JOIIS		JOIIS WSDL, NVG	
JREAP	TBC	TBC	TBC
LC2IS / SICF	SIF, NVG, AdatP-3	WSDL SIF, NVG	
LOGFAS, EVE	LOGUPDATE	NVG	
MCCIS		Overlays	Tracks*
MIP			Database replication
NIRIS			Tracks: TITO API*
NJTS	TBC	TBC	TBC
SOA	TBC	TBC	TBC
SOF FS	TBC	TBC	TBC
TRITON	TBC	TBC	TBC
TOPFAS		TOPFAS WSDL	
TOPFAS SAT	TBC	TBC	TBC

A.1 INFORMATION PRODUCTS PROVIDING BSO ASSOCIATIONS

Interface	BSO associations created by NCOP	Association
I_NCOP_ACCS	No	-
I_NCOP_ADATP3	Yes	CommandAndControl (in case of OWNSITREP …)
I_NCOP_AGS	TBC	TBC
I_NCOP_AIRC2IS	Yes	C2 Relationship Comes from DefenceTask Defending Defending against Reaching SurveillanceTask Threatening
I_NCOP_AMN_INT_CORE	No	-
I_NCOP_CBRN	TBC	TBC
I_NCOP_C4ISR_VIZ	TBC	TBC
I_NCOP_CIDNE	TBC	TBC
I_NCOP_CORE_ACTIVE_DIRECTORY	No	-
I_NCOP_CORE_DHS	No	-
I_NCOP_CORE_EMS	No	-
I_NCOP_CORE_INFORMAL_MESSAGING	No	-

Interface	BSO associations created by NCOP	Association
I_NCOP_CORE_PRINTING	No	-
I_NCOP_CORE_SECURITY	No	-
I_NCOP_CORE_XMPP	No	-
I_NCOP_CSD	TBC	TBC
I_NCOP_CYBER_DEFENSE	TBC	TBC
I_NCOP_ENVIRONMENTAL	TBC	TBC
I_NCOP_ETEE	TBC	TBC
I_NCOP_EXCEL	Yes	The associations are defined by the COP Manager. Any association can be created.
I_NCOP_FFI	TBC	TBC
I_NCOP_GENERIC_TEXT	No	-
I_NCOP_GENERIC_XML	No	-
I_NCOP_ICC_WISI	No	-
I_NCOP_IGEOSIT	No	
I_NCOP_INTELFS	No	-
I_NCOP_JCOP_WS	No	-
I_NCOP_JOCWATCH	No	-
I_NCOP_JOIIS	Yes	IsSituatedIn IsConnectedTo IsConnectedTo IsSuperiorOf NotKnown
I_NCOP_JREAP	TBC	TBC
I_NCOP_JTS	No	-
I_NCOP_LC2IS	Yes	C2 relationship – Operational ORBAT C2 relationship – Reference ORBAT
I_NCOP_LOGFAS	?	?
I_NCOP_LOGREP	Yes	IsSuperiorOf
I_NCOP_MCCIS (overlays)	No	-
I_NCOP_MCCIS (tracks)	No	-
I_NCOP_MIP	TBC	TBC
I_NCOP_NFFI_IP1	No	-

Interface	BSO associations created by NCOP	Association
I_NCOP_NFFI_SIP3	No	-
I_NCOP_NIRIS	Yes	For L16 TMD TSS only: IsConnectedTo Reporting IsPastTrajectoryOf IsFutureTrajectoryOf
I_NCOP_JTS	TBC	TBC
I_NCOP_NVG_14 & I_NCOP_NVG_15 & I_NCOP_NVG_20	No	-
I_NCOP_NVG_STREAMING	Yes	For ACCS : IsConnectedTo Reporting IsPastTrajectoryOf IsFutureTrajectoryOf
I_NCOP_OTHTGOLD	No	-
I_NCOP_REST	TBC	TBC
I_NCOP_SHAREPOINT	Yes	The associations are defined by the COP Manager. Any association can be created.
I_NCOP_SOA	TBC	TBC
I_NCOP_SOF	TBC	TBC
I_NCOP_SQL	Yes	The associations are defined by the COP Manager. Any association can be created.
I_NCOP_TOPFAS	Yes	IsSuperiorOf IsUnderCommandOf IsChildOf Supports
I_NCOP_TOPFAS_SAT	TBC	TBC
I_NCOP_TRITON	TBC	TBC
I_NCOP_WS	No	-

APPENDIX B NUMERICAL EXTENDED DATA: UNIT OF MEASURE

In order to have information on unit of measure for numerical extended data, a unit attribute is set as in the following example:

```
<ns0:SimpleField id="m_hauteurDiametre" unit="meter" />
```

The distance shall be expressed as follow (extract from JC3IEDM):

- CM: Centimetre
- FOOT: Foot
- INCH: Inch
- KM: Kilometre
- METRE: metre
- MILE: Mile
- MM: Millimetre
- NM: Nautical mile
- YARD: Yard

The following table shows some extended data and their corresponding Unit of Measure:

SourceInterface	ElementName	UnitAttribute
LC2IS XML File	m_Altitude_max_larg	meter
LC2IS XML File	m_Altitude_plafond	meter
LC2IS XML File	m_Altitude_plancher	meter
LC2IS XML File	m_altitudeAGL	meter
LC2IS XML File	m_altitudeImpact	meter
LC2IS XML File	m_AltitudeMoyenne	meter
LC2IS XML File	m_altitudeObj	meter
LC2IS XML File	m_Angle	degree
LC2IS XML File	m_angleMvt	degree
LC2IS XML File	m_angleOrientation	degree
LC2IS XML File	m_angleSecteur	degree
LC2IS XML File	m_Avancement	percentage
LC2IS XML File	m_Direction	anti clockwise
LC2IS XML File	m_directionMvtDegre	degree
LC2IS XML File	m_Etat_carburants_p	percentage
LC2IS XML File	m_Etat_equip_maj_p	percentage
LC2IS XML File	m_Etat_munitions_p	percentage
LC2IS XML File	m_Etat_personnel_p	percentage
LC2IS XML File	m_Etat_vivres_p	percentage
LC2IS XML File	m_Hauteur	meter
LC2IS XML File	m_Hauteur_de_quai	meter
LC2IS XML File	m_Hauteur_maximum	meter

LC2IS XML File	m_hauteur_mini	meter
LC2IS XML File	m_hauteurDiametre	meter
LC2IS XML File	m_hauteurMaxVeh	meter
LC2IS XML File	m_hauteurVol	meter
LC2IS XML File	m_hauteurZoneEchange	meter
LC2IS XML File	m_largeur	meter
LC2IS XML File	m_Largeur_droite	meter
LC2IS XML File	m_Largeur_gauche	meter
LC2IS XML File	m_largeur_mini	meter
LC2IS XML File	m_Largeur_minimum	meter
LC2IS XML File	m_largeurBranche	meter
LC2IS XML File	m_largeurMaxVeh	meter
LC2IS XML File	m_largeurRoute	meter
LC2IS XML File	m_longSurAutoroute	meter
LC2IS XML File	m_longueur	meter
LC2IS XML File	m_Longueur_max_piste	meter
LC2IS XML File	m_Longueur_max_quais	meter
LC2IS XML File	m_Longueur_tot_quais	meter
LC2IS XML File	m_LongueurAxe	meter
LC2IS XML File	m_longueurMaxFicelle	meter
LC2IS XML File	m_longueurMaxPasse	meter
LC2IS XML File	m_longueurMaxVeh	meter
LC2IS XML File	m_longueurSurRoute	meter
LC2IS XML File	m_mesureAngle	degree
LC2IS XML File	m_Poids_a_vide	kg
LC2IS XML File	m_Poids_en_charge	kg
LC2IS XML File	m_Vitesse	km
LC2IS XML File	m_Vitesse_de_progres	km
LC2IS XML File	m_vitesseAeronef	km
LC2IS XML File	m_vitesseDeConsigne	km
LC2IS XML File	m_VitesseDuVent	km
LC2IS XML File	m_vitesseImposee	km
LC2IS XML File	m_vitesseModule	km
LC2IS XML File	m_vitessePropre	km
LC2IS XML File	m_vitesseSolMoyenne	km
LC2IS XML File	m_vitesseSurRoute	km
LC2IS XML File	m_vitesseVentResulta	km
LC2IS XML File	m_vitSurAutoroute	km
WISI: Aco	latitude	decimal degree
WISI: Aco	longitude	decimal degree
WISI: Airbase	latitude	decimal degree
WISI: Airbase	longitude	decimal degree
WISI: AirUnit	latitude	decimal degree
WISI: AirUnit	longitude	decimal degree
WISI: Ato	latitude	decimal degree
WISI: Ato	longitude	decimal degree

WISI: Ato	missionRoute.altitude	foot
WISI: RadarUnit	latitude	decimal degree
WISI: RadarUnit	longitude	decimal degree
WISI: ReleasedPTL	latitude	decimal degree
WISI: ReleasedPTL	longitude	decimal degree
WISI: SamUnit	latitude	decimal degree
WISI: SamUnit	longitude	decimal degree
WISI: SamUnit	ptl	degree
WISI: SamUnit	stl	degree
WISI: TargetList	latitude	decimal degree
WISI: TargetList	longitude	decimal degree

APPENDIX C DOCUMENT SPECIFIC ABBREVIATIONS

ACCS	Air Command and Control System
ACO	Allied Command Operations
ACT	Allied Command Transformation
AD	Active Directory
AD LDS	Active Directory Lightweight Directory Services
AirC2IS	Air Command and Control Information System
AIS	Automated Information System
AOI	Area Of Interest
API	Application Programming Interface
BAM	Business Activity Monitoring
Bi-SC	Bi-Strategic Command
BMP	BitMaP
BPEL	Business Process Execution Language
BRITE	Baseline for Rapid Iterative Transformational Experimentation
BSO	BattleSpace Object
C2IEDM	Command and Control Information Exchange Data Model
C3	Command, Control and Communications
CBT	Computer Based Training
CDF	Common Data Format
CDM	Conceptual Data Model
CDR	Critical Design Review
CES	Core Enterprise Services
CI	Configuration Item
CIMIC	Civil Military Cooperation
CLR	Common Language Runtime
CMS	Content Management System
COP	Common Operational Picture
CORSOM	Coalition Reception, Staging and Onward Movement
COTS	Commercial Off-The-Shelf
CWIX	Coalition Warrior Interoperability eXercise
DEM	Data Exchange Mechanism
DHS	Document Handling System
DL	Data Link
DNS	Domain Name System
DTG	Date-Time Group
EDA	Event Driven Architecture
EDMS	Electronic Document Management System
EMS	Enterprise Management System
ESB	Enterprise Service Bus
EVE	Effective Visibility Execution
FAS	Functional Area Service
FS	Functional Service
FTP	File Transfer Protocol
GIS	Geographic Information System
GML	Geography Markup Language
GOTS	Government Off-The-Shelf
GoF	Gang of Four
HQ	HeadQuarters
ICC	Integrated Command and Control
ICD	Interface Control Document

IEDM	Information Exchange Data Model
IEG	Information Exchange Gateway
IEM	Information Exchange Mechanism
IER	Information Exchange Requirement
IFB	Invitation For Bid
INTEL-FS	INTELligence Functional Service
IP	Information Product
IRS	Interface Requirement Specification
ISAF	International Security Assistance Force
JICCIS	Joint Information Command and Control Information Services
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
JCOP	Joint Common Operational Picture
JPEG	Joint Photographic Experts Group (Standard)
JRE	Java Runtime Environment
JOIIS	Joint Operations/Intelligence Information System
JTS	Joint Targeting System
KML	Keyhole Markup Language
KVP	Key Value Pair
LAN	Local Area Network
LC2IS	Land Command and Control Information System
LoD	Level of Detail
LOGREP	LOGistics REPorting Tool
LOGFAS	LOGistics Functional Area Service
LOG-FS	LOGistics Functional Service
LC2IS	Land Command and Control Information Services
LDM	Logical Data Model
MCCIS	Maritime Command and Control Information System
MDA	Model Driven Architecture
MIP	Multilateral Integrated Programme
MMI	Man Machine Interface
MOM	Message-Oriented Middleware
MOTS	Military Off-The-Shelf
MS	Mission Secret
MTF	Message Text Format
MVC	Model, View, Controller
NAF	NATO Architecture Framework
NATO	North Atlantic Treaty Organisation
NCIA	NATO Communications and Information Agency
NCISS	NATO CIS SchoolNCOP NATO COP
NFFI	NATO Friendly Force Information
NIRIS	Networked Interoperable Real-time Information Services
NITB	NATO Intel ToolBox
NMRR	NATO Metadata Repository & Registry
NS	NATO Secret
NTP	Network Time Protocol
NU	NATO Unclassified
NVG	NATO Vector Graphics
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geographic Consortium
OMG	Object Management Group
ORBAT	ORder of BATtles
PDF	Portable Document Format
PDM	Physical Data Model

PFE	Purchaser Furnished Equipment
POC	Point Of Contact
QoS	Quality of Service
RAS	Reusable Asset Management
RAP	Recognized Air Picture
RGP	Recognized Ground Picture
RMP	Recognized Maritime Picture
RBAC	Role Based Access Control
RDBMS	Relational DataBase Management System
REST	REpresentational State Transfer
RIA	Rich Internet Application
SDP	Software Development Plan
SDS	System Design Specification
SL	Service Level
SLA	Service Level Agreement
SLD	Styled Layer Descriptor
SLR	Service Level Requirement
SMTP	Simple Mail Transfer Protocol
SNMP	Sensitive Network Management Protocol
SOA	Service Orientated Architecture
SOAP	Simple Object Access Protocol
SoS	System of Systems
SOW	Statement Of Work
SPoF	Single Point of Failure
SRS	System Requirements Specification
STANAG	STANdard AGreement
TDL	Tactical Data Link
TIDE	Transforming technology towards Information, Decision, and Execution superiority
TIMS	Theatre Information Management Services
TMD	Theatre Missile Defence
TOPFAS	Tools for Operational Planning Force Activation and Simulation
UDDI	Universal Description Discovery and Integration
UI	User Interface
UML	Unified Modelling Language
XEP	XMPP Extension Protocol
XML	eXtensible Mark-up Language
XMPP	eXtensible Messaging and Presence Protocol
XSLT	eXtensible Stylesheet Language Transformations
WAN	Wide Area Network
WCS	Web Coverage Service
WFS	Web Feature Service
WG	Working Group
WISI	Web ICC Standard Interface
WMS	Web Map Service
WSDL	Web Services Description Language

APPENDIX D AIRC2IS MAPPING AUGMENTATION

The Excel file attached below contains the AirC2IS interface detailed mapping augmented by NCOP.

It is based on the original “AirC2IS_SDS_Annex_04_ICD_Appendix_C_NVG” Excel file provided by AirC2IS project. It has been augmented by NCOP team: all updates have been made by using greenfont in the Excel Worksheets:

AirC2IS_SDS_Annex
_04_ICD_Appendix_(

NCOP SYSTEM DESIGN SPECIFICATION

NCOP2 SDS

Effective date: 17 December 2021

Revision No: 2.1

Issued by: NCOP Technical team

Approved by: NCOP Product Owner, C2 SL, NCI Agency

CONTENTS

FIGURES

TABLES

1 SCOPE

1.1 IDENTIFICATION

Project name: NCOP2

Addressee: NATO Communication and Information Agency

Document title: System Design Specification

Dependencies: -

Document name: 2021_NU_NCOP2-SDS V0.4.doc

Process: Development

Document Reference: F0057 67669298-424

Applicable Functional Baseline:

Name	State	Number	Rev.
NCOP-2 FBL	Approved	63242201~F0057~0026	--

1.2 APPLICABILITY

This document is the System Design Specification (SDS) for NCOP Increment 2.

Henceforth in this Plan:

The NATO Communications and Information Agency (NCIA) will be referred to as “the Purchaser”;

The NCIA, NCISS and NATO sites personnel will be referred to as “the Users”;

Thales Communications & Security will be referred to as “the Contractor”.

1.3 RELATIONSHIP TO OTHER DOCUMENTS

This document describes the design of NCOP system. Other documents related to this document are as follows:

- The test plan provided in the Engineering package,
- The System Development Plan provided in the Engineering package.

1.4 DOCUMENT PURPOSE

The System Design Specification documents the technical solution for NCOP Increment 2. The document will be updated and completed throughout the different design and development stages of the project.

The methodology, the formalism and the tools used to realise the SDS facilitate the appropriation of the design by the different technical stakeholders (contractor team, development team, test team, configuration management team, and installation and support team) and participate to the global coherence of the project.

1.5 DOCUMENT OVERVIEW

The SDS document is organised in the following way:

- Chapter 2 presents the system objective;
- Chapter 3 provides an overview of main architectural patterns used for designing NCOP;
- Chapter 4 introduces the design description methodology used to describe high-level and low-level design;
- Chapter 5 presents the high level design;
- Chapter 6 presents the detailed design;
- Chapter 6.4 provides the details of the COTS software and hardware required for NCOP Increment-2 deployments onto NATO types of site;
- Appendix A provides the traceability matrix between the system requirement specification and the Implementation Components and the Configuration Items.
- Appendix B provides NAF views;
- Appendix C provides ArchiMate views;
- Appendix D provides a mapping between IEEE 1016 ViewPoints and SDS sections
- Appendix E provides an overview of NCOP interfaces
- Appendix F provides technical information on the TIMS.js product
- Appendix G provides the Windows Registry Keys used by NCOP servers
- Appendix H provides an overview of NCOP main features
- Appendix I provides the comparison between IC of Increment-1 and Increment-2
- Appendix J provides the dependencies between IC and COTS
- Appendix K provides the dependencies between IC and Actors
- Appendix L provides the dependencies between IC and Objects
- Appendix M provides the NCOP SQL databases diagrams

1.6 DOCUMENT SPECIFIC ABBREVIATIONS

ABAC	Attribute-Based Access Control
ACO	Allied Command Operations
ACT	Allied Command Transformation
AD	Active Directory
AD LDS	Active Directory Lightweight Directory Services
AirC2IS	Air Command and Control Information System
AIS	Automated Information System
AOI	Area Of Interest

API	Application Programming Interface
BAM	Business Activity Monitoring
Bi-SC	Bi-Strategic Command
BMP	BitMaP
BPEL	Business Process Execution Language
BRITE	Baseline for Rapid Iterative Transformational Experimentation
BSO	BattleSpace Object
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CORSOM	Coalition Reception, Staging and Onward Movement
COTS	Commercial Off-The-Shelf
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DEM	Data Exchange Mechanism
DHS	Document Handling System
DL	Data Link
DNS	Domain Name System
EDA	Even Driven Architecture
EDMS	Electronic Document Management System
EMS	Enterprise Management System
ESB	Enterprise Service Bus
EVE	Effective Visibility Execution
FAS	Functional Area Service
FOSS	Free and Open Source Software
FS	Functional Service
FTP	File Transfer Protocol
GIS	Geographic Information System
GML	Geography Mark-up Language
GOTS	Government Off-The-Shelf
GoF	Gang of Four
HQ	HeadQuarters
HMI	Human Machine Interface
IC	Implementation Component
ICC	Integrated Command and Control
ICD	Interface Control Document
IEDM	Information Exchange Data Model
IEG	Information Exchange Gateway
IEM	Information Exchange Mechanism
IER	Information Exchange Requirement
IFB	Invitation For Bid
INTEL-FS	INTELligence Functional Service
IP	Information Product
IRS	Interface Requirement Specification

ISAF	International Security Assistance Force
JC3IEDM	Joint Consultation, Command and Control Information Exchange Data Model
JCOP	Joint Common Operational Picture
JPEG	Joint Photographic Experts Group (Standard)
JRE	Java Runtime Environment
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KML	Keyhole Mark-up Language
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MDA	Model Driven Architecture
MIP	Multilateral Integrated Programme
MMI	Man Machine Interface
MOM	Message-Oriented Middleware
MOTS	Military Off-The-Shelf
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MTF	Message Text Format
MVC	Model, View, Controller
NAF	NATO Architecture Framework
NATO	North Atlantic Treaty Organisation
NCIA	NATO Communications and Information Agency
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NCOP	NATO COP
NEDS	NATO Enterprise Directory Service
NFFI	NATO Friendly Force Information
NIRIS	Networked Interoperable Real-time Information Services
NITB	NATO Intel ToolBox
NLB	Network Load Balancing
NMRR	NATO Metadata Repository & Registry
NS	NATO Secret
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NU	NATO Unclassified
NVG	NATO Vector Graphics
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geographic Consortium
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PDM	Physical Data Model
PFE	Purchaser Furnished Equipment
POC	Point Of Contact
QoS	Quality of Service
RAS	Reusable Asset Management
RAP	Recognized Air Picture

RBAC	Role-Based Access Control
RGP	Recognized Ground Picture
RMP	Recognized Maritime Picture
RBAC	Role Based Access Control
RDBMS	Relational DataBase Management System
REST	REpresentational State Transfer
SAML	Security Assertion Markup Language
SDP	Software Development Plan
SDS	System Design Specification
SING	Système d'Interopérabilité Nouvelle Génération[1]
SL	Service Level
SLA	Service Level Agreement
SLD	Styled Layer Descriptor
SLR	Service Level Requirement
SMTP	Simple Mail Transfer Protocol
SNMP	Sensitive Network Management Protocol
SOA	Software Orientated Architecture
SOAP	Simple Object Access Protocol
SoS	System of Systems
SOW	Statement Of Work
SPoF	Single Point of Failure
SRS	System Requirements Specification
STANAG	STANdard AGreement
TDL	Tactical Data Link
TIDE	Transforming technology towards Information, Decision, and Execution superiority
TIMS	Theatre Information Management Services
TMD	Theatre Missile Defence
TOPFAS	Tools for Operational Planning Force Activation and Simulation
UDDI	Universal Description Discovery and Integration
UI	User Interface
UML	Unified Modelling Language
XML	eXtensible Mark-up Language
XMPP	eXtensible Messaging and Presence Protocol
XSLT	eXtensible Stylesheet Language Transformations
WAN	Wide Area Network
WCS	Web Coverage Service
WFS	Web Feature Service
WG	Working Group
WISI	Web ICC Standard Interface
WMS	Web Map Service
WSDL	Web Services Description Language

[1] New Generation Interoperability System

1.7 APPLICABLE AND REFERENCE DOCUMENTS

1.7.1 Applicable documents

1.7.1.1 Contractual documents

Ref.	Document Reference	Issue	Title
[Contract]	CO-115100-NCOP2-Parts I, II, III and IV	/	CO-115100-NCOP2 Provide NATO Common Operational Picture (NCOP) Increment 2 signed on 04/03/2021 (Contractor) and 17/03/2021 (Purchaser)
[SSS]	CO-115100-NCOP2 Part I	/	CO-115100-NCOP2 Schedule of Supplies and Services
[SOW]	CO-115100-NCOP2 Part IV	1.5	CO-115100-NCOP2 Statement Of Work
[SRS]	CO-115100-NCOP2 Part IV Annex A SRS	/	CO-115100-NCOP2 System Requirements Specifications
[IRS]	CO-115100-NCOP2 Part IV Annex A1, A2 and A3 IRS	/	CO-115100-NCOP2 NCOP2 System Interfaces
[Abbrev]	CO-115100-NCOP2 Part IV Section 8	/	CO-115100-NCOP2 Acronyms
[Views]	CO-115100-NCOP2 Part IV Annex B	/	CO-115100-NCOP2 NCOP2 Required Architectural Views and Minimum Content

1.7.1.2 Applicable standards

Ref.	Title	Issue
[AC/35-D/1015]	AC/35-D/1015, “Guidelines for the Development of Security Requirement Statements”	REV3, 31 Jan 2012
[AC/35-D/2005]	AC/35-D/2005, Management Directive on CIS Security	REV3, 12 Oct.2015
[ACMP-2100]	ACMP-2100, The core set of configuration management contractual requirements	Ed A Ver 2 March 2017
[ACT Dir 75-3]	ACT Directive 75-3, Course Development	2007
[ACT Dir 75-10]	ACT Directive 75-10, Training Needs Analysis	2006
[STANAG 4107]	STANAG 4107, Mutual Acceptance of Government Quality Assurance and Usage of the allied Quality Assurance publications (AQAP), and associated AQAPS, i.e. AQAP-2000, Edition 3, AQAP-2070, Edition B, AQAP-2105, Edition C, AQAP-2110, Edition D, AQAP-2131, Edition C, AQAP-2210, Edition A, AQAP-2310, Edition B, AQAP-4107, Edition A	Ed11, Jan 2019
[AC/322-AC1]	AC/322(SC/1-WG/1)N(2009)0005-ADD2, NATO Architecture Framework (NAF)	Version 3.1
[NAF_4.0]	NATO Architecture Framework (NAF) Architecture Capability Team - Consultation, Command & Control Board - January 2018	Version 4.0
[STANAG 6001]	STANAG 6001. Language Proficiency Levels	Edition 5, 2014
[ISO 9001]	ISO 9001:2015 Quality management systems — Requirements	2015
[ISO/IEC 12207]	ISO/IEC 12207:2017: Systems and Software Engineering - Software life cycle processes	2017
[IEEE Standard 16326]	IEEE Standard 16326-2019, IEEE Systems and Software Engineering--Life Cycle Processes-- Project Management	2019
[ISO 31000]	ISO 31000:2018 Risk management — Guidelines	2018
[IEEE Standard 15288]	IEEE Standard 15288.2:2014, IEEE Standard for Technical Reviews and Audits on Defense Programs	2014

Ref.	Title	Issue
[ISO 10007]	ISO 10007:2017, Quality management — Guidelines for configuration management	2017
[IEEE Standard 1016]	IEEE Standard 1016-2009, IEEE Standard for information technology - systems design - software design descriptions	2009
[ISO 9241-210]	ISO 9241-210:2019, Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems	2019
[UML]	Unified Modelling Language (UML) 2.1, Object Modelling Group	2.1
[ISO/IEC/IEEE 29119-1]	ISO/IEC/IEEE 29119-1:2013 Software and systems engineering — Software testing Part 1: Concepts and definitions Part 2: Test processes Part 3: Test documentation Part 4: Test techniques	2013
[ISO/IEC 25010]	ISO/IEC 25010-2011, Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models	2011
[ISO 9000]	ISO 9000:2015 Quality management systems — Fundamentals and vocabulary	2015

1.7.2 Reference documents

A reference document is a document stated in the contract or any other document and that can be usefully consulted when carrying out activities associated with the contract:

1.7.2.1 SoW referenced documents

Ref.	Title	Issue
[ACD80-80]	ACO COP Directive 80-80	May 2009, revised May 2017
[STANAG 4427]	STANAG 4427 - Configuration Management in System Life Cycle Management	Edition 3, dated Dec 2014
[AAP-20]	NATO Programme Management Framework (NATO Life Cycle Model)	Edition C Version 1 October 2015
[CP 5A0007]	Capability Package 5A0007 - Provide Information Systems in Support of ACE-wide Operations Mission Area	
[CP 0A1303]	Capability Package 0A1303 - Provide NATO-wide Theatre Missile Defence Capabilities	
[PRINCE 2]	Managing Successful Projects with PRINCE 2	Second edition

1.7.2.2 SRS referenced documents

References already included in the SOW have not been repeated in the following table.

NCOP 2.0 Protocol Interface

Protocol	Version	Standard
ESRI REST	v10.1 - 10.7	

Protocol	Version	Standard
	v10.8.1	
OGC WMS	v1.1.1 / v1.3.0	OGC WMS Version 1.3.0 - "OpenGIS Web Map Service (WMS) Implementation Specification"
OGC WMC	v1.1.1	
OGC WFS	V2.0.2	OGC WFS Version 2.0.2 - "OpenGIS Web Feature Service 2.0 Interface Standard"
OGC KML	v2.2.0 v2.3	OGC KML 2.2.0 - "OGC KML"
OGC GML	v3.1.1	OGC GML Version 3.1.1 - "OGC Geography Markup Language"
GeoRSS		GeoRSS Simple - "GeoRSS Simple"
AGeoP-26	EdA v1	AGeoP-26 Edition A Version 1 - "Defence Geospatial Web Services"
OGC WMTS	v1.0	OGC WMTS Version 1.0.0 - "OpenGIS Web Map Tile Service (WMTS) Implementation Standard"
NVG	v1.4 / v1.5 / v2.0	
NVG 2.0.2	v2.0.2	NVG Bindings to APP-6 Edition D Version 1 - "NATO Joint Military Symbology"
NVG Streaming	1.4/1.5/2.0	
Confidentiality labelling		NATO Core Metadata STANAG 4774 Edition 1 - "Confidentiality Metadata Label Syntax"
Metadata binding		NATO Core Metadata STANAG 4778 Edition 1 - "Metadata Binding Mechanism""
MS Excel	2010/2013/2016	ISO/IEC 26300: OpenDocument v1.0 ISO/IEC 26300-1: OpenDocument v1.2 -- Part 1
Generic Still Image Coding		* ISO/IEC 10918-1:1994 - "Digital compression and coding of continuous-tone still images: Requirements and guidelines" * ISO/IEC 10918-3:1997 - "Digital compression and coding of continuous-tone still images: Extensions"
Generic document exchange, storage and long-term preservation		* ISO 19005-1:2005 - "Electronic document file format for long-term preservation - Part 1: Use of PDF 1.4" * ISO 19005-2:2011 - "Electronic document file format for long-term preservation - Part 2: Use of ISO 32000-1" * ISO 32000-1:2008 - "Portable document format - Part 1: PDF 1.7"
Generic word processing documents, spreadsheets and presentations	-	* ISO/IEC 29500-1:2016 - "Office Open XML File Formats -- Part 1: Fundamentals and Markup Language Reference" * ISO/IEC 26300-1:2015 - "Information technology -- Open Document Format for Office Applications (OpenDocument) v1.2 -- Part 1: OpenDocument Schema"

Protocol	Version	Standard
		* ISO/IEC 26300-2:2015 - "Information technology -- Open Document Format for Office Applications (OpenDocument) v1.2 -- Part 2: Recalculated Formula (OpenFormula) Format" * ISO/IEC 26300-3:2015 - "Information technology -- Open Document Format for Office Applications (OpenDocument) v1.2 -- Part 3:
SQL Data OLEDB provider	-	
PostgreSQL	8.x/9.x	
SharePoint (lists)	2007/2010 2013/2016 (new)	
Friendly Force Tracking	NFFI-IP1, NFFI-SIP-3	
	FFI	* ADatP-36 Edition A Version 2 - "Friendly Force Tracking Systems (FFTS) Interoperability" (STANAG 5527) * APP-11 Edition D Version 1 - "NATO Message Catalogue"
Sensor information interface		
ISR Library Interface Profile		Basic Image Interchange Format (BIIF) ISR Library Interface ISO Standards ISR Library Interface Military Standards ISR Library Interface STANAG
Formatted Messages for Intelligence Profile (SP3)		APP-11 for Intelligence (SP3) AJS-2.5 for Intelligence (SP3)
Formatted Messages for Intelligence Profile (SP4)		APP-11 for Intelligence (SP4) AEDP-15 for Intelligence (SP4) AEDP-17 for Intelligence (SP4)
Generic XML messages	Any	XML UTF-8
OpenSearch	v1.1	OpenSearch 1.1 (Draft 6) - "OpenSearch 1.1"
JREAP	JREAP-C	ATDLP-5.16 Edition B Version 1 - "Tactical Data Exchange - Link 16" ATDLP-5.18 Edition B Version 2 - "Interoperability Standard for Joint Range Extension Application Protocol (JREAP) - Revision C"
ADatP-3	V11-V12 (limited), V13.1	AdatP-3 for Battlespace Event Federation AdatP-3 for Formatted Messages for SA (SP3)
OTH-T Gold	Baseline 2000 Rev. D	NISP Standard - OTH-G - "Operational Specification for OVER-THEHORIZON TARGETING GOLD (Revision D) (OTH-G)"
OTH-T Gold 2007	Baseline 2007	OTH-T GOLD Baseline 2007 - "OVER-THE-HORIZON TARGETING GOLD baseline 2007"
Generic text messages	Any	

Protocol	Version	Standard
MIP 3.1	4,2	MIP 3.1 Information Exchange Specification
MIP 4.3		MIP 4.3 Information Exchange Specification
WSMP		*ADatP-5644(A) - "Web Service Messaging Profile (WSMP)" *ADatP-5644(A)(1) - "Web Service Messaging Profile (WSMP)"
NCOP IPS	1.1 / 1.2 2.X (new)	SOAP WSDL REST WS Reliable Messaging JSON WS Addressing HTML5
JCOP JIPS	2011	
Active Directory	2008-2012	
Active Directory Federation Services (ADFS)	??	SAML
Cryptographic Algorithms		AES DSS SHS MODP
X.509		X.509
LDAP	v3	LDAP
Certificate Exchange Protocols		Certificate Exchange
DNS		DNS, IPv4, IPv6
MS Exchange / MAPI	2007+	
IMAP / POP3	-	
Direct/Network File access	-	
FTP / SFTP	-	
HTTP / HTTPS	-	HTTP HTML5 UTF-8
SAML	v2.0	SAML URI
APP-6	A, B D	
MIL-2525-STD	B, C D (new)	
Custom icons & over HTTPS	-	

NCOP 2.0 Supported Standards

Protocol	Version	Standard
ADatP-3 for: -Battlespace Event Federation -Formatted Messages for SA	(D)(2)	APP-11 message formats MUST be supported (MTF Identifier, MTF Index Ref Number): -Incident Report (INCREP, A078) -Incident Spot Report (INCSPOTREP, J006) -Troops in Contact SALTA format (SALTATIC, A073) -Search and Rescue Incident Report (SARIR) -EOD Incident Report (EODINCREP - J069) / EO Incident Report (EOINCREP) -Events Report (EVENTREP, J092) -Improvised Explosive Device Report (IEDREP, A075) -Tasks and Orders: -Airspace Control Order (ACO - F011) -Air Tasking Order (ATO - F058) -Features: -Killbox Message (KILLBOX - F083) APP-11(D)(2) - "NATO MESSAGE CATALOGUE"
ADatP-3: Battlespace Event Federation	(D)(1)	APP-11 message formats MUST be supported (MTF Identifier, MTF Index Ref Number): -Incident Report (INCREP, A078) -Incident Spot Report (INCSPOTREP, J006) -Troops in Contact SALTA format (SALTATIC, A073) -Events Report (EVENTREP, J092) -Improvised Explosive Device Report (IEDREP, A075) APP-11 Edition D Version 1 - "NATO Message Catalogue"
UTF-8	-	RFC 3629 - "UTF-8, a transformation format of ISO 10646"
AES		FIPS PUB 197 - "Advanced Encryption Standard (AES)" NIST SP 800-56A Rev 3 - "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography"
DSS		FIPS PUB 186-4 - "Digital Signature Standard (DSS)"

Protocol	Version	Standard
MODP		RFC 3526 - "More Modular Exponential (MODP) Diffie-Hellman groups for Internet Key Exchange (IKE)" NIST SP 800-56B Rev 1 - "Recommendation for Pair-Wise Key Establishment Schemes Using Integer Factorization Cryptography"
SHS		FIPS PUB 180-4 - "Secure Hash Standard (SHS)"
Certificate exchange		PEM format with base64-encoded data, as defined in: RFC 5280 - "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile" RFC 7468 - "Textual Encodings of PKIX, PKCS, and CMS Structures"
X.509		ITU-T Recommendation X.509 - "Information technology - Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks" * RFC 6960 - "X.509 Internet Public Key Infrastructure Online Certificate Status Protocol - OCSP" * RFC 5280 - "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile"
LDAP		RFC 2798 - "Definition of the inetOrgPerson LDAP Object Class" RFC 4519 - "Lightweight Directory Access Protocol (LDAP): Schema for User Applications" RFC 2256 - "A Summary of the X.500(96) User Schema for use with LDAPv3" Added for SP4 RFC 4510 - "Lightweight Directory Access Protocol (LDAP): Technical Specification Road Map" RFC 4511 - "Lightweight Directory Access Protocol (LDAP): The Protocol" RFC 4512 - "Lightweight Directory Access Protocol (LDAP): Directory Information Models" RFC 4513 - "Lightweight Directory Access Protocol (LDAP): Authentication Methods and Security Mechanisms" RFC 4514 - "Lightweight Directory Access Protocol (LDAP): String Representation of Distinguished Names" RFC 4515 - "Lightweight Directory Access Protocol (LDAP): String Representation of Search Filters"

