

# **A Missile Intercept Problem**

**Gim Der  
(DerAstrodynamics)**

**September 11, 2009**

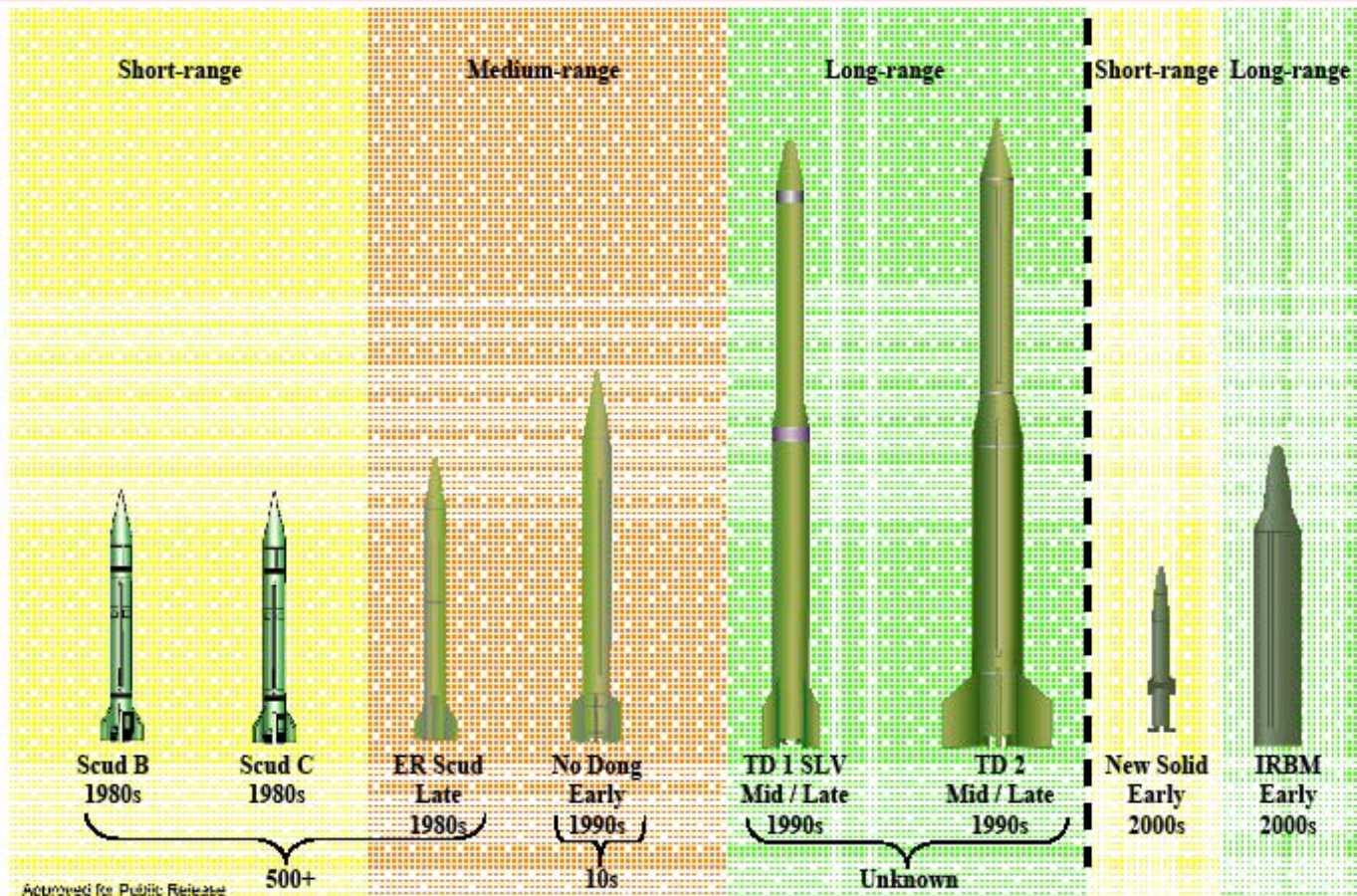
# Purpose of this Briefing

## Suggest Answers to:

1. In 2009, can we shoot down a ballistic missile?
2. Enemy Missiles = Flight Test Targets ?
3. How to use Astrodynamics?



