Protection of semi-military and civil aircraft

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Contents

- Terrorist threats to aviation
- Some MANPADS characteristics
- Challenges in protecting civil and semi-military aircraft against MANPADS
- Protection technologies and concepts

The threats and associated protection concepts

- Hijacking-misuse
  - Typical scenario
    - 911
  - Protection
    - Armed officers
    - Passenger screening
    - Intelligence
    - Misuse detection systems
    - Automated collision avoidance and landing systems

The threats and associated protection concepts

- Bombings
  - Typical scenario
    - Lockerbie
  - Protection
    - Passenger screening
    - Cargo screening
    - Intelligence

The threats and associated protection concepts

- Cyber related threats
  - Typical scenario
    - Passive listening
    - Closing line
    - Altering line
    - Substituting line
      - HF
      - VHF
      - SATCOM
      - BEACON
      - TCAS
      - ATC
      - DGPS
      - ILS
      - MLS
      - VOR
      - DME
  - Protection
    - Safeuguarding ground based assets
    - Jamming resistant antennae (directed)

The threats and associated protection concepts

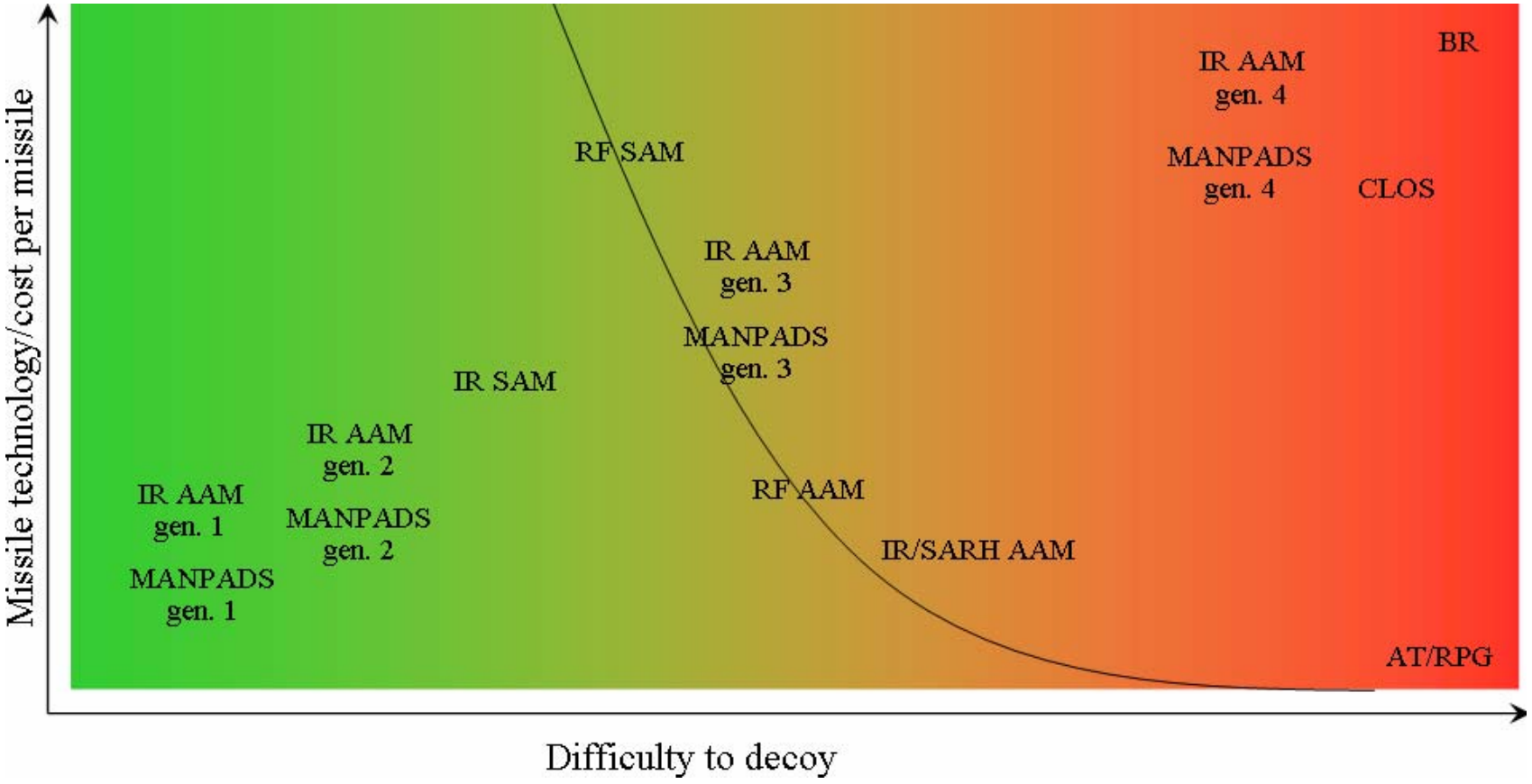
- Radiation threats
  - Typical scenario
    - Eye damaging lasers
      - Incident has occurred!
    - High Power Microwave
      - Futuristic
  - Protection
    - Likely none required