Protocol	Version	Standard
		RFC 4516 - "Lightweight Directory Access Protocol (LDAP): Uniform Resource Locator" RFC 4517 - "Lightweight Directory Access Protocol (LDAP): Syntaxes and Matching Rules" RFC 4518 - "Lightweight Directory Access Protocol (LDAP): Internationalized String Preparation"
DNS		Mandatory · RFC 1034 - "Domain names - concepts and facilities" · RFC 1035 - "Domain names - implementation and specification" · RFC 2181 - "Clarifications to the DNS Specification" · RFC 2782 - "A DNS RR for specifying the location of services (DNS SRV)" · RFC 3258 - "Distributing Authoritative Name Servers via Shared Unicast Addresses" · RFC 4786 - "Operation of Anycast Services" · RFC 5936 - "DNS Zone Transfer Protocol (AXFR)" · RFC 5966 - "DNS Transport over TCP - Implementation Requirements" · RFC 6382 - "Unique Origin Autonomous System Numbers (ASNs) per Node for Globally Anycasted Services" · RFC 6891 - "Extension Mechanisms for DNS (EDNS(0))" · RFC 7094 - "Architectural Considerations of IP Anycast"
URI		RFC 3986 - "Uniform Resource Identifier (URI): Generic Syntax"
APP-11 for Intelligence (SP3) (	(D)(2)	APP-11 messages: -Air Intelligence Report (AIRINTREP, F001) -Counter-Intelligence and Security Report (CIINTREP, J112) -Counter-Intelligence and Security Summary (CIINTSUM, J113) -Counter-Intelligence and Security Supplementary Report (CISUPINTREP, J115) -Detailed Document Report (DEDOCREP, J089)

Protocol	Version	Standard
		-First Hostile Act Report (First Hostile Act) -Intelligence Report (INTREP, J110) -Intelligence Summary (INTSUM, J111) -Maritime Intelligence Report (MARINTREP, J016) -Maritime Intelligence Summary (MARINTSUM, J015) -Supplementary Intelligence Report (SUPINTREP, J114) APP-11(D)(2) - "NATO MESSAGE CATALOGUE"
AJS-2.5 for Intelligence (SP3)	Ed. A	AJP-2.5 message formats MUST be supported (MTF Identifier): -Human Intelligence Report (HUMINTREP) -Human Intelligence Summary (HUMINTSUM) -Interrogation Report (INTGREP) AJP-2.5 Ed. A
APP-11 for Intelligence (SP4)	(D)(1)	APP-11 messages: -Air Intelligence Report (AIRINTREP, F001) -Counter-Intelligence and Security Report (CIINTREP, J112) -Counter-Intelligence and Security Summary (CIINTSUM, J113) -Counter-Intelligence and Security Supplementary Report (CISUPINTREP, J115) -Detailed Document Report (DEDOCREP, J089) -First Hostile Act Report (First Hostile Act) -Operational Tasking Intelligence (OPTASK INTEL) -Maritime Intelligence Report (MARINTREP, J016) -Maritime Intelligence Summary (MARINTSUM, J015) -Supplementary Intelligence Report (SUPINTREP, J114) APP-11 Edition D Version 1 - "NATO Message Catalogue"

Protocol	Version	Standard
AED-15 for Intelligence (SP4)	Ed. A v1	AEDP-15 messages: -Biometric Enabled Watch List (BEWL) -Biometric Intelligence Analysis Report (BIARS) AEDP-15 Edition A Version 1 - "NATO Biometrics Data, Interchange, Watchlisting and Reporting"
AED-17 for Intelligence (SP4)		AEDP-17 messages: -Intelligence Report (INTREP) -Intelligence Summary (INTSUM) -Human Intelligence Report (HUMINTREP) -Human Intelligence Summary (HUMINTSUM) -Pentagram Report (PentagramREP) AEDP-17 Edition A Version 1 - "NATO Standard ISR Library Interface"
Basic Image Interchange Format (BIIF)		* ISO/IEC 12087-5:1998 - "Image Processing and Interchange (IPI) -- Functional specification -- Part 5: Basic Image Interchange Format (BIIF)" * ISO/IEC 12087-5:1998/Cor 1:2001 - "Technical Corrigendum 1 to International Standard ISO/IEC 12087-5:1998" * ISO/IEC 12087-5:1998/Cor 2:2002 - "Technical Corrigendum 2 to International Standard ISO/IEC 12087-5:1998"
ISR Library Interface ISO Standards		* ISO 639-2:1998 - "Codes for the representation of names of languages -- Part 2: Alpha-3 code" * ISO/IEC 11179-3:2013 - "Metadata registries (MDR) -- Part 3: Registry metamodel and basic attributes" * ISO/IEC 14750:1999 - "Open Distributed Processing -- Interface Definition Language"
ISR Library Interface Military Standards		* AEDP-17 Edition A Version 1 -"NATO Secondary Imagery Format Implementation Guide" * AEDP-7 Edition B Version 1 - "NATO Ground Moving Target Indicator Format Implementation Guide"
ISR Library Interface STANAG		Implementation of JC3IEDM (STANAG 5525) in the context of the ISR Library Interface Profile is limited to the definition of unique keys that could be used to unambiguously refer to an external

Protocol	Version	Standard
		information object that is modelled in accordance with JC3IEDM. Note that AEDP-17 refers to the metadata attribute “JC3IEDMIdentifier” on page G-15, but to “identifierJC3IEDM” on page G- 79. The correct attribute to use is “identifierJC3IEDM”. * JC3IEDM Baseline 3.1.4 - "Joint C3 Information Exchange Data Model"
SAML	v2.0	OASIS - Security Assertion Markup Language (SAML) v2.0 · **RFC 5322 - "Internet Message Format"**
JSON		The application/json Media Type for JavaScript Object Notation (JSON)
XHTML	v1.0	XHTML 1.0 in XML Schema
XML	v1.0	W3C - XML 1.0 Recommendation W3C - XML Schema Part 1: Structures W3C - XML Schema Part 2: Datatypes RFC 7303 - XML Media Types
Text-based Collaboration XMPP Standards		RFC 6120 - "Extensible Messaging and Presence Protocol (XMPP): Core" RFC 6121 - "Extensible Messaging and Presence Protocol (XMPP): Instant Messaging and Presence" RFC 6122 - "Extensible Messaging and Presence Protocol (XMPP): Address Format" * XEP-0012 - "Last Activity" * XEP-0030 - "Service Discovery" * XEP-0047 - "In-Band Bytestreams" * XEP-0054 - "vcard-temp" * XEP-0055 - "Jabber Search" * XEP-0060 - "Publish-Subscribe" * XEP-0092 - "Software Version" * XEP-0106 - "JID Escaping"

Protocol	Version	Standard
		* XEP-0114 - "Jabber Component Protocol" * XEP-0115 - "Entity Capabilities" * XEP-0160 - "Best Practices for Handling Offline Messages" * XEP-0199 - "XMPP Ping" * XEP-0202 - "Entity Time" * XEP-0203 - "Delayed Delivery" * XEP-0220 - "Server Dialback" Additions for Basic Text-based Collaboration Chatroom Profile (SP4) XEP-0059 XEP-0082 XEP-0313
CSS	v2.1	W3C - Cascading Style Sheets Level 2 Revision 1 (CSS 2.1) Specification W3C - CSS Style Attributes W3C - CSS Namespaces Module Level 3 W3C - CSS Color Module Level 3
HTML5		RFC 2854 - "The 'text/html' Media Type" W3C - HTML5 - "HTML5" RFC 4329 - "Scripting Media Types" W3C - Media Queries - "Media Queries" W3C - Selectors Level 3 - "Selectors Level 3"
HTTP	1.1	RFC 7230 - "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing" RFC 7231 - "Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content" RFC 7232 - "Hypertext Transfer Protocol (HTTP/1.1): Conditional Requests" RFC 7233 - "Hypertext Transfer Protocol (HTTP/1.1): Range Requests"

Protocol	Version	Standard
		RFC 7234 - "Hypertext Transfer Protocol (HTTP/1.1): Caching" RFC 7235 - "Hypertext Transfer Protocol (HTTP/1.1): Authentication" RFC 2817 - "Upgrading to TLS Within HTTP/1.1"
URL		RFC 1738 - "Uniform Resource Locators (URL)"
REST		NISP Standard - REST - "Representational State Transfer (REST)"
SOAP		W3C Note - Simple Object Access Protocol (SOAP) 1.1
WS Addressing		W3C - Web Services Addressing 1.0 - Core
WSDL		W3C Note - Web Services Description Language 1.1 W3C - Web Services Description Language (WSDL) Version 2.0 SOAP 1.1 Binding
WS Reliable Messaging		OASIS - Web Services Reliable Messaging v1.2
MIP 3.1	v3.1	MIP4 Information Exchange Specification v3.1
MIP 4.3	v4.3	MIP4 Information Exchange Specification v4.3
WSMP	Ed. A, v1	ADatP-5644 Edition A Version 1 - "Web Service Messaging Profile"
NVG Binding	v2.0.2	NVG Bindings to APP-6 Edition D Version 1 - "NATO Joint Military Symbology"
STANAG 4774	Edition 1	NATO Core Metadata STANAG 4774 Edition 1 - "Confidentiality Metadata Label Syntax"
STANAG 4778	Edition 1	NATO Core Metadata STANAG 4778 Edition 1 - "Metadata Binding Mechanism"
SIP for Service Management and Control		Includes guidance on (www.tmforum.org): * TMForum TMF621 - "TMForum Trouble Ticket API REST Specification R14.5.1" * TMForum TMF638 - "TMForum Service Inventory Management API REST Specification, R16.5.1" * TMForum TMF639 - "TMForum Resource Inventory Management API REST Specification R17.0.1" * TMForum TMF641 - "TMForum Service Ordering API REST Specification R16.5.1" * TM Forum TMF000 - "TM Forum Event Management API TMF000 R17.5 (initial draft)"

Protocol	Version	Standard
		* TMForum TR250 - "TMForum API REST Conformance Guidelines R15.5.1" * TMForum TMF661 - "TMForum Trouble Ticket API Conformance Profile R16.5.1" * TM Forum TMF674 - "TM Forum Geographic Site Management API REST Specification, R17.5.0
SIP for Binding Metadat to XMPP Stanzas		SIP for Binding Metadata to XMPP Stanzas
SIP for binding Metadata to HTTP Messages		SIP for binding Metadata to HTTP Messages
SIP for binding Metadata to SOAP Messages		SIP for binding Metadata to SOAP Messages
SIP for binding Metadata to Common File Formats		SIP for binding Metadata to Common File Formats

1.7.2.3 Other reference documents

Reference that can be usefully consulted when carrying out activities associated with the contract.

Ref.	Title	Issue
[OGC WMS]	OpenGIS® Web Map Server Implementation Specification	Version 1.3.0 2006-03-15
[OGC WFS]	Web Feature Service Implementation Specification	Version 1.1.0 3 May 2005
[OGC WCS]	Web Coverage Service (WCS) Implementation Standard	Version 1.1.2 2008-03-19
[OGC WMC]	Web Map Context Documents	Version 1.1.1 2005-01-19
[OGC SLD]	Styled Layer Descriptor profile of the Web Map Service Implementation Specification	Version 1.1.0 2007-06-29
[TIMS GG]	Graphical Guidelines for Theatre Information Management Services – Tactical Editor Ref: F0057 62 629 322AA – 000	Latest version
[CONNECTION STRING]	http://www.connectionstrings.com	
[MSDN]	Microsoft Developer Network Library http://msdn.microsoft.com/library/default.aspx	
[PDF]	Portable Document Format (PDF), Adobe Systems Incorporated, Adobe Systems Incorporated ISBN 0 200 175839 3:2003	Version 1.4
[ISO8601]	Data elements and interchange formats -- Information interchange -- Representation of dates and times	

Ref.	Title	Issue
[XML]	W3C - eXtensible Markup Language (XML) W3C REC-xml-20001006:2000	Version 1.0 (Second Edition),
[XSD]	W3C - XML Schema Definition 1.0 REC, W3C 2001: XML Schema Part 0: Primer (W3C REC-xmlschema-0-20010502:2001), XML Schema Part 1: Structures (W3C REC-xmlschema-0-20010502:2001), XML Schema Part 2: Datatypes (W3C REC-xmlschema-0-20010502:2001).	
[XSL]	W3C - eXtensible Stylesheet Language (XSL) 1.0 W3C REC-xsl--20011015:2001	
[XSLT]	W3C - eXtensible Stylesheet Language Transformations (XSLT) 1.0 and 2.0 Recommendations	
[UUID]	Universally Unique Identifier (UUID) Specification. ISO/IEC 11578:1996 or DCE UUID	
[C#]	ISO - Information Technology - Programming Language C#, ISO/IEC 23270:2003.	
[JavaScript]	ECMA-262	

Ref.	Title	Issue
[AJP-02]	AJP-02.1 (A), Intelligence Procedures	March 2002
[AEDP-2]	AEDP-2, NATO Intelligence, Surveillance, and Reconnaissance (ISR) Interoperability Architecture (NIIA), Vol. 2: NIIA Management Guidance	Sept. 2005
[APP11-C]	APP-11C, NATO Message Catalogue	
[AJP-3]	AJP-3, Allied Joint Operations	Sept. 2002
[MCM-0038]	MCM-0038-2005 NATO Military Committee Memorandum on NNEC	June 2005
[STANAG2014]	STANAG 2014, Formats For Orders And Designation	Ed 09, October 2000
[STANAG2211]	STANAG 2211, Geodetic Datum, Projections, Grids and Grid References	May 2001
[ADatP-34]	ADatP-34 (D), NATO Interoperability Standards and Profiles (NISP), AC/322(SC/1)N(2010)0005	Ver 4 July 2010
[AdatP-3]	Allied Data Processing Publication number 3	V11-V12, V13.1
[C-M49]	C-M(2002)49 Security Within NATO, with Corrigendum 8,	April 2010
[AC322-D/52]	AC/322-D/0052-REV2, Primary Directive on INFOSEC	Dec. 2010
[AC322-D/48]	AC/322-D/0048-REV1, NC3B, INFOSEC Technical Implementation Directive for Computer and Local Area Network (LAN) Security	Dec 2007
[AC/35-D/2005-2]	AC/35-D/2005-REV2, NATO INFOSEC Management Directive for CIS	Oct. 2010
[AC/322-D30]	AC/322-D/0030-REV5, C3B, INFOSEC Technical and Implementation Directive for the Interconnection of CIS	Feb. 2011
[AC/35-D/1019]	AC/35-D/1019-REV1, Guidelines For Security Evaluation and Certification of CIS	Dec. 2008
[APP-6A]	APP-6A, Military Symbols for Land Based Systems	Dec. 1999
[APP-6B]	APP-6B, Military Symbols for Land Based Systems	JUNE 2008

Ref.	Title	Issue
[APP-6D]	APP-6D, Military Symbols for Land Based Systems - Edition D Version 1	OCTOBER 2017
[AC/322-D52]	AC/322-D(2006)0052-AS1, NATO CIS Configuration Management Policy And Directive	Sept. 2006
[AC/322-D24]	NATO Public Key Infrastructure (NPKI) Certificate Policy, AC/322-D(2004)0024-REV2	Jan. 2008
[CSD WS]	MAJIIC 2 WS-NOTIFICATION IMPLEMENTATION GUIDE - DOCUMENT VERSION 2.0	
[CSD Publish Service]	MAJIIC 2 CSD PUBLISH SERVICE SPECIFICATION SERVICE VERSION 4.4 DOCUMENT VERSION 3.0	
[MIPS]	Bi-SC AIS Minimum Infrastructure Procurement Specifications (MIPS)	Ver 5.5 10 Dec. 2010
[AFPL]	NCSA- NS Network- Approved Fielded Product List (AFPL)	Ver 2010-20
[BAPPL]	Bi-SC AIS Procurement Product List (BAPPL)	Ver12-2010
[STANAG5516]	STANAG 5516 Tactical Data Exchange – Link 16	
[AC/322-D07]	AC/322-D(2006)0007 – Guidance on the use of Metadata Element Descriptions for use in the NATO Discovery Metadata Specification (NDMS)	
[AC/322-N15]	AC/322(SC/1)N(2009)0015 (INV), NATO Core Enterprise Services Framework	V1.2 Apr.2009
[RD-2814]	NC3A RD-2814 – Bi-SC AIS SOA Implementation Guidance	Dec. 2009
[RD-2666]	NC3A RD-2666 Information Exchange Gateway (IEG) Roadmap	Mar. 2010
[ACCS ICD]	EXTERNAL INTERFACE REQUIREMENTS SPECIFICATION – NCOP Air Command and Control System (ACCS) Theatre Missile Defence Capability 1 (TMD1) Initial Operational Capability (IOC)	29 March 2016
[AirC2IS-IC]	NATO Air Command and Control Information Services (AirC2IS) – Overview of Integration Core,	Ver 0.1
[AirC2IS-SDS]	System Design Specification Interface Control Document AirC2IS_SDS_Annex_04_ICD – Revision 5.1	
[AirC2IS-SRS]	System Requirements Specification (SRS) for Air Command And Control Information Services (AirC2IS)	Ed. 1.1 Sep.. 2009
[AirC2IS-SDS Appendix C]	AirC2IS_SDS_Annex_04_ICD_Appendix_C_NVG" Excel file	
[TIDE]	TIDE Transformational Baselines	V2.0 and V3.0
[JCHAT-ICD]	Interface Control Document (ICD) For Joint Tactical Chat (JCHAT) System	Ed. 1.1 Dec. 2010
[AirC2IS-IDD]	Interface Definition between AirC2IS and TOPFAS, LOGFAS and JOIIS	Ed. 1.0 May 2009
[AirC2IS-ICD]	(AIRC2IS) INCREMENT 1 System Design Specification (SDS) Annex 4 : Interface Control Document (ICD)	0.7.1 06.03.2013
[ICC]	Standard Interface Document for ICC and JTS 2.7.3.	
[JTS/FAST 4.1.x]	JTS/FAST 4.1.x - Interface Control Document (ICD)	V.1.3 1-Dec-2019
[JTS/FAST 4.2.0]	JTS/FAST 4.2.0 -Interface Control Document (ICD)	V1.5 30 May 2020
[WISI 1.4.0]	Web Service Interface Standard for ICC (WISI) - Release ICC 1.4.0	v.1.4.0, January 2011

Ref.	Title	Issue
[WISI 3.4.0]	Web Services Interface Standard for ICC (WISI) - Release ICC 3.4.0	Release ICC 3.4.0 2020-03-09
[NIRIS-ICD 4.0]	NIRIS WEB SERVICES ICD VERSION 1.3.1 - APPLICABLE TO NIRIS 4.0.0	May 2020
[JCOP-ICD]	JCOP Interface Definition for JCOP	V0.6.1 December 2011
[IEG-C]	IEG-C Technical documentation / XML Security Labels-RD2903 and RD2077	
[Core GIS ICD]	BI-SC AIS Core Geographic Services Interface Control Document	 Version 3.0.1 8 February 2012
[IDM]	SERVICE-ORIENTED ARCHITECTURE & IDENTITY MANAGEMENT PLATFORM	
[INTEL-FS ICD]	Interface Control Document for the INTEL-FS Project	2016/08/29
[LC2IS ICD]	Increment-1 FOC Interface Control Document (ICD) for the LC2IS Project	Mar. 2010
[W3CW]	W3C Web content Accessibility Guidelines	Edition 2.0
[LOGFAS]	Interface Control Document (ICD) for LOGFAS	Draft v0.2, 21 Jun 2011
[JOIIS]	Joint Operations / Intelligence Information System (JOIIS) Interface Control Document	V0.2, January 2012
[TOPFAS]	Software Design Specification Annex 3: Interface Control Document TOPFAS: Tools for Operations Planning Functional Area Service Increment 1.1	Release 0.6 06/12/2013
[MCCIS ICD]	MCCIS INTERFACE CONTROL DOCUMENT	05 November 2007
[MCCIS ICD 1.2]	MCCIS INTERFACE CONTROL DOCUMENT	Version 1.2 25 July 2014
[MIL2525-STD-B]	MIL-STD-2525B - DEPARTMENT OF DEFENSE - INTERFACE STANDARD-COMMON WARFIGHTING SYMBOLOGY MIL-STD-2525B w/CHANGE 2	7 MARCH 2007
[MIL2525-STD-C]	MIL-STD-2525C - DEPARTMENT OF DEFENSE - INTERFACE STANDARD-COMMON WARFIGHTING SYMBOLOGY	17 NOVEMBER 2008
[MIL2525-STD-D]	MIL-STD-2525D - DEPARTMENT OF DEFENSE - INTERFACE STANDARD - JOINT MILITARY SYMBOLOGY	10 JUNE 2014
[MIP BL 3.1]	Multilateral Interoperability Programme	BL 3.1
[MIP BL 4.3]	Multilateral Interoperability Programme	BL 4.3
[FFI]	FRIENDLY FORCE TRACKING SYSTEMS (FFTS) INTEROPERABILITY	20 March 2017
[NFFI IP1]	NATO FRIENDLY FORCE INFORMATION (NFFI) STANDARD FOR INTEROPERABILITY OF FORCE TRACKING SYSTEMS (FTS) STANAG 5527	Draft 3 4 june 2007

Ref.	Title	Issue
[NFFI SIP3]	NFFI SERVICE INTEROPERABILITY PROFILE 3 (SIP3) TECHNICAL SPECIFICATIONS	VERSION 1.1.5 March 2009
[NVG]	NATO Vector Graphic	v1.4 / v1.5 / v2.0/ v2.0.1/ v2.0.2 / v2.0.3
[NVG Streaming]	NATO Vector Graphic Streaming Protocol	v1.4 / v1.5 / v2.0
[OTHT-Gold 2000 Rev D]	OVER-THE-HORIZON TARGETING GOLD	Baseline 2000 Rev. D
[OTHT-Gold 2007]	OVER-THE-HORIZON TARGETING GOLD	Baseline 2007
[JOCWatch]	JOCWatch OIR Web Services Specification Operations Incident Reporting Standard Model	Version 1.0 September 2011
[C4ISR-VIZ]	Visualization Component Interface Control Document (VC-ICD)	6 APR 2020
[XMPP ICD]	XMPP IM/CHAT Interface Control Document	1st july 2010 – AMN FOC (14-feb 2011)

1.7.3 Project Related Documents

Ref.	Document Reference	Issue	Title
[PMP]	F0057 67669226-556		Project Management Plan for the NCOP2 Project
[PPBS]	F0057 67669226-556		Annex 1 to the Project Management Plan for the NCOP2 Project: Project Product Breakdown Structure
[PWBS]	F0057 67669226-556		Annex 2 to the Project Management Plan for the NCOP2 Project: Project Work Breakdown Structure
[PMS]	F0057 67669226-556		Annex 3 to the Project Management Plan for the NCOP2 Project: Project Master Schedule
[RiskLog]	F0057 67669226-556		Annex 4 to the Project Management Plan for the NCOP2 Project: Initial Risk Log
[CMP]	F0057 67669307-396		Configuration Management Plan for the NCOP2 Project
[SDS]	F0057 67669298-424		System Design Specification for the NCOP2 Project
[Trac_Mat]	F0057 67669298-424		Annex 2 to the System Design Specification for the NCOP2 Project: Requirement Traceability Matrix
[SDP]	F0057 67669301-311		System Development Plan for the NCOP2 Project
[ICD]	F0057 67680923 558		Interface Control Document for the NCOP2 Project
[RIS]	F0057 67669301-311		Annex 1 to the System Development Plan for the NCOP2 Project: Requirements Implementation Schedule
[UEP]	F0057 67669302-311		Usability Engineering Plan for the NCOP2 Project
[TestP]	F0057 67669305-440		Project Test Plan for the NCOP2 Project
[ILSP]	F0057 67669310-437		Integrated Logistic Support Plan for the NCOP2 Project
[UIS]	F0057 67669298-424		User Interface Specification for the NCOP2 Project
[ICG-03]			INSTALLATION AND CONFIGURATION GUIDE (ICG) - 03 Configuring and testing
[SBI]			NCOP Software Build Instructions

For all these documents, the latest version is applicable.

2 SYSTEM OBJECTIVE

2.1 OPERATIONAL PERSPECTIVE

In the frame of the Bi-Strategic Command's Automated Information System Functional Services (Bi-SC AIS FS), the NCOP2 capability provides a suite of Functional Services to NATO staff to support and enhance the execution of their operational missions, processes and tasks.

The purpose of NCOP2 is to enable Organisational Entities to share common views of an Area of Interest (AOI) or mission thereby improving their situational awareness.

Fully integrated in the NATO Network Enabled Capability (NNEC) environment, NCOP2 services support coordination and de-confliction of activities during the planning and conduct of NATO-led missions.

NCOP2 provides information services to:

- Allow the definition of Common Operational Pictures,
- Allow the definition and retrieval of Information Products from Entities in order to make them part of a Common Operational Picture
- Expose this COP to any consumers.

NCOP2 services significantly improve the decision making process by enabling rapid and intuitive selection of relevant information for a particular AOI, mission or task.

NCOP-2 is the continuation of NCOP-1 and, therefore, must offer all functionalities present in the first increment.

NCOP-2 will enhance existing (NCOP-1) capability by managing the obsolescence of COTS and providing additional operational functionalities:

- Improved Geographic COP editor with 3D representation capability thanks to a modern, highly configurable, responsive and user-friendly user interface based on advanced WEB technologies,
- Improved data acquisition by supporting additional interfaces for future functional services with command and control information systems,
- Improved information construction by the possibility of creating relationships between data (correlation, aggregation, association),
- Improved dynamic and temporal representation of tracks and information flows to allow high-level commands to monitor critical actions (representation of time through smooth dynamic replay of picture evolutions),
- Improved information persistence by tracking events and changes over time,
- Improved integration with Enterprise Core Services,

- Integration to NATO Data Centre infrastructure and Identity Management (IdM) Platform products. The “eXtra Large scale” Node, which hosts multiple logical NCOP2 instances, will support up to concurrent 3000 users.

2.2 UNDERSTANDING OF KEY REQUIREMENTS

This section is intended to provide an overview of the functional requirements for NCOP as specified in the SRS. The purpose is not to be exhaustive but to provide a glimpse at major functional features expected from NCOP.

Foreword: Although NCOP shall have the ability to maintain multiple COP instances, with several NATO entities playing different roles towards each individual COP instance, this introductory section focuses on one single COP instance for the sake of clarity.

Key concept	Description
COP	A COP (Common Operation Picture) is organized as a layering of individual COP Information Products (COP IP).
Source	A source is a service belonging to a command, and sharing data or information. Systems that provide source services are called source systems and are usually information systems (C2 systems).
Command	A command is a NATO entity where NCOP is used (for example JFC Brunssum, JFC Naples, CCOMC, MARCOM, LANDCOM, AIRCOM …).
COP Information Product	COP Information products are contained in a COP, are provided by sources (external sytems) and contain Battle Space Objects (BSOs).
Security Classification	A security classification is a combination of a policy identifier, a marking and a category. COP IP are defined with 2 security classifications (informative and published: manually enforced, the original or highest of the node). COP are defined with 2 security classifications (informative and published: manually enforced or highest of the node).
Node	A node is a set of services which are deployed on the same infrastructure and which are under the same system administration authority and within the same domain.
Owner	A COP is initiated and maintained by a single organisational command: the COP Owner command.
Shared View	A Shared View is a set of predefined visualization parameters that will allow several consumer entities to display the very same representation of the COP.

2.2.1 COP concept

A COP can be thought of as a repository of information which aims at being fed by identified contributing entities and then shared by commands in order to enhance their planning and decision making processes.

Although no restriction should be brought by NCOP, it is foreseen that two types of COP will be managed:

AOI (Area Of Interest) COP: continuously monitored to spot within the AOI any event which may evolve into a situation where possible NATO intervention or operation might be decided;

Mission Specific COP: such a COP is devoted to a NATO mission (e.g. ISAF, Libya) and can be initiated by focusing on mission related contents of an AOI COP.

Contributing entities will be responsible for providing relevant information linked to their individual areas of interest or responsibility, and the COP concept will make available a set of global, joint views of operations to authorized commands.

An important concept around the COP is that of COP ownership: responsibility for initiating and maintaining a COP is assigned to a single organizational entity. Such an assignment can evolve in a COP life cycle (transfer of ownership) to reflect operational contingencies or to ensure migration from an AOI COP to a Mission Specific COP.

The following pictures illustrate the generic COP concept, and depict a possible responsibility assignment in the context of a particular mission.

Figure 2-1: Generic COP concept

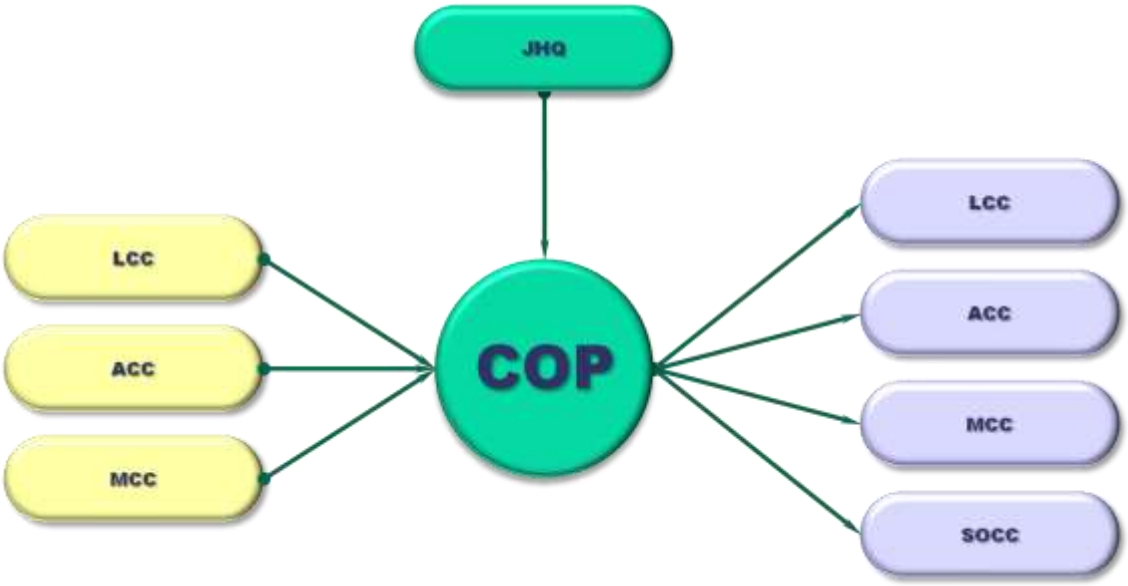

Figure 2-2: Notional use of Mission Specific COP

From a system perspective, this organizational view maps onto a system view describing interconnected systems.

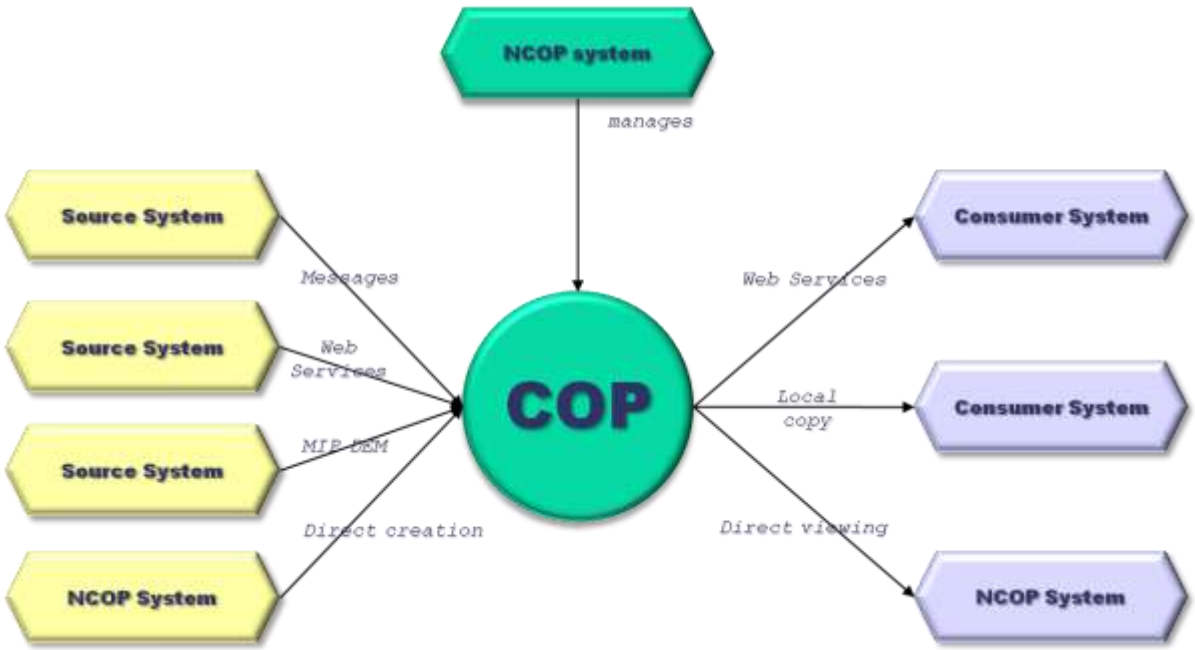

Figure 2-3: Systems involved within COP concept

This picture illustrates some key aspects of the COP implementation requirements:

The NCOP system is focused on the task of collecting, maintaining and disseminating operational information relevant to a specific COP;

Due to the flexibility in NATO deployments and foreseen evolutions of systems, NCOP should support a wide variety of transport protocols and data formats in order for source systems to interact with the NCOP system;

The preferred method for consumer systems to access COP contents is to make use of Web Services exposed by the NCOP system solution;

NCOP shall however implement a viewing capability (“end-user application”) in order to allow consumer entities to visualize a COP, either in complement or in substitution to their own systems;

Similarly NCOP shall support source entities in contributing to the COP by allowing direct creation of information into the COP.

2.2.2 COP contents

2.2.2.1 COP organisation

The operational content of a COP is organized as a layering of individual COP Information Products (COP IP), as described in the following picture.

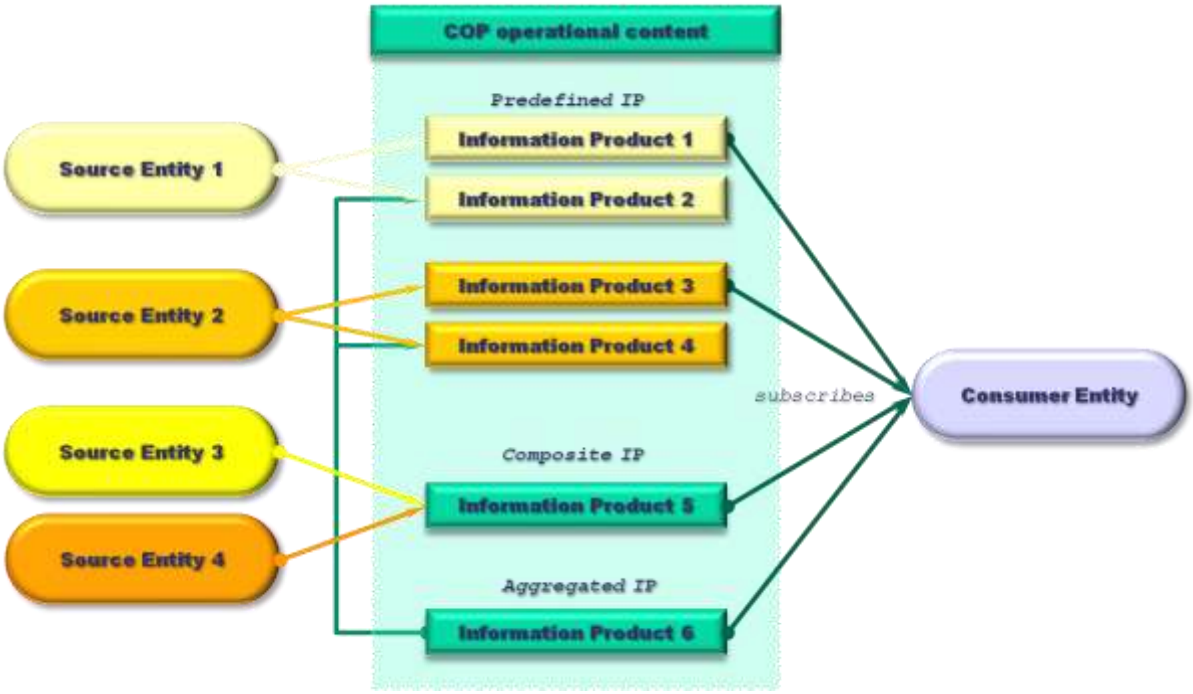

Figure 2-4: Operational content of a COP

This picture illustrates some key aspects of the COP implementation requirements:

Several types of COP IP are required:

- Predefined Information Products are those listed in Annex A.0 to the SRS. Each of them is under responsibility of one single source entity, which is the only

entity allowed to update it. A single entity can however contribute to more than one Information Product;
- Composite Information Products are Information Products that can be fed by more than one source entity. Responsibility for validation of the content of such a composite Information Products will be placed with the COP owner entity, unless other rules can be defined;
- Aggregated Information Products can be thought of as playlists pointing to other Information Product, they can be used as shortcuts to designate a collection of Information Product either for subscription or for visualization purposes. Aggregated Information Product are under responsibility of the COP owner entity and can be dynamically created, modified and deleted.

