Announcement of NFPF Competition

RFQ-CO-NFPF-2023-007

Provision of

Analysis of Compression Algorithms for usage under STANAG 4724

RFQ Estimated Release Date: Q2 2023

Estimated Bid Closing Date: Q2 2023

Estimated Award Date: Q2 2023

The prospective Not-for profit Organisations' list is attached.

Interested organizations holding an active in NFPF Agreement with the NCI Agency may contact the below POCs to request inclusion in the Bidders' list:

Lise Vieux-Rochat and Gracja Jablonska solely at:
nfpf@ncia.nato.int

Annexes:

1. Summary of Requirements
2. Prospective Organisations List

Annex A – Summary of Requirements

1. Introduction

The purpose of this Request for Quotation is provision of scientific services for an assessment of the existing data compression algorithm solution in Standardisation Agreement (STANAG) 4724, an analysis of alternative solutions and a proposal for modification of the standard.

2. Background

STANAG 4724 Ed. 2 is the evolution of the current STANAG 5030 Ed. 4 for the NATO Very Low Frequency (VLF) broadcast, being under implementation in different NATO countries. It provides a set of enhancements to STANAG 5030 Ed. 4 such as higher resilience against the impairments of the VLF radio channel as well as different modes that can privilege data throughput or higher coverage, which provide flexibility in broadcast pro-vision according to the recipient's location.

While these enhancements provide interesting features for improving the quality and the flexibility of use of the VLF broadcast service, it also imposes a set of challenges (as described further) within the NATO multinational type of operations, which are not predictable in a single Nation environment.

The standard has a basic structure that is aligned with the well-established and cur rently-in-use STANAG 5030 Ed. 4, but also adds four modes – the NATO Rate/Range Extension Modes (REM). Two modes allow backwards compatibility with STANAG 5030, while the other two do not provide such capability. The trade-off is on performance where the non-backwards compatibility modes have a higher performance.

The enhancements provided by the REM are supported by two main features added to the standard: an enhanced Forward Error Correction (FEC) algorithm and the ability to compress data. Data compression has a paramount importance in the performance of REM, since it enables the broadcast of FEC information, which has a higher amount of data as compared with STANAG 5030 modes. The higher amount of FEC data is a key enabler of the higher resilience that REM demonstrates, providing a very interesting asset for the NATO VLF broadcast.

Data compression in STANAG 4724 is performed through a Prediction by Partial Match (PPM) and arithmetic coding algorithm, which generates adaptive statistical models of conditional probabilities of the next character given the context of a number of preceding characters. Characters to be compressed are assessed if being part of a list of known character sequences – known as Statistical Model (SM) – from which the conditional probability distribution can be calculated. In addition, once the encoding has been performed, the Statistical Model is updated, hence improving the compression efficiency according to the context and also generating newer versions of the SM.

The usage of PPM in the context of a NATO multinational type of operations imposes a number of challenges not encountered in a single Nation context. Three examples of such challenges are provided: 1) the ability to extract information from

the SM, acquired from earlier missions, by participants in the current mission who did not participate in previous missions; 2) the need to have an additional distribution routine of a highly classified SM within the mission participants that can have different joining moments; 3) the need to extract from a highly classified archived information the necessary data to build the SM model able to be distributed as an Annex A to STANAG 4724.

Within this context, it is necessary: 1) to clarify the adequacy of the PPM algorithm for the data compression functionality within the NATO multinational context; 2) to identify alternative algorithms with equivalent performance that can overcome the challenges referred above; 3) to propose changes in STANAG 4724, aligned with the outcome of the previous analysis, that will allow the implementation of the standard within NATO context.

3. Project Scope

The study shall include, but not be limited to, the following activities:

1. Formulate a problem statement and agree study requirements with the requestor.
2. Collect and document background information on NATO VLF broadcast standards, namely STANAG 4724 Ed. 2.
3. Document the use cases that are impacted by the current compression algorithm as described in STANAG 4724 Ed. 2 and the requirements to overcome them.
4. Evaluate and document alternative usage of the existing data compression algorithm under the previously established requirements.
5. Evaluate and document alternative data compression algorithms that can overcome the challenges identified for the usage of STANAG 4724 in the context of the NATO multinational type of operations, focusing on:
    a. Equivalence in data compression performance with the current Prediction by Partial Match (PPM) algorithm;
    b. Coherence with NATO Rate/Range Extension Modes (REM) packets and frames structure as described in STANAG 4724 Ed. 2;
    c. Ease of use with regard to the necessary elements required to be established for using the standard;
    d. Non-disclosure of information to users, under the “need-to-know” concept.
6. The evaluation described in point 2.5 shall:
    a. Use free text and pre-formatted contents enclosed in the current formal message structure (according to Allied Communications Publication (ACP) 127 NATO SUPP-3(B));
    b. Use a NATO multinational-type context as a model to assess the several focus points as defined in 2.5;
    c. Demonstrate through simulation, based on standardized programming language, the conclusions and recommendations under points 2.5.a and 2.5.b considering:
        i. the usage of an ideal communication channel;
        ii. the usage of theoretical VLF Radio channel performance parameters.
    d. Describe the conclusions and recommendations under a set of Key

Performance Indicators (KPI) that will include as a minimum:

i. The "*Performance advantage of REM*" indicators as described in STANAG 4724 para 3.1.5;
ii. Data compression ratio and data compression ratio variation with different types of message contents (e.g. free versus pre-formatted text);
iii. Others to be discussed with the NCI Agency.

7. Develop a list of proposed changes to STANAG 4724 in accordance with the conclusions and recommendations achieved from the evaluation performed in 2.4 and 2.5. This list shall include:
    a. an assessment of the relevance and the impact of such change;
    b. the ability to be demonstrated in real environment, namely through real testing with VLF stations.

The work shall be offsite, with regular meetings in Brussels/The Hague and/or through video teleconference (VTC).

Annex B – Prospective Bidder List

1	**ISDEFE**	**Spain/ESP**
2	**Instituto de Telecomunicacoes**	**Portugal/PRT**
3	**NASK - National Research Institute**	**Poland/POL**
4	**Universidade Autonoma**	**Portugal/PRT**
5	**TECHNICAL UNIVERSITY OF MADRID/Universidad Politecnica de Madrid**	**Spain/ESP**
6	**Czech Technical University in Prague**	**Czech Republic/CZE**
7	**INOV - Portuguese research centre in Information and Communication Technologies (ICT) and Electronics**	**Portugal/PRT**
8	**INEGI – Institute of Science and Innovation in Mechanical and Industrial Engineering**	**Portugal/PRT**
9	**Spektrum RDS LTD**	**United Kingdom/GBR**
10	**INESC TEC**	**Portugal/PRT**