REA [2, 3] in larger conferences were held to discuss the progress. Lessons learned during MILOC REA exercises were reported [4 - 7] in a variety of aspects and REA data and products distributed on CD-ROM [8 - 12]. Parallel to REA exercise execution by the MILOC community, a concept of operations (ConOps) [13] was developed by the Supreme Allied Commander Atlantic (SACLANT) describing the REA organization and the distribution of responsibilities.

This report details the operations of a NATO REA Fusion Centre. It is based on experiences in 96-00 exercises and gives advice to nations and commands developing this capability in the future. For convenient inspection of examples, it is recommended that the Linked Seas 2000 CD-ROM [12] is used together with this report, a hypertext-version of which is also found on the CD-ROM with clickable links to references. The examples demonstrate appropriateness and shortfalls of certain technical solutions only. It is not the aim of this report to discuss the intrinsic quality of any contribution to Linked Seas 2000 REA. Linked Seas 2000 is at the same time the end point of data fusion concept development and the begin of operational REA being integral part of a naval exercise and controlled by a military oceanographic information center (MOIC). While during the preceding Rapid Response surveys potential contributors were invited to demonstrate their skills by submission of whatever was considered to be of value for navy operations, a comprehensive REA product list (item 15 of METOC/REA syndicate MOPC minutes) was established in the planning phase of Linked Seas.

A limited number of predefined REA products has the potential of making a data fusion centre redundant by predefined data streams between support centres and the Command Centre who, according to the REA ConOps [13] (para 12), is responsible for dissemination. Nevertheless, due to notes received from SACLANT and two participating nations, a full data fusion capability was maintained again with possibilities to manage all kinds of anticipated and unexpected contributions. In the limits of programming resources, raw data were converted into products that were offered to the command centre for dissemination in addition to the predefined list. Finally the number (almost 10000) and total size (over 800 MByte) of data files handled at the data fusion

centre for Linked Seas 2000 exceeded by far the amount of any Rapid Response data collection.

Data fusion is located between data acquisition and dissemination. The next section will describe a little more the duties of a data fusion centre before technical and operational details are explained in subsequent sections. The last section contains suggested changes to the REA ConOps. Even though the data fusion concept is presented here as one tailored for MILOC REA, it can be easily applied to any modern ocean data acquisition effort. REA data fusion methods have indeed positively influenced at-sea experiments at SACLANTCEN, where more and more teams arrive in port with the majority of environmental data fused.

# 2
# Data fusion objectives

Potential REA sources are archived historical data, observational and computational results of opportunity, specific REA survey data and feedback from clients. Even though no comments on received REA products have been reported back to the fusion centre and no environmental observations by the navy units themselves have been intermingled during one of the past exercises, a concept for operational REA data fusion should include this as a desirable option. Standard meteorology and oceanography (MetOc) products, though distinguished from and not counted as REA products, can well be input to further environmental assessment. Together with regular data from remote and in situ observation systems, standard MetOc products such as numerical weather forecasts are regarded as sources of opportunity. The responsible MOIC maintains a data base, which is used for normal MetOc support. For REA, additional archives are accessed which can spread over a variety of institutions. Public data sources such as MODB can be used by REA support centres without a need for central archiving. Archival data that are not publicly available such as a national ocean climatology must be made accessible to REA participants through a data centre, which may or may not be identical to the REA data fusion centre.

In general it is not necessary that REA data reside on a single computer. Distributed data fusion can be almost transparent to the client connecting to the network and is as appropriate if all sites that hold part of the data set are equally well accessible and if they obey basic rules of data fusion. Most importantly in a distributed architecture, the information behind a web address must not change or removed. Otherwise links from elsewhere in the structure would break or reference something unexpected. No distributed data fusion was practiced during Rapid Response and Linked Seas, all data were physically located on the server of the data fusion center. As a beneficial consequence of links only to information on the same server (see section 5), it was easy to produce hardcopies of the complete data set on CD-ROM [9 - 12].

The basic goal of data fusion is to provide a framework for all contributions from REA support centres and participants of an REA survey. For them it must not be complicated to deliver digital products. Contributions must be dispersed without delay. Potential users must be safely guided to all available information. In section 5 below it will be described how this can be achieved. Only with the experience from three years of Rapid Response data fusion with increasingly appropriate approaches, a structure for an REA web site was finally defined prior to Linked Seas 2000 which can be suggested as a template for future exercises. With a presentation [14] at the initial planning conference, the intended data fusion operation on two networks simultaneously was explained to the MetOc syndicate. The added challenge of a second web server to be maintained was assumed to be balanced by the expectation of less encyclopedic data and by contributors who would

deliver historical and survey data products in a format that would not require additional work by fusion centre personnel.

As long as many REA contributors are not fully prepared to deliver data in a desired format or to derive final products from data, the duties of the fusion centre are not restricted to data administration. Extended responsibility includes data integrity checks, conversion into more appropriate formats, graphics design, derived product generation and web page layout. Changes and augmentations to received contributions have been the most time consuming duties of fusion centre personnel. Format and product definition in advance can limit but not totally avoid this kind of effort. Under the constraining conditions of real-time operations, product development must be prioritized according to user requirements.

The concept of operations [13] distinguishes between data processing (§ 11) and dissemination (§ 12). Processed data are placed on a network server at the data fusion centre, where it is accessed by the REA command centre and organized into operational support packages (OSP), each tailored to the specific requirements of an individual supported commander. OSPs are subsets of the full REA data set complemented by standard MetOc support products. Since OSPs need not include the history of environmental conditions nor basic data that went into products, their size is significantly reduced. In Linked Seas 2000, OSPs have 16 MByte in total or 2% of the full REA data volume, which might still be too big for downloads to some military commanders. This point will be discussed again in section 10.

Besides the REA command centre, there are the REA support centres, as they are called in the ConOps, relying on the data fusion centre. REA support centres are governmental or civilian laboratories who deliver contributions produced or assembled especially for the REA exercise. In many cases such as ocean modeling or the prediction of sonar conditions, they need as an input to their products the contributions of other participants, such as *in situ* or remote measurements or tidal predictions. Essentially all potential REA support centres are connected to the Internet, the majority has no access to the NATO secure intranet NIDTS. Therefore the data fusion centre must maintain a server on the Internet to permit downloading by support centres. Even REA support centres that do not require data of other participants for the generation of their own contributions, prefer data fusion on the Internet, because it enables them to check correct placement and to invite their sponsors to visit the site.