The layering organization of Information Products reflects the fact that the NCOP purpose is to make available to consumer entities information products provided by source entities with no alteration. It avoids complexity linked to implementing a structured data model encompassing all information items delivered by source entities, and to developing fusion mechanisms between information items provided by multiple source entities;

Consumer entities will access COP contents according to their operational requirements through a subscription mechanism to specific Information Products, complemented by a Role-Based Access Control (RBAC) enforced within the NCOP system.

In addition to previously described operational content, a COP also embeds supporting information such as:

Shared Views: A Shared View is a set of predefined visualization parameters that will allow several consumer entities to display the very same representation of the COP (e.g. to support common understanding in the context of a video or audio conference). These settings include:

- Visible Information Products, Visible BSO (based on filtering);
- Level of Details;
- Geographic reference;
- Display scale factor;
- Visible geo data;
- Visualization filter settings.

COP maps;

Annotations: Those are textual comments added to each COP IP or shared view;

COP structures: these are tree-like representations of existing COP IP according to various view-points.

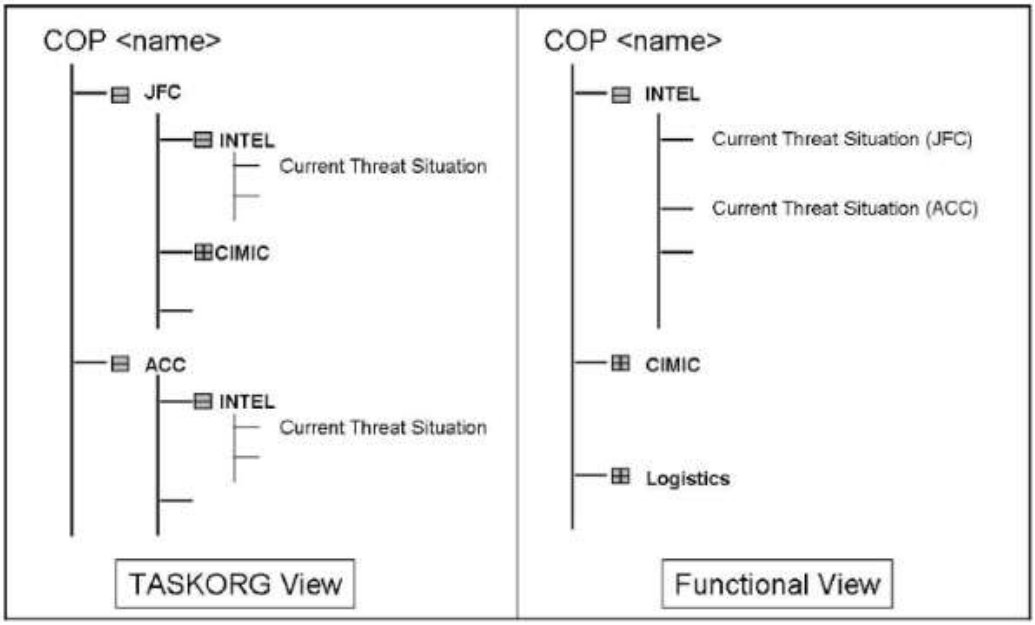

Figure 2-5: Several COP structures within COP

Supporting Elements (also called Management Information):

- Policies and security settings;
- Entity Information;
- Dissemination settings;
- Node (LAN) information;
- Services configurations settings;

2.2.2.2 COP IP contents

Each COP IP is of a specific category, identified in the SRS:

Overlay: this category of COP IP is used to store structured information relative to the battlespace. An overlay is a collection of Information Objects which can be generic or describe actual elements of the battlespace; in this case they are called BattleSpace Objects (BSO). The Information Objects of an overlay can be represented as a list ("BSO List" Information Panel) or as a matrix ("Matrix View" Information Panel); If an overlay contains relations between BSO then these relations can be represented as relationship graph or tree structure;

Geographic Data: this category of COP IP is based on OGC formats (WMS, WMTS or KML geographic layers).

Document: this category of COP IP conveys any kind of information that can be accessed through standard editing products.

COP IPs are stored in the COP Common Data Format which provides for metadata for all COP IP irrespectively of their category, amongst which:

The original information, as received from the source entity, which was used to create/update the COP IP;

Security classification for the COP IP: this setting is associated with the security classification of the source entity system responsible for this COP IP update. In the case of a composite COP IP, the higher security classification of contributing sources should be retained.

2.2.2.3 COP IP lifecycle

Most of NCOP IP will be “data-driven”: source entities will provide (through push or pull mechanisms) their contribution to the COP which will be stored in the NCOP system and made available to consumer entities. For this type of COP IP two update mechanisms are required:

Full update: In this case an update of a COP IP replaces the old content with the new content. However the previous content is not deleted so that the history of successive versions of the COP IP is available to consumers through time-based filtering mechanisms;

Partial update: In this case the update content accumulates with previous contents for a specific COP IP. As a result, creation of a history for this COP IP has to be triggered (manually or automatically) at specific points in time and consists in “freezing” the accumulation process, recording the COP IP content, and starting a new sequence of partial updates.

According to the nature of the COP IP and of COP manager preferences, the update sequence may require approval by the COP Manager.

The following picture illustrates both update methods in the case of a source entity updating a COP IP on an hourly basis, with the most recent Information Product update being performed at 2000Z.

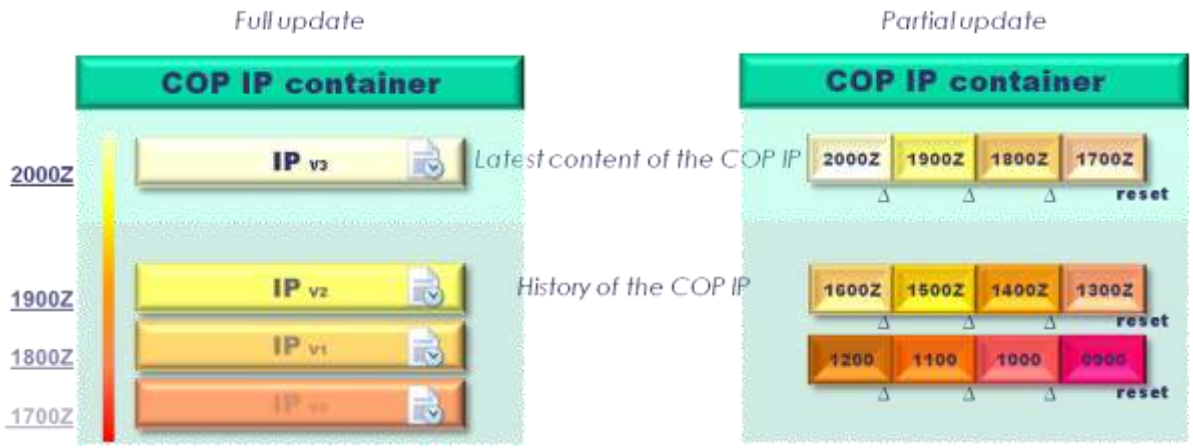

Figure 2-6: COP IP update methods

Specific COP IP will be “dynamic”: NCOP will maintain meta-data associated with the COP IP, while the operational content of the COP IP will remain within the system of the source entity. NCOP will maintain a link to this operational content and provide consumers with adequate methods for retrieving it.

2.2.3 Distributed management of a COP

Although management of a given COP is under responsibility of a single organizational entity, this entity can be deployed across several sites, resulting in assigning partial responsibility of managing COP contents to each of these sites. In this context managing the COP involves the following mechanisms:

Each source entity delivers its Information Products to a dedicated site of the COP Owner entity according to operational considerations;

The various sites of the COP owner entity synchronize periodically their COP contents. In order for global COP content to be as consistent as possible, it is assumed that this synchronization takes place after each COP IP update. This synchronization mechanism identifies one of the COP owner sites as a “Main site”;

After synchronization, COP content is available to COP consumer entities by subscribing to COP content at any of the COP owner sites. Selection of which COP site to subscribe to will likely be based on networking considerations.

The following diagram illustrates this notion. Note that for the sake of consistency with SRS wording the picture identifies nodes rather than sites: a node is a LAN deployed within a site to support operational activity of part of an entity.

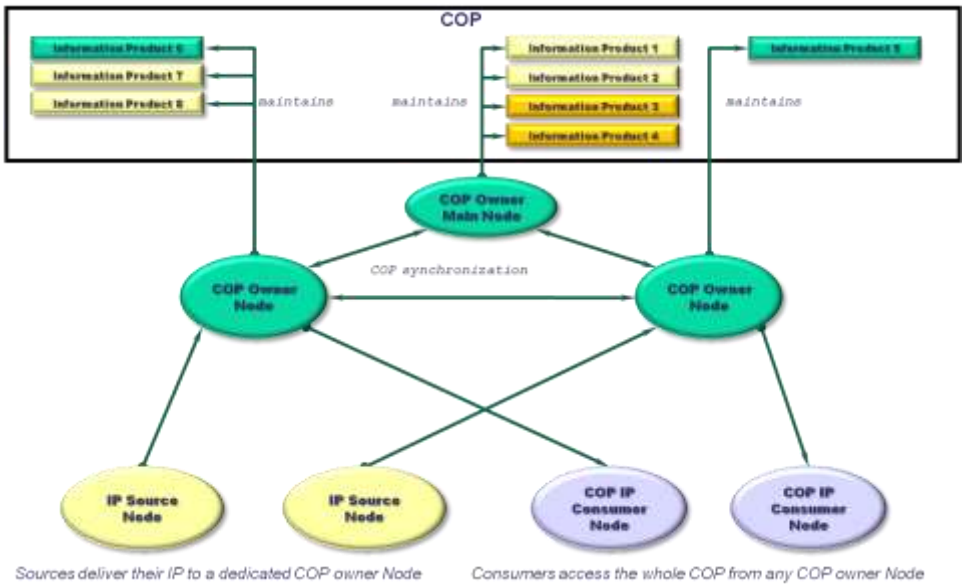

Figure 2-7: COP distributed management

2.2.4 Cross domain support

The NCOP system must support operations in the case where organizational entities interacting with a given COP operate in different security domains (National Secret, Mission Secret and NATO secret). It shall also support the case where a single organizational entity (including the COP owner entity) is deployed across several nodes in different security domains. This results in the requirement for NCOP to support the following cross-security exchange scenarios:

NATO SECRET enclave to NATO SECRET enclave (IEG case A);

NATO SECRET enclave to National SECRET enclave (IEG case B);

NATO SECRET enclave to NATO-led Mission SECRET enclave (IEG case C).

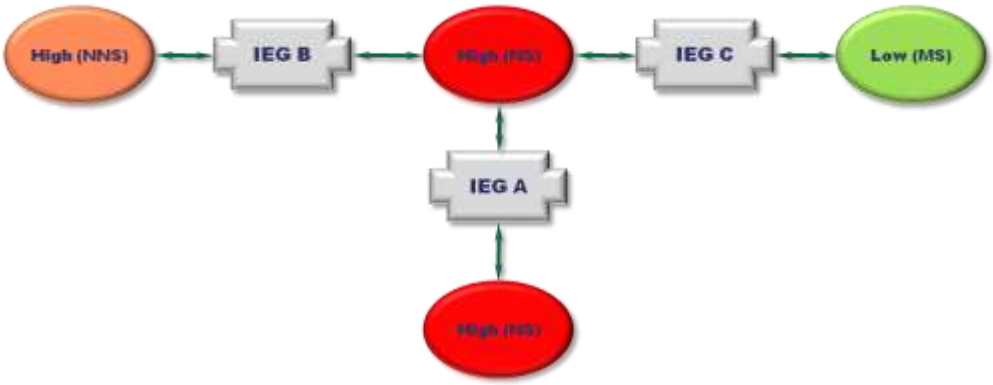

Figure 2-8: Cross-domain exchange principles

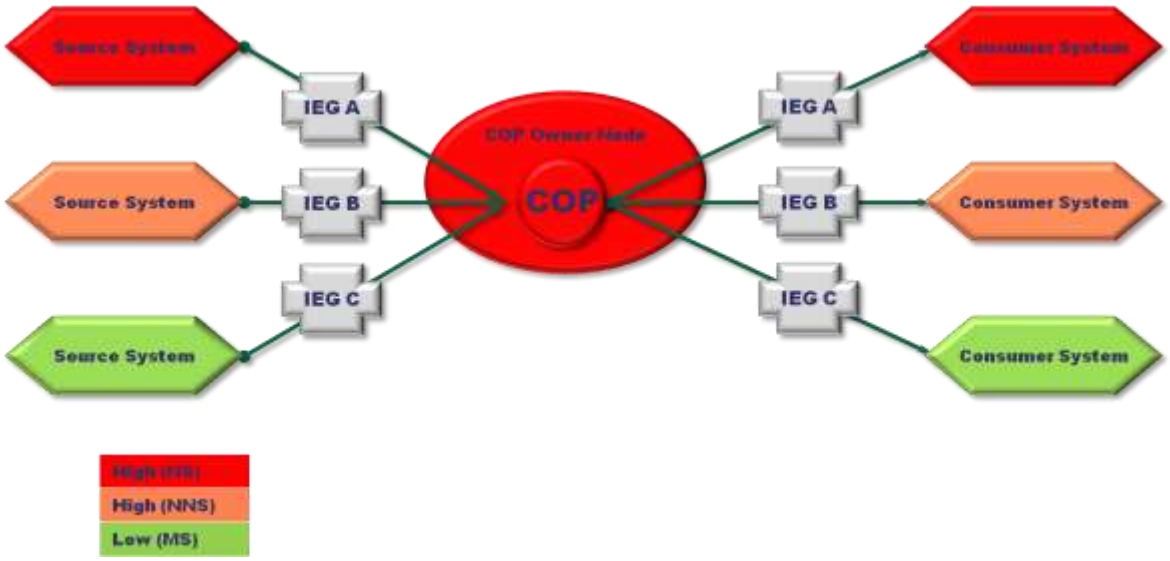

Figure 2-9: Illustration of COP cross domain operation

In cases where two NCOP nodes have to communicate but no IEG is available, the IEG could be replaced by dedicated firewall rules that would allow communication in one way only. Chapter 6.2.1 describes how NCOP synchronization protocol is implemented to adapt to these different scenarios.

2.2.5 NCOP flexibility

Due to the variability of NATO or coalition deployments face to ever evolving situations, NCOP flexibility is a key issue in meeting the operational goal assigned to it. Major dimensions of this characteristic are as follows:

It was mentioned earlier that NCOP should support a wide variety of transport protocols (e.g. SMTP, FTP) and data formats (e.g. ADatP-3, OTH-T Gold, NVG) in order for evolving source systems to interact with the NCOP system;

In addition to this requirement, NCOP should support connection of systems delivering Information Product content in data formats not known at the time the NCOP Product is being constructed, and this requirement should not necessitate in-factory reengineering of the NCOP Product.

The previous requirement may lead to identifying new categories of COP IP (in addition to those introduced in section 2.2.2.2), and NCOP must be able to handle these new categories insofar as no specific processing is required apart from “standard” visualization; In NCOP Increment-2 no additional categories of COP IP than those already defined, have been identified.

NCOP management must make extensive use of modifiable domain values (dictionaries) and support enabling/disabling most of the features, especially in the area of manual vs. automatic information processing.

2.2.6 Common Data Format

NCOP must handle a certain number of elements such as:

- COP definition,
- Information Product definition and content,
- Supporting elements

This set of information is identified as the Common Data Format (CDF). The CDF is used and exchanged across all NCOP Services for internal purpose and also made available to COP Users. It is based on XML format and takes profit of the already available, extensible XML standard NVG (NATO Vector Graphic) 2.0.2.

The design of the Common Data Format is described in the chapter §5.4.1 Data Model Agility.

3 ARCHITECTURAL PATTERNS

3.1 ARCHITECTURE OVERVIEW

3.1.1 Design Patterns

The architecture is based on the use of the following design patterns, in compliance with NATO standards listed in the SRS:

- *SOA (Service Oriented Architecture)*: The architecture takes profit in following SOA architectural pattern, not only through Web Service components/interfaces system decomposition but also through other related architectural patterns: service mediation and registration, orchestration, etc.

  This architecture pattern is detailed in section 3.2.

- *N-tier Layered Architecture*: The architecture is organized through n-tier layered architectural pattern. It is composed of the six following layers:
  - *Presentation Layer*: The user interface layer's role is to provide NCOP users with access to both NCOP end-users and COP Manager Services. It is implemented as thin client and HTML5 web-based interface providing the operational functions to all NCOP end-users. The NCOP user interface uses the latest web 2.0 technologies based on the use of URI/URL to provide the capability of the integrated software products to be understood, learned, used and attractive to any end-user;
  - *Business layer:* The business layer's role is to provide the business services allowing any NCOP end-user to consume and contribute to COPs and NCOP Manager to administrate and manage COPs. It is executed on the server side within .NET Framework environment;
  - *Service layer*: The service layer's role is to provide supervision, support, transformation and interoperability services. It is implemented either as Web Services or provided through SharePoint and BizTalk components;
  - *Data layer*: The data layer's role is to presents all data managed by the NCOP system: CDF / COP and COP IPs, Maps, IPs in their native format and CDF / Management Information;
  - *NCOP Infrastructure*: The NCOP infrastructure's role is provided through NCOP System infrastructure services: Web Application Server, Data Storage, Framework and Virtualization;
  - *Bi-SC AIS Infrastructure layer and ITM CES Infrastructure layer*: It corresponds to the service oriented infrastructure of the Bi-SC AIS CES and ITM CES, which are needed and mandatory in this particular operational context: Directory Services, Informal Messaging Services, Core GIS Services, Enterprise Management Services, Security Services & Settings, Document Handling Services and Chat Services.

  These layers are detailed in section 3.3.

- *EDA (Event Driven Architecture)*: The NCOP system has to provide all NCOP users with dissemination facilities to support the need for collection and discovery of incoming native Information Products produced and provided by source entities,

the need of dissemination of COP from NCOP nodes to COP User and / or Contributor entities.

The architecture promotes event-based message exchange pattern such as publish/subscribe message exchange pattern.

This message exchange pattern is detailed in section 3.4.

- *MDA (Model Driven Architecture)*: The NCOP system has to tackle with large amount of heterogeneous data and / or message model and formats for incoming native IP.

  A flexible well-fitted conceptual data model has to be carefully defined using MDA facilities so that the derived physical data model CDF reaches the appropriate trade-off between genericity (the condition of being generic) and evolutivity (the condition of being evolutive).

- Behavior Driven User Stories. The user stories, introduced by Agile, put the user at the center of the requirement. The acceptance criterias associated to the user stories define behaviour that needs to be designed in the architecture and implemented by the development team.

The software patterns are detailed in section 5.4, such as:

- Publish/Subscribe,
- Proxy,
- Plugin.

This modelling and development pattern is detailed in section 5.4.1.

3.1.2 Mature & Low-Risk Solution

The proposed architecture solution is a mature and low-risk solution: it is based on the extensive use of COTS, the integration of GOTS and the reuse of Thales already available products.

Indeed, the proposed architecture solution is designed to minimize development, schedule and performance risks through:

- *Limited development efforts and shortened schedule* compatible with spiralling approach for NCOP building and delivery as it takes advantage of:
  - Use of state-of-the-art COTS provided by leading software vendors such as Microsoft (SharePoint, BizTalk, SQL Server and .NET Framework) and minimize integration / adaptation code (avoiding as much as possible software encapsulation for interface mismatch adaptation);
  - Full integration with NCIA Bi-SC AIS CES infrastructure (Core GIS, Security and Setting Services, Informal Messaging);

  - Reuse of Thales confirmed software components (TIMS.js cartographic editor);
- *Delivery of high quality performance* architecture through performance-driven design, monitoring and optimization activities starting at the effective date contract and continuing through every stage of the project:
  - The design activities involves Thales best software architects and external experts such as selected COTS vendors experts;
  - The monitoring, analysis, optimization and achievement of high quality performances are guaranteed by network bandwidth optimization procedure and by the delivery of a scalable architecture based on lessons learned from already deployed systems such as: LC2IS and from NATO exercises, for example during CWIX, COBALT, NFR Preparation. An example of network bandwidth optimization based on data compression is described at chapter 6.2.1 describing NCOP synchronization mechanisms;
- *Availability of significant design work* already done by Thales during bid allowing rapid and low risk engineering phases which includes:
  - Identification the operational functions based on the provided SRS;
  - Identification the CI (Configuration Items) needed by NCOP System;
  - Allocation the requirements to the Configuration items and the Implementation Components;
  - Assessment with the legal department and providers of the compliance of the configuration items.

By promoting COTS, GOTS and Thales assets and avoiding “green-field” developments, using performance-driven system engineering techniques and adapted software process, the proposed architecture drastically minimizes the amount of specific implementation, controls schedule and ensure performances.

Being heavily based on Microsoft products, the proposed architecture promotes the use of Microsoft .NET Framework, Microsoft .NET 5 and SDK for implementation and integration purposes: CLR, C#, ADO.NET, ASP.NET. Note that doing this it avoids legacy protocols and technologies such as COM, DCOM, Active X and / or COM+.

Some FOSS may have to be included in the software architecture. This may happen especially in the case of technical standards not yet implemented by software vendors. In that case, they are to be selected with care, taking into account constraints on source code full availability, open source licence restriction (no GPL), compliance with NATO Software Accreditation Test and Security Certifications. NCOP Increment-2 includes some FOSS in the software architecture (Angular, OpenLayers).

3.2 SERVICE ORIENTED ARCHITECTURE

In accordance with the NCIA Bi-SC AIS Architecture Framework, the solution for NCOP is built using a SOA approach based on the use of SOAP (or on only when required and compliant with security constraints to be capable to interoperate REST) Web Services.

The target technical architecture is based on the following technical choices:

- *Use of Microsoft Web Service solution products* available components, provided by Microsoft.net 4.7.2 (or later) framework (WCF): WS-I compliant SOAP stack, including support of WS-* standard specifications for security, reliability and transactions as required in the NATO context, REST communication support;
- *Use of Microsoft ESB solution products* available components, provided by Microsoft BizTalk Server: Messaging, Business Rule Engine compliant with BPEL4WS, BPEL, BPMN, Orchestration, Business Activity Monitoring, etc.;
- *Definition and Implementation of new Web services* components with well-defined NCOP Web Services interfaces, based on WS-* standard specification for data dissemination and security handling;
- *Use of infrastructure Bi-SC AIS CES* component NATO Metadata Registry and Repository (NMRR) or NEDS when available.

The reference model of the SOA infrastructure follows OASIS recommendations.

The integration of external systems is done either through the use of already available Web Services (such as NVG) or through Web Services wrappers that will expose external system native Information Products providing Source Entities capabilities as Web Services following Publish/Subscribe MEP (Message Exchange Pattern), following WS-Eventing standard specification.

This technical approach will ensure:

- The consistency of the NATO SOA strategy within all the components of NCOP system;
- The appropriate level of interoperability between NCOP system and the external systems Information Products providing source entities that will be connected with the NCOP entity on the sites where they are deployed.

NCOP system Reference Architecture follows OASIS Service Oriented Reference Architecture as:

- Eligible functions are exposed as services available in the NCOP System Reference Model (see Enterprise Architect EAP file) ;
- Interactions are mediated through a service oriented mediation infrastructure composed of technical services and facilities (see §3.2.2 and §3.3.3);
- Non functional aspects such as Security and SLA are also clearly established and described through specific contracts and policies (Security contracts and policies are described in §0 and SLA contracts and policies are described in §5.3.3.1.1).

3.2.1 Contract (First) Based Web Services

The architecture benefits of the use of properly-defined service contract and associated exchanged payload together with appropriate Service Level (SL) definition.

Technically speaking, it makes intensive use of WSDL-based Web Service contract definition for exchange interface definition and XML-based payload for exchange model definition:

- *Exchange interface (contract)*: the architecture is based on the heavy use of SOAP Web Services and WSDL contract definition standards as the preferred high-level Information Product operational exchange protocol and interface for both internal (between NCOP hosting server and visualization clients, between NCOP nodes to be synchronized) and external (between Information Product provider source entities and NCOP entities) exchanges.

  This choice of WSDL contract for service definition is coherent with the chosen SOA architectural pattern, the current use of such Web Services and contract definition in the deployed Bi-SC AIS;

- *Exchange data format (payload)* the architecture is based on the use of XML Schema based documents as exchange data format for both internal and external exchanges.

  The choice of XML Schema based document for payload definition is in coherence with the choice of Web Service as high-level exchange protocol.

  For External NCOP Services (identified as NCOP Web Services), provided by NCOP to external systems, the payload XML schema uses CDF XML schema.

  For Web Services that may be provided by external systems and consumed by NCOP system, the payloads are consumed as is and transformed into CDF.

The upper described choices allow:

- Easy integration of Web Services into business processes using low-level pipelines and / or high-level orchestration;
- Validation, translation, and cross domain security (classification, encryption, and signature) treatments;
- Easy operation-based, content-based or context-based routing and payload transformation with generic XML transformation;
- Automatic registration of Web Services contracts and endpoints into an internal WSDL compliant Service Registry in coherence with the mediator centric pattern (see next section).

The architecture also leverages Open API Specification for the RESTful APIs defined for the data exchanges with the HTML5 Geographical COP Editor for the following services:

- DSS (Dynamic IP content broadcast);
- Alerting / Eventing;
- COP consumption & management.

3.2.2 Mediation Centric Architecture

In the SOA world, three main architectural design patterns are commonly identified:

- *Point-to-Point*: where every partner interacts with each other without any third party helping to know how to interact and collaborate. The desired loose-coupling between these partners is only partial as each partner still needs to discover by itself where to contact other partners (the service endpoint location) and understand how to interact and what to exchange with other (the service definition contract containing operations and associated payload data models);
- *Registry Centric*: where every partner registers itself into a common shared services registry so that other partners know where to contact, how to interact and what to exchange with this first partner. The loose-coupling is here enhanced as it is the duty of the service registry to provide service endpoint location and service definition contract, but both the service consumer partner still interact directly with the end service provider;
- *Mediation Centric*: where partners are totally decoupled from each other as they always use a mediation infrastructure whenever they want to interact with each other. The facilities provided by this infrastructure are at least proxy and routing facilities. Note that even though it is centric, this mediation infrastructure doesn't need to be localized on one sole node; it may be distributed and reside on several nodes.

Depending on the specific needs, one or more of these three patterns can be selected and used to build adapted service oriented architecture solution.

The architecture privileges the Mediation Centric Architectural Pattern. Indeed, NCOP is an integration Functional Service designed to gather on a "central" COP entity (even though a COP entity can be distributed on several sites/nodes, its fundamental function is truly to centralize a set of bottom-up and top-down situational awareness information exchanges) and must provide integration/urbanization facilities capable of evolution.

This SOA architectural pattern is usually made available through the use of an ESB, which provides ease of integration, loose coupling, use of standards, etc. useful when dealing with flexible interoperability.

It provides essential system integration and urbanization capabilities such as messaging (protocols and message formats adaptation, routing, etc.) and registry (for service discovery) together with higher-level capabilities, both useful in the NCOP context and required by the Purchaser, such as business rules engine for rules definition and orchestration of integrated and routed Web Services. In particular, these last functionalities ensure NCOP system time flexibility to follow the change of perimeter of the sets of external system with time and spatial flexibility to allow local adaptation of the processes according to NCOP node or entity and external system source entities distribution.

In the context of the NCOP system, the following ESB capabilities are used:

- *Messaging:* The Microsoft BizTalk ESB messaging component is mainly used for the subsequent purposes:
  - Routing: the need for flexible integration of external system as Information Product provider Source Entity is made available through the use of messaging

capability of an ESB. Any external system is easily integrated through available adapters (file, HTTP based protocols such as SOAP or REST Web Services, RDBMS connectors, etc.) and routed using message operation type, content or context information;

- VETO (Valid Enrich Treat Operate): the need for validation of any incoming XML message payload, for transformation of incoming Information Product in native format to COP IP in CDF format, for COP IP content composition/aggregation is made available by VETO treatment components facilities that are *de facto* available if generic or can be easily implemented and integrated; The validation process will be configurable to accept XML messages with minor deficiencies. Validation errors will be logged (minor deficiencies are those that are identified when activating the validation process - see §5.3.3.3.1.3).

- *Publish / Subscribe*: The Microsoft BizTalk ESB Toolkit Messaging component is natively built using Publish / Subscribe principles: every incoming message arriving into the message box is subsequently published to potential subscribers. The use of ESB publish/subscribe component for external exchanges support is detailed in section 3.4;
- *BAM (Business Activity Monitoring)*: The Microsoft BizTalk ESB BAM component is responsible for supporting services and processes monitoring. Activities and views can be handled through user interface tools. Monitoring can be applied to all NCOP system components of the services layer. It is de facto available on every NCOP nodes. Available BAM tools allows and are capable to expose indicators through Web Services so that these indicators are also accessible by remote (authorized) users;
- *Orchestration*: The Microsoft BizTalk ESB Orchestration Engine component is responsible for supporting NCOP collaboration needs. At run time, it executes business rules that are produced by BizTalk Orchestration Designer at design or integration time. The Orchestration Designer is a rich graphical tool for visually designing business processes, which allows full flexibility in terms of integration of external systems. Note that Business Rules produced by BizTalk Orchestration Designed are expressed in an executable language (XLANG/s files) which allows for automation and reuse. Note that these processes can be exported into standard orchestration format, such as BPEL4WS for example;
- *Service Registry*: The Microsoft BizTalk ESB Service Registry component provides the following functions:
  - Service Registration & Discovery: services contracts and payloads provided by services providers are inserted in the service registry so that service consumers can search for available services contract and payload;

The use of such a SOA infrastructure allows building adaptations either using additional composed services or with orchestrated processes that complement the already available functionalities and allow configuration flexibility.

This capacity is used for interoperability purpose, where the use of the BizTalk ESB allows independency between ESB native technical adaptation (protocols and standard format) and especially developed semantic adaptation (for example military formatted messages)

3.2.3 Centralised usage, deployed usage and automated installation

The physical architecture of NCOP Increment-2 is adaptable to comply with:

- ITM centralized usage, with up to 3000 concurrent users;
- ITM MIR (Mission Information Room) centralized usage, with up to 3000 concurrent users;
- DCIS deployed usage, with up to 500 concurrent users;
- Automated installation;
- DCIS/MIR nodes synchronisation;
- ITM MIR/ITM (NS) nodes synchronisation.

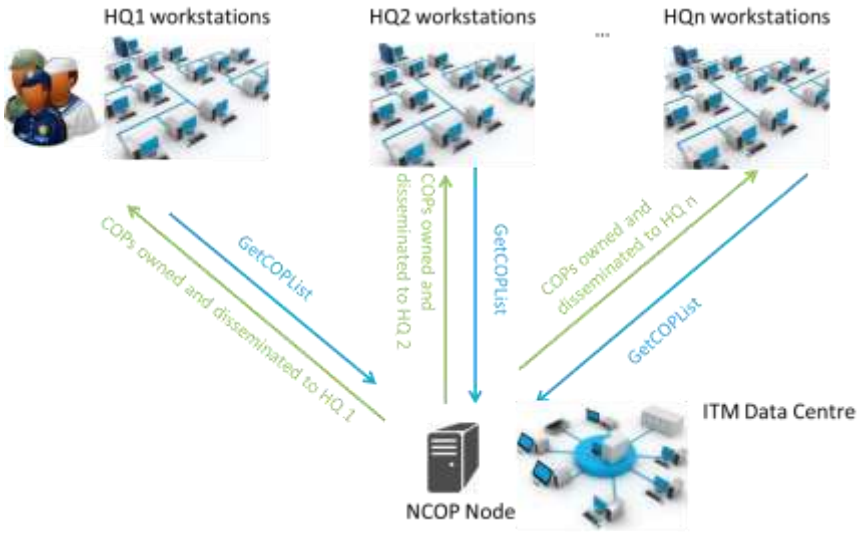

Figure 3-1: ITM centralized usage

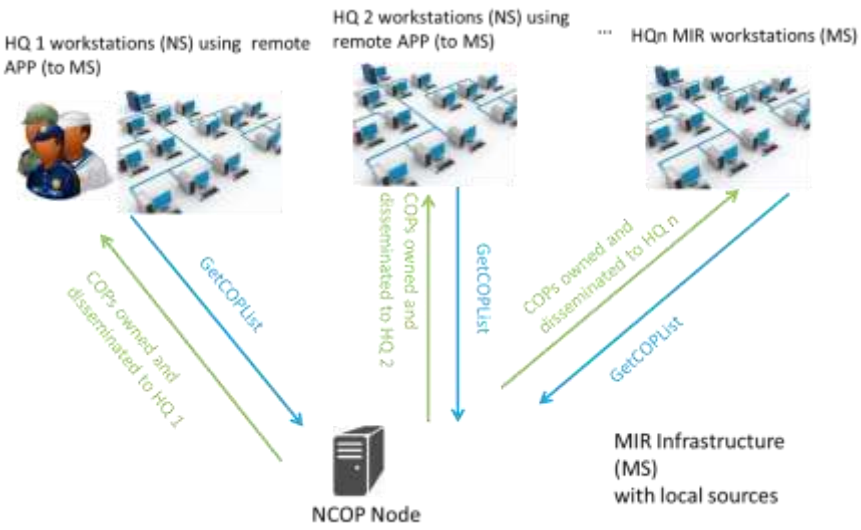

Figure 3-2: ITM MIR (Mission Information Room) centralized usage

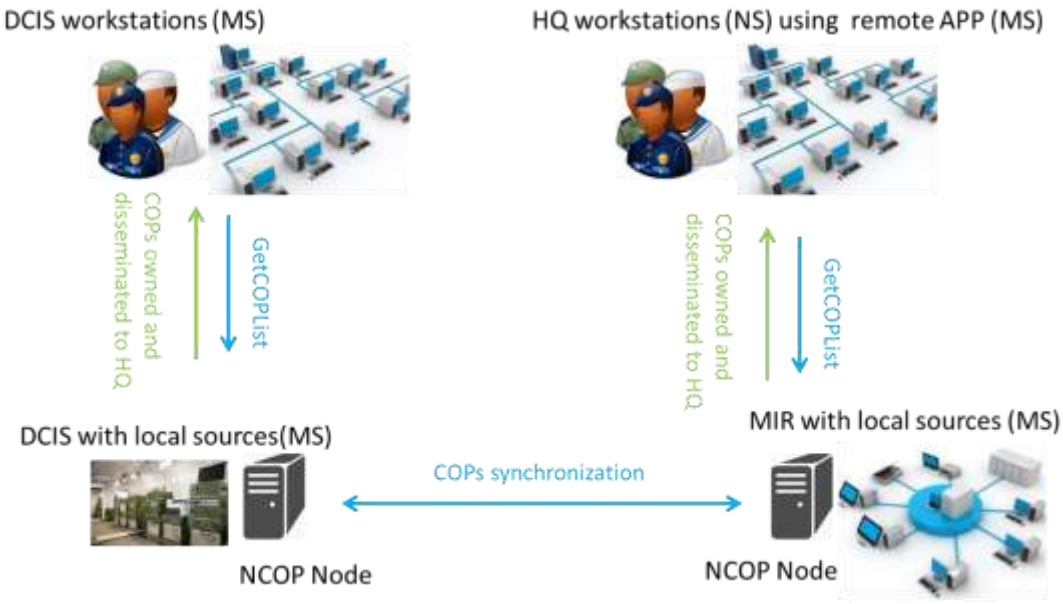

Figure 3-3: DCIS / MIR nodes synchronisation

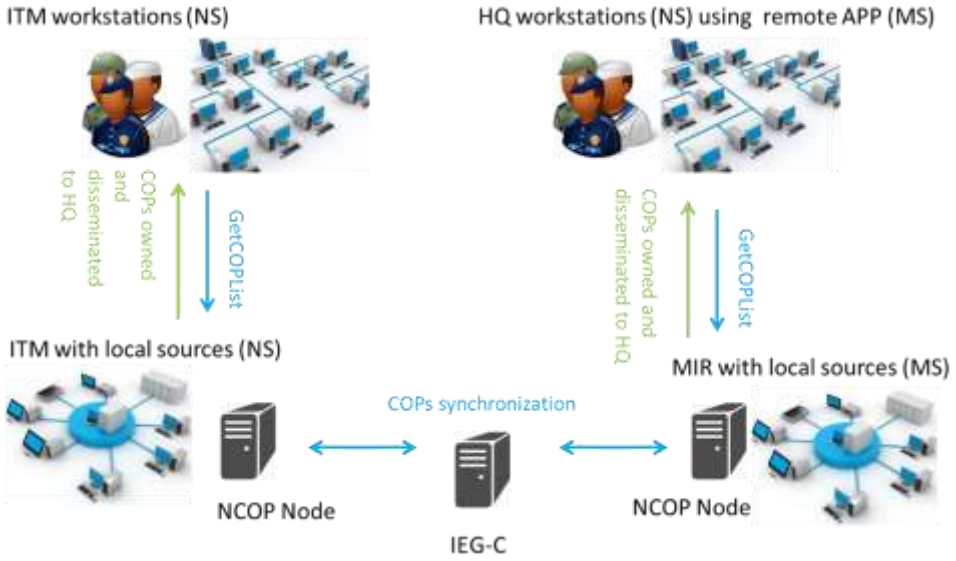

Figure 3-4: ITM (NS) / ITM MIR nodes synchronisation

In order to take into account these deployment needs and constraints, the following technical impacts are to be considered:

- The number of SharePoint servers expected by NCOP is no more limited to 1 or 2 as in Increment-1
- The installation of NCOP nodes shall be silent and automatically performed. The installation package for SharePoint is no longer including the NCOP Services (Geo COP Editor, NCOP IPS …)
- The critical implementation components shall be refactored: DSS, Alerting / Eventing, Geographical COP Editor.

