NATO NAVAL COMBAT SYSTEM INFORMATION CATALOGUE VOLUME 0 INTRODUCTION

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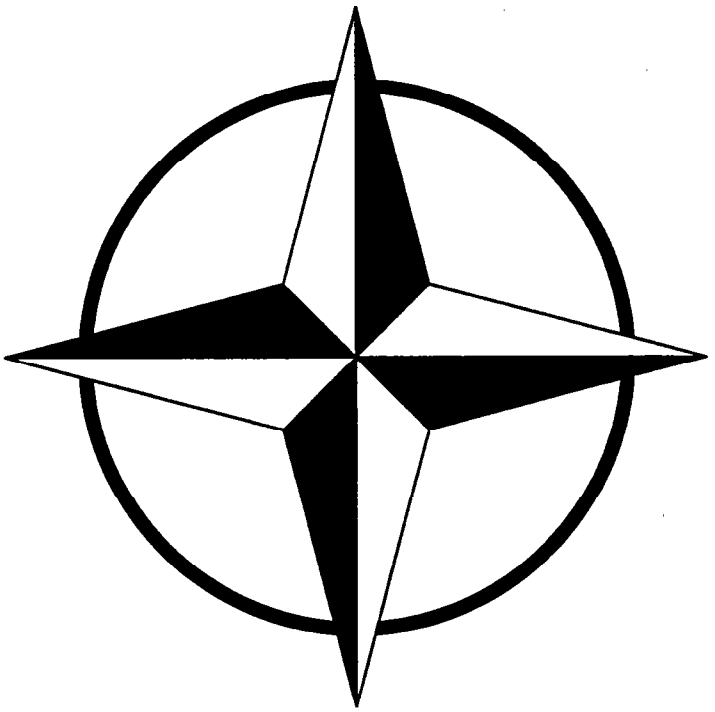

April 1998

NATO INDUSTRIAL ADVISORY GROUP

NIAG/SG-52

NAVAL COMBAT SYSTEM (NCS) ARCHITECTURE
DESIGN PRINCIPLES STANDARDIZATION

ANEP-51
Volume 0
Edition 2

NORTH ATLANTIC TREATY ORGANIZATION

MILITARY AGENCY FOR STANDARDIZATION (MAS)

NATO LETTER OF PROMULGATION

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1. ANEP-51, Volume 0 (Edition 2) - NATO NAVAL COMBAT SYSTEM INFORMATION CATALOGUE - INTRODUCTION - is a NATO UNCLASSIFIED publication.

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3. ANEP-51, Volume 0 (Edition 2) contains only factual information. Changes in this publication are not subject to ratification procedures and will be promulgated as necessary by AC/141(NG/5).

A. GRØNHEIM
Major General, NOAF
for Chairman MAS

ANEP-51
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Edition 2

RECORD OF CHANGES			
Change Date	Date Entered	Effective Date	By Whom Entered

Foreword

1. This Allied Naval Engineering Publication (ANEP) is for use with:

   ANEP-51, Volume 1, User's Guide

   ANEP-51, Volume 2, Generic Message Catalogue

   ANEP-51, Volume 3, Data Structure Catalogue

   ANEP-51, Volume 4, Message Construction Standard

   ANEP-51, Volume 5, Combat System Architecture and Key Performance Indicators

2. ANEP-51, Edition 1 was prepared by the NATO Industrial Advisory Group Sub-Group 52 (NIAG/SG-52) on a Shipboard Open Systems Environment. ANEP-51, Edition 2 was prepared by NIAG/SG-52 on Naval Combat System (NCS) Architecture Design Principles Standardization.

3. The tasking authority was the NATO Naval Armaments Group (NNAG), Naval Group 5 (NG/5) on Tactical Control and Data Handling.

4. It should be noted that this document is not an agreed standard, but is circulated for information and to provide guidance to those involved in Naval Combat System design and integration.

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Executive Summary

The NATO Industrial Advisory Group Sub Group 52 (NIAG/SG-52) was tasked to conduct a study of which one principal area was to compile a catalogue of operational information that is communicated between NATO Naval Combat System equipment (a Generic Message Catalogue). This study was conducted in two phases: the first phase addressed the Shipboard Open Systems Environment and the information communicated within a surface Naval Combat System via a Local Area Network; the second phase addressed Naval Combat System (NCS) Architecture Design Principles Standardization, and extended the concept of the Generic Message Catalogue to include ship-to-ship and ship-to-shore information exchange. The Information Catalogue was further developed to aid in the design and integration of shipboard systems and to include performance indicators. These studies were performed under the guidance and advice of Naval Group 5 (NG/5).

A principal effort of this study was to develop common definitions of the information processed within a Naval Combat System. The compatibility, interoperability, and successful integration of the application functions of a Combat System depends critically upon a common understanding and definition of the information passed between them.