# North Korean Ballistic Missiles



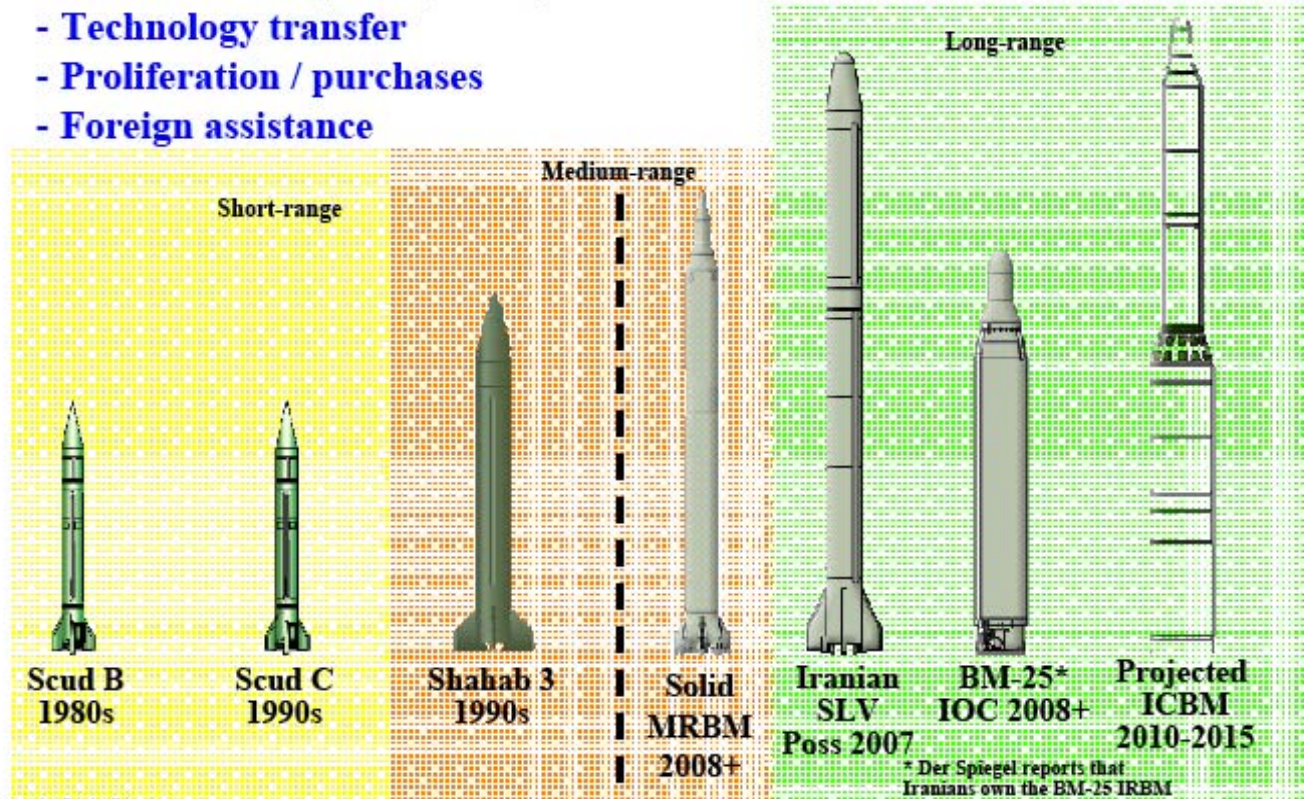
Approved for Public Release  
07-MDA-3000 (20 NOV 07)

