PAC-3® MSE Overview

LOCKHEED MARTIN

Outline

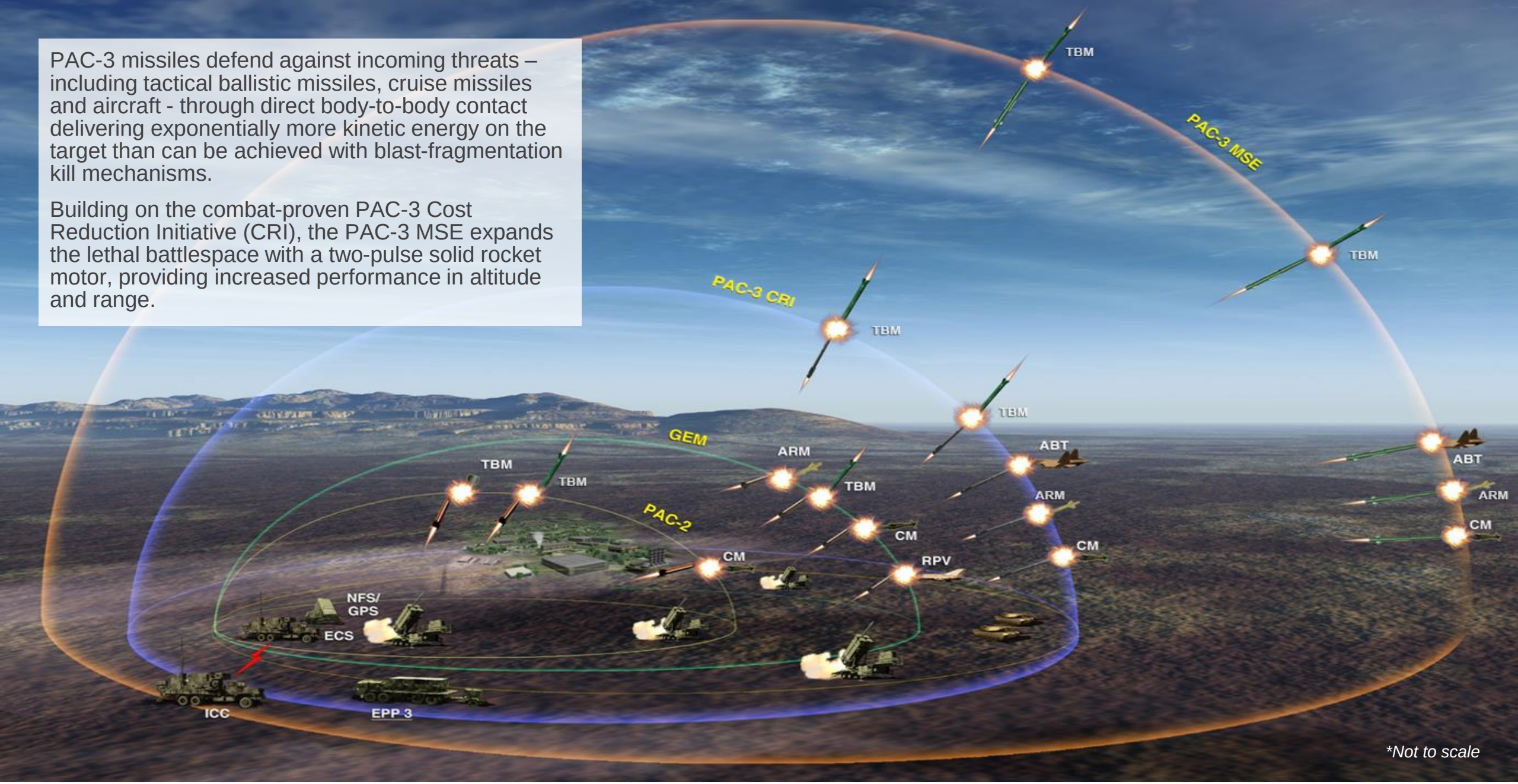
- PAC-3 Evolution
- Hit-to-Kill Technology
- Patriot and PAC-3 Missile Segment Enhancement (MSE)
- M903 Launcher Upgrades
- Summary and Reference Data




PAC-3 Evolution

PAC-3 missiles defend against incoming threats – including tactical ballistic missiles, cruise missiles and aircraft - through direct body-to-body contact delivering exponentially more kinetic energy on the target than can be achieved with blast-fragmentation kill mechanisms.

Building on the combat-proven PAC-3 Cost Reduction Initiative (CRI), the PAC-3 MSE expands the lethal battlespace with a two-pulse solid rocket motor, providing increased performance in altitude and range.



PAC-3 MSE Historical Timeline

2014
Production decision reached

2015
First Unit Equipped (FUE) declared

2016
Initial Operational Capability (IOC) declared

First FMS customer contract signed

2017
PAC-3 MSE intercept opens door to full-rate production

2018
Full-rate production (FRP) achieved

2019
Contract signed to increase annual production capacity to 500 missiles

2020
600th Launcher Modification Kit (LMK) delivered

400th PAC-3 MSE conversion kit delivered

2021
First Field Surveillance Program (FSP) flight tests

First successful engagement with U.S. Army's Integrated Air and Missile Defense Battle Command System (IBCS)

2022
Contract signed to increase annual production capacity to 550 missiles

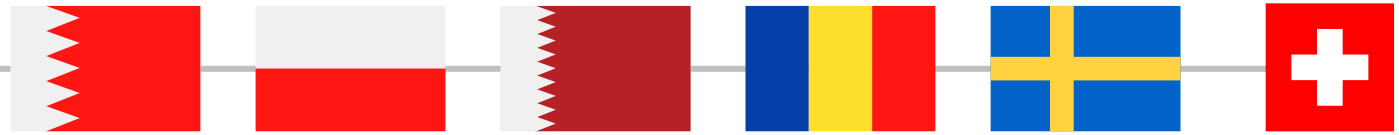
2023
Expanded international user community

PAC-3 International User Community

CRI & MSE

Germany, Japan, Kuwait, Netherlands, Republic of Korea, United Arab Emirates, Taiwan

