AIRCRAFT PROTECTION IN MODERN THREAT ENVIRONMENT

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Outline

• Threat environment
• Air defense systems
  • Acquisition radar
  • Track radar
• Aircrafts survivability requirements
  • Reducing probability of engagement
  • Reducing probability of kill
• Support jamming
• Self protection jamming
• DRFM based jammers
• New trends in EW capabilities
• Future jammer
Threat environment

• Emergence and proliferation of new generation SAMs.
• Integrated air defense system
• New air defense tactics and employment enabled by commercial information and communications technologies.
• Construction of air defense systems with comprehensive defenses, active, and decoys.
• 4th and 4.5 generation fighter aircrafts
• Signals dense environment
S-300 air defense system
Some of point defense systems
ARM decoy
Acquisition radar role

• Detect incoming targets.
• Cue TTR to the location of the target in space and trigger lock-on.
• Keep acquisition on all targets in its range.
• Recue TTR in case of brake lock
TTR role

• Lock-on to the assigned target and track it till missile impact.
• Create range gate, angle gate, and velocity gate for the target.
• May provide illumination for semi-active missile guidance.
EW requirements

- EW assets are necessary to enhance aircrafts survivability during their mission, and increase mission effectiveness
- Self protection equipments are not enough.
- Support EW assets are required to deny\ reduce air defense probability of engagement
  - Suppression of enemy air defense (SEAD)
  - Support jamming
  - Communication jamming
- Multiple EW assets have cumulative effects
Suppression of Enemy Air Defense

• Employ anti radiation missiles to kill radars
• SEAD aircrafts should be able to detect, locate, and target operational air defense.
• Missile uses GPS, and active seeker to target turned off radars, and identify decoys.
• SEAD aircraft should be able to receive target information from external sources.
• Other types of weapons may be used.
ISR relay threat locations to SEAD aircrafts
SEAD aircraft\ missiles
Why jam acquisition radar

• Jamming acquisition radar will deny\delay cuing TTR to lock-on and track targets.

• If break lock-on has accrued, jammed acquisition radar will not be able to recue TTR. To regain lock-on.

• Jamming acquisition radar will force the operator to spend more time on the air, making it easy target for SEAD operation.

• Use of support jammer for this mission
Support jamming

- Conducted to jam early warning and acquisition radars
- Employed by separate dedicated aircraft.
- Conducted outside the lethal range of missiles to provide support for friendly attacking aircrafts (stand-off jamming).
- Employ escort, and/or stand-off jamming to stay outside missile lethal range of missile.
- Can simultaneously protect multiple attacking aircrafts
Support jammer

- Alq-99 bud carried by f-18 growler \EA6B
Support jamming

- Can employ noise or deception techniques
- Have enough power to jam antenna side lobs.
- Multiple bods and/or multiple jamming aircraft may be required to maximize protection.
- Stand-in jamming may be performed using UAV\MALD with smaller jamming systems.
Stand-off jamming

- Stand-off jamming should be accomplished in the side lobes
  - Using modulated noise
  - To prevent the use of home-on jam missiles
  - The precise direction to the attack is not revealed
- Modern radars employ advanced waveform, low side lobe antennas, side lobes canceler & blanker.
- Smart noise and deception jamming have better chance of being unaffected by side lobe canceler and blanker
Stand-off jammer

- Typical SOJ provide high power to jam antenna side lobes and minimize burn through range
- consists of ESM with DF capability to provide situation awareness.
- Multiple jamming transmitters coupled through directive antenna to provide high ERP
- Power management system to allocate jamming resources
Stand-in jamming

- Small jamming system
- Carried by UAV\RPV or air launched decoy
- MALD-J loiter and jam decoy
- Expendable decoy modified to employ jamming
- Launched from F-16, F-18, and C-130, tested on f-15
- Fly preprogramed rout
- Employ close-in, and stand-in jamming
- Can be integrated with other platforms to work as a net jammers
Stand-in jamming

- MALD decoy
noise jamming

• stand-off in jammer may Employ noise jamming to target search radars (Early warning & Acquisition)
• Can jam main lobe and/or side lobes (high power is required)
• Jammer, attacking aircraft and the targeted radar need to be lined-up for main lobe jamming.
• Burn-through range shall be at minimum
• Care should be exercised when executing noise and deception jamming from the same platform against the same threat.
Self protection jamming

