# AE673A: Rocket and Missile Structures (2020-21)

Group: **IMOA** | Assignment 2


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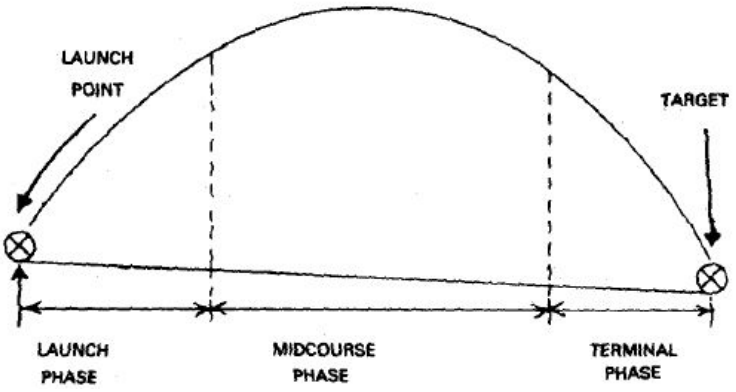
Agni-5 (Intercontinental Ballistic Missile) | *src: google images*

# CH3: MISSILE GUIDANCE & CONTROL

## MISSILE GUIDANCE

In order to ensure that a launched missile hits the target, a guidance system is essential.
Based on the mission profile, various types of guidance systems are used.

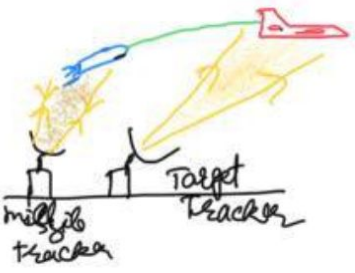



Stages of typical missile mission | *src: DRDO guided missiles*

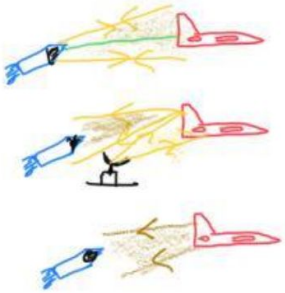
The following are the types of guidance systems used in general:

- Command Guidance
  The guidance signal to stay on the trajectory(aka LOS) is computed and transmitted from the launch site to the missile. And thus the missile after receiving the signal actuates via its control systems. Communication links:
  - Wired link (up to 4km range and v<1Mach)
  - Fibre-optic wire link (beyond line of sight and v<1Mach)
  - Wireless radio link

  Pros: Little guidance equipment onboard
  Cons: cannot be used for multiple targets



- Homing Guidance
  The missile receives signals reflected/emanated from the target and corrects itself thus aka “fire & forget”. Instruments: homing head and seeker head. Types:



  - Active: Missile illuminates the target and receives its location. Range<4km. Accuracy>>command guidance
  - Semi-Active: Base station illuminates the target which is reflected towards the missile. Range~50/60km
  - Passive: No illumination, just receiving the EM/infrared signals from the target. Aka “Heatseeker”. Range~7/8km

- Beam Rider Guidance
  The missile is fired into a cone of radiation formed by base station radar pointing towards the target. The sensitivity decreases at the start and end of flight. Missile equipment tracks the center axis of the radar beam. Missile needs to be launched nearly parallel to the beam axis.


  Pros: Simple, low cost, high reliability
  Cons: Not at operating speed thus less efficient controls and high lateral acceleration in the terminal phase.

- Inertial Navigation System
  Accelerometers are used to measure translation acceleration, velocity and distance traveled. Systems can have accelerometers kept on a reference axis (using gyroscope) or fixed with body axes.
  Pros: It does not rely on external reference and guidance, and therefore cannot be easily detected.
  Cons: It demands high accuracy from individual components. Small errors can combine to produce substantial errors. Therefore, this system is used for a large and fixed target like a city.
- Stellar Guidance
  Uses star constellations as a reference point for guidance.

## MISSILE CONTROL

The Control system actuates the control surfaces and thrust vector surfaces to maintain zero deviations from the critical path. Various turn generation methods are used such as,

- Aerodynamic Control generates a differential force. It results in the rotation about a particular axis by computing the turning moment as a function of control force, altitude, velocity, location of NP, CG, and CP during a mission.
- Thrust Vector Control generates force and moment by deflecting thrust force. Either by gimballing the engine, rotation of nozzle, or by vane/blade insertion at the jet's exit.
- Reaction Control System governs on the propulsion. Extra small thrusters provide controls along with the various axes.

Major control system elements, Autopilot, and Actuation systems use feedback from the inertial sensors & aerodynamic deflection respectively, throughout the mission to develop counter moments that keep the missile on its desired path.