Overview

of the

NATO Army Armaments Group (NAAG) AC/225
Integrated Capability Group Indirect Fire
Sub-Group 2 (Panel) – Ballistics, Effectiveness, and Fire Control Software

SG/2 Shareable Software Suite (S4)

25 September 2024

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Overview of the SG/2 Shareable Software Suite (S4)

Discussion Topics

- **NAAG ICGIF SG/2 Areas of Work**
- **S4 Description**
- **Application Domain**
- **Guiding Documents – STANAG 4537 (cover) and APP-18, AOP-49**
- **Programme Framework – project structure and areas of responsibility**
- **Independent Software Auditor (ISA) Role**
- **S4 Collaboration**
- **S4 Projects and Products – product descriptions and capabilities**
  - **NABK Project – NABK, TEDM, TAFT, and FCIGen Products**
  - **NIFAK Project – NIFAK Product** [new baseline development on hold]**, NIFAK Demonstrator**
  - **NAMK Project – METM and GMVerify Products**
  - **NASS Project – NASS, UDM, and CodeCAT Products**
- **Use of the S4 Products**
- **Key S4 Documents – suite level and project/product level**
- **S4 Manpower Resources**
- **Summary**

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Overview of the SG/2 Shareable Software Suite (S4)

NAAG ICGIF SG/2 Areas of Work

The SG/2 is responsible for a set of

- **Standardization Agreements (STANAG's)**
- **Standardization Recommendations (STANRECs)**
- **Allied Engineering Publications (AEPs)**
- **Allied Ordnance Publications (AOPs)**
  and
- **Cooperative Programmes**
  - ➤ **SG/2 Shareable Fire Control Software Suite (S4)**
    - ➤ **NATO Technical Shareable Software (NTSS)**
    - ➤ **…**

that serve as a basis for commonality across the nations in the areas of Ballistics, Effectiveness, and Fire Control Software.

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Overview of the SG/2 Shareable Software Suite (S4)

What is the S4?

It is a NATO Programme:

• A cooperative programme under the auspices of the NAAG AC/225; Integrated Capability Group Indirect Fire; Sub-Group 2 (Panel) on Ballistics, Effectiveness, and Fire Control Software

• The programme is recognized as a NATO Smart Defense Initiative (Tier 1; Number 1.1254)

It is a set of Projects and Products:

• The Programme contains four distinct Projects, each producing one or more distinct software Products

• All Products in total comprise the SG/2 Shareable (Fire Control) Software Suite (S4)

It is Software:

• The suite is comprised of separate software components, 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*

• *Although being phased out, you may still see the "S⁴" identifier for the suite in addition to "S4"*

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Overview of the SG/2 Shareable Software Suite (S4)

The Suite Software Components

The 10 software items currently being developed and maintained by the group and implemented by the countries to varying extent are organized by project and are:

Under the NABK Project:

- NATO Armaments Ballistic Kernel (NABK) software Product;
- Terrain Elevation Database Manager (TEDM) software Product;
- Tabular Firing Tables (TAFT) software product;
- Fire Control Inputs Generator (FCIGen) software Product.

Under the NIFAK Project:

- NATO Armaments Indirect Fire Appreciation Kernel (NIFAK) software Product.
  [Mature Capability; New Product Development on Hold Awaiting Resources]

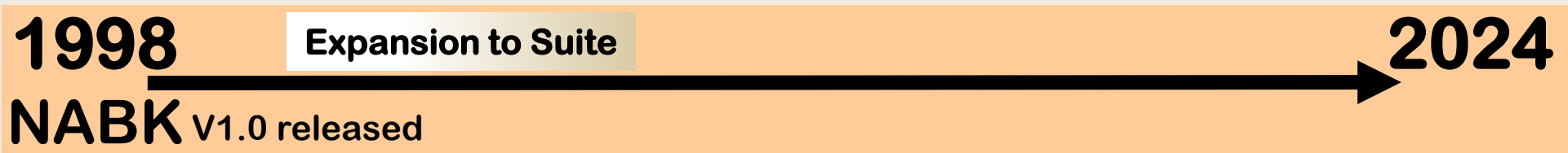## Under the NAMK (NATO Armaments Meteorological Kernel) Project:

- Meteorological Manager (METM) software Product;
- Gridded Met(eorological) [Message] Verification (GMVerify) software Product.

Under the NASS Project:

- NATO Armaments Support Services (NASS) software Product;
- Universal Database Manager (UDM) software Product;
- Code Coverage Assessment Toolset (CodeCAT) software Product.

Overview of the SG/2 Shareable Software Suite (S4)

1998   **Expansion to Suite**   **2024**

NABK V1.0 released

Trajectory Simulation; Gun Orders	**NABK**
Delivery Accuracy and Effectiveness Estimation	**NIFAK**

Embedded into Weapon System Software

Supporting: *Minimum Implementation: NABK or NIFAK plus NASS and METM*

Terrain Data; Masks	TEDM
Met Processing and Management	**METM**
Foundation and Common Services	**NASS**

Additional Capabilities: Enables OS Interfacing, Data Streaming, Graphics, Hashing, Compression and Encryption

Applications:

Generates Firing Tables (STANAG 4119)	TAFT
Reformats and Subsets Met Files	GMVerify
Provides Code Coverage Assessment, Suite Testing	CodeCAT
Used by SMEs to Determine Ballistic Performance Parameters	FCIGen
Establish Code for Implementing and Managing Databases	UDM

Who participates in the S4 Forum?

- Software developers, ballisticians, managers (decision makers), and other personnel from groups that produce products for their national systems such as aerodynamic and ballistic database information that drives trajectory simulations, tabular firing tables, and the ballistic software embedded into weapon systems.

- Subject matter experts in delivery accuracy, lethality, and effectiveness.

- Developers of weapon, command and control, and mission planning systems and those that integrate fire control software into them.

- Meteorologists supporting initiatives to ensure accurate fires and for liaison with the NATO Military Committee Working Group (MCWG) Meteorological and Oceanographic (METOC) Military Meteorology (MILMET) Panel.

- National recipients of the software the group develops which is formally distributed to the nations for implementation, with or without national modification.

- Representatives from the current countries, which to varying extent, field the S4 software, and those that plan to field the S4 software.

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Overview of the SG/2 Shareable Software Suite (S4)

Programme Organization and Operation

- **Guiding Documents**
  - **APP-18 under cover STANAG 4537 – tenets for development, sharing, disclosure, use**
  - **Terms of Reference – for the Suite, S4PR, SDR; Project Charters**
  - **AOP-37 – electronic media; all programme artifacts and product releases**
  - **AOP-49 – process quality system**
  - **S4 Programme Plan – frontline guiding document (next level below APP-18)**
- **Programme Reviews and Suite Collaboration**
  - **2 Programme Reviews (S4PRs) held each year (February and September)**
  - **Software Development/Design Review held each year (April)**
  - **Suite effort and project status presented at SG/2 meetings by the S4 Chair and the lead independent software auditor (Lead ISA)**
- **Product Development Standards, Dependency, & Release Schedule**
  - **Product development standards have been established and tools and utilities have been developed for the formal products to assist national implementers to do integration and testing**
  - **In general, products meant for implementation into operational systems (NABK, METM, NIFAK, TEDM) are developed in Ada and have some level of dependency on NASS; additionally, NABK has dependency on METM and if used TEDM and then NIFAK on METM; to be discussed further when "S4 Architecture" is addressed**
  - **Release schedule noted on "S4 Products" chart**