3.3 N-TIER LAYERED ARCHITECTURE

The NCOP layered architecture is decomposed as follows.

3.3.1 Presentation Layer (User Interface)

The presentation layer of the NCOP system is implemented either as thin client or HTML5 user interface embedded in a web browser to provide NCOP system end-users with high added value operational functions.

The NCOP user interface is based on state-of-the-art Web 2.0, 3.0 and 4.0 software technologies to allow easy understanding and quick adoption by NCOP system end-users.

The NCOP system web portal provides a unique web based access to NCOP user interfaces dedicated to COP Management and COP consumption/contribution. It makes a heavy use of standard internet addresses (URL, URI). The technology used to implement the views is selected to meet end-user expectations in term of user interface reactivity and graphical complexity:

- *Thin client user interfaces* are web-browser based HTML5 views provided by the Microsoft IIS application server using ASP.NET (Ex: SharePoint portal, etc.);
- *HTML5 user interfaces* are Angular views also provided by Microsoft IIS application server using HTML 5/JavaScript. JavaScript libraries are fetched and downloaded from the application server at runtime and run into the HTML5 compliant web browser (Ex.: Geographical Editor, etc.).

Both thin client and HTML5 user interface are integrated in the single web based access through the standard Microsoft WebParts web portal integration mechanism. Views content from both parts are synchronized through MVC mechanism.

Examples of such thin client and HTML5 user interfaces are respectively the web portal and the embedded Geographical COP Editor.

3.3.2 Business layer

The NCOP system business layer is made of a comprehensive set of .NET components (back-end) and Angular (User Interface), which are responsible to provide the core of NCOP operational capabilities:

- COP Dissemination Management;
- COP Management and COP IP Management;
- COP Visualization and Contribution Management.

These components are executed on server side within .NET Framework environment and made available to NCOP end-users through user interface layer.

3.3.3 Services Layer

The NCOP system services layer is used either by the NCOP user interface or remote service consumer clients such as other NCOP system nodes or external systems Source Entities nodes.

These NCOP services provide NCOP actors with the following capacities:

- Information Product Source Entities discovery and collection;
- COP definition;
- COP dissemination;
- COP consumption and contribution.

The NCOP services are implemented as SOAP Web Services. Their operations and associated payloads expose the required business logic necessary to interact with other parts such as lightweight client user interfaces or remote NCOP or Source Entity nodes.

As explained in the previous section 3.2, the NCOP Web Services are integrated and made available to any consumer through the use of Microsoft BizTalk ESB acting a centric mediation partner.

3.3.4 Data Layer

The NCOP Data layer is one of the key components of the NCOP architectural solution.

The NCOP storage architecture solution stores all COP managed by any NCOP Entity node from the native Information Products collected from Information Product providers Source Entities.

It is heavily based on SharePoint CMS storage capabilities, which use SQL Server as persistency:

- The CDF COPs are stored either as XML files into SharePoint Document Library or SharePoint data structures (such as Lists, etc.);
- The related CDF COP IPs are stored as XML files into SharePoint Document Library;
- The related native IPs are stored into a SharePoint Document Library and referred by COP IP entries using a specific metadata (link).

The following figure displays several COP IPs stored into a SharePoint Document Library containing COP IP and related native Information Products:

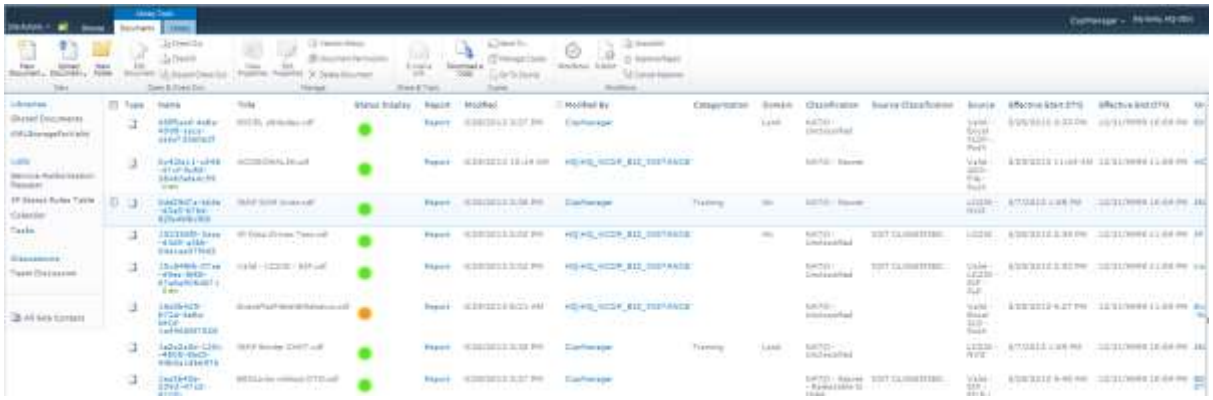

Figure 3-5: List of COP IPs displayed within SharePoint

NCOP storage capability is capable to manage in coherence several NCOP information stores, corresponding to different use (e. g. Live, Exercise, Training). NCOP storage is detailed in the chapter §5.3.4.1.

NCOP storage capability provides capacities in coherence with the nature of the stored data: in particular attribute and geographical search capacities.

Being based on Microsoft products, SharePoint and SQL Server, the NCOP storage solution takes profit from the maturity of these COTS: it guaranties COP (COP structures, COP IP, etc.) data and referential integrity, the deletion of COP relationship is properly handled to take into differences of lifecycle between composition and / or aggregation; it uses when needed cascade deletion and it ensures the consistency of all views within one NCOP system (between NCOP client and server, between synchronized NCOP nodes and between COP providers, consumers and contributors).

3.3.5 NCOP Infrastructure Layer

The NCOP infrastructure layer contains all infrastructure software components needed to host services, business components and user interface components.

- Microsoft Window Server;
- Microsoft Hyper-V (or VMware if required by the Purchaser) as virtualization means;
- Microsoft BizTalk;
- Microsoft SharePoint.

3.3.6 Bi-SC AIS CES Infrastructure Layer

Numerous required capabilities and functions of the NCOP system take profit through tight integration from BI-SC AIS CES such as: GIS (Geographical Information System) Services, Security Services & Settings, Informal Message Services, etc.

Note that even though the NCOP architecture solution strongly relies on the use of the Bi-SC AIS CES, it is also designed to maintain a minimum set of functions available,

if one or more of these services are not available. This capacity is obtained through loose-coupling and asynchronicity good qualities provided by the SOA principles applied during the establishment of the NCOP architecture solution.

The use of internal publish/subscribe mechanism with persistence provided by Microsoft BizTalk ESB allows to keep a trace of all service invocation request or information element publication that may have failed due to momentary unavailability, loss of connectivity, etc. and to retry exchanges when services are available again.

For other potentially needed infrastructure services that may not be available at the beginning of the project (such as NATO Metadata Registry and Repository (NMRR) or Bi-SC AIS Integration Core), the architecture solution is designed to remain compatible with through the reference and technical architectural choice the compliance of SOA standards as they are listed in the SRS annex A.0.

NCOP interfaces already implemented with Bi-SC AIS CES are the following:

- Bi-SC AIS Core Directory (AD) Services;
- Bi-SC AIS Enterprise Management Services (EMS);
- Bi-SC AIS Informal Messaging Services;
- Bi-SC AIS Core GIS Services;
- Bi-SC AIS Security Services & Settings;
- Bi-SC AIS Document Handling Services (DHS);
- Bi-SC AIS Chat Services.

New interfaces with Bi-SC AIS CES are planned according to the following schedule:

- Increment-2:
  - Bi-SC AIS Core NEDS;
- Increment x:
  - Bi-SC AIS Core Integration Services.

This schedule is provisional and may be updated during the progress of the project to take into account the actual availability of the relevant services. If some services are not available at the planned date, it may be possible to continue to use interim capabilities which are already available for Increment-2. On the other hand, if the services are available in advance Thales may consider their early use in NCOP.

3.4 EVENT-DRIVEN ARCHITECTURE

The architecture takes advantage of EDA (Event Driven Architecture) event-driven message exchange patterns. Amongst them is the (asynchronous) brokered (mediated) publish/subscribe exchange pattern.

Following this pattern, information producers/publishers and information consumers/subscribers are totally loosely coupled as they rely on an intermediate partner, namely the notification broker; they not have any knowledge about other partners except topics as provided by the broker:

- Information consumers express interest on particular information by subscribing to corresponding topics to the broker;
- Information producers publish information corresponding to these topics;
- Information consumers are notified of information that corresponds to these topics.

Note that messages are published and notified in an asynchronous way with no necessary expectation of a direct response.

A topic may be simple or hierarchic following an inheritance organization. Information consumers subscribing to one topic located on a particular location in the tree arborescence, indicates that it is interested in all the (sub) topics that inherit from this topic. As a consequence, if an information producer publishes to a node topic located “below” this topic, the subscriber will receive the notification message. It is the role of the broker to decide whether the notification shall be sent or not to the subscriber;

It is possible to enrich topic-based publish/subscribe mechanism with refinement such as:

- Message Type subscription: Consumers are allowed to subscribe to topics corresponding to messages of certain data type;
- Message Content subscription: Consumers are allowed to subscribe to topics corresponding to messages of certain data content;
- Message Context subscription: Consumers are allowed to subscribe to topics corresponding to messages of certain data context such as geographical and time location;

Note that this publish/subscribe implementation is *de facto* asynchronous and brokered to remain coherent with the mediation centric SOA pattern. Indeed, the mediation infrastructure (the ESB) takes the role of the mediation broker between publishers and subscribers, provides subscribers and publishers with facilities to define and use hierarchical topics in order to ease and optimize the IER between Information Product provider Source Entities, NCOP Entities and COP Users and / or Contributors.

From a technical point of view, due to the choice of Web Services as the main exchange protocol between information element providers and consumers, this Publish / Subscribe mechanism is provided through Web Services following WS-* standard specifications (such as WS-Eventing or WS-Notification) and SignalR.

As a consequence, as far as NCOP system components are concerned, wherever they are located (client or server side) or located in remote sites all information elements exchanges use publish / subscribe mechanisms.

3.5 MAINTAINABILITY AND PORTABILITY

3.5.1 Software Maintainability

NCOP components are developed with .NET Framework versions 4.7.2, 4.8 and .NET Core by using C# language.

The source code is documented with formatted comments according to the “XML Comments” format in order to easily generate technical documentation.

The Microsoft Azure DevOps server is used:

- As source code repository;
- To build NCOP .NET and Angular components;
- To analyse the source code according to rule sets (such as Microsoft Basic Correctness Rules, Basic Design Guideline Rules …);
- To define and run unit tests.

3.5.2 Installation and configuration

NCOP installation on servers is automated via a specific wizard (a manual installation of Microsoft Internet Information Server and Microsoft Windows Server is required prior to the package installation).

The wizard is supported by an installation manual and provides the ability to:

- Install NCOP into the “Program Files” application directory by default or allow alternate directory/drive to be selected for installation;
- Execute “Complete”, “Typical” and “Custom” installation;
- Install/uninstall NCOP only by an administrator;
- Re-run the wizard to selectively add or remove components that have been or are still to be installed respectively;
- Detect its environment and appropriately address the correct Windows version;
- Detect and appropriately address a previous or earlier installation of the same application. In this case, the installer notifies the User and prompts the User to select reinstall, repair or cancel. If the option to reinstall or repair is selected, the installer effects reinstall/repair the application(s);
- Take into account the specific configurations (file protection, audio/video hardware …).

As far as NCOP installation and operation is concerned, Thales promotes the use of the following Windows Registry keys: HKEY_LOCAL_MACHINE.

The Windows Registry keys that are set for each NCOP server are located in the following paths:

TABLE 3-1: REGISTRY PATH FOR NCOP KEYS STORAGE

NCOP Servers	Registry Path for NCOP keys storage
BizTalk	[HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Nato\NCOP] [HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Nato\SICF]
SharePoint	[HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Nato\NCOP]
SQL	[HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\Nato\NCOP]
APP	

For more details see Appendix G.

NCOP stores temporary files only in the User's temporary folder and stores less than 128K of application data in the registry for User.

3.5.3 Portability

NCOP Web components are able to run on Microsoft Edge Chromium. They more globally run natively on the NATO Desktop environment.

NCOP is able to run on a virtualized server environment (Hyper-V or VMware) as well as physical environments.

NCOP does not rely on the NetBIOS interface to communicate with other applications, clients or management services.

3.6 OTHER DESIGN CONSTRAINTS

Because NCOP relies on massive usage of off-the-shelf software, design constraints will apply to bespoke software (including Thales in-house reused software). These constraints are:

- Error Handling (Fault Tolerance) (SRS § 4.1.2.6)
- Usability (SRS § 4.1.3) which addresses the following issues:
  - Learnability (SRS § 4.1.3.1)
  - User Friendliness (SRS § 4.1.3.2)
  - Language Requirements (SRS § 4.1.3.3)
  - Accessibility (SRS § 4.1.3.4)
  - Printing (SRS 4.1.3.5)
  - Time zone (SRS § 4.1.3.6)
- Customisability (SRS § 4.1.6.3)

4 DESIGN DESCRIPTION METHODOLOGY

This Chapter introduces the methodology used by the Contractor to describe in this SDS and associated Annexes the design he performed to successfully deliver the NCOP functionality.

In accordance with [SOW] requirements, three levels of design description elements are provided:

- NAF (NATO Architecture Framework) v3.1 views and v4.0 viewpoints. These views mainly capture the operational intent of the NCOP capability (more than design issues). For that reason the NAF views are provided as an Appendix to this SDS. Some views however do reflect design decisions, and as such are part of the structured high level design description introduced hereafter.
- High level design information, to be provided in the form of an NCOP logical model. This logical model comprises a set of UML diagrams. In addition, textual description of the design components is provided as well as discussion of focused high level design topics.
- Detailed design information, to be provided in the form of an NCOP implementation model. In addition, selected detailed design topics are discussed.

Each of the three modelling levels are introduced in the remainder of this Chapter.

The three models are consistent and structured. Each artefact is entered only once and relationships between artefacts ensure consistency between NAF views, logical model and physical model. These models are designed using SPARX Enterprise Architect and provided as a single EAP file attached to this SDS.

4.1 NAF VIEWS

In accordance with Appendix A.2 of the NCOP Increment-1 [SRS], the following NAF v3.1 views are provided in an updated version:

TABLE 4-1: NAF 3.1 VIEWS

NAV-1	• List of NAF views provided as part of the model • Vocabulary used in NAF views
NCV-1	Enterprise vision of the NCOP capability
NCV-2	2 levels decomposition of the NCOP capability
NCV-4	Dependencies between NCOP sub-capabilities
NOV-2	Relationships between NCOP sub-capabilities and types of nodes where NCOP will be deployed
NOV-3	Internodes Exchange Matrix linked to NCOP
NOV-5	Description of Operational Activities linked to the usage of NCOP. This view is augmented to capture additional information (where the activity takes place, which role is in charge) where appropriate.
NSV-1	• Software decomposition of NCOP into Implementation Components • Software decomposition of Implementation Components into Software Artefacts • Software grouping of Software Artefacts into Computer Software Configuration Items (CSCI) • Hardware decomposition of recommended hardware configurations • Allocation of CSCI to hardware components

	• External interfaces of NCOP
NSV-4	System Functionality Breakdown and allocation to client or server hardware
NSV-5	System Function to Operational Activity Traceability Matrix
NSV-7	Major quantitative or qualitative non functional requirements over software or hardware components
NSV-10a	Major constraints over software or hardware components
NSV-11a	Logical Data Model
NTV-1	Standards Profile
NSOV-2	*This view is not provided in accordance with a VTC held between Thales and NCIA on 22 November 2012.(see Minutes of Meeting Ref:TH/TCS/SYS/DT/fd,12/0010/CRR)*

For NCOP Increment-2, NAFv4 addresses the v3.1 limitations and is a step towards a single Architecture Framework across NATO and Nations.

The NAF Grid Representation (see below) is a two-dimensional classification scheme for the standardized NAF viewpoints, which serve as the baseline for any NAF-Compliant architecture effort.

However, the selection of Viewpoints must be tailored to the specific architecture effort, i.e. suitable Viewpoints need to be identified in the grid, and additional Viewpoints must be defined, if and when required.

TABLE 4-2: NAF GRID REPRESENTATION

Each cell at the intersection of the rows and columns is a Viewpoint (usually an existing NAFv3 View). The new approach is Information-Centric. It divides the framework up

into categories of architectural information rather than how the information is presented.

The NAF viewpoints retain an equivalence with the NAFv3 Views, albeit with names that better describe their purpose, as indicated in following table (Mapping of NAFv3 Views to NAFv4 Viewpoints):

TABLE 4-3: MAPPING OF NAFV3 VIEWS TO NAFV4 VIEWPOINTS

NAFv3 View	NAFv4 Viewpoints
Capability (NCV)	Concepts (C)
Service-Oriented (NSOV)	Service (S)
Operational (NOV)	Logical (L)
Systems (NSV)	Physical Resource (P)
All Views (NAV)	Architecture Foundation (A)

Most of the NAFv3 Views match one cell (Viewpoint). However, because the grid is based on the type of information, rather than how it is presented, there are cases where a cell covers more than one NAFv3 View (usually this is where there is a graphical View and a tabular one showing the same information).

NAFv4 compliant architectures can be creating using the following meta-models; The Open Group®'s ArchiMate® and the Object Management Group®'s Unified Architect Framework (UAF) ® Domain Meta-model (DMM)®.

ArchiMate® is an open and independent modeling language for Enterprise Architecture developed by The Open Group® to enable Enterprise Architects to describe, analyze, and visualize the relationships among architecture domains in an unambiguous way.

As required by the "Annex B to the NCOP Increment-2 SOW (NCOP Required Architectural Views and Minimum Content)", the following Archimate ViewsPoints/Views are provided in Appendix C.

Archimate ViewPoints (NAF V4)	Archimate Views	Related NAF V3.1 Views	View Provided in the NCOP current SDS
P1 – Resource Types	**Application Component**	**NAV-2/NCV-3/NSV-2A, 7, 9, 12**	**NAF V4**

	System Software	**NAV-2/NCV-3/NSV-2A, 7, 9, 12**	**NAF V4**
	Node	**NAV-2/NCV-3/NSV-2A, 7, 9, 12**	**NAF V4**
P2 – Resource Structure	**Application Component - *Composition* - Application Component**	**NSV-1**	**NAF V3.1**
	Node - *Composition* - System Software	**NSV-1**	**NAF V3.1**
	Application Component - *Composition* - Application Interface	**NSV-1**	**NAF V3.1**
	System Software - *Composition* - Technology Interface	**NSV-1**	**NAF V3.1**
P3 – Resource Connectivity	**System Software - *Serving* - Application Component**	**NSV-2B, 2C, 6**	**NAF V4**
	Node - *Serving* - Application Component	**NSV-2B, 2C, 6**	**NAF V4**
	Application Interface - *Serving* - Application Component	**NSV-2B, 2C, 6**	**NAF V4**
	Technology Interface - *Serving* - Application Component	**NSV-2B, 2C, 6**	**NAF V4**
P4 – Resource Functions	**Application Component - *Assignment* - Application Service**	**NSV-4**	**NAF V3.1**
L4-P4	**Application Service - *Serving* - Business Process**	**NSV-5**	**NAF V3.1**
	Application Service - *Serving* - Business Role	**NSV-5**	**NAF V3.1**
P8 – Resource Constraints	**Application Component - *Association* - Constraint**	**NSV-10A**	**NAF V4**
	System Software - *Association* - Constraint	**NSV-10A**	**NAF V4**
	Application Interface - *Association* - Business Object	**NSV-10A**	**NAF V4**
	Technology Interface - *Association* - Business Object	**NSV-10A**	**NAF V4**
A8 - Standards	**Business Object**	**NTV-1**	**NAF V4**

4.2 HIGH LEVEL DESIGN

4.2.1 Components identification

This section of the high level design introduces two levels of components:

- Main Configuration Items (CI) that split NCOP functionality into components that can be independently specified and tested.
- Implementation Components (IC) that represent the software components to be developed in order to build the main Configuration Items.

4.2.2 NCOP logical model

This section introduces the UML diagrams that are required by the [SOW] and explains how they are used, i.e. which information is conveyed by each diagram and how they interact.

Required UML diagrams are used to describe main information elements handled in NCOP as well as software components that make up the NCOP software. For each of these description areas, both static and dynamic descriptions are provided.

4.2.2.1 Static description

UML diagrams used for static design description are as follows:

- A *Component diagram* illustrates the pieces of software that make up NCOP (called Implementation Components or IC), and their organization in layers according to the N-tiers layering paradigm; this diagram is provided under the form of an NSV-1 NAF view.
- *Class diagrams* describe key information elements handled within NCOP (e.g. COP IP, COP structure). Structuring properties of each information element is captured in the class diagram. An overarching diagram shows relationships between information elements (in particular cardinality of relationships is captured).
- *Object diagrams* provide an illustration, on a real case, of information elements described by class diagrams.

In addition*, Software deployment diagrams* are also provided in the NSV-1 Software Deployment Diagrams NAF Views.

4.2.2.2 Dynamic description

UML diagrams used for dynamic design description are as follows:

- *Use case diagrams* capture use cases of the system. Two types of use cases are provided :
  - Business Use Cases: these are user-centric use cases where NCOP reacts to a user action in order to fulfil a given task. These Business Use Cases are further decomposed in smaller grain use cases. The decomposition is part of the model definition and is also captured by a NOV-5 NAF view.
  - System Use Cases: these are system-centric use cases where NCOP reacts to events not involving any specific action from the user (e.g. acquire an Information Product from a source).

  Use case diagrams are the preferred way to enter within the dynamic part of the logical model: other dynamic UML diagrams relate to one of the use cases.

- For each use case, the following dynamic diagrams are provided:
  - A *Sequence diagram* depicts the sequenced interactions of IC (identified by the component diagram). It is used to depict workflow, message passing and how elements in general cooperate over time to achieve the desired result.

  - When necessary, an *Activity diagram* is used capture in simple and human-readable form the algorithm that the sequence diagram describes.
- Lastly, *State Machine diagrams* describe how information elements (identified by the class diagram) can evolve (change status) over time as a result of system operation (see Enterprise Architect EAP file in the NCOP repository/Business Concepts section: COP, IP, Shared View and Annotation).

4.2.3 Textual description

In addition to structured UML modelling, each Implementation Component is described in Chapter 5.3 in textual format.

The description is in accordance with the component template provided in the Bi-SC AIS Target Architecture Engineering Methodology. Supplementary information is provided where appropriate.

The components are classified in accordance with the Bi-SC AIS Target Architecture Engineering Methodology:

- A component tagged IS (Information System component) corresponds to a bespoke software that will be either reused and enhanced or specifically developed for NCOP;
- A component tagged TI (Technology Infrastructure component) corresponds to COTS, MOTS, or GOTS software that will be used in support to IS-components;
- A component tagged I (Information component) corresponds to a database for storing data manipulated by IS-components and/or TI-components.

Interfaces to Bi-SC AIS Core Services, other Bi-SC AIS Services and external systems are categorized as application programming interfaces (APIs). These interfaces are listed in Appendix D and described in the NCOP ICD [ICD].

TABLE 4-4: COMPONENT TEMPLATE

Property Name	Description
Identification	The unique name of the implementation component.
Classification	The implementation component's classification. This information is coloured according to the colour code introduced in the previous section.
Behaviour	A brief description of the implementation component's functionality, responsibilities, intended usage (scenarios), method of invocation and distribution. For TI-implementation components implemented using standard packaged software or hardware: identification of the parts of the type(s) of product(s) that implements the required behaviour.
Actors involved	The names of the Actors using/invoking this implementation component. For each Actor, an Actor description using a separate template. This information is provided when relevant.
Objects involved	The names of the Object(s) this implementation component uses, manages or delivers.

Property Name	Description
	For each Object an Object description using a separate template. This information is provided when relevant.
Location (Types)	The names of the Location (Types) where this implementation component is running. For each Location (Type) a Location (Type) description using a separate template. This information is provided when relevant.
Interfaces	Interface signatures with inputs expected and results delivered (in terms of Objects), specification of triggers, optional pre-/post conditions and invariants. This information is provided when relevant.
Collaboration mechanism	A description of the mechanisms that this implementation component uses to collaborate with other implementation components. This information is provided when relevant.
Local/Configuration data	Local data (e.g. actual time) and/or configuration data (e.g. a subscription list) that the implementation component uses to operate. This information is provided when relevant.
Operating context	A description of the implementation component's operating context, e.g. the targeted hardware platform, history of development, expected versions of installed software, and known limitations or deficiencies. This information is provided when relevant.
References	References to other architectural modelling entities contained in other parts of the framework (e.g. for logical implementation components: a reference to a Service of which construction the logical implementation component is a part; e.g. for physical implementation components: a reference to a logical component that is implemented by the physical implementation component; e.g. for TI-implementation components: a reference to the IS-implementation component that this TI-implementation components seeks to run, maintain or manage). This information is provided when relevant.
Quality of Service requirements (QoS)	Quality of service description (e.g. performance, availability etc.), i.e. the level of quality with which the implementation component offers its functionality/behaviour. In the case of IS-implementation components these quality requirements are inferred directly from the quality of service requirements of the Service that is supported by this implementation component. In the case of TI-implementation components these requirements may also be inferred from the quality of service requirements for the IS-implementation component that this TI-implementation component seeks to run, maintain or manage. This information is provided when relevant.
Complexity	Identify the value of the Adjusted Function Points Count, as the measure of IC's complexity. Three levels of complexity are defined: Easy, Medium and Difficult (Same as those defined in Sparx Enterprise Architect tool)

4.2.4 Design discussion

This part of the high level design description addresses a number of topics which cannot be easily captured via UML diagrams. Each topic is assigned a dedicated subsection.

4.3 DETAILED DESIGN

4.3.1 NCOP implementation model

The detailed design uses two types of UML diagram:

- *Sequence diagram*. The sequence diagrams from the high-level design are refined by:
  - Splitting IC into lower level elements called Software Artefacts (SA).
  - Adding to the high-level sequence diagram interactions between SA within the various IC.
- *Class diagrams* provide implementation details for each dll.

The decomposition of IC into SA is provided in section B.8.3

4.3.2 Design discussion

This part of the low level design description addresses a number of topics which cannot be easily captured via UML diagrams. Each topic is assigned a dedicated subsection.

4.3.3 Configuration items

This section of the low level design introduces the subordinate Configuration Items (CI) used to master system configuration over time. Each developed software subordinate CI encompasses a number of Software Artefacts.

The traceability between IC, SA and NUPKG is defined in section B.8.3 Viewpoint 2: Decomposition of Implementation Components into Software Artefacts.

4.4 SYNTHESIS OF DESIGN DESCRIPTION

The following picture summarizes the approach used in describing NCOP design:

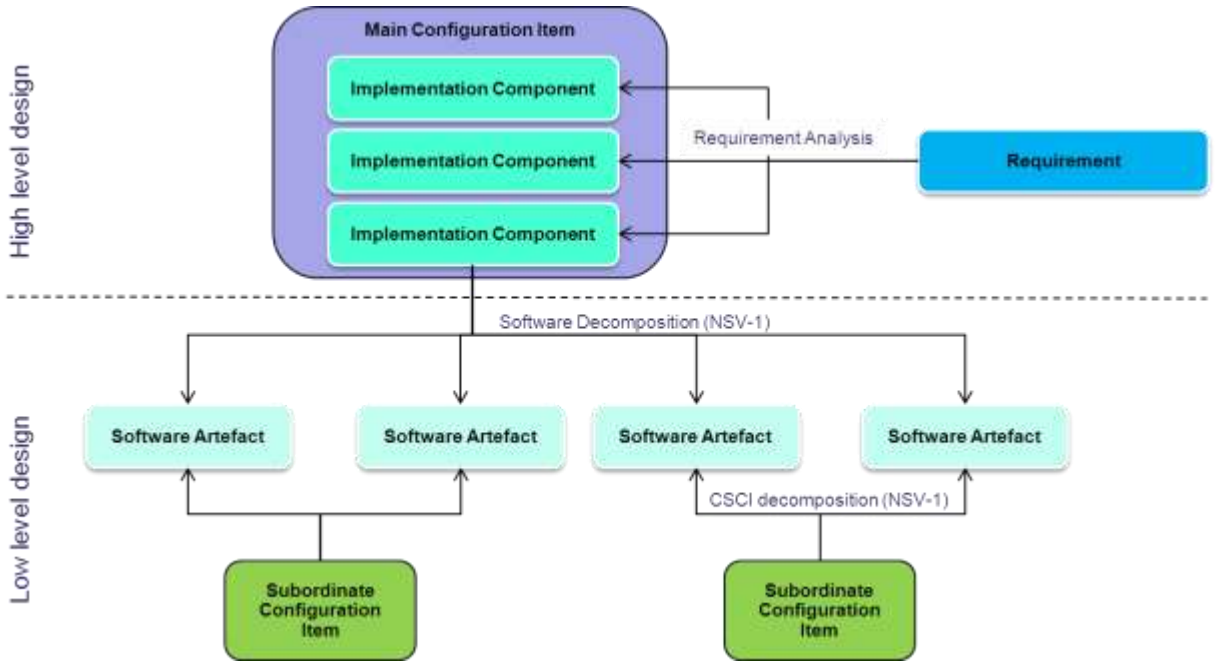

Figure 4-1: Relationships between design constructs

5 HIGH-LEVEL DESIGN

5.1 COMPONENTS IDENTIFICATION

5.1.1 Main Configuration Items

Main Configuration Items correspond to the notion of Computer Software Configuration Items (CSCI) as defined by DOD 2167A. In particular, each Main CI:

- Has its own specifications: those are derived from the SRS by directly allocating SRS requirements. This allocation is described in the Requirement Traceability Matrix (Appendix A).
- Can be tested independently from other Main CI;
- Has its own set of constraints.

The following table lists Main CI, a summary of functionality and identifies their constraints.

TABLE 5-1: MAIN CI

Main CI name	**Main CI Functionality**	**Main CI Constraints**
NCOP2 Software	All NCOP functionality except that of other main CI.	Must execute on infrastructure configurations defined in § 7.1.
On-Line Help	Provide On-line help.	Must execute either as a stand-alone application from a Web browser or interfaced with the NCOP Application.
Computer Based Training (CBT)	Provide Computer-based Training	Must execute either as a stand-alone application from a Web browser or interfaced with the NCOP Application.
NCOP2 Tools	All NCOP Tools Test Automation Tool Software Build Tools Software Build Instruction Data Migration Tool NCOP Installer Training Data for Training database	Must be executed from a removable media.

Main CI name	Main CI Functionality	Main CI Constraints
	NCOP Feedback Extractor Tool: Extracts data produced with the “Provide feedback” function so that it can be exported. NCOP Import Geonames Tool: Import Gazetteer data from iGeoSIT, Geonames files or Excel files. NCOP WebService Consumer Tool: Consumes JIPS and/or NCOPIPS Web services in order to provide COP data to disconnected external systems.	
COTS Software	Each COTS must be a main CI (as directed by SOW § 3.13.4.6). For a list of COTS please refer to §7.3.2.	Must execute on infrastructure configurations defined in § 7.1.
TIMS & Add-ins	TIMS.js framework and background Add-ins (SIF to NVG Converter, SING)°	

5.1.2 Implementation Components

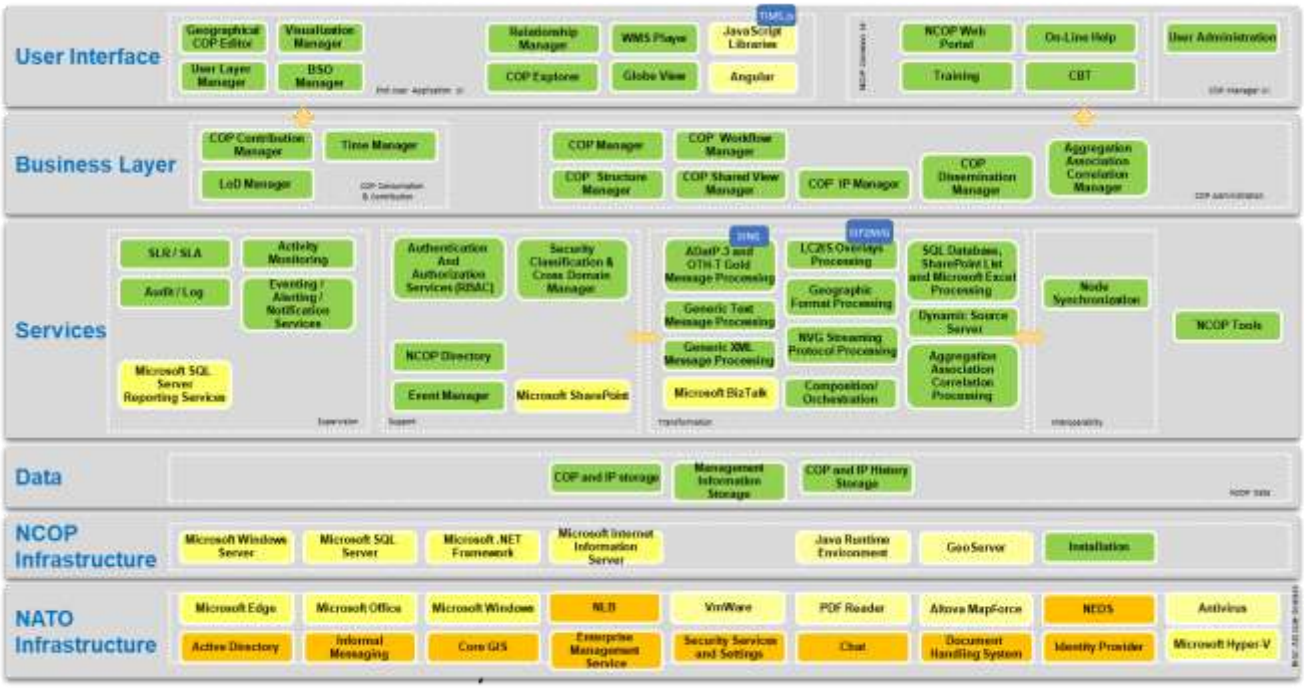

Figure 5-1: Detailed implementation components (TI, IS, I)

In this figure the following colour code is used:

The following table links Implementation Components (outside tools) to main Configuration Items.

