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# *Winning the Airwaves*

*Regaining America's Advantage in the Electromagnetic Spectrum*

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Center for Strategic and Budgetary Assessments

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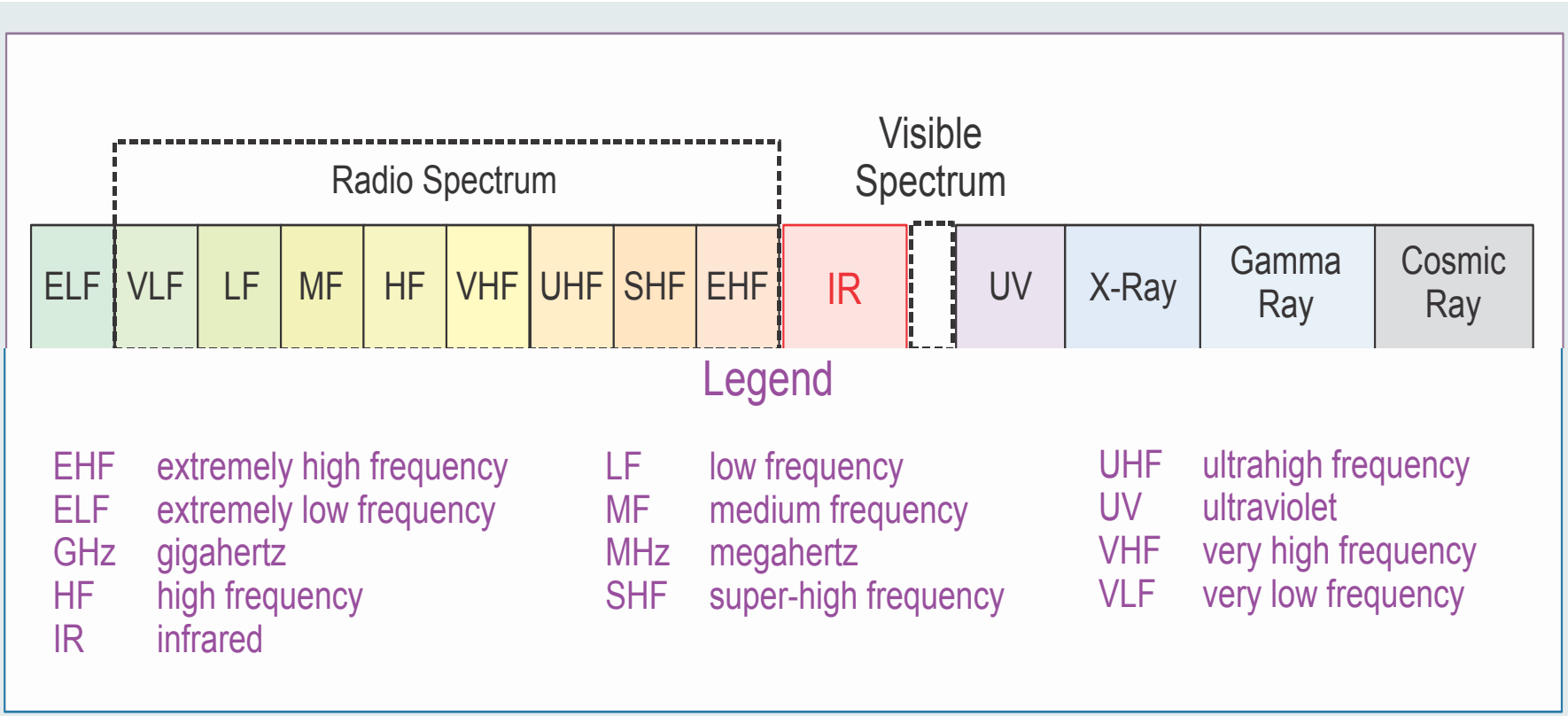
# EMS warfare defined




- All military operations in EMS are elements of EMS warfare
- Not broken up into communications, sensing, and electronic warfare
- EMS a domain analogous to air, sea, and undersea

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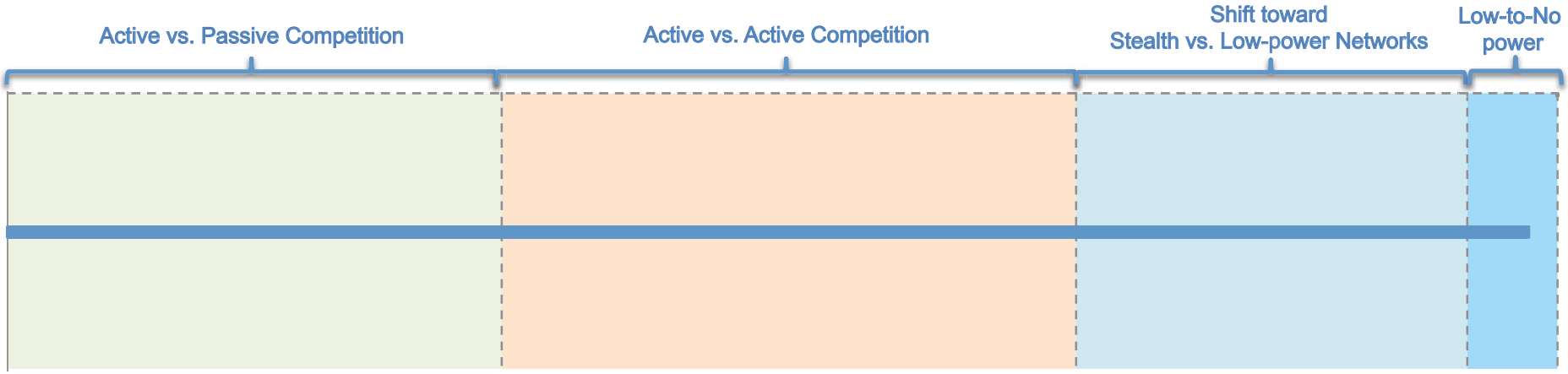
# Hypothesis

- Warfare areas evolve as long-term competitions
- Each moves through phases or "competitive regimes"
  - Driven by predominant operational concepts and technology
- Shifts in competitive regimes are coming
  - EMS warfare, undersea warfare, air warfare, strike, etc.
- The U.S. can advantageously position itself for next phase
  - This should be the focus of "offset" strategies

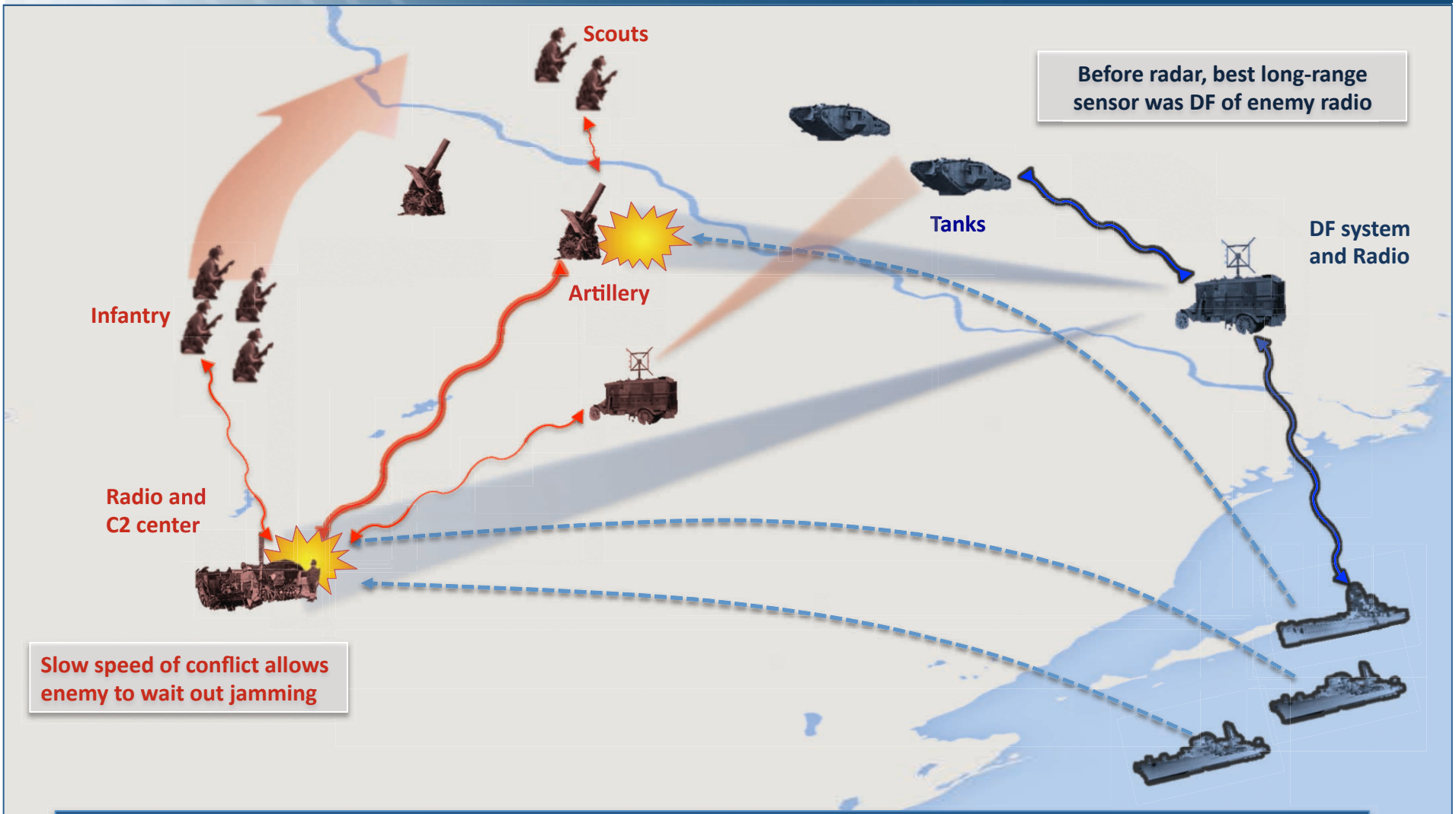
# Long-term EMS warfare competition

- **WW I to mid-WW II: active comms/sensing vs. passive counters**
- **Mid-WW II through Cold War: active systems vs. active counters**
- **Late Cold War: a shift toward stealth, LPI/LPD, and passive**
- **Next phase: low power / passive sensors, comms, and counters**



