ECE 495 – Electromagnetic Warfare and Survivability

Block 2: RF Electronic Warfare
Lesson 18: Active Deception

Juan Jurado, Col, USAF, Ph.D.
Permanent Professor and Head
Electrical and Computer Engineering

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Where We Left Off

L17 was **noise**: raise the floor until the real return drowns. Brute force — and burn-through eventually beats it.

Deception is the surgical option. Instead of hiding the target, hand the radar a *convincing lie* and let it track that.

Today: DRFM, false targets, gate pull-off, and decoys — the deception toolkit.

Lesson Objectives

By the end of this lesson, you will be able to:

- Contrast **deception** with noise jamming
- Explain how a **DRFM** repeater builds believable false returns
- Walk through **range-gate pull-off** step by step
- Describe **towed** and **expendable** decoys

Deception: Make the Radar Track a Lie

A tracker keeps its books in **bins** — a range cell, a Doppler cell, an angle cell — one per quantity it follows.

- Noise **masks** a bin; deception **fills** or **shifts** it with a false but believable return
- The radar locks the strongest, most plausible return — not always the real one
- Win the bin and you own what the radar thinks is true

Noise denies the picture; deception paints a fake one.

From Transponder to DRFM

- **Transponder** — reply to each pulse after a *fixed delay*; makes a range-false target, but non-coherent and easy to flag
- **DRFM** (Digital RF Memory) — digitize, store, and replay a **phase-coherent** copy under software control
- DRFM sets precise **delay, Doppler, amplitude**, and can replicate pulses — false returns that look real

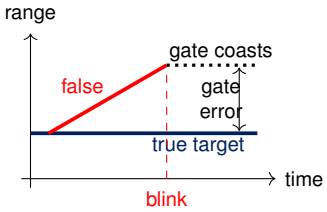
A coherent copy earns the radar's own matched-filter gain — the lie is as loud as the truth.

False-Target Injection

Fill the range/Doppler bins with believable replicas:

- A **search** radar drowns in plausible contacts — which one is real?
- A **tracker** can be seduced into locking the wrong return

Stealing the Gate: Cover Pulse then RGPO



1. **Cover pulse** floods the range bin — the gate locks the jammer, not the target
2. **Grow the delay** — the false return walks out and drags the gate with it
3. **Blink off** — the gate coasts in empty space; the target has escaped

VGPO does the same in Doppler; together they pull a range-Doppler diagonal.

Angle Deception: Inverse Gain

Range and Doppler are not the only bins — the **angle** track can be fooled too.

- A monopulse radar reads angle error from its Δ/Σ (difference-over-sum) ratio
- Inverse-gain jamming transmits a **phase-inverted** Δ to null that ratio
- The radar reads *zero* angle error — the tracker freezes or drifts off

Modern digital monopulse and ECCM blunt this — but the principle still drives decoy design.

Decoys: Towed and Expendable

If you cannot fool the gate from on board, give the radar a *better* target to lock:

- **Towed decoy** — a repeater trailed behind the aircraft; brighter and offset, it seduces the lock away
- **Expendable decoys** (MALD, ITALD) — saturate the picture, bait radars into radiating, transfer the lock
- Active decoys beat **chaff** — no zero-Doppler notch, and they look real

The safest target to shoot at is the one that is not you.

Deception Isn't Free

Every trick has a counter — the ECCM half of the duel:

- **Leading-edge tracking** beats RGPO — the real skin return always arrives first
- **Digital monopulse** and track logic blunt angle deception
- **Processing gain, polarization, waveform agility** expose the copy
- A coherent DRFM replay still leaves **fingerprints** — timing and phase artifacts

Deception buys *time* and *doubt*, rarely a permanent kill of the track.

Today's Interactive Demo: Walk the Gate

Today's interactive demo.

- Place a true target at fixed range and a DRFM false return on top of it
- Grow the false return's delay — watch the gate follow it outward
- Blink the jammer and measure how far the gate sits from the target

Companion script: `L18_RangeGatePullOff.m`

The jammer disappears at the end. The radar is still looking the wrong way.

Quick Exercise / Type-along: Spot the Deception

For each, name the technique and a counter:

1. The tracked range slowly walks away while the real target holds steady.
2. The scope fills with a dozen identical contacts at different ranges.
3. The monopulse angle error reads zero, yet the target is clearly off-boresight.
4. A bright return separates from the aircraft and the missile follows it.

Wrap-Up

Key ideas:

- Deception fills or shifts the tracker's range, Doppler, and angle bins
- DRFM replays a coherent copy — a false return as loud as the real one
- Cover pulse then pull-off walks the gate off the true target
- Decoys give the radar a brighter target to lock; ECCM fights back

Next lesson:

- **L19: Project 2 work day** — B-21 RWR AoA characterization
- Block 2's EW toolkit now goes to work on a real scenario