

FLEETING TARGETS

Rethinking Orbital & Airborne Sensors

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***“Every target is going to be time-critical
in the future. Every target is going to be
fleeting.”***

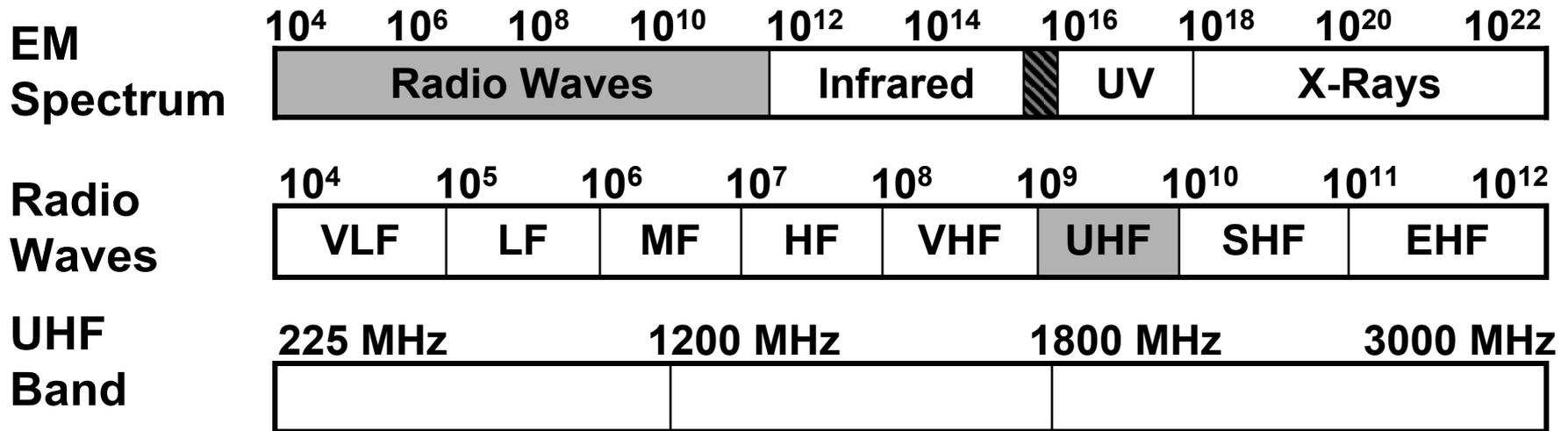
**-- Adm. Vern Clark
Chief of Naval Operations
November 4, 2004**

Fleeting Targets: Logic Flow

- **In the future, most military targets will be fleeting – mobile, time-sensitive & hard to track.**
- **U.S. forces are resolving the issues associated with finding & targeting conventional mobile targets (SAM's, Scud launchers, etc.).**
- **But plans for addressing unconventional fleeting targets – terrorists, insurgents, weapons traffickers – may be grounded in unrealistic assumptions.**
 - **Surface access to areas of interest**
 - **Timely funding of transformational tools**
 - **Utility of orbital sensors**
 - **Availability of airborne sensors**
- **The military needs to rethink what will be feasible & available for finding fleeting targets in the future.**

Electromagnetic Spectrum Shapes War

- As frequency (vibrations per second, or Hertz) increases, wavelength decreases – different combinations produce very different properties.



- Cellular phones
- Mobile satellite
- Personal communication services
- Global positioning
- Satellite phones
- Tactical communications
- Wireless local loop
- Point/point microwave
- Tactical datalinks

- Speed-of-light (300,000 km/sec) but fades as square of distance.

Conventional Targets Are Understood

- U.S. intelligence has a detailed understanding of signatures generated by conventional mobile/fleeting targets.

SA-12 SURFACE-TO-AIR MISSILE BATTERY

	Idle	Breakdown	Moving	Setup	Launch
Acoustic					
Infrared (DSP)					
IMINT (KH-11)					
IMINT (SAR)					
SIGINT (ELINT)					
SIGINT (COMINT)					
MOVINT (JSTARS)					

The table below shows the presence of various intelligence capabilities for an SA-12 Surface-to-Air Missile Battery across different operational states. Shaded cells indicate where the capability is present.