The initial study utilised a 'bottom up' approach to effectively filter over 630 current messages from existing and on-going surface ship systems and projects down to approximately 130 generic messages, and successfully established a set of common data structures (components of messages) used by a number of messages. These generic messages and data structures were documented in the NATO Naval Combat System Generic Message Catalogue (ANEP-51, Volume 2, Edition 1), which defined the standard messages transferred between Combat System functions, and in the NATO Naval Combat System Data Structure Catalogue (ANEP-51, Volume 3, Edition 1), which defined standard data structures and data elements used within messages. In addition, the NATO Naval Combat System Message Construction Standard (ANEP-51, Volume 4, Edition 1) provided formal rules for the definition of messages and message components, and defined basic data elements, from which all messages and data structures can be developed. It was recognised that additional project specific messages will be required to meet the operational needs of some elements of the Combat System, and the Message Construction Standard provided facilities for the extension of Generic Messages or the creation of new messages by individual projects.

The second phase of the study enhanced the Generic Message Catalogue and the Data Structure Catalogue by taking a 'top down' approach, and incorporated messages appropriate to aircraft carrier, submarine, amphibious, and mine warfare operations. This was accomplished through a functional analysis of the Command System of each of these types of vessels, and resulted in a generic Combat System architectural framework common to all vessels. Existing formatted messages (typically text messages) from ACPs, together with existing Tactical Data Link messages, are incorporated by reference and are considered part of the Generic Message Catalogue with no change to their content or structure. An encapsulation technique was defined to facilitate handling of these messages in accordance with the existing protocols and procedures for these messages. In addition, a methodology was established to support the infrastructure design by assessing key performance

indicators, particularly throughput and latency. This has resulted in a Generic Message Catalogue of approximately 200 messages.

In parallel with the definition of additional generic messages and data structures, the mechanisms for the formal definition of these elements was further considered. This element of the study resulted in a significant simplification of these mechanisms by the adoption (without modification or addition) of Abstract Syntax Notation One (ASN.1). ASN.1 is formally defined in ISO 8824, and is formally adopted by NATO as STANAG 4258. ASN.1 has been used in a number of ISO standards (notably in IEEE STD 802.1E-1990, System Load Protocols, and in IEEE STD 802.5C-1991, Recommended Practice for Dual Ring Operation with Wrapback Reconfiguration). The successful use of ASN.1, already adopted as a NATO STANAG, makes the development of additional standards unnecessary. The adoption of ASN.1 enables the use of automated tools (ASN.1 translators and compilers) to ensure consistency between messages defined in the Generic Message Catalogue and data structures defined in the Data Structure Catalogue. It is also envisaged that projects using ANEP-51 will utilise similar technology to extend the Information Catalogue to meet the specific project needs.

The output of this study is ANEP-51, Edition 2, comprising this Introduction and five other volumes:

Volume 1 provides an overview of Volumes 2, 3 and 4. It describes the overall structure and the different components used to construct a message and provides the basic knowledge required to further understand the contents of the Generic Message Catalogue and the Data Structure Catalogue. Volume 1 also explains the necessary steps for the use of ANEP-51 during the definition of a Project Information Catalogue. It further develops the requirements for the evolution and maintenance of the NATO Information Catalogue and proposes a maintenance strategy which resolves the conflicts generated by the co-existence of NATO and Project Information Catalogues. It recommends use of electronic facilities for the maintenance and distribution of the NATO Information Catalogue, and suggests cost-effective mechanisms for evolving and maintaining the NATO Information Catalogue.

Volume 2 provides the results of the analysis of the data collected and analysed during this study, and provides a recommended Generic Message Catalogue for NATO Naval Combat Systems. The generic messages were based upon current known Naval Combat Systems and reflect emerging Combat System designs. The generic messages were further enhanced or modified, where necessary, by experts currently developing new Combat Systems for future warships.

Volume 3 provides the data structures and data elements required to define the Generic Messages provided in Volume 2. Data structures are sequences of data elements commonly or logically grouped together (e.g., Bearing, Elevation Angle, and Range). Data elements include numeric, enumerated, Boolean, and string variables. Both the data structures and the data elements are formally defined using the ASN.1 syntax notation. As an example of how the Information Catalogue can facilitate the use of COTS products, the data structure used to denote source and destination addresses now provides fields for Force address, System address, and Owner address. This can be considered as the last three fields of a hierarchical address, and supports the use of standard COTS protocols such as the Internet Protocol (IP) as recommended in ANEP-53.

Volume 4 provides a formal and unambiguous syntax for the definition of messages and data structures. A number of basic data elements, from which all messages and data structures can be developed, are also formally defined. This ensures that the written form of a message provides a complete and unambiguous definition of its transmitted form.

Volume 5 presents the functional analysis of shipboard command systems and the methodology to determine and assess Key Performance Indicators. It includes a generic Combat System architectural framework common to all Naval vessels

The use of standard messages and the Message Construction Standard within the shipboard Combat System will facilitate:

- improved combat function compatibility and interoperability, streamlined system integration, and transportability of functional implementations between ship projects
- simplification of combat system specification, design, and integration, without placing unacceptable constraints on individual ship projects
- a reduction in integration risk
- equipment change-out with little or no change to the rest of the system

The results of this study indicate the operational need for radical standardisation within and across Naval platforms, which will also provide a considerable cost saving and risk reduction. ANEP-51, Edition 2, demonstrates that it is feasible to generate standard generic messages.

