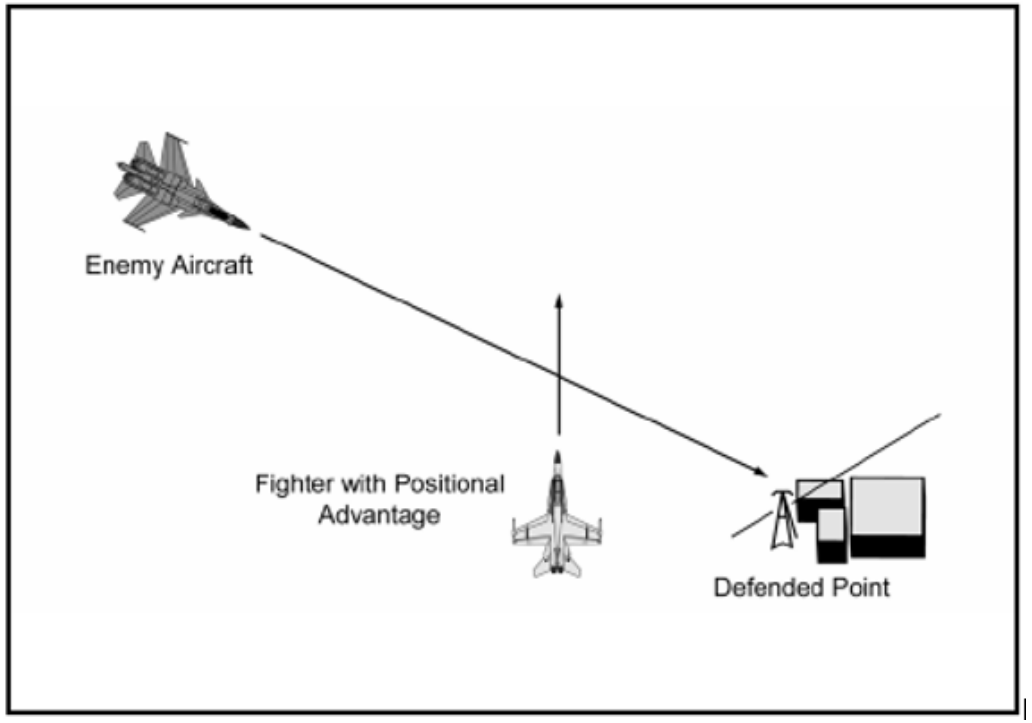
Intercept Geometry and Progression

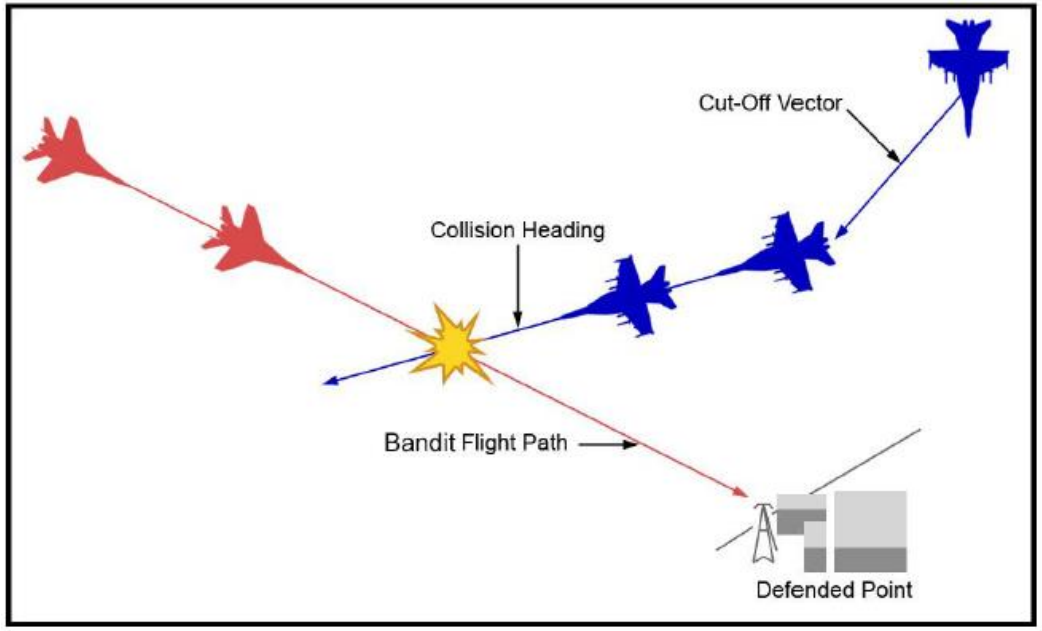
Purpose

- Obtain and sustain air superiority over contested airspace. To successfully accomplish this, the fighter aircrew must execute an intercept in a manner designed to:
  - Attain a position in space between the attacking aircraft and the defended force (positional advantage)
  - Control the intercept geometry to achieve an optimal weapon's Launch Acceptability Region (LAR) and manage the enemy's Weapons Employment Zone (WEZ). This is done to maximize the probability of kill (Pk), while simultaneously preventing the enemy from achieving weapons release
  - Arrive at the merge with an advantage in position and/or energy. Then use basic fighter maneuvers to deter or destroy the enemy



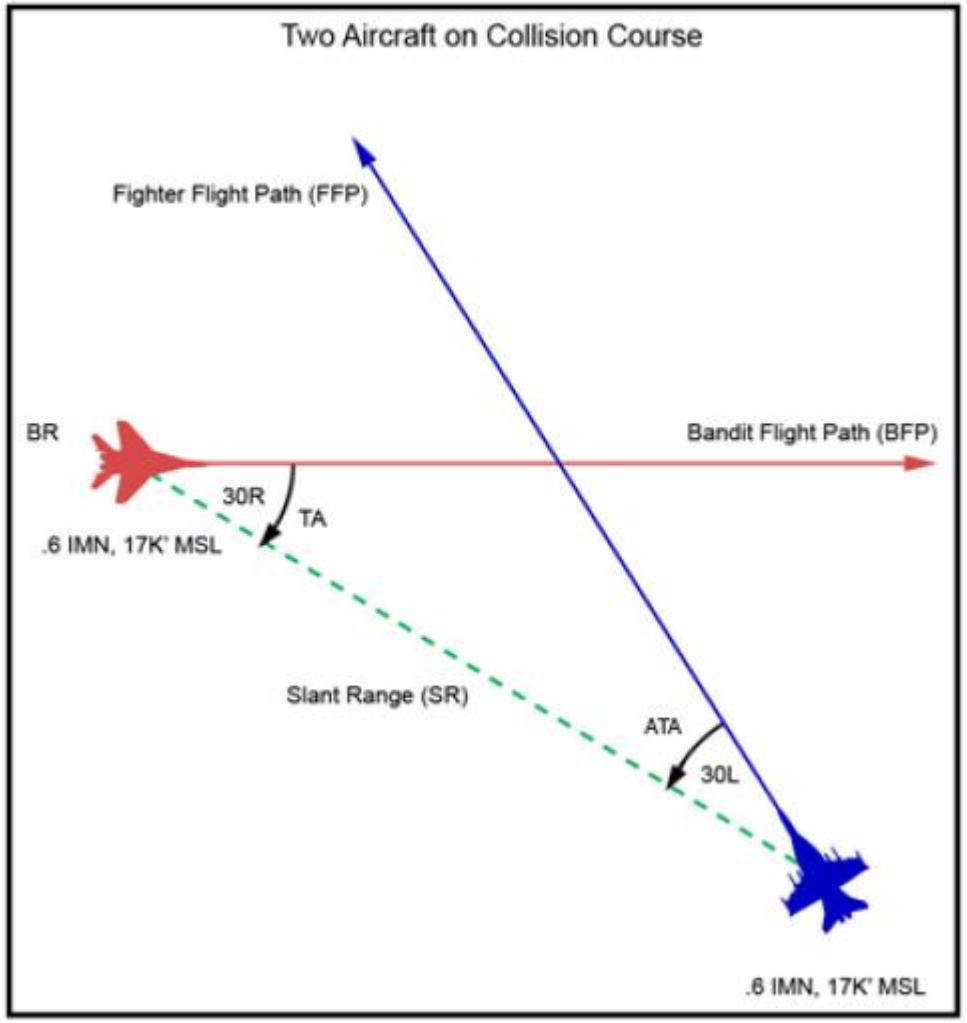
Establishing Positional Advantage

- Normally, there are two primary methods that a fighter may use to close on a bogey:
  - Establish a cut-off vector in order to obtain positional advantage
    - A cut-off vector is one that will place the interceptor in a position between the bogey and the defended point
  - Establish a collision course
    - A collision course is a vector that will allow the fighter to close on the bogey in the fastest possible manner