ms-110150 / 112607

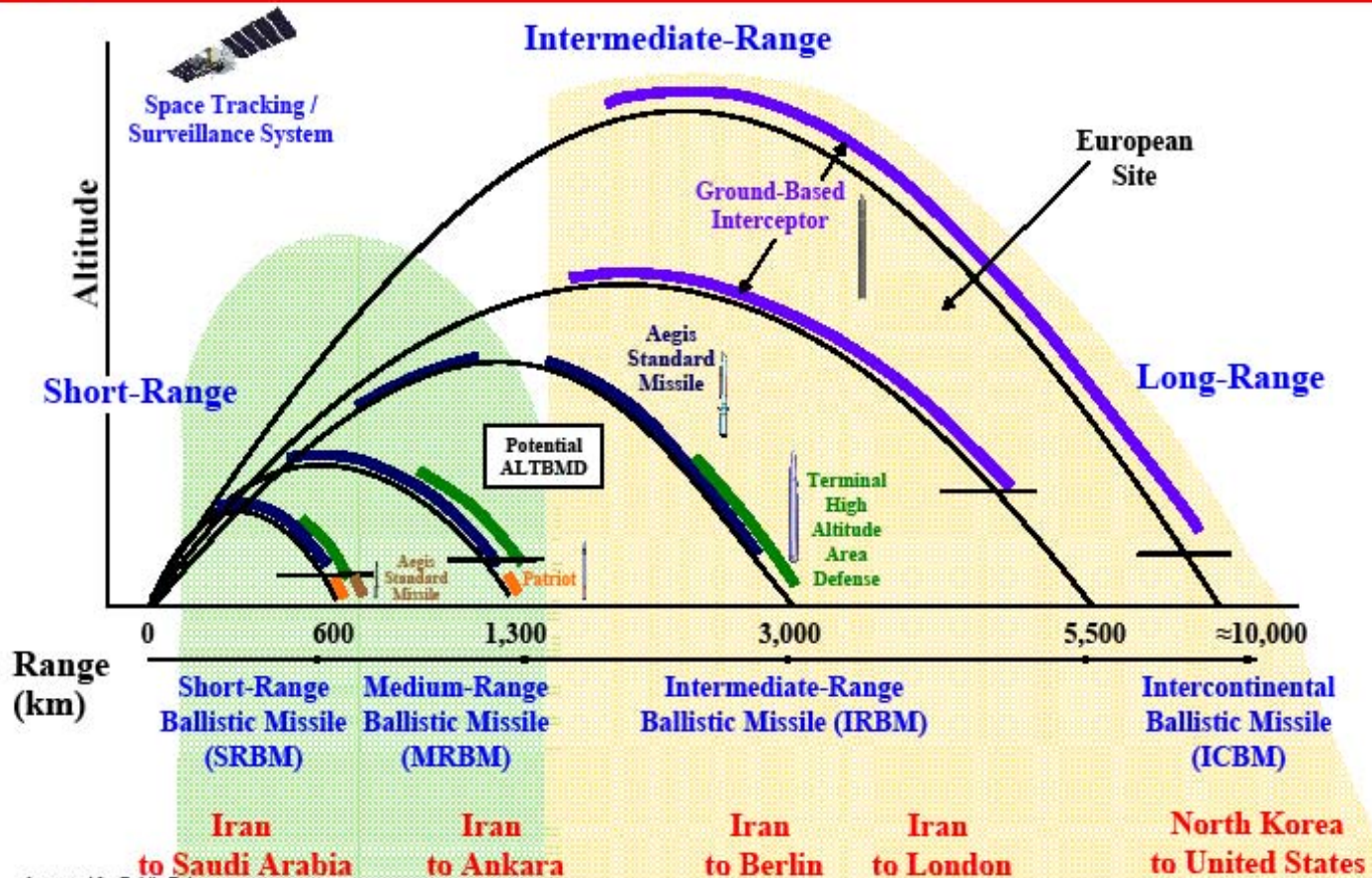
# Iranian Ballistic Missiles

• Iranian missile capability likely to accelerate due to

- Technology transfer
- Proliferation / purchases
- Foreign assistance



# Layered BMD



# Flight Tests of Cooperative Targets

**33 Of 41 Terminal And Midcourse Hit-To-Kill Intercepts In The Atmosphere And Space Since 2001**

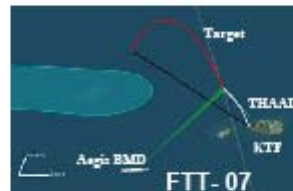
**MDA Achieved 25 Test Successes In Last 26 Flight Tests Since September 2005**