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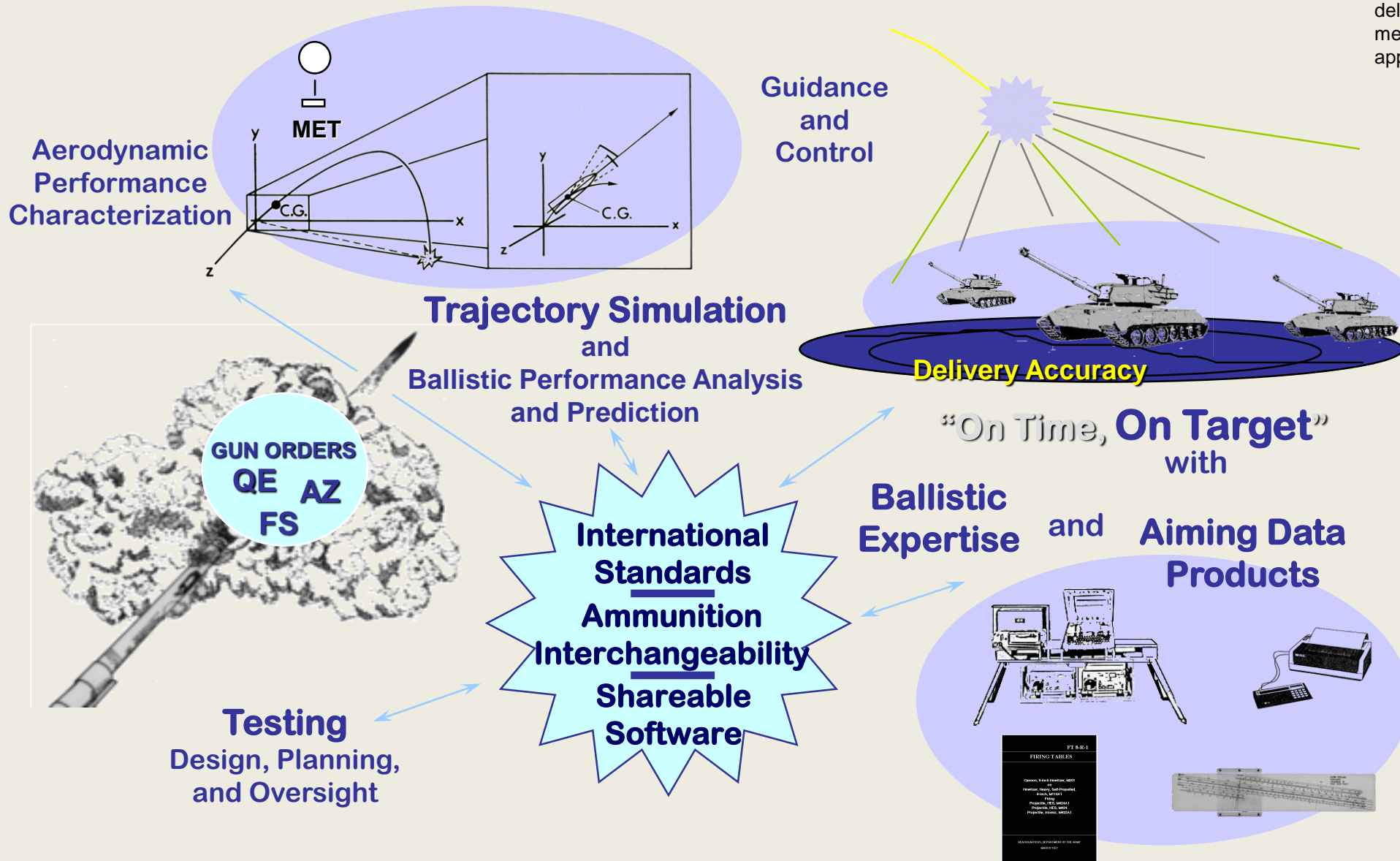
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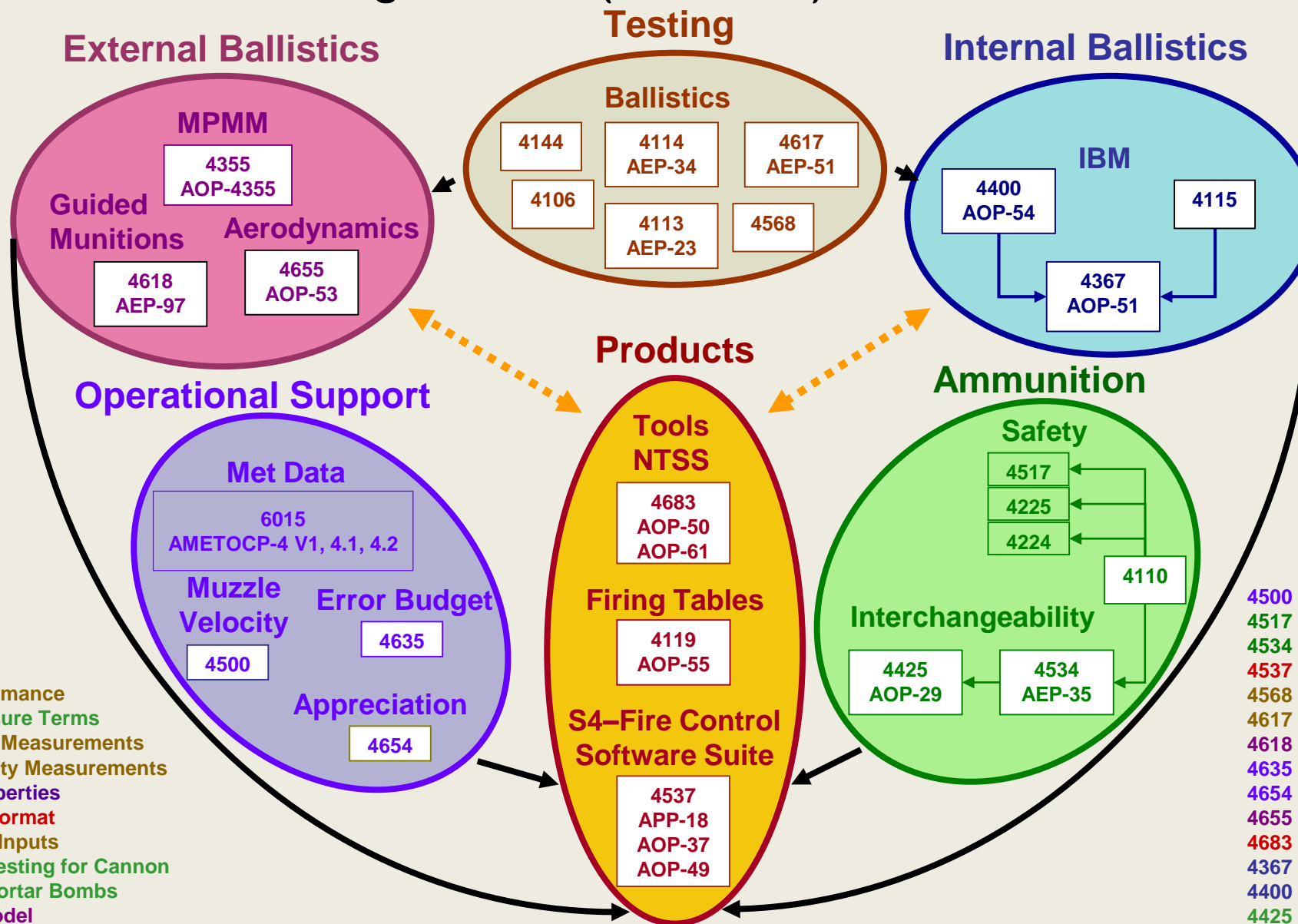
Ballistic Fire Control Domain

Scope of S4: Development of products related to ballistics, delivery accuracy, battlefield meteorology, and fire support appreciation

Overview of the SG/2 Shareable Software Suite (S4)

NATO Standardization Agreements (STANAGs) that are Basis for S4 Technology

Testing

External Ballistics

Internal Ballistics

Ballistics
- 4144
- 4106
- 4114 / AEP-34
- 4113 / AEP-23
- 4617 / AEP-51
- 4568

MPMM
- 4355 / AOP-4355

Guided Munitions
- 4618 / AEP-97

Aerodynamics
- 4655 / AOP-53

IBM
- 4400 / AOP-54
- 4115
- 4367 / AOP-51

Products

Operational Support

Ammunition

Met Data
- 6015 / AMETOCP-4 V1, 4.1, 4.2

Muzzle Velocity
- 4500

Error Budget
- 4635

Appreciation
- 4654

Tools NTSS
- 4683 / AOP-50 / AOP-61

Firing Tables
- 4119 / AOP-55

S4–Fire Control Software Suite
- 4537 / APP-18 / AOP-37 / AOP-49

Safety
- 4517
- 4225
- 4224
- 4110

Interchangeability
- 4425 / AOP-29
- 4534 / AEP-35

Note: Text boxes with white backgrounds denote the STANAGs, AEPs, and AOPs for which SG/2 is the proponent. The others with the color of the bubble belong to other NATO groups.