Use of the NATO Naval Information Catalogue (ANEP-51) has the potential to reduce cost and development time by reducing integration risk while increasing the probability of meeting design requirements and improving both performance and interoperability in the NATO Naval Environment. However, interoperability within and across future Naval Combat Systems is unlikely to be achieved within the NATO Nations until the use of the NATO Information Catalogue is made mandatory.

Comments on any aspect of this ANEP are welcomed and should be forwarded to the NG/5 Secretary, NATO Headquarters, 1110 Brussels, Belgium.

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1. Introduction

1.1 General Introduction

Based on prior studies, AC/141(NG/5) has concluded that the goal of intra-ship Combat System compatibility and interoperability will be enhanced significantly by establishing standards for:

- The interface between the application functions and the supporting infrastructure of the Combat System. Application functions, whether manually or automatically performed, are dependent on the mission and operating context of the host Combat System. The functions of the infrastructure (such as computation, interconnection, and display) which are necessary to support the application functions, are generic to all Combat Systems.

- Common definitions of the information processed by the Combat System. The compatibility of the application functions of a Combat System depends critically on common understanding and definition of the information passed between them.

These standards have capitalised on recent developments in computer system technology, such as the Common Operating Environment (COE) and Open System Environment (OSE) concepts, to establish a Shipboard Open Systems Environment (SOSE) which will allow the development of application functions which are mutually compatible and independent of the Combat System infrastructure.

Use of the Shipboard Open Systems Environment for intra-ship Combat System design will offer substantial benefits:

- Improved combat function compatibility and interoperability, streamlined system integration, and transportability of function implementations between Combat Systems.

- Simplification of Combat System specification, design, and integration, without placing unacceptable constraints on individual ship projects.

- A reduction in system integration risk, substantially reducing the cost of this activity by ensuring the compatibility of information held within and transmitted across the complete Naval Combat System

The development and adoption of suitable standards and guidelines for the introduction of improved technology into NATO and National ship system projects across NATO will ensure that the full benefits of these standards will be realised.

For this reason a NATO Industrial Advisory Group Sub Group 52 (NIAG/SG-52) was tasked to conduct a set of pre-feasibility studies. The pre-feasibility studies were conducted in two phases.

The first phase addressed the Shipboard Open Systems Environment and included three major study areas:

a. The preparation and definition of a NATO catalogue of operational data that is communicated between equipment, sub-systems, and systems installed in a Naval platform. The NATO Generic Message Catalogue is defined in Volume 2 of this ANEP, and the NATO Data Structure Catalogue is defined in Volume 3.

b. The preparation of guidelines and standards for the specification of the above operational data. This drew upon the work undertaken to produce STANAG 4222 [Ref 6] and provides a formal and unambiguous definition of the standard data elements in Annex A of STANAG 4222. The rules for the definition of messages and data structures are defined in Volume 4 of this ANEP.

c. The preparation of a specification for interface standards that are applicable to the Naval shipboard combat system. The Shipboard Open Systems Environment (SOSE) interface standards describes the services (and, where applicable, the protocols) available at the interface between the application function and the generic application platform/infrastructure; i.e., the Application Program Interface (API). The focus of the standardisation effort took the advantage of commercial standards and Commercial-Off-The-Shelf (COTS) developments. Emerging technologies and standards were monitored and their impact on the SOSE interface definition assessed. The specification is contained in NATO ANEP-50.

The second phase addressed Naval Combat System Architecture (NCS) Design Principles Standardization. The principal areas of this study were:

a. Detailed definition of the SOSE services; in particular, those services that are identified as the "add-on" services in military real-time systems. Areas that required detailed definition included real-time database services and system control and management services. The study examined specific aspects of the proposed SOSE in greater depth and detail in order to enhance the standards to which future Combat Systems should adhere. As part of this study, emerging technologies that could impact future Combat System architecture were addressed. The results are documented in ANEP-53.

b. The preparation of guidelines on the consequences of the insertion of COTS products in Naval systems. and strategies for the insertion of COTS products, with emphasis on the issues of integration and life-cycle support. The guidelines and strategies for the insertion of COTS products are presented in ANEP-54.

c. The extension of the Generic Message Catalogue (GMC), and its implementation on a database for analysis of similar and proposed new messages and maintenance of the Catalogue. Further definition of the procedures and standards on the use of the GMC and the associated representative Combat System architecture applied to Combat System design and integration were developed.

d. The extension of the GMC with performance indicators (e.g., accuracy, timing, etc.).

e. A survey of design tools for Combat System architecture, simulation, and performance. The results of the design tools survey are provided in ANEP-55.

All of these study areas were addressed by a single NIAG/SG-52 team, guaranteeing maximum consistency between the different aspects of the work and the outputs produced.

This ANEP-52 (Edition 2) contains the results of the study areas related to the Generic Message Catalogue.