MSE



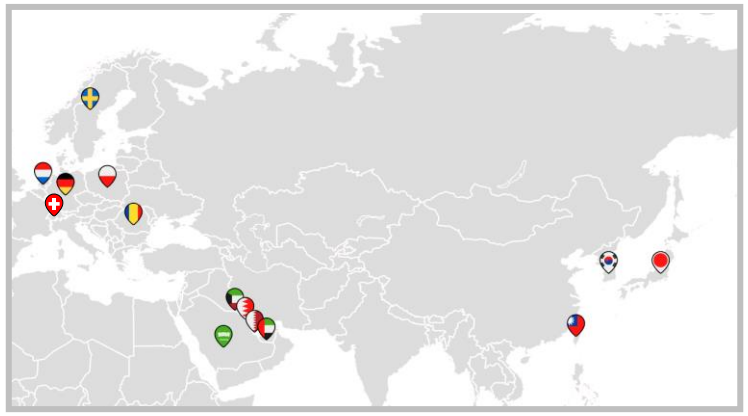
Bahrain, Poland, Qatar, Romania, Sweden, Switzerland

CRI

Kingdom of Saudi Arabia

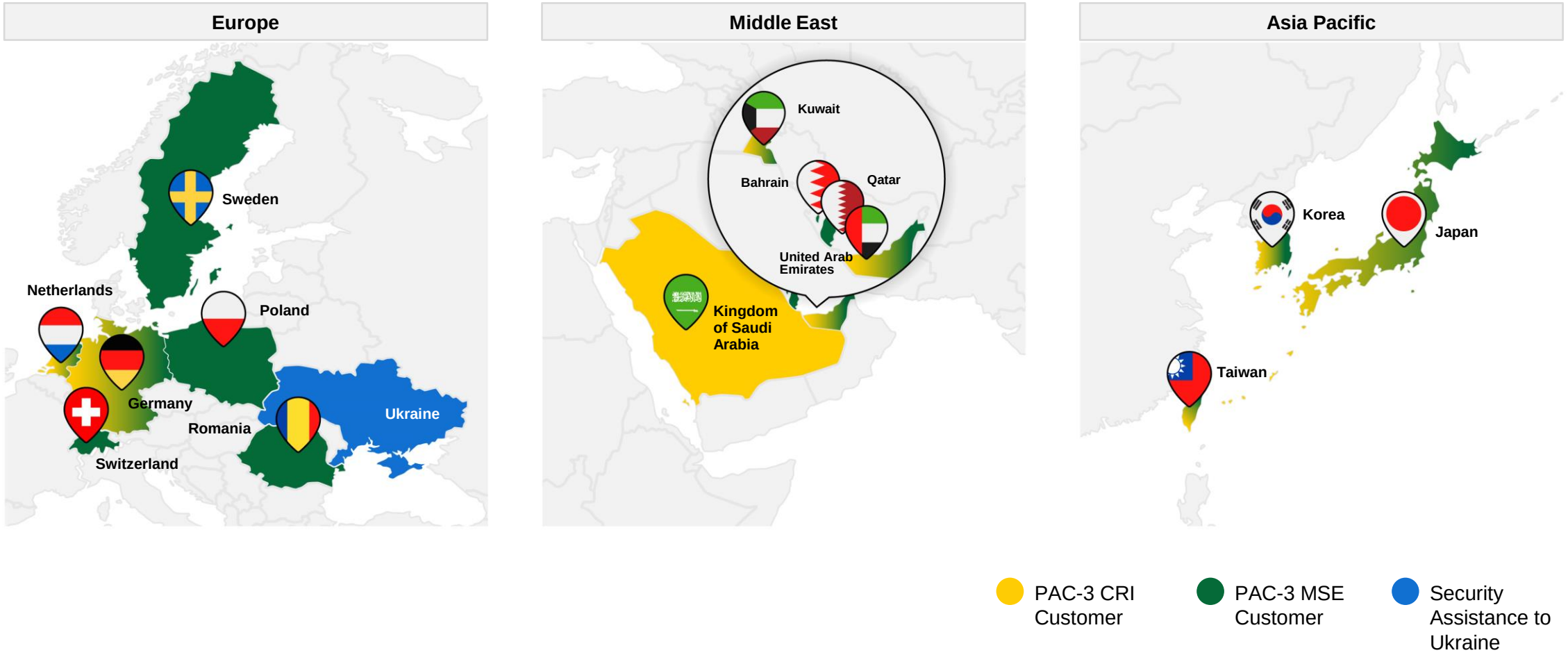
Security Assistance

Ukraine



14 INTERNATIONAL PAC-3 USERS ON CONTRACT

PAC-3 International User Community



Hit-to-Kill Technology

PAC-3 Hit-to-Kill Fundamentals

Sensing the Threat

- Highly accurate seeker
- High data processing rates
- Scanning and search capability

Guidance

- Optimum engagement geometry
- Aimpoint selection
- High-speed computing of guidance algorithms
- World-class simulation and testing

