

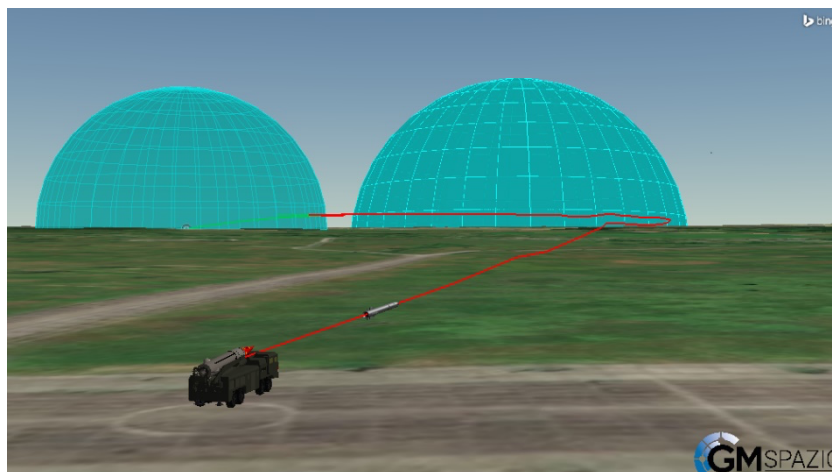
## SHIELD MASTER – GM SPAZIO Missile Defence Tool-Kit Tested and Approved at CWIX 2023

**Shield Master** is a powerful yet straightforward software environment to evaluate the performance of the Missile Defence System (see *MDS note at the end of this brochure*). **Shield Master** works side by side with STK (Systems Tool-Kit) to quantify the essential metrics characterizing the performance of such kinds of systems against any incoming missile threat.

Shield Master modular architecture, according to the literature, includes:

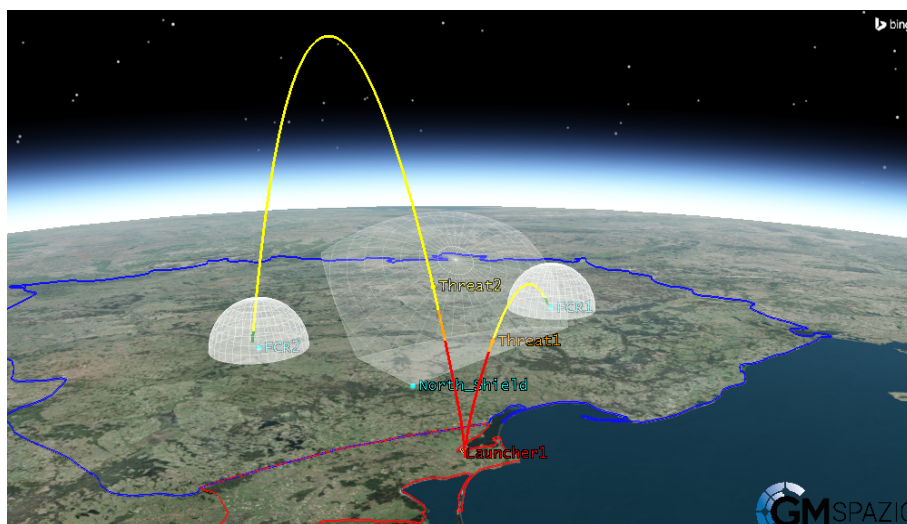
- The **Missile Designer Module (MDM)** allows the definition and storage of enemy missile characteristics for performance calculation and display.
- The **Missile Propagation Module (MPM)** propagates (if applicable) missiles from the launch site to the target and interceptors from the defence battery to the threat.
- The **Defence Network Module (DNM)** evaluates the performance of the defence system (sensor network + interceptor) and defines system metrics.

