NATO SHAREABLE SOFTWARE DEVELOPING INTO TRUE SUITE SUPPORTING NATIONAL OPERATIONAL, FIRE CONTROL SYSTEMS

André J. SOWA [1]

[1] *U.S. Army ARDEC, Firing Tables and Ballistics Division, Attn: AMSRD-AAR-WSF-T, Building 305, Aberdeen Proving Ground, Maryland 21005-5001, USA, andre.j.sowa@us.army.mil*

The indirect fire support community, to varying extent, is familiar with the mature NATO Armaments Ballistic Kernel (NABK). The NABK is a software component item that performs the ballistic computations necessary to support howitzers, rockets, and mortars to accomplish a fire mission. In 2001, the development of additional capability through other components gained momentum, and a suite of software aimed primarily at fire control applications started to emerge. Five cooperative projects were established, from the NABK baseline release, to produce a mix of domain specific kernels and support products, designed to be embedded in the executive level software e.g. of a fire control computer. When combined together, the kernels provide all of the basic capability required for the delivery of accurate fires. This paper is presented on behalf of the NAAG AC/225 Land Capability Group 3, Sub-Group 2 (SG/2) on Accuracy and Ballistics.

INTRODUCTION

The indirect fire support and most of the international (primarily NATO) ballistics communities, to varying extent, are familiar with the mature NATO Armaments Ballistic Kernel (NABK) and other software component items that have emerged from the NABK development effort. The collection of these software items is the "suite" of NATO sharable fire control software. Formally, the suite is known as the NAAG AC/225 LCG/3 SG/2 Sharable Software Suite or S^4 (or S4) for short. A number of papers and presentations have been published, some in this ISB forum; references [1, 2, 3, 4, 5, 6] are provided as examples. Between 1998 and 2001 with the success of the NABK effort, SG/2 expanded its efforts to develop software to cover domains other than ballistics. Initially, totally separate component items were envisioned, but soon it became apparent that relationships between the individual component items and a reorganization of functionality amongst the items had to be developed to minimize duplicate functionality. In true suite fashion, the result of this reorganization is now being implemented. Since mid-2006, NABK builds require the implementation of multiple suite products to construct a national application. This year marks a milestone for the programme in that there is actual code in some form for each of the software items. This paper provides an updated overview of the current suite products, status of development, and extent of implementation. Requests for additional information and for referenced documents can be made to s4_poc@aop-37.org.

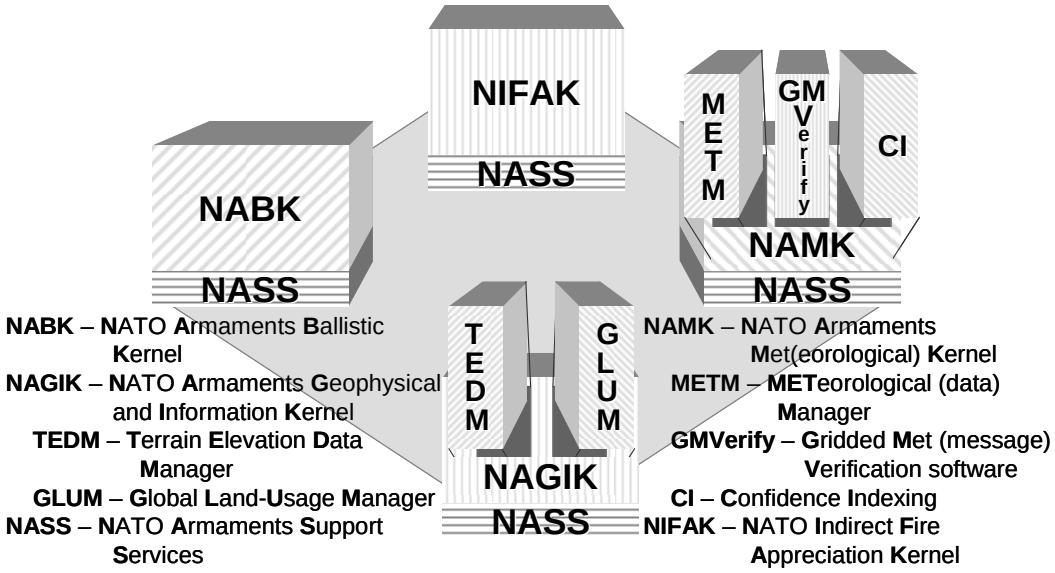

Figure 1. NAAG AC/225 LCG/3 SG/2 Sharable Software Suite (S^4)