1.2 Objectives of the Study

The objectives of this study were:

a. To define a catalogue of information that is communicated between member equipment, generally via a Local Area Network (LAN) which is installed on a Naval Weapon Platform. The LAN is sometimes known as the Combat System Highway or Data Transmission System (DTS). In the second phase of the study, this work was expanded to exchange of information at the Force level.

b. To define data formats and construction rules providing a formal and unambiguous definition of the format of the data communicated between member equipment of a Naval Combat System. These rules are presented in Volume 4, the Message Construction Standard.

c. To develop a strategy for the evolution, growth and maintenance of the information catalogue.

d. To address primarily transfers of digital data between member equipment, but include recognition of voice and video transfer standards.

e. Produce a NATO ANEP defining the catalogue of data and the analysis undertaken.

f. To further define the procedures and standards on the use of the NATO Information Catalogue and the associated representative Combat System Architecture applied to Combat System design and integration.

g. To extend the NATO Information Catalogue with respect to performance indicators (e.g., accuracy, timing, etc.).

2. Study Approach

2.1 The Development of the Generic Message Catalogue

The first task in the development of the Generic Message Catalogue was to gain access to a number of identified NATO warship Combat System message catalogues. The Combat System data messages that were accessed included the following :

- All Data Exchange Specifications for Type 42 Frigate Combat System Highway
- All Data Exchange Specifications for Type 23 Frigate Combat System Highway
- IRST, Meteorological, Alignment, and Electronic Warfare data messages based upon those similar to the Canadian Patrol Frigate Programme

- Data messages from the French Charles de Gaulle Aircraft Carrier
- Data messages from the US (IC)2 Naval programme
- Data messages from programmes which implemented IFF and Surveillance
- Radars, CIWS, Data Link, and Above Water Data Fusion
- Interface Design Specifications for the US LHD-1

•

Information from the Vanguard class and Upholder class Tactical Weapons System was used to augment the surface ship Combat System message data so that the Generic Message Catalogue could also be used for submarines.

For reasons of national security, the full message catalogues for the Canadian Patrol Frigate (CPF), the Dutch M Frigate, Project Horizon Common New Generation Frigate (CNGF), and the Tri-lateral Frigate Consortium (TFC) could not be made available. Knowledge from these programmes was made available and was used in the development of the generic messages.

This data was then compiled into an agreed format and processed in order to analyse the messages further. Each message was assigned to one of 19 Category Groups, which are those defined in ANEP-38 [Ref 7]. During the course of this study, four additional Category Groups were defined: Operational Reports, Direct Transduced Data, On-Board Training Messages, and Video Data. Thus, Volume 2 presents 23 Category Groups. Figure 1 illustrates 21 tactical Category Groups (excluding On-Board Training and Video Data) and their relationship to significant shipboard functions

