Leveraging Small Modular/Molten Salt Reactors for

21st Century Energy Weapons

Economic & Military Applications

Industrial applications

- Dominant Global Energy Platform with Zero Greenhouse Gas Emissions
  - Liquid Fuels from Coal
  - Hydrogen Production
- Reformulation of the Global Steel Industry
- Reformulation of the Global Chemical Industry
  - **Fertilizer**
  - **Food**
- Medical Isotopes
- **Water Desalination**

Military Applications

- **Energy weapon systems**
  - Laser Based Ballistic Interceptors
  - Magnetically Impelled Kinetic Energy Weapons (e.g. Rail guns)
- Continuous Land, Naval & Air propulsion
  - **Mega-Drones**
  - **Continuous Duty Mega Bombers**
- Forward-Deployable Energy Systems
  - Liquid Fuels
  - Water Desalination
    - Reduction in Supply Chain Forces
      - (Typically ~ 70% of Deployed Force)
- End of Petroleum Dependence

- Defining Technology: Global Energy Hegemony / Reserve Currency

Partial List of Energy Based Weapon Systems That Could Utilize Thorium/Molten Salt Reactors

- **Continuous Duty Applications**
  - **Mega Drone Bombers**
  - **Naval Applications**

Existing Systems

- **Directed Energy Weapons/LASER**
  - YAL-1 Airborne Laser (ABL) /Advanced Tactical Laser (ATL)
  - Zeus-HLONS (HMMWV Laser Ordinance Neutralization System)
  - Mid-Infra-Red Advanced Chemical Laser (MIRACL)
  - Firestrike (JHPSSL – Joint High-Power Solid State Laser)
  - Tactical High-Energy Laser (THEL)
  - Laser Close-In Weapon System (CIWS)
  - High Energy Laser-Mobile Demonstrator (HEL-MD)
  - High Energy Liquid Laser Area Defense System (HELLADS)
  - Laser Avenger
  - Laser Air Craft Counter-Measures (ACCM)

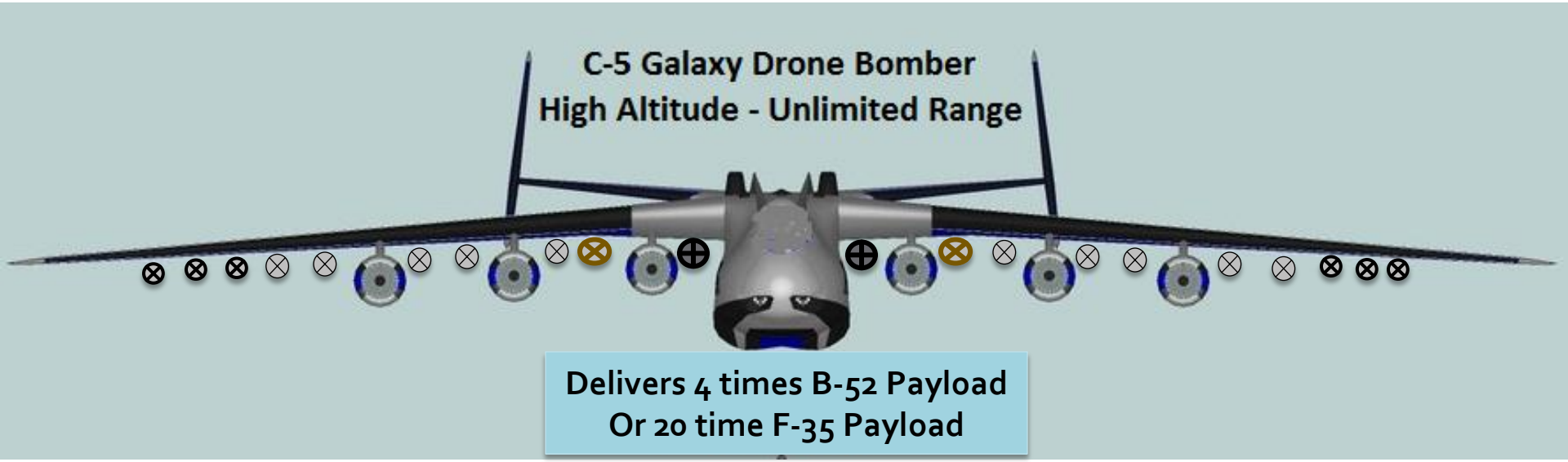
- **MASER/Electrolaser/Particle Beam Weapons**
  - Millimeter-Wave (Active-Denial System)
  - Vigilant Eagle
  - Bofors HPM Blackout
  - Stun-Strike (XADS)
  - Electrolaser [Applied Energetics/Ionatron]
  - Pulsed Energy Projectile (PEP)
  - Shiva Star