Operational data fusion in a military environment may include secret information. Then the Internet is not an appropriate platform and data fusion must occur on NIDTS. REA data during Linked Seas 2000 were all unclassified except for laser bathymetry and a few memos including the situation reports of the command centre which were restricted. However national policy prohibited part of the modelling results to be placed on the Internet, even not encrypted and password protected. In order to meet the objective of a complete REA data set maintained at the fusion centre, the concept of a dual service on Internet and NIDTS was observed. Unclassified data fusion happened on the Internet server. The unclassified site was copied to NIDTS, extended by the before mentioned data and a common access structure created.

# 3 Hardware and software requirements

Whatever network is used for data collection and dissemination, it is based on the quasi standard of Internet technology. The philosophy behind the Internet is independence from computer hardware achieved by standard protocols and formats for interchange. The most important software for the connection to the Internet (tcp/ip, http, ftp, mail) are part of the operation system or can be easily loaded for free from open sources. This philosophy is sometimes not congruent with the commercial interests of software companies. Occasionally they offer extra features that would force clients to exclusively use their software or, even worse, to use their software on a special computer platform (see sitreps of days 21 and 25 to 31). Web masters must try to avoid to step into that trap.

There is continuous progress with the development of standards on the Internet. Therefore an older version of a web browser might not support new features on a page. The html version of this report, for example, is displayed with justification at 10% wide margins on both sides by modern (version 4) browsers. Programs of the third generation omit the margins while with even older versions that do not support frames, the report is not displayed at all. As a general rule for an REA exercise, web page design should avoid everything that could be a challenge to a few years old standard computer and its software (see section 8).

Consequently there are no special requirements for the hardware and software on the client side. Any high or low performance computer with standard software and connected to the respective network is appropriate for the communication with the data fusion centre. The problem with portable network graphics experienced with the Internet Explorer during Linked Seas could have easily been worked around (see section 8) if the fusion team had been aware of it.

Also on the server side at the data fusion centre, the requirements are quite low. Any workstation or medium performance PC loaded with an inexpensive web server program would suffice for a fusion server. During Linked Seas 2000, the data fusion centre had a PC under Windows NT connected to NIDTS and a PC with a Linux operation system running on the Internet. Standard Linux incorporates all necessary software including ftp and http servers. This is one of the reasons why the fusion team had a preference for Linux. The differences between the Windows and Unix operation systems and the fact that both were used, did not complicate data fusion operations.

# 4

# Access and access rights

## *4.1 Write access*

In every organization special authorization is needed if somebody intends to modify the contents of the portal to the Internet or NIDTS. The pages are usually maintained by a single or very few information technology specialists, who would be highly overcommitted if they were asked to develop and timely update all pages of an REA fusion centre.

During an REA exercise, new contributions can arrive at any time including week ends and nights. Some data are needed by other participants without delay. The fastest method is direct placement of the contribution by the originator. An area of the disk space is opened to the specific contributor for write access by file transfer (ftp). Since this area is located in the access range of the web server program, new files are immediately available to users without fusion centre intervention. Authorization for file placement is examined via user name and password and the ip address of the transmitting computer. If the web server is located behind a firewall, the firewall must also have been opened in advance for the ip number of the contributor.

Continuous maintenance by the fusion team consists of insertion of contributions that arrive through channels different from ftp, of changes to the contributions and of pages developed under own responsibility. Even if changes and own developments are created and tested on a separate computer, the fusion team needs the expertise and authority to directly populate the REA server (or REA part of the general server of the institution). Separate responsibilities for development by a REA team and for placement by a CIS team would unavoidably be a source of frustrating delays and reduced functionality (REA CC sitreps 3 to 28). During past MILOC REA exercises, server population at the data fusion centre has always been the responsibility of the data fusion team. In fact, the Information Technology Office at SACLANTCEN has been very cooperative with hardware procurement, firewall and network maintenance, NIDTS server installation etc., but is too limited in manpower to help with REA data fusion.

All members of the fusion team may be given the rights to write and change everywhere in the information tree. Usually each of them is working on a different branch of the directory tree, so that interference is not an issue. A web master with competence for coordination must take care of the pages that link all information together and need to be changed on many different occasions.

### *4.2 Read access*

On NIDTS there is no reason at all to put restrictions on the access to REA data and products. On the contrary, everybody who has access to NIDTS is invited to browse all information and verbalize comments from his point of view. The REA commander should communicate the data fusion server address to all his clients, at least by a hyperlink from his own homepage.

Data of a military REA exercise are not for public release. The access to the REA fusion server on the Internet must therefore be restricted to authorized persons. Even the existence of the website should not be told to the public, ie. its address should not appear as a hyperlink on any public home page. For authorized clients, the provision of username and password is a sufficiently safe protection mechanism, since all REA products on the Internet are kept at an unclassified level.

### *4.3 Security*

On NIDTS, security against interception and fraud are part of the environment so that no additional measures have to be taken by the data fusion manager. On the Internet the password protection mechanism minimizes the risk of unintentional distribution of information. In addition, the fusion centre should continuously log all server invocations and regularly evaluate and scan the list of connections from outside for unauthorized attempts.

It has been demonstrated in Rapid Response 98, that even encryption as used in the commercial world for flight bookings and money transfer, is a pragmatic option that would impede potential spies from interception of transfers. Since standard Internet browsers can deal with secure (encrypted) transfers, no special software or preparations are required on the client side. The fusion centre needs a digital server certificate issued by a recognized certificate authority (CA), which verifies the identity of the certificate's holder. Digital personal certificates can, as a safe and convenient alternative that has not yet been tested in MILOC REA, replace password protection. In-depth treatments of data security can be found on the Internet as part of browser documentation.