The threats and associated protection concepts

- Unguided weapons
  - Typical scenario
    - Small caliber gunfire
    - .50 cal anti-air gun
    - Rocket Propelled Grenades
    - In general limited range weaponry
  - Protection
    - Intelligence
    - Armor
    - Restricted access to airport vicinities
    - The dumbest weapons are often the most difficult to counter…

The threats and associated protection concepts

- Guided weapons
  - Typical scenario
    - Command to Line of Sight
    - Beam Riders
    - MANPADS
  - Protection
    - Arms control
    - Intelligence
    - Susceptibility reduction – signature management
    - Vulnerability reduction A – Armor B – Bury C – Consolidate D – Duplicate E – Eliminate F – Fly very high
    - Counter-MANPADS-system


Missile technology/cost per missile
Difficulty to decoy
IR AAM gen. 1
MANPADS gen. 1
IR AAM gen. 2
MANPADS gen. 2
IR SAM
RF SAM
IR AAM gen. 3
MANPADS gen. 3
RF AAM
IR/SARH AAM
IR AAM gen. 4
MANPADS gen. 4
CLOS
BR
AT/RPG

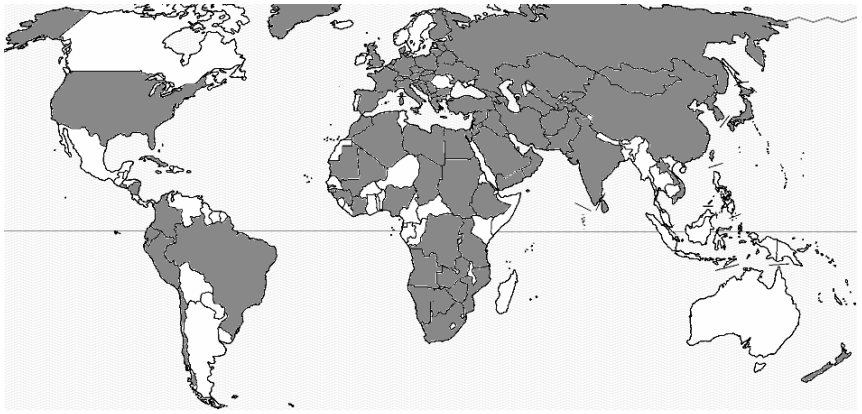
Man-Portable Air Defense System facts and figures

- IR MANPADS
  - Light weight, compact, cheap
  - Relatively easy to use
  - Generally small warhead
  - Generally contact fuse – has to make direct hit
  - Simpler models widely proliferated
  - Likely multiple launches in attack

MANPADS facts and figures

Countries with IR MANPADS

- Over 700.000 MANPADS have been produced worldwide since the 1970s[1]
- 35 MANPADS engagements over 10 years, 24 a/c downed, 500 people killed[4]



Location of “non-state” organizations with IR MANPADS

- 150,000 MANPADS estimated in the hands of “non-state” organizations[2]
- Prices as low as 5,000 $US[3]

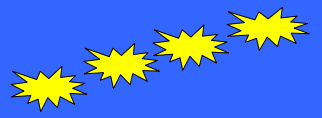
[1] CSIS, “Transnational Threats Update,” Vol. 1, No. 10, 2003