- **Kinetic Energy Weapons (aka Exo-Atmospheric Kill Vehicles)**
  - Blitzer System Rail Gun
  - SM3 Kill Vehicle (KV)
  - Kinetic Energy Interceptor (KEI)
  - Lightweight Exo-Atmospheric Projectile (LEAP) [Aegis BMDS]
  - THAAD

Systems Applications: Air Force Mega Drone Bombers

Mega Bombers could be inexpensively developed on existing and proven Air-frames

Th-MSR propulsion systems would allow for higher altitude, increased speed, unlimited range & duration



Th-MSR was originally developed for piloted aircraft. By eliminating crew and life support systems, thus increasing payload, a single mega-drone could deliver the full striking force of an aircraft carrier in a single sortie (equal to 20 f-35 sorties)

Large rotational fleets could remain airborne for weeks or months. Rotation patterns could be limited to international waters and the polar icecaps, using non-continental landing and maintenance platforms . Strike response time would be dramatically reduced.

System Applications: Navy Nearly All Naval Propulsion

- Low Cost Conversion for Most Naval Vessels
  - Elimination of Range Limitations
  - Enhanced Power to Drive
  - End of Diesel/JP Fuel Dependence
  - Reduced Operational Costs
  - Underway/J.I.T. Fuel Production for aircraft assets from salt water (existing Navy Pilot Program)
  - Underway/J.I.T. Water Desalination

System Applications: Navy Advanced Systems

- Zumwalt Class Destroyer

- The ***Zumwalt*-class** destroyers are a class of United States Navy guided missile destroyers designed as multi-mission stealth ships with a focus on land attack. The class emerged from the previous DD-21 vessel research program. The program was previously known as the "DD(X)". The class is multi-role and designed for surface warfare, anti-aircraft warfare, and naval gunfire support. They take the place of battleships in filling the former congressional mandate for naval fire support, though the requirement was reduced to allow them to fill this role. The vessels' appearance has been compared to that of the historic ironclad warship.

- The class has a low radar profile; an integrated power system, which can send electricity to the electric drive motors or weapons, which may someday include a rail gun or free-electron lasers; total ship computing environment infrastructure, serving as the ship's primary LAN and as the hardware-independent platform for all of the ship's software ensembles; automated fire-fighting systems and automated piping rupture isolation. The class is designed to require a smaller crew and be less expensive to operate than comparable warships. It has a wave-piercing tumblehome hull form whose sides slope inward above the waterline. This will reduce the radar cross-section, returning much less energy than a conventional flare hull form.

Directed-Energy Weapons (Laser)

- YAL-1 Airborne Laser (ABL)
  - Megawatt-class chemical oxygen iodine laser (COIL) mounted inside a modified Boeing 747-400F.
  - It is primarily designed as a missile defense system to destroy tactical ballistic missiles (TBMs), while in boost phase.
  - The high-energy laser was used to intercept a test target in January 2010,and the following month, successfully destroyed two test missiles.
  - Th-MSR would enable rapid power-up, higher total power, and greater discharge durations.

Directed-Energy Weapons (Laser)

- Advanced Tactical Laser (ATL)
  - US military program to mount a high energy laser weapon on an aircraft, initially the AC-130 gunship, for use against ground targets in urban or other areas where minimizing collateral damage is important.
  - The laser will be a 100 kilowatt-class chemical oxygen iodine laser (COIL).
  - It is expected to have a tactical range of approximately twenty kilometers and weigh about 5,000–7,000 kg.
  - This program is distinct from the Airborne Laser, which is a much larger system designed to destroy enemy missiles in the boost phase.