# 5
# Server structure

## 5.1 Basic rules

In a strict sense, a server is a program that answers a correctly formatted inquiry with the desired information. Also the computer on which the server program runs is called a server. And finally the files on the hard disk that can be accessed by a client through an enquiry is called the server contents. It is made up by the files in a special directory, the server root, and all its subdirectories. The directory tree growing from the server root must be appropriately structured in order to be easily filled by contributors, accessed by clients and maintained by the fusion team. With the server structure defined in the beginning of Linked Seas 2000 REA planning and described below, all three requirements are satisfied even with several thousand data files of various types filling several hundred megabyte of disk space.

With a link on the home page, the client of Linked Seas 2000 data fusion was informed about the concept of the unclassified server and of the combination of unclassified and restricted branches. The methods for data uploading and downloading were explained. The large amount of data held on the REA fusion server is a consequence of the rule that no data are ever deleted or replaced. The full data set is maintained for back-tracking and for post exercise analysis. The names of information replacements must therefore differ from their predecessors unless the updated files are placed into a different directory. The demanding directive of short (8 + 3 characters) file names prescribed in the ISO 9660 standard was released. The Linked Seas 2000 CD-ROMs of the data fusion centre were produced under Linux and equipped with file systems that support long file names of the Unix and Windows operation systems as well.

## 5.2 Contributions branch

Any contribution to the REA data set that is not produced by the data fusion team itself is placed into a subdirectory of the contributions directory. Preferably contributions are delivered by ftp. The contributor can only write into and create a tree structure starting at his individual contribs subdirectory. After placement, his contribution is immediately available to all clients of the server. The fusion team will take a little longer to establish hyperlinks to new contributions. The ownership (but not the content, format or name) of contributed files can be changed by the team in order to prevent the originator from modifications.

Contributions that arrive at the fusion centre through channels different from ftp are also placed into the appropriate contribs subdirectory by the fusion team, who in these cases optionally can alter the name (but not the content or format) of original files. Contributions can be anything from simple ASCII text files and graphics up to complex interlinked products that, like the SPOT satellite image derivation and the MCM survey results on Roebuck, do not require further processing.

Usually a REA support organization is considered one contributor. But also different teams of the same organization or even single persons can act as separate contributors if they are responsible for certain data sets. The latter rule is quite flexible. Only accidentally satellite imagery and sea bottom assessment are combined in the same contribs subdirectory while ocean modeling is separate.

When a link points to a directory rather than a file, the web server transmits the index file in the directory if one exists, otherwise it sends the directory list. In order to provide clients with directory lists and unrestricted access to all files in the contributions tree, the contribs directory and all its subdirectories should not contain a file named index.html or index.htm.

### *5.3 Changes branch*

Whenever a contribution needs to be reformatted or modified, the corrections made by the fusion team do not affect the submitted contribution. A new file is created instead and inserted in the changes branch, a structure parallel to the contribs branch with subdirectories and often even files having the same names as in the contribs origin. Also the changes directory should be fully accessible via directory lists and therefore not contain index files. Another rule of the contribs branch is valid also for the changes branch: Once a file is placed into a changes directory, it must not be moved, renamed or altered.

Data fusion results, presumably multi-file products, that are developed by the fusion team from contributions, also find their place in the changes branch in a subdirectory related to the original data originator.

### *5.4 Opinfo, tools and more*

Contribs and changes are the only branches, the tables of contents of which are directly offered to clients by the web server program. The full tree starting from the server root becomes visible when the hardcopy on CD-ROM is browsed. It is convenient and saves loading time on the client side if icons and pictograms for multiple use are held in common directories that are shared by web page developers. There are also directories for server administration and software tools, some of which are for use at the fusion centre, others also for clients. Who wants to modify existing or create new products, can find helpful software (eg. as Matlab scripts) in contribs and changes subdirectories.

Information about the REA exercise and fusion centre operation offered from the server's home page does not fit into one of the above categories and fills a directory on its own.

### *5.5 Links*

While the described directory structure meets best the requirements for REA data storage by contributors and the fusion team, a user left alone with the tree structure of directories would not know where to find a desired piece of information. An inventory is required with an appropriate hierarchical structure which guides to the specific topic. Ambiguity should be avoided so that clients can be assured to find information in the expected place in the inventory. The user must also be assured that the information does not exist if it cannot be easily found. Out of the manifold[1] of possible hierarchies the one was chosen [4], which on its highest level splits into the locations or stories the environmental variable of concern.

- Atmosphere
- Beach and surf zone
- Sea surface
- Water column
- Sea Bottom

The inventory pages are entered from the environment column in the centre of the home page. They contain the links to data and products, sometimes accompanied by comments or short descriptions. Even at his first visit, a user will safely and quickly navigate through the linked pages.

In total, the links tree has only few hundred kilobyte. Its maintenance by the fusion team is nevertheless the most demanding part of data fusion. Pages can change several times per day while cross-links are required not to break.

---

[1] Alternative hierarchies and their respective top levels are

Data provider (REA support centre, ship names)
Customer (CINC, ASW, MCM, AW)
Measurement platform (satellites, aircraft, ships, coastal stations, archives, models)
Physical unit (temperature, pressure, velocity, density, light attenuation etc)

### 5.6 Dual tree

During Linked Seas 2000, the fusion centre was for the first time challenged by the requirement of two parallel web servers. The contents of the Internet server augmented by an expectedly small amount of classified contributions was distributed in addition via NIDTS. According to the concept [14] developed one year in advance, the complete tree starting from the server root was copied from the unclassified server to the unclassified branch of the classified server. A restricted branch was added, again with contributions, changes, links and opinfo sub-branches. The REA data files on NIDTS and on the classified CD-ROM [12] are consequently one level higher up from the server root than on the Internet and on the unclassified CD-ROM [11]. Since all hyperlinks are written as relative addresses, the distance to the server root does not matter.

It would be inconvenient for the client, if he had to visit the unclassified and the restricted branches on NIDTS separately. Therefore the access on NIDTS is common for both branches. The home page which looks almost the same as the unclassified home page, links into the unclassified branch when no restricted information exists under the respective topic, eg. sea surface. If however at any level a link points to restricted information, the whole logical hierarchy up to the home page resides in the restricted branch even though it does not contain restricted information by itself. These web pages in the restricted branch are marked NATO UNCLASSIFIED. Whenever their counterpart in the unclassified branch is modified by the fusion team, they must be edited as well.