Capability	Idle	Breakdown	Moving	Setup	Launch
Acoustic					
Infrared (DSP)					
IMINT (KH-11)					
IMINT (SAR)					
SIGINT (ELINT)					
SIGINT (COMINT)					
MOVINT (JSTARS)					

Unconventional Targets Are Harder

- **Irregular forces seldom exhibit the predictable patterns that aid tracking of conventional forces.**
 - **Not just mobile, but fleeting & elusive**
 - **Terrain (mountains, forests, cities) masks movement**
 - **Cultural/behavioral traits unique to setting**
- **Every step in the kill-chain is more challenging.**
 - **Detection impeded by absence of repetitive patterns**
 - **Identification impeded by deceptive practices**
 - **Tracking impeded by variability of emitted signatures**
 - **Strike impeded by proximity of noncombatants**

IRAQI COUNTER-SIGINT TACTICS IN OIF

- | | |
|-------------------------------------|------------------------------------|
| • Low-power communications | • Colocation with civilians |
| • Couriers in lieu of radios | • Deception & disguise |
| • Dispersal of key assets | • Frequency hopping |
| • Cable replaces wireless | • Encryption of messages |

Signatures Fade Fast With Distance

- Terrorists & insurgents generate many trackable signatures, but proximity is essential to precise tracking.

<u>Emission Source</u>	<u>Max Tracking Range</u>
• Equipment	
-- Cellular communications	< 100km
-- Handheld radios	< 25km
-- Electronic watches	< 25km
• Vehicles	
-- Electrical system	< 10km
-- Exhaust system	< 10km
-- Mechanical noise	< 10km
• Sanctuaries	
-- Heat venting	< 40km
-- Machine vibration	< 10km
-- Magnetic fields	< 10km

- Feasible range for continuous tracking depends on ambient “noise” in relevant frequencies.

