

# Space Strategies Center

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# SWAT

## Space Warfare Analysis Tools

### - Summary -

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*“You may not be interested in war ...  
but war is interested in you.”*  
(Leon Trotsky)

# SWAT Purpose

- **Develop Space Warfare Theory, Doctrine, Strategies, Tactics, Techniques & Tools that Enable Informed Decision Making by Space Control Warfighters:**
  - Will Space Systems be Under Attack In the Near Future?
  - Are Space Systems Currently Under Attack?
  - Who Is Attacking?
  - What is the Adversary Attack Strategy?
  - What Damage Has Been Caused to Military Capabilities?
  - What Is Optimal Blue Military/Diplomatic/Economic Response?

**Provides a “Unified Field Theory” for  
Space Situational Awareness (SSA) & Satellite Attack Warning (SAW)**

# SWAT Tools Developed (1)

- View Automatic Space Object Mission ID**
- View Auto Space Object State Change Detection**
- View Automatic Red Space COA ID**
- View Space Choke Point Maps (SAW – Satellite Attack Warning)**

**Anticipate What an Adversary's Next Move Is**

# SWAT Tools Developed (2)

- [View](#) **SSA Requirements (1,900)**
- [View](#) **Space INTEL Indicators List (6,000)**
- [View](#) **Auto INTEL Message Generation**
- [View](#) **Resolution Requirements (Space NIIRS)**
- [View](#) **Sensor Requirements Tasking Optimization Software, Plus Reconnaissance Contingency Checklists**

**Determine What We Know & Don't Know About an Adversary**

# SWAT Tools Developed (3)

## [View](#) Space Blue COA Support

[View](#) Space Strategies Checklist (Based on Sun Tzu)

[View](#) Space Principles of War Checklist

[View](#) Space Military Objectives Database (5,000 Objectives)