TABLE 5-2: IMPLEMENTATION COMPONENTS TO MAIN CONFIGURATION ITEMS MAPPING

Implementation Component	Main Configuration Items
Activity Monitoring	NCOP2 Software
ADatP-3 and OTH-T Gold Message Processing	TIMS & Add-ins
Aggregation Association Correlation Manager	NCOP2 Software
Aggregation Association Correlation Processing	NCOP2 Software
Audit / Log	NCOP2 Software
Authentication and Authorization Services (RBAC)	NCOP2 Software
BSO Manager	NCOP2 Software
CBT	Computer Based Training (CBT)
Composition/Orchestration	NCOP2 Software

Implementation Component	Main Configuration Items
COP and IP History Storage	NCOP2 Software
COP and IP storage	NCOP2 Software
COP Contribution Manager	NCOP2 Software
COP Dissemination Manager	NCOP2 Software
COP Explorer	NCOP2 Software
COP IP Manager	NCOP2 Software
COP Manager	NCOP2 Software
COP Shared View Manager	NCOP2 Software
COP Structure Manager	NCOP2 Software
COP Workflow Manager	NCOP2 Software
Dynamic Source Server	NCOP2 Software
Event Manager	NCOP2 Software
Eventing / Alerting / Notification Services	NCOP2 Software
Generic Text Message Processing	NCOP2 Software
Generic XML Message Processing	NCOP2 Software
Geographic format Processing	NCOP2 Software
Geographical COP Editor	NCOP2 Software
Globe View	NCOP2 Software
Installation	NCOP2 Software
LC2IS Overlays Processing	TIMS & Add-ins
LoD Manager	NCOP2 Software
Management Information Storage	NCOP2 Software
NCOP Directory	NCOP2 Software
NCOP Tools	NCOP2 Tools
NCOP Web Portal	NCOP2 Software
Node Synchronisation	NCOP2 Software
NVG Streaming Protocol Processing	NCOP2 Software
On-Line Help	On-Line Help
Relationship Manager	NCOP2 Software
Security Classification & Cross Domain Manager	NCOP2 Software
SLR / SLA	NCOP2 Software
SQL Database, SharePoint List and Microsoft Excel Processing	NCOP2 Software
Time Manager	NCOP2 Software

Implementation Component	Main Configuration Items
Training	NCOP2 Software
User Administration	NCOP2 Software
User Layer Manager	NCOP2 Software
Visualization Manager	NCOP2 Software
WMS Player	NCOP2 Software

5.2 SAMPLE UML DIAGRAMS

These UML diagrams are designed using SPARX Enterprise Architect and provided as a single EAP file attached to this SDS.

The following sequence diagram shows the interactions between Implementation Components when executing the “Manage Roles” Use Case.

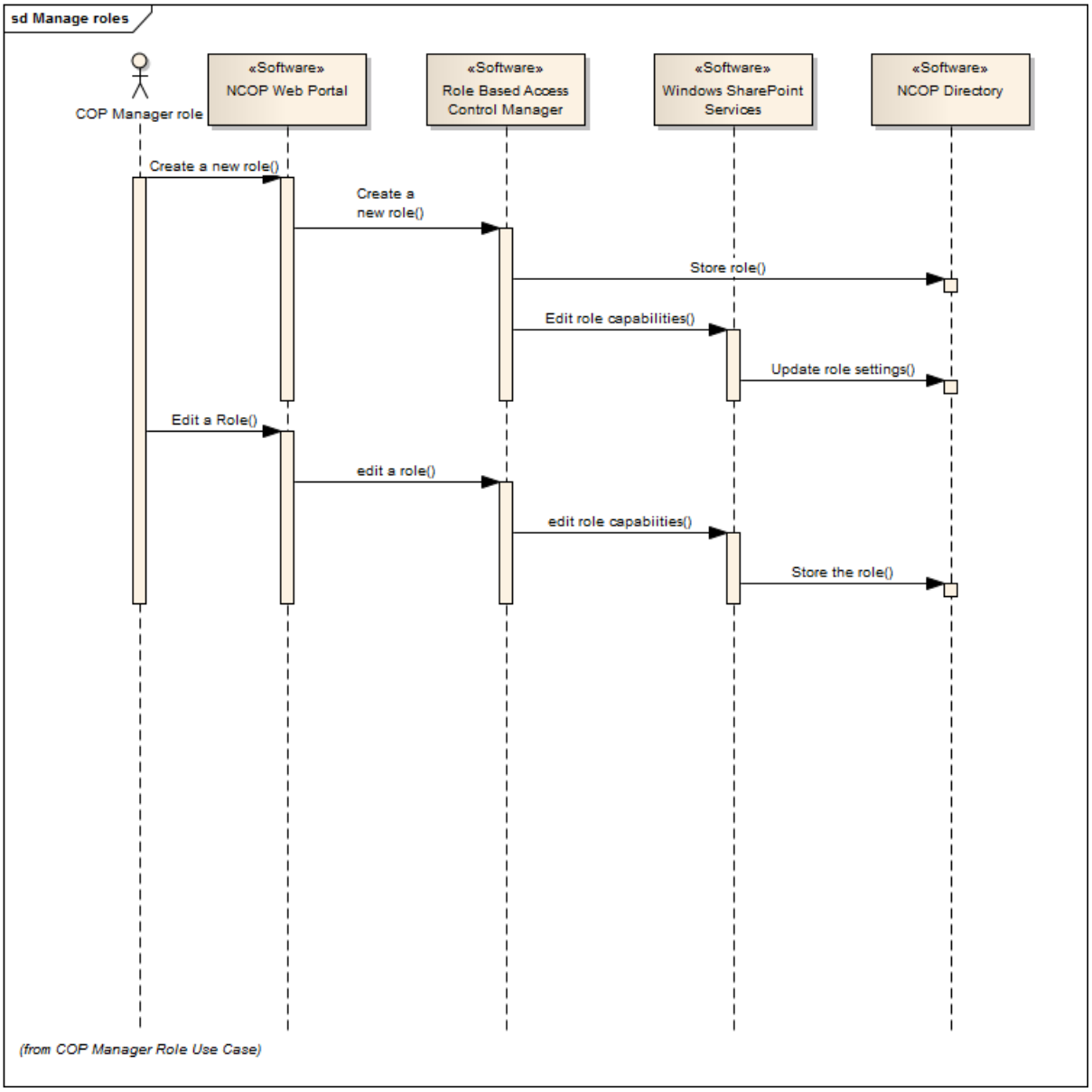

Figure 5-2: High level sequence diagram for the “Manage Roles” Use Case

The following activity diagram depicts the algorithm implemented in support of the “Manage Roles” Use Case.

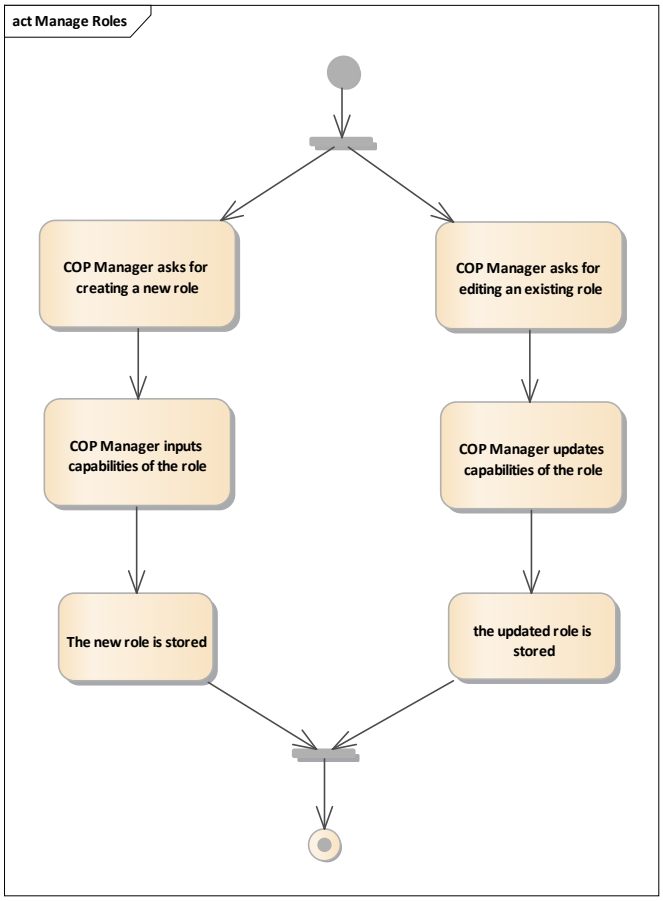

Figure 5-3: Activity diagram for the “Manage Roles” Use Case

5.3 IMPLEMENTATION COMPONENTS DESCRIPTION

5.3.1 User Interface

NCOP user interface is based on two technologies:

- The Geographical COP editor is a rich web application based on Angular
- The NCOP management UI is based on a Microsoft SharePoint portal solution displaying web pages

The Geographical COP editor HMI are defined in the [UIS] document.

These user interfaces have been designed to be able to operate with a screen resolution 1280x1024 or above.

NCOP User interfaces are based on Web pages and Web services and therefore, browsers proxy settings can be applied to NCOP user interfaces. However, since most of the data displayed in NCOP is dynamic, the use of proxy caching will not be efficient

because most of the HTTP responses produced by NCOP web server contain a “no-cache” directive to explicitly avoid data caching.

5.3.1.1 End User Application UI

5.3.1.1.1 Geographical COP Editor

Property Name	Description
Identification	Geographical COP Editor
Classification	IS
Behaviour	This component displays and manipulates the geo-referenced Information Products (Overlays) giving the COP User roles, a spatial view of IPs. This component allows to display Information Panel with the following capabilities: - Support Information Panel to be moved on the display and collapsed to a single title bar; - Allows the Information Panel to be used to display BSO additional information; - Memorize the state of Information Panels for a User; - Allows the Information Panel to be used to display notifications. COP User role can acknowledge notifications. Acknowledged notification is removed from the Information Panel of the COP User role; - Allows choosing the transparency of an Information Panel. Information Panels are made transparent from 0 to 100% to provide for visualization of underlying Panels or geographical display. - NCOP keep consistent display between the Geographical COP Editor and Information Panels displays: - When a filter is applied onto a COP IP, the BSOs displayed in the different visualizations are consistent. - When a COP IP or a BSO is updated, all panels reflect the update and are consistent
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	Several configuration json files
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

The following UML Use Case Diagram shows the main responsibilities of the COP User role.

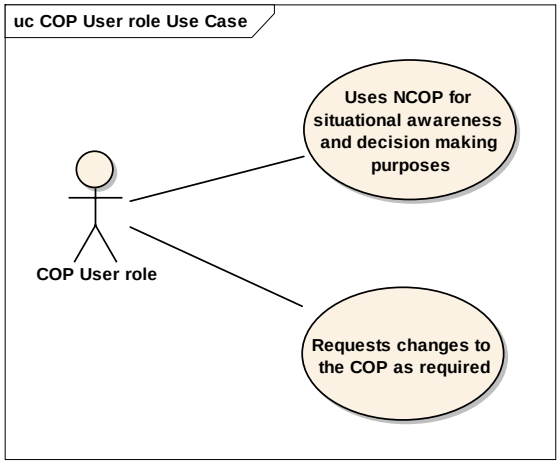

Figure 5-4: UML Use Case Diagram of COP user role

The Geographical COP Editor implementation component allows NCOP Users roles to display and manipulate (Create, update, delete and annotate) all geo referenced Information Products including:

BSO (e.g. units, places, events, persons, organizations, equipment);

CIMIC symbols;

Graphical symbols (line, polyline, polygon, arrow, rectangle, circle, ellipse, arc, arc band, scalable text, scalable symbols from a symbol library and scalable bitmaps).

The Geographical COP Editor provides standard geographic characteristics, traditionally implemented for military situational awareness through:

Display of map background, from Bi-SC AIS core GIS services, containing:

- Raster maps: NATO standard digitised map formats (including at least USRP, ADRG, CADRG, CIB, Geo-TIFF, DTED) chosen and loaded using WMS services or ArcGIS REST API;
- Vector data (also called geo data features) such as ESRI Shape which are loaded using WFS, this includes generic features, points, lines, polygons, roads, railways, lakes, waterways, bridges, boundaries, populated areas, vegetation, buildings, relief, harbours, pipelines and power lines;
- Display of BSO and geo data features whose symbols are automatically allocated based on attribute values of each object (e.g. BSO symbols are compliant with STANAG APP6A, APP6B, APP6D and MIL-STD 2525B & 2525C & 2525D or can be displayed with custom symbols which are provided by NCOP or by external URLs).

Customization of graphical symbol characteristics. For instance, the following parameters can be modified:

- colour and style for lines;
- colour and style for area fills;
- transparency for areas;
- styles and shapes for arrows;
- Colour, styles, format for texts.

Management of different coordinate systems that includes:

- Permanent display of cursor position in latitude/longitude, UTM or MGRS formats.

Displacement functionalities including:

- Scales management;
- Scroll, zoom (zoom in and zoom out), pan and spatial bookmark functionalities.

Annotation tool: annotations (graphics, texts and even APP6 symbols) can be drawn and associated to an Information Product for:

- General-purpose annotation;
- Correction.

Symbols decluttering: This prevents symbols from overlapping.

Level Of Support Details (LoD): to group or aggregate objects for visualization based on inter-BSO relationships;

Graphic selections (including BSOs and selectable geo data features): Using the mouse or keyboard, multi-point and rectangular selections can be made;

Display of the details Text Box for selected BSO and selectable geo data features. The details of BSOs can be:

- BSO basic data;
- BSO metadata;
- BSO extended data;

Spatial search on geo-referenced information;

Global search capability, to query BSOs or locations from different scopes:

- NCOP Gazetteer or external Gazetteer;
- Information Products that are currently displayed;
- COPs selected by the user (“COP-wide search”);
- User bookmarks;

Full-text search for BSOs including basic data, metadata and extended data;

Applying COP Shared view including Visualization Filter settings:

- Subset of BSOs to be extracted or displayed using a filter on the COP IP's BSO;
- Particular representation of the BSO (icon size, symbol set used, transparency);
- Set of BSO properties available for details Text Box;
- Particular representation for the COP IP itself (geographical, table, list, etc.).

Import/export Visualization Filters settings in OGC Style Layer Descriptor format.

Support Geo data with time dimension selection and animated Geo data using the time dimension available for the Geo data;

Representing BSO history (with a time slider and time marker);

BSOs activation in a COP IP upon/after selection which can be seen as a way of highlighting BSOs of special interest;

Creation of a User Layer from the currently activated BSOs;

Save User-defined layers within a Named View;

Export: the whole view or selected overlays can be exported (PDF, HTML, GeoTIFF, PNG, JPEG BMP formats) in order to paste into another application with additional on-screen User-selectable information:

- Current user;
- Currently selected COP IPs;
- Time of the export;

Printing: printing to a User-selected printer or output device.

The Figure 5-5 illustrates a sample of the Geographical COP Editor displaying Information Product overlay.

Figure 5-5: Geographical COP Editor displaying Information Product Overlay

The Figure 5-6 illustrates a sample of the Geographical COP Editor displaying a WMS map background.

Figure 5-6: Geographical COP Editor displaying WMS layers

Regarding the display of map layers, the Geographical COP Editor performs a client-side tiling. This technique is based on the use of a virtual grid dividing the final image in small square images. It allows to:

- Download multiple but smaller images,
- Request tiles if necessary when the user moves the map,
- Take advantage of the browser's cache,
- Take advantage of the browser's parallel download capability.

After NCOP is installed on a site, it is possible to adjust the settings to improve the users' experience using NCOP.

This tiling technique can greatly improve performance by:

- Reducing the impact on the map server by requesting tiles only when necessary,
- Optimizing network bandwidth usage by downloading smaller images only when necessary.

The Geographical COP Editor is based on JavaScript OpenLayers.

The Geographical editor offers the capability for end users to give feedbacks on the user application. This option is available from all modules of the Geographical COP Editor. It allows the user to enter a comment on functionalities, HMIs or report bugs

detected using NCOP. The feedback tool has the capability to capture a screenshot of what was being displayed by the user and attach it to the user's comment.

The feedback tool is also integrated in the error messages windows that can appear when an error occur using the application. In this case, the comment will be automatically set with the error message and code.

All user feedbacks are stored in the NCOP Storage component. These feedbacks can be exported for later analysis by the NCOP team.

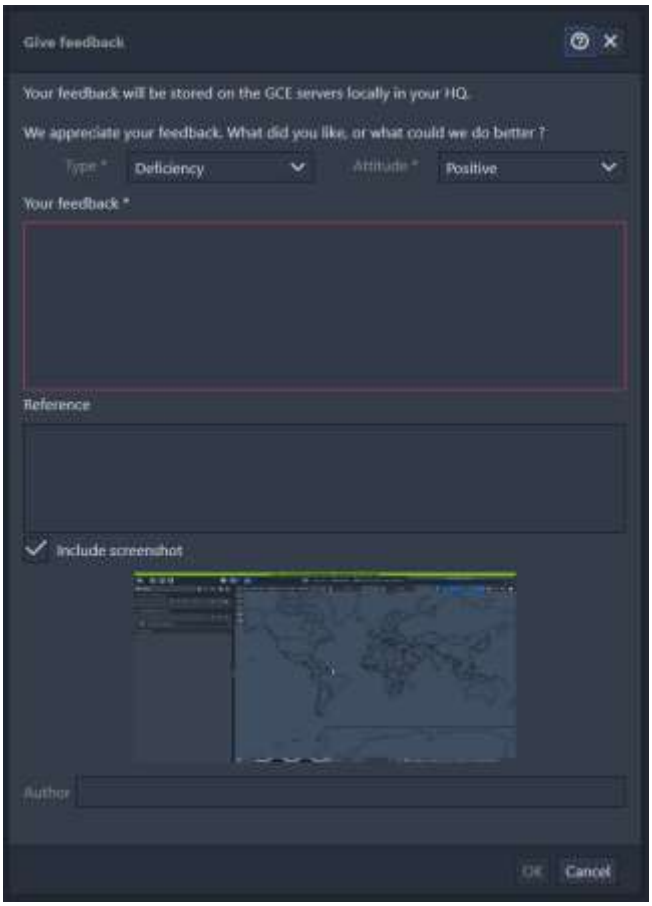

Figure 5-7: User feedback tool

On top of the Geographical COP Editor, the NCOP system proposes a set of information panels dedicated to COP viewing and COP management..

For COP viewing, an information panel allows the users to browse the existing COPs and displays them in a tree fashion reflecting their associated structures. This panel (COP Explorer) browses the available COPs using the JIPS Web Service exposed by the NCOP system (or by an external system providing JIPS interface). This panel also allows the users to visualize information products, annotations, shared views and maps.

For contribution purposes, some panels are available to create annotations, information products, views and submit them to the COP manager for inclusion into a

specific COP. All contributions are submitted using the contribution Web Services exposed by the NCOP system that will save the submitted user data into the NCOP storage component.

The COP Manager uses specific COP management panels that allow the design of COPs, including the definition of COPs, Information Products and structure templates. Each COP management panel uses a dedicated Web Service to read and write data into the NCOP storage component.

The following figure presents the COP edition panel embedded into the Geographical COP Editor.

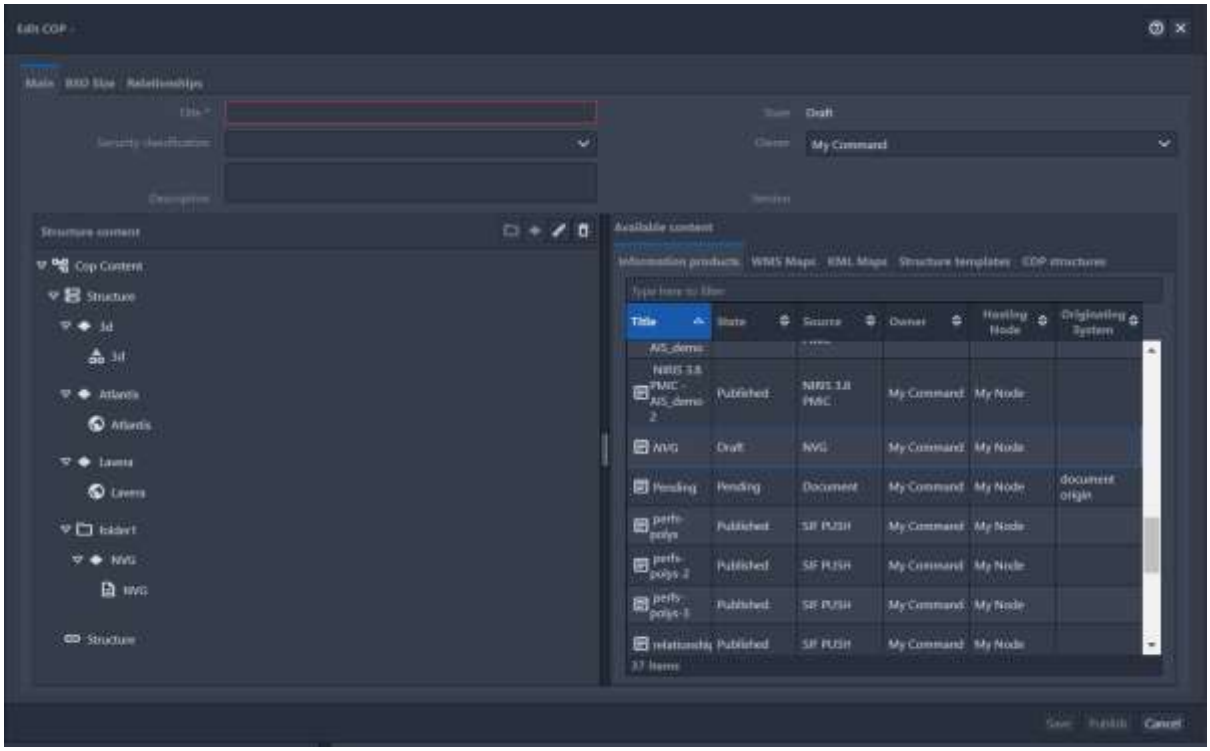

Figure 5-8: “COP Edition” Information Panel displayed on top of the Geographical COP Editor

Note that each panel is available only if the user has the appropriate role.

The NCOP generic icon shall be defined by the four graphical components:

- **Primary**: Military symbol (including modifiers), ISO Flag, custom icon
- **Indicators**: Colors + shapes, histograms
- **Superimposed frame**: circle, ellipse, square, diamond , half shapes, base military symbol shape, ...
- **Mini flag**: { ISO Flag}

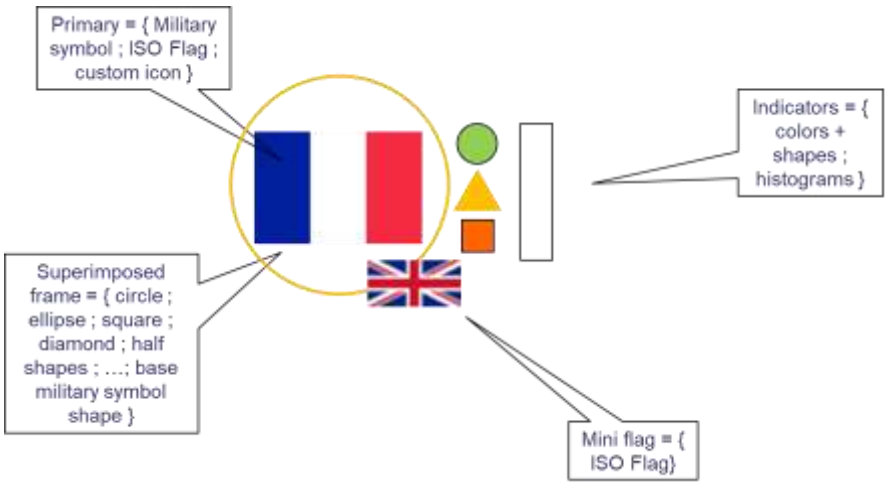

Figure 5-9: Description of NCOP generic icon

The NCOP generic icon and the associated decorators relies on TIMS.js capabilities (see Appendix F).

The symbology picker is a tool enabling the user to create new BSO based on their military symbol or custom symbology.

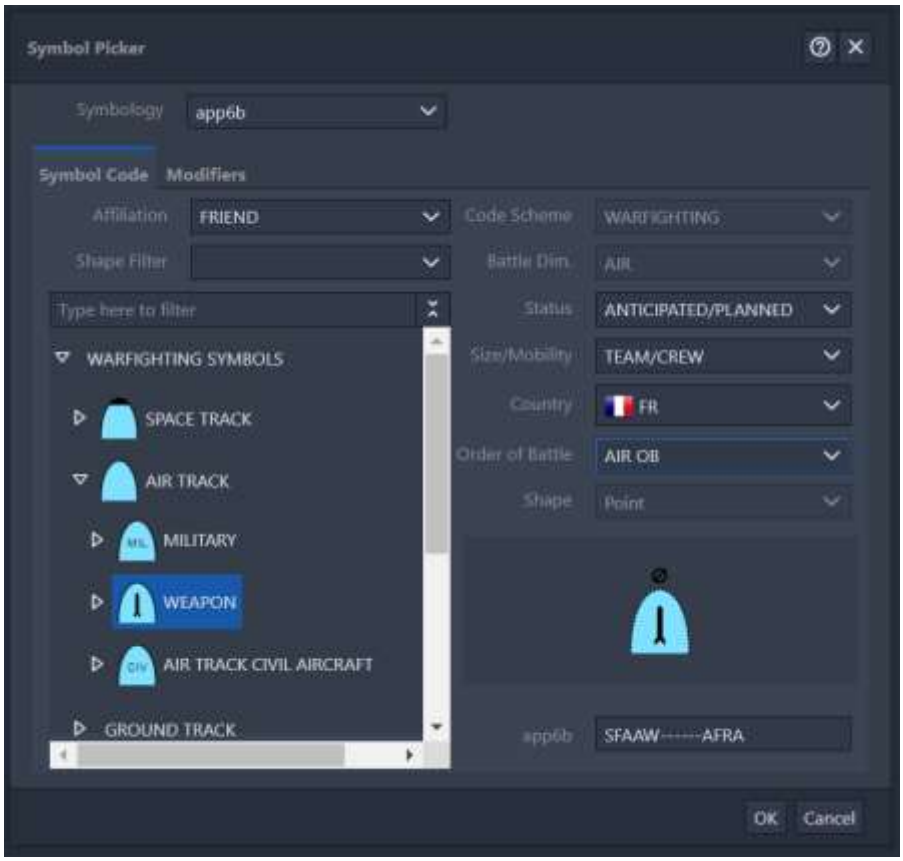

Figure 5-10: Symbology picker

The HTML5 Geographical COP Editor interacts with back-end services through REST API:

- DSS REST API (hosted on the Application Server)
- NCOP Eventing REST API (hosted on the Application Server)
- Geographical COP Editor REST API (hosted on the Application Server)
- SQL/Excel Preview REST API (hosted on the BizTalk Server)

Below, the illustration of the NCOP Eventing REST API:

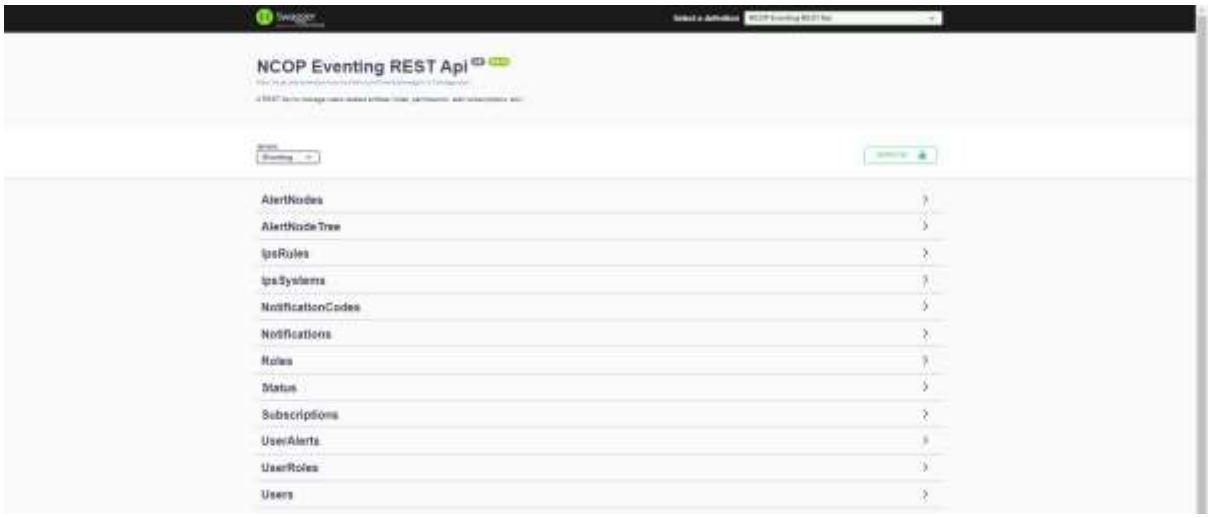

Figure 5-11: NCOP Eventing REST API overview (with Swagger)

Below, the illustration of the NCOP Geographical COP Editor REST API:

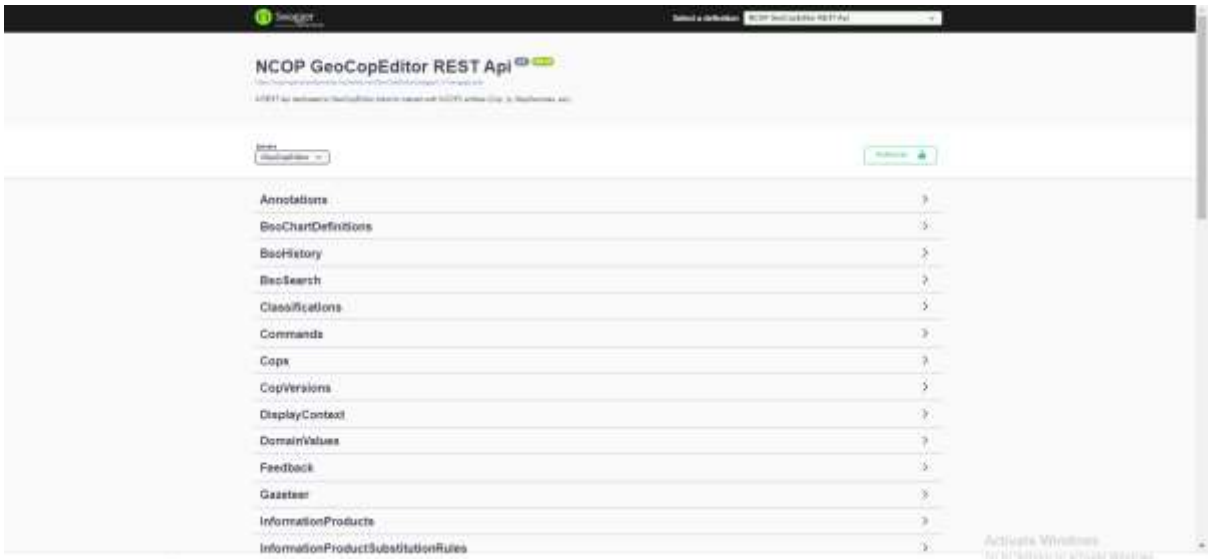

Figure 5-12: NCOP Geographical COP Editor REST API overview (with Swagger)

Below, the illustration of the NCOP DSS REST API:

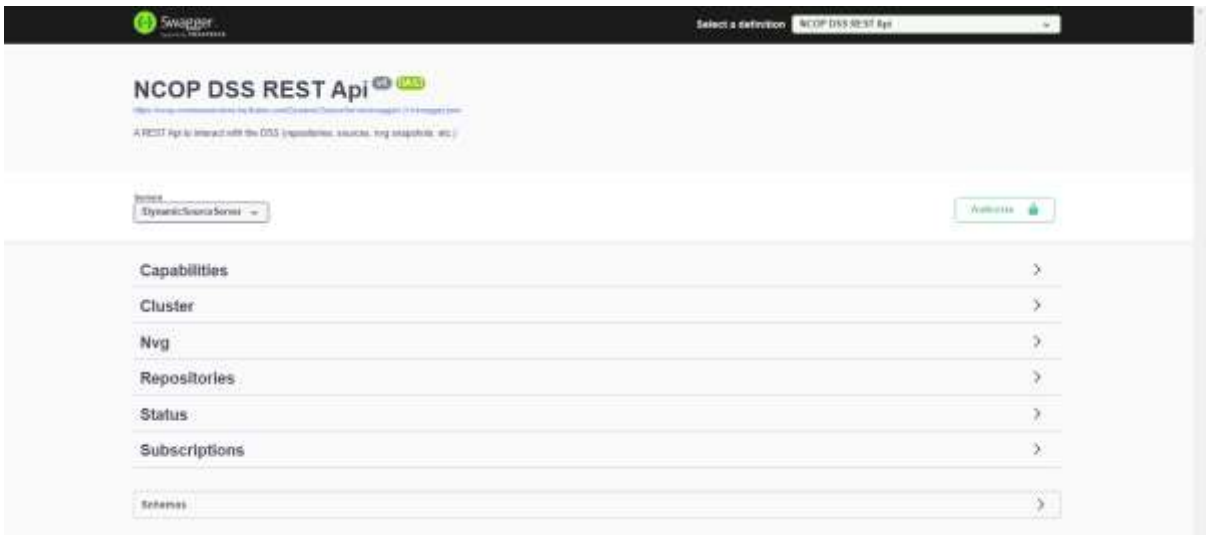

Figure 5-13: NCOP DSS REST API overview (with Swagger)

The REST API follows recommendations defined in [SIP for Service Management and Control]:

For each REST API specification, the following information MUST be included:

- Purpose of the API.
- URL of resources and API including version number.
- HTTP verbs supported.
- Representations supported: JSON (XML is optional)
- Response schema (and where PUT, POST, PATCH are supported – request schema).
- Links supported (Optional in L2 APIs)
- Response status codes supported.

The API MUST be described using Open API Specification (http://swagger.io/specification/)

NCOP Swagger JSON files are provided in the NCOP ICD [ICD].

5.3.1.1.2 Globe View

Property Name	Description
Identification	Globe View
Classification	IS
Behaviour	This component displays the geo-referenced Information Products (Overlays) giving the COP User roles, a spatial view of IPs on a globe (2.5 and 3D views). The display of IP on the globe view can be synchronised with the Geographical COP Editor 2D view. The globe view is based on HTML 5 JavaScript and dedicated JavaScript library.
Actors involved	See details in Appendix K IC vs Actors Involved

Property Name	Description
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	Several configuration json files
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

The Globe View is integrated in the Geographical COP Editor and, as such, is available to all NCOP Users roles. The Globe View complements the Geographical COP Editor with a 3D viewport that projects the content of Information Products and map layers on a virtual globe representing the Earth.

This view is interactive, allowing users to freely rotate, pan and zoom the contents according to their needs.

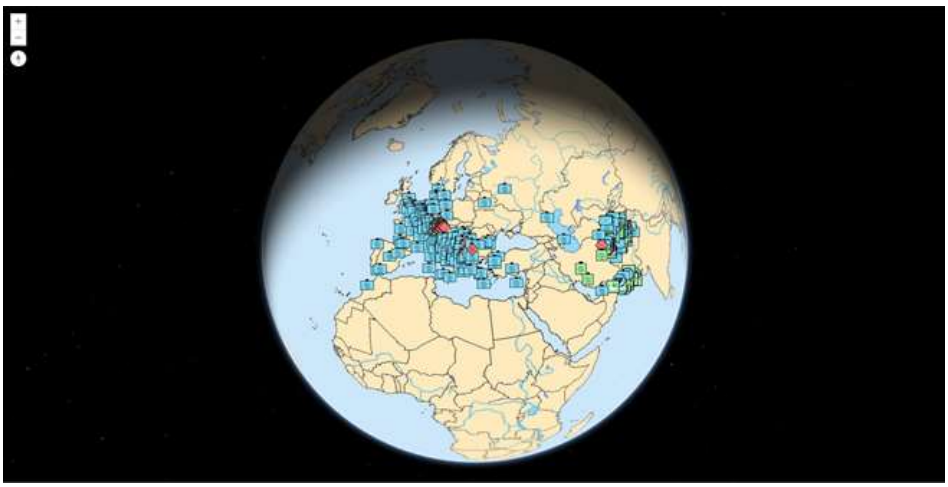

Figure 5-14: Information Product content and map layers displayed in a Globe View

Compared to the standard 2D view, the Globe View provides a less biased view of the situation being displayed:

- The extra dimension helps leveraging elevation data when available (e.g. terrain elevation, BSO with an altitude component, true heading according to yaw/pitch/roll);

- When projected on a globe, the distances and relative angles are consistent with the ground truth, making it easier to apprehend for the user;

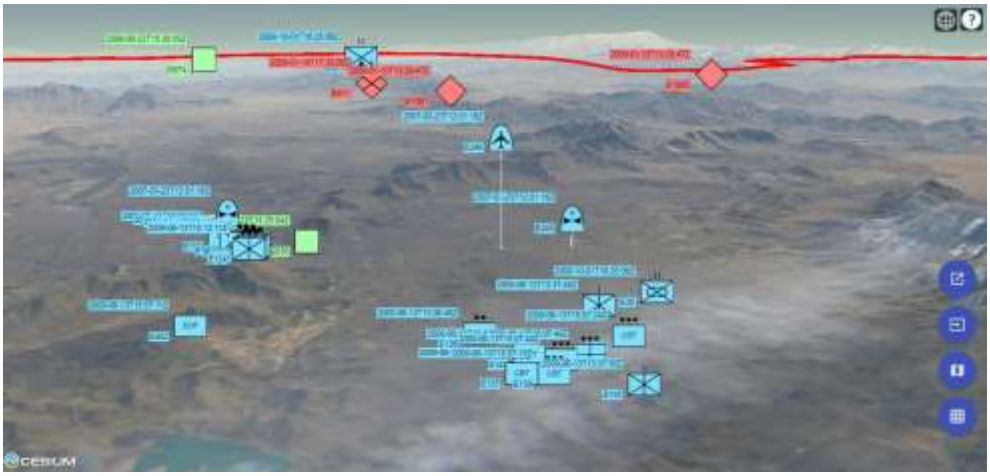

Figure 5-15: Terrain and elevation data in the Globe View

Graphical symbols from the 2D view can be rendered in 3D as volumes, to account for their physical footprint: e.g. weapon/sensor range (dome, sphere, cone), air corridor (shape with height), delimited area, …

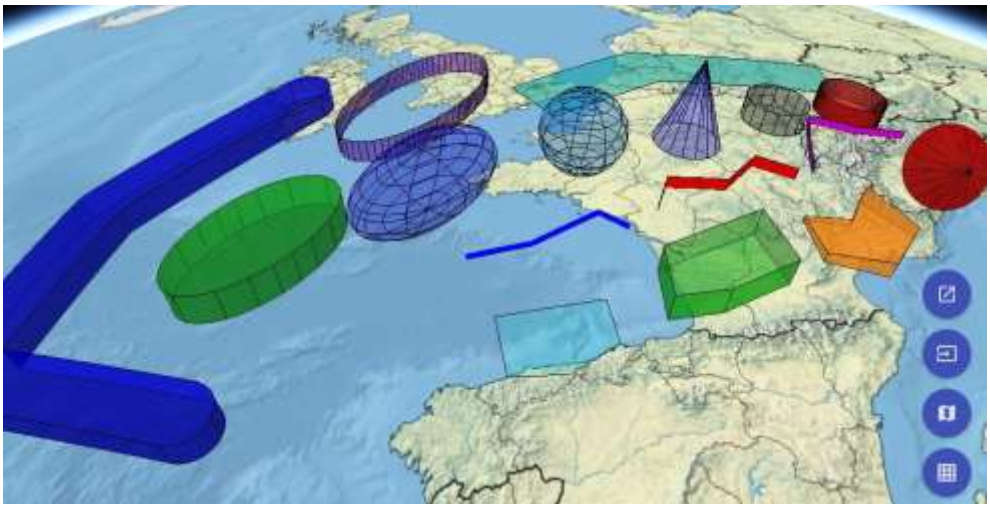

Figure 5-16: Examples for shapes rendered as 3D volumes in Globe View

The Globe View is based on Cesium.JS, a JavaScript library which uses WebGL for hardware-accelerated graphics, and is cross-browser.