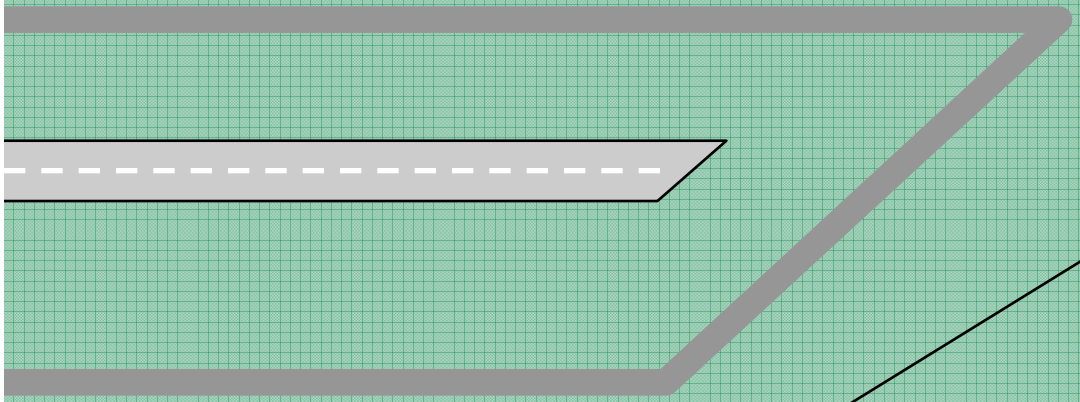
[2] Jane’s Intelligence review February 12, 2003

[3] Jane´s Terrorism and Insurgency Centre, “Proliferation of MANPADS and the Threat to Civil Aviation”, August 13, 2003

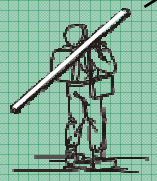
4 C. Bolkcom, B. Elias, and A. Feickert, Congressional Research Service Report for Congress: Homeland Security: Protecting Airlines from Terrorist Missiles, 2003

Manpads attack timeline





Airport perimeter



Aircraft rolls down the runway

Target aircraft picked; prepare missile, activate battery and spin-up missile seeker

Tracking, lock-on and pre-launch confirmation

Launch of missile

MAW detects UV emissions, possible missile

MAW track possible missile

Missile confirmed

Calculate optimum decoy timing

Dispense decoys

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 Time (s)

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Examples of MANPADS attacks

- In Nov 2002 two SA-7 missiles was fired against an Israeli Boeing 767 taking off from Mombasa
- In Nov 2003 one SA-7 and one SA-14 was fired against DHL A300 taking off from Baghdad

MANPADS inflicted damage to DHL A300

MANPADS damage on the Airbus A300

Challenges – differences

Property	*Military*	*Head-of-state/VIP*	*Commercial*
Threat	Various, hi-end	MANPADS	MANPADS
Tactics	Various employed	Limited employment	Not employed
Effectiveness	High probability low to medium consequence	Low probability medium to high consequence	Low probability high consequence
Safety requirements	Not low but not prioritized	Very high – civil environment	Very high – civil environment
Cost	High costs accepted	High costs generally accepted	Airlines have thin margins!
Tempo of operation	Hundreds of flight hours per annum	Hundreds of flight hours per annum	Thousands of flight hours per annum
Reliability	Typically hundreds of hours	Typically thousands of hours	Typically thousands of hours
Operational environment	Extreme	Benign	Benign
Exportability	No requirement	May be required	Required
Support infrastructure	Specialized, mobile	Civil, generic	Civil, generic

Capability

- Capability = tactics + technology
- Only small possibility to employ tactics in civil context;
  - No or small maneuverability
  - No possibility to alter throttle settings
  - Difficult to be unpredictable
  - Difficult to employ spiral takeoffs etc

Counter-MANPADS-systems

- Land based systems – Point defense of airports
  - High energy lasers
  - High power microwave
- Aircraft based systems – Point defense of aircraft
  - Missile detection systems
  - DIRCM
  - CLIRCM
  - Hard kill DIRCM
  - Pyrotechnic flare based systems
  - Pyrophoric flare based systems

Counter-MANPADS-systems

- Land based directed energy systems
  - High power microwave
  - High energy laser
  - Point defense of airports
    - Ground based grid of sensors
    - Ground based grid of directed energy weapons
    - Limited geographic coverage;
      - Footprint of several hundred km^2
  - Safety issues

Counter-MANPADS-systems

- Missile Detection Systems
  - None (or the “old eye-ball”)
    - Pre-emptive dispensing of flares inhibits missile seeker target acquisition
    - Not suitable to civil aviation
  - Active RF
    - Measures rough direction, closing speed (Time To Intercept)
    - Sensitive to false alarms in some environments
    - Interoperability concerns
  - Passive UV
    - Imaging system measuring UV radiation from missile plume
    - Operates in UV solar blind spectrum
    - False sources include welding, sparks and flashes and some outdoor lamps
    - Measures direction, estimates time to intercept
    - Limited range (enough for MANPADS)
  - Passive IR
    - Imaging system measuring IR from missile plume and tracking radome emissions
    - Measures direction, estimates time to intercept
    - Has to cope with massive amount of man-made IR sources
  - Sensor fusion and processing