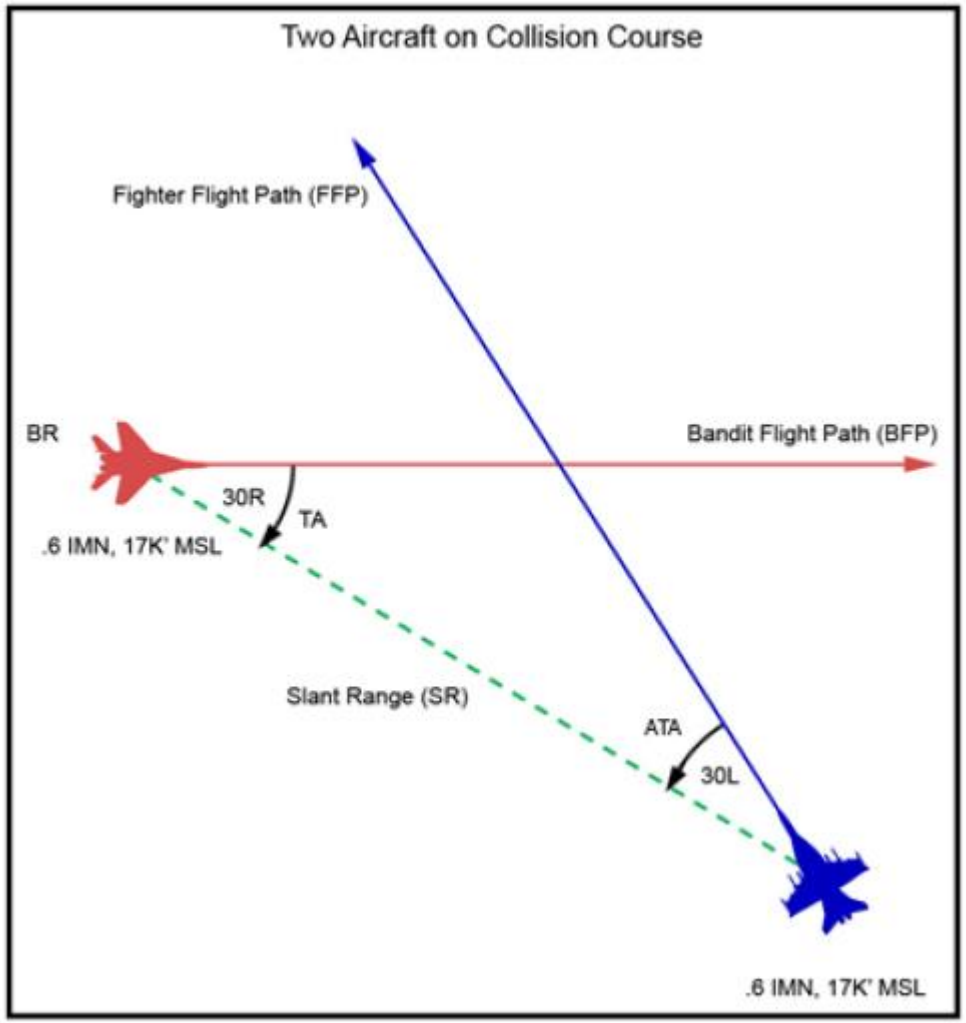
Collision Course

- A collision course is a straight-line course where the angle at which the fighter sees the bogey (Antenna Training Angle or ATA, also called Angle Off or AO) and the angle at which the bogey sees the fighter (target aspect or aspect angle) (TA) remains constant with decreasing range
  - In a co-speed situation, the two angles will be equal, but in opposite directions
- This situation is also known as constant bearing, decreasing range (CBDR)
- When a speed differential exists, the angles will not be equal. However, if the fighter is on a collision course, the angle off (AO) and the target aspect (TA) / aspect angle (AA) will remain constant. There exists only one collision course for a given speed ratio.
- A successful conclusion to a collision course would be a mid-air collision if both aircraft were at the same altitude



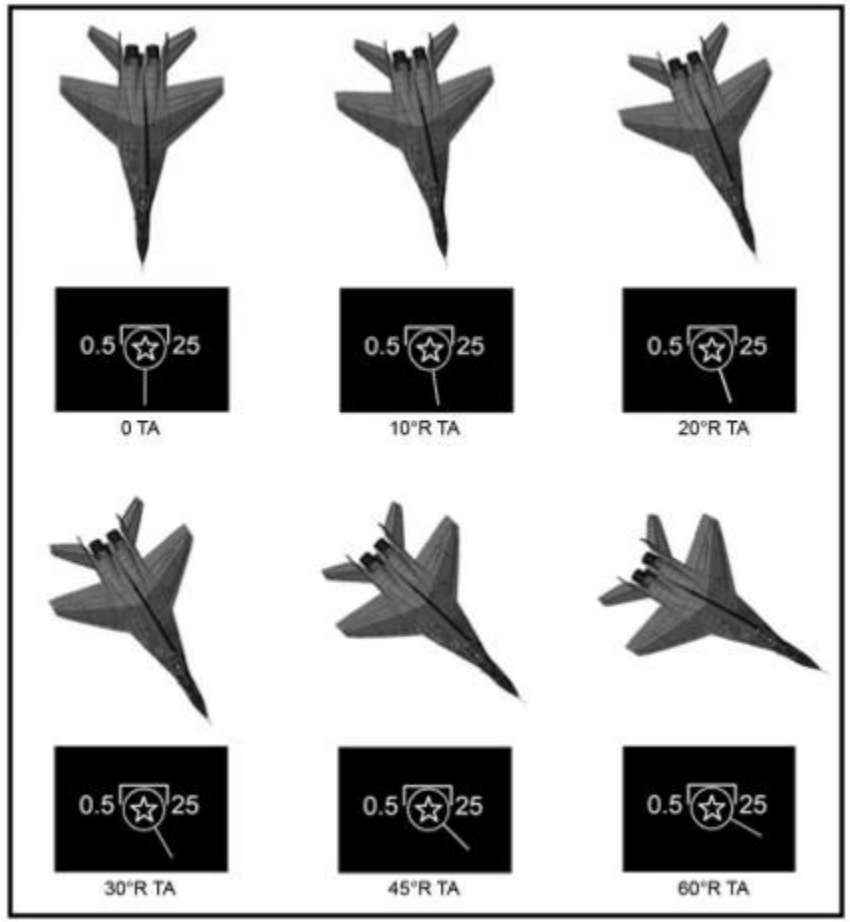
Intercept Terms

- Target Aspect (TA) is the angle from which the bandit sees the fighter
- Antenna Training Angle (ATA), also called Angle Off (AO) is the angle from which the fighter sees the bandit
- Slant Range (SR) is the straight-line distance between the bandit and the fighter
- Bandit Heading (BH) is the heading of the intercepted aircraft and Bandit Flight Path (BFP) is the extension of the bandit's travel through space on the current BH
  - Fighter Heading (FH) and Fighter Flight Path (FFP) are similar terms for the fighter
- Bandit Reciprocal (BR) is the bandit's reciprocal heading and Bandit Bearing (BB) is the bearing between the fighter's position and the bandit's position