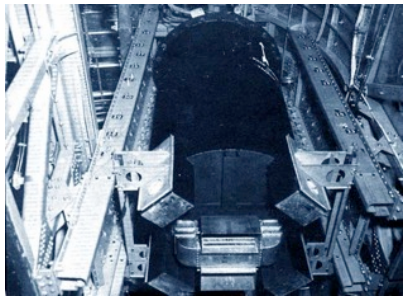

***EMS warfare drives the "hider-finder" competition***

# CSBA Phase 1: active networks vs. passive counters




***Jamming possible; not used due to impact on friendly comms and greater benefit in exploiting enemy comms***

# CSBA Phase 2: active networks v. active counters



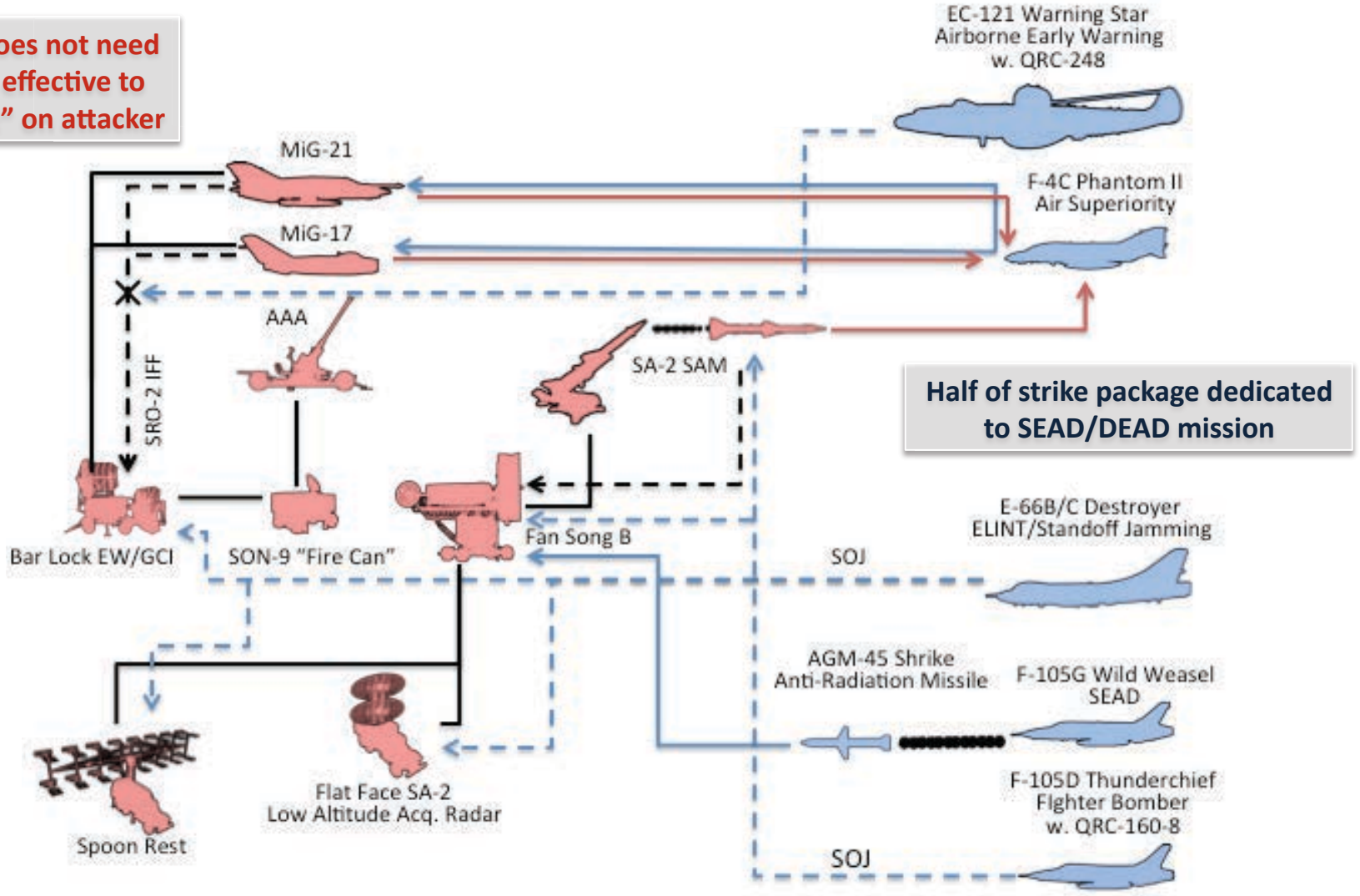
One of four 2.5 kW/650 lb Jostle VHF communications jammers in bomb bay of B-17




***Smaller, more powerful radars & jammers and speed of conflict made jamming of sensors/comms more advantageous***

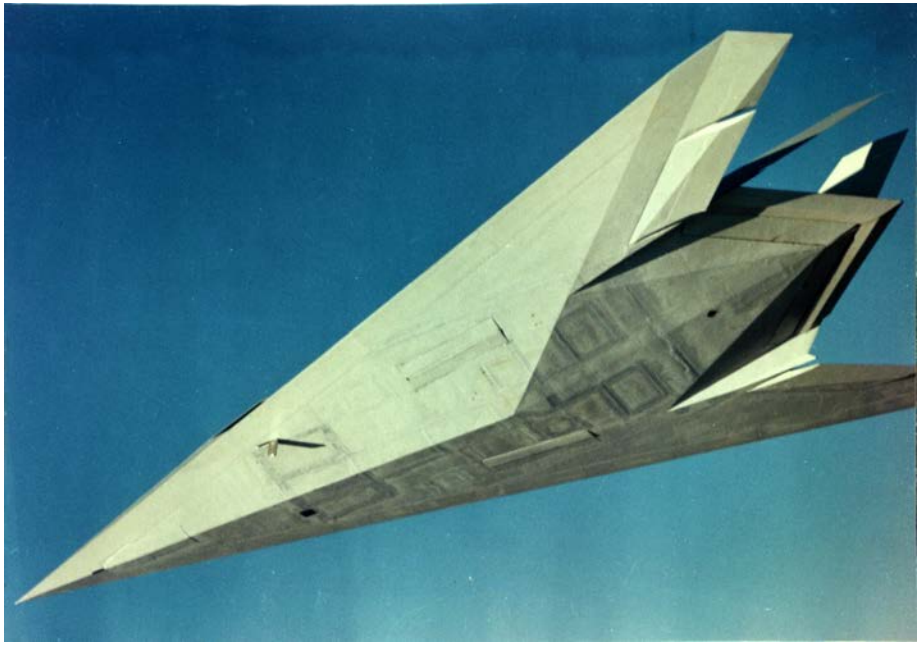
# CSBA Active vs. active CONOPs grew unsustainable