- 4106 : External Ballistic Performance
- 4110 : Design and Proof Pressure Terms
- 4113 : Copper Crusher Gauge Measurements
- 4114 : Projectile Muzzle Velocity Measurements
- 4115 : Propellant Ballistic Properties
- 4119 : Standard Firing Table Format
- 4144 : Determine Fire Control Inputs
- 4224 : Safety and Suitability Testing for Cannon
- 4225 : Safety Evaluation for Mortar Bombs
- 4355 : Modified Point Mass Model

- 4500 : Muzzle Velocity Management
- 4517 : Safety and Suitability for Service
- 4534 : Ammunition Interchangeability Data
- 4537 : S4–Fire Control Software Suite
- 4568 : Propellant Lot Performance Levels
- 4617 : Miniaturized Piezo-Electric Gauges
- 4618 : Six/Seven DoF for Guided Munitions
- 4635 : Error Budget Model
- 4654 : Indirect Fire Appreciation Model
- 4655 : Determination of Aerodynamics
- 4683 : NTSS–Technical Shareable Software
- 4367 : Thermodynamic Ballistic Model
- 4400 : Thermochemical Value Derivation
- 4425 : Ammunition Interchangeability

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Overview of the SG/2 Shareable Software Suite (S4)

APP-18 under cover STANAG 4537

Will Need Update When New Edition of APP-18 Promulgated

- Aim is to

  - Serve as the official cover document for the associated AOP-37 (structure of S4 product releases) and AOP-49 (ICGIF mandated quality system for the S4 programme)

  - Defines and identifies the structure, techniques and procedures to be applied to the development, sharing, disclosure, and the use of any software and documentation relating to the S4

- Establishes

  - Intellectual property rights

  - General rules for classification of information

  - To whom information can be shared and how the information can be used; depends if you are a

    - Participating or non-participating NATO government
    - Contractor to a NATO government
    - Sponsored PfP, EAPC, or non-NATO government
    - Contractor to PfP, EAPC, or non-NATO government
    - And what your contribution is

  - Statements for use in national contracts concerning secondary distribution, reverse engineering, and liability

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Overview of the SG/2 Shareable Software Suite (S4)

Classification of S4 Information

- **Documented in the "S4 Security Classification Guide" and individual product SCGs**

- **NATO RESTRICTED (NR)**
  - **Source code (Implementation)** [NABK and NIFAK]
  - **Detailed design documents** [NABK and NIFAK]
  - **Operating Environment** [TAFT]

- **NATO UNCLASSIFIED (NU) Releasable to Interoperability Platform (IP)**
  [Legacy NATO/PFP UNCLASSIFIED (NPU) labelled documents handled as NU REL TO IP]
  - **Source code (Implementation)** [NASS, UDM, METM, GMVerify, TEDM, FCIGen, CodeCAT]
  - **Source code (Interfaces)**
  - **Tools (includes Autotest)**
  - **Object code**
  - **All the rest except what is noted below**

- **UNCLASSIFIED (UNCL)**
  - **Advertising/Marketing materiel**
  - **Final compiled executable code (no debug information)**

- **Some of the above info may be designated as "SG/2 Approved for Public Release"**

- **National info may raise classification of the final product as integrated into an application**

- *Always consult the S4 SCG and the individual product classification guides*

Overview of the SG/2 Shareable Software Suite (S4)

Current NATO Nations (32) & NATO IP Nations (21): →

Note: The list of NATO IP nations is updated annually. It has been stable for the last few years.

NATO Nations	NATO Interoperability Platform (IP) Nations
Albania	Armenia
Belgium	Australia
Bulgaria	Austria
Canada	Azerbaijan
Croatia	Bahrain
Czech Republic	Bosnia and Herzegovina
Denmark	Georgia
Estonia	Ireland
Finland	Japan
France	Jordan
Germany	Kazakhstan
Greece	Moldova
Hungary	Mongolia
Iceland	Morocco
Italy	New Zealand
Latvia	Republic of Korea
Lithuania	Serbia
Luxembourg	Switzerland
Montenegro	Tunisia
Netherlands	Ukraine
North Macedonia	United Arab Emirates
Norway	
Poland	
Portugal	
Romania	
Slovakia	
Slovenia	
Spain	
Sweden	
Türkiye	
United Kingdom	
United States	

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Overview of the SG/2 Shareable Software Suite (S4)

AOP-49 "SG/2 Quality System"

Programme Management Domain	Project Management Domain
✓ Coordination ✓ Oversight	✓ Project Planning ✓ Project Monitoring and Control ✓ Risk Management
Engineering Domain	Support Domain
✓ Requirements Management ✓ Technology Development ✓ Software Development	✓ Configuration Management ✓ Process Assurance ✓ Product Evaluation

Each development site implements the QS using their own local QS.

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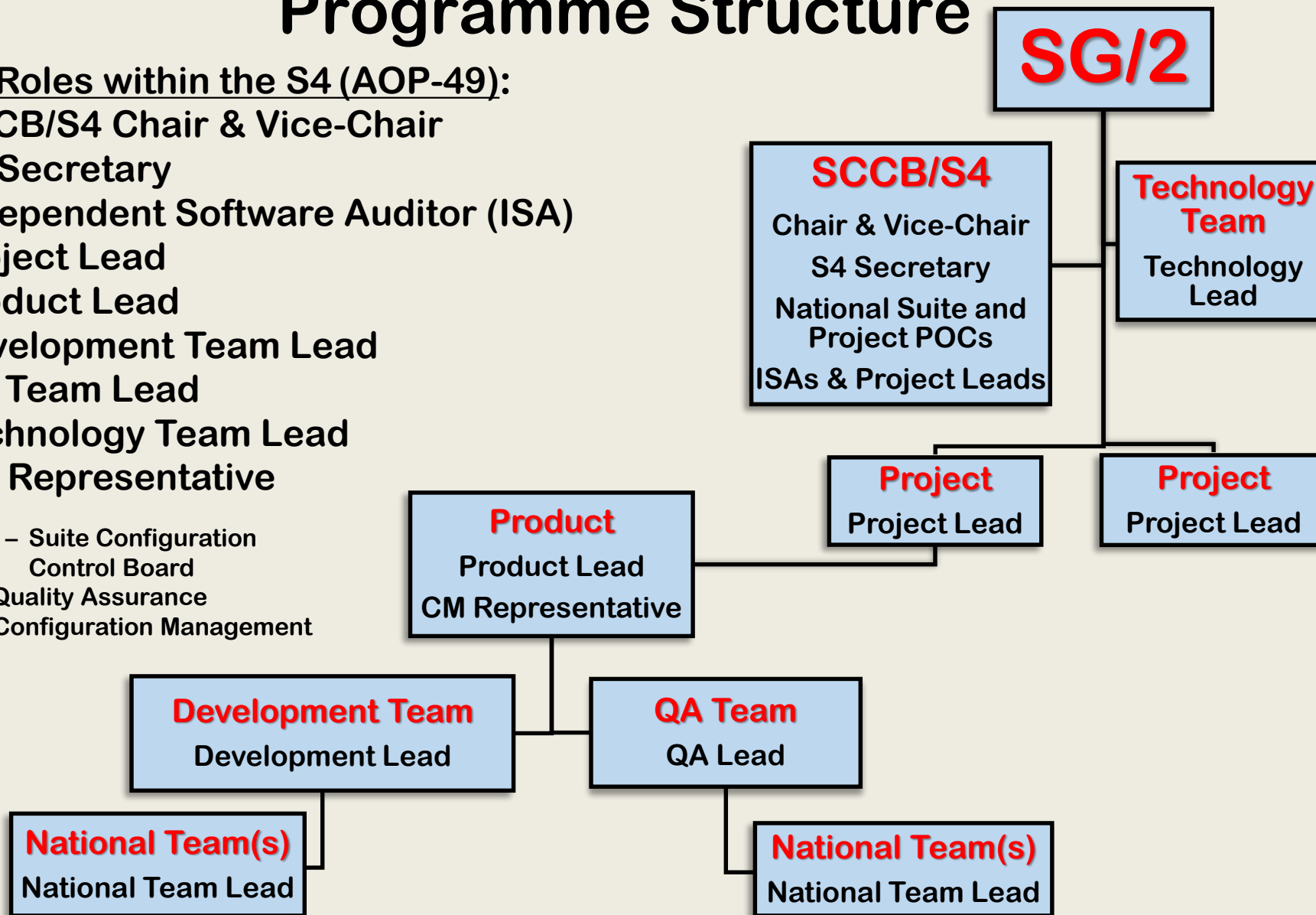
Overview of the SG/2 Shareable Software Suite (S4)