# 6
# Maintenance of server contents

## 6.1 Web master duties

Every member of the fusion team may technically have the access rights for file posting and modification. Continuous communication within the team and prudent discipline is required to avoid damage to the information by simultaneous or controversial operations in the same area of the web site. The early definition of the server structure and contents does not exclude new decisions to be taken almost every day during the REA exercise. An authority acting as web master must be informed and asked for consent prior to deviations from standard routine. The web master must monitor all arrivals in the contributions directory, check the fusion results produced by the team and take control over the html-pages providing logically consistent access.

The web master need not be the most skillful information technology specialist in his team. He must however understand web technology sufficiently well that he can find solutions to a problem, can follow discussions with his experts and is able to take knowledge based pragmatic decisions. For the web master, a good understanding of the subject matter presented on the server and its value for naval operations is more important than his computer skills. He decides, if necessary after discussions with the REA officer, which contributions should be transformed into products and suggests how it is done. In order to present a consistent REA web site, it is necessary that the web master overlooks the whole cluster of files on the server. The transfer of partial responsibility for single branches to team members does not release him from overall responsibility.

During Linked Seas 2000, a work list was maintained with items that had not been automatically or immediately assigned to a person. Team members who had finished their current duty were able to pick from that list.

## 6.2 Editing web pages

During product development no preliminary or untested html-pages and images must be present on the server. Every new file must be tested outside the server access tree or, better, on a different computer. If for a successful test other files residing on the server are required, the developer should copy parts of the web site to his own work space. When the files are finally transferred to the web server, ftp is the most recommended

method because it automatically assigns the actual date and time to the files. Otherwise it must be guaranteed by other means that date and time are changed to the present.

Because of the inherent danger to screw things up, html-pages that belong to the logical access tree should never be edited inside the server and modified on the fly. They must be copied to the own workspace and ftp'd back when ready. As another safety mechanism, date and time of the last change are written on the bottom of the modified page. The developer must check that the newest version is in his workspace before he starts editing.

### *6.3 Transfer between computers*

With the necessary precautions, the maintenance of a second server that displays classified material in addition, is not too demanding. As a principle, all unclassified contributions, through whatever channel they arrive, are included on the unclassified web. After a certain time, if necessary several times per day, an incremental backup is produced. An incremental backup is a compressed archive of all files that have a time stamp later than the last backup. It is brought to the classified server and unpacked into the existing structure, which automatically updates the unclassified branch.

The operator is now obliged to scan through the links branch of the classified tree, check for pages whose unclassified counterparts have been modified between the last backups and make the appropriate changes on the page in the classified branch.

Apart from that, work on the classified branch can be performed independently and at any time. During Linked Seas 2000, classified data fusion was not demanding. Actually, the fusion centre would not have had the tools and manpower for major developments in the classified computer area.

# 7
# Search engines

## 7.1 Latest files

Many clients of data fusion waiting for information on the server need a simple tool to find out whether something new arrived and where it is. The highest need is with the fusion team itself and primarily the web master. For them it would be unacceptable to continuously scan all directories in order to find the most recent arrivals among the contributions, latest changes, new products and updated html-pages. A cgi-script which can be invoked from the "data access" link on the unclassified home page, generates a list of the "latest files" on the Internet server. The script sorts all files on the server according to their creation date and time, which is identical with the time of file arrival at the server, and sends a list of the 100 newest files. The next 100 in sequence etc can be subsequently requested.

The cgi-script was written for the fusion server on the Internet that runs under Linux. It does not run with a web server under a different operating system and it cannot be activated by a browser that directly reads files, eg. from CD-ROM. In order to preserve the feature for clients of the classified fusion server on NIDTS, which during Linked Seas 2000 was implemented under Windows NT, the script was modified for use prior to incremental backup (see section 6.3). The modified script creates the same sorted list as the cgi-script and writes it, divided into pages of 100 file entries each, on disk into a special directory. The link to the "latest files" on the "data access" page of the classified server and the CD-ROM does not call a script at all, but displays the first page of the stored list. The list contains, of course, only files of the unclassified branch.

## 7.2 GIS search

Geographical information systems (GIS), besides their capability for scalable layered maps, typically have an option for data search with user adjustable selection criteria, the most important of which are data type, location boundaries and time window. By a number of reasons, no GIS was implemented at the fusion centre. With the large number of data files on the fusion server, however, a GIS type search engine is desirable for customers who are interested in more than the gross overall picture. It enables them to find a photograph of a beach section or a single measured CTD profile.

Long file names do sometimes contain some, but never all, values of the selection criteria for the search engine. It is also not possible to have them coded in a consistent manner in

all file headers. A special data base of meta-data is therefore required for search engine operation, which must be continuously maintained by the data fusion team. Header or descriptor files accompanying every data file were requested from data originators already in Rapid Response 97 and 98 to alleviate meta-data base maintenance.

In Rapid Response 97 and 98, the GIS search engine was implemented as a script running at the server with the advantage of immediate usability by clients and the shortfall of missing off-line capability. The disadvantage was partly overcome by a DOS-program with the same search engine functionality and distributed on the CD-ROM [10].

A different approach was used for Linked Seas 2000. The search engine is supplied as a plug-in to the browser, and the search on the meta-data base or part of it is carried out on the client side. Consequently there is no difference between a search from the server and one from CD-ROM. Plug-ins are freely available for all common computer platforms. The drawback of this solution is the necessity of a slightly complicated installation of the plug-in to the client's browser.

The GIS search engine has become operational quite late during Linked Seas 2000 after a large number of files to be referenced had piled up already. The meta-data base might therefore have some shortfalls. The same engine as on the Internet was offered on NIDTS for a few days before it was removed because computer security would not allow to put any piece of executable code on NIDTS. As solution to this problem, clients can load the plug-in from the Internet and ask their computer department for installation on their NIDTS computer.

# 8
# Page development

## 8.1 Simplicity

Developers of web pages should remember the concept of the hyper-text markup language (html). Somehow it is the opposite of a page description language; html-pages are displayed according to the capacity of the browser program, computer hardware and client options (such as window size). The actual position of line breaks is not predictable by the page developer. Standard fonts, headers, emphasized text etc. can appear differently on different platforms. There is a tendency in modern web page design to use frames and tables to force pages into the corset of identical screens on all platforms. This tendency has created a challenge to computer memory and speed and to clients who are patiently waiting during multiple file transfer until the browser has sufficient information to start displaying. Under REA conditions, fancy but demanding web pages are discouraged.

