TACOM

Lethality, Survivability, Mobility and Sustainment for America's Army

The NATO Armaments Ballistic Kernel

Ballistics Software Available for Small Arms and Mortar Fire Control

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Firing Tables and Ballistics

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International Infantry Session

N A B K

NATO

Armaments

Gun Fired

Spin Stabilized

and

Fin Stabilized

Projectiles

Ballistic

Solves

the

Gunnery

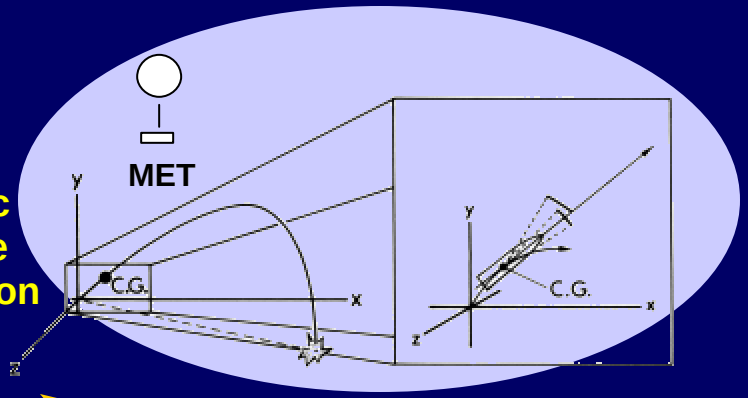
Problem

Kernel

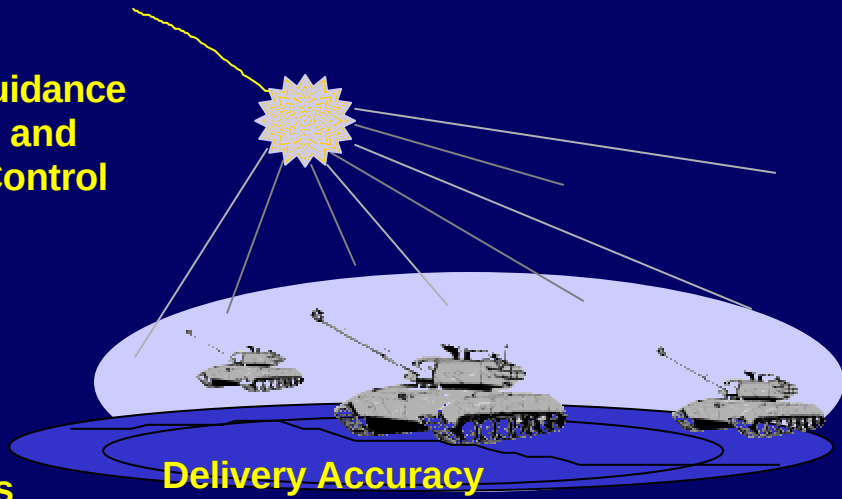
Software

Fire Control Ballistics Domain

Aerodynamic Performance Characterization



Guidance and Control



Delivery Accuracy

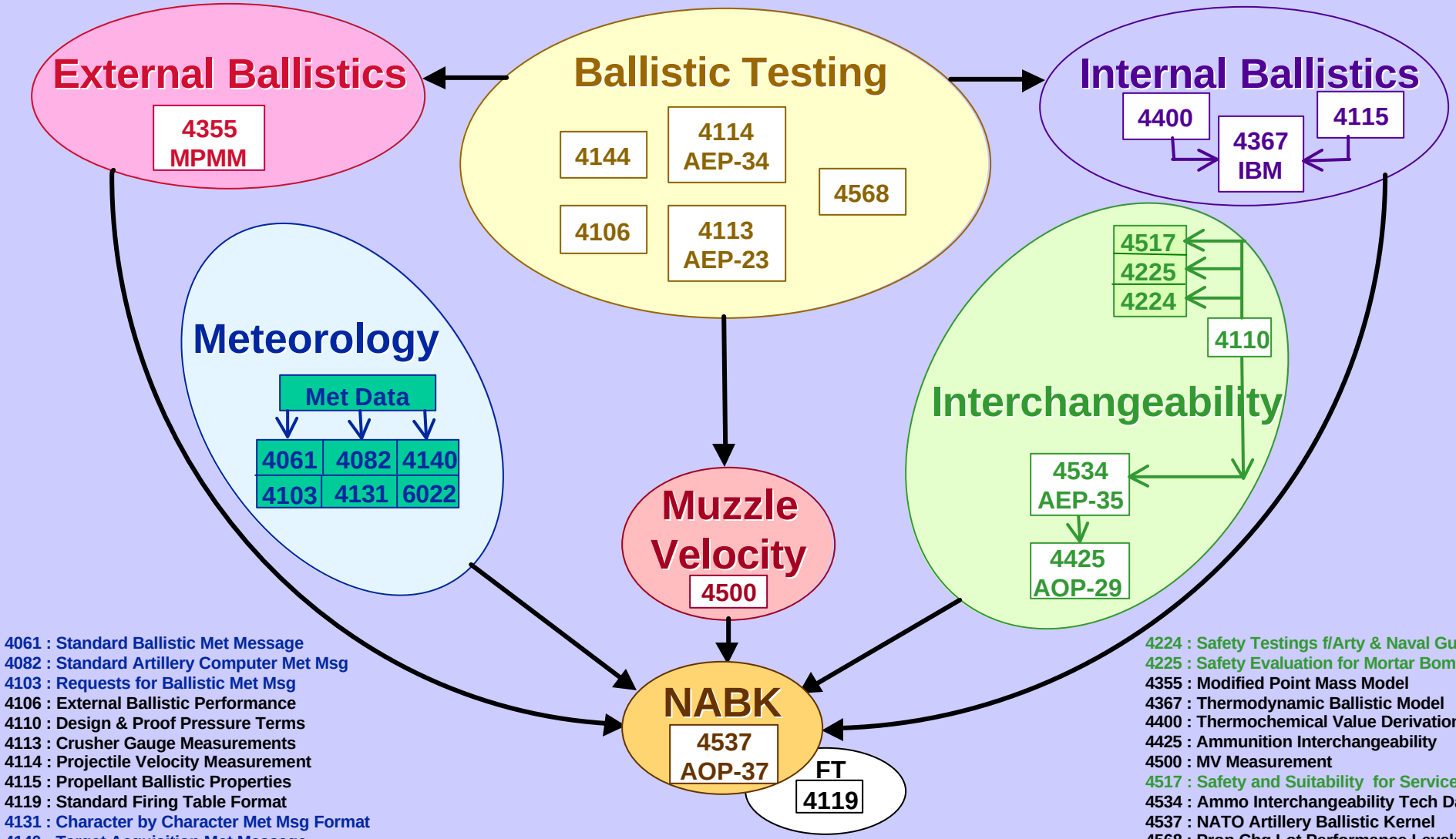
Trajectory Simulation
and
Ballistic Performance Analysis and Prediction

International Standards
Ammunition Interchangeability
Sharable Software

Testing
Design, Planning, and Oversight

"On Time, **On Target**" with
Ballistic Expertise and **Aiming Data Products**

Supporting Standardization Agreements



4061 : Standard Ballistic Met Message
4082 : Standard Artillery Computer Met Msg
4103 : Requests for Ballistic Met Msg
4106 : External Ballistic Performance
4110 : Design & Proof Pressure Terms
4113 : Crusher Gauge Measurements
4114 : Projectile Velocity Measurement
4115 : Propellant Ballistic Properties
4119 : Standard Firing Table Format
4131 : Character by Character Met Msg Format
4140 : Target Acquisition Met Message
4144 : Dynamic Firing Techniques