Programme Structure

Key Roles within the S4 (AOP-49):
- SCCB/S4 Chair & Vice-Chair
- S4 Secretary
- Independent Software Auditor (ISA)
- Project Lead
- Product Lead
- Development Team Lead
- QA Team Lead
- Technology Team Lead
- CM Representative

*SCCB – Suite Configuration
      Control Board
*QA – Quality Assurance
*CM – Configuration Management

SG/2

SCCB/S4
Chair & Vice-Chair
S4 Secretary
National Suite and Project POCs
ISAs & Project Leads

Technology Team
Technology Lead

Project
Project Lead

Project
Project Lead

Product
Product Lead
CM Representative

Development Team
Development Lead

QA Team
QA Lead

National Team(s)
National Team Lead

National Team(s)
National Team Lead

Overview of the SG/2 Shareable Software Suite (S4)

S4 Key Roles

as of Sep 2024

Key Roles in the S4 Programme		
Chair SCCB: **Denmark**		S4 Secretary: **United States of America**
Vice-Chair SCCB: **United States of America**		Lead ISA: **Netherlands**
S4 Technology Coordinator: **United States of America**		S4 Quality Assurance: **Norway**
MILMET Liaison to SG/2: **United States of America**		Chair SDR: **United States of America**

NASS Project		Product Lead	Development Lead	Quality Lead	ISA
Lead: **United Kingdom**					
Products	NASS	**United Kingdom**	**United Kingdom**	**Australia**	**Netherlands**
	UDM	**United Kingdom**	**United Kingdom**	**Sweden**	To Be Determined
	CodeCAT	**Norway**	**Norway**	**Germany**	Not Required

NAMK Project		Product Lead	Development Lead	Quality Lead	ISA
Lead: **Norway**					
Products	METM	**Norway**	**Norway**	**Finland**	**Canada**
	GMVerify	**Norway**	**Norway**	**Finland**	**Canada**

NABK Project		Product Lead	Development Lead	Quality Lead	ISA
Lead: **United States of America**					
Products	NABK	**United States of America**	**United Kingdom**	**United States of America**	**Netherlands**
	TEDM	To Be Determined	To Be Determined	**Germany**	To Be Determined
	TAFT	**United States of America**	**United Kingdom**	**Netherlands**	**United States of America**
	FCIGen	**Spain**	**Spain**	**Spain**	**Czech Republic**

NIFAK Project (see **Note** below)		Product Lead	Development Lead	Quality Lead	ISA
Lead: To Be Determined					
Product	NIFAK	To Be Determined	To Be Determined	To Be Determined	To Be Determined

Note: DNK in custodian role for NIFAK while development of new baselines on hold awaiting new PL, PrL, DL, QL.
Note: NLD is the NIFAK ToE Lead.

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Overview of the SG/2 Shareable Software Suite (S4)

Areas of Responsibility Across Projects
SG/2 Level

- Policy (APP-18 under cover STANAG 4537)
- S4 Quality System (AOP-49)
- Management of resources
- Terms of reference and project charters
- Monitoring national implementations of S4 products
- Technology
  – Generation
  – Verification, Validation, and/or Evaluation
  – Through a Technology Lead (and Team if necessary):
    Specific Product Technology Generation and Adaptation
- Suite Configuration Control
- Project reviews and audits
- Suite and product assurance
- Appoints independent software auditors

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Overview of the SG/2 Shareable Software Suite (S4)

Areas of Responsibility Across Projects
Suite/SCCB Level

- **Suite Configuration Control**
    - **Monitor scope of the programme and projects**
    - **Allocation of requirements**

Suite Configuration Control Board (SCCB)

- **Suite Level Requirements**

- **Product Interface Control**
    - **Waivers on code deprecation rules**
    - **Waivers of "Board Level" coding standard rules (via the SDR)**

- **SG/2 Quality Process (AOP-49) Procedures**
    - **Requirements management**
    - **Coding standard waivers**

- **Programme Reviews and S4 Telecons**

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Programme Framework
Overview of the SG/2 Shareable Software Suite (S4)

Areas of Responsibility Across Projects
Project Level

- **SG/2 Quality Process Implementation**
- **Project (Development) Plan**
- **Component Item Lifecycle Requirements**
- **Software Requirements Generation (including DB, Interface, etc. Requirements)**
- **Technology Adaptation**
- **Software Development**
- **Project and Product Configuration Management**
- **Qualification Testing (Product QA)**
- **Within Project Reviews and Audits**
- **Software, Test Procedures, and Doc Peer Review**
- **Product Configuration Control**
- **Training (Development Process and Product Use)**
- **Product CDs/DVDs (AOP-37 and related information)**

Analysis of Requirements through a Requirements Analyst

Product And Project CM through a CM Rep

Through a Development Lead (and Team if necessary)

Through a Qualification Lead (and Team if necessary)

Development Lead and Team
- **National Quality Process**
- **Software development Plan**
- **Software Requirements Implementation**
- **Technology Implementation**
- **Software Analysis and Design**
- **Engineering Testing**
- **CM of SW & Documents in Development**
- **Comply with S4 Product Dev Standards**

Quality Lead & Qualification Team
- **National Quality Process**
- **Software Test Plan and Test Description**
- **Autotest and Other Tool Development**
- **Scenario Development**
- **Final Qualification Testing**
- **Software Test Report**
- **CM of Test Tools and Artifacts**
- **Comply with S4 Product Dev Standards**

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Independent Software Auditor

➢ **Implemented as a role in the SG/2 maintained S4 Quality System (AOP-49)**

➢ **The ISA role is at a level above the project level; the ISA role is in the "Programme Management Domain"**

➢ **The ISA role was established so that SG/2 in part can meet its responsibility for conducting quality system reviews and to meet its responsibility agreed to conduct project reviews and audits**

➢ **ISA Responsibilities:**

- **Conducts an audit of each release**
  - **Evaluates compliance with applicable coding standard(s)**
  - **Evaluates project documentation for accuracy, completeness, etc.**
  - **Publishes an audit report for each major product release (Assesses product 'fitness for use' which means verified and validated in the intended domain)**

- **Monitors product quality and, when issues are identified, coordinates with development team process auditors**

- **Reviews third party product code and appropriate development and qualification documentation**

- **Participates in Software Design Reviews**

- **Reports audit results at project reviews and to the SCCB/suite level management**

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S4 Collaboration

- **S4 Programme Reviews**
  - **February**
  - **September**

- **S4 Software Development Review in April** (Netherlands)

- **Collaborative S4 Website** (Hosted by Netherlands TNO)

- **S4 Level and Project Level Meetings**
  - **Teleconferences**
  - **Web conferences**
  - **Meetings adjacent to S4PRs**

- **E-mail**

- **Select NATO group portals when appropriate**

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S4 Product Release Schedule (annual cycle)

Product	Release Date	Rationale
NASS UDM CodeCAT	September	NASS is provided as a foundation for the other S4 Products and therefore must be released first along with UDM for database development. CodeCAT is released at cycle start so all other product teams can use in their testing.
METM GMVerify	November	The METM Product depends on NASS (for compression, data integrity and hashing code) but not on other S4 Products. METM is released now for inclusion in NABK testing. GMVerify depends on METM for its functionality.
NABK TEDM	February	The NABK Product depends on NASS, UDM, and METM, while the TEDM Product depends on NASS.
TAFT	July	The TAFT Product depends on the NABK Product. It will be released approximately 4 months after the NABK. Release of TAFT currently completes a release cycle.
NIFAK FCIGen	August	The NIFAK Product is dependent on the NASS Product and when development of new baselines is restarted will also be dependent on the UDM, METM, and NABK products. The FCIGen Product depends on the NASS, UDM, METM, and NABK Products.

