The american missile shield: still Science Fiction or a reality?

With the growing balistic missile threats posed by rogue countries like Iran or North Korea, the old, cold-era, american « Star Wars » programm makes its come-back. But this time, we are talking about real and effective Anti-balistic missile systems (ABM) rather than exhausting the opponent economy in an arms race. Indeed, great improvments both in missile technology and directed-energy weapons like lasers during lastest years make possible to intercept and destroy in-flight ennemy tactical balistic missiles.

Part 1: analysing the threat.

But what are tactical balistic missiles?

Currently deployed by NK and Iran among others countries, tactical balistic missiles have usually a range somewhere between 200 km for the smallest ones and 2000 km for the largest. We call them « tactical missiles » because they are intended to be used as a support weapon during a war, to attack military objectives of the opponent. But it is no surprising that Teheran and Pyongyang use them as strategic balistic missiles in order to threaten their neighbourhood, or to deter the NATO to launch military operations in the vincinity. However from a strict weapon expert view, they are still tactical weapons, even if they are re-armed with Weapons of Mass Destruction (WMD)...
Classical strategic balistic missiles are rather Intercontinental Balisitic Missiles (ICBM) or Sea-Launched Balistic Missiles (SLBM) belonging to « the Club », like Russian Topol-M, American Trident D5 or French M45.

Most of the rogue state's balistic arsenal are derivatives of the well known, soviet designed Scud missile, as shown on this picture.

During the first Gulf War, modified Iraqi scud missiles with extra-range were fired at Israeli cities, but the Iraqi modification led to a unstable missile which often broke during its flight (because of a lack of structural strenght), causing its warhead to have erratic patterns, hence poor accuracy. Most of them were intercepted by American Patriot missiles, which were deployed as a theatre air defense system.

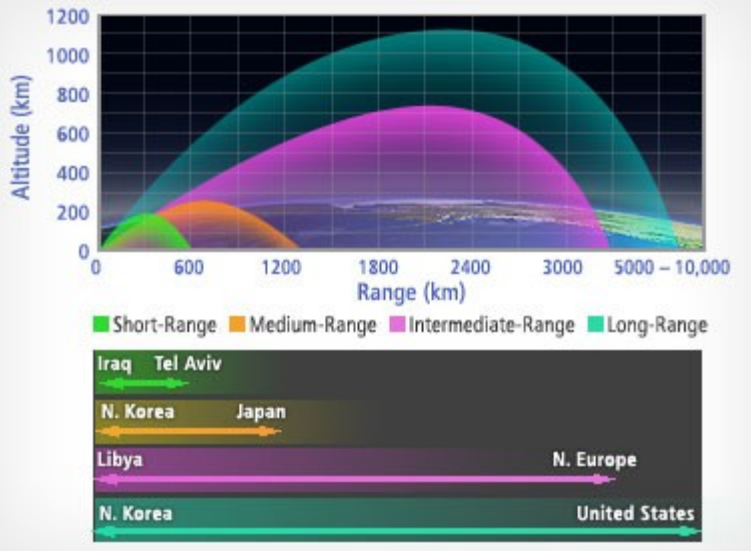
And why balistic missiles are so hard to counter?

Let see first how they operate.
As their name suggests it, balistic missiles use a quasi-balistic flight path like any object will follow during a free-fall, under the gravity force. Like a civilian rocket do it to place an orbital satellite, a balistic missile takes off and begins its ascencion toward the space, propulsed by a solid or liquid fuel rocket motor. This is the first phase of the flight, where the speed of the missile is relatively low, because it has to escape earth gravity. Thus this is the weaker phase of the missile, it has still its different stages (for a mutli-staged missile), making it a bigger target and remains full of fuel. However intercepting the missile is not easy, since there is only a very small countermeasure window after the launch detection, and the need of ABM systems with enough range to reach it.

The second phase is the separation phase. Since TBM are often single-staged missiles (or have at max two stages), this phase can be merged with the climbing phase. On the contrary, ICBM/SLBM have two to four propulsion stages, which are jettisonned sucessively while the missile reach its apogee in space. For TBMs, the apogee can be somewhere between 100km to 400km above earth surface, while strategic missiles usually have a high trajectory with an apogee of more than 800 km.

This phase, where the missile is in space and reach its apogee, is called mid-course or mid-flight. The main difficulty to intercept the TBM during its mid-flight is identiftying the warhead among the different elements of the missile now separated and decoys that might have been released with the warhead. It requires strong radar computing and discrimination power together with a specialy designed ABM to intercept the warhead in its mid-course in outer space. If countering TBM in mid-course is hard as we see, intercepting ICBM/SLBM could be impossible, since their trajectory is really high and they are often "MIRVed". MIRV is an acronym for "Multi Independant Reentry Vehicle", that means the missile deploys several independant warheads with their own reentry trajectory in space, together with decoys and more space debris from the missile's body. Therefore, our nuclear dissuasion is still credible.

To the right is a picture which illustrates the different types of balistic missiles and their associate ranges together with their apogee.



Once the warhead has been released, it's time for it to strike its target. Since most of TBMs used a inertial navigation system, the warhead itself is not guided and follow a pure balistic path during the reentry phase. Indeed, using inertial navigation, a TBM just knows its initial coordinates and the coordinates of the target, and by the mean of accelerometers and gyros, computes its position and corrects its trajectory during the boosting and mid-flight phase. Most of ABM systems are designed to intercept the warhead during the reentry phase, however there's only a few among them capable of countering TBMs with a range exceding 600 km, because the reentry speed of the warhead may be too high for the ABM to perform a successfull interception. For

example, the reentry speed of an SLBM warhead is around 8 km/s (Mach 25...). It requires the ABM system to have a fast target acquisition system and discrimination algorithms, furthermore when decoys are deployed together with the warhead, and the ABM a pinpoint terminal accuracy in order to hit directly the TBM's warhead (other methods than a kinetic hit, like nearby powerful explosion, could be employed, but scoring a direct hit is the only reliable way to completely destroy a WMD). To draw the parallel, it is like striking a handgun bullet with another bullet while you are drunk... *but you do have the calculation power of a computer!*

In a second part, we will see what are the technologies involved in the American Missile Shield.

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