4224 : Safety Testings f/Arty & Naval Guns
4225 : Safety Evaluation for Mortar Bombs
4355 : Modified Point Mass Model
4367 : Thermodynamic Ballistic Model
4400 : Thermochemical Value Derivation
4425 : Ammunition Interchangeability
4500 : MV Measurement
4517 : Safety and Suitability for Service
4534 : Ammo Interchangeability Tech Data
4537 : NATO Artillery Ballistic Kernel
4568 : Prop Chg Lot Performance Levels
6022 : Adoption of a Std Gridded Met Msg

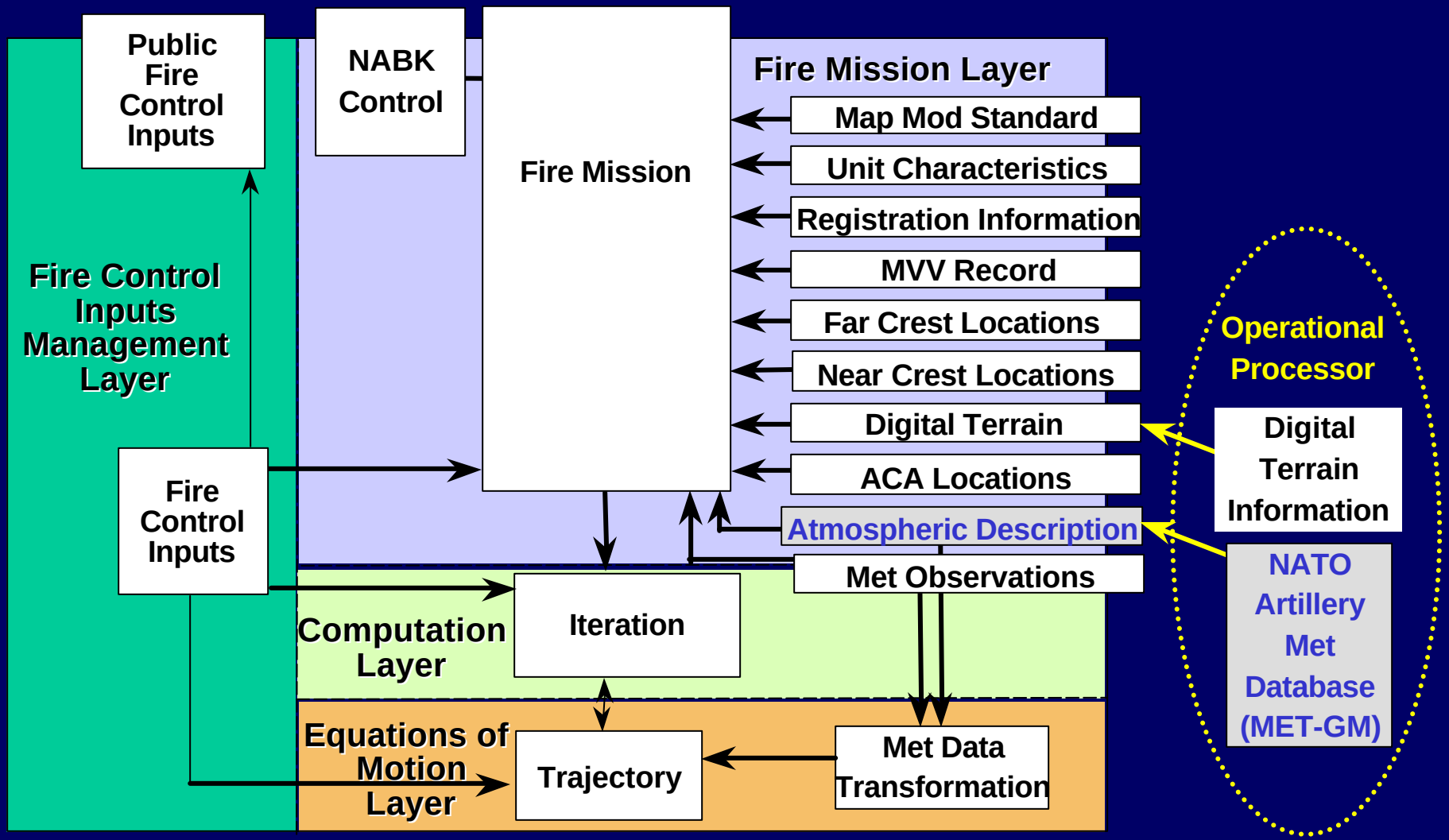
What does the NABK do?