**Defender does not need to be very effective to impose "tax" on attacker**




***"Virtual attrition" of strike power demanded a new approach***

# CSBA Phase 3: Passive/LPD networks & counters

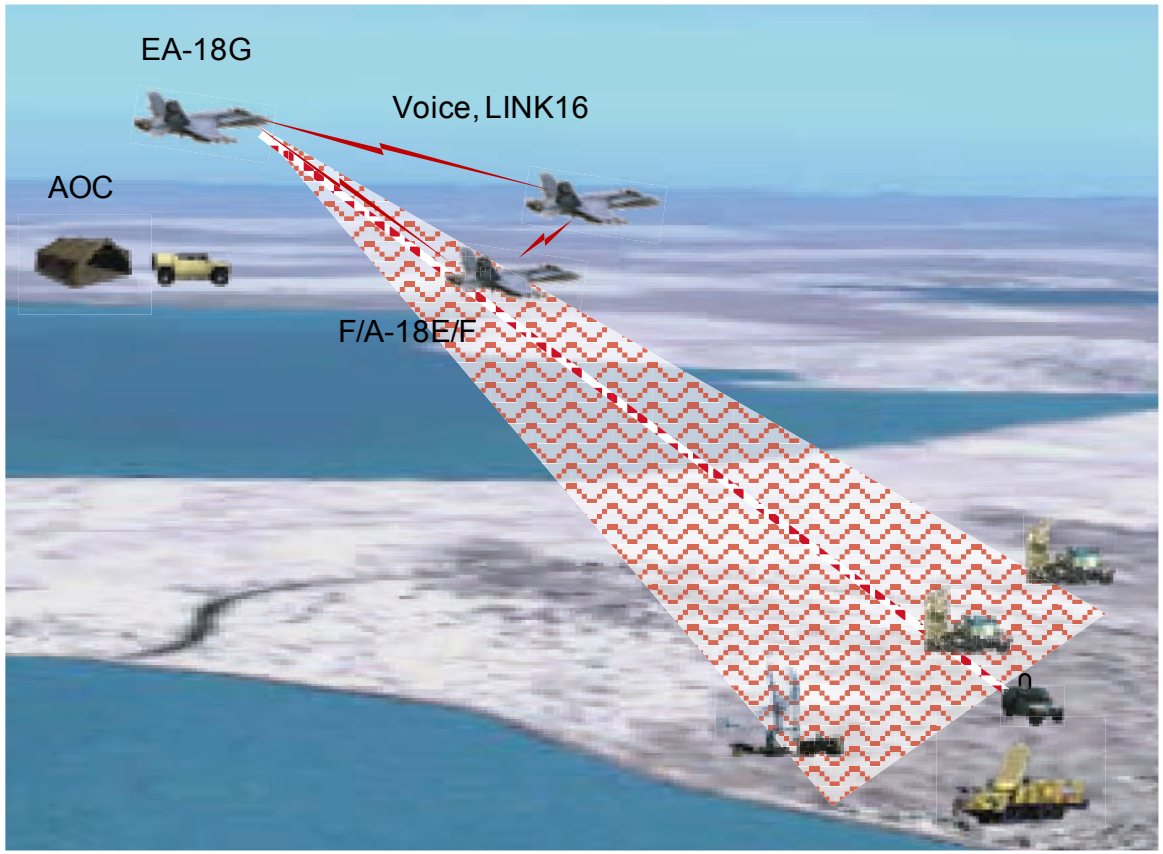


DARPA Have Blue demo led to F-117 and showed ability to reduce RF signature in some frequencies and aspects

B-2 bomber built on Have Blue and F-117 to provide all-aspect stealth across wider frequency range

***LO aircraft with LPI/LPD sensors and comms, and lower-power jamming reduce "overhead" for air defense suppression***

# CSBA Shift to Phase 3 truncated w/ Cold War's end




- *U.S. partially adopted low-to-no power EMS warfare*
- *Today's force is a hybrid of stealth, LPI, LPD and active vs. active*
- *Will competition restart with today's emerging threats?*

# Today's hybrid force is falling behind

- **Adversary anti-access/area denial (A2/AD) improving**
  - In capability & scope, including new players such as Iran and Syria
  - U.S. forces will operate at increasing range from enemy
  - Active sensors and countermeasures must operate at higher powers
- **Adversaries have home field; can adopt new approaches first**
  - Enemy can use larger, networked sensor arrays in A2/AD complex
  - Can operate at lower frequency, passive, and multi-static
  - Defender more likely to detect U.S. high-power active forces first
- **U.S. EM capabilities are static and occupy defined frequencies**
  - Adversaries targeting them as part of A2/AD with jammers and ECM
  - Enemy sensors and comms able to avoid U.S. countermeasures

# CSBA New EMS warfare operational concepts

- **Need to move away from high-power active approaches**
  - Unless they are carefully controlled to be LPI/LPD
- **"Low-to-no power" detection ("finder")**
  - Use of low-power "probes" to stimulate enemy emissions
  - Multi-static sensors using friendly or enemy emitters
  - Passive geolocation of emitters in IR/RF
  - LIDAR and highly directional low-power RF sensors
  - Passive coherent detection using reflected ambient EM energy
- **"Low-to-no power" counter-detection ("hider")**
  - Stand-in jamming of enemy's active sensors and weapons
  - Reduction of EO/IR/RF signatures (i.e., expanded stealth tech)
  - Low-power decoy and deception

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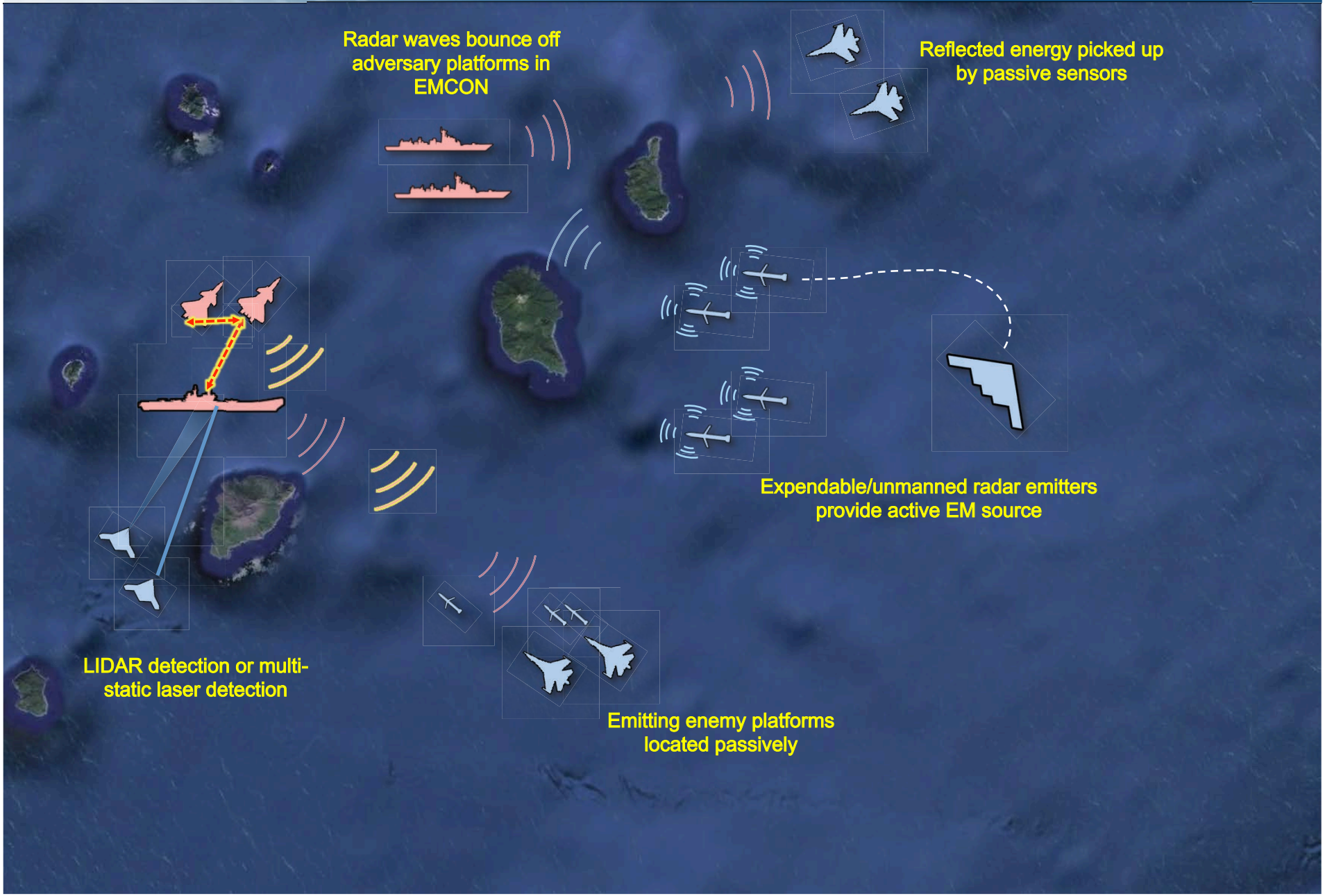
# Passive and multi-static detection