[View](#) Space Centers of Gravity Checklist

[View](#) Space Escalation Ladder

[View](#) Auto Joint Space & Ground Target Prioritization

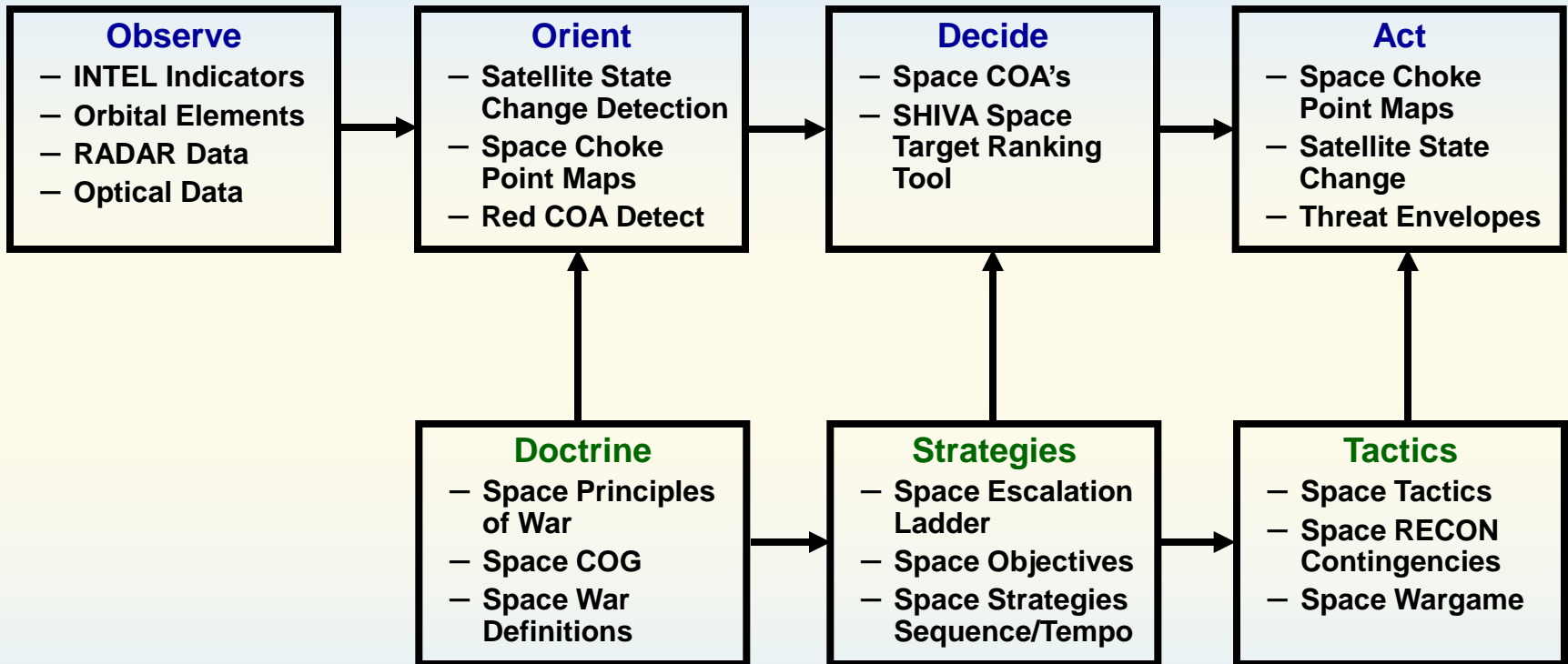
[View](#) Information Targets Ranking

## [View](#) Space Control Scenario

[View](#) Automatic Space Scenario Generation Tool & Space Game (In Work)

**SWAT Supports Timely & Decisive Blue Courses of Action Generation**

# SWAT Process Flow



SWAT Products Listed Inside Boxes

**SWAT Provides an Integrated Space Warfare Conceptual Framework**

# Space Object State Change Algorithms

# SWAT State Change Parameters Analyzed (26 Total)

## Physical Characteristics

- Radar Cross Section (RCS)
- Optical Cross Section
- Flashing or Not
- Flash Period
- Stabilization Type (Spinning or 3-Axis)
- Object Shape (Sphere, Cylinder, Box)
- Length
- Width
- Height
- Mass
- Spin Rate
- Delta-V
- Satellite Position (Geosynchronous)
- Beginning of Life On-Board Power
- Major COMM Antennas & COMM Signals
- Major Optics On-Board
- Retro Reflectors On-Board