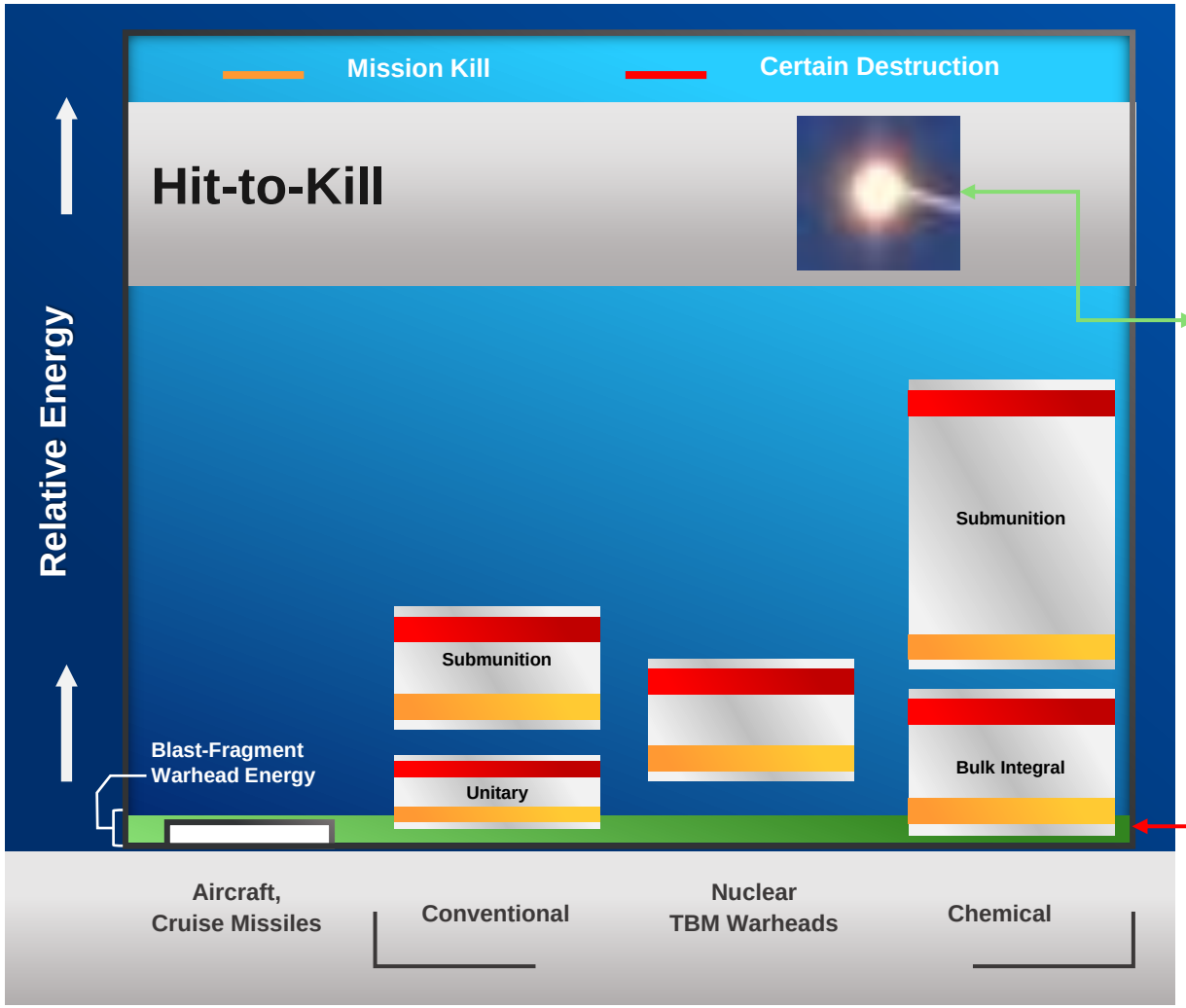
Hitting the Threat

- Extremely responsive control system with forward-mounted side thrusters
- High agility airframe

Lethality

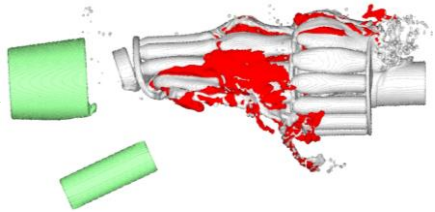
- High-energy impact defends against current and emerging threats
- Momentum transfer

Energy Required for Intercept



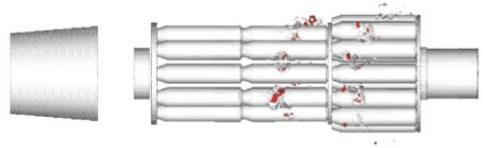
Effectiveness vs. Submunitions

Hit-to-Kill Intercept



- Typically the aeroshell is destroyed
- Most submunitions are destroyed
- Remaining submunitions typically sustain moderate to significant deformation
- Debris propagates downwards

Blast Frag Intercept



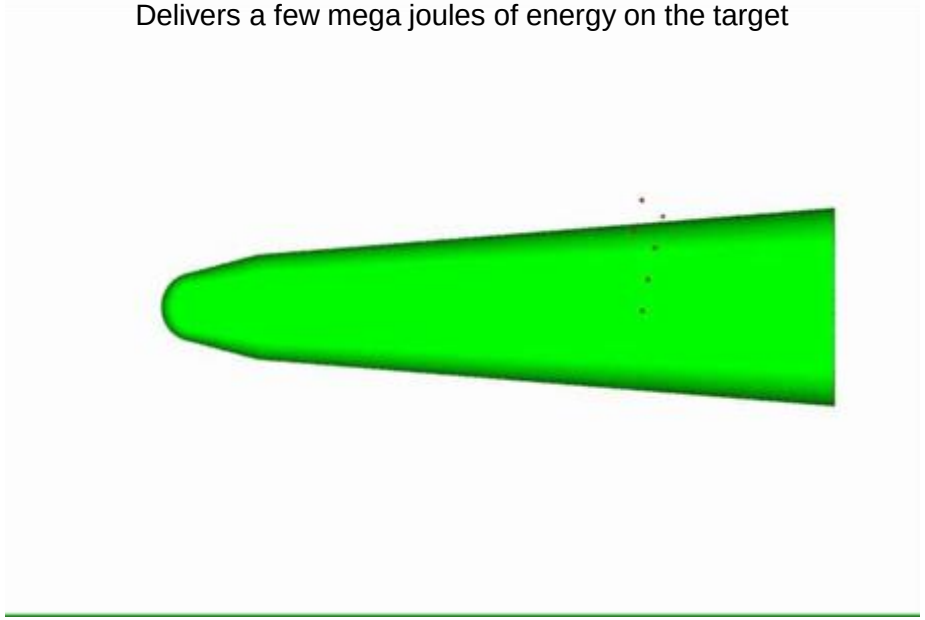
- Typically the aeroshell is destroyed
- Few submunitions are punctured
- Outer layer of submunitions provides effective shielding of inner layer and far-side submunitions
- Ballistic trajectory of debris is generally unchanged