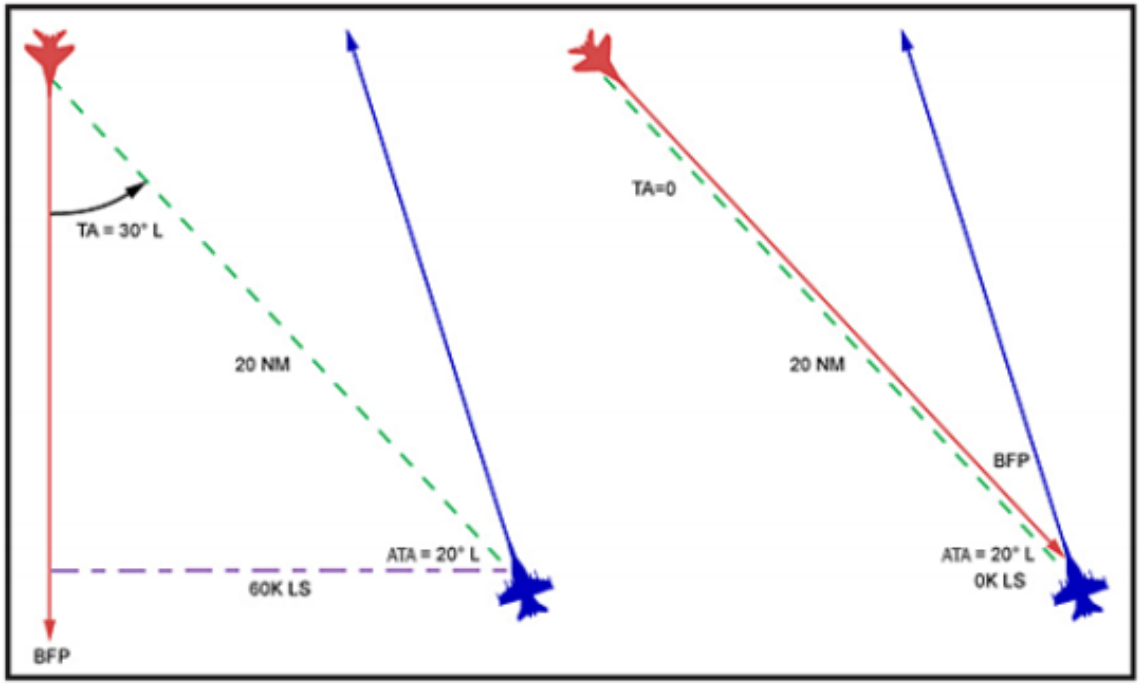
Target Aspect Recognition

- It is important to be able to interpret TA to within 10 degrees from the radar attack display



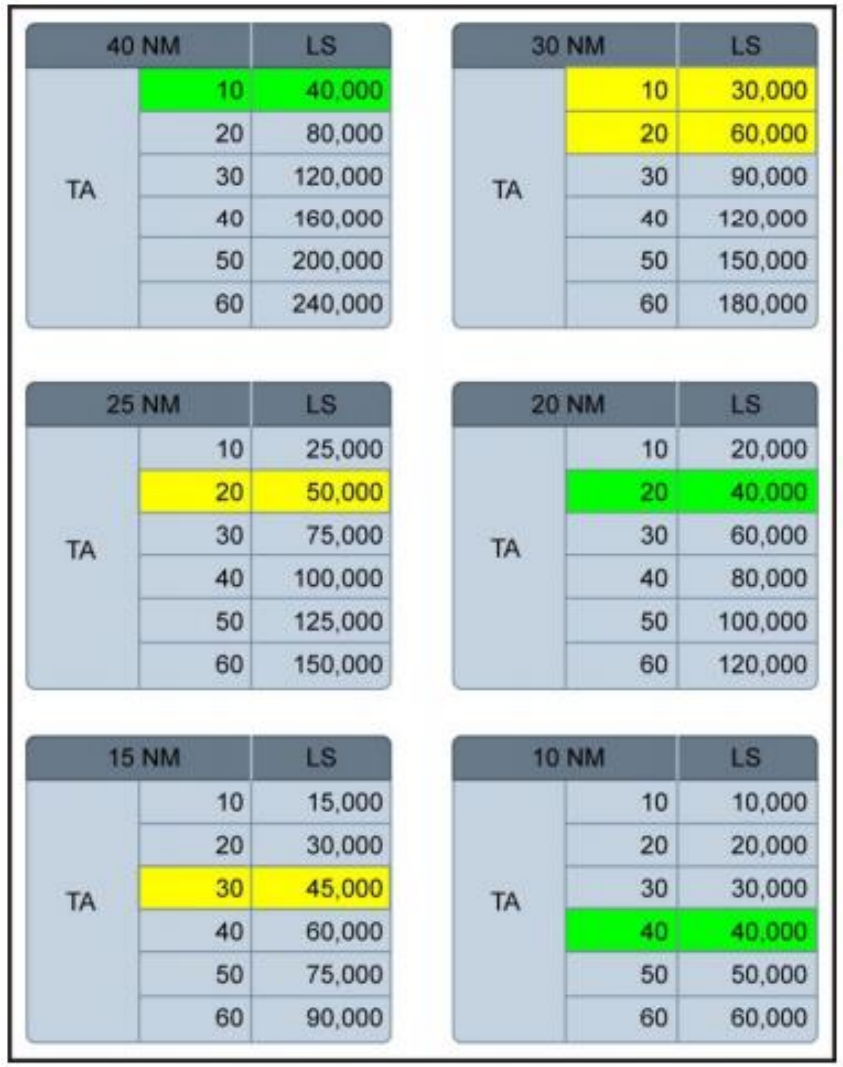
Intercept Terms

- Lateral separation is the horizontal distance from the fighter to the BFP. LS is turning room. LS (in thousands of feet) is computed by: LS = TA x SR x 100. Since SR will only change over time, but TA can change instantaneously, LS will change instantaneously with changes in TA and very slowly with changes in SR



Lateral Separation Goal

- **The lateral separation goal of an intercept is to have 40K feet of lateral separation at 10NM (TA=40)**
- With 40K of LS the fighter has enough turning room to turn nose-on at 10 NM, maintain pure pursuit and rollout in a rear quarter (RQ) LAR for an SRM
- In order to meet this goal, the fighter will have to do one of the following:
  - Turn to create LS
  - Turn to preserve LS
  - Turn to remove LS
- Which type of turn will be required can be determined at various points during the intercept by memorizing the lateral separation gates that are the goals during the intercept