Overview of the SG/2 Shareable Software Suite (S4)

S4 Product Compatibility Matrix

Release Cycle	Release Timing/Period	NASS	NAGIK	UDM	CodeCAT	METM GMVerify	NABK	TAFT	TEDM	FCIGen	NIFAK
Alpha	Sep 2005- Feb 2006	1.0 / 1.1	1.0 / 1.1				8		1.2		
Bravo	Sep 2006- Feb 2007	2	2				8.5		1.5/2.0		
Charlie	Sep 2007- Feb 2008	3	2.1			-	9		2.1		-
Delta	Sep 2008- May 2009	4	2.2			1	10		2.2		1
Echo	Sep 2009- Mar 2011	5	2.3			1.1	11		2.3		-
Foxtrot	Sep 2010- May 2011	6	2.4			1.2	11.1	0.90	2.4		1.5
Golf	Sep 2011-May 2012	7	2.5			2.5	12	0.91	2.5		2
Hotel	Sep 2012-Aug 2013	8	2.6			2.6	13	(0.92)*	2.6		3
India	Sep 2013-Aug 2014	9	2.7	0.1		2.7	14	0.93	2.7		4
Juliet	Sep 2014-Aug 2015	10	2.8	0.5	1.5	2.8	15	0.94 (Jul 2016)	2.8		4.5
Kilo	Sep 2015-Aug 2016	11	2.9	1	1.6	2.9	16	1.0/1.1	2.9		5
Lima	Sep 2016-Aug 2017	12	2.10	1.1	1.7	2.10	17	1.2	2.10		6
Mike	Sep 2017-Aug 2018	13	2.11	1.2	1.7	2.11	18	1.3	2.11		On hold
November	Sep 2018-Aug 2019	14	Merged into NASS	1.3	1.8	2.12	19	1.4	2.12		On hold
Oscar	Sep 2019-Aug 2020	15		1.4	1.9	2.13	20	1.5	3.0		On hold
Papa	Sep 2020-Aug 2021	16		1.5	1.10	2.14	21	1.6	3.1		On hold
Quebec	Sep 2021-Aug 2022	17		1.6	1.11	2.15	22	1.7	3.2		On hold
Romeo	Sep 2022-Aug 2023	18		1.7	1.12	3.0	23	1.8	3.3	0.9	On hold
Sierra	Sep 2023-Aug 2025	19		1.8	19	3.1	24	1.9	3.4	1.0	On hold
Tango	Sep 2025-Aug 2026										
Uniform	Sep 2026-Aug 2027										
Victor	Sep 2027-Aug2028										

*TAFT (0.92) was an internal release only. NABK 16 needs UDM 1.1a. NIFAK 6 did not switch to UDM.

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Overview of the SG/2 Shareable Software Suite (S4)

NABK Project

Lead Nation: **USA**

<u>4 Products</u> (See next slide for 4th):

1)<u>N</u>ABK – <u>N</u>ATO <u>A</u>rmaments <u>B</u>allistic <u>K</u>ernel
- *Product Lead Nation:* **USA**
- *Development Lead Nation:* **GBR**
- *Quality Assurance Lead Nation:* **USA**
- *Independent Software Auditor:* **NLD**

2)<u>T</u>EDM – <u>T</u>errain <u>E</u>levation <u>D</u>ata <u>M</u>anager
- *Product Lead Nation:* **To-Be-Determined (TBD)**
- *Development Lead Nation:* **TBD**
- *Quality Assurance Lead Nation:* **DEU**
- *Independent Software Auditor:* **TBD**

3)<u>T</u>AFT – <u>TA</u>bular <u>F</u>iring <u>T</u>ables
- *Product Lead Nation:* **USA**
- *Development Lead Nation:* **GBR**
- *Quality Assurance Lead Nation:* **NLD**
- *Independent Software Auditor:* **USA**

<u>**NABK**</u> **provides ballistics related services that are typically required by technical fire control systems. Currently addresses most indirect fire artillery and mortar applications, some direct fire and naval applications, and some guided projectiles.**

<u>**TEDM**</u> **provides an approximation for local ground altitude, normally referenced to mean sea level and the appropriate ellipsoid, accuracy of approximation is based on the level of DTED data used. DTED Level 0 is provided with the product. Designed for rapid access to the data with tools for integrators to include higher resolution DTED data.**

<u>**TAFT**</u> **provides the ability to produce tabular firing tables in accordance with the formats established in STANAG 4119. The trajectory information generated is produced by the NABK product.**

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Overview of the SG/2 Shareable Software Suite (S4)

NABK Project (Cont'd)

Lead Nation: **USA**

<u>4 Products:</u>

4)FCIGen – <u>FCI</u> <u>G</u>enerator
- *Product Lead Nation:* **ESP**
- *Development Lead Nation:* **ESP**
- *Quality Assurance Lead Nation:* **ESP**
- *Independent Software Auditor:* ==**CZE**==

<u>**FCIGen**</u> **provides the ability to produce Fire Control Inputs (FCIs) for Artillery and mortars (currently for unassisted projectiles) in accordance with the rules established in AOP-65 STANAG 4144. FCIGen is composed of three graphical user interfaces: Trazador3, TrajAn, and Hadrian tool.**

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the NABK Product

- Implements STANAG 4355 (Lieske MPM and 5 DoF Trajectory Models)

- Current NATO baseline is version 23.0

- High level capabilities include:

  ➤ Trajectory computations
    - Modified 3 degree-of-freedom
    - Compute a projectile trajectory from initial conditions
    - Compute the elevation and azimuth required to reach a target
    - Compute probable errors for a mission

  ➤ Projectiles supported:

Categories:
  - Artillery
  - Tanks
  - Mortars
  - Small Arms
  - Rockets (Beta) [Removed in NABK 16] Working to address, again
  - Naval (Medium and Large Caliber)

Types:
  - High Explosive
  - Improved Conventional Munitions/Bomblets
  - Rocket-Assisted
  - Base Burn
  - Illuminating
  - Smoke
  - Guided/ Course Correcting ⎰ Excalibur
                                    Spacido
                                    Vulcano
                                    PGK

  ➤ Fire mission support (details next slide)

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the NABK Product (Cont'd)

- **Fire Mission Support**
  - ➢ **Operate on groups of weapons (configurable):**
    - o **Battalion / Battery / Platoon / Weapon**
  - ➢ **Coordinate systems**
    - o **UTM / MGRS / BNG**
    - o **Latitude/Longitude/Altitude**
  - ➢ **Meteorological Data**
    - o **MetCM, MetGM, Ballistic Met (via METM)**
    - o **Uses a Met key to METM; can use any type of Met that METM supports**
  - ➢ **Charge Selection**
  - ➢ **Fire Support Coordination Measures**
    - o **Air Corridors**
    - o **Near and Far Crests**
  - ➢ **Muzzle Velocity Variations as specified by operator**
    - o **Round by Round**
    - o **Averaged Occasions**
  - ➢ **Registration Corrections**
  - ➢ **Digital Terrain Data (via TEDM)**
    - o **Occupied Areas**
  - ➢ **Moving Weapon**

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the TEDM Product

Core Capabilities	
Capability	**Purpose**
Add new DTED (or DMED)	To read Standard DTED files
Get an altitude of a Location	To return the altitude for a given location
Perform DTED crest-clearance and position re-plotting for the NABK	To provide NABK with capability as well as for stand-alone use

Ancillary Capabilities	
Capability	**Purpose**
Initialization	To start TEDM processing in a controlled manner
Finalization	To Stop processing is a controlled manner
Profiles & Dead Ground	To generate altitude profiles along a line between two locations and, separately to assess "dead ground".
DSI	Get DSI Data
Bitmap processing	To produce (Windows) bitmaps. Also included here is the ability to output numeric maps to permit graphical representation by other means
Sea Cell recognition	If the user's data set contains no information about a cell, a map from worldwide DTED0 is used to allow the recognition of cells known to be sea
Integrity Check	To demonstrate the integrity of the generated TEDM files
Editing page file sets	Ability to open a page file set for editing. Subtraction (or removal) of new cells is supported in such cases