- Anything that requires knowledge of trajectories or is related to ballistics
- Trajectory simulation
- Computes gun orders
- Charge selection
- Muzzle velocity management
- Calculates and selects registration corrections
- Includes fire support coordination measures that require trajectory information (e.g. near crest, far crest, and ACA locations)

What does the NABK NOT do?

- Ammunition selection
- Effectiveness calculations
- Fire support coordination measures that do not require trajectory data (e.g. no fire areas)
- Does not know target details just aim points
- Does not know about locations of forward observers
- Does not have its own interfaces to digital communication equipment (info is passed by OPr)

NABK Software Architecture



Developers

- **International development effort under the auspices of the NATO Army Armaments Group AC/225 Land Group 4, Sub-Group 2 on Ballistics**

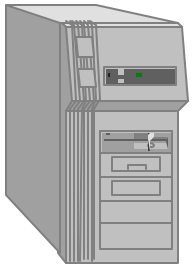
- **Current countries involved**
  - ❖ Belgium, Canada, Denmark, France, Germany, Italy, Netherlands, Norway, Poland, Turkey, United Kingdom, United States

- **Procedures being proposed to include participation by Partners for Peace through NATO member country sponsorship**

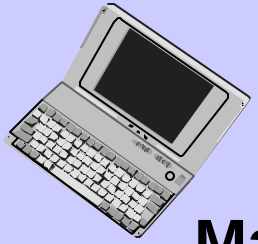
Sharable Fire Control Software Kernels

Communications

Fire Control System

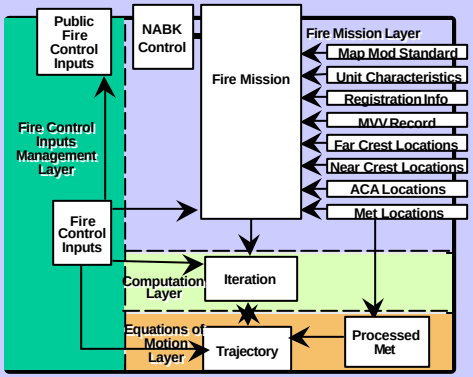


Appreciation Kernel (Targeting)

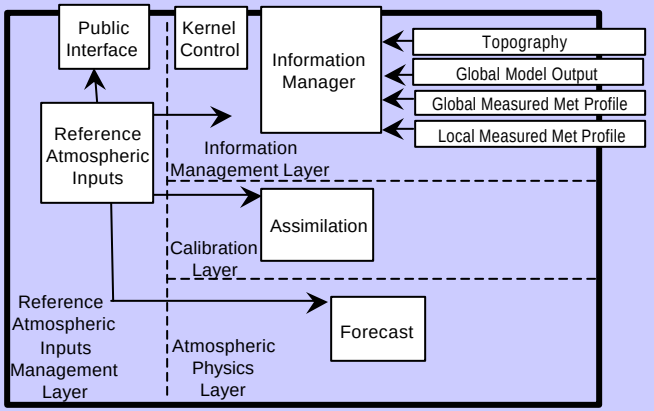


Man-Machine Interface

NATO Armaments Ballistic Kernel



Met Kernel



Rationale for Program

- To significantly reduce or eliminate duplication of effort by standardizing the implementation of NATO ballistic technology
- To avoid significant expenditure of time and money in future development and updates of ballistic fire control software
- To ensure accuracy and reliability
- To establish a common method to facilitate the use of NATO ammunition interchangeability
- To develop a single software package that is reusable across multiple weapon systems