Kill-Chain Steps Consume Time

Intelligence indications

Broad-area surveillance

Fusion/correlation

Target identification

Value analysis/prioritization

Target tracking

Communication/handoff

Engagement planning

Weapon assignment

Weapon launch

Weapon transit

Target acquisition

Aimpoint selection

Terminal homing

Detonation target

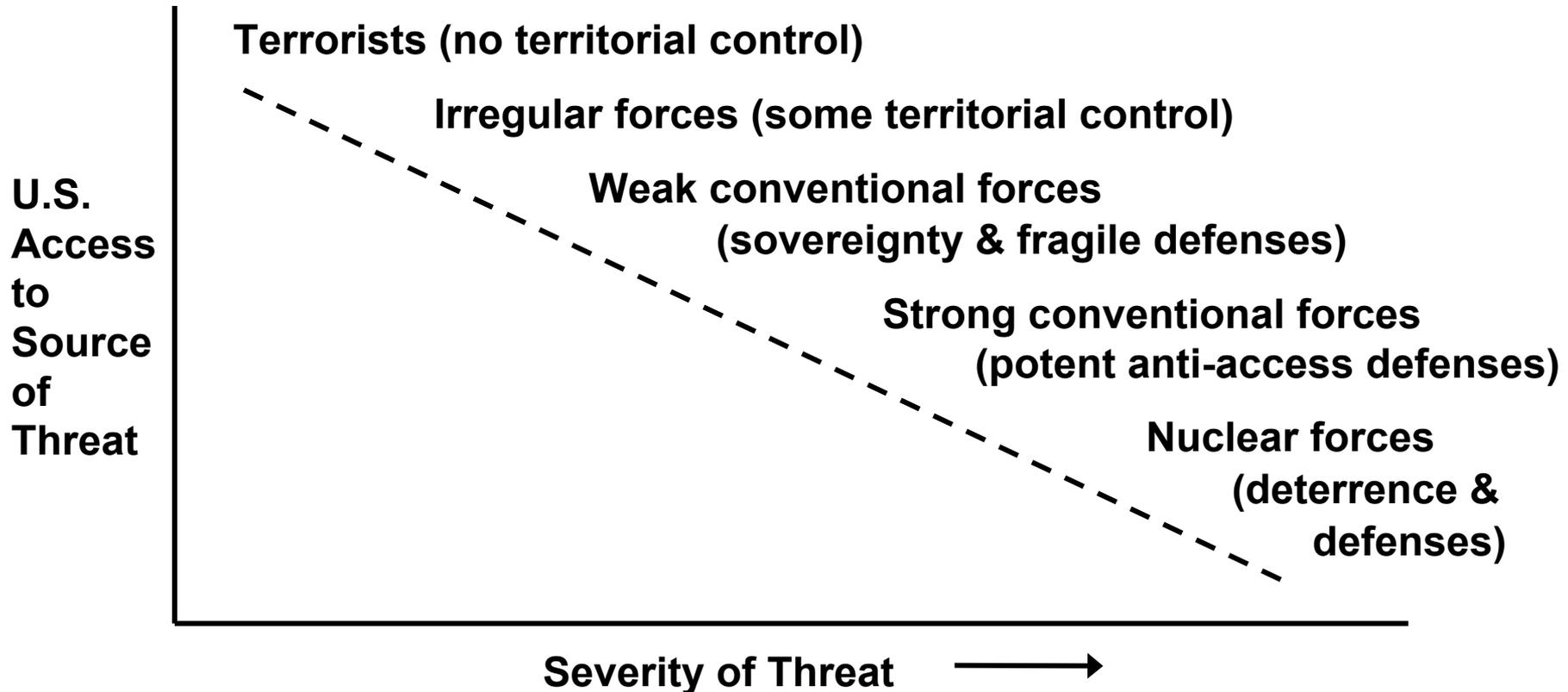
Damage assessment

- **Precision engagement requires over a dozen discrete steps from detection to destruction.**

- **Complexity of process impedes capacity to engage fleeting targets in a timely fashion.**

Is Access Inverse to Enemy Power?

- U.S. policymakers assume that access to contested areas is inversely proportional to military power of adversaries.



- But relationship doesn't always hold – Vietnam, Lebanon, Somalia show irregulars can deny access (especially ground access).

Will Transformation Tools Be Funded?

- **Prevailing theory of war presumes more powerful sensing & communications systems will come to fruition.**
- **But a combination of competing needs, technical challenges & weak Pentagon political skills could prevent that.**

Problematical Programs

Space Based Radar

- Repeatedly rejected by Congress
- Performance & spec's unclear
- Astronomical pricetag

**Transformational
Communications**

- Extreme technical challenges
- Congressional cuts/delays
- Bandwidth constraints in atmosphere

**E-10 Multimission Sensor
Aircraft**

- USAF delays I.O.C. to 2019
- Opposition in OSD
- Congressional cuts/delays

Future Combat System

- 33 million lines of code
- Two decades to fruition
- Political footprint inverse to funding

How Useful Are Orbital Sensors?

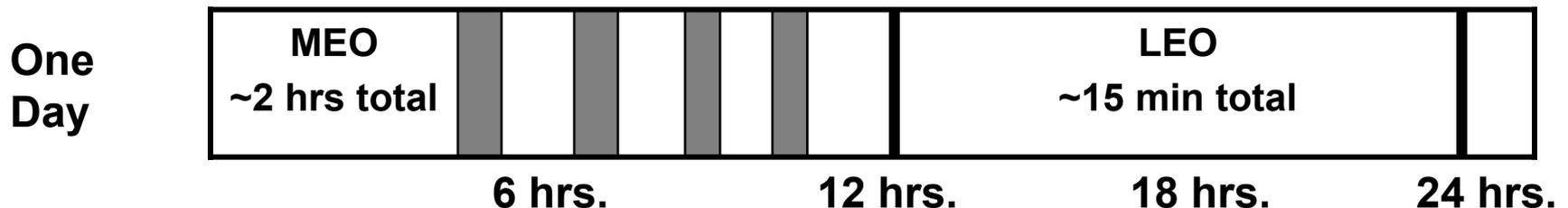
- U.S. operates three categories of space-based sensors.
 - Signals (geosynchronous, low-earth & elliptical)
 - Imagery (low-earth passive EO/IR & active radar)
 - Early warning (geosynchronous & elliptical)

DISTANCE TO TARGET



- But “stationary” geosynchronous satellites are 36,000km from earth, and closer LEO/MEO satellites are moving 7km/sec. relative to earth’s surface.

