Missile guidance systems

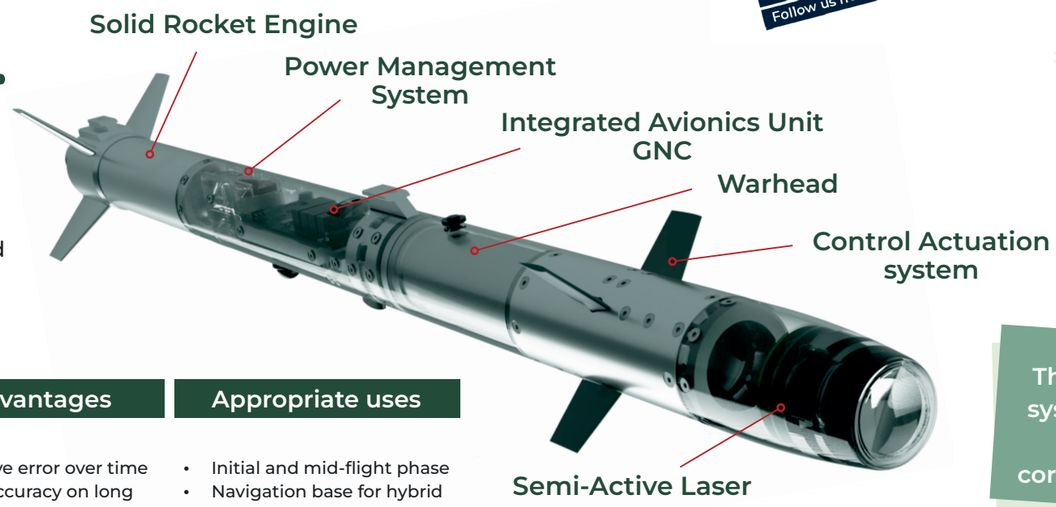
Principles of navigation, sensors and terminal guidance in precision munitions

See what's next. Follow us now!

AERTEC

Missile guidance is the set of methods and systems that enable the determination of a missile's position, speed and trajectory, and the correction of the latter to reach a specific target.

Sensors (inertial, radar, infrared, etc.) are used to adjust the missile's trajectory by means of aerodynamic surfaces or thrust vectoring during the boost, mid-course and terminal phases.

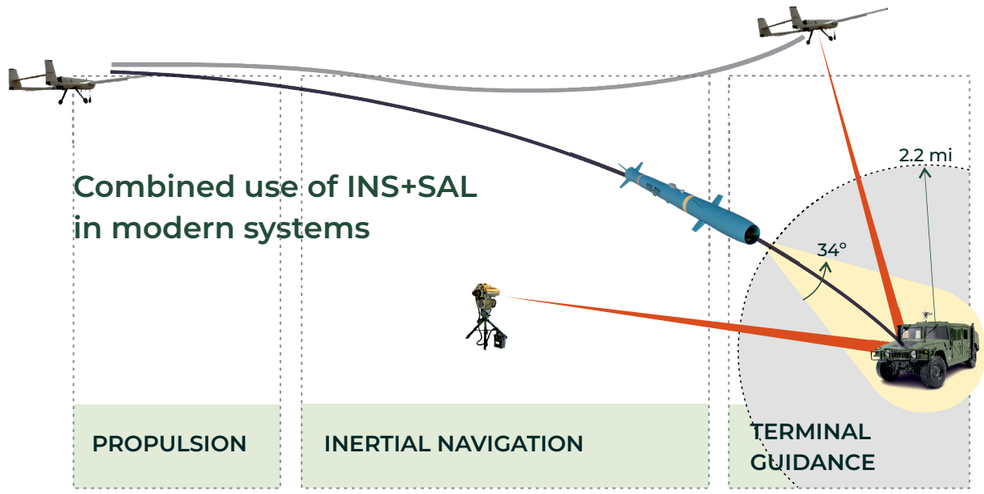


The first missiles (Germany, 1944) used a gyroscope guidance system.

The effectiveness of a guidance system is based on the coherent integration of navigation, correction and terminal guidance.

Systems	Key points	Advantages	Disadvantages	Appropriate uses
Navigation **Inertial (INS)**	**Autonomous navigation based on accelerometers and gyroscopes. Calculation of position and attitude without external references.**	• Total autonomy • Immune to interference and electronic countermeasures • Operates in any environment and weather conditions	• Cumulative error over time • Limited accuracy on long trajectories if not corrected	• Initial and mid-flight phase • Navigation base for hybrid systems • Environments with high electronic threat
Navigation **Satellite (GNSS)**	**Correction of inertial navigation using global positioning signals.**	• High navigation accuracy • Significantly reduces INS drift • Global coverage	• Dependence on external signal • Vulnerable to interference, signal degradation or denial	• Mid-flight phase • Attack on stationary targets • Long-range missions
Guidance **Semi-active laser (SAL)**	**The missile detects the laser energy reflected by an externally illuminated target.**	• Very high terminal accuracy • Capacity against moving targets • Reduced collateral damage	• Requires direct line of sight • Dependence on an external designator • Sensitive to weather, smoke, and dust	• High-precision terminal phase • Precision strike on visible targets • Environments with battle space control
Guidance **Radar**	**Use of radio waves reflected or emitted by the target. It can be active, semi-active or passive.**	• All-time capability • Long range • Less dependence on visibility	• Greater technical complexity • Vulnerable to electronic countermeasures • Detectable electromagnetic signature	• Air-to-air missiles • Anti-ship missiles • Maritime and low-visibility environments
Guidance **Electro-optical / infrared (EO/IR)**	**Identification and tracking of the target using visual or thermal sensors.**	• High terminal accuracy • Missile autonomy in final phase • Target discrimination capability	• Dependence on visual or thermal contrast • Affected by environmental conditions • Greater processing complexity	• Precision terminal phase • Complex or urban environments • Selective attack on specific targets

Modern missiles **integrate several guidance systems** to take advantage of each one's strengths and reduce their limitations. The combination of autonomous navigation and precision terminal guidance defines the current standard. The systems do not compete, but rather complement each other. This hybrid architecture improves **robustness, operational flexibility, and probability of impact**:



The missile accelerates to reach the speed required for the rest of the flight.

Inertial navigation eliminates disturbances and adjusts the attitude to optimise laser reflection acquisition.

In the terminal guidance phase, accuracy is maximised by relying on the laser designator.

Guidance laws

These are **mathematical algorithms** that transform the information provided by the tracking system into manoeuvre commands (accelerations or control deflections) to intercept the target.

Tracking methods (self-guidance)

Pasive	The missile does not emit its own signal, but detects natural or functional emissions from the target.
Semiactive	The missile does not emit any energy, but the target is illuminated by an external source and the missile seeks out the reflection of that energy.
Active	The missile incorporates its own transmitter-receiver sensor (usually active radar) that allows it to illuminate and track the target autonomously.

Source: © AERTEC Solutions S.L.
The contents of this document are intellectual property of AERTEC Solutions S.L.
Any copy or diffusion is allowed as long as the entire document is used, with the AERTEC Solutions S.L. logo being included at all times.

aertecsolutions.com