When the fusion team develops html-pages for the REA server, it must take into consideration that many clients might have aged low performance computers. In order to educate a developer of a web page, he can be asked to download his product via a 1440 bps modem to a computer with not more than 600 by 800 pixels on its screen and to make a print-out. This exercise will convince him to restrict the page format, to limit the size of images and to avoid complex tables that must be completely transmitted before the browser starts displaying. He will retype rather than display as an image, text that was scanned or saved from screen. If in special cases such as satellite imagery, the transmission of large files cannot be circumvented, the large file should not be included in the introduction page but offered separately.

The suitability of a graphic layout depends on whether it is intended for an oral presentation, a web page, a printed document or a large map on paper. The character size of annotations can be small without hampering readability on paper. If the same drawings are used for digital display, either the small characters become unreadable or the image becomes so large that only a portion is visible on the computer screen. Occasionally it is advised that a contribution designed by the originator as a paper product must be redrawn by the fusion centre. If the concept of a complex product implies a printed map, its digital version is of limited value.

The principle of simplicity should also be observed with directory and file names. Even though after Rapid Response, compatibility with ISO 9660, DOS and Windows 3.1 was released so that names longer than 8 + 3 (name and name extension) characters are now conceded in accordance with 32-bit Windows (95, 98, NT) and Unix, short and

suggestive names should be used to ease readability of paths. Names should not contain spaces and should not start with special characters, otherwise they could cause unexpected results on a computer with a different operating system. Case sensitivity of Unix is a particular challenge for page developers working under Windows. If names in hyperlinks are not consistent with the paths of the file system, the information is not delivered by a Unix web server and not displayed from CD-ROM on a Unix machine.

### *8.2 Page development tools*

Rich tools for html-page generation are often counterproductive. Some of them generate unwanted directories and files. It is even not excluded that they create hyperlinks which are later identified as invalid by a link checking tool. In more severe cases complex tools prevent page developers from desired constructions, which without application of these tools would have been easily accomplished (sitrep of day 5, para 3). Html-pages can directly be saved from office tools such as document writers, spread-sheet calculators and presentation graphics managers. In single cases web page generation is thus nicely alleviated. Automatically generated html-files often contain such an amount of redundant code that subsequent editing is impeded. Office software is therefore not recommended as primary tool.

A simple ASCII text editor is sufficient for html-page editing and has actually been used for most pages generated by the fusion centre. Useful alternatives are special html-editors, which display html tags in a different colour, assist in tag generation and might even check the syntax. An HTML-Kit is included on the Linked Seas 2000 CD-ROM. It was found on a visit to the home page of the World Wide Web Consortium [15], the portal to information about all aspects of web page generation.

### *8.3 Vector graphics*

A slant line displayed on a computer screen or printed by a matrix printer consists of dots aligned in a staircase. If an image file stores the dots, a zoom on the line magnifies the steps of the staircase. If however start and endpoints are stored and the line representation as dots is generated on the fly, a zoom creates a magnified line with again the smallest possible stairs of the displaying medium. This is particularly important for optimal results on printer, where the point density is much higher than on screen.

A standard for scalable vector-graphics on web pages [15], that would be supported by common browsers, is still missing, but there are viewer applets and plug-ins available on the Internet for free downloading, which display vector images in html-pages or expose as entire pages files of vector graphics code. Portable document files (pdf) have become a standard for pages with a fixed layout and multi-page documents. A fusion centre can feel free to distribute pdf-files, because the client will have the Adobe Acrobat Reader already in place or can be presumed to download and install it.

### 8.4 Compressed bitmaps

Images on the computer screen consist of coloured pixels. Three merged colours, each with 256 intensity levels are sufficient to create virtually any colour. The storage space in bytes for a true colour bit map such as Windows bmp-files is three times the number of raster points. Digital cameras produce more than a million pixels, a challenge for storage space and transmission bandwidth in networks.

Approaches for the reduction of image file size are

- reduction of the number of different colours
- reduction of the image dimensions on the screen (number of pixels)
- lossless compression
- filter (lossy compression)

Even a colourful image does usually not contain more than a couple of hundred distinguishable colours. The image file can contain a table (palette) with up to $2^8 = 256$ actually used colours out of possible $2^{24}$ . An 8-bit index into the palette is then stored in the bitmap rather than the 24-bit colour. Computer generated graphics sometimes consist of only 16 colours or are purely black and white, so that smaller colour tables and 4 and 1-bit indices are sufficient.

REA product developers must resist the temptation to create large decorative figures, but use the smallest possible size to expose the information. If the information is already rasterized such as satellite images and model output, a magnified image contains no more information than one with raster points matching image pixels.A small figure also eases proper incorporation into the context. Whenever possible, a raster image should be produced in the finally intended size. Changing the raster of an image unavoidably and irreversibly deteriorates its content. Symbols that have become indecipherable cannot be repaired by other means than by pasting intact symbols on top.

Compression algorithms like those known from zip and gz files are able to shrink number sequences if the numbers are not random. When compression is applied on simple line graphics and images with homogeneously coloured shapes, they are deflated to a small percentage of their original bitmap (bmp) size. The new Internet standard for compressed bitmaps is the portable network graphic (png). It is appropriate for lossless compression of true colour and colour map graphics. Browsers of the fourth generation display png-files when they are included in html-pages (the crest on the unclassified home page of Linked Seas 2000). When the daily tidal curves were put on the web, the fusion team unfortunately was not aware that the Internet Explorer even in version 5.0 does not display bare png-files. Otherwise the graphic files would have been encapsulated in small html-files.

The still most-used standard for lossless compressed images on the Internet is the graphics interchange format (gif) owned by the provider Compuserve. It always uses a

palette and indices of 1 to 8 bit length. Compression efficiency is hardly lower than with portable network graphics (png).