5.3.1.1.3 User Layer Manager

Property Name	Description
Identification	User Layer Manager
Classification	IS
Behaviour	This component allows a COP User role to define “User Layer” by:

Property Name	Description
	Selecting several IO from different COP IPs and link them to a single layer; Selecting the currently activated BSO and regrouping them into a single layer; A COP User role can save User Layers for later reuse. Then the COP User role don't' need to re-create his User Layers for each usage of the NCOP Client. User Layer Manager allows saving User-defined layers within a Named View. This component also allows any COP user to manually design a layer by manually drawing objects on the map and setting properties to these objects.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript SQL .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

5.3.1.1.3.1 User layers based on COP Information Products content

The user layer manager is integrated in the COP explorer. It is available to all authenticated COP consumers and proposes options to create and organize layers and fill them with BSOs coming from COP Information Product.

User layers are personal and not seen from other users unless they are shared. When a user decides to share one of his user layers, it can be used (read only) by other users.

User layers options are available with a right click on the User layers section in the COP explorer. Options are different when the right click is done on a layer item:

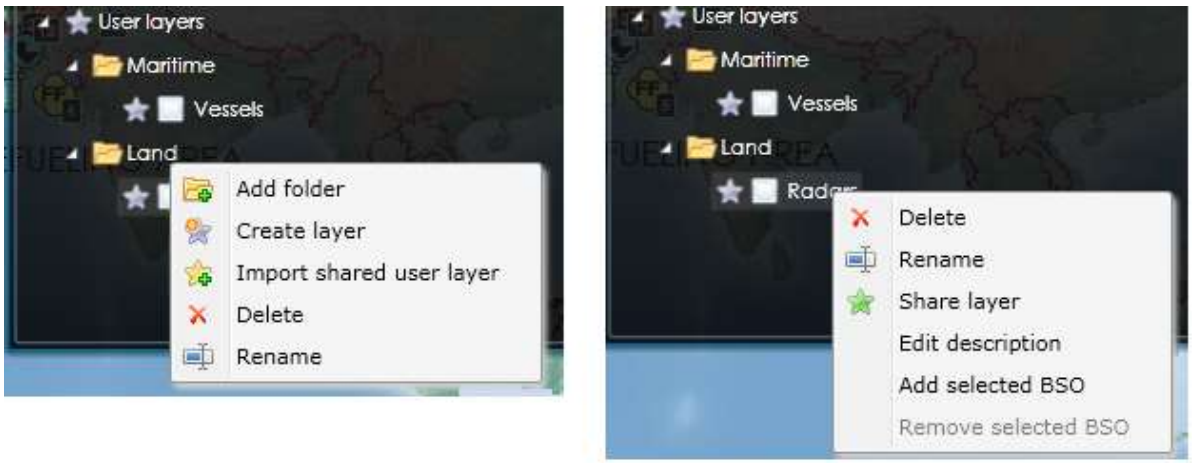

Figure 5-17: User layers management options

A user layer can contain references to BSOs coming from different Information Products. When a user layer is loaded, only the referenced BSO are loaded in the Geographical COP Editor.

The user layers functionality is described in more details in chapter 6.2.10.

5.3.1.1.3.2 Manual user layer design capabilities

The Geographical COP Editor proposes a mode to allow users to design their own layers. A drawing palette can be used to select BSOs and place them on the map. The user can also edit the properties of these BSOs.

Figure 5-18: Geographical COP Editor displaying Drawing Palette

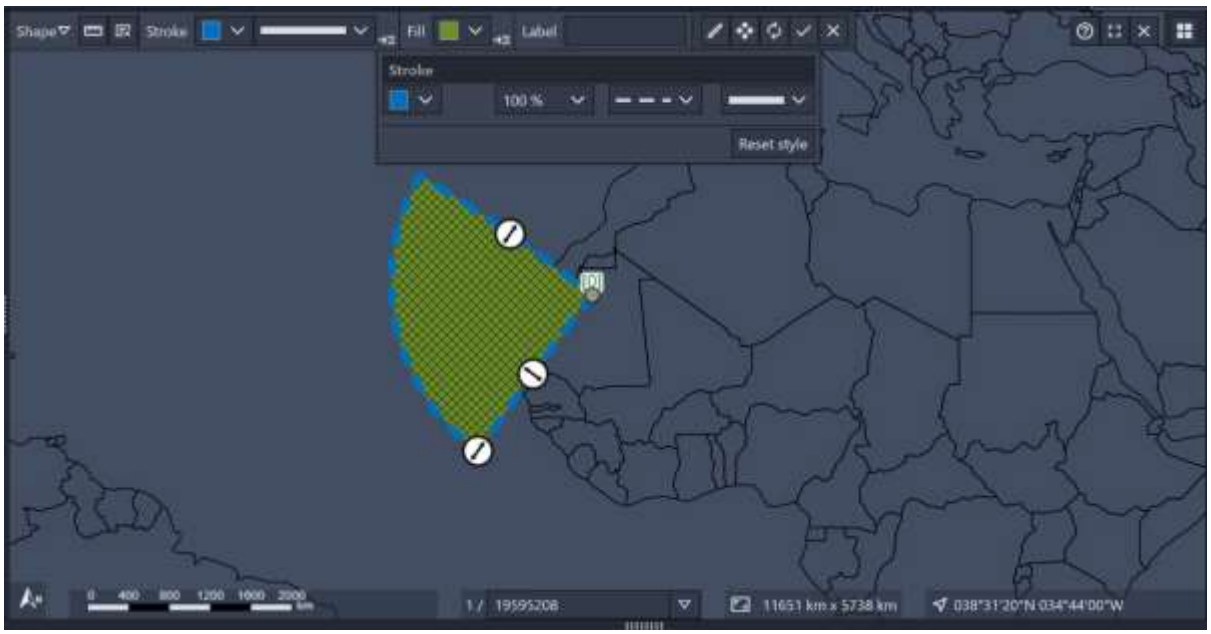

Figure 5-19: Geographical COP Editor displaying BSO edition

5.3.1.1.3.3 Export options

The Geographical COP Editor allows the user to export his user layer as a local file. The user can select a destination file format among the following formats:

- NVG
- KMZ (Zipped KML)
- Shapefile

Figure 5-20: Geographical COP Editor displaying export capabilities

5.3.1.1.4 Visualization Manager

Property Name	Description
Identification	Visualization Manager
Classification	IS

Property Name	Description
Behaviour	The visualization Manager is able to display the content of a CDF into several representations: Table display, allowing ordering, sorting or filtering the displayed data; Tree display, rendering hierarchical properties; The Geographical display which is assumed by the Geographical COP Editor (5.3.1.1.1). Information Panels are used to display CDF into the several representations. These representations are web-based and are implemented using HTML5 capabilities of Angular. The visualization Manager is capable of defining mapping from the CDF properties to an associated representation for visualization.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The Visualization Manager is part of the Geographical COP Editor. It has the capability to display an Information Products in various representations to allow users to view information with a specific perspective.

The following representations are available:

- Geographical visualization,
- BSO Relationships visualization (see §5.3.1.1.10),
- Information Product structure visualization,
- Matrix visualization,

The Visualization Manager takes advantage of the CDF properties to determine the visualization modes that are available for an Information Product or a BSO.

5.3.1.1.4.1 Geographical visualization

The geographical visualization is the default visualization mode for Information Products that are overlays that contain geo-localized BSO.

BSOs are displayed on the map background according to their coordinates and visualization style. Coordinates and visualization style of a BSO is described in the basic data part of the CDF representation of a BSO. This visualization mode is able to represent:

- points,
- lines,
- surfaces
- text

For each type of shape a style can be applied according to the BSO style properties (line colour, line pattern, fill colour, etc.). The style that is applied to shapes takes into account the military symbology that is associated with the BSO (applies to points, lines and surfaces.

Also, text shapes can be screen-referenced instead of geo-referenced.

The Geographical visualization mode can be configured to activate/de-activate the decluttering of points.

The Geographical visualization mode also takes into account the size of symbols (points) and text, based on an enforced size or based on a zoom-scale dependant size.

Figure 5-21: Geographical visualization

5.3.1.1.4.2 Information Product structure visualization

The Information Product structure visualization mode mainly applies to AdatP-3 messages that have been converted into CDF.

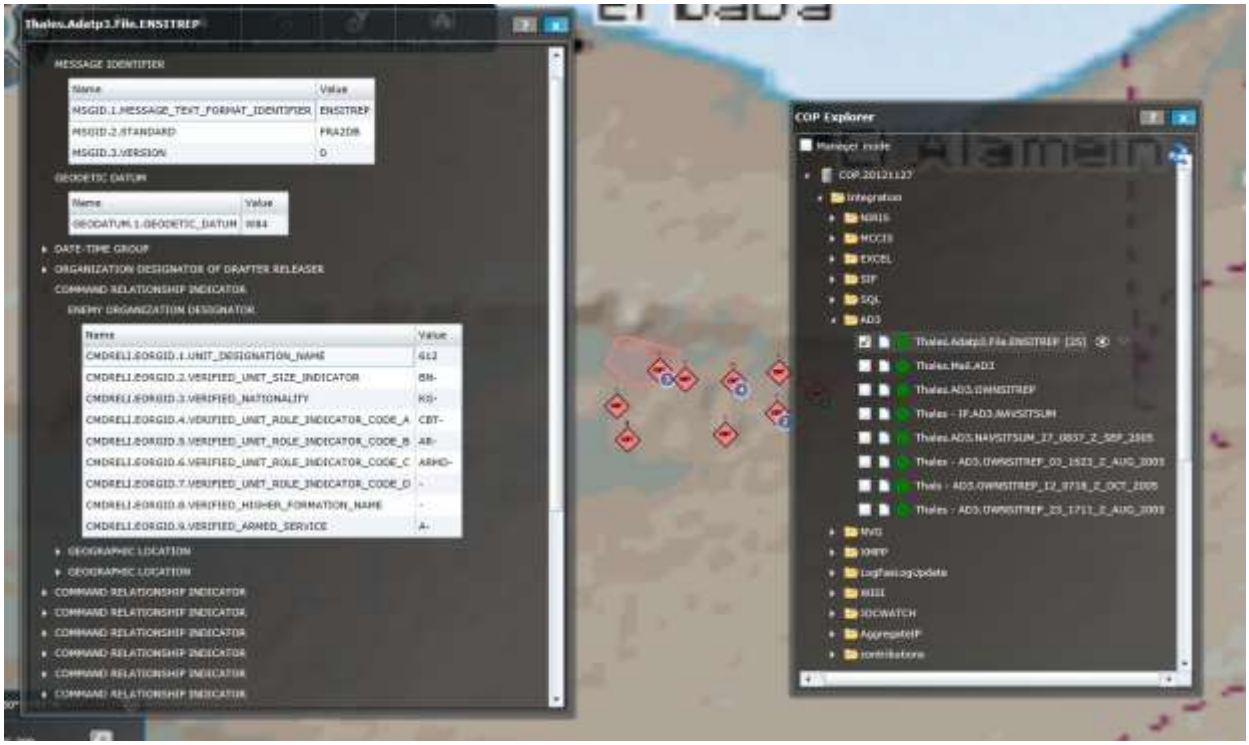

Figure 5-22: Information Product Structure visualization

5.3.1.1.4.3 Matrix visualization

The matrix visualization mode applies to overlays. BSOs contained in several overlays may be listed in a unique matrix. In this mode, a line of the matrix corresponds to one BSO and each column corresponds to a BSO property. The following capabilities are provided to the user:

- select the properties to be displayed,
- edit BSO properties,
- sort the listed BSOs according to column criteria,
- group BSOs according to the displayed properties (Grouped by overlay, Grouped by ClassLabel ...)

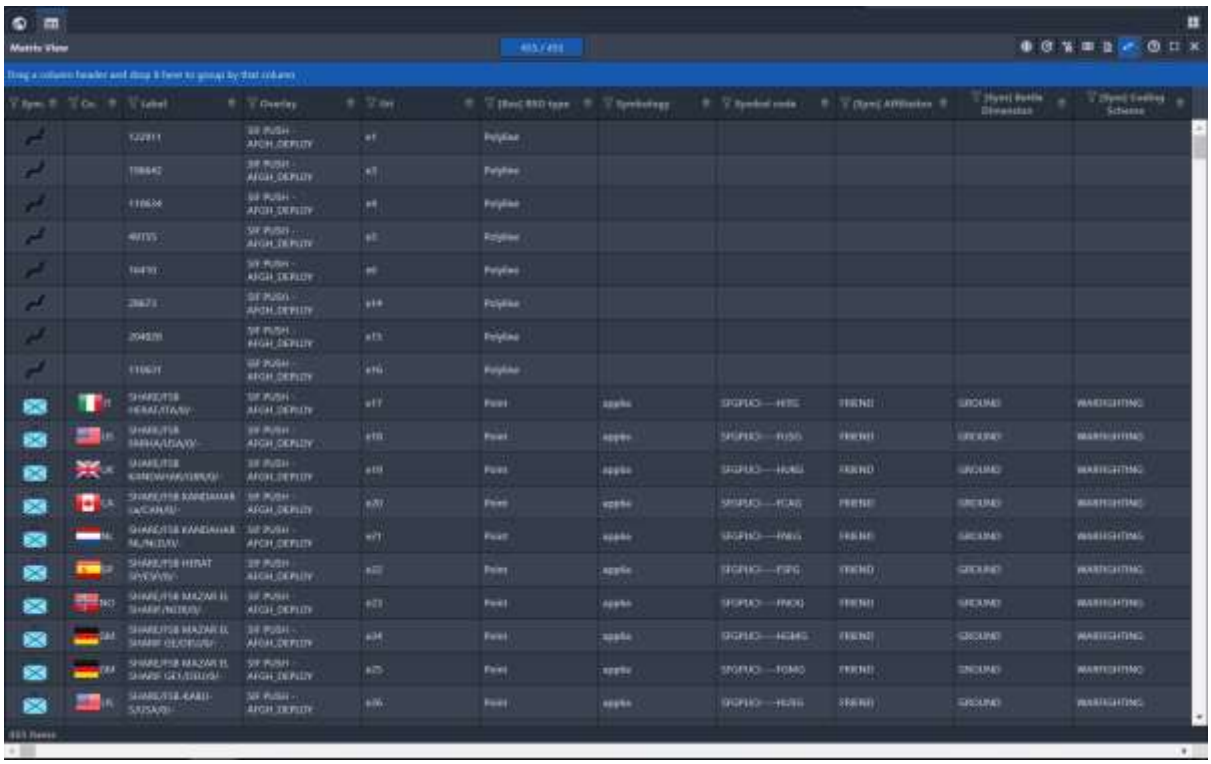

Figure 5-23: Matrix visualization

5.3.1.1.5 Angular

Property Name	Description
Identification	Angular
Classification	TI
Behaviour	This implementation component is a COTS product (with latest patches). Angular is a development platform, built on TypeScript. As a platform, Angular includes: A component-based framework for building scalable web applications A collection of well-integrated libraries that cover a wide variety of features, including routing, forms management, client-server communication, and more A suite of developer tools to help you develop, build, test, and update your code
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript
References	-

Property Name	Description
Quality of Service requirements (QoS)	-
Complexity	Difficult

Angular is used to develop the NCOP Geographical COP Editor user interface. The current release used in NCOP is Angular 10:

- Angular is a framework for building client applications in HTML and TypeScript that compiles to JavaScript
- The 8 main building blocks of an Angular application are Modules, Components, Templates, Metadata, Data binding, Directives, Services and Dependency injection
- Regarding the Model-View-Controller (MVC) or Model-View-Viewmodel (MVVM), in Angular, the “Component” plays the part of the controller/viewmodel, and the “Template” represents the view.
- Angular applications are made up of components. A component is the combination of an HTML template and a component class that controls a part of the application

Rationale for the choice:

- Commitment to coding good practice in an Angular environment (syntax, conventions, and application structure: see Angular coding style guide https://angular.io/guide/styleguide)
- End to end tests rather than unit tests
- Standalone mode, allowing the Geographical COP Editor to be run without SharePoint, BizTalk etc… This mode avoids the team developing the Geographical COP Editor to be dependent on the schedule of team developing the server and eases the presentation of Geographical COP Editor features.
- Modular application: an application can be built with a subset of the Geographical COP Editor components and have its own specific components.

5.3.1.1.6 JavaScript Libraries

Property Name	Description
Identification	JavaScript Libraries
Classification	TI
Behaviour	This implementation component is a set of COTS products executed on the Users Workstations and provides the framework for HTML5.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved

Property Name	Description
Location (Types)	Installed on the Application Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript JavaScript Libraries are used for by the Geographical COP Editor.
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The main JavaScript Libraries components used by the Geographical COP Editor are:

- Prime NG (UI Component Library) for User Interface components (examples:, ColorPicker, DropDown, Calendar, TreeTable, FlexGrid, Listbox, …)
- D3.js for User Interface advanced controls (example: Relationship Graph)
- OpenLayers (embedded in TIMS.js)
    - OpenLayers is a pure JavaScript library for displaying map data in most modern web browsers, with no server-side dependencies. OpenLayers implements a JavaScript API for building rich web-based geographic applications, similar to the Google Maps and MSN Virtual Earth APIs, with one important difference – OpenLayers is Free Software, developed for and by the Open Source software community
- CesiumJS (embedded in TIMS.js)
    - CesiumJS is a pure JavaScript library capable of creating 3D globes in modern browsers, with no server-side dependencies. CesiumJS exposes a JavaScript API and WebGL for hardware-accelerated graphics. CesiumJS is Free Software

The source code developed in the HTML 5 JavaScript Geographical COP Editor will be based on TypeScript:

- TypeScript is a free and open-source programming language developed and maintained by Microsoft and also a compiler. It helps building large-scale JavaScript applications. It is a strict superset of JavaScript, and adds optional static typing and class-based object-oriented programming to the language

Additional information on http://www.typescriptlang.org.

5.3.1.1.7 WMS Player

Property Name	Description
Identification	WMS Player
Classification	IS
Behaviour	This component provides the capability to display sequentially several map sublayers in a user-defined order. This geo-data animation uses WMS layers.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with http/https WMS end-points
Collaboration mechanism	http, https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

Geo-data animation can be realized through a specific panel dedicated to Geo-data management. With this panel, the user can select multiple Geo-data layers (WMS) and display them successively on top of the background map.

This geo-data player is an alternative solution to simulate the time dimension for protocols that don't take it into account (WMS).

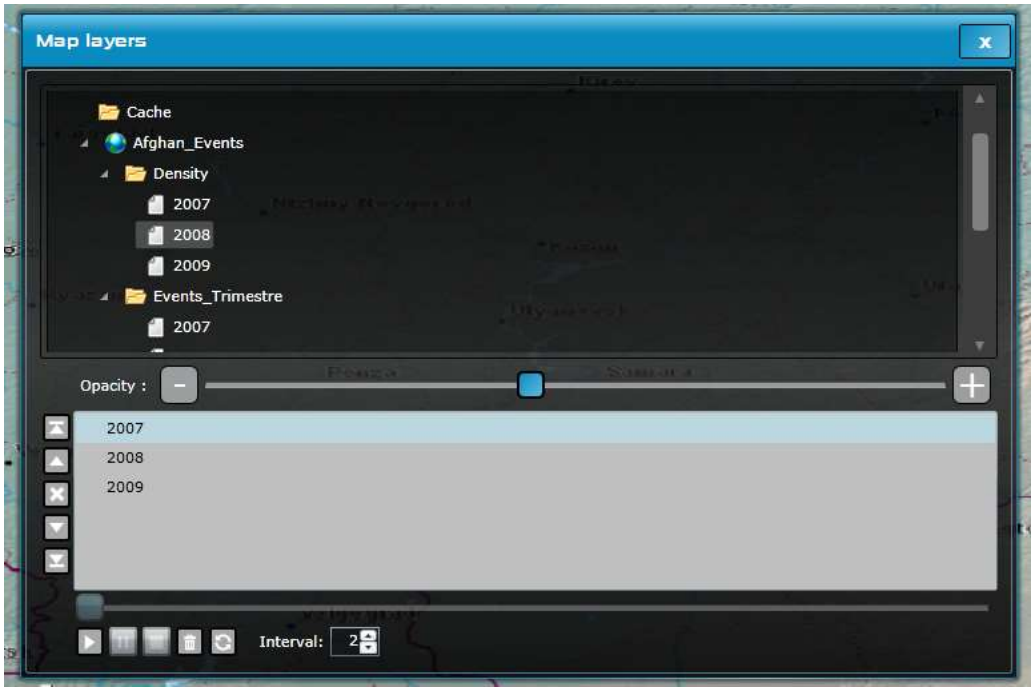

Figure 5-24: Animation of geo-data (WMS layers)

5.3.1.1.8 COP Explorer

Property Name	Description
Identification	COP Explorer
Classification	IS
Behaviour	The COP Explorer is a Web User Interface allowing COP Users, Contributor and Manager roles to access to the COP content. The COP Explorer is automatically refreshed when the COP content is updated: - IP content changed - COP Structure changed - IP status changed - …
Actors involved	See details in Appendix K IC vs Actors Involved**Error! Not a valid result for table.**
Objects involved	See details in Appendix L IC vs Objects Involved

Property Name	Description
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The Geographical COP Editor includes a basic information panel available to all NCOP users. This panel called COP Explorer allows the users to browse the COPs that have been defined by the COP Manager. It displays the COPs in a tree fashion reflecting the hierarchical structure defined by the COP manager and allows the user to load and display COP Information Products.

Figure 5-25: COP Explorer

In addition to this panel, an additional configuration tool allows each user to customize the content of the COP Explorer. The user can unselect specific COPs in order to hide them in the COP Explorer. Also for each COP, the user can decide which COP structure shall be shown or hidden in his COP Explorer.

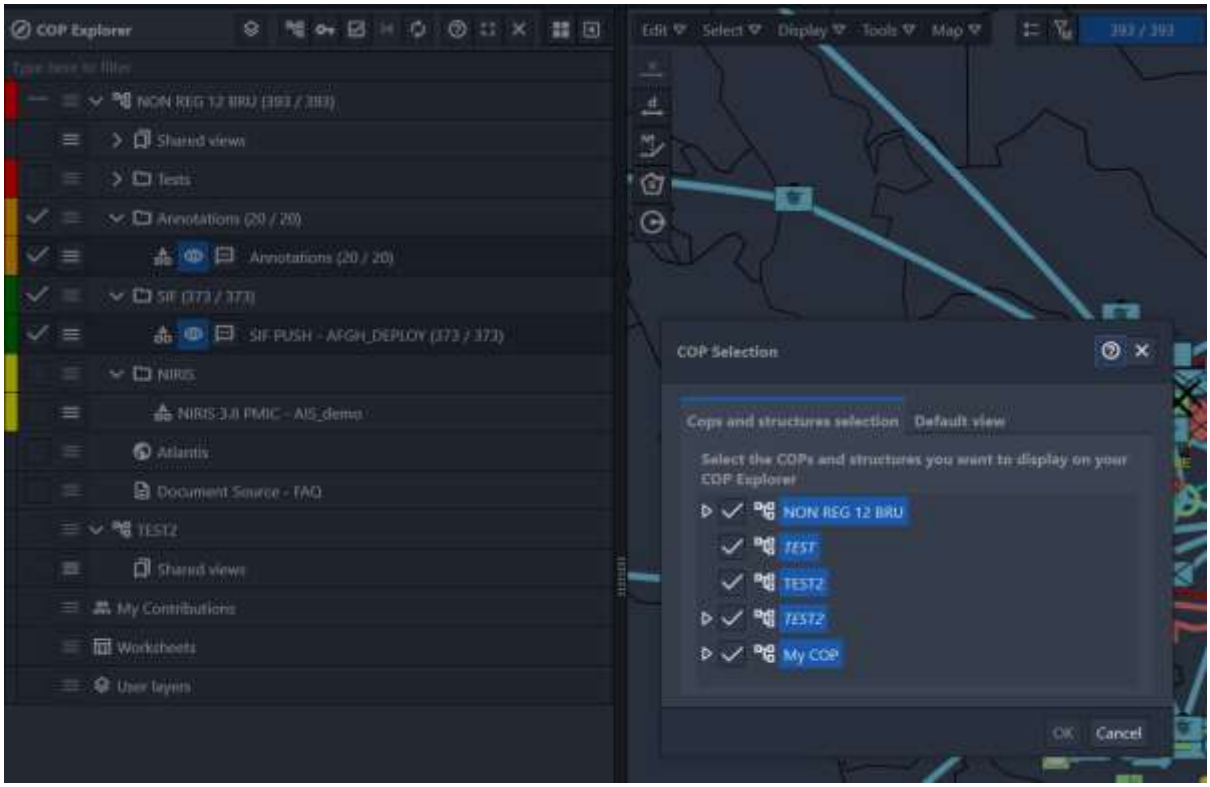

Figure 5-26: COP and structure selection

The following information panels are provided to present additional information for BSOs:

- BSO properties,
- BSO relationships
- BSO attached documents

Segmentation

Sometimes some Information Products coming from specific interfaces (e.g. AirC2IS or TOPFAS interfaces) shall not be displayed entirely on the Geographical COP Editor.

For example in AirC2IS interface, some Information Products (Defence Design …) contains the data of all Planning Periods of a Phase. The display shall be limited to one or several Planning Periods contained in the Information Product.

These Information Products are composed of segments.

In the initial implementation, these segments are defined as NVG groups.

During the Information Product definition, several optional parameters are present in the Main\Extended View:

- Segmentation criteria:
  - First choice will be the NVG Group (<g>)
- Maximum depth of the breakdown structure
- Exclusive mode (Yes/No)
  - User can select a single segment
  - User can select multiple segments

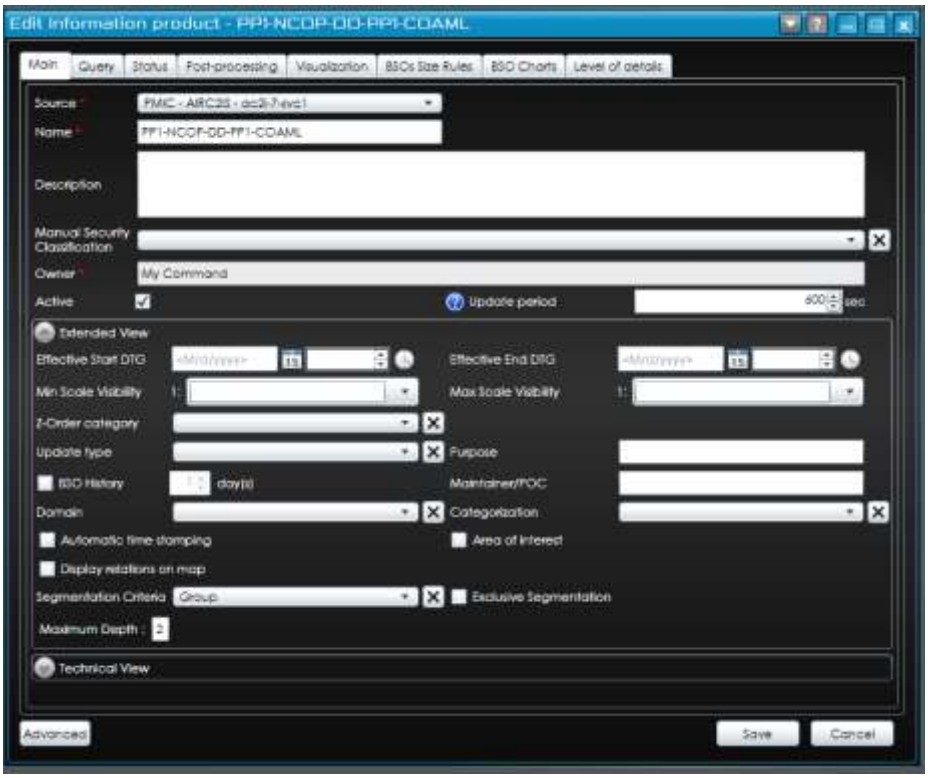

Figure 5-27: Information Product Definition with Segmentation criteria

On the COP Explorer, the selection of the expected segment(s) appears under the Information Product, as illustrated below:

Figure 5-28: Several exclusive segments

The expected segment(s) could be displayed by ticking a radio button (exclusive mode) or a checkbox (none exclusive mode)

The BSO associations display is limited to the expected segments.

The result of the segmentation criteria definition is available for all NCOP roles. A user chooses which segment to display.

The user selection is stored (as already done for the visualization filters) in user preferences.

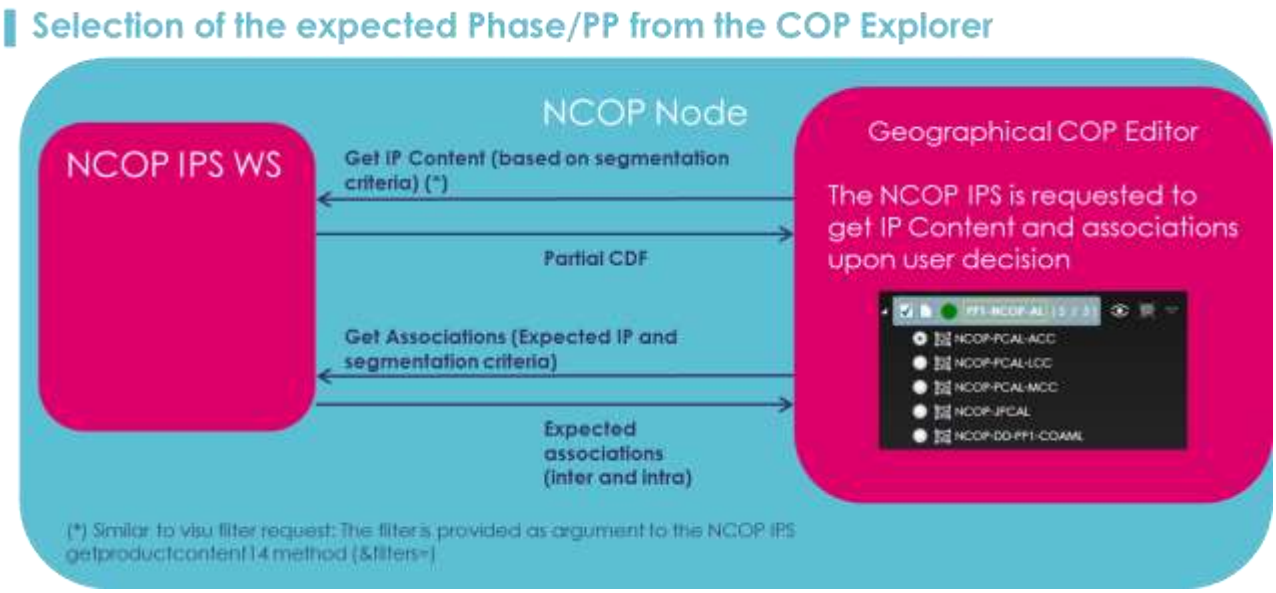

Figure 5-29: Segments in AirC2IS context: Phase/Planning Periods

5.3.1.1.9 BSO Manager

Property Name	Description
Identification	BSO Manager
Classification	IS
Behaviour	The BSO Manager is a Web User Interface allowing COP Users, Contributor and Manager roles to access to any BSO content: - BSO properties (basic data, metadata, extended data and symbol modifiers) - BSO relationships - Attached documents - BSO Charts
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server

Property Name	Description
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

5.3.1.1.9.1 BSO properties

When a BSO is selected on the map, an information panel is displayed presenting a synthesis of main properties as well as a set of buttons that can be used to display additional information for the BSO such as the BSO relationships panel and the BSO attached document panel:

Figure 5-30: BSO properties summary and actions

The BSO detailed properties information panel is available from both geographical and matrix visualization modes via a click on a BSO.

The panel displays the BSO properties and associated values in the CDF.

A header displays the basic data of the BSO (name, symbol, and country flag). Other Properties are displayed grouped according to the following categories:

- Geometry,
- Metadata,
- Extended Data.

Figure 5-31: BSO properties panel

5.3.1.1.9.2 BSO relationships

The BSO relationship panel displays the BSOs that are linked to the selected BSO. The graphical representation of this panel shows the selected BSO in the centre of the

panel and associated BSOs are displayed around with oriented arrows between them to represent the associations.

This panel allows the user to navigate from one BSO to another by following the association's links.

Figure 5-32: BSO relationships display and navigation

5.3.1.1.9.3 BSO attached documents

This information panel allows the visualization of documents that are attached to the BSO.

Documents attached to a BSO are described in a dedicated extended data in the CDF. This extended data value contains the links (URL) to access these documents.

Attached documents can be previewed and visualized in their native format. Visualization of attached documents relies on the availability of appropriate software to handle specific file formats.

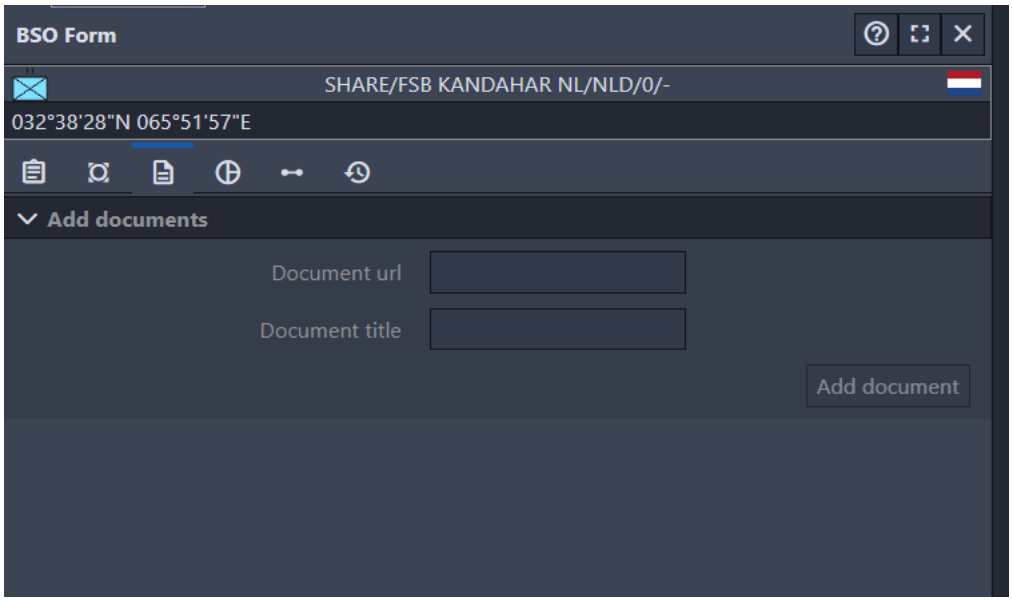

Figure 5-33: Attached documents visualization

5.3.1.1.9.4 BSO charts

NCOP offers the possibility to display BSO properties using a diagram representation. The properties to be used and the presentation method are defined by the COP Manager when he configures the information product. The diagrams can be visualized by any COP consumer using the dedicated tab in the BSO extended form.