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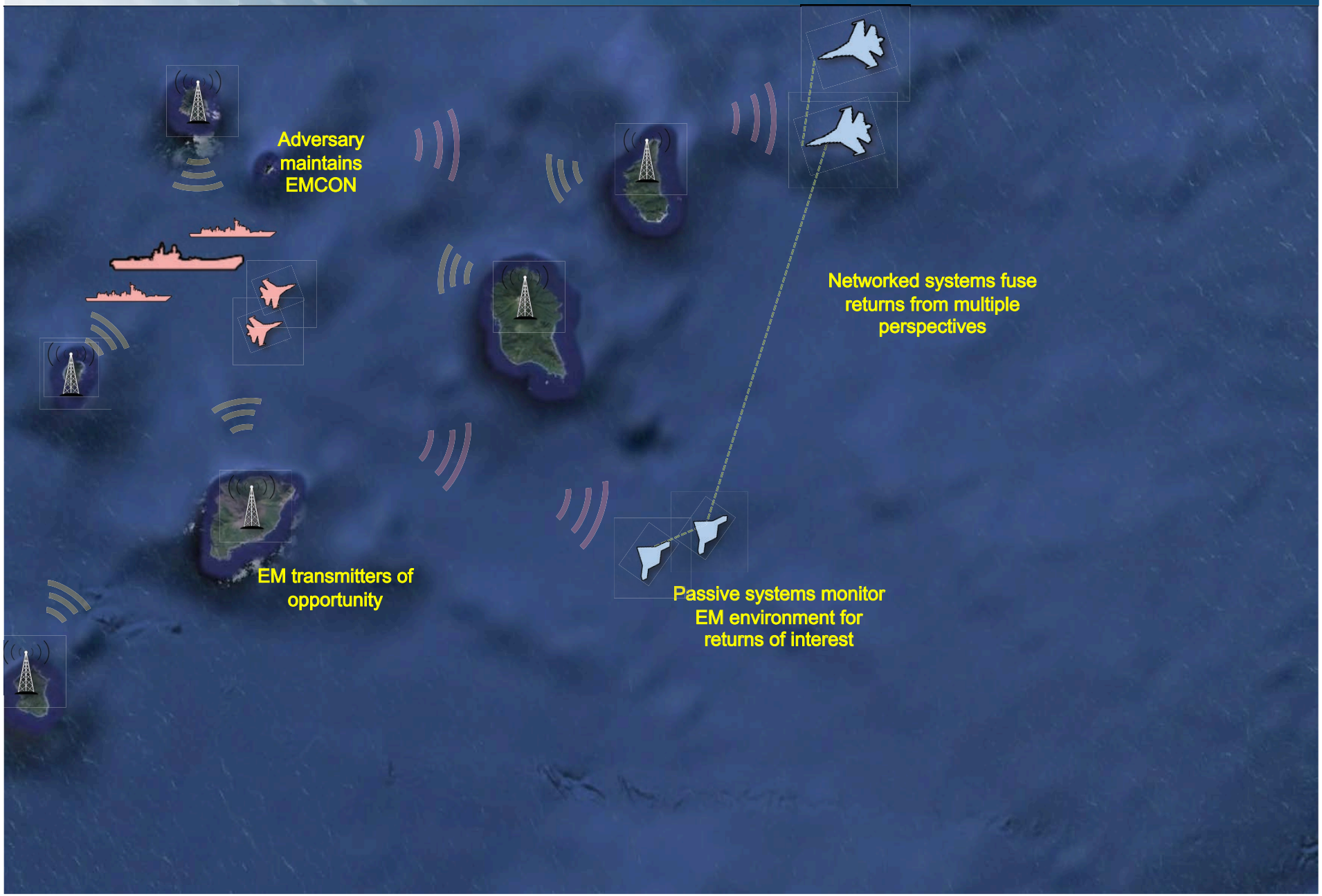
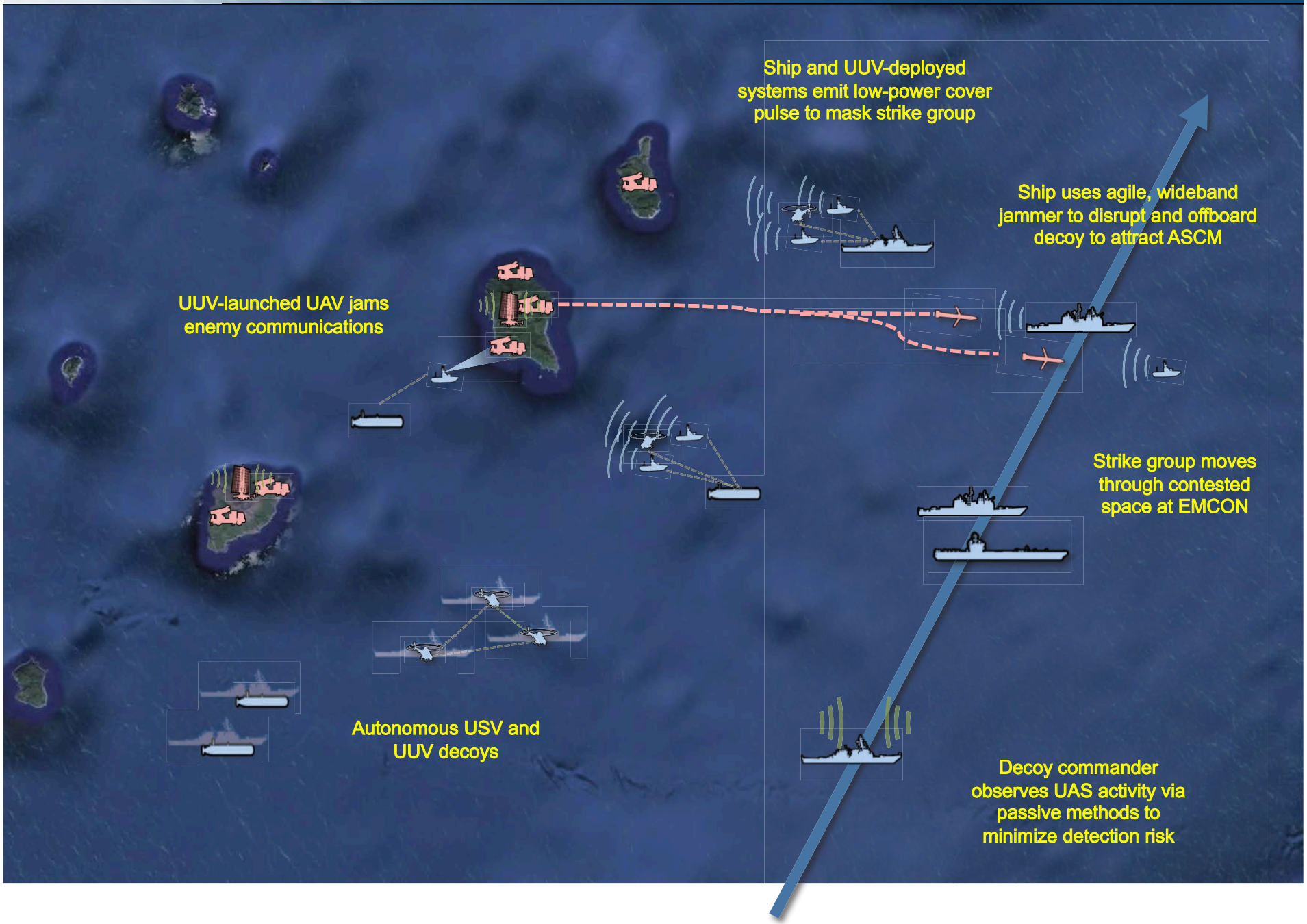
# Detection with reflected ambient noise



# CSBA Protecting forces vs. anti-access threats



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# What the enemy sees

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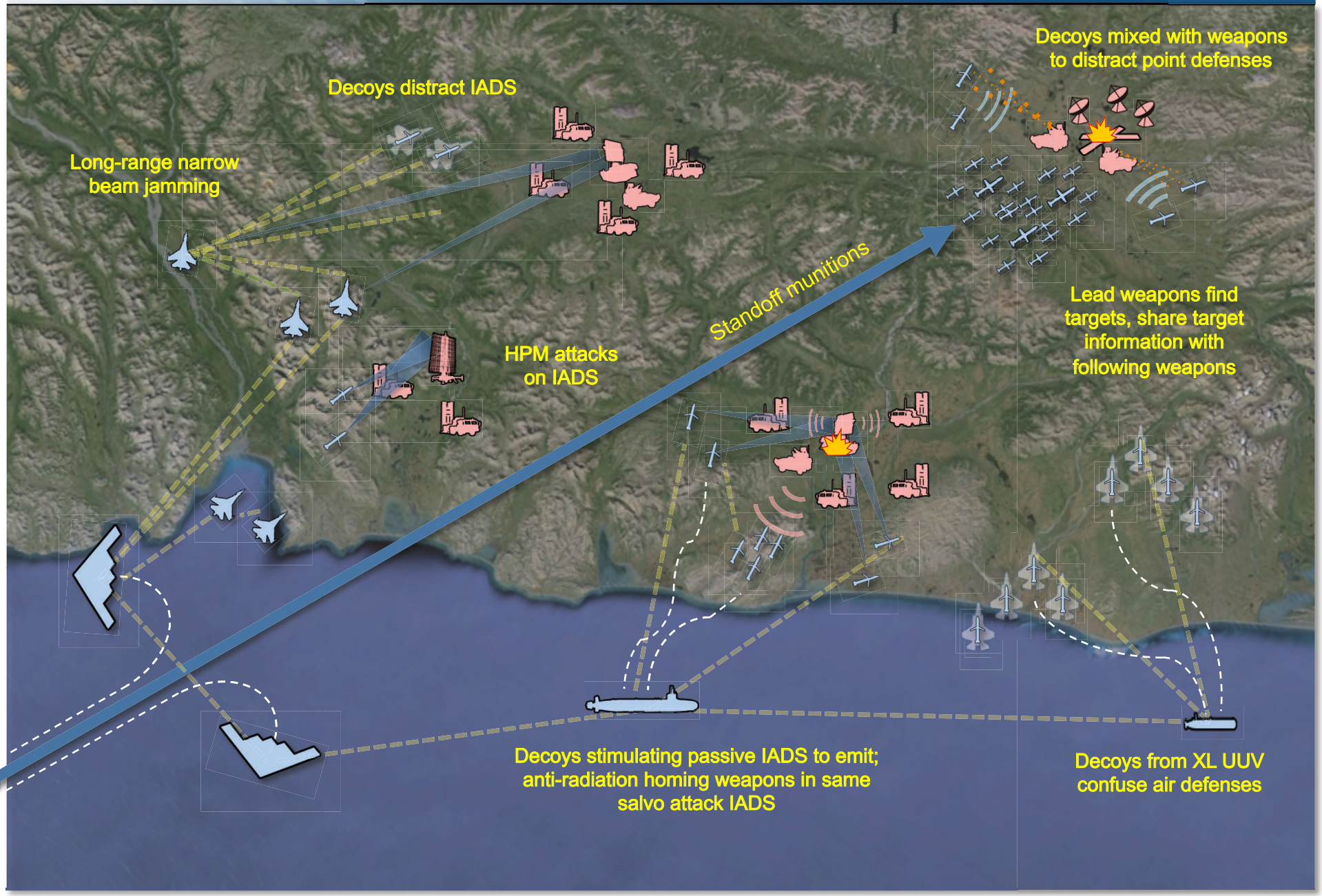
# Conducting strike operations