Development Process

- **Program guidance (STANAG 4537) established**
- **Software development plan established and maintained**
- **Key areas managed:**
  - ❖ Requirements, Technology, Database Development, Software Development, Configuration Management, Quality Assurance, Policy
  - ❖ Peer review integral to each area
- **Program documentation (AOP-37 and source documents) established and maintained**
- **Overall program review initially held every 4 months, now every 6 months; appropriate persons in each key area communicate and meet as required**

Key Design Goals

- Plan, design and engineer the code for safety and reuse
- Develop the software in the Ada95 programming language
- Allow Fire Control Inputs data to be updated without modifying source code
- Accommodate each country's Fire Control Inputs and the implementation of AOP-29
- Make the software configurable without modifying source code
- Check all input for correctness; verify the integrity of the Fire Control Inputs

Current Status

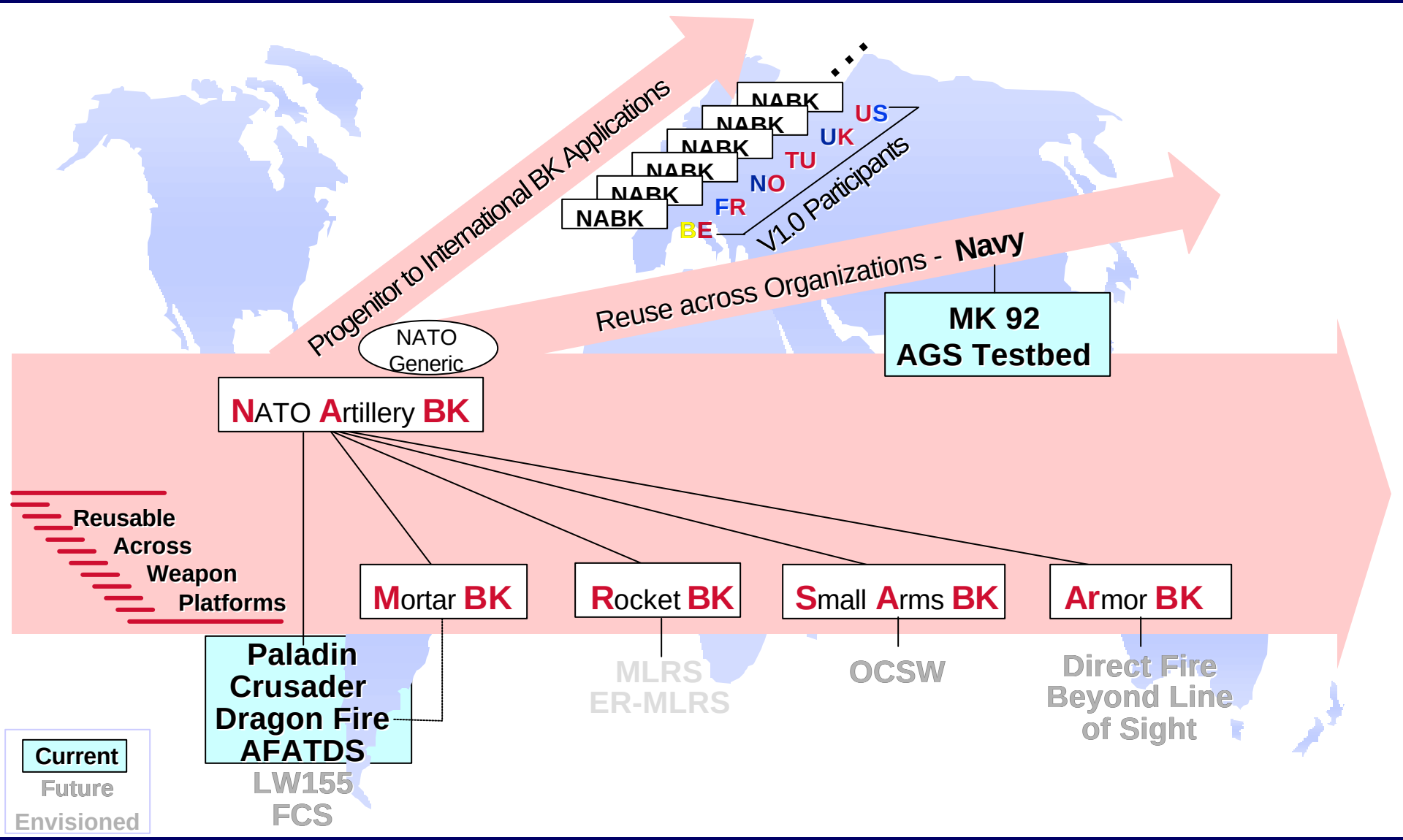
- **Software releases:**

Version	Release Date	Meets U.S. Rqmts for:
1.0	Sep 98	Dragon Fire Demo
1.0+	Dec 98	Paladin V11
1.1	Feb 99	
1.5	Jul 99	Crusader, MK 92
1.6	Sep 99	
1.63	Apr 00	AFATDS-99
2.0	Sep 00	
3.0 Beta	Jul 01	
3.02	Dec 01	AFATDS-99+/V7, Paladin V7
4.0 Beta	Release scheduled for Jul 02	
5.0	Release scheduled for Feb 03	

National Implementations

- 12 countries currently participating in the continued development and maintenance effort
- 19 current implementations in 8 countries
- 32 future implementations being worked in 12 countries
- 3 different compilers being used: Aonix, GNAT, Rational

U.S. Applications of NABK Software



Controls on Information

- Program guided by STANAG 4537 and documented in the associated AOP-37 and source documents
- All NATO member nations can implement the NABK into their national weapon systems
- Appropriate contractors must formally agree and adhere to non-disclosure and non-use criteria
- Only participating NATO member nations can sell a product containing the NABK (executable code)
- Procedures are being proposed to include participation by Partners for Peace through NATO member country sponsorship