THE CURRENT S^4

The S^4 is an umbrella NATO cooperative programme with five individual cooperative projects, all under the auspices of NAAG AC/225, Land Capabilities Group 3 (Fire Support), Sub-Group 2 (Accuracy and Ballistics). Each project develops one or multiple software products. The suite is comprised of the separate software products, designed to be embedded in the executive level software of a fire control computer, which when combined will provide most if not all of the basic capability required by a fire control computer for mission planning and accurate fire except for communication and the soldier-machine interface. Figure 1 depicts the five individual software projects: NABK, NAGIK, NAMK, NIFAK, and NASS and the formal software products for each. The NABK project produces the NABK product. The NAGIK project produces the TEDM, GLUM, and NAGIK Common (not depicted) products. The NAMK project produces the METM, GMVerify, and CI products. The NIFAK project produces the NIFAK product. The NASS project produces the NASS product.

The umbrella or parent programme is managed by SG/2 through the S^4 Configuration Control Board (SCCB). This level has oversight of all projects, manages key requirements and product-to-product interfaces, suite quality assurance, technology generation, and independent software/safety audits. Each project is managed by a project lead from a lead nation and the project team at a minimum has the key roles of software development, quality assurance, and configuration management. A NATO Standardization Agreement (STANAG) 4537 [7], two companion Allied Ordnance Publications [8, 9], and the S^4 Programme Plan [10] guide the programme organization and operation.

THE S^4 PROJECTS

A brief description of the five S^4 projects is given below. Most of the primary sources of technology for each product are identified, but behind the ones listed is a set of NATO STANAGs covering internal and external ballistics, ballistics testing, ammunition safety and interchangeability, and operational support; a listing can be obtained upon request to s4_poc@aop-37.org.

NATO Armaments Ballistic Kernel (NABK)

Key project roles: Project Lead – USA (nabk_pl@aop-37.org), Development Lead – USA, Quality Assurance Lead – USA, and Independent Software/Safety Auditor – GBR.

The NABK product provides ballistics related services that are typically required by technical fire control systems. It currently can address most indirect fire artillery and mortar applications, some direct fire and naval applications (this is a growing area), and guided projectiles (also a growing area). The design is highly configurable and portable to facilitate incorporation of user requirements. The technology implemented in the product primarily is based on that in STANAGs 4355 [11] and 4500 [12]. The first formal release of an S^4 product was NABK version 0.9 in 1998 and NABK version 10.0 is scheduled for release in Feb 2009.

NATO Armaments Geophysical and Information Kernel (NAGIK)

Key project roles: Project Lead – GBR (nagik_pl@aop-37.org), Development Lead – GBR, Quality Assurance Lead – GBR, and Independent Software/Safety Auditor – CAN.

The NAGIK product manages and provides terrain and surface characterization data required by particular functions in NABK, NAMK, and NIFAK. Until recently, the product also managed and provided meteorological (Met) data, and this function has been transferred to the NAMK products so Met related functionality is managed under one project. The TEDM product is designed to build page files from standard digital terrain data (DTED) [13], check integrity, and access DTED data in response to requests from the other products. NAGIK version 1.0 was released in Feb 2004 and NAGIK version 2.2 will be released in Nov 2008.

NATO Armaments Met Kernel (NAMK)

Key project roles: Project Lead – NOR (namk_pl@aop-37.org) recently transferred from DNK, Development Lead – GBR, Quality Assurance Lead – DNK, and Independent Software/Safety Auditor – CAN/USA.