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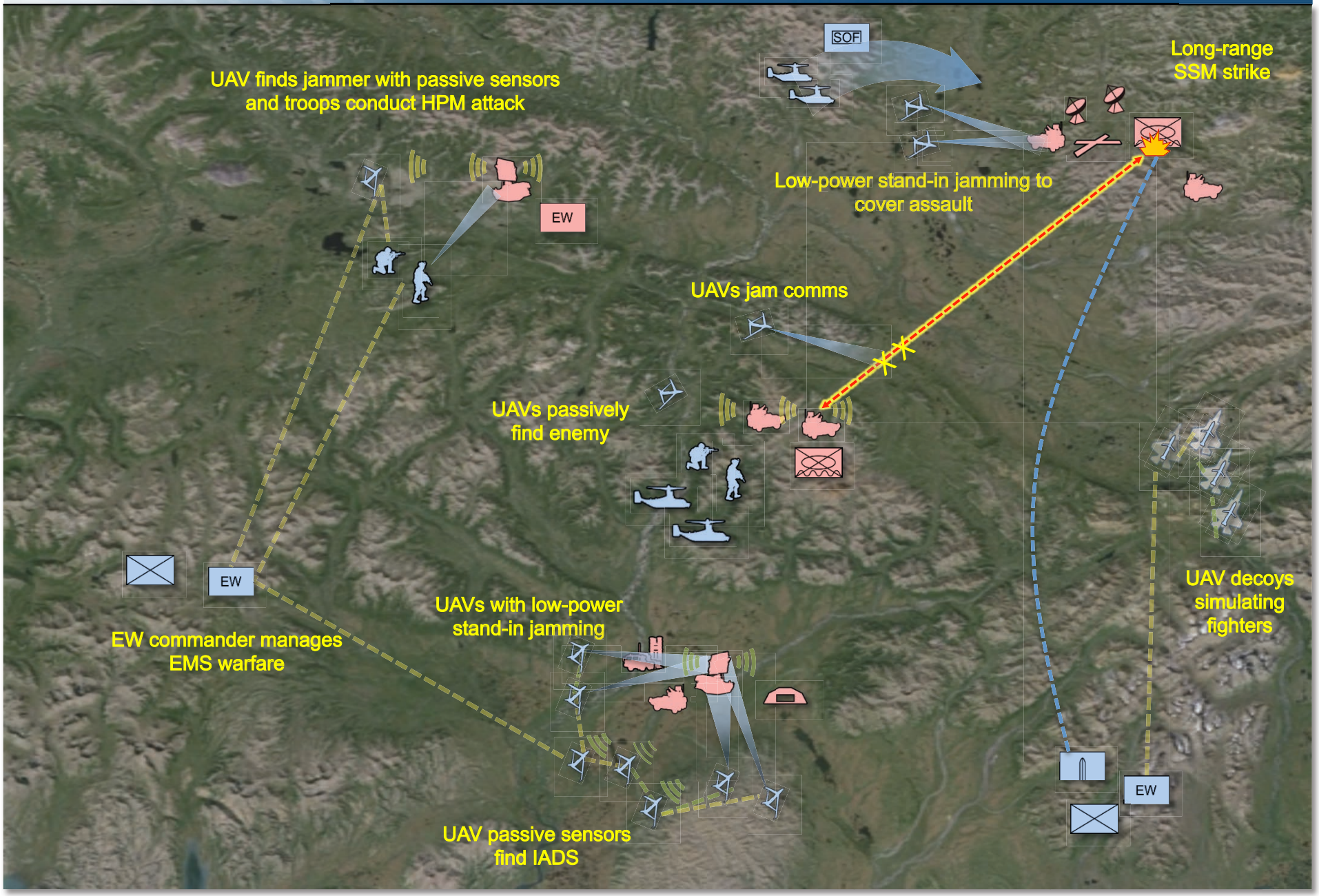
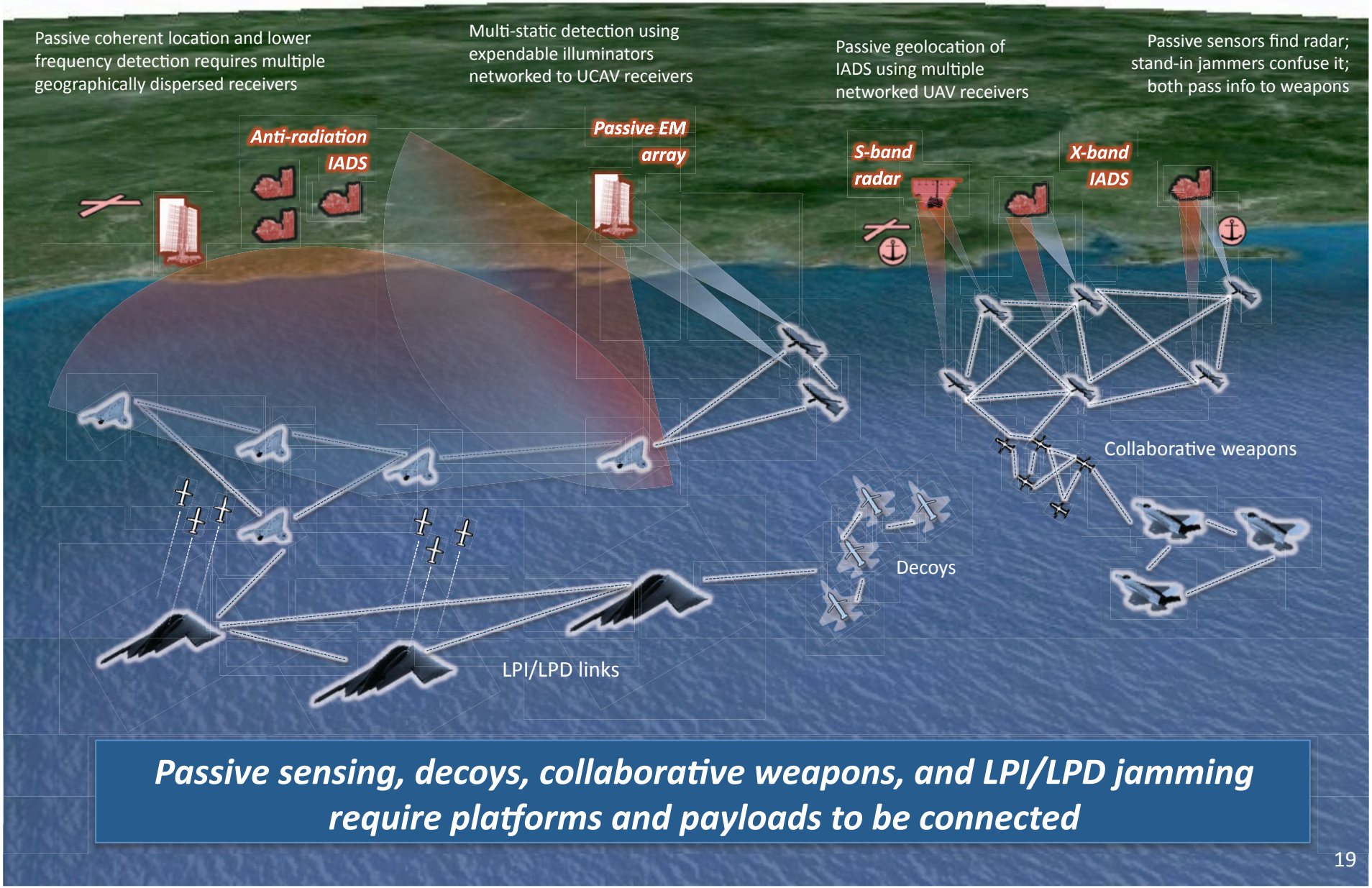
# Conducting assault operations



# CSBA *Priorities for EMS warfare technologies*

- **Networked**
- **Agile and maneuverable**
- **Multifunction**
- **Small and less expensive**
- **Adaptable**