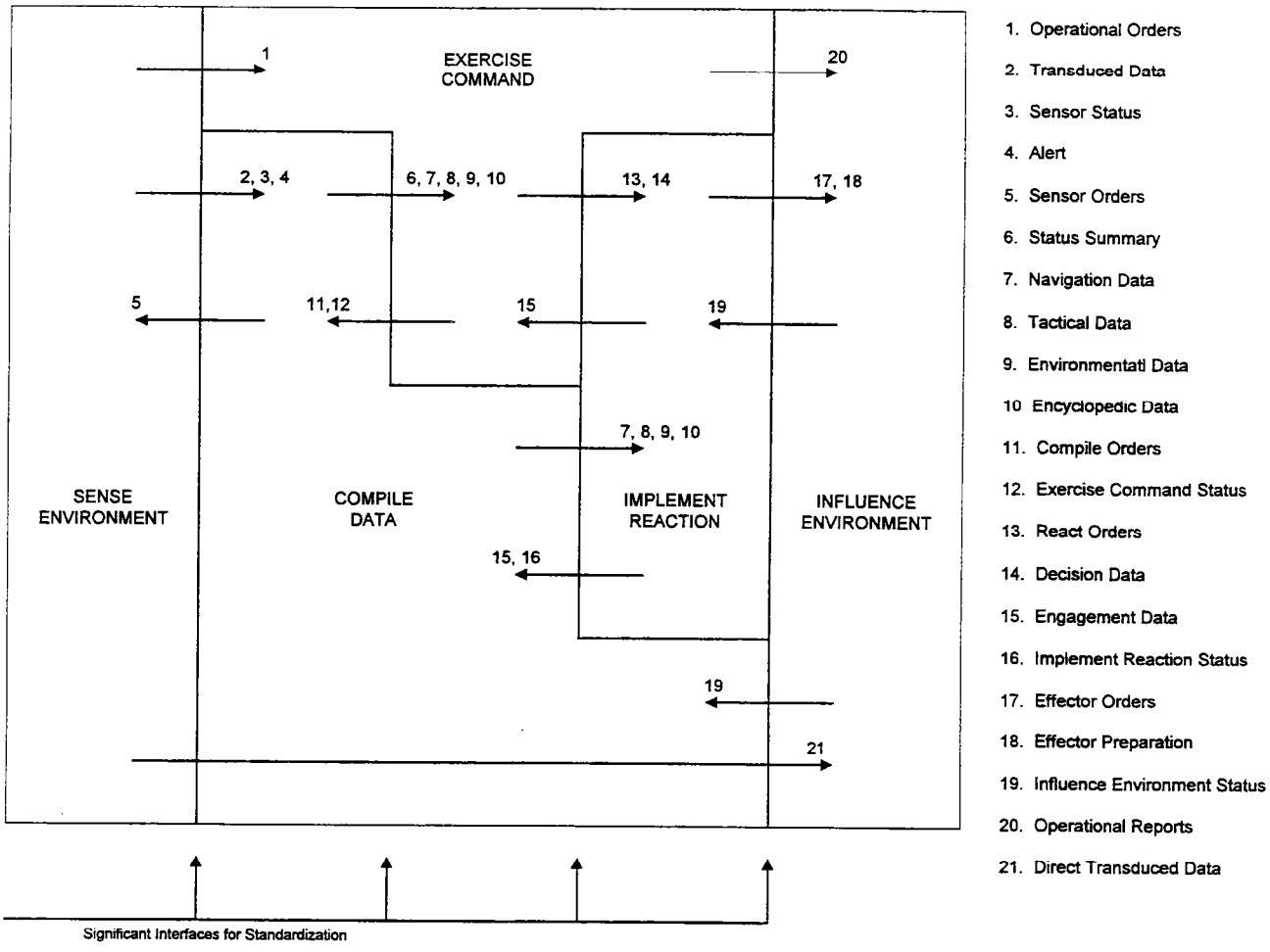

Figure 1 - Significant Shipboard Interfaces and Category Groups

In order to sub-divide and categorise the messages further, a leveled Combat System was developed based upon a multi-role surface warship (refer to ANEP-51, Volume 2 [Ref 2], section 4, which describes the Leveled Combat System. This identifies 44 member equipment (*senders*) within the Combat System against which the Message Data was assigned. The Leveled Combat System was defined as a tool for the purpose of defining message senders within an open architecture. The Generic Combat System Leveled Representation is essentially structured into five levels of functional processes:

- Sensors (Sense Environment)
- Sensor Control Processing (Compile Data)
- Command Processing and Decision Aids (Exercise Command)
- Effector Control Processing (Implement Reaction)
- Effectors (Influence Environment)

The last stage of this element of the study was to identify and define standard messages within each of the 23 Category Groups and to compile the NATO Naval Combat System Generic Message Catalogue. The generic messages are presented in Volume 2 of this ANEP. The following is an example of a generic message:

```
CooperativePlatformPosition(Grid) ::= [APPLICATION 08800] SEQUENCE
    {
        PlatformID,
        Time OfValidity,
        -- Grid Position
                X-Coordinate,
                Y-Coordinate,
                Z-Coordinate        }
```

This message, named Cooperative Platform Position (Grid), is assigned an Application Number (or Message Control Number) 08800. The leading '08' indicates the Category Group number (i.e., Tactical Data). The message comprises a sequence of two Data Elements (Platform ID and Time Of Validity) and a Data Structure (Grid Position). The Grid Position Data Structure comprises a sequence of three Data Elements (X-Coordinate, Y-Coordinate, and Z-Coordinate).

2.2 The Development of the Data Structure Catalogue

The formal definition of standards for data representation was, to a great extent, dependent upon the data required to support the defined generic messages. In advance of the first draft of this information, a search for data representation and message standards, with particular reference to COTS software, was undertaken using:

a. ISO Standards

b. NATO Standards, particularly STANAG 4222 and ANEP-38

c. Industry Standards, particularly in the area of Digital Audio and Video

This search determined that all primary standards for the representation of numeric and alphanumeric data were already adopted by NATO via STANAG 4222. The NATO Basic Data Element types and data representation types described in STANAG 4222 are:

Floating Point	Boolean
Integer	ASCII String
Fixed Point	String
Enumerated	Binary Coded Decimal (BCD)

Derived Data Elements are elements derived from the Basic Data Elements (e.g., Bearing, Range, etc.), and are the operational variables found in tactical and technical messages. Data Structures are

ordered sets of Derived Data Elements and other Data Structures. Figure 2 shows the relationship between the Data Elements and Data Structures of the Data Structure Catalogue and the Message Body of the Generic Message Catalogue.