Using Missile Designer Module (**MDM**), the user can define his database of missiles (both threats and interceptors), defining notional characteristics like: Structural and Propellant Mass, Thrust, etc.; the second step of this phase is the definition of operations' scenario to include the physical environment in terms of launch sites, target's location, defence sensors network (Early Warning Radars and Fire Control Radars) and interceptor launch sites.



The Missile Propagation Module (**MPM**) assists end-users during the simulation of the created scenario to assess several metrics like travel times, detection and reaction delays, and interceptor fire times windows. The user will then perform end-to-end analysis over a complete set of scenarios involving short, medium, and long-range ballistic, guided missiles, and interceptors.

Finally, the Defence Network Module (**DNM**) evaluates and assesses the most critical metrics useful to evaluate MDS reaction performance to any given threat, integrating all the involved assets (threats, interceptors, and sensors network), discriminating access times across different sensors typologies to evaluate the effectiveness of defence systems.



The features available in the current version of **Shield Master** are listed hereafter:

### Missile Designer Module

#### Missile Catalogue

- SQL based
- Define and store guided ballistic threats and interceptors

#### Flight Performances Display

- Display flight envelope and critical parameters at burnout
- Display flight profile at any given flight path angle
- Display thrust, mass & acceleration over time

#### Threats Analysis

- Define launch site, target location, and time of launch
- Discriminate between high and low trajectories
- Display boost/mid-course/terminal phase

### Missile Propagation Module

- Ballistic Threats Propagator
- Guided Missiles Propagator
- Proportional Navigation Interceptors Propagator
- Runge-Kutta 4<sup>th</sup> order integrator
- WGS84 Rotating Earth with inertial corrections
- US Standard Atmosphere 1976 for drag model
- Programmable or gravity turn pitch profile

### Defence Network Module

#### Interceptor Database

- Define speed profile and burning time
- Define operational parameters such as Commit Time and Keep-out Radius
- Display Mach profile and intercept volume

#### Defence Network Analysis

- Calculate detection Times
- Implement interceptor battery
- Discriminate between Early Warning Radar and Fire Control Radar systems
- Calculate intercept launch windows, Commit windows, and interceptor flyout times
- Define operational timelines

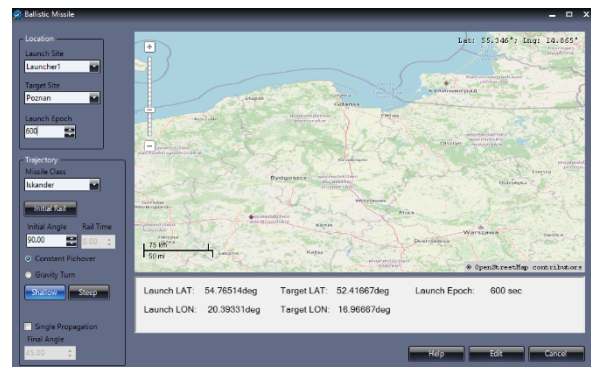
### Tactical Protocol Module

#### Tactical Data Link

- Real-time communication
- Link 16 and JREAP standards
- Record exchanged messages for post-mission analysis

#### Distributed Interactive Simulation

- Operational PDUs (Entity state, Fire, Detonation)
- Automatic data encoding/decoding
- Broadcast/Unicast/Multicast network mode



Shield Master is a framework supporting the evaluation and analysis of attacking and interceptor missiles' performance based on the specifications stored in the databases. The accuracy of the results mainly depends on the input values, considering that several assumptions have been made to simplify the (very complex) task of integrating 6-DOF equations of motion over time.

*"MDS (Missile Defence Systems) are used in attacking missiles' detection, tracking, interception, and destruction. Originally conceived as a defense against nuclear-armed intercontinental ballistic missiles (ICBMs), its application has broadened to include shorter-range non-nuclear tactical and theatre missiles. Since ballistic missiles have different ranges, speeds, sizes, and performance characteristics, the MDS is an integrated, "layered" architecture that provides multiple opportunities to destroy missiles and their warheads before they can reach their targets."*