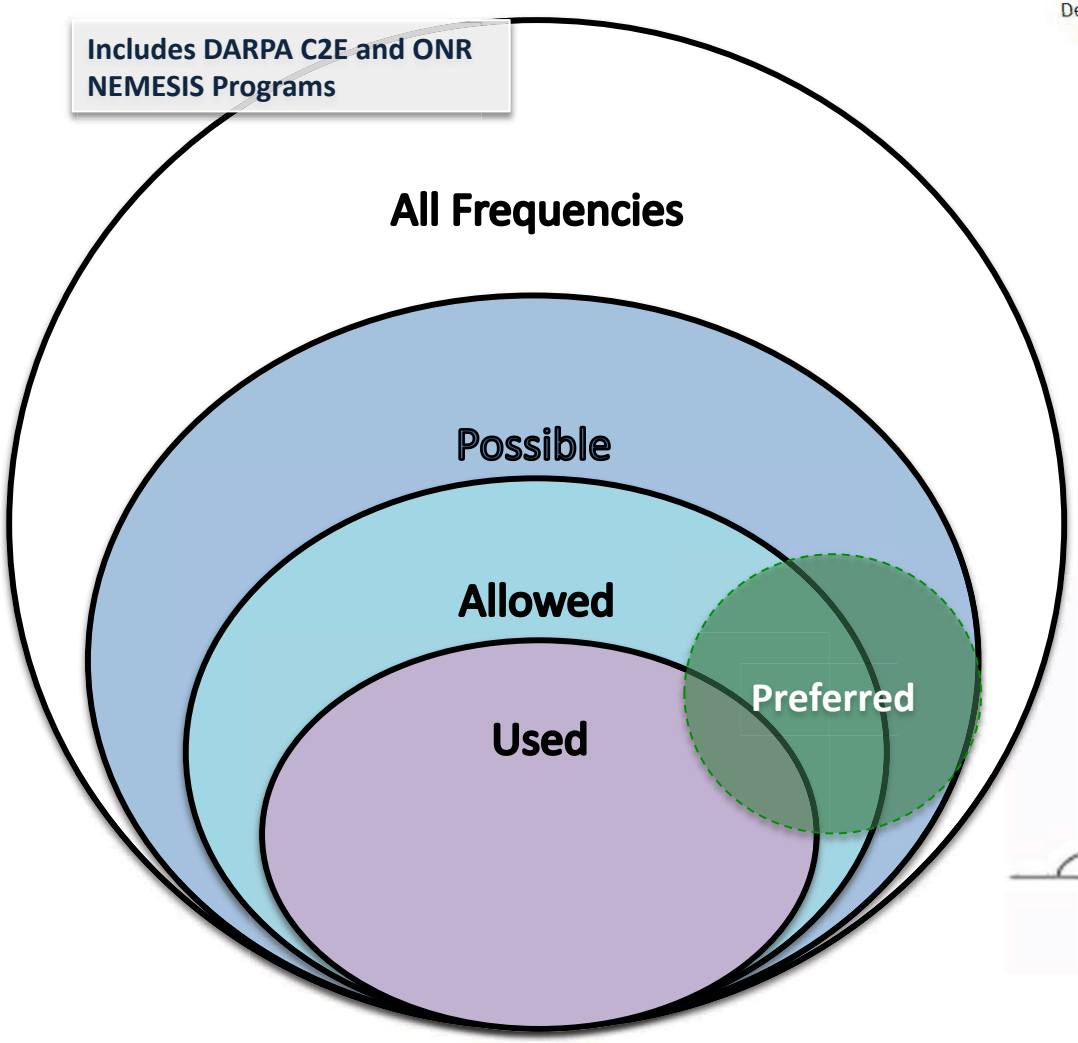
# CSBA Networking essential to new concepts

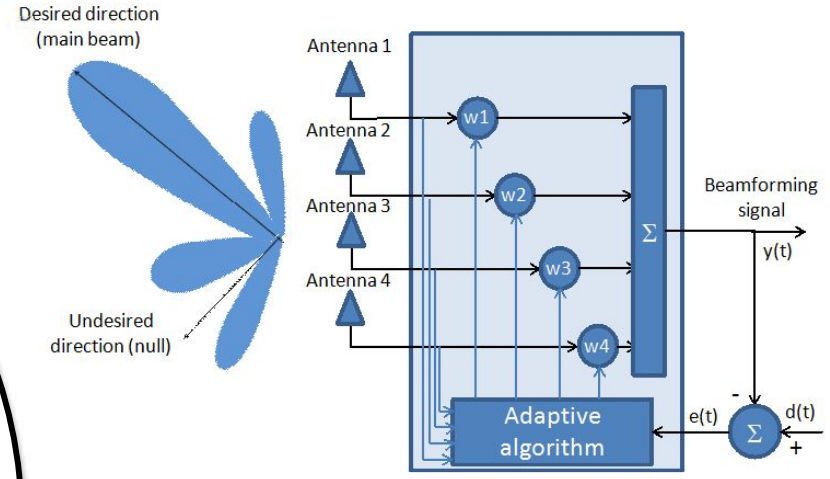



***Passive sensing, decoys, collaborative weapons, and LPI/LPD jamming require platforms and payloads to be connected***

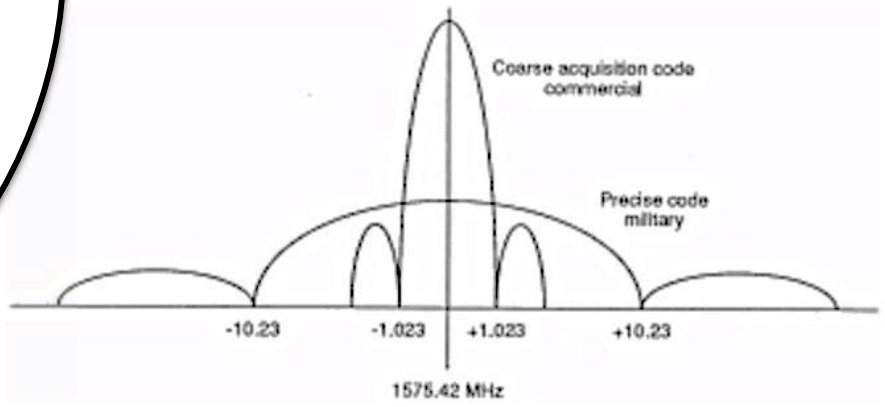
# CSBA Agility to evade threats, exploit openings

Includes DARPA C2E and ONR NEMESIS Programs



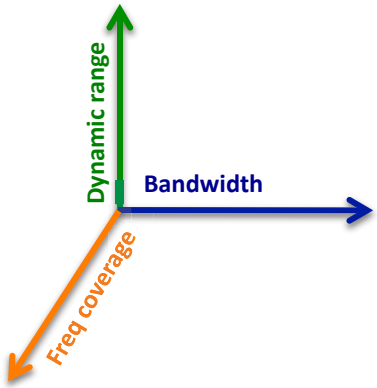

Beamforming and steering

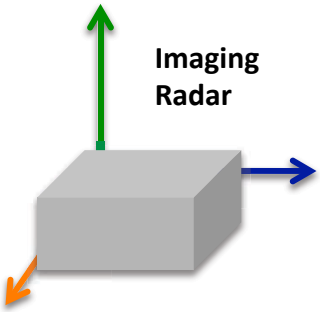


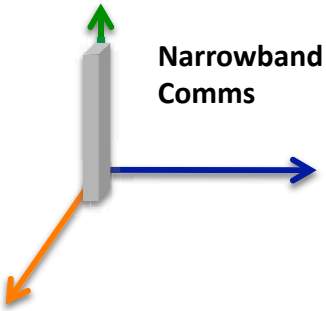

Signal spreading

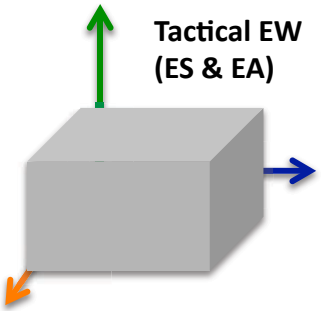
***Maneuver in frequency, power, time, beam direction, & beam shape to protect friendly EMS operations while denying those of enemy***

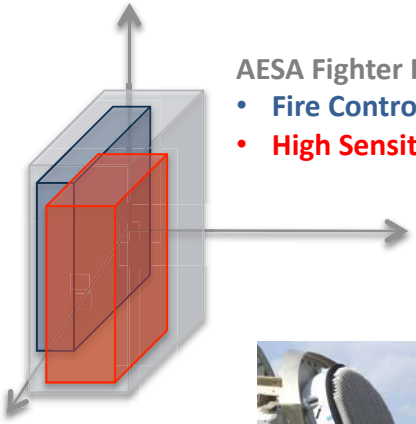
# CSBA Multifunction arrays improve efficiency