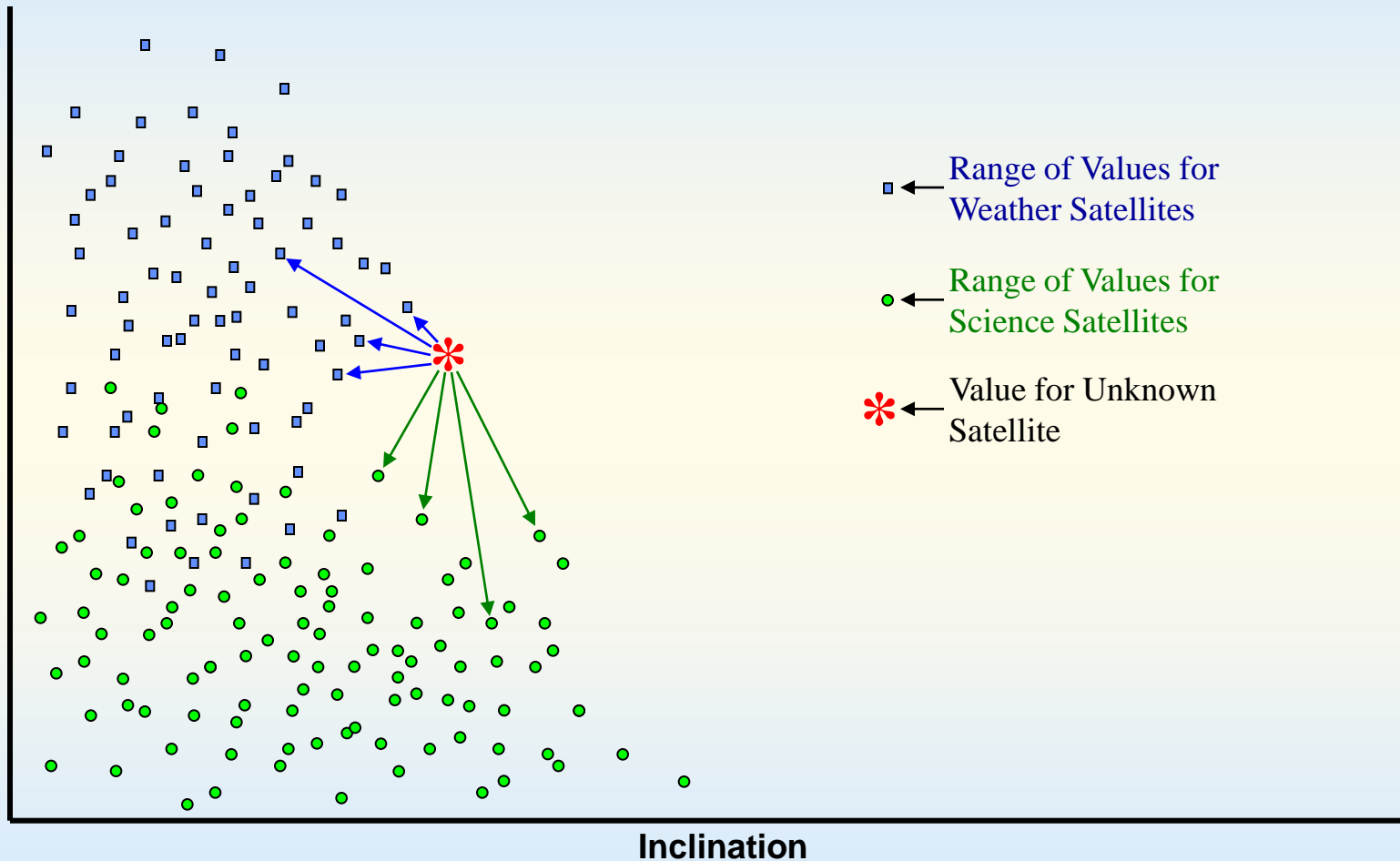
## Orbital Characteristics

- Inclination
- Eccentricity
- Mean Motion
- Mean Anomaly
- RAN
- Argument of Perigee
- BStar
- 1st Mean
- 2nd Mean

**SWAT Assesses State Changes Beyond Orbital Characteristics**



# SWAT Automatic Space Object State Change Algorithm



**Unknown Space Objects Compared to Those of Known Mission Characteristics**

# Data Correction & Segmenting

- **Correct Mission Designations**
  - e.g.: “Science” vs. “Scientific” Missions
- **Correct Data Values**
  - e.g.: Zero vs. Null Data
    - Change Zero Values to Null for Mass
    - Change Null Values to Zero for Spin
- **Segment Missions**
  - By Satellite Status (Dead vs. Live)
  - By Space Object Orbital Location

# SWAT Databases

- **Space Objects: 37,932 Records**
  - Also Includes Decayed Objects
- **Orbital Elements: 5.3 Million Records**
  - 15 Months of Data Internal to SWAT
  - All Orbital Data Since 1957 In External Archives
- **RADAR Cross Sections: 1.5 Million Records**
  - All RCS's for All Space Objects Since 1957
- **Satellite Characteristics History: 7.5 Million Records**
  - Almost 3 Years History for All Space Objects (Live & Dead)
- **Optical Visual Magnitude & Flash Rate: 73 Thousand**
- **Space Acronyms: 35,542 Records**

# Orbital Location Segmenting

Region	Region Definition
SDR GEO	Space Defense Region Geosynchronous
SDR GEO ASIA	Space Defense Region Geosynchronous over Asia
SDR GEO EU	Space Defense Region Geosynchronous over Europe
SDR GEO ME	Space Defense Region Geosynchronous over the Middle East
SDR GEO US	Space Defense Region Geosynchronous over the United States
SDR GEO-G-A	Space Defense Region Graveyard Orbit Above Geosynchronous
SDR GEO-G-B	Space Defense Region Graveyard Orbit Below Geosynchronous
SDR GEO-I	Space Defense Region Geosynchronous Inclined
SDR HEO	Space Defense Region Above Geosynchronous (High Earth Orbit)
SDR LEO-E	Space Defense Region Low Earth Orbit Highly Eccentric
SDR LEO-H	Space Defense Region Low Earth Orbit - High (>600 and <5,000 km)
SDR LEO-L	Space Defense Region Low Earth Orbit - Low (<=500 km)
SDR LEO-M	Space Defense Region Low Earth Orbit - Medium (>500 and <=600 km)
SDR LEO-R	Space Defense Region Low Earth Orbit Retrograde
SDR LEO-S	Space Defense Region Low Earth Orbit Sun-Synchronous
SDR MEO	Space Defense Region Medium Earth Orbit (>=5,000 and <25,000 km)
SDR MOLY	Space Defense Region Molniya
SDR NOE	Space Defense Region No Orbital Elements