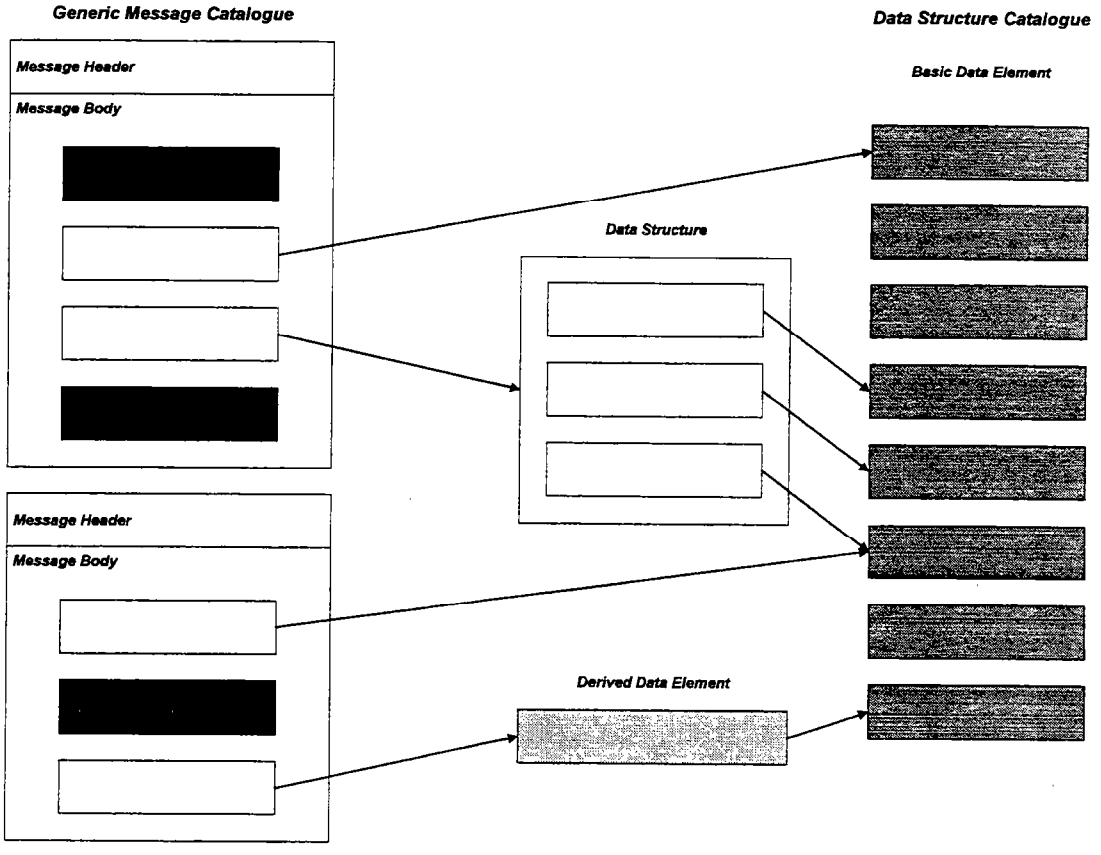

Figure 2 - Relationship between Generic Message Catalogue and Data Structure Catalogue

An example of a Data Structure is:

```
GridPosition ::= SEQUENCE
    {
        X-Coordinate,
        Y-Coordinate,
        Z-Coordinate        }
```

It was also established that no single standard suitable for adoption by NATO existed for the digital representation of voice or video. These standards are not sufficiently well established to form a basis for adoption, and are still being evolved. Consideration of voice and video distribution is included in ANEP-50 [Ref 8], Section 4.3 Communications Services.

2.3 The Development of the Message Construction Standard

A review of existing NATO and Industry approaches to message definition and construction was undertaken, primarily based on the rules inherent in ANEP-38, and the initial draft of the message construction rules proposed for Project Horizon.

The use of Abstract Syntax Notation 1 (ASN.1) [Ref 9] in ANEP-38 was considered to provide a powerful approach for the formal and unambiguous definition of messages. It was noted, however, that currently this only extended to the use of standard data parameters as defined in Annex A of STANAG 4222. A *formal* definition of these standard data parameters is not provided by STANAG 4222, Edition 2.

It was therefore decided to adopt the use of ASN.1 within the Message Construction Standard and also to include a formal definition of the STANAG 4222 standard data parameters in terms of ASN.1 simple types.

The formal definition of rules for the construction of messages and the use of a Data Structure Catalogue by Project Horizon was also considered to provide the necessary rigour for the definition of the written form of messages and data structures.

The adoption of this approach (also using ASN.1), together with the formal definition of basic data elements ensures that the transmitted format of a message is also *formally and unambiguously defined* by the written form.

2.4 The Development of the Strategy for the Maintenance of the Catalogues

The maintenance strategy was developed by undertaking an analysis of existing strategies for the dissemination of data representation and message standards, and the consideration of the key requirements for the dissemination and maximum use of the Information Catalogue by projects. These include:

a. The maintenance philosophy must support the adoption and maintenance of a subset of the Information Catalogue by a project.

b. The maintenance philosophy must support the addition of messages within the Information Catalogue to meet national or project specific requirements.

c. The maintenance philosophy must support the extension of messages within the Information Catalogue to meet national or project specific requirements. Approaches and mechanisms which encourage adoption with minimum modifications should be identified and used.

In addition, a further key requirement was identified to be responsiveness to the needs of users of the information catalogue. The maintenance philosophy therefore includes consideration of:

a. the provision of the Information Catalogue in database form

b. timely processing and promulgation of proposed modifications and additions and the automatic provision of updates to the Information Catalogue immediately they are available

c. the provision of guidance as to how to apply the Information Catalogue to an individual project

d. Provision of support for the addition of project specific messages

e. provision of support for the allowed/recommended approach to the extension of generic messages

These key requirements were used to develop an approach which aims to ensure that the NATO Information Catalogue is kept relevant and up-to-date in a cost-effective manner.

2.5 The Development of a Generic Combat System Architecture

The Command Processing and Decision Aids (Exercise Command) processes were sub-divided further into relevant warfare groupings, including multi-user workstations. A detailed functional analysis was performed in order to identify the information exchanged between the sub-functions and activities of this Catalogue Group, as well as to investigate further the messages exchanged between this group and other functional processes. The functional analysis investigated the Command System of an aircraft carrier, frigate, submarine, amphibious ship, and a minehunter. Functions common to all of these platforms were identified and assembled into a generic Combat System architecture framework applicable to any class of Naval vessel.