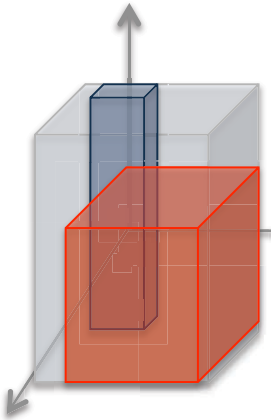



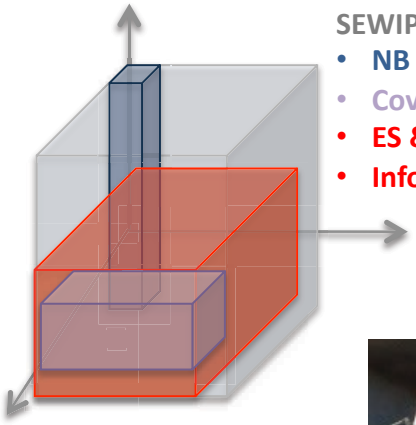



AESA Fighter Radar
- Fire Control Radar
- High Sensitivity EW



Next Gen Jammer
- NB Comms
- Electronic Attack
- Information Ops



SEWIP
- NB comms
- Covert comms
- ES & EA
- Information Ops

***Each platform and payload must participate in EMS warfare network; multifunction arrays reduce the number of separate systems needed***

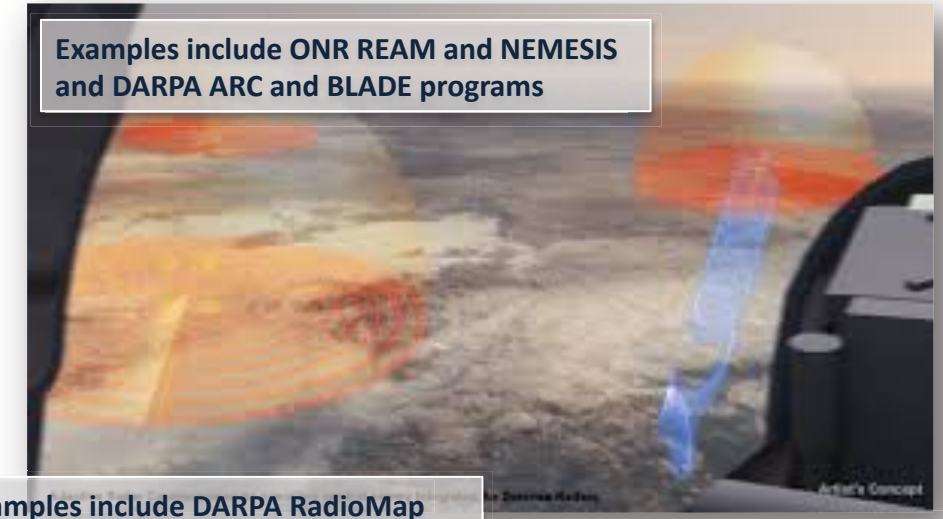
# CSBA Smaller, cheaper EMS systems needed

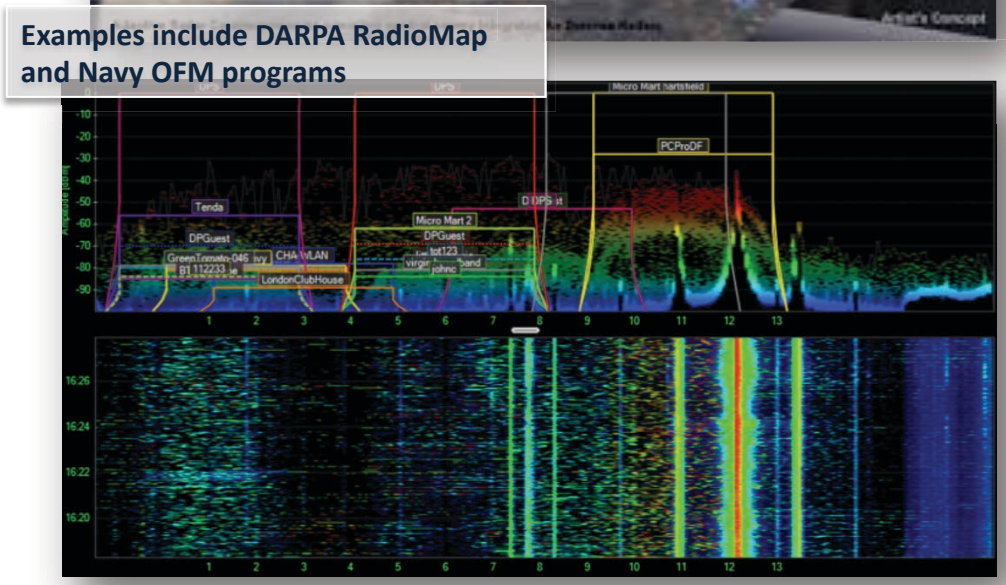
New concepts:

- Use more expendable EMS warfare payloads
- Incorporate almost every manned or unmanned platform
- Employ multiple RF and EO/IR arrays per platform

***EMS emitter/receivers need to become commoditized to enable every platform and payload to participate in network***

# CSBA Moving from automation to adaptation




## EMS Warfare Operating Cycle

Spectrum Monitoring

- Assess threats, opportunities and previously attempted EM effects
- Review & adjust EM requirements based on commander's intent and current environment
- Develop COAs using modeling and simulation
- Allocate EM operations by function
- Schedule tasks to EM systems
- Tasks to EM systems
- Generate EM effects

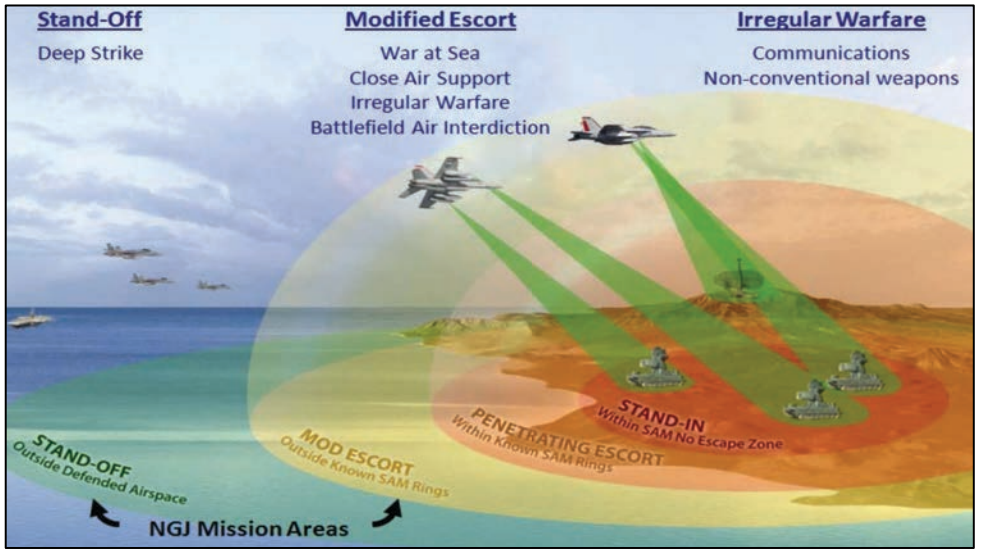
***Today's systems react to recognized situations w/ pre-planned responses; future systems must assess EMS and develop & refine COAs to best exploit it***

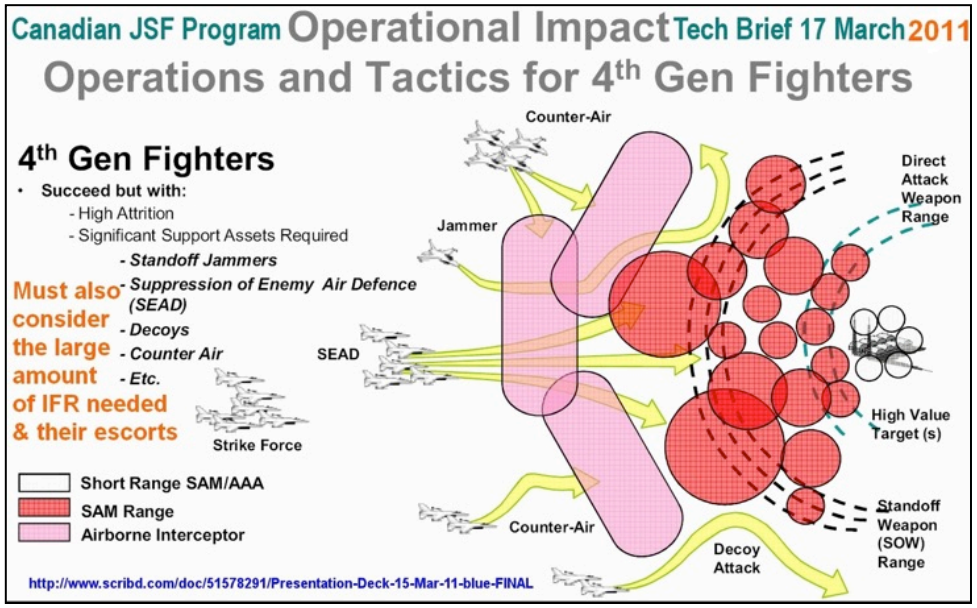
# *Impediments to progress*

- **Lack of new operating concepts**
  - Needed to drive requirements & acquisition structure
- **Acquisition process and organization**
  - Focused on programs, vice capabilities
- **Funding aligned to R&D, not acquisition**
  - Only S&T orgs and labs can look holistically