- Carried on targeted aircraft itself.
- Targets TTR, and may targets missile seeker head.
- It’s mission is to prevent reduce kill through deny lock-on, brake lock, or induce enough miss-distance.
- If brake lock-on has occurred, air defense system has to go back to acquisition radar to acquire lock-on again.
Monopulse radar deception

- Not easy to deceive in angle.
- Range gate pull-off is possible
- Miss distance in range may not provide protection even with enough miss-distance due to missile fusing close to the target
Coherent jamming

- Pulse Doppler radar have the ability to distinguish between skin return and jamming signal.
- DRFM based jammer can provide coherent jamming techniques to counter such radars.
- Can generate both reactive, and pre-emptive jamming techniques.
- Slight variation in frequency can be made to create Doppler errors.
- Can be used for cross-eye jamming to create distorted phase-front at the receiving antenna to counter monopulse radars.
- Can be generated by DRFM based jammers
DRFM based jammer

• Can be used for both self-protection & support jamming
• DRFM based jammer (when directed to search radars) have the ability to generate multiple moving falls targets, causing extreme confusion in enemy air defense system denying \ reducing engagements with attacking aircraft,
• DRFM based jammer support advanced target simulation through complex target scatter generation.
• Less power is required.
DRFM jamming

• Most DRFM s are inherently single-threat in nature
  • the content of the memory will be overwritten by extraneous signals unless prevented at the system level
  • ECM effectiveness can be unacceptable.

• Using real time pulse de-interleaving, a single DRFM can be used to jam multiple radars on timeshared basis.

• A type of controller is needed on system level to perform real time pulse de-interleaving for ECM applications.
  • Select/deselect emitters for ECM
  • control DRFM write and read signals to implement ECM timesharing on the selected systems
Active air-air missile

- Jamming should aim to deny lock-on.
- Missile may guide without directions from TTR.
- Hard to counter once seeker head is activated.
- Towed radar decoy is effective if deployed with right maneuver.
Towed Radar Decoy

- Toed behind aircraft when deployed.
- Active, transmitting right RF signals
- Techniques generator onboard aircraft passed through fiber optic cable.
- Deployed with the right tactics to lure incoming missile.
- Can be retracted, or jettisoned if not used.
TRD

• There are number of these decoys type developed by Selex, Raytheon, BAE America, and cassidian.
• Has provided combat proven aircraft protection against RF missile threats.
• Used on Typhon, f-18, b-1, tornado IDS and others
Phased array radars and countermeasures

- Phased array radars allow for multiple simultaneous beams.
- Can change frequency from pulse to pulse, and it is capable of spreading its frequency across a wide band
- High power, and rapidly deployable
- Low probability of intercept (LPI)
- Can be switched to receive only to track jammer
- Anti-access Area denial (A2\AD)
Phased array radars and countermeasures

- Broadband Noise jamming does not have enough power.
- Highly sensitive RF ESM receivers combined with off board real-time ISR data on threat locations
- Jammer with AESA technology and fast processing capability with very high power is required.
- Multi platform employing cooperative jamming.
- Low altitude approach
- Stand off missiles
New trends in EW capabilities

- Advanced digital RWR that can detect LPI signals, de-interleave similar signals, and identify emitters.
- Advanced EW suites featuring integrated digital RWR, and missile warning system.
- EW systems are highly integrated to automatically fuse and correlate data from all sources, on and off-board and present it on a multifunction display, or helmet-mounted display.
- EW suites should provide emitter geo-location.
New trends in EW capabilities

• AESA radars high-gain antenna can be exploited by RWR, in addition AESA radar can provide some EA capabilities.
• Fiber optic towed radar decoy.
• Advanced active RF expandable decoy (Brite Cloud)
• Future jamming capabilities.
BriteCloud

- Developed by SELEX
- DRFM driven
- Solid-state power source (High ERP)
- Compact wideband antenna
- Mission programmable
- Employ a variety of jamming techniques to defeat modern RF guided missiles, fire control radars, and TTR
The future jamming system

- self-protection jammer will have some support jamming capability.
- DRFM based jammer with AESA technology
- Wide band DRFM.
- Multi jammers using real-time data link to coordinate their jamming actions.
- Cover low band threats, and millimeter wave
- Able to jam communication in addition to radars
Next generation jammer

- Expected to inter service around 2020 to replace ALQ-99
- Very high power output using AESA antennas
- Include cyber warfare
Cooperative jamming

Phased array
Aircraft protection

End of presentation

Thank you