The figure below presents this visualization panel:

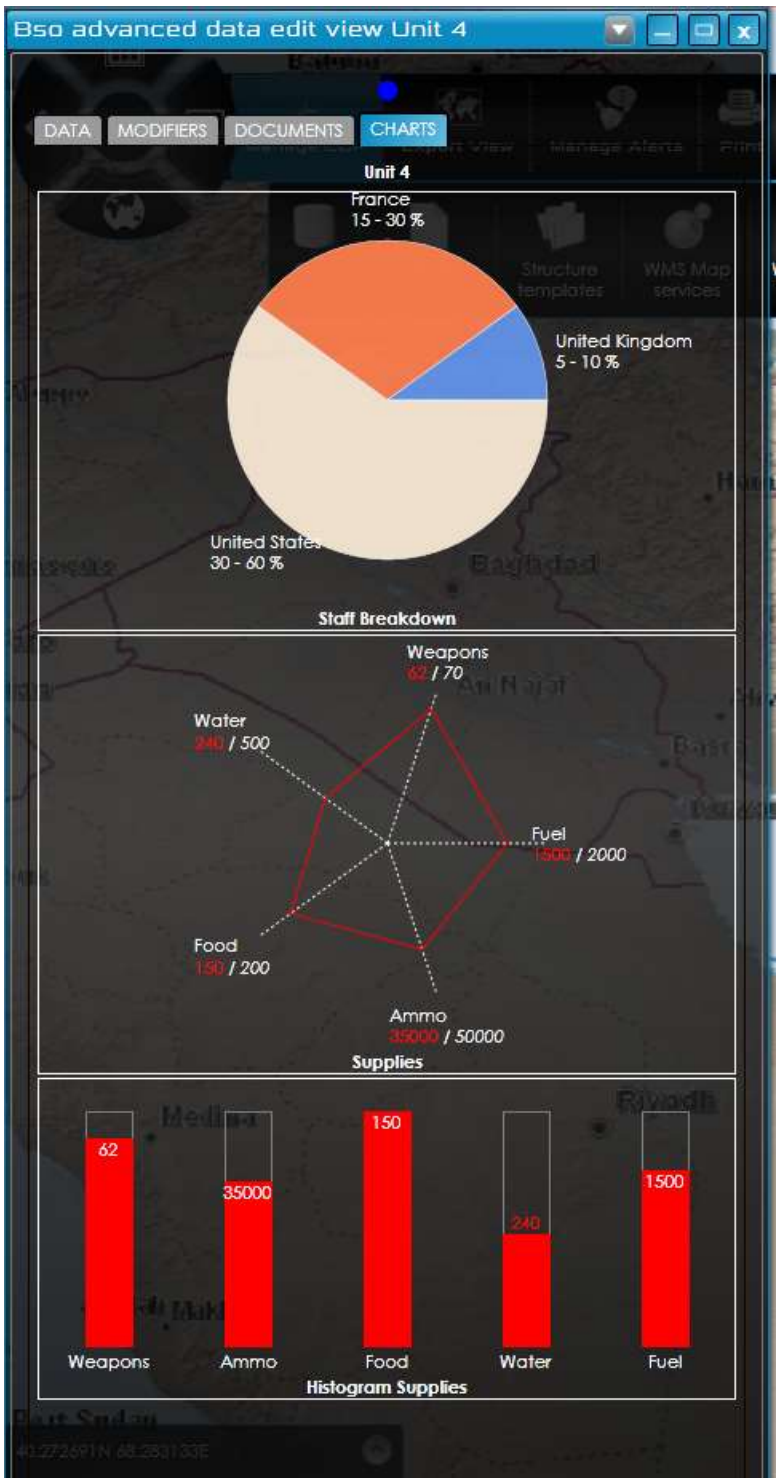

Figure 5-34: BSO charts visualization panel

The visualization panel uses the characteristics of the BSO charts defined by the COP manager (Chart type, BSO properties to be used as values) and the BSO properties to draw the diagram associated representation. Chapter 5.3.2.2.4.7 presents the configuration UI available to the COP Manager for defining the contents of the BSO charts.

5.3.1.1.10 Relationship Manager

Property Name	Description
Identification	Relationship Manager
Classification	IS
Behaviour	The Relationship Manager allows the management and display of the relations between BSOs. This component relies on d3.js JavaScript library for the rendering.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The Relationship Manager is only available for:

- Information Products that contain BSO relationships (Intra-IP BSO relationships).
- Inter-IP relations defined on a COP by a COP Manager. A relation is manually defined by the COP Manager with a rule set. Each rule set describes a relation between a BSO A from a first Information Product and a BSO B from a second Information Product. Example: When BSO A from “ICC Air Units” has property “Label” equal to property “Label” of BSO B in “AirC2IS RAP” then BSO A is “Subject” of relation “Augments” with BSO B.
- Inter-IP relations defined on an aggregated Information Product by a COP Manager. A relation is manually defined by the COP Manager with a rule set. Each rule set describes a relation between a BSO A from a first Information Product and a BSO B from a second Information Product.
- Inter-IP relations defined during source acquisition (introduced with AirC2IS interface)
- Relationships extracted by the Aggregation Association and Correlation Processing component. BSOs that are in aggregated IP or correlated IP are linked to the original BSOs.

The BSO relationships NCOP Service is used to retrieve the links between BSOs.

This visualization mode allows multiple representations of relationships:

- Hierarchical representation

  Using a tree representation reflecting the hierarchy relationships between BSOs

Figure 5-35: Hierarchical display

This representation can be used to visualize ORBATs.

- Geographical representation

Drawing lines on the map reflecting the hierarchy relationships between BSOs

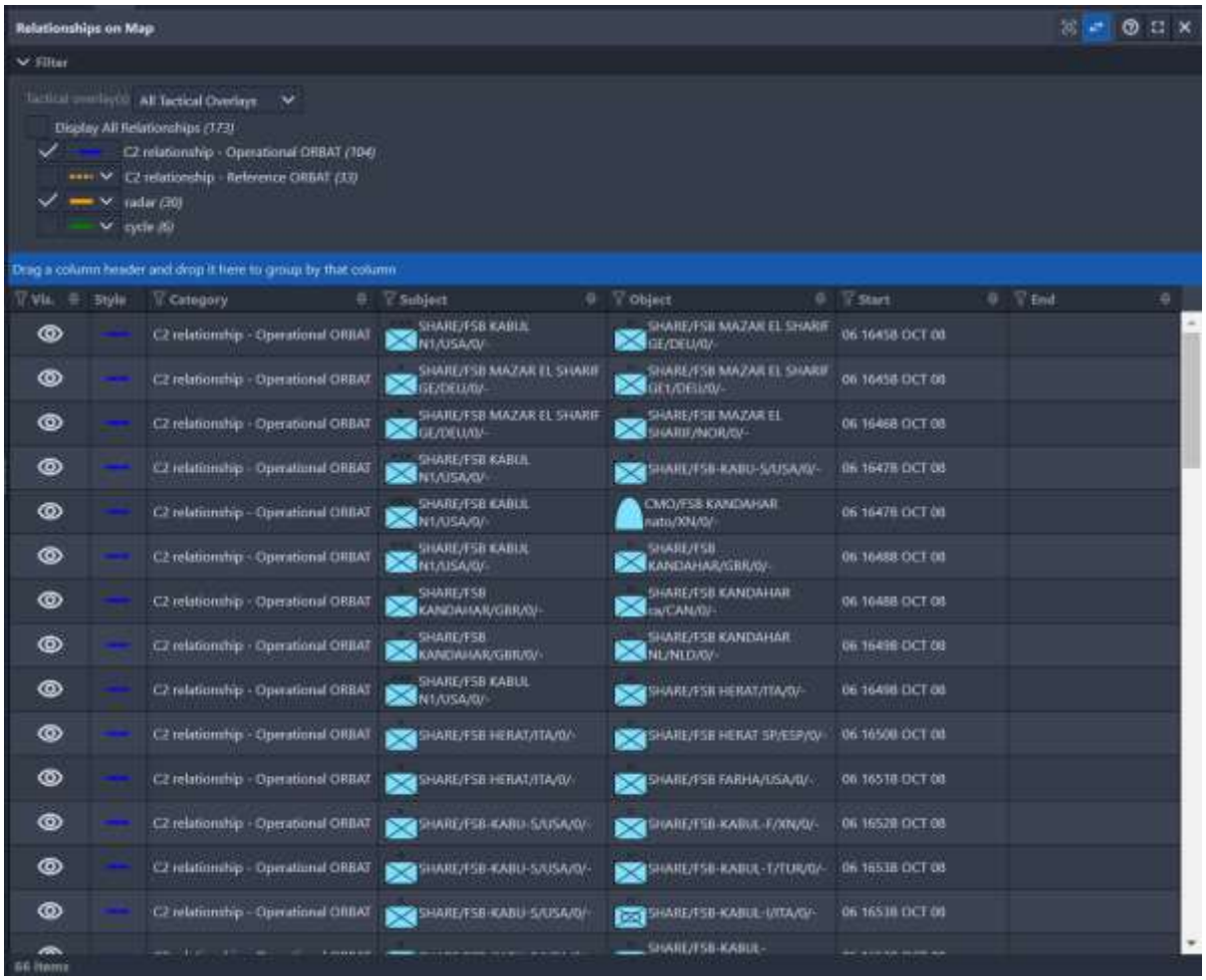

Figure 5-36: BSO relationships geographical display

- Graph representation

Displaying all BSOs and all relationships in a dedicated interactive panel.

Figure 5-37: Relationship graph display panel

The symbols that are drawn in the “BSO Relations” Panel are the same as those drawn on the map background.

If a BSO has a relation with another BSO that is defined in another IP which is not loaded (inter-IP relations) then a  icon is drawn. When this IP is loaded the symbol of the unknown BSO is updated with the correct value. See the example below:

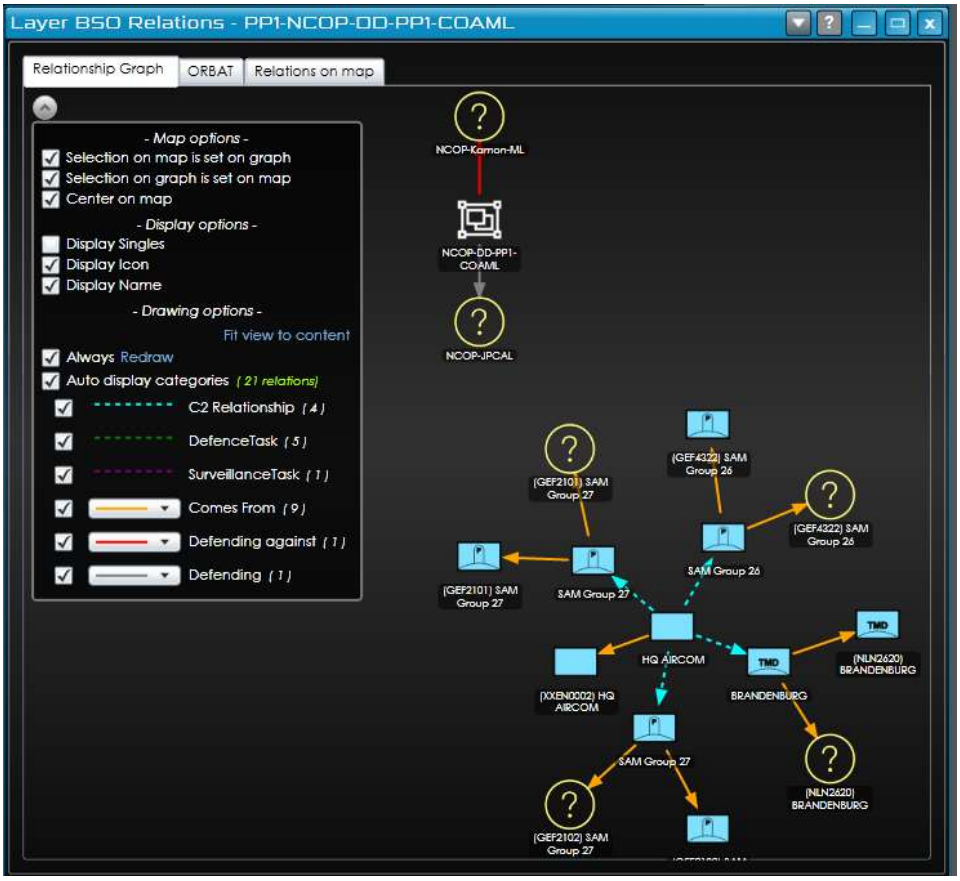

Figure 5-38: Relationship graph display panel showing Inter-IP relations

The name of the Information Product containing the unknown BSO is displayed as tooltip on top of the unknown BSO.

The following picture shows the events having impact on Associations display:

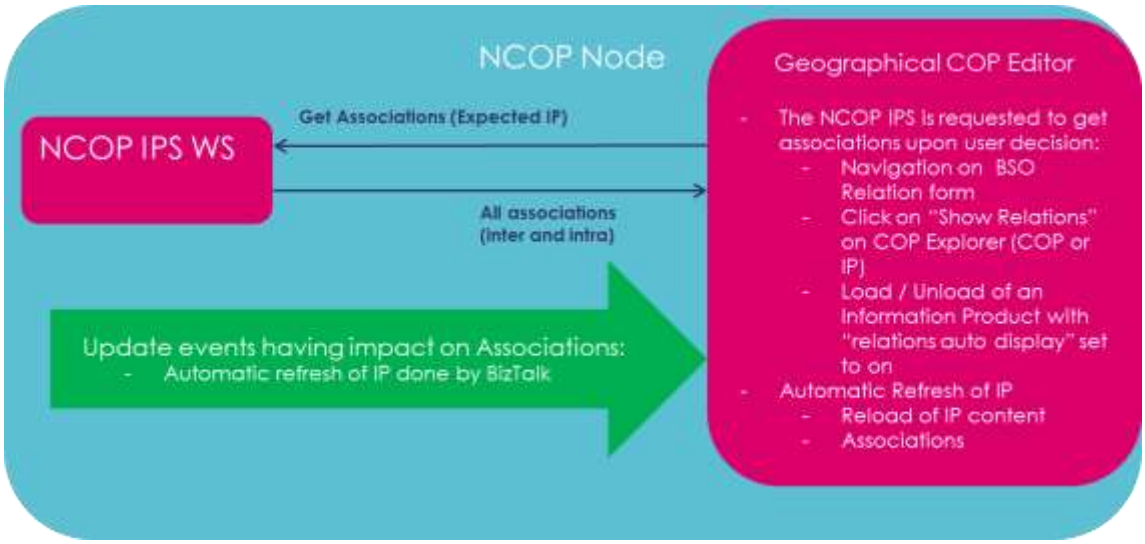

Figure 5-39: Events having impact on Associations display

Computation of relations for dynamic Information Product.

NCOP is able to compute on the fly, the BSO relationships of the NIRIS L16 TMD dynamic Information Product. It is illustrated below:

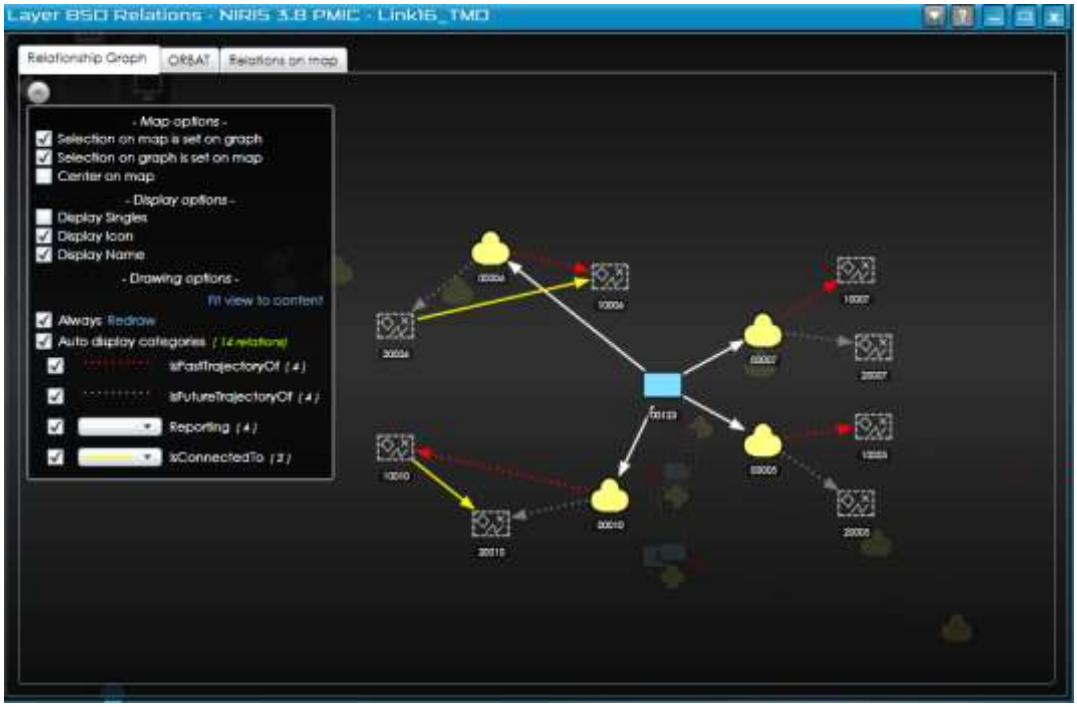

Figure 5-40: NIRIS L16 TMD relations computation

The relations can be displayed by type or individually. The ellipses around LPE (Launch Point Estimated) and IPP (Impact Point Predicted) are also computed and displayed by NCOP as illustrated below:

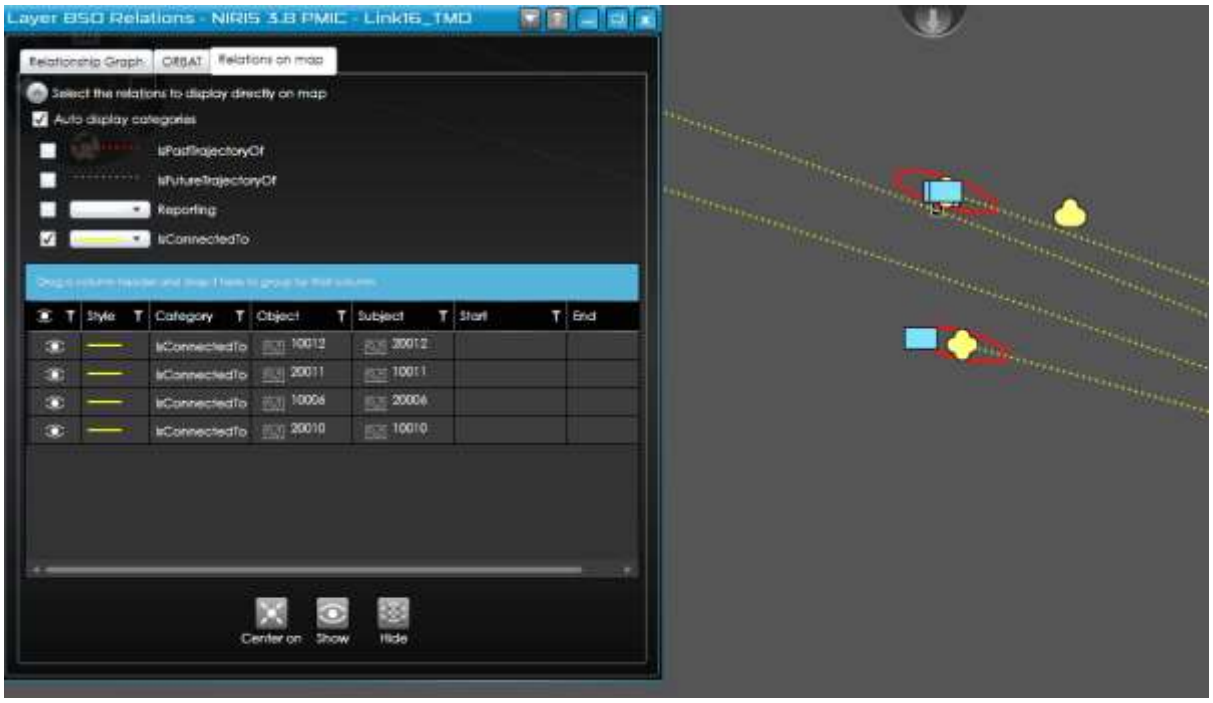

Figure 5-41: NIRIS L16 TMD relations display on map background

5.3.1.1.11 Aggregation Association Correlation Manager

Property Name	Description
Identification	Aggregation Association Correlation Manager
Classification	IS
Behaviour	The Aggregation Association Correlation Manager is a Web User Interface allowing COP Manager role to manage the rules that lead to the creation of aggregations, associations and correlations on BSOs.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

The aggregation, correlation and association of BSO are described below:

- Association:
  - Definition of a relationship between BSO (without creating a new BSO)
- Aggregation:
  - Creation of a new BSO linked to several existing BSO
  - The new BSO is persisted in a new specific IP or not persisted at all (display only)
- De-confliction:
  - Process by which several BSO reporting on the same “physical” object (from different perspectives) are identified
  - De-confliction is a preliminary step to correlation and sanitization
- Correlation:
  - Merging of de-conflicted BSO into a new BSO
  - The new BSO is persisted in a specific IP

- Use case: MCCIS tracks merged with ships in Excel file

The key assumptions to implement aggregation, correlation and association of BSO in NCOP Increment-2 are:

- Aggregation, correlation and association of BSO will be persisted in SQL tables
- Aggregation, correlation and association of BSO will be executed by analyzing the BSO's attributes stored in the SQL tables. It will be performed by the most efficient language or component optimizing CPU and memory:
  - OLAP (On-line Analytical Processing) or OLTP (On-line Transaction Processing)
  - Stored procedures
  - Transact-SQL

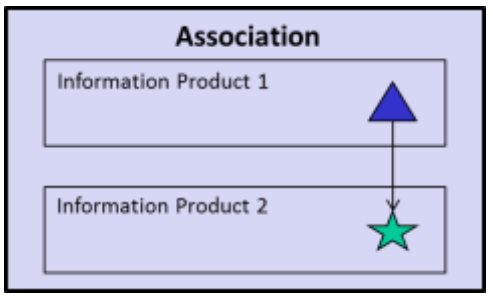

Figure 5-42: Association of BSO: main principles

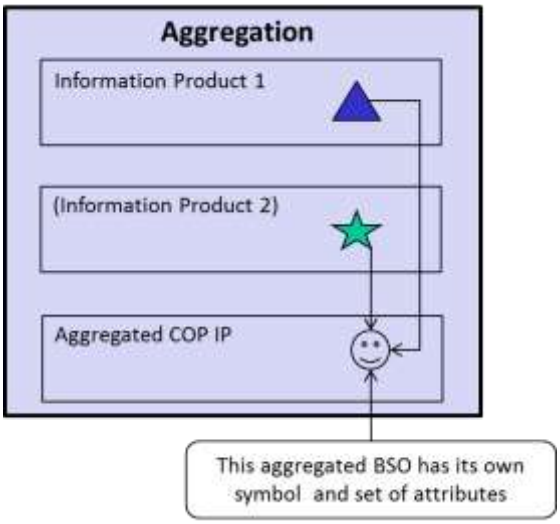

Figure 5-43: Aggregation of BSO: main principles

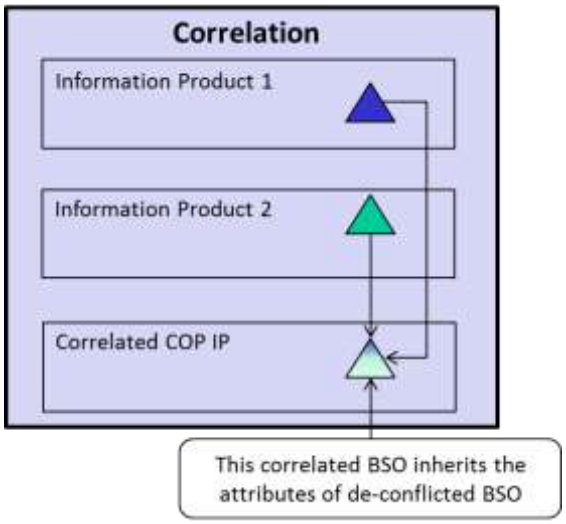

Figure 5-44: Correlation of BSO: main principles

5.3.1.2 NCOP Common UI

5.3.1.2.1 NCOP Web Portal

Property Name	Description
Identification	NCOP Web Portal
Classification	IS
Behaviour	A unified NCOP Web Portal HMI provides a single point of access for the end-users and administrators to the NCOP applications (according to their permissions) such as: COP Structure Manager UI; COP Shared View Manager UI; COP IP Manager UI; COP Workflow Manager UI; COP Contribution Manager UI; COP Dissemination Manager UI; Geographical COP Editor; This web client User Interface (UI) is provided inside Microsoft Edge The NCOP Web Portal and his web pages are hosted by the Microsoft SharePoint Services.

Property Name	Description
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the SharePoint Server
Interfaces	This IC interacts with the SQLback-end natively (SharePoint mechanism) This IC provides the SharePoint accessor interface used by the Geographical Cop Editor Service and BizTalk to access to the SharePoint portal
Collaboration mechanism	https
Local/Configuration data	-
Operating context	.NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

The NCOP Web Portal is the main frame of the application and provides the following functions for all screens:

The login page;

The menu and toolbar giving access to the Web-based applications as required;

The access to the On-Line Help, User manual, administration guide, installation guide and frequently asked questions;

The User interface appearance control;

The database management (e.g. Live, exercise, training).

The On-Line Help allow the User to:

Access a link from every form/page to a support person or organisation or document, on-line User documentation, on-line help, computer based training and relevant chapters in the User Manual;

Retrieve all relevant documentation for users (including Operational Trainer role), accessible via the browser based application, including:

- User Documentation;
- System Administration Documentation;
- Installation Documentation;
- Release Notes;
- Tutorials (Key concepts and terminology, Frequently Asked Questions, Common data entry, query and reporting tasks).

Based on the Microsoft SharePoint product, the NCOP Web portal allows data to be manipulated in a datasheet mode. This capability is available in all SharePoint lists and document libraries if Excel is installed on the user's workstation. For NCOP, this capability has not been deactivated but some SharePoint views are provided to perform mass modification using this mode. These views have been designed to mask some technical fields and expose only attributes that can be modified without risk. Using NCOP specific user interfaces (Geographical COP Editor, SharePoint forms) remains the preferred way to access and manipulate data in NCOP.

Since the NCOP Web portal is identified as the single point of access to all NCOP functionalities, when a user logs in, the NCOP Web portal displays a home page containing links to all the applications the user can use according to his roles. This welcome page can be customized to include additional applications links for the users.

By default this main home page is made of a set of SharePoint web parts presenting the list of available COPs, access to NCOP features (depending on the user role), links to other websites, shared documents etc. The content of this home page can be configured by an authorized user.

The following figure presents a screenshot of a sample NCOP Web Portal home page:

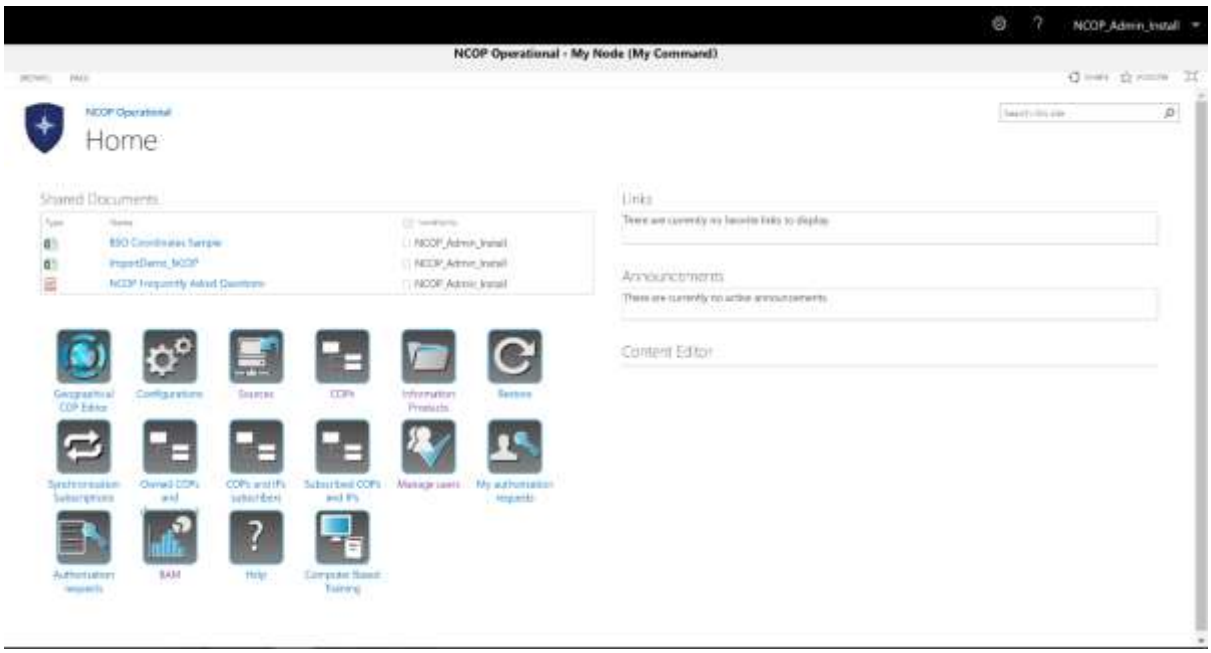

Figure 5-45: NCOP Web Portal

In addition, a home page is automatically created for each COP that is available in the NCOP node. By default it includes a set of specific NCOP web parts presenting:

- The geographical editor displaying a selected shared view
- A list of COP Information Products referenced in the COP
- A list of BSOs contained in an Information Product (selected by an authorized user)

Additional standard web parts can also be included in this page.

Each COP page can be configured (content and arrangement) by an authorized user.

The following figure is an example of a possible COP home page configuration:

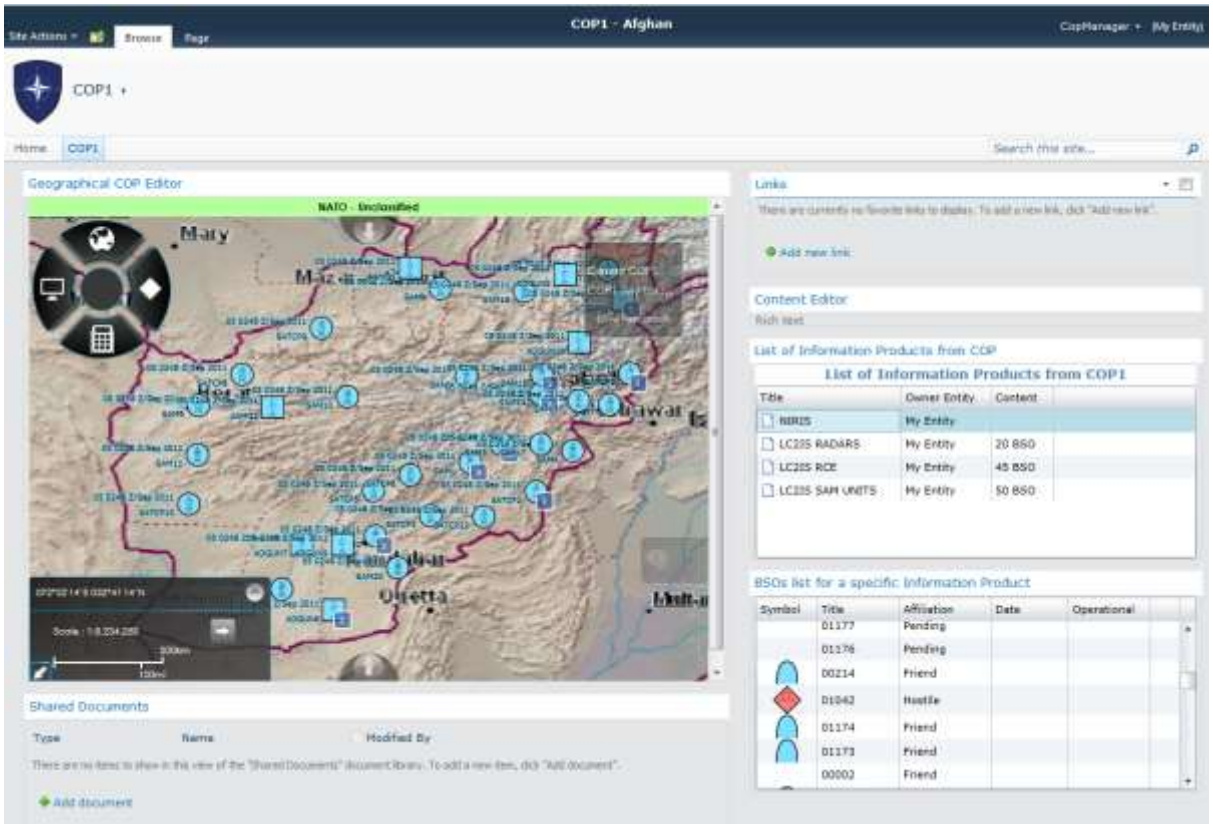

Figure 5-46: COP Home page sample

5.3.1.2.2 On-Line Help

Property Name	Description
Identification	On-Line Help
Classification	IS
Behaviour	This component is the on-line help describing all functionalities of the NCOP system. It is hosted by the NCOP Web Portal (see §5.3.1.2.1) and use Microsoft standard interface methods for accessing on-line documentation resources such as CHM/HTML.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The following figure presents a screenshot of the NCOP On-line Help:

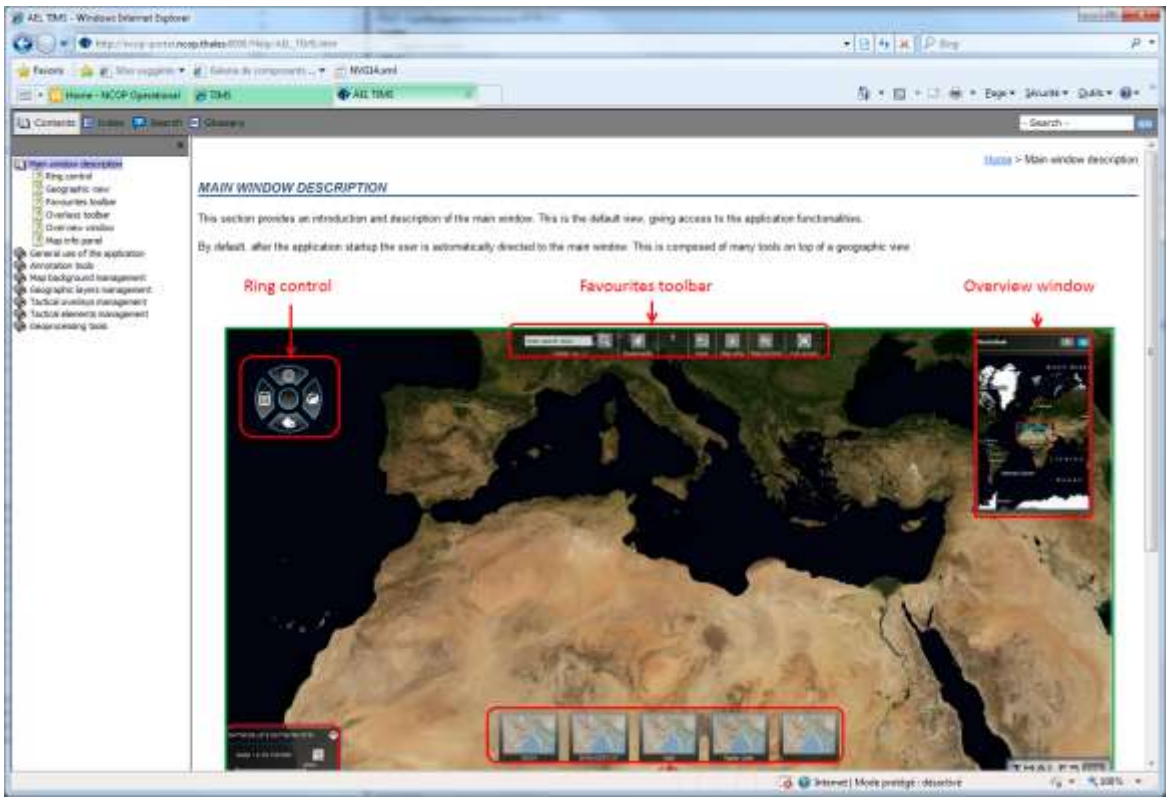

Figure 5-47: On-Line Help Screenshot

5.3.1.2.3 Training

Property Name	Description
Identification	Training
Classification	IS
Behaviour	The Training component has the main following capabilities: Has a comprehensive, integrated training capability for scenario development and generation which allows: o To run a scenario application using future dates/time; o To save an exercise scenario which has been executed for review; Allows to install and un-install the NCOP Training Data from the Training environment. Training Data contains: o Exercise or simulated data for consumption by NCOP Services; o Dataset representative of an operational dataset in size and coverage (i.e., all Information Entities and relationships); o Dataset with evolutionary data across a representative period of time for training and representative evolutions for each type of Information Product contained in the NCOP Training Data. Display a notification to the User that he is working in a training environment;
Actors involved	See details in Appendix K IC vs Actors Involved

Property Name	Description
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server Installed on the SharePoint Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

In training mode, it might be necessary to access operational data. However, it is not recommended to share the same storage between operational and training data. So if an operational information product is needed to be used in the training environment, it shall be done by creating a copy of the operational information product into the training environment. If the data needs to be updated in the training environment, it shall be done on demand with a manual copy of the data.