Preventing lethal effects on the ground requires Hit-to-Kill

Hydrocode Analysis of the Intercept

Blast Frag Intercept

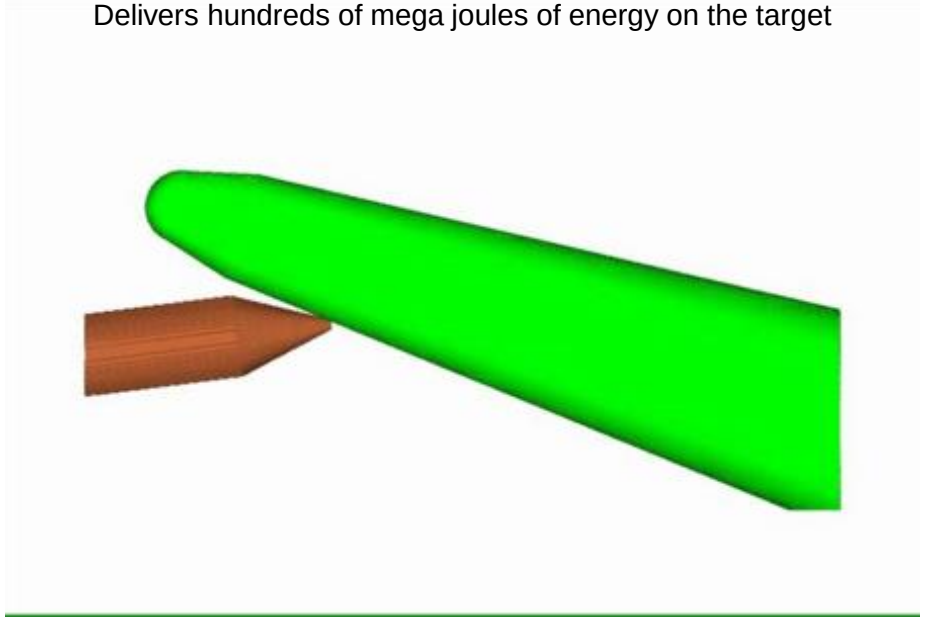
Delivers a few mega joules of energy on the target



VIDEO - Click on picture

Hit-to-Kill Intercept

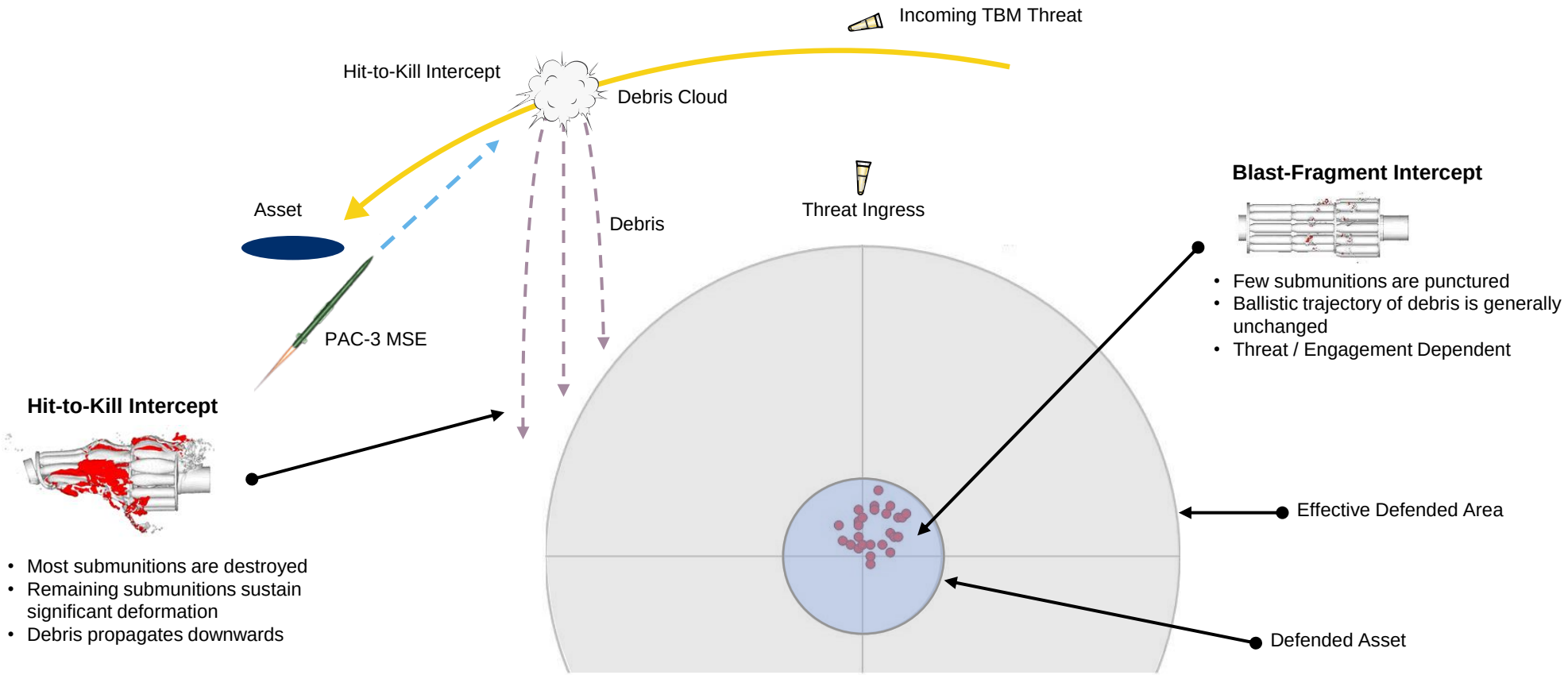
Delivers hundreds of mega joules of energy on the target



VIDEO - Click on picture

Hydrocode provides a means to analyze the intercept dynamics of missile defense intercept mechanisms