While png and gif achieve excellent compression results on graphics with large homogeneous portions, they are not very efficient with photographs, which usually do not contain repetitions of pixels with exactly the same colour. Colours might instead gradually change. The present standard (jpeg) for the compression of photographs applies spatial Fourier transforms on the three colour components. When all Fourier amplitudes are preserved, the transformation can be reversed without degradation. File size is decreased as soon as "unimportant" Fourier components are suppressed. The compression rate is controlled by threshold for omitted components. Before it is set too high, decreasing the image dimensions should be considered as a better alternative.

Jpeg compression was developed for photographs only. The suppression of higher order Fourier components creates artefacts (overshooting oscillations) at sharp edges, therefore it is inappropriate and must not be used for line graphics and computer generated shapes. Once a graphic has been corrupted by conversion to jpeg (jpg), conversion back to a lossless format cannot repair the damage.

### *8.5 Text file formats*

Variable width fonts are standard on html-pages. Since there can be site dependent differences between actual font sizes, table tags are recommended for the creation of aligned columns instead of less expensive tab-characters. In many cases it is however much simpler to use fixed width characters which automatically are vertically aligned. A hyperlink may point to a simple ASCII text file, which according to browser settings would either be handed over to a separate viewer or displayed by the browser itself. Another option is to include teletype (`<tt>`) or preformatted (`<pre>`) tags in the html code. All characters between the tags including white spaces are displayed as typed with a fixed width font.

Text that must be displayed and printed exactly the same as drafted, independent from the computer platform, should be converted into a portable document file (pdf). This format can be read and printed under any common operating system. Office documents, on the contrary, such as MS-word files do not meet Internet standards. They require special hardware (PC), operating system (Windows) and software package. Office documents can be simply converted to pdf.

# 9
# Manpower and skills

During Linked Seas 2000, the data fusion centre was run by 6 persons, all of whom had a sound knowledge of computing and many years of experience in data handling for military oceanography. The fusion team was busy far beyond regular working hours. With a larger team it would have been possible to complete more items of the work list and to deliver some products earlier. A smaller team would be acceptable if part of the time consuming products offered by the fusion centre are declared irrelevant or redundant. The complication of a second web server maintained on the classified network absorbed one third of team power.

The REA Survey Director supervises the data fusion team. If he can spend at least three or four hours every day working with the team and on server content, he should retain the duty of the web master as defined in section 6.1 for himself. His work begins well in advance of the REA survey with the sighting of archival information and decisions of what and how it is presented.

Also far in advance, a specialist on operation systems, software tools, networking and system programming must be permanently assigned to get the server running, all tools for data fusion in place and the ambitions of the Survey Director and web master taken care of. He keeps the list of authorized users updated and facilitates connections from outside. During the REA trial he takes care of technical and software problems, he monitors the accesses to the server and produces connection statistics. He gives advice to team members and participates in data fusion. During the REA trial a second person with the same capability should be in the team.

Team members should be familiar with the environmental requirements of naval operations. They should have an appropriate education in environmental sciences to understand the value and disposition of submitted data and products, to rate their correctness and completeness and, if necessary, to interact with originators and assessment specialists. Team members must have a very good background in information technology. They must be able to write programs that convert raw data into a required format, use visualizing tools such as Matlab and GMT, know how to produce and modify graphics and have some experience in editing html-code. Since it is impossible to predefine all products, flexibility and high motivation are compulsory.

# 10

# Suggested changes to the REA concept of operations

In this section, it is suggested to recombine the REA fusion centre and the REA command centre into a single REA command cell. It is believed that synergy can save almost half of the manpower and improve the quality of service to the operational customer. The following considerations induced this conclusion.

## *10.1 Requirements for REA product distribution*

The full REA data set of Linked Seas 2000 hardly fits on a CD-ROM. The amount of several hundred megabyte of data is two orders of magnitude higher than what would be downloaded through a network by a warfighter. In the present organization structure which meets the concept of REA operations [13], the REA command centre is responsible for REA product distribution. The staff selects from the web site of the fusion centre, perhaps makes some modifications, merges with standard MetOc products and puts everything into a proper context. Main requirements for the offer to the naval customers are

- Focus separately on ASW, MCM and AW
- Fast and safe navigation to wanted material
- No redundancies
- Only significant information

While the first three requirements can be accomplished by careful web design and maintenance, the decision on what is significant requires in-depth understanding of environmental and operational issues. There are several aspects on significance.

1. An environmental parameter might not be of interest at all.
   *Example*: Ocean currents, if not excessive, do not directly impact ASW.

2. A parameter might be in a range that is of no interest.
   *Example*: Tides do not affect operations in almost the entire Mediterranean Sea.

3. In scene assessment might be preferable.
   *Example*: For the calculation of sonar performance, ambient noise measured through the ship's own sonar system is superior to predicted noise.

4. Error bounds might be extremely wide.
   *Example*: Layer depth in spring is critically dependent on not well predictable conditions.

It is a waste of transmission bandwidth if maps and other graphic products are offered instead of a few words with the same information. However, different customers will have different opinions. If one is happy with a weather forecast like this: "NE 4, decreasing 3, visibility good.", another may want to see a weather map (or even several from different stations) and make his own assessment for the risk of wind force 5 that would obstruct the completion of a delicate task.

The optimal degree of complexity of environmental advice depends on a diversity of circumstances. One of it is the capability of the customer to make use of extended and background information. A commanding officer on a small unit does not have the time for extensive investigations, while on a larger command ship there will be trained support staff who is able to collect all available information and, according to the actual operative situation, can extract the best possible advice. An example of this favorable situation was the deployment of a forecaster with a complete REA CD-ROM [10] in his luggage to the MCM commander after Rapid Response 98.

The web site maintained by the REA command centre should serve both customers and provide concise messages in the first place for those in a hurry, and more and more details, background information and references as clients follow the respective links. With this concept the total amount of data on the product distribution server can easily come close to that on the data fusion server.

### *10.2 Relation to standard oceanographic products*

The military oceanographic data centre (MOIC), which functions as the REA command centre at the same time, routinely provides meteorology and oceanography (MetOc) support. For their tactical oceanographic summary it uses the best currently available information, which can be, in absence of actual measurements, just climatology. The daily composite sea surface temperature map, for example, can under favorable conditions be extracted from an actual thermal satellite image. After a long cloudy period, it will only contain estimates and some ship observations. The user is not informed about the density and sources of confirmed data. He is usually not able to assess the reliability of the product.