5.3.1.2.4 CBT

Property Name	Description
Identification	CBT
Classification	IS
Behaviour	Computer-Based Training (CBT) component has the main following capabilities: Complement the on-line help function by defining and explaining key concepts and terminology of the NCOP and TMD operational processes incorporated into NCOP features and functions; Explain all menu items, dialog windows, data entry and query fields, and terminology implemented in the NCOP Product Baseline; Provide 'Walkthrough Wizards”;
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	-
Collaboration mechanism	-
Local/Configuration data	-
Operating context	TypeScript/JavaScript
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The CBT module does not access operational data.

The following UML Use Case Diagram shows the main responsibility of the COP Operational Trainer role.

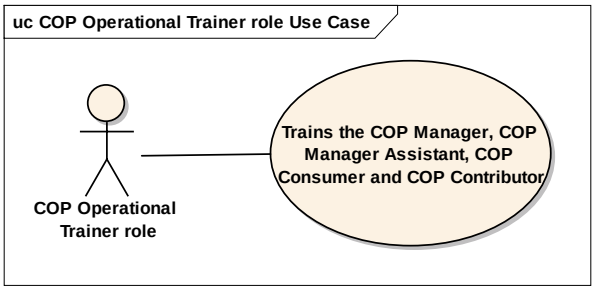

Figure 5-48: UML Use Case Diagram for COP Operational Trainer role

A link on the NCOP Web portal home page allows accessing the HTML5 NCOP CBT web application.

The CBT application is organized in different sections:

The first section allows the user to select the role for which he wants to be trained.

Then according to the role selected, the user chooses a training session from a list of use cases associated to the previously selected role. Each use case allows the user to:

- Run videos detailing specific functionalities,
- Run, using a guided step by step approach, exercises dedicated to specific functionalities,
- Check his knowledge through a Quiz covering all the use case's functionalities.

5.3.1.3 COP Manager UI

The following UML component diagram details the components involved by the COP Manager role during his main activity: "Maintain the COP".

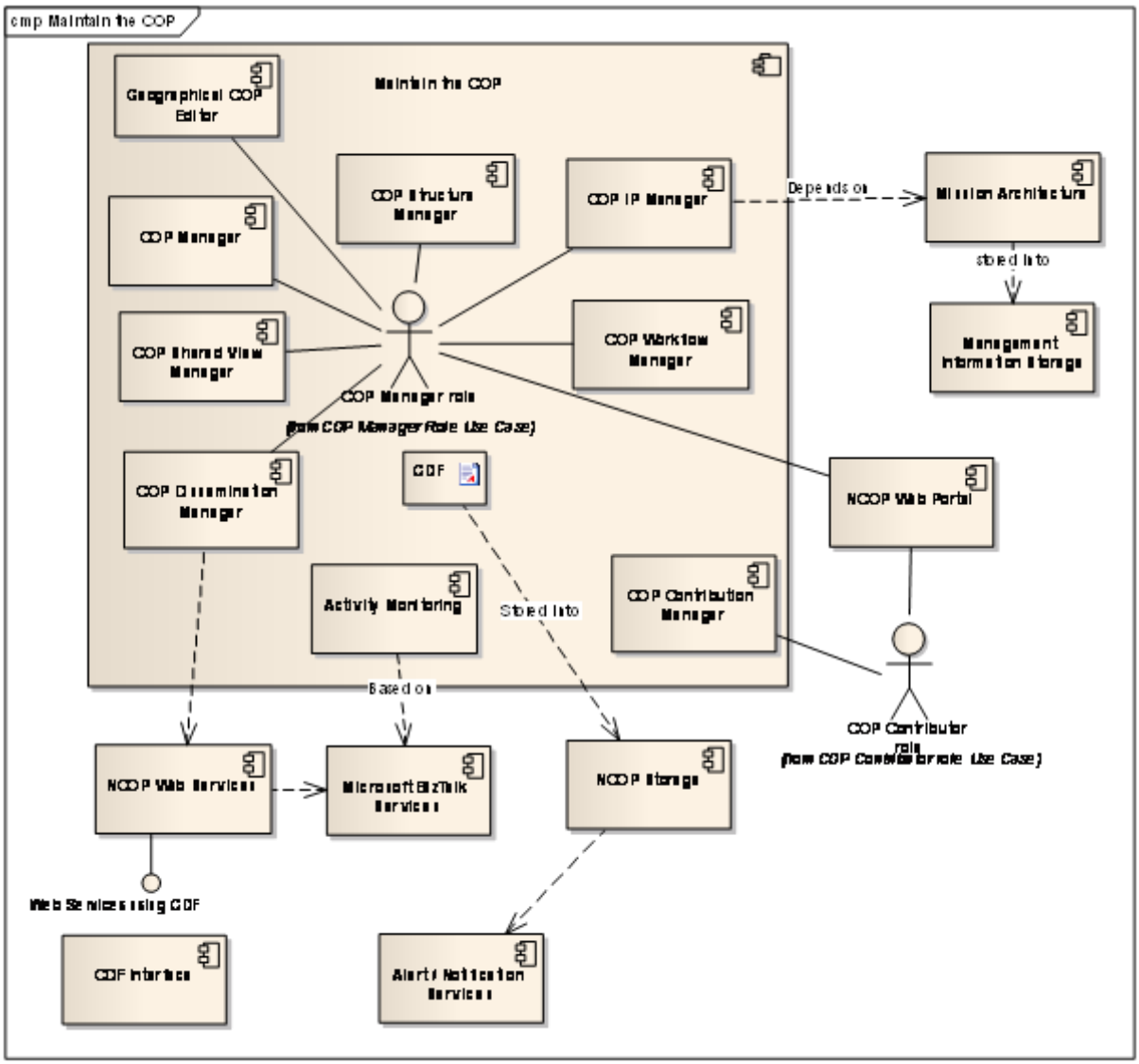

Figure 5-49: UML component diagram of "Maintain the COP"

The following UML sequence diagram details the components involved by the COP Manager role during the “Determines the structure and content of the COP” activity.

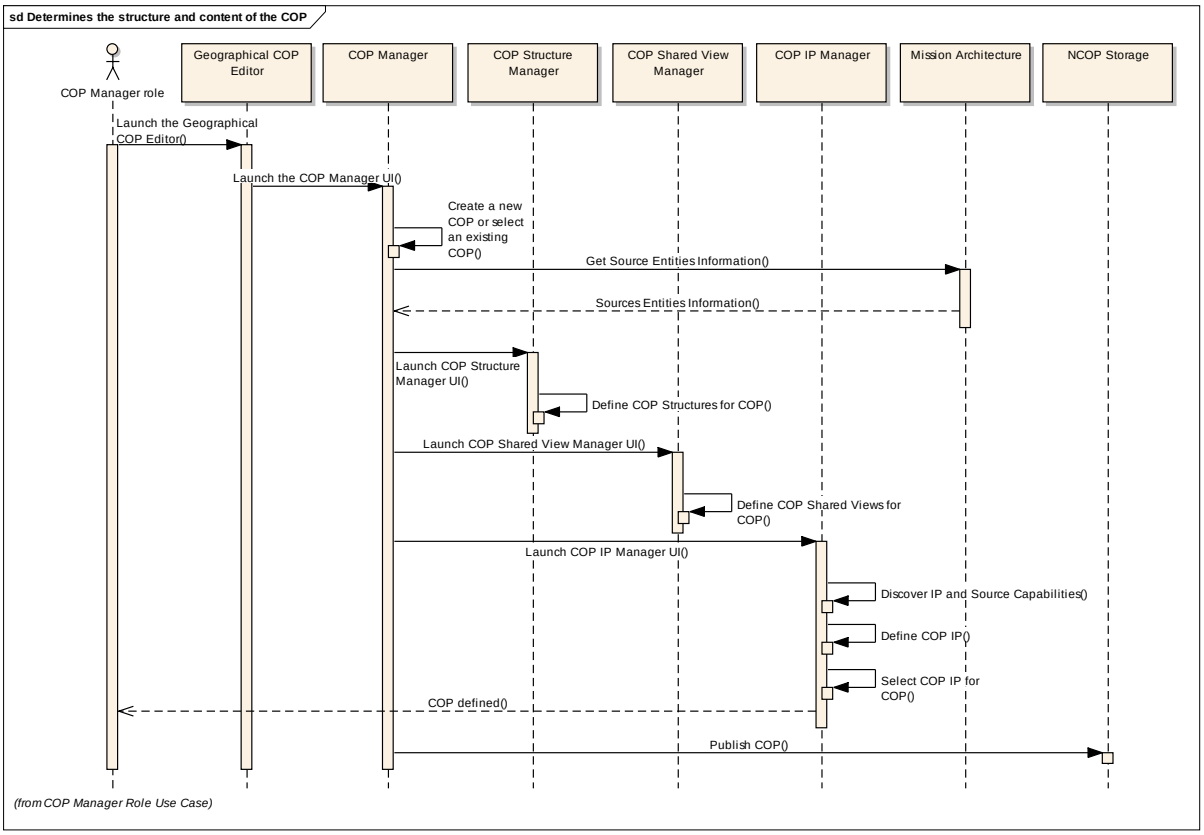

Figure 5-50: UML sequence diagram for “Determines the structure and content of the COP”

The following UML sequence diagram details the components involved by the COP Manager role during the “Determines the sources that are needed to contribute to the COP” activity.

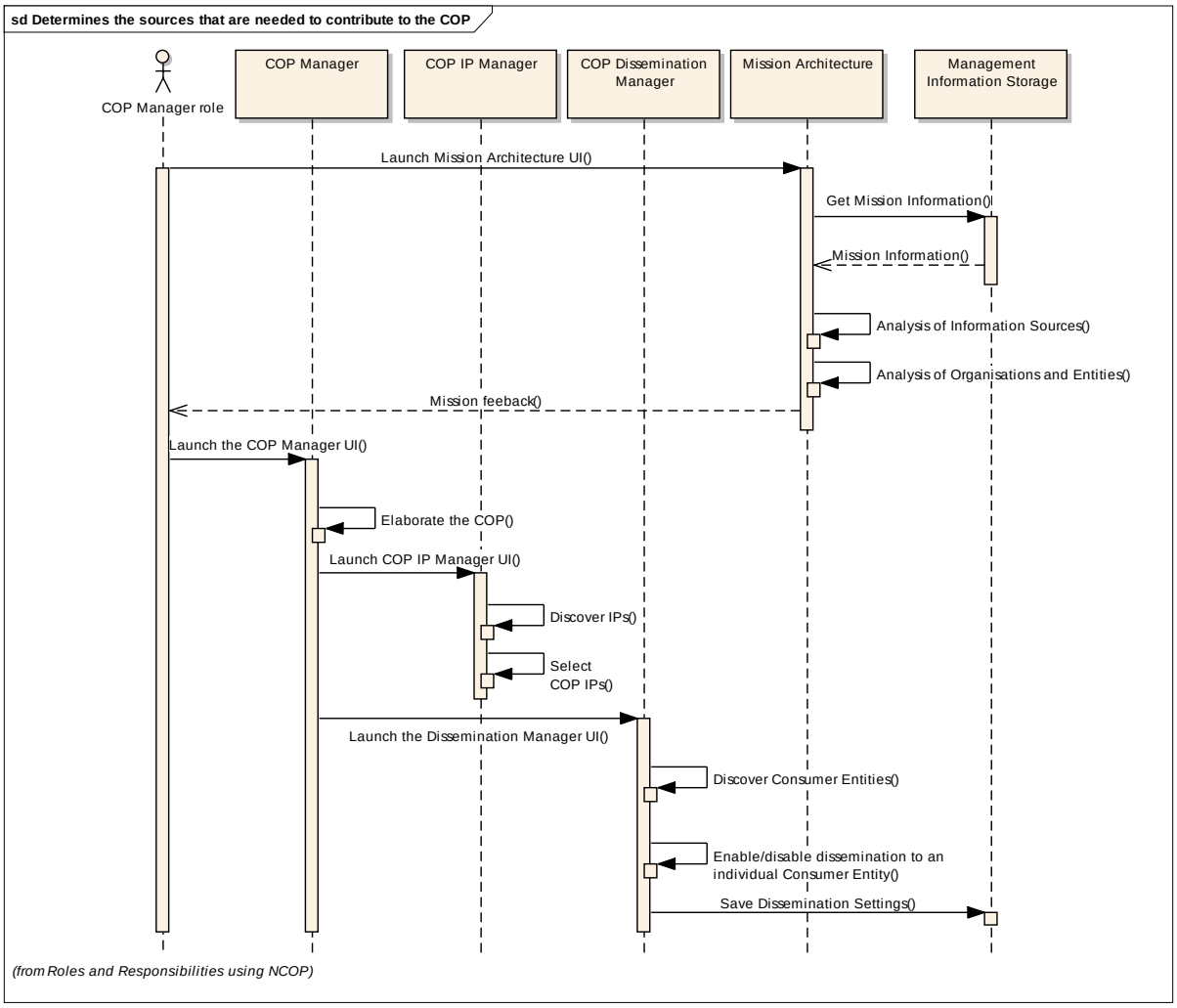

Figure 5-51: UML sequence diagram for “Determines the sources that are needed to contribute to the COP”

The following UML sequence diagram details the components involved by the COP Manager role during the “Monitors the currency of the COP” activity:

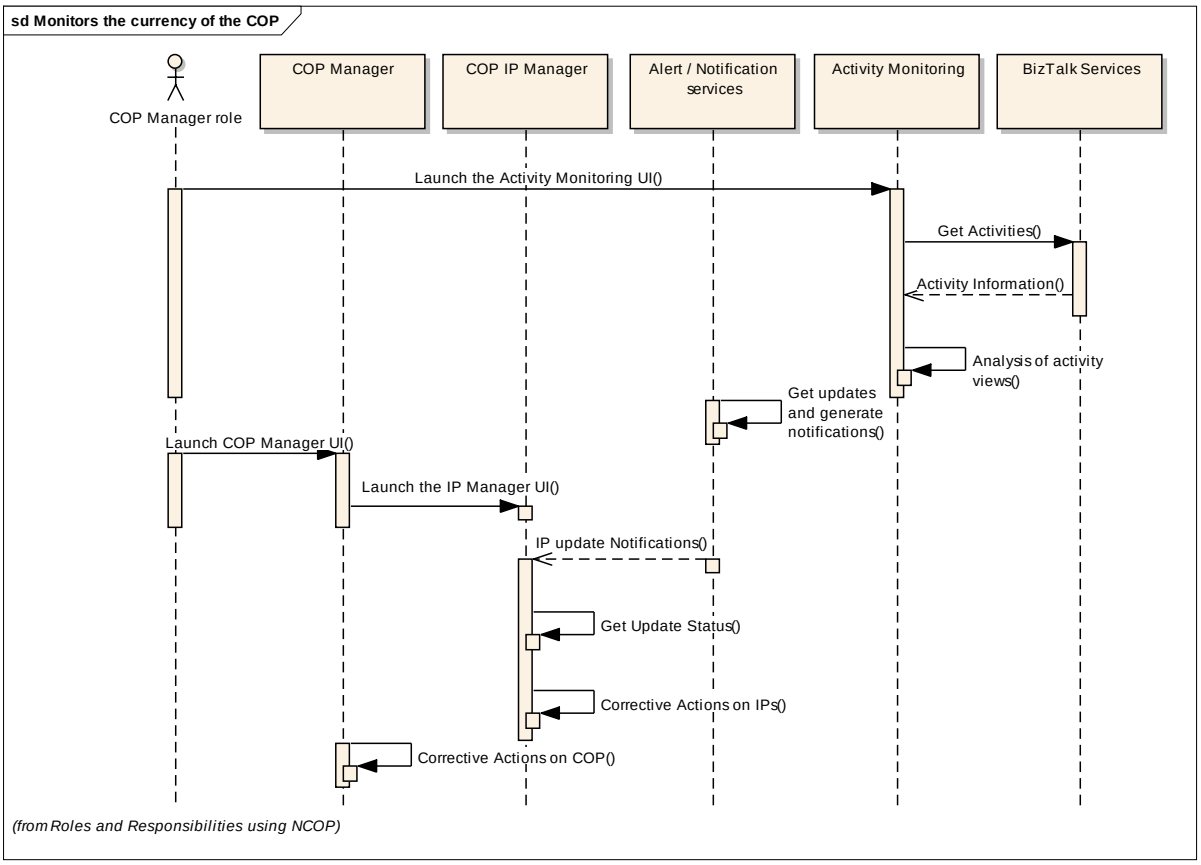

Figure 5-52: UML sequence diagram for “Monitors the currency of the COP”

The following UML sequence diagram details the components involved by the COP Manager role during the “Publishes the COP” activity.

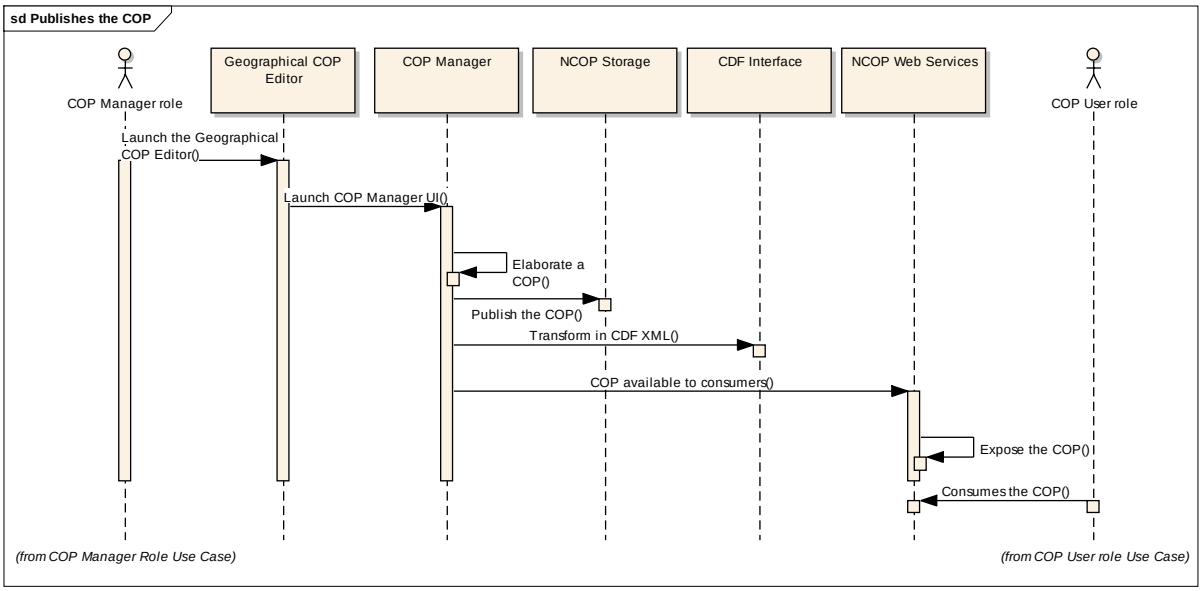

Figure 5-53: UML Sequence Diagram for “Publishes the COP”

The following UML sequence diagram details the components involved by the COP Manager role during the “Approves contribution submitted for inclusion in the COP” activity.

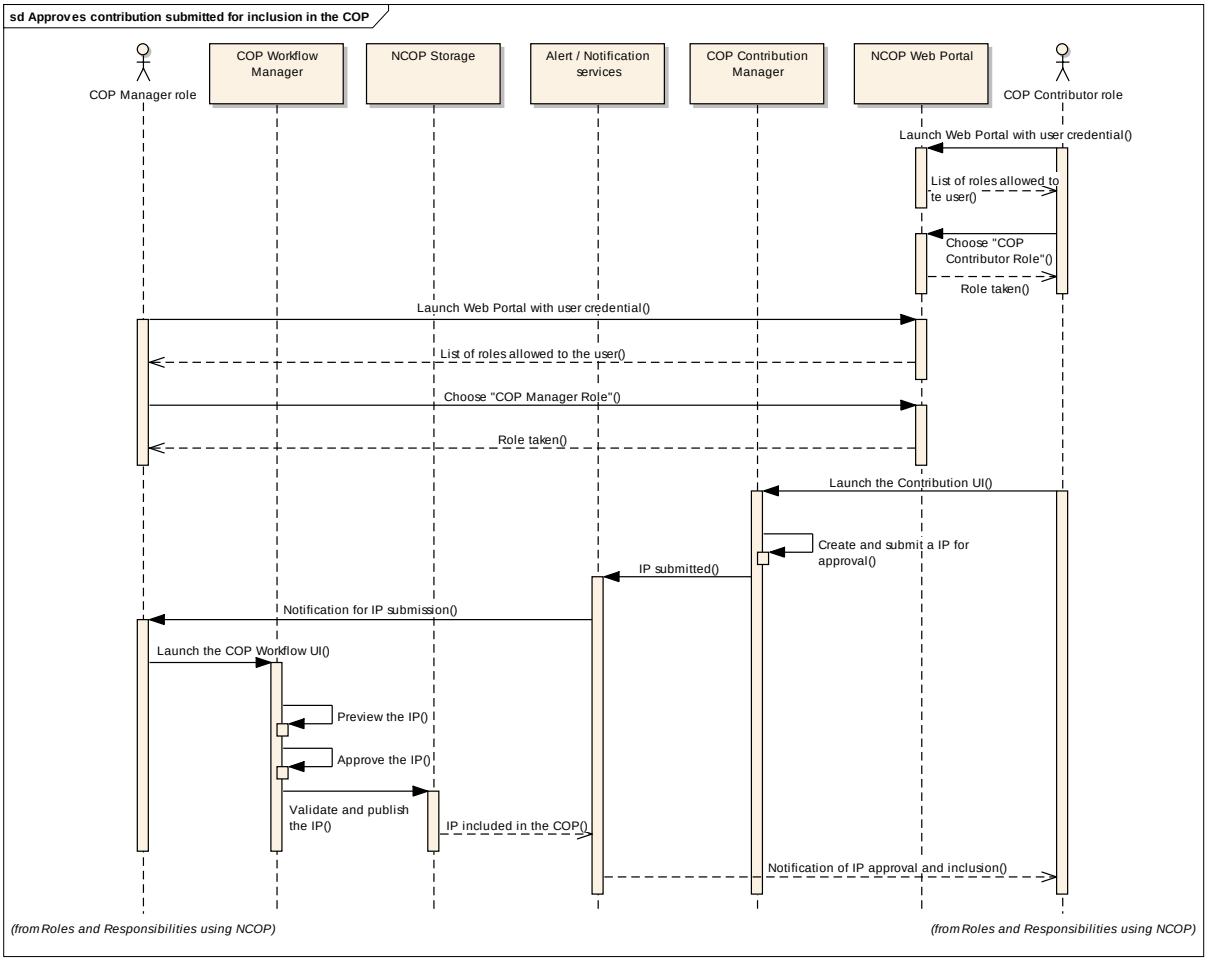

Figure 5-54: UML Sequence Diagram for “Approves contribution submitted for inclusion in the COP”

The Configurations Items involved by the COP Manager to “maintain the COP” are described in the §5.3.2.2.

5.3.1.3.1 User Administration

Property Name	Description
Identification	User Administration
Classification	IS
Behaviour	The system management is performed via a web administration tool, allowing the administrator to: Manage and monitor NCOP operational configuration; Manage Users, Roles and permissions (based on the Authentication and Authorization Services (RBAC)).

Property Name	Description
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the SharePoint Server
Interfaces	This IC interacts with the SQLback-end natively (SharePoint mechanism)
Collaboration mechanism	https
Local/Configuration data	-
Operating context	.NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

This “user administration” is a set of pages available in the NCOP portal. Depending on his permission an authorized user is able to access the following administration pages:

- Roles and permissions management
- Assignment of roles to users
- NCOP IPS monitoring and configuration panel
- Workflow configuration (enforce or bypass approval for contributions)

5.3.2 Business Layer

5.3.2.1 COP Consumption & Contribution

5.3.2.1.1 COP Contribution Manager

Property Name	Description
Identification	COP Contribution Manager
Classification	IS
Behaviour	The COP Contribution Manager is a Web User Interface allowing COP Contributor role to create and submit for approval the following Information Elements: View: View definition on a COP submitted for inclusion in the COP as a Shared View definition; Information Product: Information Product submitted as a source for COP Information Products; Annotations Product: Annotation Product submitted as: ○ General-purpose annotation or correction of a COP IP; ○ General-purpose annotation of a COP Shared View. COP Worksheet: Set of data used to create multiple COP Information Products based on objects properties

Property Name	Description
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The following UML Use Case Diagram shows the main responsibility of the COP Contributor role.

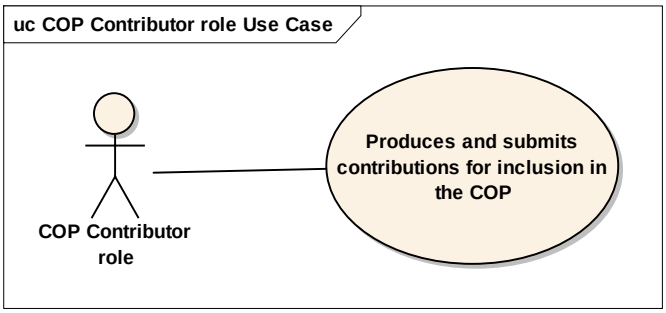

Figure 5-55: UML Use Case Diagram of COP Contributor role

Contributions can be created from the Geographical COP explorer with dedicated options to design and propose the following elements to be included in the COP:

- Shared Views
- Annotations on Information Products or Shared Views
- Contributed Information products
- COP Worksheet

All contributions options are available as contextual menu from the COP explorer with a right click on the dedicated section or item. These contribution options are only available to the users with the COP contributor role.

The following figure illustrates the annotation creation option from the COP Explorer:

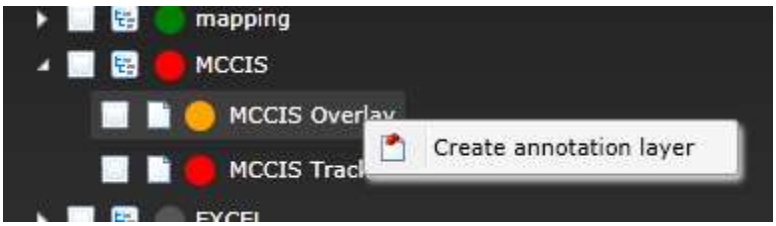

Figure 5-56: Annotation creation from the COP Explorer

The following figure presents the “Submit named view” option from the COP Explorer:

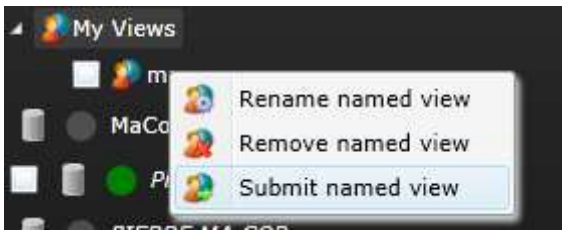

Figure 5-57: View submission option from the COP Explorer

The following figure presents the menu available in the COP Explorer to create a new contributed Information Product:

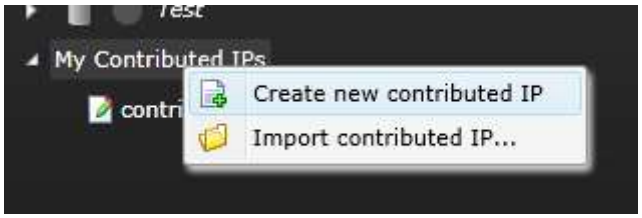

Figure 5-58: Information Product contribution creation options from the COP Explorer

The following figure presents the Information Product contribution options that will among other options allow a contributor to submit his contribution so it can be included into the COP:

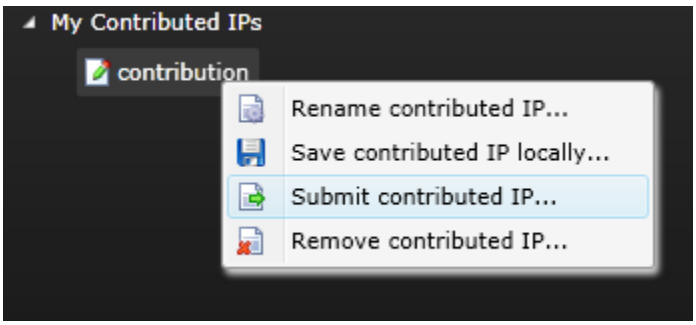

Figure 5-59: Information Product contribution options from the COP Explorer

A user with the COP manager role is able to view, approve or reject contributions that have been submitted for approval. These pending contributions can be viewed in a dedicated panel available in the Geographical COP Editor:

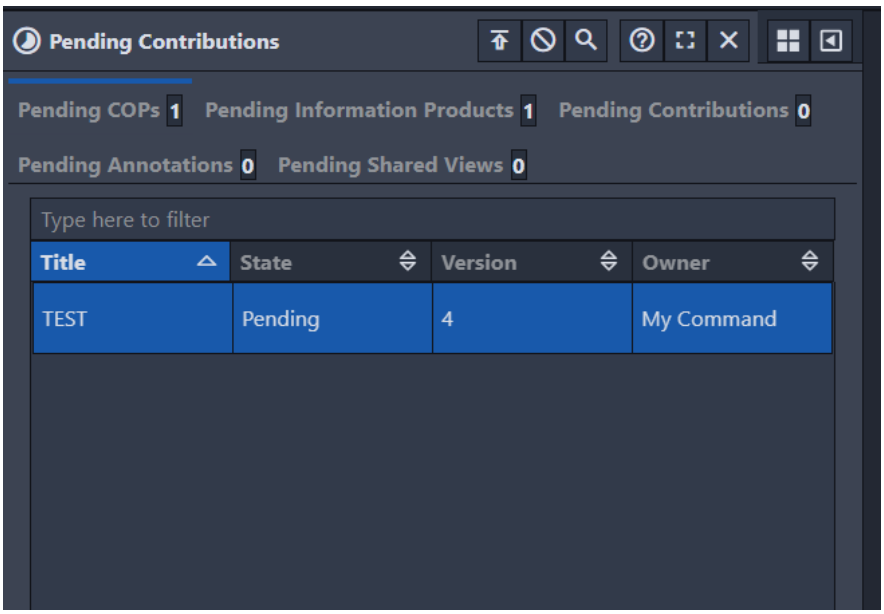

Figure 5-60: Pending contributions control panel

Note that this contribution control panel also allows the approval or rejection of COPs and Information Products that have been submitted by users with the COP Manager assistant role (authorized to design COPs and Information Products but not authorized to publish them).

COP worksheet is another type of contribution. The purpose is to allow contributors to rapidly capture and display information. A tabular representation with columns for BSO properties provides the following capabilities:

- Copy/paste BSO properties
- Add BSO properties by adding columns
- Filtering and sorting objects based on properties (column values)

NCOP implementation is based on the use of an Excel file that contains the data and the reuse of Excel data acquisition mechanism and Information Product visualization filters in this contribution context.

The COP worksheet acquisition mechanisms are described in more details in chapter 6.2.12.

5.3.2.1.2 LoD Manager

Property Name	Description
Identification	LoD Manager
Classification	IS

Property Name	Description
Behaviour	The LoD Manager is a set of User Interfaces allowing COP User role to define multiple Level of Details (LoD) to support different resolutions of the data (Information Product or COP maps). The definition of LoD for COP maps is based on the Core GIS capabilities or NCOP GeoServer component. The definition of LoD for Information Product is based on a bespoke Web User Interface. The NCOP User Interfaces allow displaying data by grouping or aggregating objects for visualization on geographical maps scales, geospatial distribution of each BSO and inter-BSO relationships.
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Medium

The definition of level of details for map is mainly done when defining the Cartographic data before it is exposed by the Cartographic server. It is during this conception phase when the cartographic administrator defines the map layers with their associated zoom scales visibility. The corresponding map service will be consumed by the NCOP Geographical COP Editor and the level of detail will be applied automatically based on the current layer selection, the current map scale and the scale-based visibility parameters defined by the cartographic administrator. Using WMS as the protocol to access maps, this level of detail is applied automatically by the cartographic server.

In addition, NCOP offers the possibility to refine the map scale visibility of a set of map layers when defining a Geographical Information Product. If such a refinement is defined by the COP Manager, the Geographical COP Editor will override the visibility settings of associated map layers.

Regarding Information Products, NCOP offers the possibility to define level of details taking into account the following aspects

- Objects filtering
- Objects display
- Level of details manual selection
- Level of details automatic selection based on current map scale

Levels of details are defined with the purpose of displaying different information depending on the users needs. That is why they can be associated with entities and can be considered as business rules.

A bespoke user interface is available in the edition panel of an Information Product edition form.

Level of details implementation is described in more details at chapter 5.4.15.5

5.3.2.1.3 Time Manager

The content of this section represent the currently envisioned description of this IC and is provided for information purposes only; further technical validation needs to be performed to ensure its suitability before committing to this design.

Property Name	Description
Identification	Time Manager
Classification	IS
Behaviour	This component handles Time dimension for the Information Products, Geo data and BSO. Time dimension can be used : for time-based filtering of IPs, to visualize BSOs history, to query, display and animate a Geo data Information Product
Actors involved	See details in Appendix K IC vs Actors Involved
Objects involved	See details in Appendix L IC vs Objects Involved
Location (Types)	Installed on the Application Server
Interfaces	This IC interacts with back-end through the Geographical COP Editor Services REST API
Collaboration mechanism	https
Local/Configuration data	-
Operating context	TypeScript/JavaScript .NET Framework
References	-
Quality of Service requirements (QoS)	-
Complexity	Difficult

5.3.2.1.3.1 Time-based filtering

In NCOP Increment-1, time-base filtering was done through the NCOP Geographical COP Editor with a dedicated panel. This panel allowed the user to activate time filtering, select a date range and select the Information Products for which the time filter was to be applied. The panel also embedded a player which allowed the user to visualize successive time ranges.

The time-based filter was applied to an entire Information Product content and filtered the BSOs according to their temporal properties. These temporal properties were unified and the same attributes were used for all Information Products. The filter applied to CDF Information Products as well as KML Information Products.

Figure 5-61: Timer slider allowing time-based filtering

The acquisition process of each Information Product associated incoming temporal properties with CDF time properties for each BSO. These BSO time properties were the following:

- Date & time when the BSO existed for the first time
- Date & time when the BSO was updated
- Date & time when the BSO didn't exist anymore

The mappings of these date & time properties were different depending on the Information Product source and format. These mappings are described in more details in the NCOP [ICD].

In NCOP Increment-2, the time-based filtering will be not limited to Information Products loaded in the Geographical COP Editor. An option will allow requesting the History database when applying the time-based filter.

5.3.2.1.3.2 BSOs history visualization

The NCOP BSO history capability allows the COP User role to retrieve and visualize the history of a BSO. In NCOP Increment-1, to enable this feature in the Geographical COP Editor, the Information Product acquisition must have been configured with activation of the BSO history feature. In NCOP Increment-2, the feature will be set by default for all Information Products.

In NCOP Increment-1, an option allowed the user to launch a query on a selected BSO and retrieve and visualize the history of the BSO. The history period could be configured by the user as well as the choice to visualize or not the successive BSOs locations (and associated path) during the selected period. When the query was