DWELL TIME



How Available Are Airborne Sensors?

- Major theater-level reconnaissance assets for finding surface targets are mainly manned, fixed-wing aircraft.
 - USAF RC-135 Rivet Joint, E-8 JSTARS & U-2 Dragon Lady
 - Navy P-3 Orion, EP-3 Aries & EA-6B Prowler
 - Army RC-12 Guardrail & RC-7 ARL
- All of these aircraft are low-density/high-demand assets that are over-committed, aging & expensive to support.
- Despite continuous hype, few high-altitude/long-endurance unmanned reconnaissance vehicles have been bought.

USAF SURFACE RECON AIRCRAFT

<u>Aircraft</u>	<u>Mission</u>	<u>Number</u>	<u>Airframe Age</u>
E-8 Joint Stars	Manned GMTI/IMINT	16	> 20 yrs
RC-135 Rivet Joint	Manned SIGINT	16	> 20 yrs
U-2 Dragon Lady	Manned IMINT/SIGINT	34	~ 20 yrs
Q-1 Predator	Unmanned IMINT	6	~ 3 yrs
Q-4 Global Hawk	Unmanned GMTI/IMINT/SIGINT	2	~ 4 yrs

Alternative Solutions Are Needed

- **If ground access is precluded ...**
 - **If transformational tools don't come to fruition ...**
 - **If current orbital sensors are ineffective ...**
 - **If current airborne sensors are unavailable ...**

**... then many of tomorrow's fleeting targets
will not be found.**

- **Policymakers need to think more creatively – and less ideologically – about what their other options may be.**

Orbital: Future Imagery Architecture

- **FIA is more than a successor to Cold War photo-reconnaissance satellites – it is an integrated system for tasking & exploiting all imagery resources (U-2, Q-4, etc.).**

FIA PRIORITY GOALS

- Big increase in area & point collection**
- Improved day-or-night, all-weather coverage**
- Rapid revisit rates to minimize gaps**
- Better airborne imagery capabilities**
- Streamlined tasking, exploitation & dissemination**

- **Mission Integration & Development (MIND) ground segment became operational December 2003.**
- **Internet-style system generates user-friendly imagery database that is readily accessible & expandable.**
- **Ground segment gains predate launch of first spacecraft.**

Orbital: Space Based Infrared

- **Space Based Infrared Systems (SBIRS) replaces Cold War early warning satellites with multimission IR collector.**
 - **Scanning & staring sensors in GEO**
 - **Scanning only on HEO host satellite**

SBIRS MISSION CAPABILITIES

- **Missile warning**
- **Missile defense**
- **Battlespace characterization**
- **Technical intelligence**

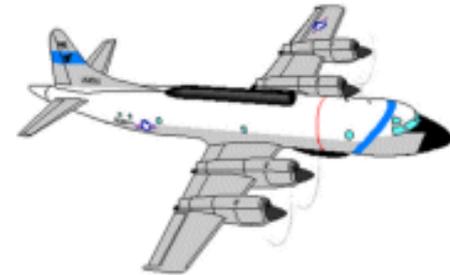
- **SBIRS ground segment enhances tactical value of IR collections by fusing inputs from multiple perspectives (air & space)**
 - **Increment One operational with legacy satellites since 2002**
 - **Increment Two exploits new sensors for increased versatility**
- **Multimission Mobile Processors (M3P) provides direct downlink from all IR satellites for timely tactical intelligence.**

Airborne: P-3C Orion AIP

- **P-3C Aircraft Improvement Program (AIP) variant provided time-critical, responsive recon to ground forces in OEF & OIF.**

P-3C AIP RECONNAISSANCE FEATURES

- Long range & endurance
- Bigger payload than UAV's
- Lower & slower than jet
- On-board processing/analysis