40 NM	LS
10	40,000
20	80,000
30	120,000
40	160,000
50	200,000
60	240,000

TA

30 NM	LS
10	30,000
20	60,000
30	90,000
40	120,000
50	150,000
60	180,000

TA

25 NM	LS
10	25,000
20	50,000
30	75,000
40	100,000
50	125,000
60	150,000

TA

20 NM	LS
10	20,000
20	40,000
30	60,000
40	80,000
50	100,000
60	120,000

TA

15 NM	LS
10	15,000
20	30,000
30	45,000
40	60,000
50	75,000
60	90,000

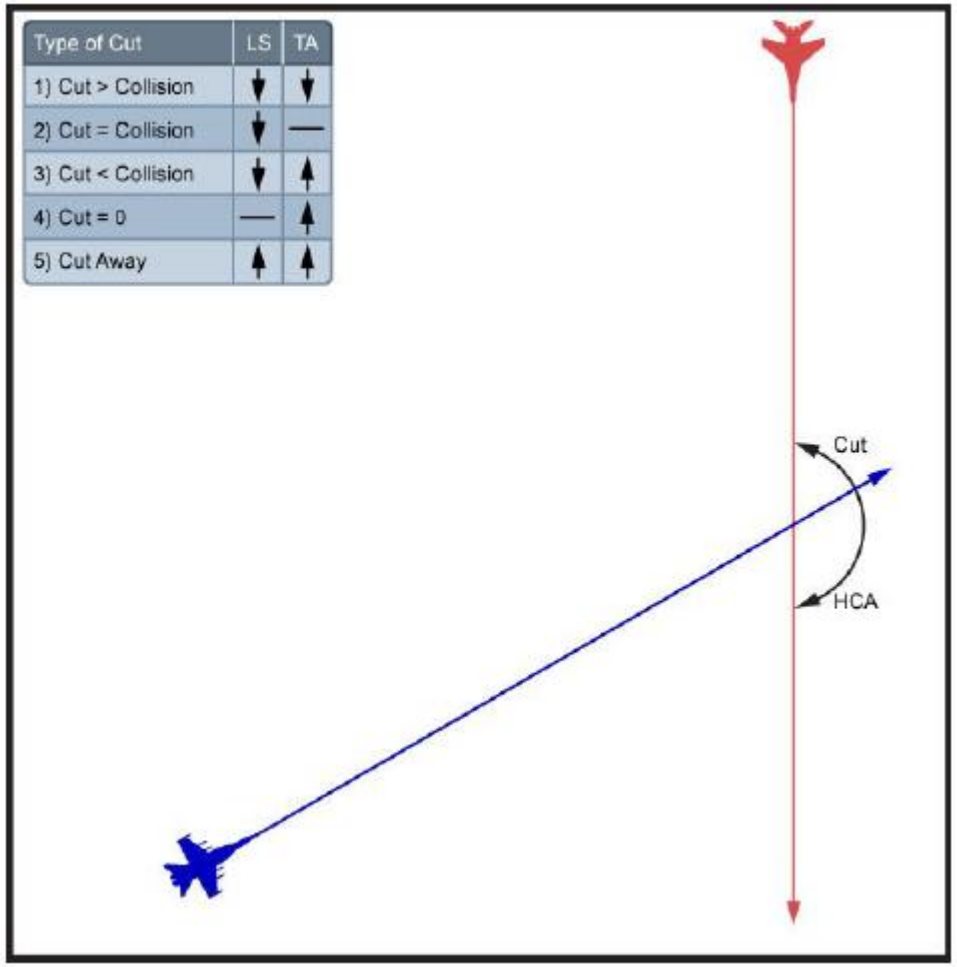
TA

10 NM	LS
10	10,000
20	20,000
30	30,000
40	40,000
50	50,000
60	60,000

TA

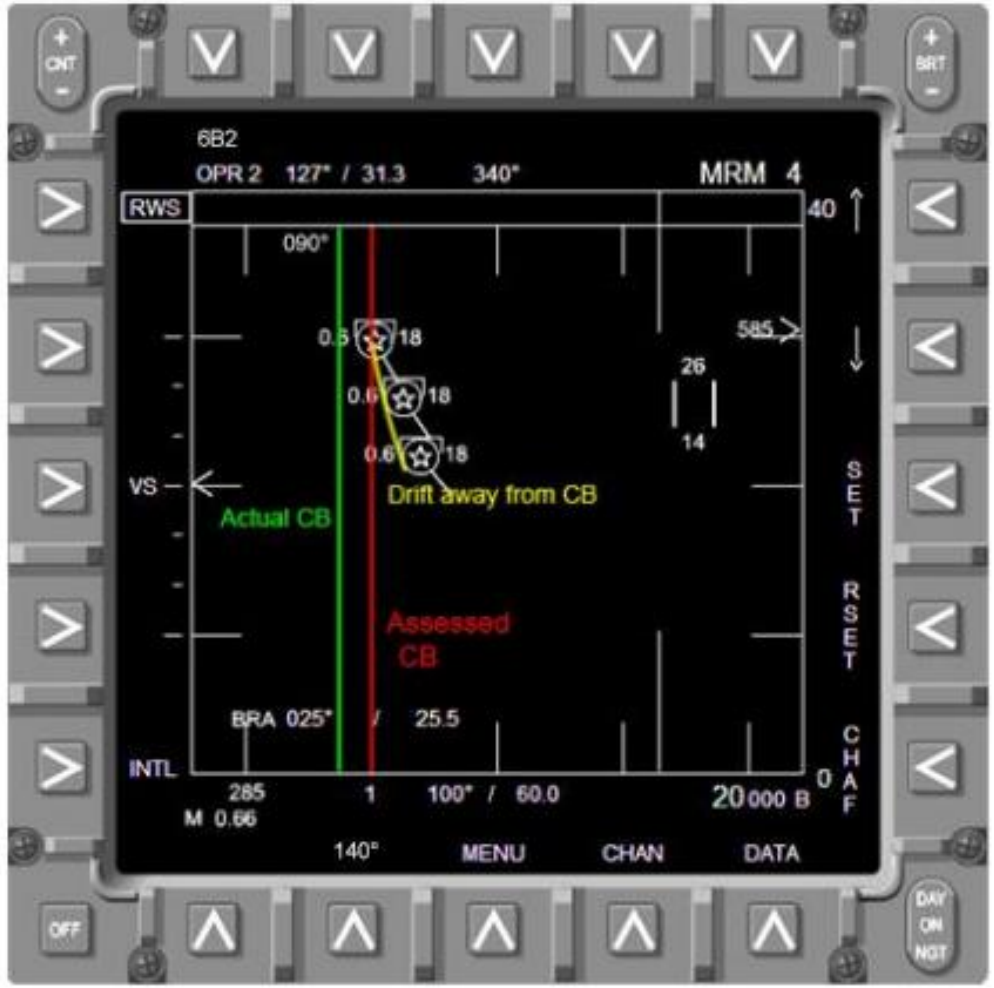
Other Intercept Terms

- Heading Crossing Angle (HCA) is the number of degrees between FH and BH at the point of intercept.
- Cut is the measure of angle from FH to BR which is equal to 180 degrees minus HCA.



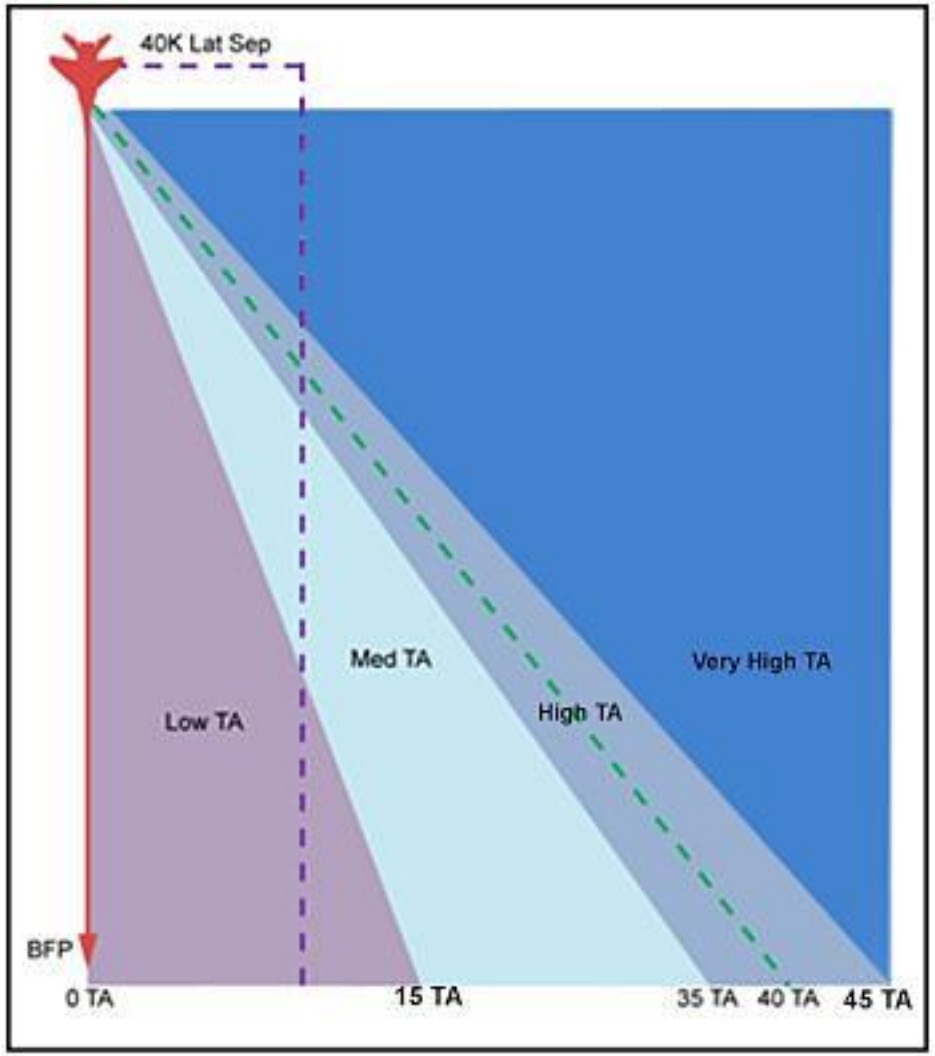
Drift

- If a CB intercept is not established, then one of two things can happen:
  - The bandit will pass in front of the fighter (a good thing at close range)
  - The fighter will pass in front of the bandit (a bad thing)
- A contact not on a collision course will be subject to intercept drift
- This intercept drift will always be away from collision bearing