Included Applications

Tools to support:

- Development of TEDM itself

- Building of page files

- Sizing of page files

- Image production

- Crest clearance testing

- Some altitude and position conversions

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the TAFT Product

Standardized Artillery Tables Supported by TAFT		
Table	**Name**	**STANAG 4119 Ed2 Ref**
Charge Selection Table	Charge Selection Table	Annex F
Table A	Line Numbers Of Ballistic Meteorological Message	Annex G
Table B	Complementary Range And Met Line Number	Annex H
Table C	Wind Components	Annex I Alternative 1
Table C Alt	Alternative form of Table C	Annex I Alternative 2
Table D	Ballistic Air Temperature And Ballistic Air Density Corrections	Annex J Alternative 1
Table D Alt	Alternative form of Table D	Annex J Alternative 2
Table E	Propellant Temperature	Annex K
Table E.1[1]	Corrections For Rocket-Assist Motor And Base-Bleed Unit Propellant Temperatures	Annex N
Table F (i)	Basic Data And Corrections To Bearing	Annex L
Table F (ii)	Corrections To Range For Non-Standard Conditions	Annex M
Table G (i)	Supplementary Data - Probable Errors	Annex O
Table G (ii)	Supplementary Data - Trajectory Information	Annex O
Table H	Rotation Of The Earth – Range	Annex P
Table I	Rotation Of The Earth – Azimuth	Annex Q
Table J	Corrections To Fuze Setting For Non-Standard Conditions	Annex R
Table J.1[2]	Corrections to Fuze Setting to Compensate for Variations in Propellant Temperature of the Base Bleed or Rocket Motor	Annex R
Table K	Data for Alternative Fuzes	Annex S
Illum	Illuminating Projectiles	Annex T
Cargo	Cargo Projectiles	Annex U Alternative 2
Add-A	Firing Table For Cargo Projectile (Quadrant Elevation)	Annex U Alternative 1 for QE
Add-B	Firing Table For Cargo Projectile (Fuze Setting)	Annex U Alternative 1 for FS
Abridged	Abridged Firing Table	Annex V

Current Capabilities of the TAFT Product (Cont'd)

Mortar Firing Tables Supported by TAFT	
Table	**Name**
Table MT1	Corrections in quadrant elevation to correct for complementary angle of site (same format as table B in STANAG 4119)
Table MT2	Basic data, probable error data; bearing and range corrections
Table MT3	Propellant Temperature (equivalent of table E in STANAG 4119)
Table AoS-QE	Elevation Corrections for Angle of Site (similar to T1, but without Met line numbers)
Table AoS-FS	Fuze Setting Corrections for Angle of Sight
Table AoS-ToF	Time of Flight Corrections for Height Difference

Non-Standardized Tables Supported by TAFT	
Table	**Name**
Table BF	Complementary fuze setting & met line number
Table BTF	Complementary time of flight & met line number
Table BQE	Complementary quadrant elevation & met line number
QE	Quadrant Elevation
DF	Direct Fire Firing Table
Table R	Abridged MV Table (bursting)
Table S	Abridged MV Table (cargo)
Table T	Carrier MV Supplement
Table CC	Crest Clearance (BETA STATUS ONLY)
Table CC_Alt	Crest Clearance (BETA STATUS ONLY) – previously CC
Table Ricochet	Proposed table to support ricochet
Table TP	Trajectory Plots

Current Capabilities of the FCIGen Product

FCIGen Fire Control Input generator Suite (composed of 3 tools)	
Tool	**Description**
Trazador 3	Allows the user to fit data tables (in an automatic or manual way) by means of piecewise polynomial functions. Data tables can come directly from the loading of data files or indirectly from the loading of piecewise polynomial functions.
TrajAn (Trajectory Analysis)	Allows loading and reading of files obtained from tracking radars and makes polynomial fitting, using a robust algorithm with outlier removal (ROUT method) in the final segments of the trajectories. The polynomial fitting allows for identifying Aimpoints (final ordinate, final range, final deflection, maximum ordinate, and time of flight) for the ballistic characterization. The Aimpoint is the point (not necessarily observed, always determined by fitting and never by extrapolation) that presents enough reliability (the radar got measurement records in its surroundings with acceptable signal-to-noise ratio). Allows loading and reading MetCM, MetGM, and MetGC (compressed MetGM) meteorological messages. Optimal assignment of a message to each occasion of rounds fired.
Hadrian	Helps the user, through a number of steps, to generate ballistic information required in an FCI (Fire Control Input). The user invokes, in an ordered way, a series of command line scripts: <iform_fl_calculator>, <tcorr_calculator>,<pei_pefl_calculator>, <pem_calculator>, <pemv_calculator>, <ped_calculator>, <fork_calculator>, <delum_calculator>, <delupt_calculator>, and perform a goodness of fit for a particular characterization process.

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Overview of the SG/2 Shareable Software Suite (S4)

NIFAK Project

Project Lead Nation: **To-Be-Determined**

1 Product:

* NIFAK – NATO Indirect Fire Appreciation Kernel
  * *Product Lead Nation:* **To-Be-Determined (TBD)**
  * *Development Lead Nation:* **TBD**
  * *Quality Assurance Lead Nation:* **TBD**
  * *Independent Software Auditor:* **TBD**

Notes:

1) Work on the development of new baselines of the NIFAK product is on hold awaiting the PL, PrL, DL, and QL roles to be refilled.

2) **A Team of Experts currently continues work on**:
  * Technology addressing effectiveness against structural targets
  * Establishing input data for NIFAK & other effectiveness models
  * Creation of a NIFAK Demonstrator
  * Prep for Round Robin 3 (Comparing national models to NIFAK)
    [The last 3 are linked, input - software - application.]
  * Considering an additional product: a lethal area generator

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NIFAK provides (a set of possible) answers identifying either the number of rounds needed to obtain certain desired effects on a given target, or the effects you will obtain for a certain number of rounds delivered on a given target. The goal is to answer all of the following 5 questions:

1) **Who**? (which delivery systems) will fire
2) **What**? (kind of ammunition)
3) **How**? (using which method of fire)
4) **Where**? (which aim points) and
5) **How many**? (the number of rounds).

The product currently answers 4) and 5), "**Where**?" and "**How many**?".

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the NIFAK Product

- Implements STANAG 4654 (Indirect Fire Appreciation Modelling)

- Current NATO baseline is version 6.0

- Capabilities (what can be "played") include:

  - Fragmenting and bomblet munitions (implements damage matrices)
  - Simple targets (1 target area with all target elements the same)
  - Point, circular, linear and rectangular targets
  - Group targets (adjacent targets or overlapping target areas)
  - Estimation of delivery errors (linear model)
  - Complex targets (groups of target elements with related capabilities)
  - Defined target element locations in target area
  - Multiple ammunition types in a mission
  - Multiple firing units/types of weapons
  - MRSI (Multiple Rounds Simultaneous Impact)
  - Risk Distances (collateral damage of personnel and danger close)
  - Posture change and target hardening
  - Sensor fuzed munitions and false targets (SADARM, BONUS (SWE), SMART, etc.)
  - Firing platforms can shoot to multiple aimpoints in a mission
  - FUTURE: Calculation of a real time mission error budget (implement STANAG 4635)
  - FUTURE: Effects on and within building and collateral damage to buildings

- Tool (backend and GUI) currently being developed by NIFAK ToE

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Overview of the SG/2 Shareable Software Suite (S4)

NIFAK Demonstrator

- **Created for use in Round Robin 3 and to demonstrate the capabilities of NIFAK**

- **Each NIFAK capability is represented by an Opr, each built to generate a .dll**

- **A Python "workbench" environment is used to build the GUI and run the .dlls**

- **All current capabilities implemented EXCEPT:**
  - o **Circular targets**
  - o **Group targets (adjacent targets or overlapping target areas)**
  - o **Sensor fuzed munitions and false targets (SADARM, BONUS (SWE), SMART, etc.)**