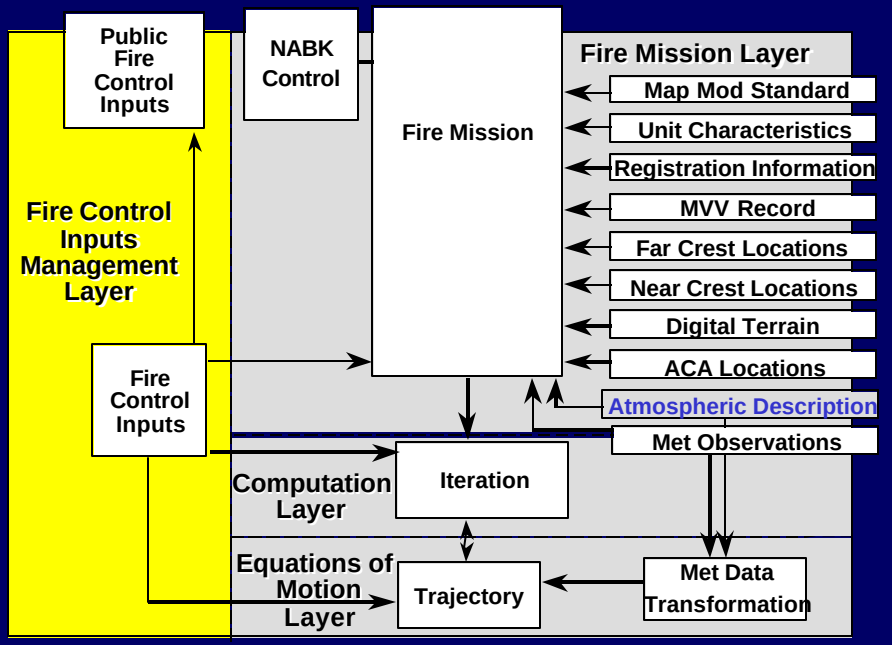
Summary

- The NABK standardizes the implementation of NATO ballistic fire control technology in a reusable and sharable product
- Reliability is ensured through extensive code and safety criticality review, testing, and product use
- The NABK provides for horizontal integration across weapon systems
- The NABK contains the necessary physics and algorithms to “shoot” mortar and small arms ammo; development of FCI databases and test tools required
- Life cycle maintainability and cost avoidance are being realized

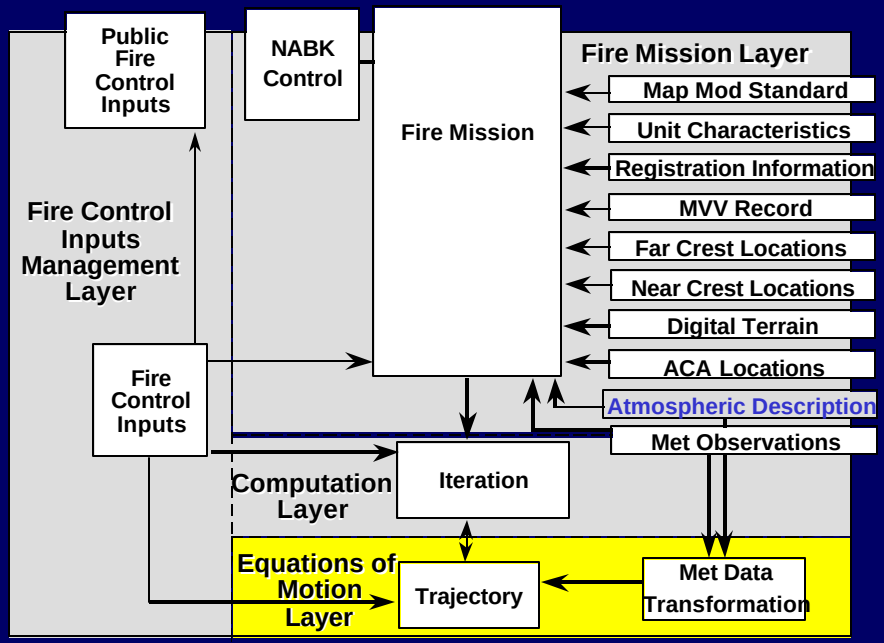
Fire Control Inputs Database Layer

- Contains pertinent projectile and weapon data
  - aerodynamic coefficients
  - physical characteristics (caliber, weight, moments of inertia, etc.)
  - probable error data
  - propulsion characteristics
  - payload characteristics
  - fuze data
  - interchangeability data
- ASCII file or embedded Ada code
- Accessed by all layers

- Portion accessible to other fire control system configuration items which require data such as
  - legal wpn/proj combinations
  - maximum and minimum range data
  - probable error data