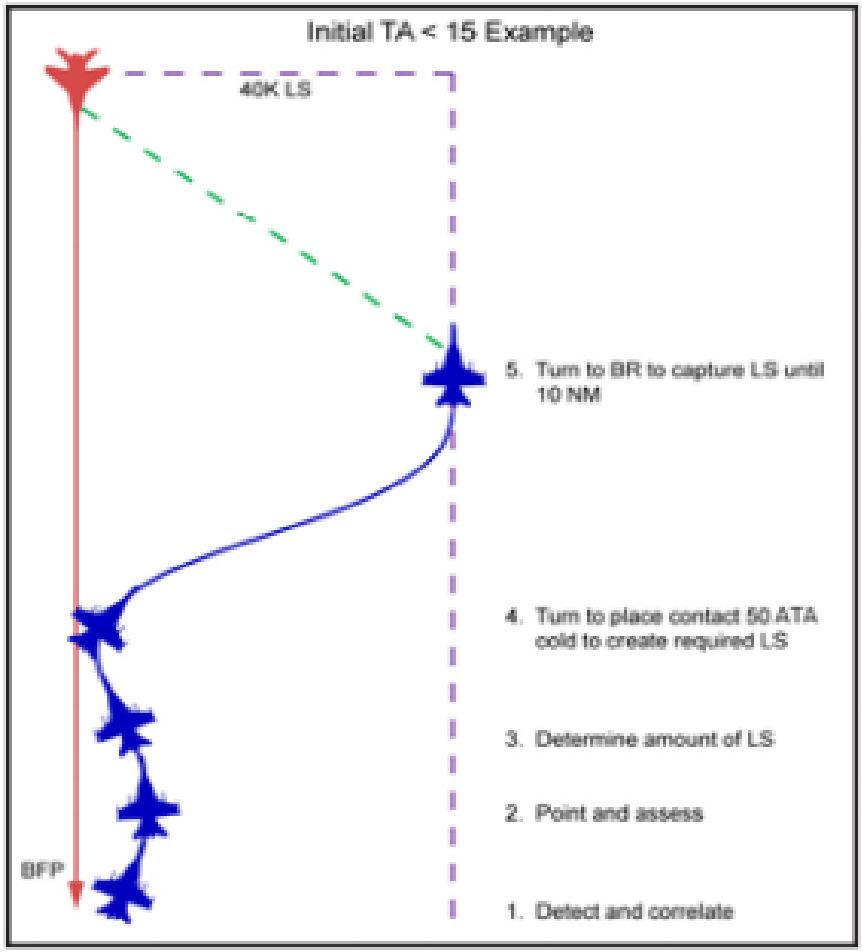
Intercept Game Plan –Low TA

- Low TA setups are those with TA of 0 to 15 degrees and are characterized by initial rates of closure equal to the sum of the fighter and the contact's airspeeds
  - Medium TA setups are those where the TA is between 15 and 35.
  - High TA intercepts begin with TA of 35-45 degrees.
  - Very high TA intercepts begin with TA of >45 degrees
  - Depending on the initial target aspect, the fighter may execute more than one turn to manage geometry; however, the goal will always be to reach 40 TA and hold that on collision to 10 NM or turn to BR with 40K LS and hold that to 10 NM.



Low TA – Kick And Build Game Plan

- With TA at 0, the fighter must build LS (and TA) to meet the 40K requirement. This can be done rapidly at range by placing the contact at 50 ATA cold (away from TA) which is also called the “kick and build” game plan.
- If at any time during the creation of LS, gimbaling becomes a possibility due to contact drift, this can be corrected by turning 10 degrees toward the contact to return it to 50 ATA cold.
- When the 40K LS goal is met, the fighter captures this LS by turning to BR and maintaining this heading until 10 NM. TA will increase to 40 at 10 NM. The fighter must recognize the 20 NM, 20 TA goal, or be ready to turn to BR at 15 NM with around 30 TA.

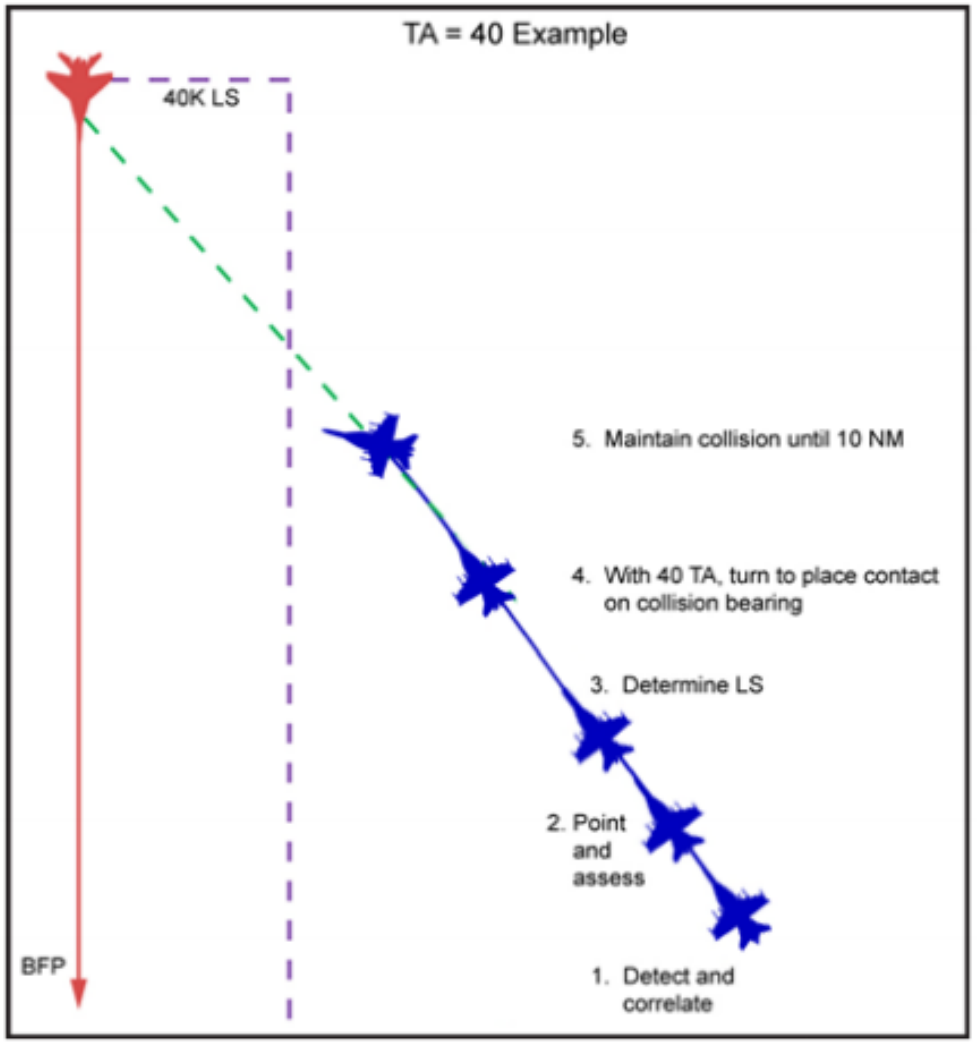


Medium TA Game Plan

- With a TA between 15 and 35 at 30 NM, the fighter has more than enough LS
- Rather than chase the 40K LS goal, the fighter will turn to bandit reciprocal and let TA build to 40
- Once TA approaches 40, the fighter turns to capture 40 TA on collision until 10 NM
- During the turn, the bandit is not yet on collision, so the contact will continue to drift
  - The rule to use to account for this drift is that the bandit will have 1 degree of drift during every 20 degrees of fighter heading change. The turn to capture 40 TA should be 80 degrees of heading change and should be started when the contact is at 36 TA, which normally corresponds to 36 ATA.