In the case of an existing REA component to an exercise, the best available data for many environmental parameters are provided by REA. Undoubtedly they should be used for the preparation of the standard MetOc support. A clear separation between routine MetOc support and REA is therefore neither possible nor advised. The naval customer will probably be most accustomed to the simple products of routine MetOc support. It

might be advantageous if compact standard products come up first on the computer screen as the principal and simplest layer with links to the more complex information.

### *10.3 Web site layout and directory structure*

The incorporation of standard MetOc forecast and the special entries for different warfare disciplines require a layout of the product distribution web site different from the data fusion site. In contrast to the policy for data fusion, it is not prohibited to replace a piece of information on the product server by a new version of the same kind. This can be done by overwriting the old file or by adjusting the link to the position of the new file, while the obsolete information still remains in its place. The second option is preferable, because it leaves an archive on the server, which can be valuable for post-exercise analysis. Sometimes the older files may even be offered together with their updates to naval customers.

If agreement between the data fusion and REA command centres was achieved in advance about a complex product, the product can be displayed as it is. It may consist of several files located in different directories and interlinked by relative web addresses. After transfer to the command centre the links will remain valid, only if file names and the directory tree of the data fusion server are exactly the same on the distribution server. It does not matter whether on the distribution server the data fusion tree is implemented as a sub-branch or parallel to the information originated by the command centre. On the Linked Seas 2000 CD [12], reverse engineering of parallel branches was applied. Unmodified products were not copied to the CSL branch, but appropriate links to the NR and NU branches established.

If the data fusion centre and the command centre are collocated, their web sites can share one server. Otherwise the REA command centre should take advantage of the incremental backup procedure (see section 6.3) at the data fusion centre to update their copy of the data fusion directory tree.

### *10.4 Responsibilities*

The head of the military oceanographic information centre (MOIC) is responsible for standard oceanographic support, while the REA commander has the responsibility for REA product distribution. Since according to the REA conops [13], both positions are combined in one person, the amalgamation of standard MetOc with REA products does not establish organizational interference. This person would however be overloaded if he takes responsibility as a web master in analogy to the data fusion web master as defined in 6.1. Even the compulsion to know every item on the data fusion and product distribution servers would be too demanding. Therefore the REA commander should be left with overall supervisory responsibility only.

A web master with the same profile as for data fusion is required at the REA command centre. He discusses with the REA commander how products are merged and presented. He directs the team of product page developers. He is aware of all existing REA data and products, passes results to producers of standard MetOc support, advises the web team on products to be shown and informs the REA commander about what is missing. The ideal person for this duty is the REA director.

### *10.5 Synergy effects*

The discussion above demonstrates that the REA command centre and the data fusion centre have almost identical requirements for

- a supervisor of a specialists team (REA director), preferably also acting as
- a webmaster who controls fusion and keeps track of every REA contribution,
- a systems programmer and network specialist,
- an information technology team, knowledgeable also of military oceanography.

From what was discussed before, it is obvious that the REA director and webmaster can comply with the requirements of both REA servers with little (~20 %) more effort. The additional workload on the fusion team by merged standard MetOc products and by a second set of portals to REA products is easily compensated by the fact, that no product needs to be developed without prior confirmation of its subsequent utilization on the REA product distribution web site.

In conclusion it is suggested to merge the REA data centre and the REA command centre.

# Acknowledgements

Data fusion for Linked Seas 2000 REA took place at the SACLANT Undersea Research Centre in La Spezia, Italy. A data fusion team had gathered consisting of Eric Lepicier (Service Hydrographique et Océanographique de la Marine), Alex Trangeled (SACLANT Undersea Research Centre), Thomas Gunkel, Detlef Kittler (Marineamt, Spezialstabsabteilung Geophysik) and Frederik H. Vink (Koninklijk Instituut voor de Marine). They did excellent work in tool development, server maintenance and product generation. The ocean modeling team of Reiner Onken (SACLANT Undersea Research Centre), Joao Vitorino, Catarina Costa Clemente (Instituto Hidrográfico) and Patrick Haley (Harvard University) took also responsibility for quality control and format conversion of hydrographic data received from the survey ships. The MCM bottom assessment team of Tuncay Akal, Anthony Lyons, Andrea Cavanna, Roberto Lombardi and Alberto Figoli (SACLANT Undersea Research Centre) came back from cruise with a complete final product for the web, thus reducing demands for the fusion team. Out of the many contributors to the Linked Seas 2000 data set, the Portuguese Hydrographic Institute deserves particular appreciation for the outstanding environmental characterization put together one year in advance by Catarina Costa Clemente. At SACLANTCEN, the Information Technology Office was very cooperative with the provision of good working conditions for the fusion team. The data communications system to and between the survey ships was set up by Alex Trangeled, Alessandro Berni (SACLANT Undersea Research Centre), Frederik H. Vink (Koninklijk Instituut voor de Marine).and Eric Lepicier (Service Hydrographique et Océanographique de la Marine). In the important position of the Coordinator with the NATO MILOC group (Military Coordinator before 1998) Dieter Schaa was a reliable and relieving deputy of the REA Director.

# References

[1] Pouliquen, E., Kirwan, A.D., Pearson, R.T., *editors*, Rapid Environmental Assessment, Proceedings of a conference held in Lerici, Italy, 10-14 March 1997, SACLANTCEN CP-44, 290 pp, ISBN 88-900 194-0-9.

[2] Oceanology International, Brighton, UK, Conference Proceedings, 1998, Vol 2, 382 pp, ISBN 0 900254 21 1.

[3] Forum Acusticum, Berlin, 1999, Acustica, **85**, 1999:Suppl. 1 and *Journal of the Acoustical Society of America*, **105**, 1999:1040.

[4] Sellschopp, J. Experience gained and lessons learned in three years of Rapid Response, UDT London, Conference Proceedings, 1998: pp.69-73.

[5] Trangeled, A., Franchi, P., Berni, A., *Data communication and data fusion architectures for Rapid Response 96-98*, SACLANTCEN SR-296, 1999

[6] Sellschopp, J. *Rapid Environmental Assessment for naval operations*, Naval Forces, **20**, 3, 110-115 and SACLANTCEN SR-328, 1999.