- **NABK 18 .dll ready for implementation**

- **Additionally included with capabilities implemented**
  - o **Damage matrix storage array can be constructed within OPr**
  - o **Information can be retrieved from the damage matrix**
  - o **Range and deflection gridlines can be created and can be set to the damage matrix object**
  - o **Cell Pks or an array of the Pks can be retrieved; Pk at a location can be determined**

- **Users can create their own GUI with different applications using generic .dlls; instructions and samples available**

- **Full open source**

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Overview of the SG/2 Shareable Software Suite (S4)

NAMK Project

Project Lead Nation: **NOR**

<u>2 Products:</u>

1) METM – <u>MET</u> data <u>M</u>anager
- *Product Lead Nation:* **NOR**
- *Development Lead Nation:* **NOR**
- *Quality Assurance Lead Nation:* **FIN**
- *Independent Software Auditor:* ***To-Be-Determined (TBD) CAN***

2) GMVerify – <u>G</u>ridded <u>M</u>et msg <u>V</u>erification
- *Product Lead Nation:* **NOR**
- *Development Lead Nation:* **NOR**
- *Quality Assurance Lead Nation:* **FIN**
- *Independent Software Auditor:* **CAN**

METM provides ability to read, process, and output meteorological data in specific NATO formats. Does not provide forecast capability. Services include validation of data files supplied for processing, extraction and output into other supported formats. The key operational service is to extract and provide appropriate met data for ballistic computations in NABK and imminently for delivery accuracy computations in NIFAK.

Core functionality for **GMVerify** is provided by METM. A command driven backend containing METM is driven from a frontend GUI providing useful capabilities to producers and manipulators of METGMs. Services include validation of supplied METGM files; spatial, temporal, and data subsetting; integrity fingerprint; data conditioning and compression.

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the METM Product

- **METM reads and interpolates meteorological data for technical fire control**

- **Reads gridded met messages – METGM**
  - METGM – AMETOCP-4 Vol I, Appendix A.4
  - METGC – Conditioned & compressed METGMs (S4 internal)
  - Reduces coverage (spatial, temporal or parameters)
  - Increases horizontal grid spacing
  - Converts between Edition 1, 2 & 3 formats

- **Reads text met message – METCM**

- **Provides met data to "user" i.e. the NABK**
  - For METGM – provides interpolated data for a given point in time, x, y, and altitude
  - For METCM – provides interpolated data for a given altitude

- **Extracts text met messages from METGM**
  - METCM, METB2, METB3, METTA
  - CBRN Weather Reports – BWR, CDR & EDR

- **Writes gridded and text met messages**
  - From the above

- **Performs data integrity checks and highlights potential problems incl. extreme weather conditions**

- ***Does NOT generate data***

- ***Does NOT generate forecasts***

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the METM Product (Cont'd)

Capability	Message Type Supported
Reading**	GM*, CM
Get header info	GM*, CM, B2, B3, TA, BWR, CDR, EDR
Get line by line info	CM, B2, B3, TA, BWR, CDR, EDR
Data extraction for requested point	GM*, CM
Sub-setting (slice & dice) – spatial, temporal or parameters	GM*
Increase horizontal grid spacing	GM*
Validating vertical trends and gross error checking	GM*, CM
Message extraction from METGM*	CM, B2, B3, TA, BWR, CDR, EDR
Extrapolation of surface data	CM
Message extraction from METCM	B2, B3
Writing**	GM*, CM, B2, B3, TA, BWR, CDR, EDR

*   6 gridded variants – METGM & compressed METGC / AMETOCP-4 Vol I, Appendix A.4, Version 1, 2 & 3

** Conversion between the 6 variants through reading and writing

Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the GMVerify Product

- **Application with GUI front-end and command based back-end that calls METM**

- **Ensures a METGM reads with METM**
  - Supports AMETOCP-4 Vol I, Appendix A.4, Version 1, 2 & 3 formats
  - Allows display of internal parameters

- **Processes METGM data**
  - Optionally "slices & dices" and/or increases horizontal step sizes in METGM data
  - Checks validity and highlights potential problems incl. extreme weather conditions
  - Converts between Version 1, 2 & 3 formats

- **Outputs subset METGMs**
  - As "sliced & diced," w/increased horizontal step sizes, and/or w/format converted
  - In uncompressed (METGM) and compressed (METGC) forms [METGC is S4 internal]

- **Outputs text Mets by interpolating within the 3D/4D data**
  - METB2, METB3, METCM, or METTA
  - CBRN Weather Reports: BWR, CDR, or EDR
  - Optionally height limited
  - Optionally with data integrity hash

- **Outputs METCMs extrapolated from surface data**

- **Outputs files with Universal Default Names**

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Overview of the SG/2 Shareable Software Suite (S4)

NASS Project

Lead Nation: **GBR**

3 Products:

1) NASS – NATO Armaments Support Services
- *Product Lead Nation:* **GBR**
- *Development Lead Nation:* **GBR**
- *Quality Assurance Lead Nation:* **AUS**
- *Independent Software Auditor:* **NLD**

2) UDM – Universal Database Manager
- *Product Lead Nation:* **GBR**
- *Development Lead Nation:* **GBR**
- *Quality Assurance Lead Nation:* **SWE**
- *Independent Software Auditor:* **TBD**

3) CodeCAT – Code Coverage Assessment Toolset
- *Product Lead Nation:* **NOR**
- *Development Lead Nation:* **NOR**
- *Quality Assurance Lead Nation:* **DEU**
- *Independent Software Auditor:* **Not Required**

NASS provides the foundation that allows other S4 products to work together, providing common services useful to two or more products and common definitions that allow products to interoperate. It has no dependencies on other S4 products. It originated from the NABK Support Layer. Example of capabilities: common domain and software interface types (bounded strings, Real64,..), generic software services (storage pools, lists, vectors, buffers, MAC,..), location management (e.g. datums), coordinate transformations, etc.

UDM provides the ability to generate code from XML schemas for database files intended to hold data common to multiple products. Current focus is a common database for use by both the NABK and NIFAK products to ensure appropriate data is synchronized and available.

CodeCAT provides integrators the capability to automate tests of a single S4 product or a combination of products intended to be embedded together under an operational processor. The primary functionality is to assess the amount of code that is covered by the qualification testing.

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the NASS Product

- **Constants and Base Types required to support the NABK, NIFAK, TEDM, & METM Products**

- **Geodesy and Geodetic support**
  - **Location Packages and Datums**
  - **Coordinate Systems – UTM, BNG, Lat/Long, some MGRS support & conversions between**
  - **Magnetic Declination**

- **World Magnetic Model (2020)**

- **Earth Gravitational Models (1996 and 2008)**

- **Advanced Math**
  - **Numerical Integration**
  - **Vectors**
  - **Random Number Generation and Distributions**

- **Lists**

- **Storage Pools**

- **Aimpoints**

- **File Management**
  - **Compression**
  - **Hashing for file authentication/integrity**
  - **Obfuscation (non assured encryption)**

- **Portable Network Graphics PNG**
  - **Used for plotting aimpoints**

- **Streams**

- **Status Messages – an alternative to raising Ada exceptions**

- **Source Code Pre-Processor tool**

- **"Autotest" framework for testing software libraries**

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the UDM Product

- Accepts <u>any</u> data in XML with schemas describing the format

- UDM processes the set of schemas and generates Ada code including:

  o Data types and tables to store the data
  o Basic functions to access the data
  o Functions to read data files into tables
  o UDM_Embed to write data files into embedded code
  o Testing of reading and accessing data