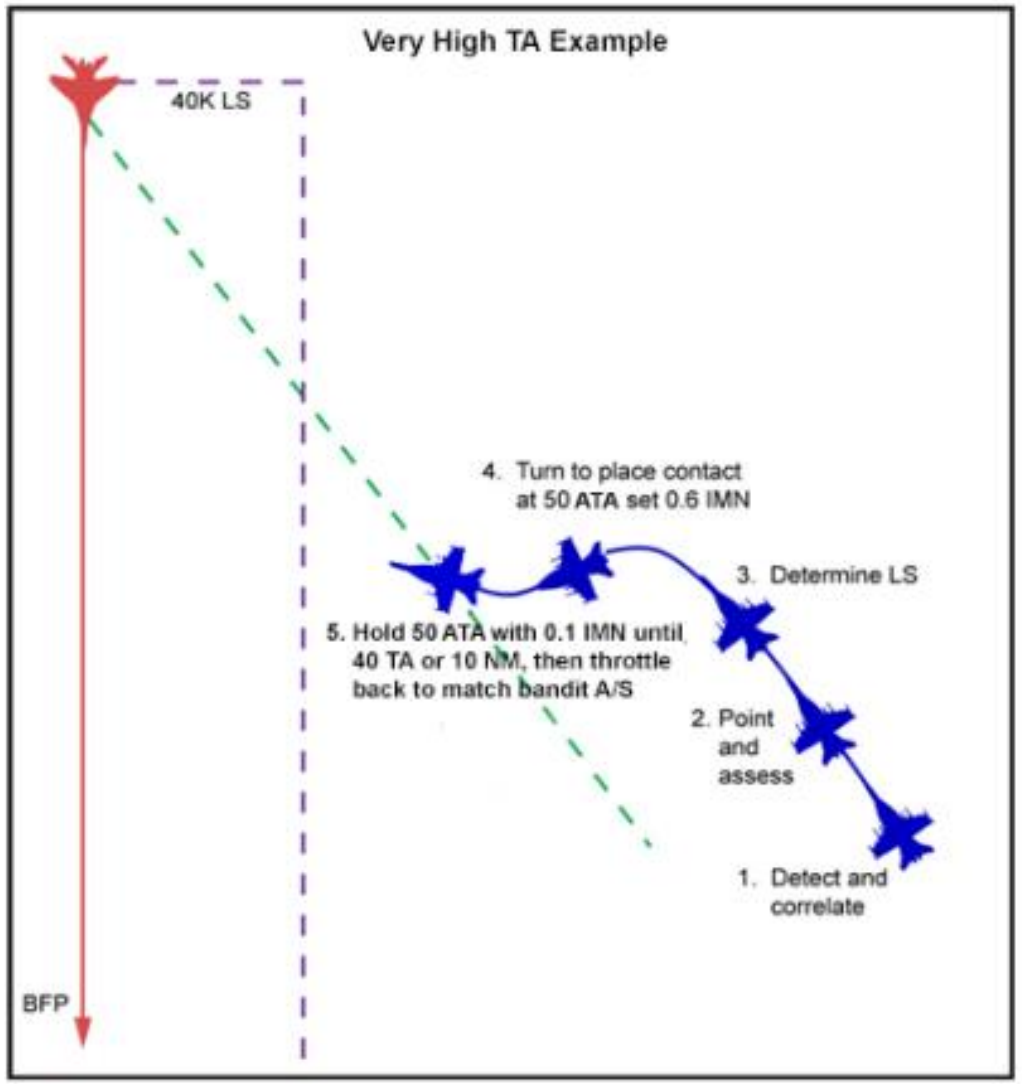
High TA Game Plan

- With a bandit that initially has 35-45 TA, immediately turn to place this near collision bearing at 40 degrees L/R ATA as appropriate and keep the contact there until 10 NM.



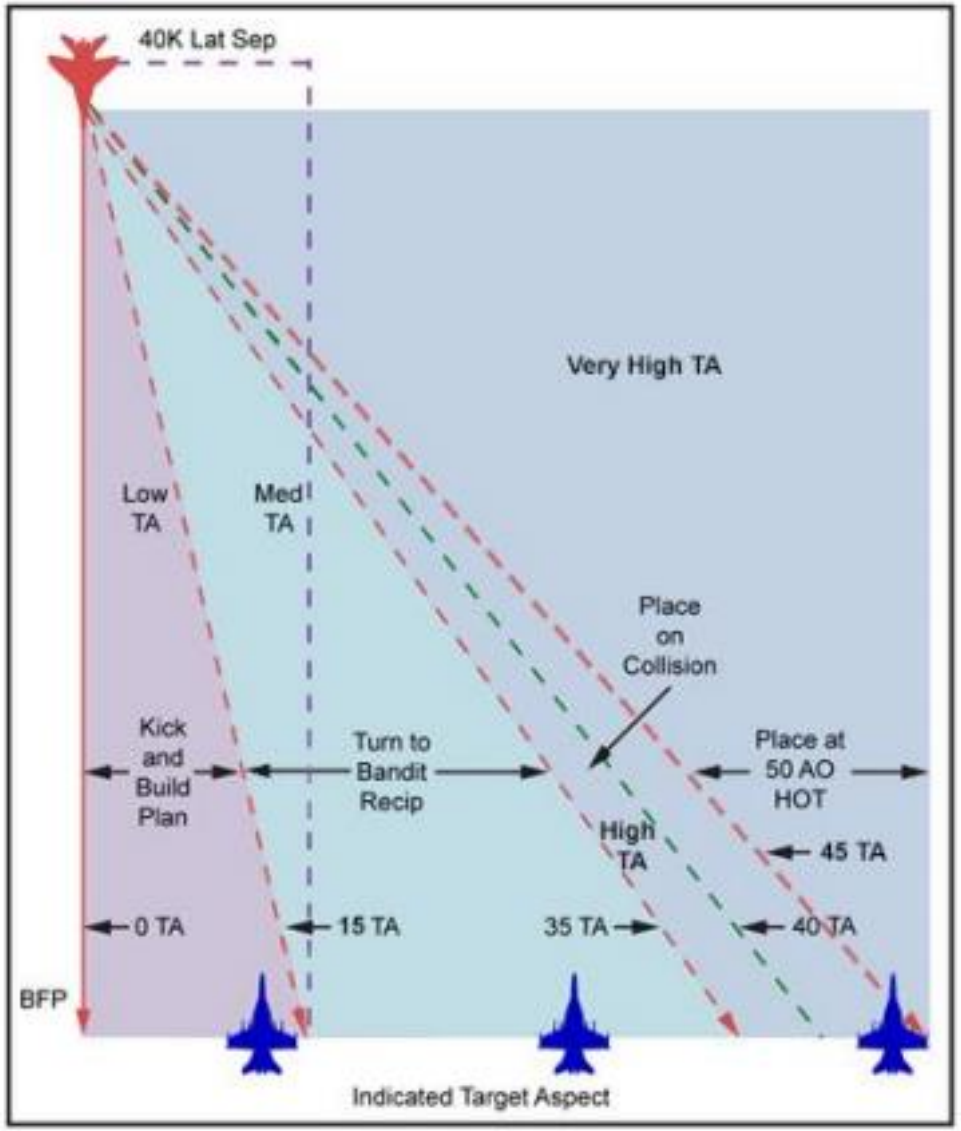
Very High TA Game Plan

- With TA greater than 45 the contact should be placed at 50-60 ATA hot with a 0.1 IMN speed advantage
- For any aspect less than 50, this will reduce both LS and TA
- Once the fighter assesses that 40 TA has been reached, turn immediately to capture 40 TA on collision, remove the speed advantage and continue to 10 NM.