[7] Robinson, A.R., Sellschopp, J. *Rapid assessment of the coastal ocean environment. In*: Pinardi, N., Woods, J.D. *editors*, Ocean Forecasting: Conceptual Basis and Applications (in press).

[8] Sellschopp, J., Trangeled, A., Zahorodny, M. *Rapid Response 96 & 97, MILOC Surveys for Rapid Environmental Assessment*, SACLANTCEN CD-19,1998.

[9] Sellschopp, J. (editor), Rapid Response 98 fused data and contributions as of 20 February 1998, SACLANTCEN CD-1,1998.

[10] Sellschopp, J. (editor), MILOC Survey Rapid Response 98 Data and Products, SACLANTCEN CD-2,1998..

[11] Sellschopp, J., Lepicier, E., Trangeled, A., Gunkel, Th., Kittler, D., Vink, F. *Linked Seas 2000 data fusion web site*, SACLANTCEN CD-39,2000..

[12] J. Sellschopp, E. Lepicier, A. Trangeled, Th. Gunkel., D. Kittler, F. Vink, *Linked Seas 2000, the complete REA data set*, SACLANTCEN CD-40,2000. NATO RESTRICTED.

[13] Chief of Staff, Supreme Headquarters Allied Powers Europe, Chief of Staff, Headquarters Supreme Allied Commander Atlantic, Maritime rapid environmental assessment (REA) concept of operations (CONOPS), MCM-051-00, March 2000, NATO UNCLASSIFIED.

[14] Sellschopp, J. 1999. Operational data fusion for REA support in the naval exercise Linked Seas, personal communication.

[15] World Wide Web Consortium, home page on the Internet http://www.w3.org/.

# Annex
# Questions and recommendations

*Would REA data fusion on NIDTS make the Internet server redundant?*

No.

1. Two-way communication with the data fusion site is essential. REA support centres (with the exception of NEMOC and SACLANTCEN) are not connected to NIDTS.
2. Working conditions at the fusion centre might be unsatisfactory in the classified computer area.
3. Experimenting with new ideas is less constrained on the Internet, which by its very nature is conducive to innovation
4. NIDTS is not as reliable as the Internet.

*Can restricted information be transmitted through the Internet if encryption is used?*

Home banking and e-commerce employ software for secure data transmission which virtually excludes access by unauthorized persons. The transmission of NATO owned information depends on NATO policy, which prohibits restricted data on the Internet. NATO policy prescribes hardware encryptors which cannot be bypassed by mistake. Current plans are for separately encrypted branches of the NIDTS for restricted and secret information.

*What is wrong with spreadsheets and office documents?*

Internet technology is conceptually independent from the computer platform. Office software is not and compatibility is therefore limited.

Recommendation: Use ASCII stored as *.txt files for simple text and tables.

*Why are data formats not predefined in all cases?*

There are recommended formats for certain data types such as CTD profiles. Some institutions deliver their contributions in predefined formats, others are constrained by their acquisition systems and do not have a programmer to write appropriate conversion software. The fusion team prefers to process raw data in the original acquisition format rather than the results of less than successful attempts to meet the specifications. The delivery of so called header files should be mandatory to allow automatic creation of a meta-database. Recommendation: deliver header files.

*Why are old data not removed or overwritten?*

Exercises are documented and subsequently analyzed in order to evaluate and learn from real-time assessment. The environment is part of the scenario and should not be excluded from post exercise analysis.

Recommendation: archive data for future use.

*How can degradation of image quality by resizing be avoided?*

This is one of the main problems of data fusion. Large bitmaps cannot be reduced without degradation. The image processing software tool will either omit single rows and columns thus randomly eliminating thin vertical and horizontal lines, or it will average adjacent pixels, so that thin black lines on a white background become grey. As the number of colours is increased by the latter method, a smaller image does not necessarily imply a smaller image file.

Recommendation: Produce bitmap graphics in final dimensions.

*Is it mandatory that every client uses the same software?*

No. The data fusion concept is an open configuration for different platforms and application programs. The Internet requires standard tools, which are part of the operating system or freely available for all platforms. Apart from the Internet browser, Linked Seas 2000 data fusion clients should install Acrobat Reader or an equivalent viewer for portable document files (pdf). If the client intends to run the GIS search engine, the installation of a plug-in is necessary. The fusion centre did offer some Matlab files, but only in addition to other formats for the convenience of clients with Matlab.

*Are two different centres required for data fusion and product compilation and dissemination?*

There are good reasons for different home pages as portals to the REA data set. REA customers and participants have different requirements reflected by a different preselection and guidance through contributions and products.

Recommendation: Collocate data fusion and distribution in the same building and even on the same computer to save manpower and to improve product quality.

# Document Data Sheet

| Security Classification | | Project No. |
|---|---|---|
| UNCLASSIFIED | | 01-A |
| **Document Serial No.** | **Date of Issue** | **Total Pages** |
| SR-336 | September 2000 | 34 pp. |

**Author(s)**

Sellschopp. J.

**Title**

Fusion centre operations for maritime rapid environmental assessment

**Abstract**

A capability for data fusion in rapid environmental assessment (REA) operations has been developed and practiced. The concept and the steps for its realization are described in enough detail to be used as a guide to similar exercises in the future. Examples are taken from Linked Seas 2000 data fusion, the most recent, most advanced and most complex data fusion activity for military oceanography. All functions of a data fusion centre are described, from data collection over data base organization, administration, maintenance, conversion, visualization and search to placement on one or more networks. Platform independent Internet technology is used with standard software for servers and clients. An html-version of this report is included on the SACLANTCEN CD-40 with active links to the respective examples.

**Keywords**

military oceanography - rapid environmental assessment - data fusion - Internet

**Issuing Organization**

North Atlantic Treaty Organization
SACLANT Undersea Research Centre
Viale San Bartolomeo 400, 19138 La Spezia, Italy

*[From N. America: SACLANTCEN (New York) APO AE 09613]*

Tel: +39 0187 527 361
Fax:+39 0187 527 700

E-mail: library@saclantc.nato.int