**Hit-To-Kill Since 2001**

**Since January 2007**

**Note: Patriot PAC-3  
(12 of 15)**

**Terminal High Altitude Area Defense  
(4 of 4)**



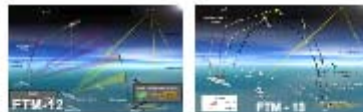
**January 26, 2007**

**April 5, 2007**

**October 27, 2007**

VM313

**Aegis Ballistic Missile Defense  
(11 of 13)**



**April 26, 2007**

**June 22, 2007**

**August 31, 2007**

**November 6, 2007**

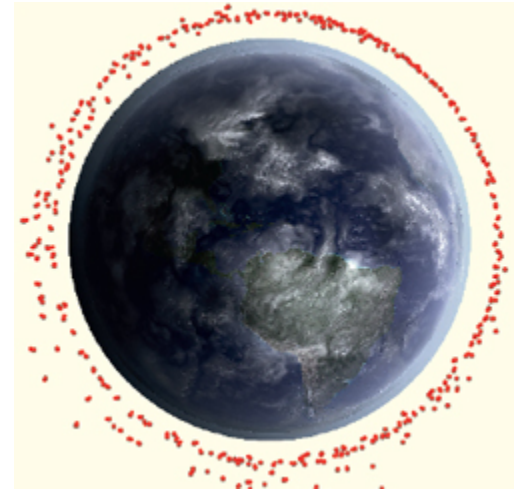
VM339C

VM355

# Chinese ASAT (Jan 11, 2007)

Popular Mechanics

July 2007



**IMPACT + ONE DAY** It takes only 24 hours for debris to spread along ..... but most of the wreckage remains at the satellite's original altitude of about 860 km.

Ask China how long it took to plan and shoot down its own satellite, which is a **COOPERATIVE** Target

# Debris Generated by

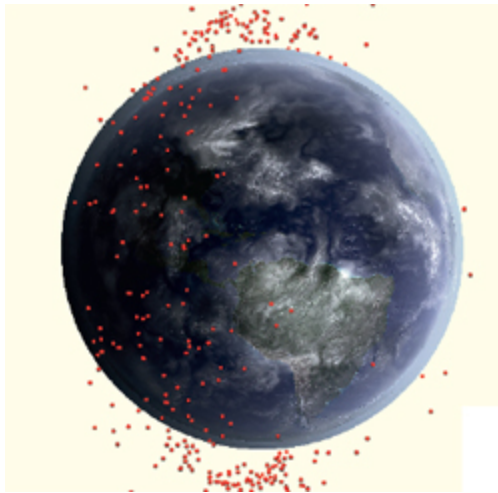
Chinese ASAT

Low Ball Estimate: 5000+

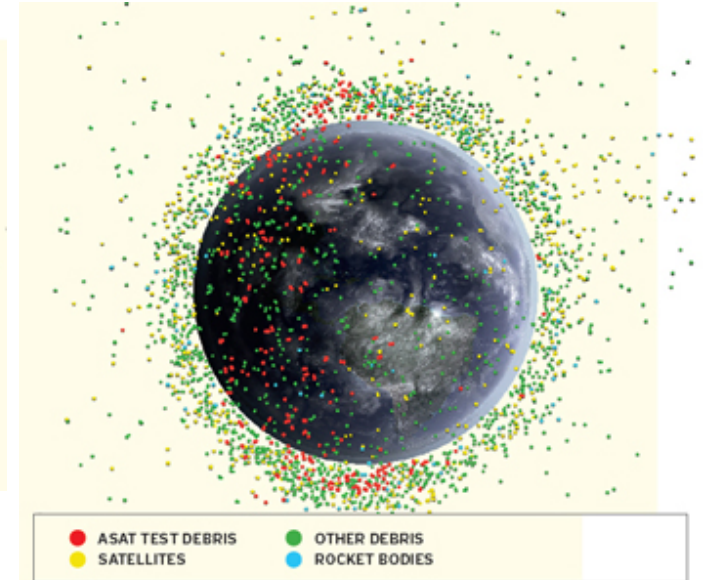
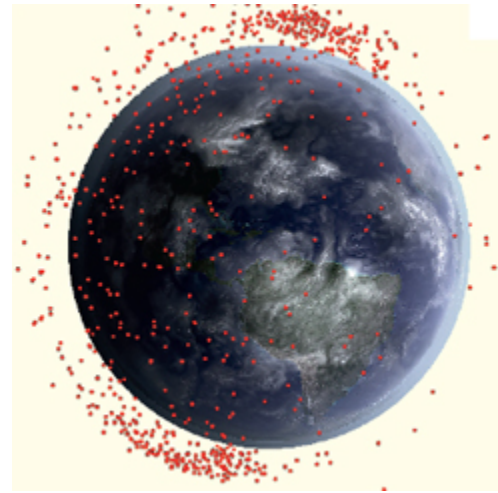
And Others

30,000+

Popular Mechanics



July 2007



**JULY 2007** The debris ring broadens ..... extends to an altitude of about 1240 miles or 2000 km.

**JANUARY 2008** A year after the test, the debris field continues to spread, joining the cloud of general space junk.

“We **can't track** the smaller pieces, much more out there ..... junk in orbit up to an altitude of 22,000 miles 36,000 km and **looming collisions**. . .”