Game Plan Summary

TA Assessment at 30 NM	Initial LS	First Turn	Second Turn	Third Turn
0 – 10	0 – 30K	50 ATA Cold	Bandit Recip	Collision at 40 ATA Hot
20	60K	Bandit Recip	Collision at 40 ATA Hot	Nose-on at 10 NM
30	90K	Bandit Recip	Collision at 40 ATA Hot	Nose-on at 10 NM
40	120K	Collision at 40 ATA Hot	Nose-on at 10 NM	
>=45	135K+	50-60 ATA Hot with 0.1 IMN speed advantage	Collision at 40 ATA Hot and remove speed advantage	Nose-on at 10 NM



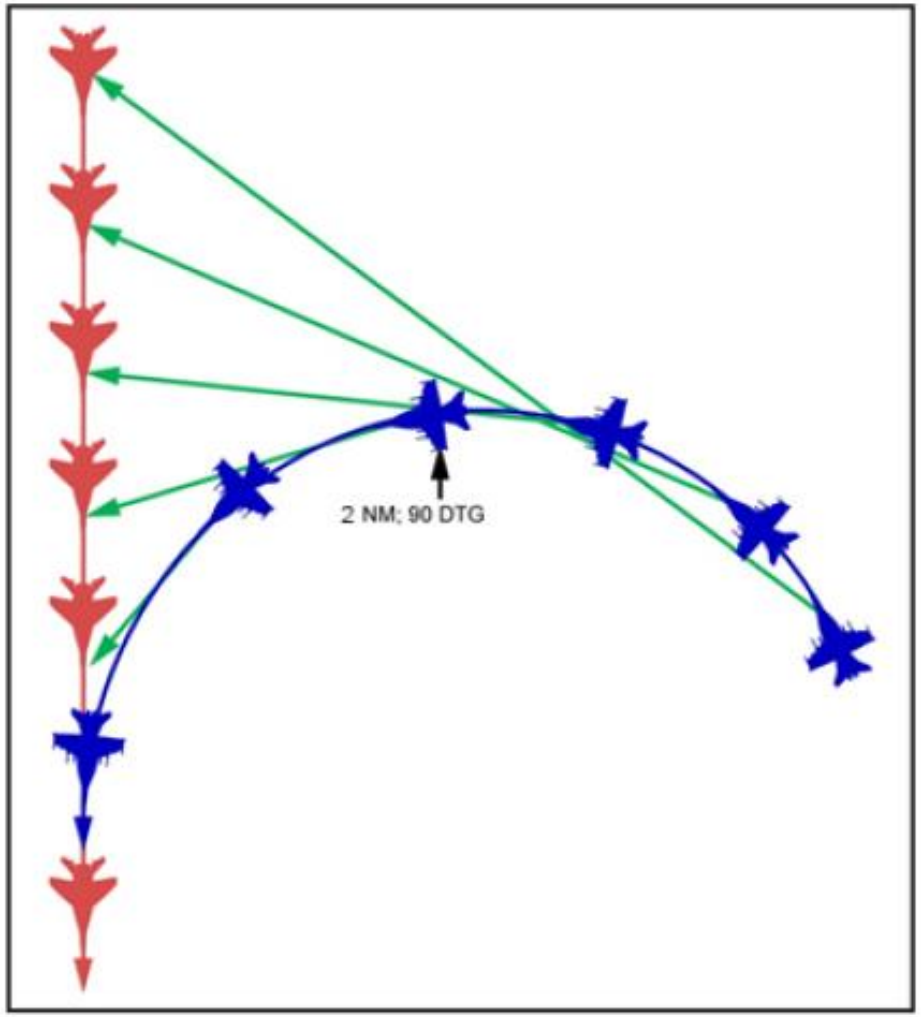
Displacement Turn

- In the event the fighter arrives at 10 NM with significantly more or less than 40K of LS, a maneuver must be made to create turning room while maintaining radar contact with the bandit or other aircraft being joined on
- This turn is called the displacement turn
- Although during an intercept the displacement turn is only executed if the fighter has arrived at 10 NM with more or less than the desired amount of turning room, the principle applies when joining on a formation of aircraft or on an aircraft on a predictable flight path, like a tanker.
- The fundamental rule for displacement is the **Rule of 40**. This rule states that the proper displacement point for a contact at 10 NM is 40 ATA cold minus the current TA

Target Aspect	LS @ 10 NM (in feet)	Displacement ATA (40 ATA Cold - TA)
0	0K	40 ATA, either side
10 L/R	10K	30 ATA L/R
20 L/R	20K	20 ATA L/R
30 L/R	30K	10 ATA L/R
40 L/R	40K	0 ATA
50 L/R	50K	10 ATA R/L

Counter Turn

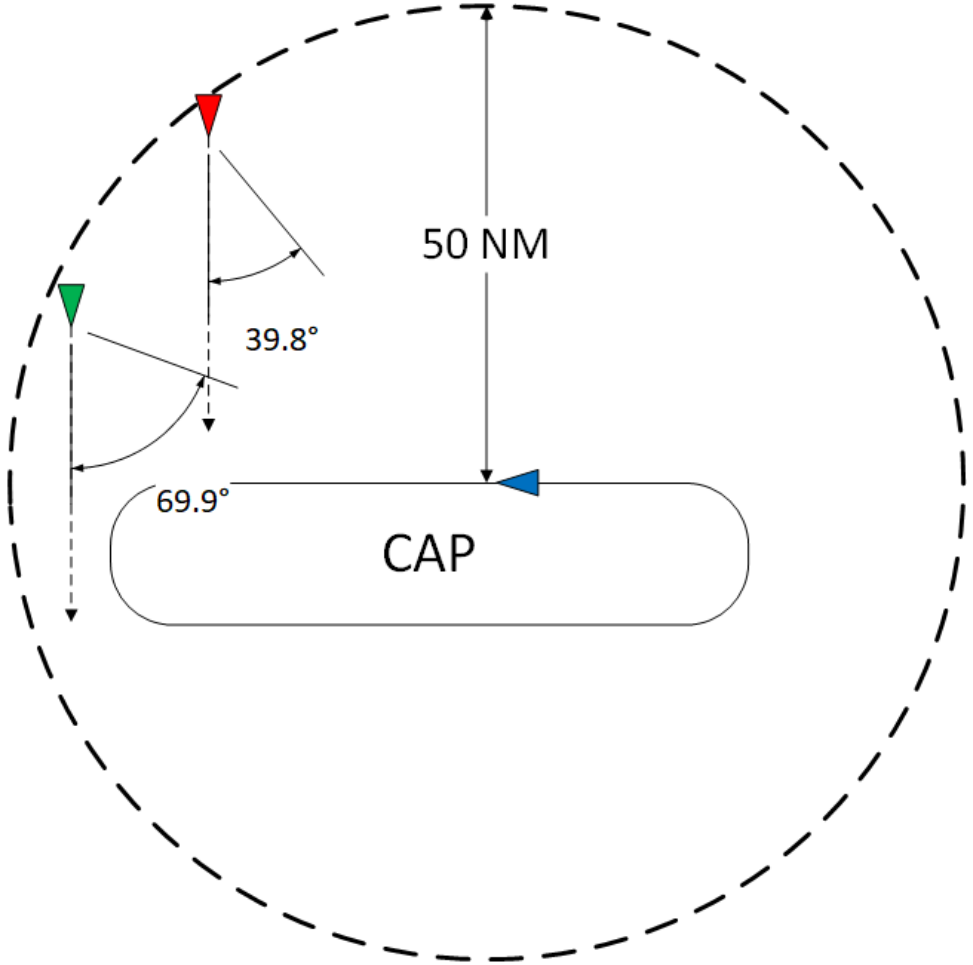
- The 40K LS goal sets up the fighter for this stern conversion turn. Due to the rapidly changing geometry at this stage of the intercept, the fighter must perform a counterturn in order to compensate for intercept drift, maintain radar contact and arrive within SRM parameters in the rear quarter.
- The goal of the rear quarter counterturn (CT) is to arrive in the rear quarter within SRM parameters. It counters outward drift from the contact. Ideally, the CT will begin at 10 NM with 40K feet of lateral separation.
- If the fighter has achieved the goal of 40K LS at 10 NM and brought the contact to the nose on timeline, then the counterturn is easily accomplished.