# SWAT Correlation Types

- **Current Correlations**
  - All Objects (Dead & Live) Against All Objects for Current Analysis Date
- **Historical Correlations**
  - All Objects (Dead & Live) Against All Objects for Current & Past Dates (6,056,355 records)
- **Self Correlations**
  - All Objects (Dead & Live) Against Their Own Historical Characteristics

# Example State Changes

- **GPS**
- **ECHOSTAR 5**
- **MOLNIYA**
- **Beidou MEO**
- **Beidou GEO**
- **SJ's**

# ECHOSTAR 5 Maneuver



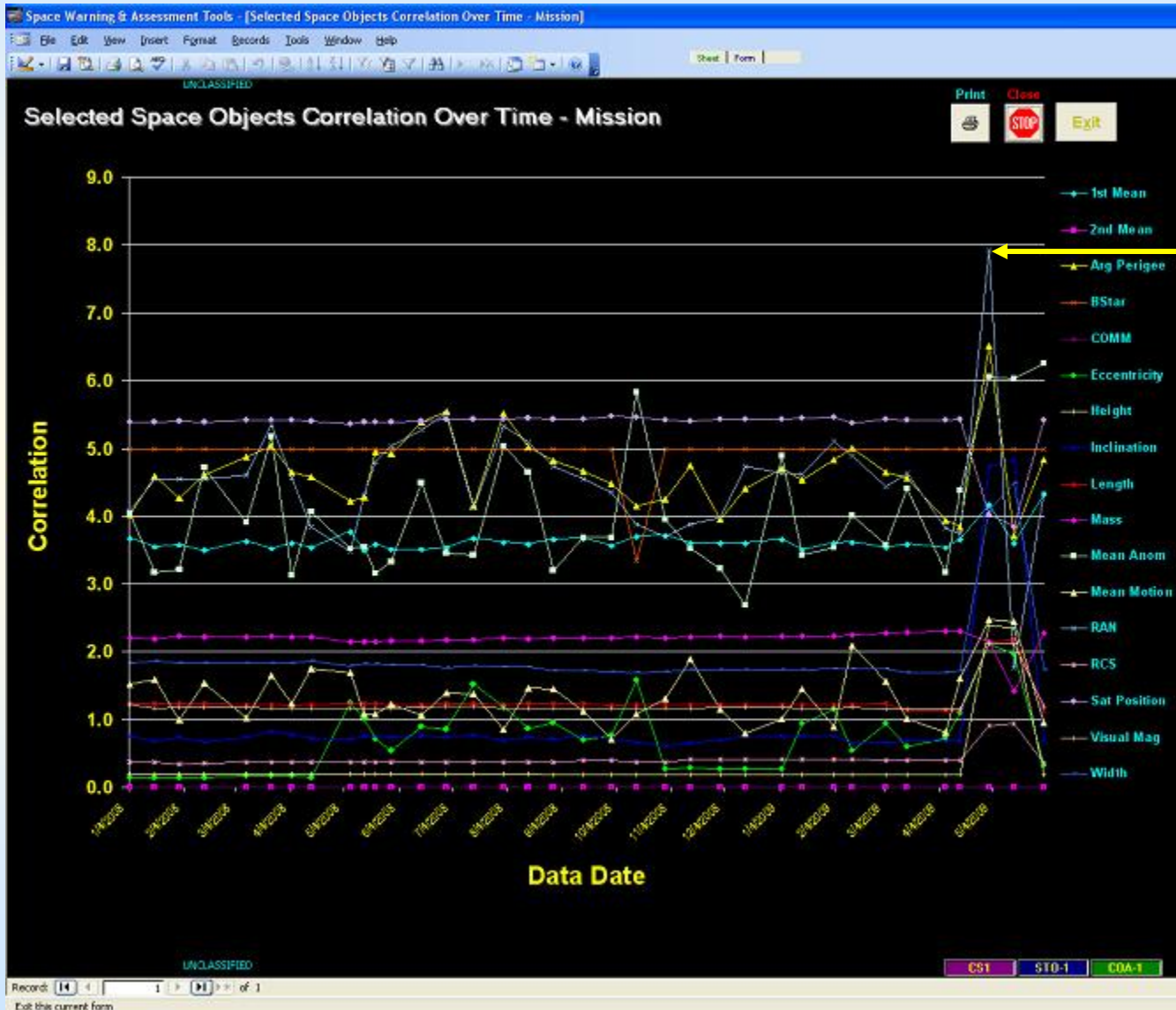
**Orbital Maneuver Detected In State Change Algorithms**