UDM_XML
- Processes User's schema into Ada code

UDM_Embed
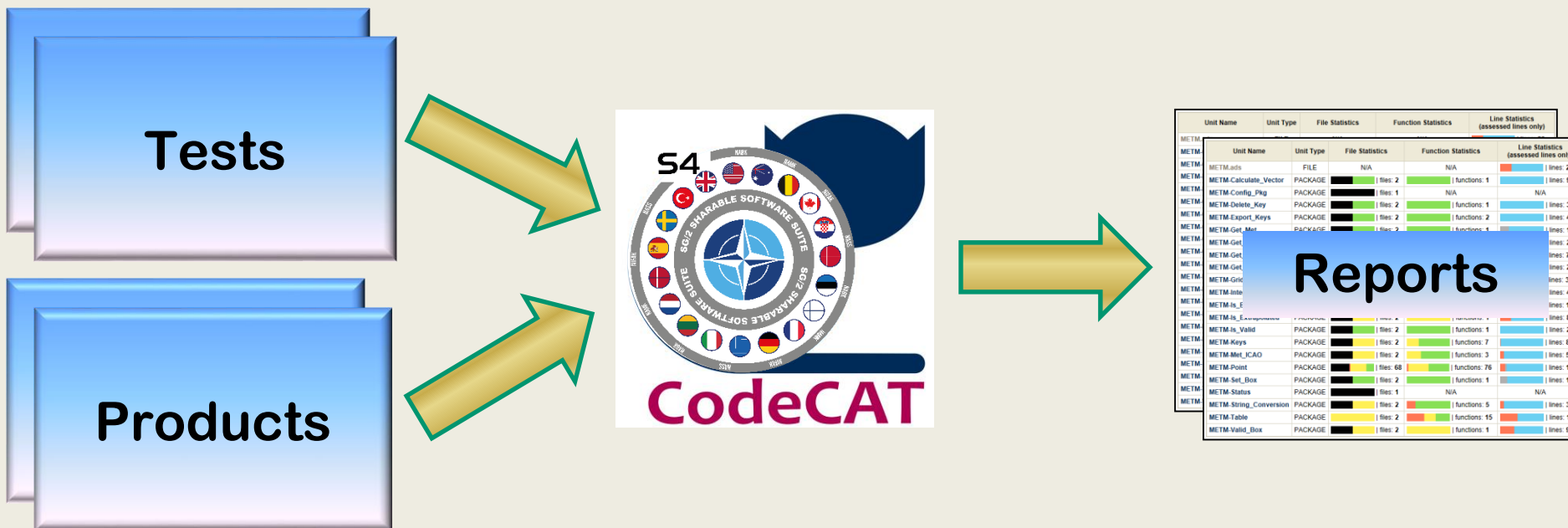- Produces sized configurations from User's data

OPr
- Optionally reads User's data

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Overview of the SG/2 Shareable Software Suite (S4)

Current Capabilities of the CodeCAT Product

- **For test verification, validation and analysis of S4 Products**
- **Verifies that the S4 Products work together in different configurations**
  - Integrated support for Source Code Pre-Processor to automatically configure source code
- **Builds products, tests, analyses coverage, generates test reports**
  - Coverage report provides percentage of and identifies lines executed many times, one time and never executed during testing
  - Option to identify code lines as untestable through ignore and defensive code markers

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Overview of the SG/2 Shareable Software Suite (S4)

Use of the S4 Products Across the Nations

World Implementations of S4 Products – as of September 2023										
Project	**NABK**				**NASS**			**NAMK**		**NIFAK**
Product	**NABK**	**TEDM**	**TAFT**	**FCIGen**	**NASS**	**UDM**	**CodeCAT**	**METM**	**GMVerify**	**NIFAK**
Fielded Systems	57	19	-	-	54	20	-	19	2	1
Technical Applications	26	6	14	1	23	9	-	13	19	6
Planned Future	41	23	7	?	37	38	-	43	2	8
# Nations Currently Implementing	19	8	13	1	15	8	-	11	10	6
# Additional Nations Implementing Near Future	1	3	4	?	2	5	-	4	1	6

<u>Note</u>: This chart depicts all current implementations which includes earlier versions of the products. The numbers for the NABK and NASS Products are not the same, as the NASS Product was created from a support layer that is in earlier versions of the NABK Product.

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Overview of the SG/2 Shareable Software Suite (S4)

National Use of the S4 Products

- S4 products are *designed to be tailored to national needs*

- *Each nation establishes their own FCIs for their weapon/ammo combos*

- S4 Products can be tailored in several ways

  - Modifying configuration packages
  - Configurable software modules
    - o Adding/removing Ada packages
    - o Adding/removing lines of code related to specific capabilities; S4 tool Source Code PreProcessor (SCPP) available
  - Modifying existing code to meet national requirements

- *Each nation is responsible for testing their implementation*

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Overview of the SG/2 Shareable Software Suite (S4)

Key S4 Documents

SG/2 and S4 Suite Level

- S4 Terms of Reference*

- STANAG 4537, APP-18, AOP-37, AOP-49*

- S4 Security Classification Guide

- S4 Product Development Standards

- S4 Ada Coding Standard

- S4 Glossary

- S4 Training Materiel

- Project Charters

- SCCB Procedures

- Marketing Material

Project/Product Level

- Project and Product Plans

- Product Security Classification Guides

- Software Requirements Specifications

- Release Notes and Version Descriptions

- Waiver Registers

- Integration and Usage Guides

- Software Test Plans, Descriptions, and Reports

- Audit Reports

*See Key References Slide/Chart.

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Overview of the SG/2 Shareable Software Suite (S4)

S4 Manpower Resources - as of September 2023

September 2023 – August 2024

- **Total work years:**   **18.75**
  - **Number of countries contributing resources: 13** (0.5+ wk yrs), **3** (>0 but <0.5 wk yrs)
  - **Work years by project:**

NABK	NIFAK	NAMK	NASS
9.4	0.1	0.85	1.8
	ToE separate		

Other S4
- Technology, ISAs, other: 4.75
- Met: 0.55
- Meeting prep and support: 0.55
- Planning and administration: 0.75

Numbers do not include participation in meetings.

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Overview of the SG/2 Shareable Software Suite (S4)

Summary

- S4 domain encapsulates products related to ballistics, delivery accuracy, battlefield meteorology, and fire support appreciation

- ICGIF and SG/2 provide programme oversight

- S4 technology is based on International Standards, NATO STANAGs and STANRECs, and national documentation

- AOP-49 *"SG/2 Quality System"* provides the framework for the development of S4 products

- Programme review & SCCB meetings held twice a year (February and September)

- Software design review held once a year (Apr)

- Project and product meetings are held as appropriate

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Overview of the SG/2 Shareable Software Suite (S4)

Additional Key Points

- **Ballistics software (through a suite of components) is available to embed in fire control computers/weapons**

- **Mature products, mature processes; nationally and internationally developed and maintained; international development audited by NATO**

- **Software provides for a consistent implementation of fire control technology across national and NATO systems**

- **Confidence in exchange of fire control ballistics data within multinational coalitions; facilitates interchangeability and interoperability**

- **Cost savings benefit realized through reuse and shared effort; reliability improved through extent of implementation**

Key References

1) NAAG AC/225 ICGIF SG/2. "(NAAG ICGIF) SG/2 Shareable (Fire Control) Software Suite (S4) Terms of Reference," Version 1.0, dated 14 September 2018.

2) NATO Standardization Agency (NSA). 07 October 2015. NATO Standardization Agreement STANAG 4537, Edition 4, "Sub-Group 2 Sharable (Fire Control) Software Suite (S4)." (Cover STANAG)

3) NATO Standardization Agency (NSA). 07 October 2015. NATO Standard Allied Procedural Publication APP-18, Edition A, Version 1, "The Sub-Group 2 Sharable (Fire Control) Software Suite (S4)."

4) NAAG AC/225 ICGIF SG/2. Allied Ordnance Publication 37 (AOP-37). Multiple issuances each year through S4 project/product releases. (The NATO S4 annually releases a suite of software products which includes associated information and data; AOP-37 comprises the full suite release in a set of .zip files, each released in specific months over the period September through August.)

5) NAAG AC/225 ICGIF SG/2. October 2015. NATO Standard Allied Ordnance Publication 49 (AOP-49), Edition D Version 1, "SG/2 Sharable (Fire Control) Software Suite (S4) Quality System."

6) NAAG AC/225 ICGIF SG/2. "Programme Plan for the SG/2 Shareable (Fire Control) Software Suite (S4) October 2023 through September 2026," Version 3.0, dated 15 Mar 2024.

7) NAAG AC/225 ICGIF SG/2. "SG/2 Shareable (Fire Control) Software Suite (S4) Security Classification Guide," Version 1.5, dated 27 Feb 2019.

8) NAAG AC/225 ICGIF SG/2. "Product Development Standards for the SG/2 Shareable (Fire Control) Software Suite (S4)," Version 1.20, dated 25 Sep 2024.