Debris on the Ground

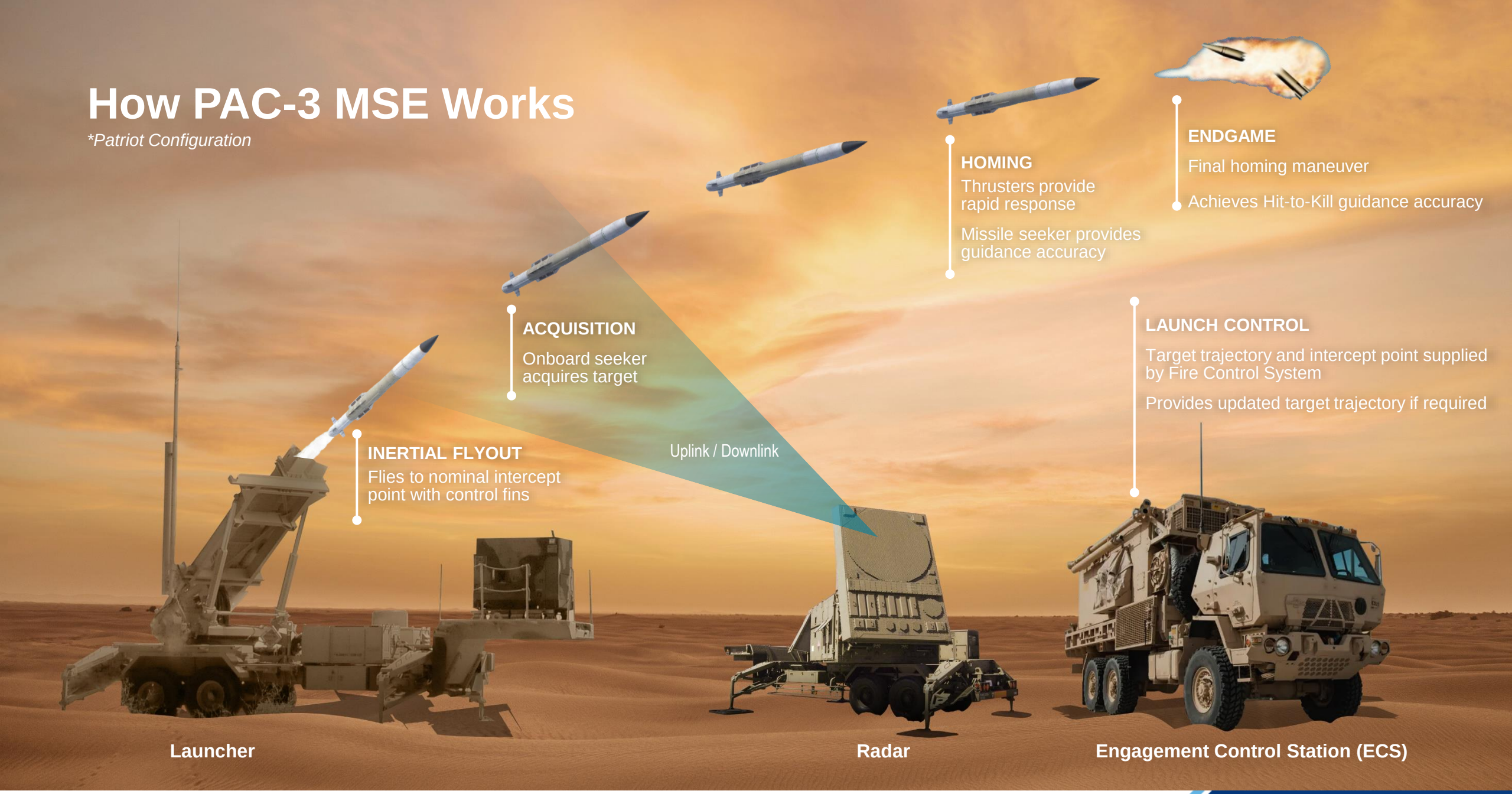


Protect Defended Asset and Minimize Collateral Damage

PAC-3 Missile Segment

How PAC-3 MSE Works

**Patriot Configuration*



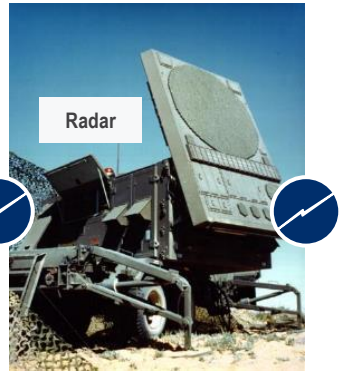
PAC-3 Missile Segment Components

M903 Launcher Components

1. PAC-3 MSE One-Packs
2. Junction-Box / Launching Station Diagnostic Unit (J-Box/LSDU)
   - Power/signal distribution for missile umbilicals
   - Performs cable diagnostic test
3. Launcher Cables
   - ELES/J-Box/LSDU interconnect
   - Dedicated umbilicals for PAC-3
4. Enhanced Launcher Electronics System (ELES)
   - Provides power and signals to missiles

Canister

PAC-3 MSE One-Pack facilitates launcher reconstitution



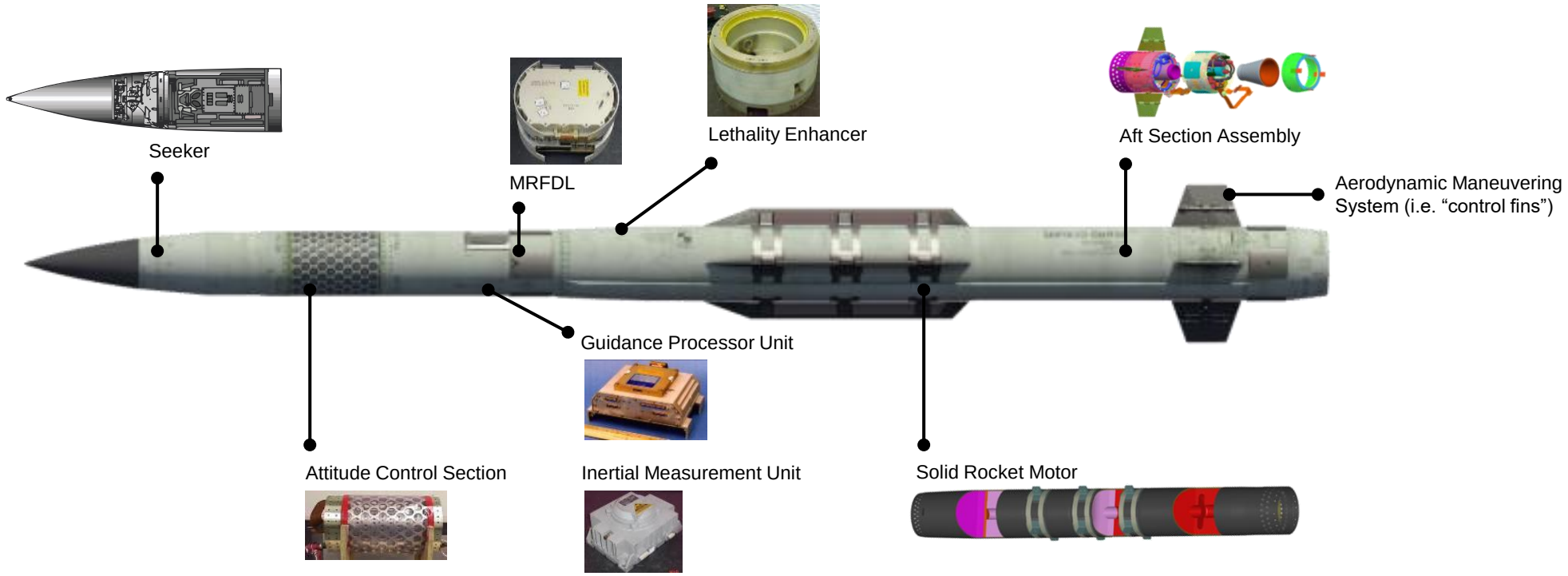
Fire Solution Computer Redesign (FSCR)