A table relating the functional group, sub-group, and activity (from the Command System functional model) to individual messages, the receiving function, and/or the receiving Command System functional sub-group was developed. This table can be used to determine, given a defined physical architecture for the system that allocates functions to separate equipment, those messages which will be transmitted on the LAN and those messages that will be internal to the various equipment, thus, assists in generation of the project specific message catalogue. Figure 3 illustrates this process.

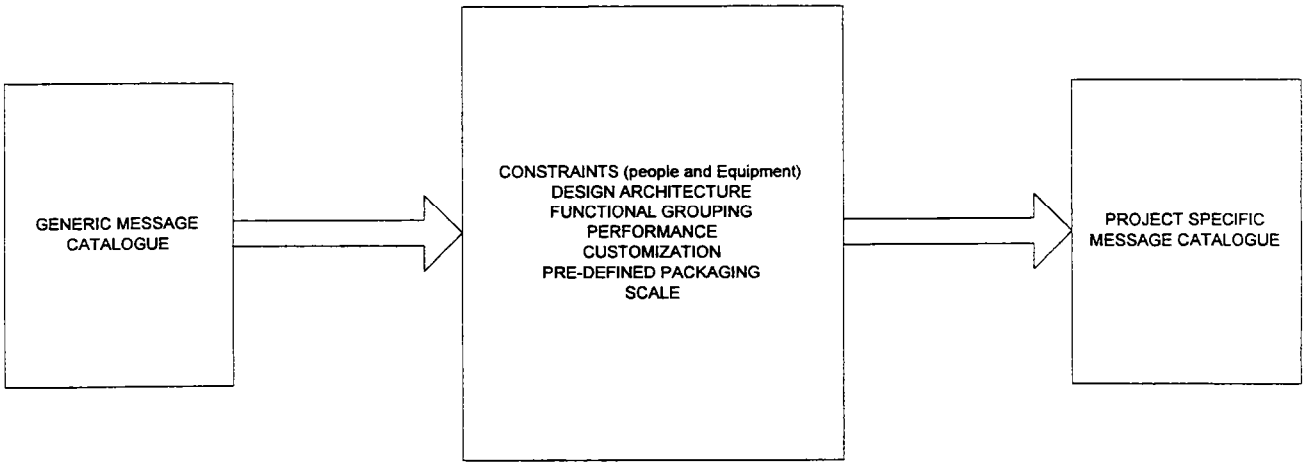

Figure 3 - Transition from Generic Message Catalogue to Project Specific Message Catalogue

2.6 The Consideration of Key Performance Indicators

A methodology for developing and evaluating the key performance indicators of a Combat System (with respect to the Data Transfer System) was developed. It describes the relationships between the Generic Message Catalogue, physical architecture, project specific message catalogue, and Data Transfer System technology and how they impact the Key Performance Indicators. It further describes the data load calculation (i.e., throughput requirements), and prediction of data latency.

3. Projects Considering Use of ANEP-51

Interest in the potential use of ANEP-51 has been expressed by the following projects:

Project Horizon /CNGF (UK, FR, IT)

Tri-Lateral Frigate (NL, GE, SP)

Principal Anti-Air Missile System (PAAMS) (UK, Project Horizon)

CMS (UK)

Inner Layer Missile System (ILMS) (UK)

Infra-Red Alerting System (IRAS) (UK)

Target Indication Sensor (TIS) (UK)

Medium Calibre Gun System (MCGS) (UK)

ADC Frigate (NL)

DD-21 (US)

CVN-77 (US)

CVX (US)

LPD-17 (US)

Arsenal Ship (US)

4. Document Organisation

ANEP-51 is organised in a number of volumes:

Volume 1 : Guide to the Use of the NATO Information Catalogue.

This volume provides an overview of Volumes 2, 3 and 4 of this ANEP. It describes the overall structure and the different components used to construct a message, and provides the basic knowledge required to further understand the contents of the Generic Message Catalogue and the Data Structure Catalogue. Volume 1 also explains the necessary steps for the use of ANEP-51 during the definition of a Project Information Catalogue.

Volume 1 develops the requirements for the evolution and maintenance of the NATO Information Catalogue and proposes a maintenance strategy which resolves the conflicts generated by the co-existence of NATO and Project Information Catalogues, makes use of electronic facilities for the maintenance and distribution of the NATO Information Catalogue, and provides cost-effective mechanisms for evolving and maintaining the NATO Information Catalogue

Volume 2: Generic Message Catalogue.

This volume provides the results of the analysis of the data collected and analysed during this pre-feasibility study, and provides a recommended NATO Naval Combat Generic Message Catalogue for NATO Naval Combat Systems. These were based upon current known Naval Combat Systems and reflect current Combat System designs. However the generic messages were further enhanced or modified, where necessary, by experts currently developing new Combat Systems for future in service warships.

Volume 3: Data Structure Catalogue.

This volume provides the data structures and data elements required to define the messages provided in Volume 2.

Volume 4: Message Construction Standard.

This volume provides a formal and unambiguous syntax for the definition of messages and data structures (components of messages). A number of basic data elements, from which all messages and data structures can be developed are also formally defined. This ensures that the written form of a message provides a complete and unambiguous definition of its transmitted form.