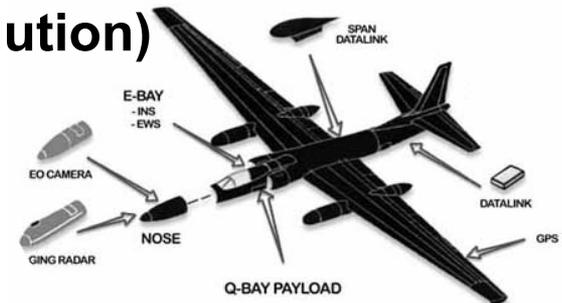
- **AIP offers a diverse package of sensors operating in close proximity to fleeting targets.**
 - FLIR has wider range of view than Predator
 - Large multimode radar provides high-fidelity SAR imagery
 - Specific emitter identification capability
 - Able to download videos to tactical ground stations
- **Low, slow flight enhances performance of electro-optical & IR sensors (but better datalinks off board needed).**

Airborne: U-2S Dragon Lady

- **U-2 is configured for high-altitude collection of multi-spectral imagery & signals intelligence in any weather, day or night.**

U-2 RECONNAISSANCE FEATURES

- **Imaging in visible, short & medium wave IR**
- **Synthetic aperture radar (1-10 foot resolution)**
- **Ground moving-target indication**
- **Operational SIGINT capability**
- **Superior space/weight/power to UAV's**
- **Wideband datalinks to ground & SATCOM**



- **Average U-2 airframe has 86% of structural life remaining, which implies operation through 2050.**
- **However, airframe potential under-utilized due to UAV competition.**
 - **Needs integrated connectivity to theater forces & ground stations**
 - **Shortage of sensor packages**

Airborne: E-8 Joint Stars

- **The E-8 radar plane is the most sophisticated tracker of moving surface vehicles in the world.**

JOINT STARS RECONNAISSANCE FEATURES

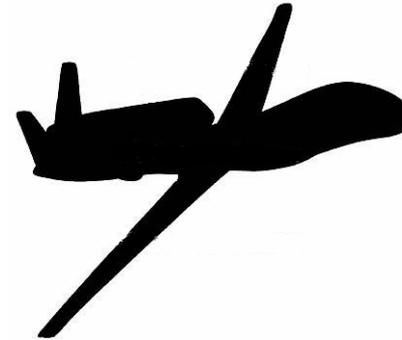
- Determines vehicle count, direction, speed & formation**
 - High power, dwell time & revisit rates**
 - Defeats most camouflage & deception**
 - High resolution SAR imaging**
-
- **Joint Stars precision & persistence enables continuous tracking of individual vehicles in difficult terrain (e.g. cities) – well suited to change analysis.**
 - **However, competition from E-10 & SBR have prevented radar upgrades that could enhance sensor performance.**
 - Target quality data on smallest vehicles**
 - Highest fidelity imagery**

Airborne: RQ-4 Global Hawk

- **Global Hawk is the first high-altitude, long-endurance unmanned aerial vehicle fielded by the U.S. military.**

GLOBAL HAWK RECONNAISSANCE FEATURES

- Endurance of 36-42 hours
- Range ~ 22,000 km (12,000 nm)
- Operational ceiling ~ 20,000 m (65,000 ft)
- Synthetic Aperture Radar/MTI
- Infrared/Electro-optical Imagery



- **An initial SIGINT quick-reaction capability has been integrated onto RQ-4; NSA pleased with results.**
- **Follow-on efforts will expand SIGINT capabilities into higher & lower bands.**
- **Once 3,000 lb. payload of RQ-4B becomes available, Global Hawk will be able to collect IMINT & SIGINT simultaneously – if services buy the vehicles.**

Network Bolsters Existing Platforms

- **Past experience indicates that some of the most ambitious transformation initiatives won't come to fruition.**
- **However, existing platforms can provide much of the reconnaissance needed – if they have adequate connectivity to intelligence networks.**

BACKUPS TO TRANSFORMATIONAL COMMUNICATIONS

- Advanced EHF satellite**
- Mobile User Objective Systems**
- Wideband Gapfiller satellite**

- **Emerging intelligence tools such as MAJIC and Distributed Common Ground System use network links to greatly enhance the value of existing collections.**
- **So even if transformation falters, the U.S. ability to fund, fix & trace future fleeting targets can continue growing.**