Calculates PAC-3 missile engagement solutions

PAC-3 Hit-to-Kill Missiles

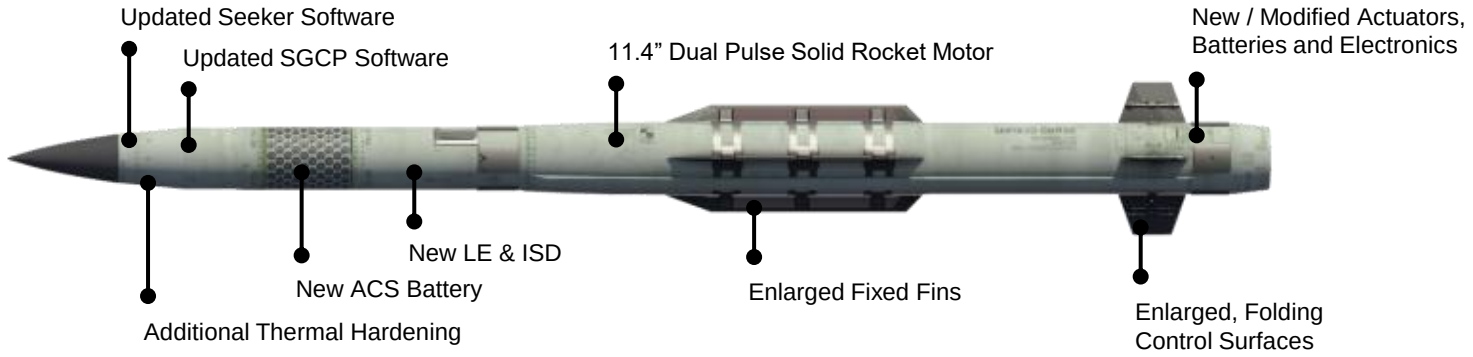
PAC-3 MSE Interceptor

- Small (diameter, length, weight)
- Rapid acceleration from solid rocket motor (SRM) boost phase
- Sustain phase maintains high velocity for Hit-to-Kill engagement with second pulse for long-range or high-altitude intercepts
- Dual-control autopilot provides fast divert response
  - Aerodynamic Maneuvering System (control fins)
  - Attitude Control Section - Attitude Control Motors (ACM)
- High-power, highly accurate, all-weather active Ka band radar seeker
  - Range, range rate, angle data to homing guidance
- Guidance Processor Unit (GPU) - Main computer
- Inertial Measurement Unit (IMU) - Navigation system
- Multi-band Radio Frequency Data Link (MRFDL) – Uplink/downlink communication

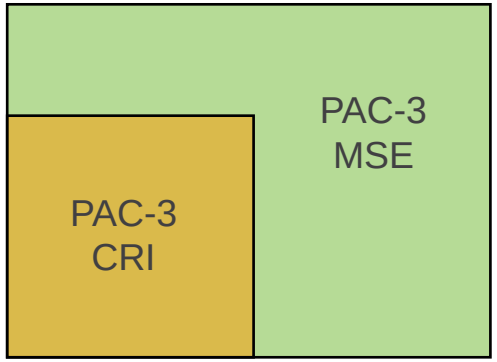


PAC-3 MSE Capability Enhancements

- Provides performance growth against existing and advanced threats
- Improves lethality and maneuverability over entire battlespace
- Increases footprint significantly against threats
- Provides improved Insensitive Munitions (IM) capability
- One-Pack approach improves operational flexibility
- Achieves larger battlespace with longer range and higher altitude