Directed-Energy Weapons (Laser)

- Zeus-HLONS (HMMWV Laser Ordinance Neutralization System)
  - solid-state laser weapon used by the U.S. military in order to neutralize surface land mines and unexploded ordnance.
  - The ZEUS-HLONS system was a co-operative effort between Sparta Inc and NAVEODTECHDIV (Naval Explosive Ordnance Disposal Technology Division) to demonstrate that a moderate-power commercial solid state laser (SSL) and beam control system could be integrated onto a Humvee (HMMWV) and used to clear surface mines, improvised explosive devices (IEDs), or unexploded ordnance from supply routes and minefields.

Directed-Energy Weapons (Laser)

- Mid-Infra-Red Advanced Chemical Laser (MIRACL)
  - a directed energy weapon developed by the US Navy.
  - It is a deuterium fluoride laser that first became operational in 1980.
  - It can produce over a megawatt of output for up to 70 seconds, making it the most powerful continuous wave (CW) laser in the US.
  - Its original goal was to be able to track and destroy anti-ship cruise missiles, but in later years it was used to test phenomenologies associated with national anti-ballistic and anti-satellite laser weapons.
  - Originally tested at a contractor facility in California, as of the later 1990s and early 2000s, it was located at WSMR, New Mexico
  - The beam size in the resonator is about 21 cm (8.3 in) high and 3 cm (1.2 in) wide. The beam is then reshaped to a 14 x 14 cm (5.5 in x 5.5 in) square.

Directed-Energy Weapons (Laser)

- Firestrike (also known as JHPSSL)
  - Laser introduced by Northrop Grumman on November 13, 2008,
  - Purportedly the first combat-ready solid-state laser weapon.
  - 15 kW modular laser "building block" which can be combined with other systems for specific missions, or 7 more FIRESTRIKEs for a single 100 kW laser.
  - Bundled with Northrop Grumman's own LCSA power supply, the Firestrike can fire continuously as long as power and cooling are maintained.

Directed-Energy Weapons (Laser)

- Tactical High-Energy Laser (THEL)
  - A laser developed for military use, also known as the **Nautilus laser system**.
  - The mobile version is the **Mobile Tactical High-Energy Laser**, or **MTHEL**.
  - In 1996, the United States and Israel entered into an agreement to produce a cooperative THEL called the Demonstrator, which would utilize deuterium fluoride chemical laser technologies.
  - In 2000 and 2001 THEL shot down 28 Katyusha artillery rockets and five artillery shells.
  - On November 4, 2002, THEL shot down an incoming artillery shell.
  - The prototype weapon was roughly the size of six city buses, made up of modules that held a command center, radar and a telescope for tracking targets, the chemical laser itself, fuel and reagent tanks, and a rotating mirror to reflect its beam toward speeding targets.

Directed-Energy Weapons (Laser)

- Laser [Close-In] Weapon System (L[CI]WS)
  - A directed-energy weapon developed by the United States Navy.
  - The weapon was installed on USS *Ponce for field testing in 2014.*
  - *In December 2014 the United States Navy reported the LaWS system works perfectly,*
  - *The commander of the Ponce* is authorized to use the system as a defensive weapon.

Directed-Energy Weapons (Laser)

- High Energy Laser-Mobile Demonstrator (HEL-MD)
  - rugged, mobile solid state laser system that meets the size, weight and performance needs of the Army.
  - The effort includes maturing technologies to execute missions including: force protection; intelligence, surveillance, and reconnaissance; counter-ISR; and offensive operations.
  - To obtain that capability, multiple subsystems are in development to integrate into the prototype weapon system, including the laser subsystem; beam control subsystem; electrical power subsystem; thermal management subsystem; and Battle Management Command, Control, Communications, Computers and Intelligence (BMC4I) subsystem.
  - These subsystems are mounted on a customized Heavy Expanded Mobility Tactical Truck (HEMTT).