# Debris Generated by

US Iridium Comm Sat & Russian Defunct Sat (Feb 2009)

**Low Ball Estimate: 17,000+**  
( > 10 cm)

**200,000+**  
(1 to 10 cm)

Google/The Christian Science Monitor  
Feb 11, 2009



NASA's Orbital Debris Program Office has counted about 17,000 objects larger than 10 centimeters, and it estimates that there are more than 200,000 particles between one and 10 centimeters. ... The objects are shown at an exaggerated size to make them visible at the scale shown.

*(European Space Agency)*

# Current Total numbers of Debris (2009)

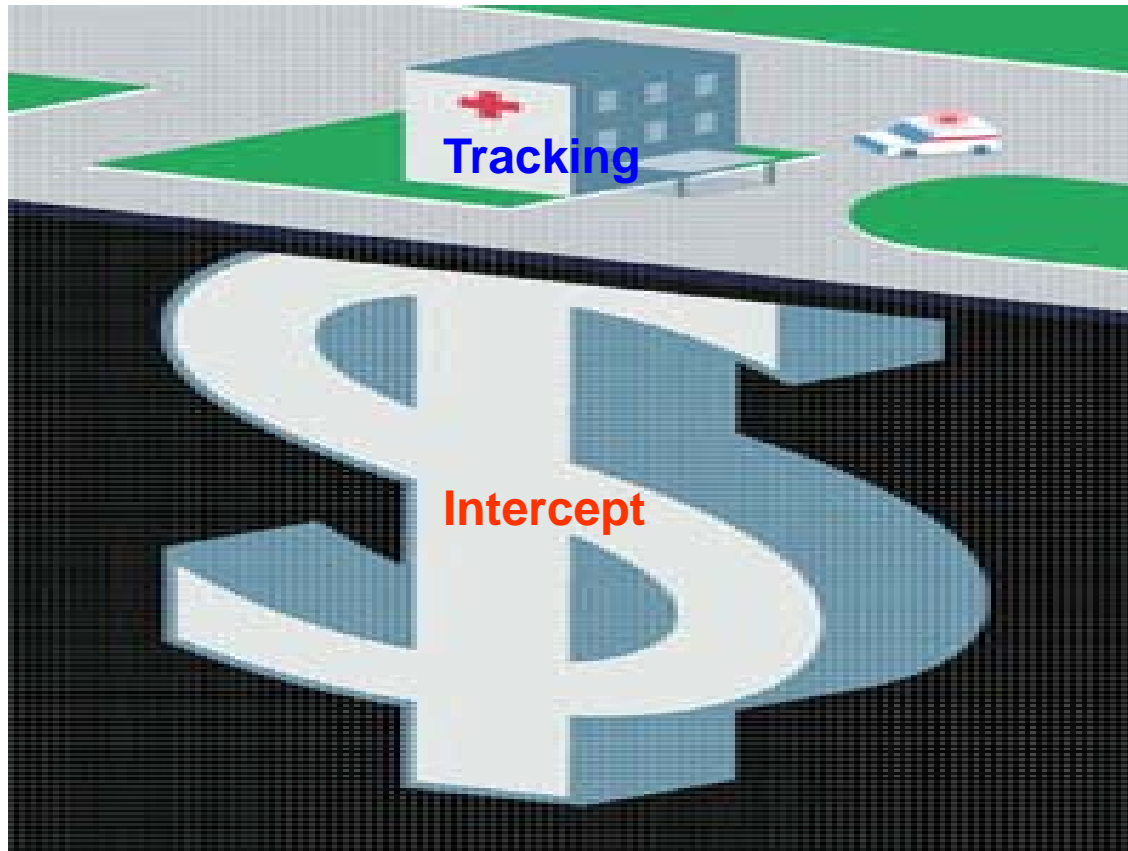
**Low Ball Estimate: 35,000+**  
**(tracked: greater than 10 cm)**