Significant battlespace growth



Jointly defined ECS changes with Raytheon

Updated FSCR software

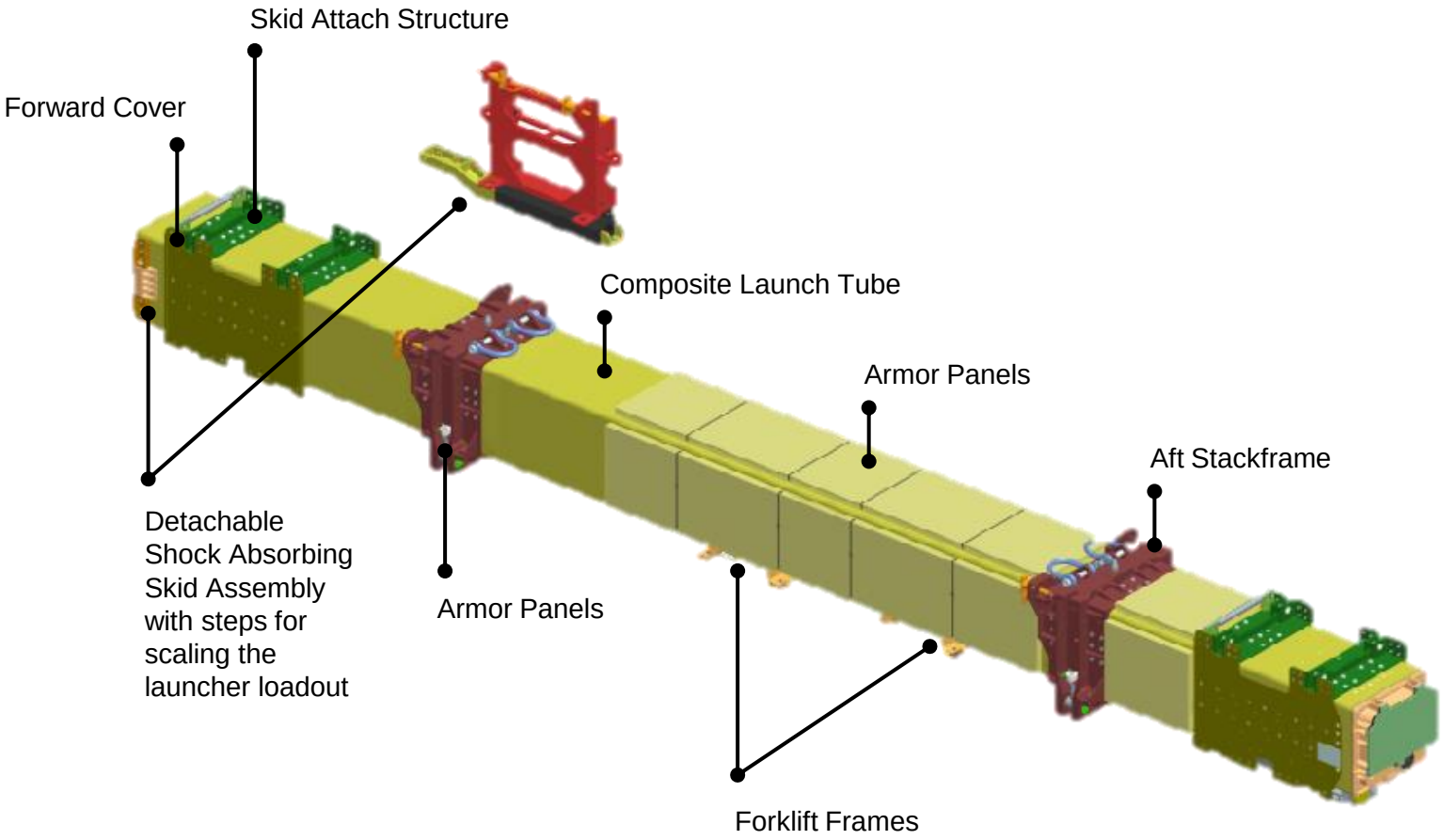
- “Kitted” Single Canister
- Armor
- TIVS

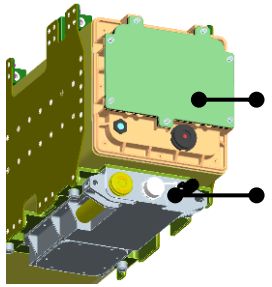
Updated ELES software

PAC-3 MSE defends against new and evolving threats while increasing capability against existing threats

PAC-3 MSE Canister Design Overview

One-Pack, External Components

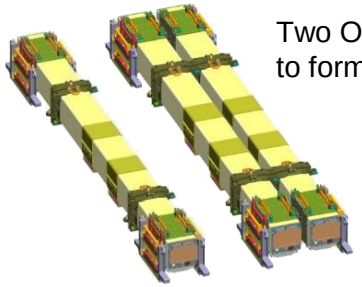




Aft End View

Improved Aft Cover

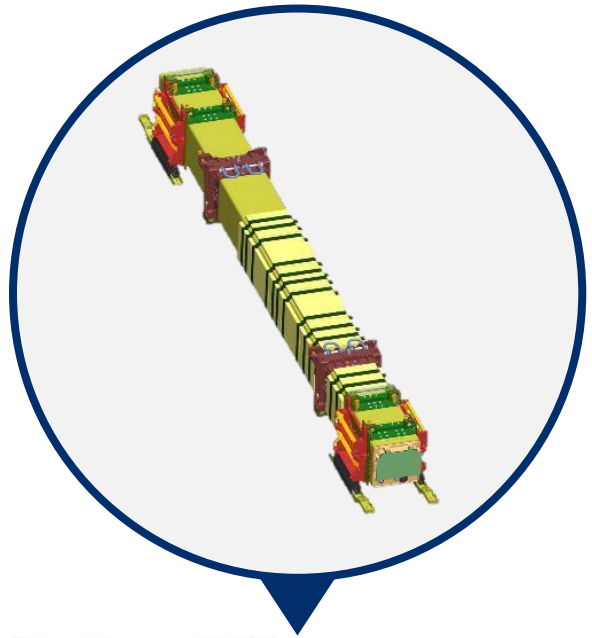
Transition Box

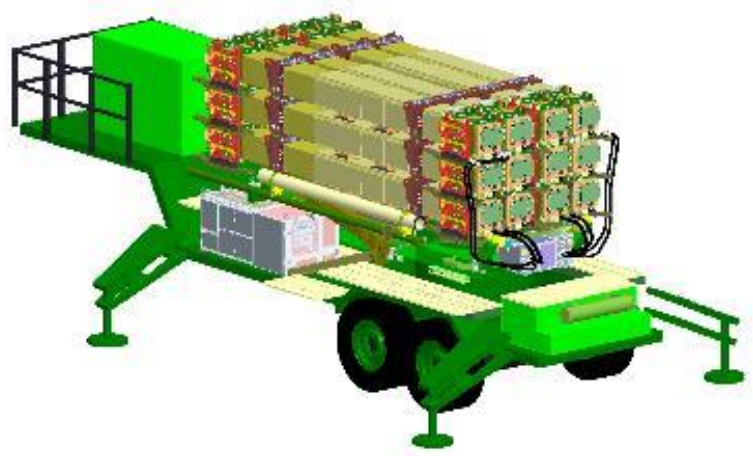


Two One-Packs combine to form a Two-Pack

MSE Single Canister Summary

Reconstitution / Reload	One-Packs are field replaceable. Single use canister, missiles are not reconstitutable.
Explosive Ordnance Disposal (EOD) of Single Missile	Single One-Pack may be removed and disposed.
Shipping Configurations	Can ship as double Two-Pack, Two-Pack, or One-Pack.
OCONUS Road March	12 missile max load meets OCONUS height requirements without need for off-loading.
Insensitive Munitions Compliance	System is IM compliant.
Modularity	Mechanical interfaces maintained for multiple launcher platforms.