Directed-Energy Weapons (Laser)

- High Energy Liquid Laser Area Defense System (HELLADS)
  - Counter-RAM system under development that will use a powerful (150 kW) laser to shoot down missiles, rockets, and artillery shells.
  - The initial system will be demonstrated from a static ground based installation, but in order to eventually be integrated on an aircraft
  - design requirements are maximum weight of 750 kg (1,650 lb) and maximum envelope of 2 cubic meters (70.6 $feet^3$)
  - Development is being funded by The Pentagon's Defense Advanced Research Projects Agency (DARPA)

Directed-Energy Weapons (Laser)

- Laser Avenger
  - Infrared laser system (with power levels somewhere in the tens of kilowatts range)
  - Mounted on an **AN/TWQ-1 Avenger combat vehicle**
  - Developed by Boeing Combat Systems in Huntsville, Alabama
  - Laser Avenger integrates a directed energy weapon together with the kinetic weapons of the Avenger air defense system.

Directed-Energy Weapons (Laser)

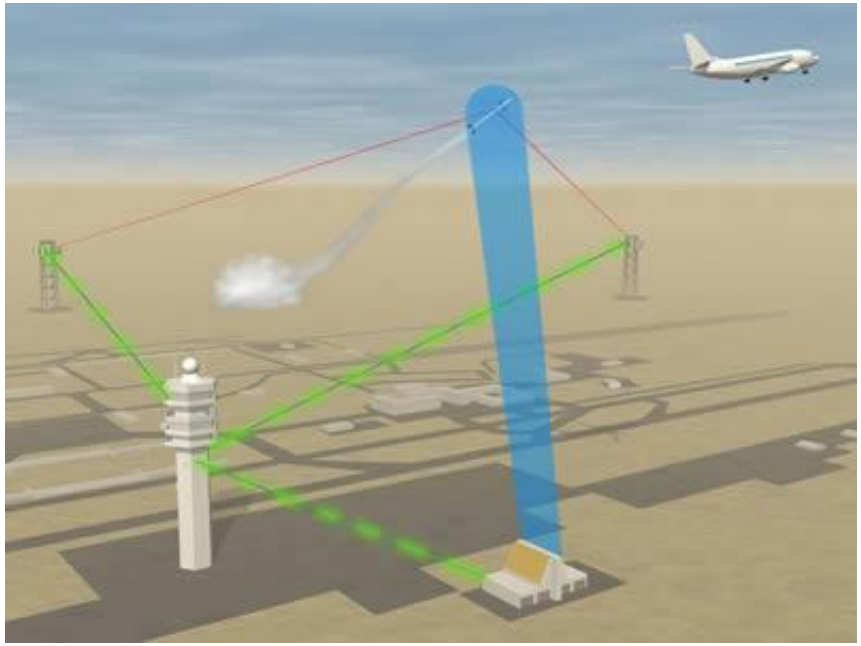
- Laser AirCraft CounterMeasures (ACCM)
  - Non-lethal, coaxial door-mounted laser
  - Mounted alongside other weapons
  - Protects helicopters from small-arms and machine-gun fire
  - It dazzles the target, preventing them from firing accurately and providing protection for the helicopter, but without risking civilian casualties.

Directed-Energy Weapons (Maser)

- Millimeter-Wave (Active-Denial System)
  - A non-lethal, directed-energy weapon developed by the U.S. military
  - Designed for area denial, perimeter security and crowd control.
  - Informally, the weapon is also called the **heat ray**
  - It works by heating the surface of targets, such as the skin of targeted human subjects.
  - Raytheon is currently marketing a reduced-range version of this technology
  - The ADS was deployed in 2010 with the United States military in the Afghanistan War, but was withdrawn without seeing combat

Directed-Energy Weapons (Maser)

- Vigilant Eagle
  - Proposed directed-energy weapon
  - Under development by the U.S. military under a Defense Department contract with Raytheon.
  - It would create an invisible microwave dome around an airport that could block missiles heading toward incoming and outgoing aircraft.



Directed-Energy Weapons (Maser)

- Bofors HPM Blackout
  - High-powered L-Band microwave weapon system
  - Built by BAE Systems,
  - Stated to be able to destroy, at distance, a wide variety of commercial off-the-shelf (COTS) electronic equipment
  - It is stated to be non-lethal to humans

Directed-Energy Weapons (Maser)

- StunStrike (XADS)
  - Wireless electroshock weapon
  - Developed by XADS.
  - Built in various sizes from rifle size upwards, with various ranges. It is intended to incapacitate men and pre-detonate IEDs and incoming RPGs
  - One reported version of StunStrike is a directed-energy weapon which makes a cone-shaped field of powerful electric discharges in one direction.

