



THALES

# NEMESIS Phase 1

# EXECUTIVE SUMMARY

**Contract n°B-0202-IAP2-GC (7 May 2009)**

Executive Summary

# CONTENT



**Executive Summary**

# 1. Introduction

## 1.1. Generalities on the Contract

Contract n°B-0202-IAP2-GC

| | | |
|---|---|---|
| Contract name | : | Naval Environment Modelling & Electro Magnetic Signature of Surface Radar Targets for Improved Simulations (NEMESIS) |
| Contract Signature Date | : | 7 May 2009 |
| Contract Starting Date | : | 7 May 2009 |
| Contract End Date | : | 7 May 2010 |
| Customer | : | the European Defence Agency (EDA), placing the contract on the account and for the benefit of RTP Participants : France (lead nation) and The Netherlands |
| Contractor | : | THALES Air Systems (TR6), |
| Sub-Contractors | : | OKTAL-SE (FR), ONERA (FR), TNO (NL) |

## 1.2. Purpose of the Contract

The purpose of this program is to define a methodology to support and structure the modelling activities of naval targets in their environment in the design, development and implementation process. This methodology will emphasise the validation of models by use of measurement data and assess the adequacy of models resolution to their expected use. Models can then reliably be used as inputs for radar signal generator (i.e. the simulation of the radar front end including propagation and environment). These models will be put into domain-related libraries. These libraries will be operated under the “management” of a capture tool, but they will be compatible with other capture tools (commercial or proprietary).

The NEMESIS programme will be divided into two phases:

- NEMESIS Phase 1: concept study
- NEMESIS Phase 2: design & development & implementation. NEMESIS Phase 2 could be carried over in the scope of the Common Radar Simulation Framework

## 1.3. Object of this Document

This document is the executive summary.

# 2. Documents

## 2.1. Reference documents

### 2.1.1 Documents issued by the Customer

[1.1] Contract n°B-0202-IAP2-GC from the Europe an Defence Agency (EDA)
[1.2] Amendment n°1 to Contract n°B-0202-IAP2-GC

# 3. Achievements

## 3.1. WP1: Management

Management activities covered:

1. Kick off meeting
2. Amendment 1 to contract
3. Consortium contract
4. Project Plan
5. Progress Meetings
6. Final Meeting
7. Invoices
8. Export Control Authorization
9. Presentations to IAP02 Meeting

## 3.2. WP2: Modelling Methodology

WP 2.0 Main objectives

The main idea is that the set of models to be generated sticks to a pragmatic engineering approach, aiming at a first order of magnitude. The key point is to link CEM (Computational Electro-Magnetics) tools to naval scenarios. Scenarios should illustrate modeling issues: the perimeter of the study is defined through the instantiation of parameters:

- Radar bands
- Target configurations
- Environment
- Resolution classes

WP 2.1 Targets models

Various methods of modelling exist for given targets. The efficiency of such methods has been evaluated according to the situations to be simulated and to the input data available. Different approaches have been analysed.

WP 2.2 Clutter models

Different available methods have been investigated, using both experimental data and validated models. In relation with WP 2.0, the level of detail required for the clutter models that will be included in the NEMESIS Environment library has been analysed in order to assess the most effective strategy of exploitation. This analysis is in close relation with the modelling of

targets, in order to take into account the possible coupling between the clutter and the target according to the scenario and according to the relative motion between the sea and the target. A global approach of clutter model generation matched to the NEMESIS Environment has been derived from this analysis.

WP 2.3 Influence of propagation

The report presents the state of current knowledge and different of models currently available and the two sets of modelling respectively at ONERA and TNO. Ongoing works in this field have been investigated. From that knowledge, two codes have been developed and continuously improved. They use a methodology and a relevant level of details (specific behaviour of propagation due to evaporation ducts are taken into account).

WP 2.4 Synthesis and perspectives

Through this modelling methodology WP, review of main existing principles and tools in the NEMESIS context was made and presented. The main objective is to sum up the most promising techniques in the simulation in naval environment. Different approaches have been presented concerning the modelling of EM waves propagation from the transmitting antenna towards the targets and back to the antenna by taking into account the various constraints connected to the presence of the sea clutter and the specific conditions of propagation.