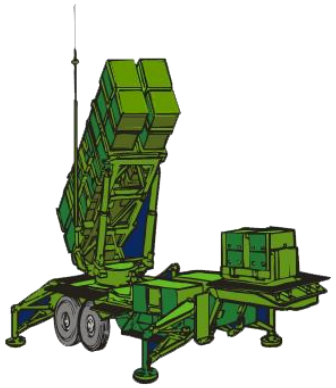


Launcher Upgrades

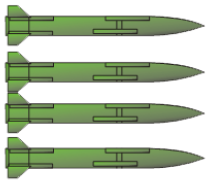
PATRIOT Load Out Options

- PAC-3 provides up to four times the firepower and less reloads versus PAC-2 family of missiles.
- PAC-3 CRI and PAC-3 MSE provide high load out configurations and enable defense against mass raids.
- M903 allows for a mix of PAC-3 CRI and PAC-3 MSE missiles.
- All new US launchers are M903 configuration.

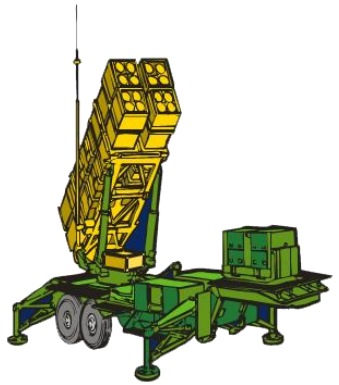
M903 can launch entire family of Patriot missiles



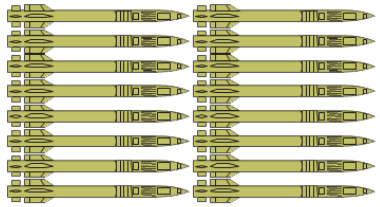
M901



4 PAC-2 (GEM)

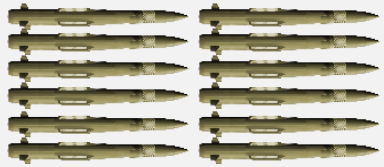


M902

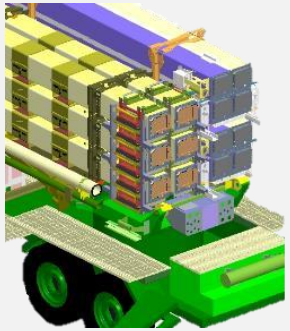


16 PAC-3 CRI
or 4 PAC-2 (GEM)

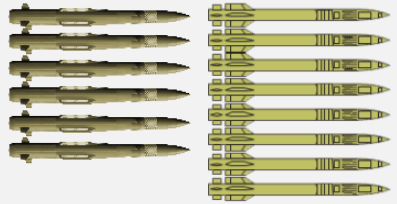
M903



12 PAC-3 MSE, or 16 PAC-3 CRI
or 4 PAC-2 (GEM)



M903



6 PAC-3 MSE and 8 CRI
or 4 PAC-2 (GEM)

Summary

Summary

- The PAC-3 family of missiles are **combat proven Hit-to-Kill interceptors** that defend against incoming threats, including tactical ballistic missiles, cruise missiles, advanced threats, and aircraft.
- PAC-3 missiles defend against incoming threats through direct body-to-body contact **delivering exponentially more kinetic energy on the target** than can be achieved with blast-fragmentation kill mechanisms.
- Building on the combat-proven PAC-3 CRI, the PAC-3 MSE **expands the lethal battlespace** with a two-pulse solid rocket motor, providing increased performance in altitude and range.
- **Fifteen** nations have chosen PAC-3 to provide missile defense capabilities.

World's Most Advanced Air Defense Missile

LOCKHEED MARTIN

Acronyms

ABT	Air Breathing Threat
ACM	Attitude Control Motors
ACS	Attitude Control System
AMS	Aerodynamic Maneuvering System
ARM	Anti-Radiation Missile
CDI	Classification, Discrimination, Identification
Config	Configuration
CONUS	Continental United States
COTS	Commercial off-the-shelf
CRI	Cost Reduction Initiative
D-Cables	Distribution Cables
D-Box	Distribution Box
DT	Development Test
ECS	Engagement Control Station
ELES	Enhanced Launcher Electronics System
EOD	Explosive Ordnance Disposal
ERINT	Extended Range Interceptor
EWCC	Expanded Weapons Control Computer
FLAGE	Flexible Lightweight Agile Guided Experiment
FMS	Foreign Military Sales
FOTP	Follow-on Test Program
FSC	Fire Solution Computer
FSCR	Fire Solution Computer Redesign
FUE	First Unit Equipped
FWD	Forward
GEM	Guidance Enhancement Missile
GMT	Guided Missile Transporter
GPU	Guidance Processor Unit
GSE	Ground Support Equipment
GTF	Guided Test Flight
HTK	Hit-to-Kill
HW	Hardware
IM	Insensitive Munitions
IMU	Inertial Measurement Unit
IOC	Initial Operational Capability
ISD	Ignition Safety Device
J-Box	Junction Box
Km	Kilometer
LE	Lethality Enhancer
LEM	Launcher Electronics Module
LMRD	Launcher Missile Round Distributor
LS	Launching Station
LMK	Launcher Modification Kit
LSDU	Launcher Station Diagnostic Unit
MAP	Modular Adjunct Processor
MEADS	Medium Extended Air Defense System
MFG	Master Frequency Generator
MRFDL	Multi-band Radio Frequency Downlink
MSE	Missile Segment Enhancement
MSL	Missile
NFS	North Finding System
OCONUS	Outside the Continental United States
OT	Operational Test
PAC-3 ®	Patriot Advanced Capability-3
PDB	Post Deployment Build
PALS	PATRIOT Automated Logistics System
POP	Proof of Principle
REP	Radar Enhancement Phase
RDP	Radar Digital Processor
RF	Radio Frequency
RLCEU	Remote Launch Communications Enhancement Upgrade
RPV	Remotely Palletized Vehicle
SBC	Single Board Computer
SGCP	System Guidance Computer Program
SIG	Signal
SP	Shorting Plug
SRHIT	Small Radar Homing Interceptor Technology
SRM	Solid Rocket Motor
SW	Software
TBM	Tactical Ballistic Missile
T-Box	Transition Box
THAAD	Terminal High Altitude Area Defense
TIVS	Thermally Initiated Venting System
UMB	Umbilical Cable
UL	Upper Left
UR	Upper Right
VME	Versa Module Eurocard
WMD	Weapon of Mass Destruction