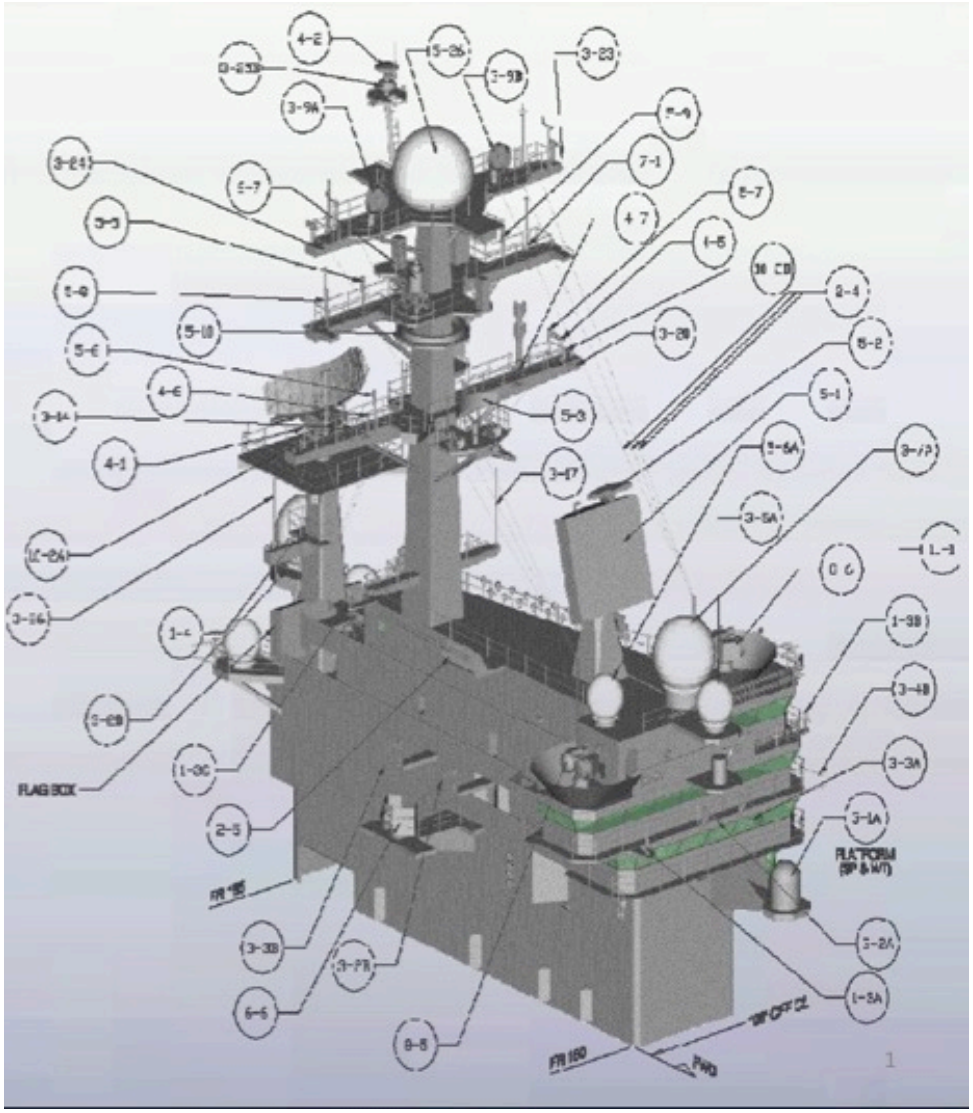
# CSBA Today's CONOPs constrain innovation

- **Don't exploit new tech**
  - Networked emitters/receivers
  - Adaptive EMS systems
  - Agile EO/IR/RF operations
  - Multifunction arrays & controllers
- **Remain system v. system**
  - Pre-planned techniques
  - Library of threats and responses
- **Keep "high-power" approach**
  - Unsustainable vs. A2/AD threat
- **Delay requirements changes**



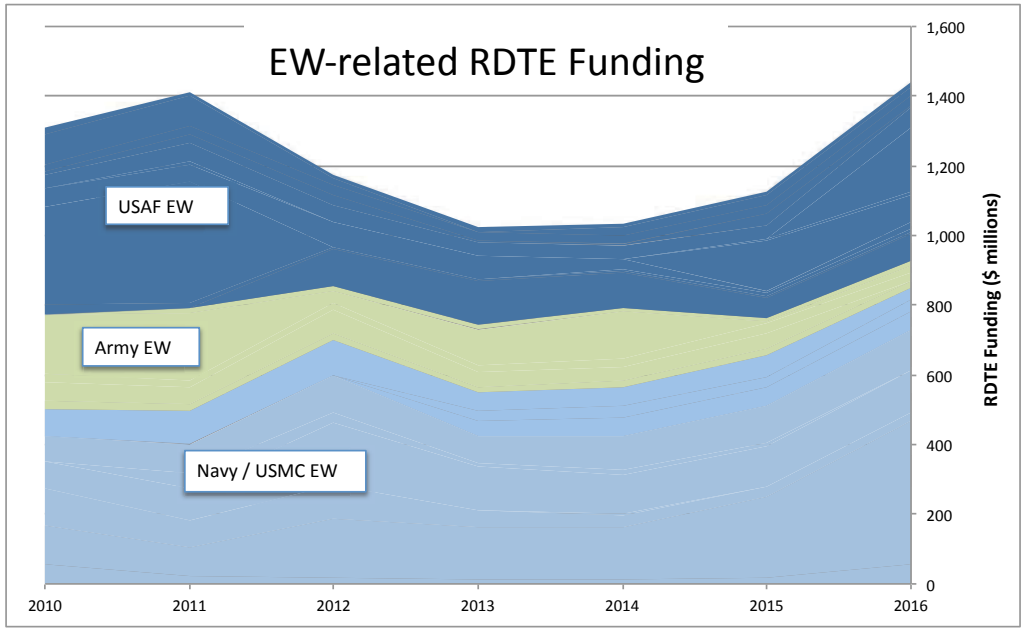
# CSBA Acquisition stove-piped & slow to act

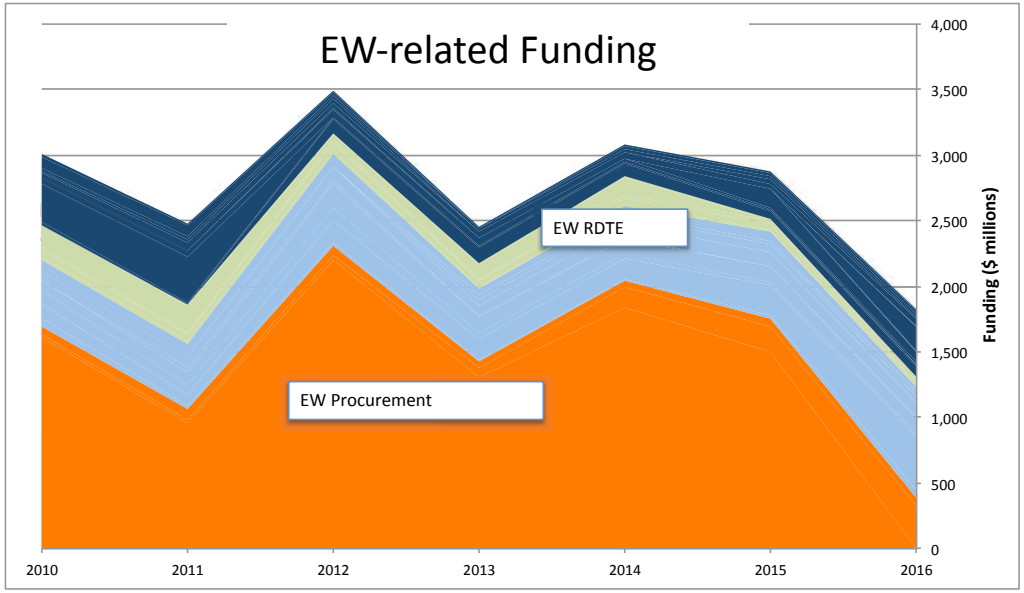


- **Dependent on requirements**
  - DoD generates new documents for each program
  - Limited options to shorten requirements process
- **Organized by hardware**
  - PMs for individual missions (radio, EW, RWR, radar, SIGINT)
- **No incentives for cooperation**
  - Multifunction EM systems cross multiple PMs and PEOs
  - Increases programmatic risk

# CSBA New tech maturing, not being fielded

- **RDTE funding rising**
  - Technology rapidly maturing
  - Or transitioning w/out requirements
- **Procurement falling**
  - Completion of E/A-18G
  - Will rise with NGJ, SEWIP
  - No programs for new approaches
- **EW EXCOM focused on PB**
  - Not yet exploring new EW or EMS warfare approach
  - Should be driving new approaches and tech transition



# Recommendations

- **EW EXCOMM establish "pull" for new EM technologies**
  - Set priorities for implementing low to no power EMS warfare
- **Services develop new EMS warfare operational concepts**
  - And establish requirements for low to no power capabilities
- **Services / CCDRs expand EMS warfare demonstrations**
  - In near-term to field new capabilities & inform requirements
- **Congress and DoD refine acquisition process**
  - Reduce new requirements analysis for payloads (vs. platforms)
- **Services promote integration between EMS warfare PMs**
  - Through capability area PMs & incentivizing integration

# *Questions*