Intercept Progression

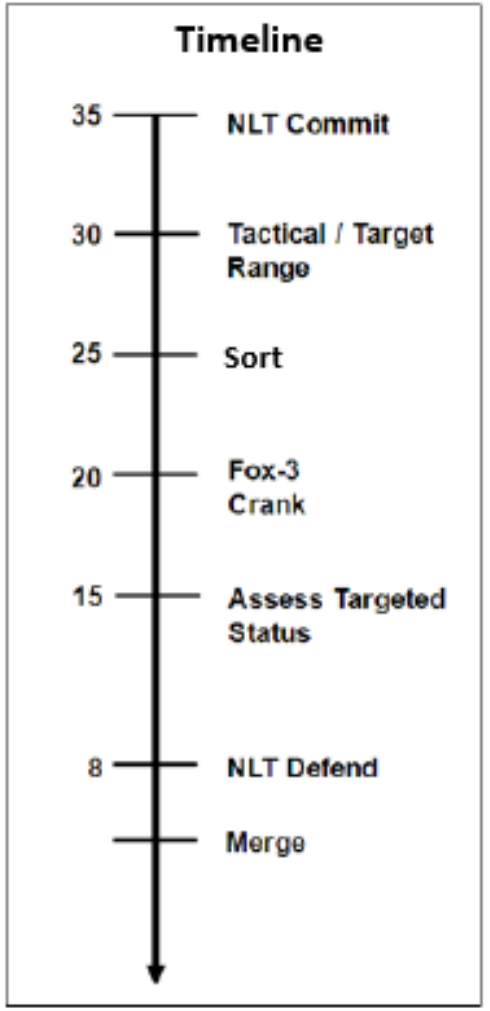
Committing

- An intercept begins with the decision to commit
- Commit criteria is derived from the mission objectives. If the mission objective is to defend a high value asset, the fighter assets will have a more restrictive commit criteria in order to not be “dragged away” from the protected asset.
  - Missions, such as Offensive Counter Air, will have less restrictive commit criteria as they are offensive in nature, vice defensive.
- Commit criteria should be established in the brief. For example, a commit criteria may be:
  - Range <50 NM but NLT 35 NM
  - Target Aspect ≤ 60 degrees (Flanking or less)
- After the commit, accelerate to tactical airspeeds (vice fuel conservation airspeeds on CAP) and work to establish initial intercept geometry.



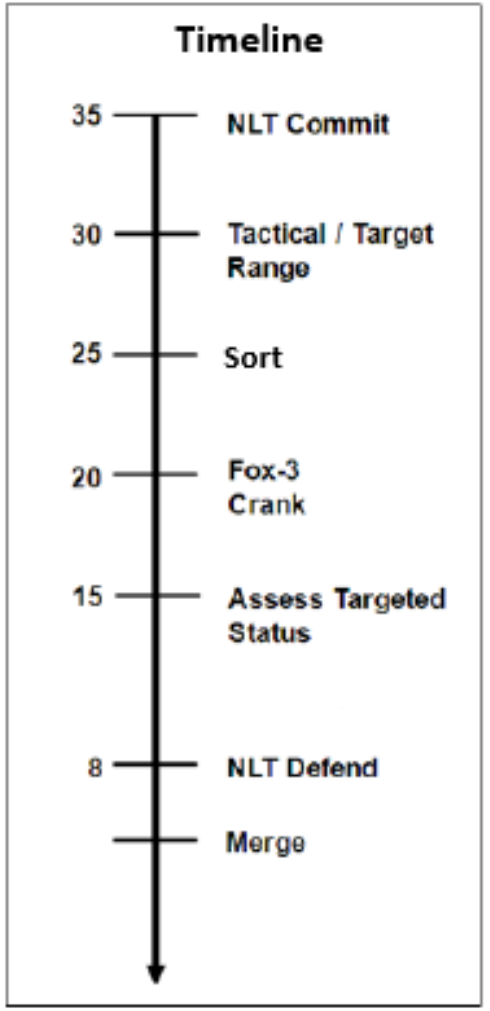
Intercept Phases

- **50 NM - Point and Assess** – the purpose is to gain radar SA in order to establish intercept geometry. Point and Assess does not necessarily need to be done with the contact on the nose of the aircraft, but the fighter should ensure they have radar SA while making decisions on geometry.
- **NLT 35 NM – Commitment and Targeting** - Targeting is used to inform all aircraft concerning the intent to prosecute targets.
  - *"Lion, targeting single group, Bullseye 270 for 100"*
- **30 NM - Tactical Range Call** - A tactical range call is given at 30NM in order to inform all aircraft that the targeting aircraft has begun the intercept timeline.
  - *"Lion, targeting single group 30 miles*"



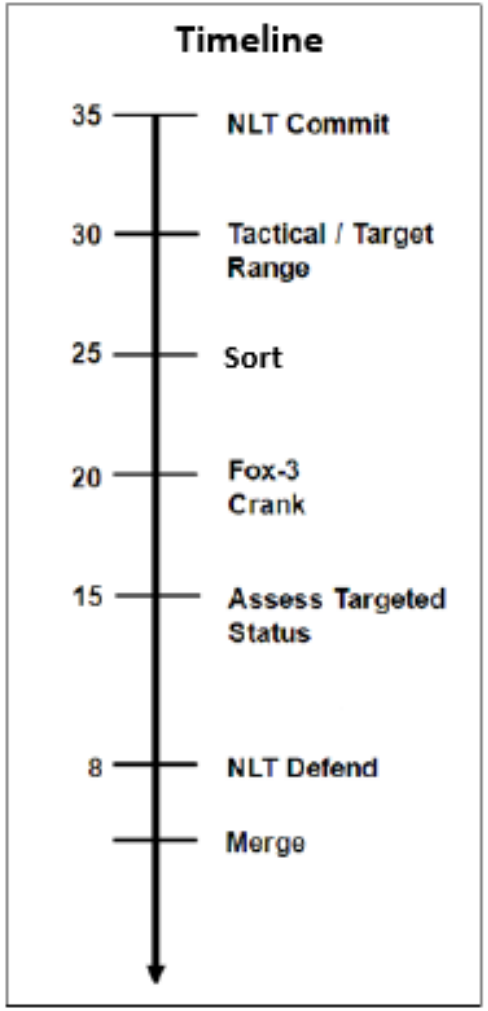
Intercept Phases

- **25 NM - Sort** – A directive call to establish/assign targeting responsibility within a group. Typically, the aircraft on the right targets lead and right, and the aircraft on the left targets left and trail.
- *“One targeting right”*
- *“Two targeting left”*
- **20 NM - MRM Employment** – at 20NM a turn is made to place the target in the LAR and an MRM shot is taken.
  - After weapon release, a crank maneuver is executed to place the target 50 degrees ATA.
  - The crank maneuver:
    - Minimizes threat WEZ and slows the downrange travel.
    - Must be at least 50 degrees ATA to be effective. Fighter velocity vector must have more of a cross-range component than a downrange component.
    - Should be done as to not gimbal the contact, lose track and trash the shot.



Intercept Phases

- **15 NM -Assess Targeted Status/Defend -** Defend after MRM timeout (Pitbull) but NLT defense range (8 NM), whichever is first
- Assuming a 50-degree fighter crank, the defense heading is about 40 degrees more of turn, in the direction to place the bandit in the beam.
  - *"One, defending South"*
- **Merge - Follow-On Employment** - Expect to pitch in to the bandit with 110-130 degrees of turn, out of the defense.
  - *"One, in left"*
- **Post-Employment** – Following the engagement, command a flow heading and work to re-establish SA.
  - *"Lion, flow 090, Angels 10, Smash 400"*



Intercept Geometry and Progression