**400,000+**  
**(not tracked: less than 10 cm)**



**Fear what you can't see, not what you can.**

# Seeing Tracking \$, not Missile Intercept \$



**Missile Tracking** is not the Same As  
**Missile Intercepts**

# Missile Intercepts

## Cooperative and Uncooperative

### Can We Really Intercept an Enemy's Missile?

1. Astrodynamics Indicates **No UNCOOPERATIVE Target Intercept**  
(unless using fast and accurate  
Analytic Trajectory Algorithm for Targeting)
2. Flight Test and History Indicate (assuming no animation)  
**Cooperative? Maybe. Uncooperative? No.**

# Question: Can We Intercept an Enemy's Missile?

## In Addition to Tracking: Other questions

- Did we ever shoot down an **UNCOOPERATIVE** missile?
- Will an enemy announce their missile **Launch Timing**,  
and **Launch and Impact Points**?
- Will an enemy not use the **Blind Spots** of our radar systems?
- Will an enemy make **Detection, Discrimination and Intercept**  
difficult for our radar and intercept systems?
- Did we apply the proper **Missile Guidance and Targeting Algorithms**?

**Battle Management & Intercept Problems Indicate **No Intercept****

## Astrodynamics:

- Too much Radar Tracking and Homing Sensors
- No Efficient Computation of **UNCOOPERATIVE** missile Trajectories  
(All Radar system numerically integrate missile trajectories,  
showing NO interest in CPU timing and intercept!,  
why not using the Vinti analytic algorithm?)

**Astrodynamics Indicates **No UNCOOPERATIVE Target Intercept****

# Question: Can We Intercept an Enemy's Missile?

## Answer from Requirements and History

1. Technical Obstacles of **Uncooperative** Missiles Intercept:
  - Efficient Trajectories Algorithms
  - Correct Intercept Guidance and Targeting Algorithms
  - Proper Homing Sensors
2. Successful Intercept of **Cooperative** Missiles:
  - Chinese ASAT (Jan 2007) **Cooperative**
  - USA 193 (Feb 2008) **Cooperative**
  - MDA 25 out of 26 (since 2005) **Cooperative**
3. Unsuccessful Collision/Intercept of **Uncooperative** Missile:
  - US/Russian Satellites (Feb 2009) **Uncooperative**
  - Japanese Aegis/SM3 (Nov 2008) **Uncooperative**

Can We Really Intercept an Enemy's Missile in 2009?  
**Cooperative? Maybe. Uncooperative? No.**

# US tests missile defence system

11:13 GMT, Saturday, 1 August 2009 12:13 UK

<http://news.bbc.co.uk/2/hi/americas/8179663.stm>

The latest US missile defence test was deemed a 'success' by the Pentagon as tensions continue with North Korea over their country's missile programme.

A short-range ballistic missile was fired from the Pacific Missile Range Facility on the island of Kauai and was shot down by a three-stage interceptor missile from a destroyer, the USS Hopper.

*This video was distributed to the APTN news agency by the Pentagon and has not been independently verified*

**A Staged Intercept on  
a **Cooperative** Target with Animation Help?**

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## Feel for Speed

Cruising Speed of a Jumbo Jet  
= Mach 0.85 = **567 mph** or 913 km/h  
 $\cong$  **0.25 km/s** approx.



Speed of a NK Ballistic Missile =  
**3 to 6 km/s** (Short to Long Range)  
approx. **12X** to **24X** that of a Jumbo jet

Speed of an Interceptor (SM-3)  $\cong$  **3 km/s**

**Intercepting a NK Target from the Side at these Speeds requires a lot more than Astrodynamics**

Speed of a NK Ballistic Missile between **100X** and **250X** of **55 mph**

# The Common Sense Answers

1. In 2009, can we shoot down a ballistic missile?

**No**

2. Enemy Missiles = Flight Test Targets ?

**No**

3. How to use Astrodynamics?

**Compute a Ballistic Missile Trajectory with  
Speed and Accuracy**

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**Use the analytic Vinti algorithm for  
real-time trajectory prediction and targeting**