Counter-MANPADS-systems

- DIRCM
  - Laser based DIRCM
    - Detection sensors
    - Tracking sensors
    - Turret with laser slewed with tracking sensor data
    - Modulated light induces false steer commands in missile seeker; generic jam code
    - If powerful enough, may cause stray light in seeker
  - Is not a true decoy, i.e. may attract missile under some circumstances
  - Has problems with multiple missile launches due to timing issues
  - Experiences problems with modern missile seekers
  - Technology under ITAR restrictions

Counter-MANPADS-systems

- CLIRCM
  - Laser based DIRCM
    - Detection sensors
    - Tracking sensors
    - Turret with laser slewed with tracking sensor data
    - Seeker characteristics measured by laser, e.g. reticle frequency
    - Modulated light induces false steer commands in missile seeker; jamcode adapted to threat
  - Is not a true decoy, i.e. may attract missile under some circumstances
  - Has problems with multiple missile launches due to timing issues; though adapted jam codes may provide quicker jamming sequence
  - Experiences problems with modern missile seekers
  - Technology under ITAR restrictions

Counter-MANPADS-systems

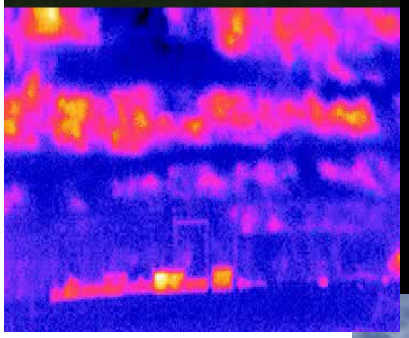
- Hard kill DIRCM
  - Not operational or demonstrated
  - Energy focused by missile optics to detector which pops
  - Not mature
    - Requires lots of power
    - Has to operate in several bands
    - Repeat rate issues

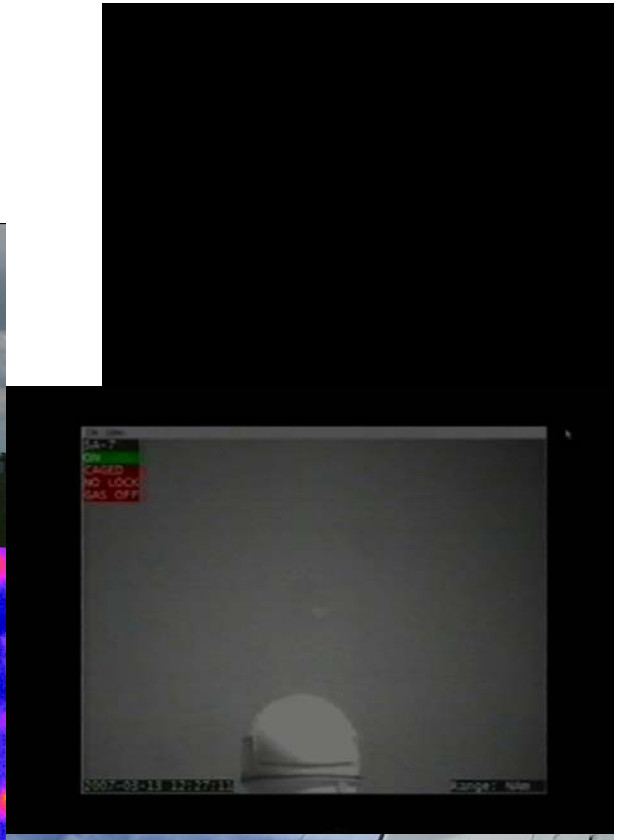
Counter-MANPADS-systems

- Pyrotechnic flare based system
- Legacy military technology
  - Various types of flares exist
    - Adapted to specific threats
      - Spectral characteristics
      - Kinematic characteristics
      - Temporal characteristics
    - Generally employed in “cocktails”
    - Masses typically 0,2-1 kg
    - Ejection velocities typically 10-40 m/s
  - Technology under ITAR restrictions
  - Safety issues

Counter-MANPADS-systems

- Pyrophoric decoy based system
  - Electromechanically dispensed pyrophoric decoys
  - No pyrotechnics
  - Medium temperature area decoy competes with engine signature(s)
  - Very low visual signature and not audible when dispensed
  - Masses in range of 50 g
  - Ejection velocities 2 m/s
  - Safe!



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