## 3.3. WP3: Validation Methodology

WP 3.1 Inventory of existing databases

Existing Databases are listed.

WP 3.2 Inventory of existing validated models

Existing validated models are listed

- Radar sensor models
- Propagation model, including clutter
- Surface clutter models
- Target RCS models
- Target dynamics (6D models)
- Target terrain/Surface model
- Target scenario model
- Ground clutter models
- Ground obstacle reflections

WP 3.3 Methodology of validation

In order to instill credibility in the implemented simulation model, a process of verification, validation and acceptance shall be done. This process will involve the customer as well as domain specialists and OEM suppliers.

The Validation methodology is developed. This methodology includes:

- Why verify and validate?
- Model validation approaches
- Scenarios
- Model calibration
- Model validation
- Overall acceptance of the Model

Distinction is made between Verification (Was the model built right?), Validation (Was the right model built?) and Acceptance (Is the model fit for use?)

## 3.4. WP4: Relation to Simulator

The simulator is composed of:

- Databases
- Environment models
- EM Field simulation
- Radar simulation

The general concern of WP4 becomes:

- Relation between databases, environment models, EM fields simulation and RADAR simulation, devoted to implementation process and the computer transcription of data and models, with respect to models and tooling requirements
- Based on the results obtained with the WP 2, this work package provides a methodology for the coupling of databases, environment models, EM fields simulation and RADAR simulation.

A general review of the software architecture of models, file formats, interface between software modules, radar simulation tools and scenario building tools was conducted.

WP 4.1 Definition of Software models

The theoretical models highlighted by the WP2 for the scene description are to be coupled with the front-end generator with the constraints of preserving the level of details of the models

- Definition of the software architecture of target models
- Definition of the software architecture of scene models
- Definition of the software architecture of scenarios models
- Study of the data base structures for databases and environment models storage and capitalization
- Study of the data base structures that ensure the openness to real data and to other models

WP 4.2 Definition of common interface

The definition of a common interface format is needed to ensure the compatibility of models with front end signal generator, as well as to allow:

- Capitalization
- Cross comparison
- Validation.

Emphasis will be put on definition of the interfaces between:

- Target and environment scene models
- Existing EM Field simulation tools and Radar Front End simulation tools.

WP 4.3 Inclusion of targets in the radar scene

A study was conducted concerning the most adapted approaches to incorporate target models in a synthetic radar scene based mainly on a synthetic 3D data base representation of the environment.

This study also focused on the transposition of this synthetic radar scene into a radar scenario based on models (targets, environment, sensors and eventually trajectories related to targets or sensors) interfaced with the Front-End RADAR simulator generator.

## 3.5. WP5: Scenario

The purpose of the demonstration has been described. Generic cases as defined in WP2 and/or model-to-model comparison are used for verification of apparent RCS. The evaluation can be based on sensitivity to one parameter, like first detection range and lowest detectable RCS in a range cell. For more sophisticated situations, a comparison can be made with measurements and/or littoral warfare scenarios can be used to analyze the performance in a more operational way. The various scenario elements are described and finally two littoral dynamic scenarios are given;

The point is the balance between the capacity of performance demonstration provided by the scenario and the realism of the scenario.

## 3.6. WP6: Synthesis

Synthesis covers the complexity of the topology of models, the achievements in software architecture, in validation, the complementary necessary refinements (e.g. inclusion of spikes in sea clutter models). Regarding added value, NEMESIS is fully in line with IAP02 Key Technologies & Skills list.

# 4. CONCLUSION

The originality of the NEMESIS Programme is to address the full Radar Scene by taking dynamically care of the interactions between all the players of the scene (which are all mobile) such as propagation, environment, targets and radar by relevant hybridization of state of the art models with the best modeling level.

NEMESIS is a federative transverse systemic long term initiative fully in line with IAP02 Key Technologies & Skills list. It's not only part of an ambitious long-term RF Modelling and Simulation project but also a structuring transverse support to long-term cooperation for Research, R & D, Engineering, Training and Education.