The NAMK project started as a result of an action by LG/4 (now LCG/3) to SG/2 to investigate ways to improve artillery delivery accuracy at extended ranges (>30km). A SG/2 document on tube artillery accuracy [14] identified Met as the

largest error contributor. Two team of experts meetings, one in 1997 and one in 1998, were conducted which concluded that using 4-dimensional (lat, long, alt, time) Met data in the gunnery solution provides the most promise to significantly reduce the Met error contribution to inaccurate fire. A side effort under the project was spawned that resulted in two NATO tests, one in Denmark in 2003 and the other in Turkey in 2006, that validate the conclusion. Another 24th ISB paper [15] addresses this NATO testing.

The NAMK project like NAGIK has multiple products. The METM product manages and provides Meteorological data required by particular functions in NABK and NIFAK and will be a source of such data to a wide scope of users in the field. It implements STANAG 4082 [16] and a subset of STANAG 6022 [17]. STANAG 6022 is a recent document that establishes a standard format for 4-dimensional Met data (called METGM) and is expected to be widely used in NATO for indirect fire support and many other applications. The GMVerify product validates/verifies a METGM for use in S^4-based systems; the product may be extended to provide the capability to convert World Meteorological Organization formatted GRIB files to METGM form. The CI product is currently in the technology generation and proof of concept stage. It is hoped that the level of confidence in a Met forecast can be related to forecast quality. Canada with support from the USA is investigating CI technology. CI has the potential for use to determine which Met data is used in a fire mission by NABK and what Met error budget is used by NIFAK to compute delivery accuracy. NAMK version 1.0 containing METM 2.2 and an initial version of GMVerify is expected in Nov 2008.

NATO Indirect Fire Appreciation Kernel (NIFAK)

Key project roles: Project Lead – BEL (nifak_pl@aop-37.org), Development Lead – USA, Quality Assurance Lead – USA (with BEL support), and Independent Software/Safety Auditor – TUR.

The purpose of the NIFAK product is to provide to all the NATO countries a common methodology for computing indirect fire appreciation (effectiveness estimates). Fire support appreciation includes the five questions of Who? (which platforms) will aim Where? (aiming points), How Many? (number of rounds) of What? (kind of ammunition) and How? (method of fire). Currently the project is addressing the How Many? question and in part the Where? question. The current product implements the technology in STANAGs 4635 [18] and 4654 [19]. An initial NIFAK version 0.1 is expected to be released by Sep 2008 with NIFAK version 0.5 being released sometime in 2009.

NATO Armaments Support Services

Key project roles for NASS: Project Lead – SWE sponsored by DNK (nass_pl@aop-37.org), Development Lead – SWE, Quality Assurance Lead – CAN, and Independent Software/Safety Auditor – GBR.

The NASS product provides the foundation that allows other S^4 products to work together, providing common services useful to two or more products and common definitions that allow products to interoperate. It is a standalone product that evolved from what was the NABK Support Layer. The technology implemented in the product is based on open sources. NASS version 1.0 was released in Sept 2005 and NASS version 4.0 will be released in Sep 2008.

PROGRAMME ORGANIZATION AND OPERATION

Guiding Documents

The aim of STANAG 4537 [7] is to define and identify the structure, techniques and procedures to be applied to the development, sharing, disclosure, and the use of any software and documentation relating to the S^4. It also serves as the official cover document for the associated AOP-37 [8] and AOP-49 [9] documents. It establishes intellectual property rights; general rules for classification of information; to whom information can be shared and how the information can be used which is dependent on status as participating or non-participating NATO Government, contractor to a NATO Government, a sponsored PfP, EAPC, or non-NATO Government, and contribution to the programme; and statements for use in national contracts concerning secondary distribution, reverse engineering, and liability.

AOP-37 evolved from a paper document containing all artifacts of the NABK project to become separate issuances of a DVD or set of DVDs specific to a particular project/product release. So for example, a formal release of a new version of the NABK product is issued on DVD(s) identified as the AOP-37 NABK Library containing NABK version x.x and all project artifacts.