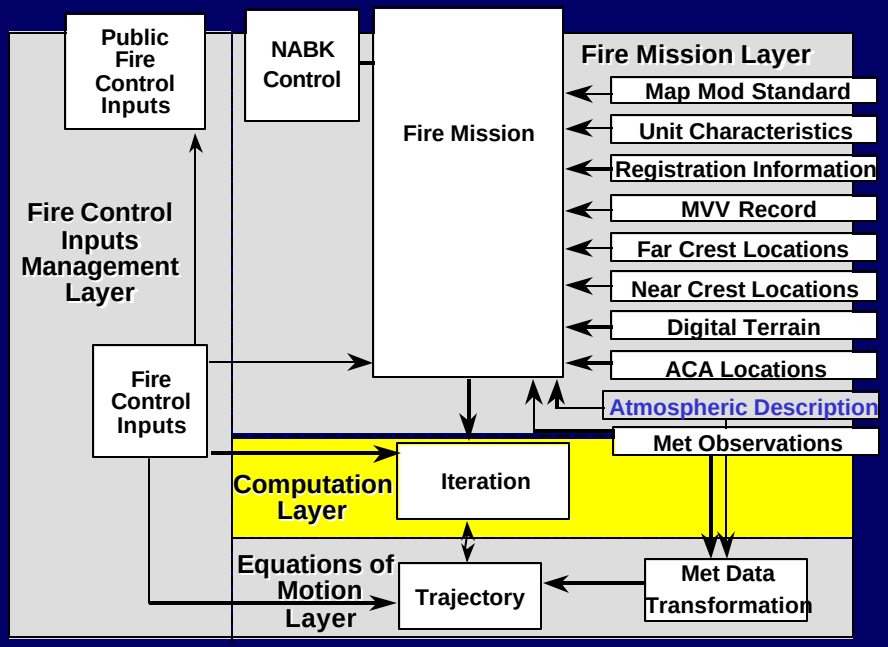


Equations of Motion Layer



- Single trajectory simulation
- Input:
  - Azimuth
  - Elevation
  - Muzzle Velocity
  - Gun position
  - Meteorological conditions
- Output:
  - Impact or fuze function point
  - Time of flight
  - Trajectory flight path

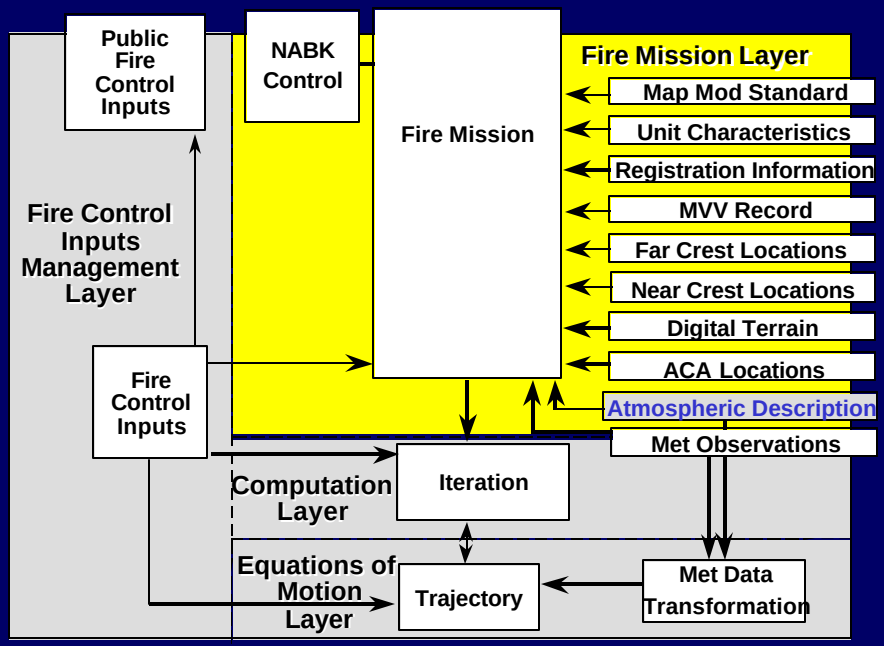
Computation Layer



- Communicates with equations of motion layer
- Iterates on azimuth and elevation to converge on a trajectory solution to hit desired target(s)
- Solutions generated for low angle or high angle fire

Fire Mission Layer

- Bridge between technical ballistics and operational procedures
- Interface to operational processor



- Access to all databases
- Input is a set of aimpoints
- Charge selection
  - Made by input from operational processor or
  - Selected using predefined criteria
- Accounts for MVV and registration correction data and performs checks for air corridor and crest violations
- Governs computational processing of each fire mission
- Can handle a number of fire missions concurrently