Volume 5: Combat System Architecture and Key Performance Indicators

Volume 5 presents the functional analysis of shipboard command systems and the methodology to determine and assess Key Performance Indicators. It includes a generic Combat System architectural framework common to all Naval vessels

5. Observations

During the study, messages from current NATO vessels were catalogued and reduced to Generic Messages. It was apparent that a considerable number of the existing messages had similar, if not the same, data. An additional attribute in some instances resulted in an almost identical message being transferred. This was concluded to be a result of member equipment needing similar messages as the Combat System design evolved. It shows the need for Combat System design to address the message content and structure at an early stage of its concept/design phase. If this is not addressed early, then additional complexity will be introduced into the Combat System causing additional cost and risk

The evolving nature of Naval Combat Systems (including the development of more advanced and new sensor technology, and the increasing use of COTS technology) reduces the 'shelf life' of the information generated by this study. This indicates the needs for the maintenance strategy and the continuous nature of the evolution of the NATO Information Catalogue.

Existing Naval Combat Systems make extensive use of fixed point format, primarily in order to reduce the use of bandwidth and the lack of support for floating point arithmetic in some military systems. The higher bandwidth and processing power available due to the use of COTS make these considerations less important, and the use of fixed point format is a classical source of confusion and error in the implementation of Naval Combat Systems.

The use of a hierarchical, referential system for the definition of messages and data structures has proved to be ideal. This approach can result in the definition of messages and data structures on paper, and a syntax for the written form has been provided. It is considered, however, that the development of messages and data structures will be easier when supported by the use of a relational database.

Annex A - References

No.	Title	Reference	Issue
1	NATO Naval Combat System Information Catalogue, Volume 1 : User Guide	ANEP-51, Vol. 1	2
2	NATO Naval Combat System Information Catalogue, Volume 2 : Generic Message Catalogue	ANEP-51, Vol. 2	2
3	NATO Naval Combat System Information Catalogue, Volume 3 : Data Structure Catalogue	ANEP-51, Vol. 3	2
4	NATO Naval Combat System Information Catalogue, Volume 4 : Message Construction Standard	ANEP-51, Vol. 4	2
5	NATO Naval Combat System Information Catalogue, Volume 5 : Combat System Architecture and Key Performance Indicators	ANEP-51, Vol. 5	2
6	Standard Specification for Digital Representation and Encoding of Shipboard Data Parameters	STANAG 4222	2
7	Standard Specification for Intra-Ship Data Constructions in NATO Naval Systems	ANEP-38	1
8	NATO Shipboard Open Systems Environment	ANEP-50	2
9	Specification of Abstract Syntax Notation One (ASN.1)	BS ISO/IEC 8824 : 1990	Ed 2
10	Project Horizon CNGF CSDT 002 Message Construction Standard Draft D, 18 May 1995	CNGF CSDT 002	Draft D
11	Combat System Reference Model for Open Shipboard Combat Systems	ANEP-32	1
12	Combat System Data Model for Interface Analysis	ANEP-33	1

13	Naval Combat System Architecture - Extension to Ship Open System Environment Interface	ANEP-53	1
14	Guidelines for COTS Insertion	ANEP-54	1
15	Naval Combat System Architecture Design Tools Study Report	ANEP-55	1

Annex B - Definitions

ITEM	DEFINITION
Information Catalogue	The combination of the NATO Generic Message Catalogue and the NATO Data Structure Catalogue
Generic Message Catalogue	A set of generic messages between the various Combat System functions. These functions are defined in ANEP-32, Combat System Reference Model for Open Shipboard Combat Systems, and in ANEP-33, Combat System Data Model for Interface Analysis
Data Structure Catalogue	A set of formally defined data elements and data structures used in generic messages
Message Construction Standard	A set of rules for the construction of messages for the NATO Information Catalogue and Project Information Catalogues, together with a formal syntax defining these rules
Project Information Catalogue	The combination of the Project Message Catalogue and the Project Data Structure Catalogue
Project Message Catalogue	A set of project specific message derived from the NATO Generic Message Catalogue using the Message Construction Standard
Project Data Structure Catalogue	A set of project specific data structure derived from the NATO Data Structure Catalogue using the Message Construction Standard
Data Exchange Specification	A complete definition of the messages to be exchanged between two equipment within a project's Combat System. The DES is derived from the Project Information Catalogue and may include, in addition to the referenced data structures, specific maximum and minimum data values to be used by the sending equipment.
Message	Data in a format defined in the Message Definition which is passed between combat system components via the information transfer system as defined in the Generic Combat System Model.

ITEM	DEFINITION
Message Definition	Description of the structure of a Message. The Message Definition defines the message name, Message Catalogue Number, the header and the message body. The header includes the message structure and message length. The body is a combination of Data Structures and Data Elements. The composition rules are described in the Message Construction Standard [Ref 4].
Data Structure	Combination of Data Elements and other Data Structures grouping a number of related elements in a Message Definition. The composition rules are described in the Message Construction Standard [Ref 4].
Data Element	Basic variable type used to compose Data Structures and Message Definitions. The different Data Elements are defined in the Data Structure Catalogue [Ref 3].