Directed-Energy Weapons (Electrolaser)

- Applied Energetics (Laser Guided Energy)
  - Rapid response, speed-of-lightning
  - Rapid effects, no dwell-time required
  - Tunable effects, from less-than-lethal to lethal
  - Efficient effects mechanism, tens-of-joules
  - Laser accuracy, reduced collateral damage
  - Distance control, reduced collateral damage
  - Multi-mission, single platform capability
  - High firepower
  - Deep magazine

Directed Energy Weapons (Electrolaser)

- Pulsed Energy Projectile (PEP)
  - Crew served, counter personnel non-lethal directed energy weapon
  - Provides controllable bio-effects to deter, disable, and distract individuals.
  - The device directs an invisible induced plasma pulse at a target that will create a flash-bang near the intended target
  - This counter-personnel capability projects a beam that creates a plasma pulse at the target resulting in a flash-bang effect that startles and distracts, and it also has a kinetic effect on the individual's nerve sensors
  - It vaporizes the first thing it hits creating a plasma that heats the surrounding air causing it to explodes. The resulting shock wave will knock targets to the floor.
  - United States Special Operations Command plans include Counter UAV Pulsed Energy Projectile research.

Directed-Energy Weapons (Particle Beam/Plasma)

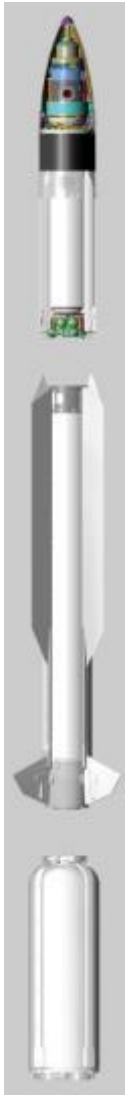
- Shiva Star
  - High-powered pulsed-power research device,
  - Originally built in the 1970s for high-power X-ray research,
  - Later re-directed to studies for the Strategic Defense Initiative (SDI)
  - Now being used for magnetized target fusion research.
  - Most recently revived for work in fusion research (magnetized target fusion) compresses a small plasma load with an imploding metal foil.
  - Shiva Star's 10 MJ capacitor banks are perfect for this role
  - The new FRCHX experiment has been using Shiva Star with 1 mm thick aluminum foil accelerated to about 5 km/s.

Kinetic Energy Weapons

- Blitzer System (Hypervelocity) Rail Gun [General Atomics]
- Electrically-powered electromagnetic projectile launcher based on principles similar to the homopolar motor. The rail gun comprises a pair of parallel conducting rails, along which a sliding armature is accelerated by the electromagnetic effects of a current that flows down one rail, into the armature and then back along the other rail.
- Railguns are being researched as a weapon with a solid metal projectile that would use neither explosives nor propellant, but rather rely on electromagnetic forces to achieve a very high kinetic energy. While current kinetic energy penetrators such as an armor-piercing fin-stabilized discarding-sabot can achieve a muzzle velocity on the order of Mach 6-7+ (2400+m/s), with power levels in excess of 32 Megajoules.
- Hypervelocity impact achieves high lethality through kinetic energy, eliminating the safety and logistic burdens of explosives. Rail gun weapon systems employ guided, maneuverable projectiles which can accomplish multiple missions with the same round. Rail guns can also fire a family of different projectiles with varying capabilities, levels of sophistication, and cost. Because rounds are launched electromagnetically, propellant is not required. This results in much smaller rounds, enabling many more stowed rounds in a constrained volume as well as improved safety and reduced logistics burden. The confluence of microelectronics, nanotechnologies, and electromagnetic acceleration enable missile performance without rocket motors. Rail gun-launched guided projectiles are expected to be much lower cost than current assets for integrated air and missile defense. With deep magazines and high, sustained firing rates, rail guns provide unprecedented fire power. The lower cost and higher fire power of rail guns levels the playing field with potential adversaries