AOP-49 establishes the quality system (QS) to be used by all levels of the S^4 programme during the life cycles of the S^4 products. Twelve policies are identified and organized into 4 major domains (program management, project management, engineering, support). Addressed are coordination, oversight, project planning, project monitoring and control, risk management, requirements engineering, technology development, software development, configuration management, process assurance, product evaluation, and archival policies. Each participating country, especially those supporting software development are required to map their organizational quality system to the SG/2 QS to ensure consistency. This was set up to ensure higher product integrity and confidence, and to enable continuous improvement of the products. Exceptions to the policies have to be explicity authorized by SG/2.

The S^4 Programme Plan [10] describes the processes, resources, orientation/training, and schedule for implementing S^4 requirements for the period from 01 July 2006 through 30 June 2009. The plan is reviewed once each year by SG/2. The plan also defines the current programme and project processes as tailored

from the standard processes described in AOP-49. This is the frontline document guiding the effort.

Programme Reviews and Suite Collaboration

Two S^4 Programme Reviews are held each year in February and September where all nations participating in the S^4 projects meet to review each project and product status, requirements, conformance to the SG/2 QS, etc. and results from each review are reported to the entire SG/2 at the subsequent SG/2 meeting.

Many countries are involved in different aspects of each project. To facilitate the sharing of documents, code files in development, other project artifacts, and information necessary for routine business, Canada hosts an S^4 collaborative website (www.aop-37.org). A Microsoft SharePoint Portal server is used for file sharing, notices, repository, etc. IBM Rational ClearQuest is used for software change requests and problem reports, programme and project action items, and product change control. Only appropriate persons can access the "S4 Members Only Area" of SharePoint and the "CQWeb Login - AOP-37" link to ClearQuest. The public can access "S^4 Public Area" of SharePoint which is the cover webpage to the site and "Public Documents" folder.

Product Development Standards, Dependency and Release Schedule

Each project develops formal products intended for implementation into fielded systems. Each project also develops tools and utilities to assist national implementers in integrating and testing the particular S^4 products. Product development standards [20] have been established for these items. For the formal products to be labeled a version 1.0 or higher, a minimum set of standards has to be met.

In general, formal products are primarily developed in the Ada programming language, and all have direct dependency on the NASS product. With the next release of NABK, all products requiring meteorological data will have direct dependency on METM. The dependencies between the other products are functionally driven, and if a particular product is not integrated with another, the integrated product may not have full functionality. This dependency drives the release schedule, since for example a new version of the NABK product must work correctly with the new versions of TEDM, METM, and NASS products; and the TEDM and METM products must work correctly with NASS product.

The current, general release schedule for new versions of software is: NASS product each September, NAGIK and NAMK products each November, and NABK and NIFAK products each February. Exceptions occur as is the case for NIFAK, since it is in very early development. The 6 months from September to February are dominated by testing. As the S^4 has grown, there has been strain on resources, and this yearly release schedule may be expanded to eighteen months or two years for some or all products. This topic will be discussed by the SCCB in September 2008.

	NABK	NAGIK (TEDM)	NAMK (METM)	NIFAK	NASS
Field System Implementations	30	4	2	-	5
Technical Application Implementations	9	4	5	-	6
New Implementations (within 3 years)	31	6	7	2	13
Number of Nations (Currently Implementing)	13	6	5	0	6
Number of New Nations (Implementing in 3 years)	3	2	3	2	2

Figure 2. Current and Near Term Implementations of S^4 Products

CURRENT AND NEAR TERM IMPLEMENTATIONS OF S^4 PRODUCTS

The maturity of any software development and maintenance effort is partly measured by the extent of implementation of the software. Figure 2 depicts the number of current and near term implementations of S^4 products. The NABK effort is approaching 15 years and there are currently 39 known implementations amongst 13 countries; 31 more implementations are expected within 3 years which will yield 70 implementations amongst 16 countries. The use of products from all projects is expected to nearly double within 3 years. As more countries upgrade their field systems to the newer versions of NABK, the use of NASS and METM will increase. The NIFAK product is the least mature and this fact is reflected in the numbers; once the product reaches a version 1.0 level, the number of expected implementations should increase. It must be pointed out that although the primary intent for the S^4 products is for use on fielded weapon systems, other "technical" applications can use them. An example is the use in generating firing tables and a paper [21] presented at the 23rd ISB identifies such an application in Turkey.

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