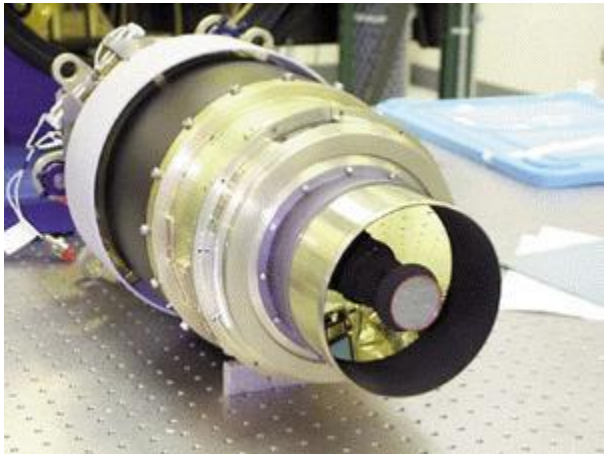
Kinetic Energy Weapons

- SM-3 Kill Vehicle (KV) [Raytheon]
  - Aegis BMD uses the Raytheon Standard Missile-3 mid-course interceptors and the Standard Missile-2 Block IV (SM-2 Block IV) terminal-phase interceptors
  - The SM-3 is capable of intercepting ballistic missiles above the atmosphere (i.e., exo-atmospheric intercept) during the midcourse phase of a hostile ballistic missile's flight.
  - The missile is launched from the MK 41 vertical launching system (VLS) of the warships.
  - Receives in-flight target updates from the ship. The kinetic warhead (KW) is designed to destroy a ballistic missile's warhead with more than 130 megajoules of kinetic energy by colliding with it.
  - The existing SM-3 Block IA version will be upgraded to SM-3 Block IB, SM-3 Block IIA and SM-3 Block IIB to counter future ballistic missile threats.
  - The SM-2 Block IV can engage the ballistic missiles within the atmosphere (i.e., endoatmospheric intercept) in the terminal phase of a missile's trajectory. The missile carries a blast fragmentation warhead. The SM-2 Block IV will be replaced with a new extended range SM-6 interceptor.



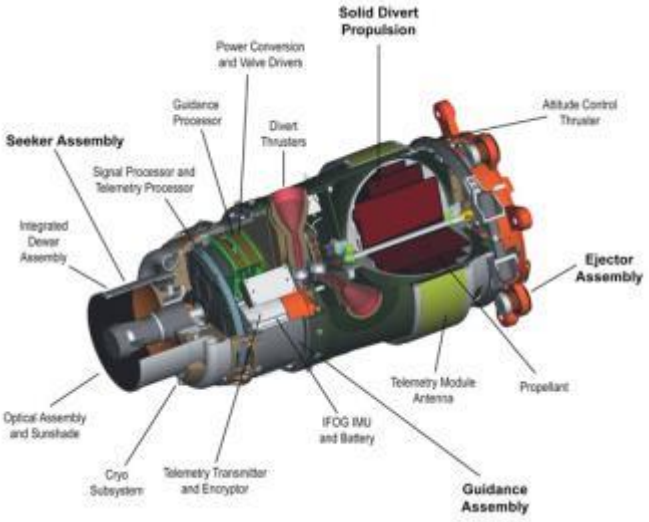
Kinetic Energy Weapons

- Ground Based Interceptor (GBI) [Raytheon]
  - The anti-ballistic missile component of the United States' Ground-Based Midcourse Defense (GMD) system.
  - Comprised of a boost vehicle, constructed by Orbital Sciences Corporation, and an Exoatmospheric Kill Vehicle, built by Raytheon.
  - Integration is performed by Boeing Defense, Space & Security
  - The boost vehicle uses the solid-fuel rocket upper stages of the Taurus Launcher



Kinetic Energy Weapons

- Lightweight Exo-Atmospheric Projectile (LEAP)
  - Lightweight, miniaturized kinetic kill vehicle designed to destroy incoming ballistic missiles both inside or outside the Earth's atmosphere.
  - The warhead is delivered to the interception point by a system such as the Aegis Ballistic Missile Defense System.



Kinetic Energy Weapons

- Terminal High Altitude Area Defense (THAAD)
  - United States Army anti-ballistic missile system designed to shoot down short, medium, and intermediate ballistic missiles in their terminal phase using a hit-to-kill approach.
  - The missile relies on the kinetic energy of the impact to destroy the incoming missile.