**Orbital Maneuver (57 km)**

**1st Derivative of Altitude**

SWAT 1  
SWAT 2  
SWAT 3

# ECHOSTAR 5 Correlations



**Orbital Maneuver  
Affected RAN, Arg  
Perigee, Mean  
Anomaly, Sat Position,  
Inclination,  
Eccentricity, Mean  
Motion, RCS, and  
Visual Mag  
Correlations Against  
Other GEO Satellites.**

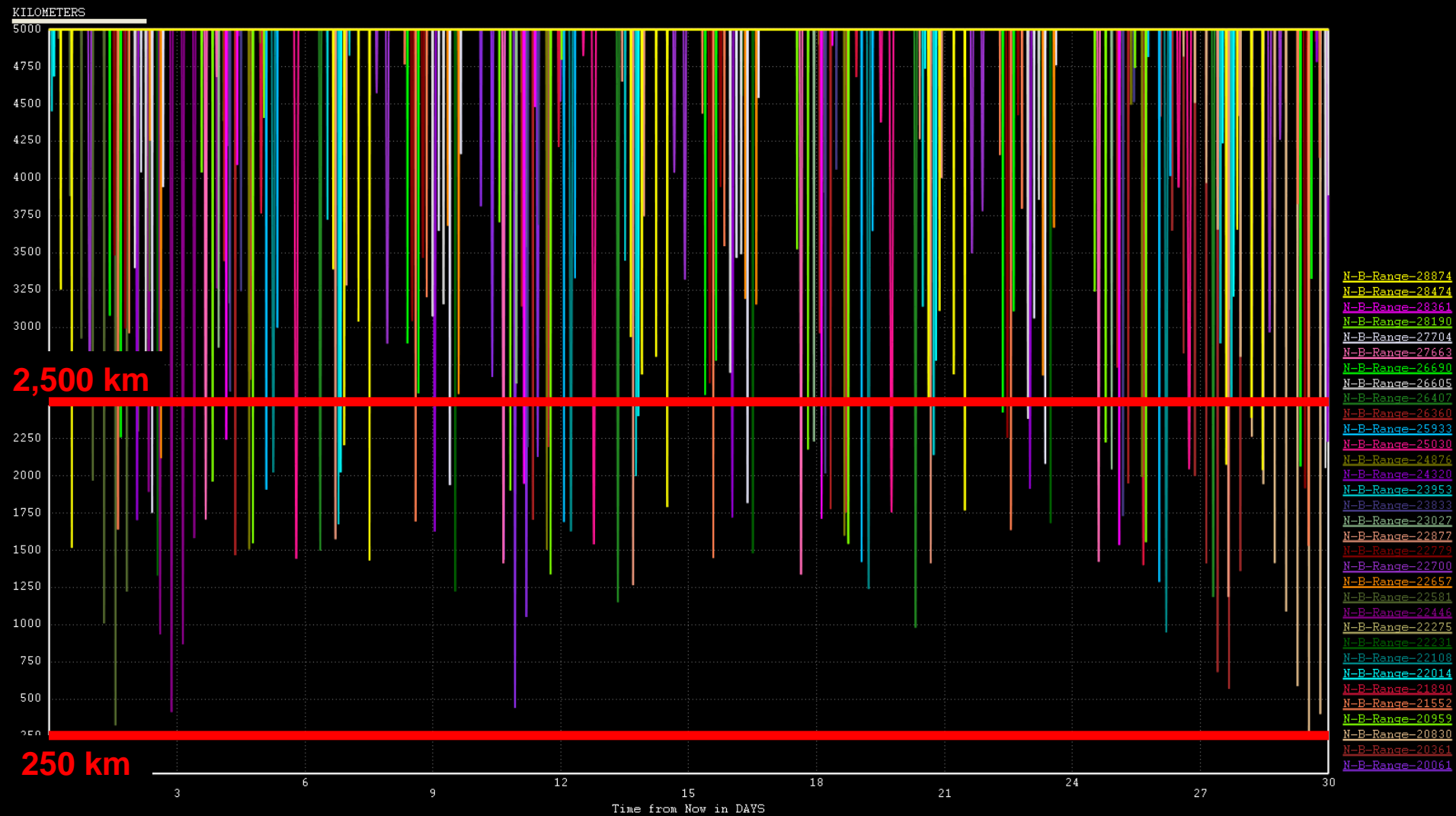


# MOLNIYA Decay



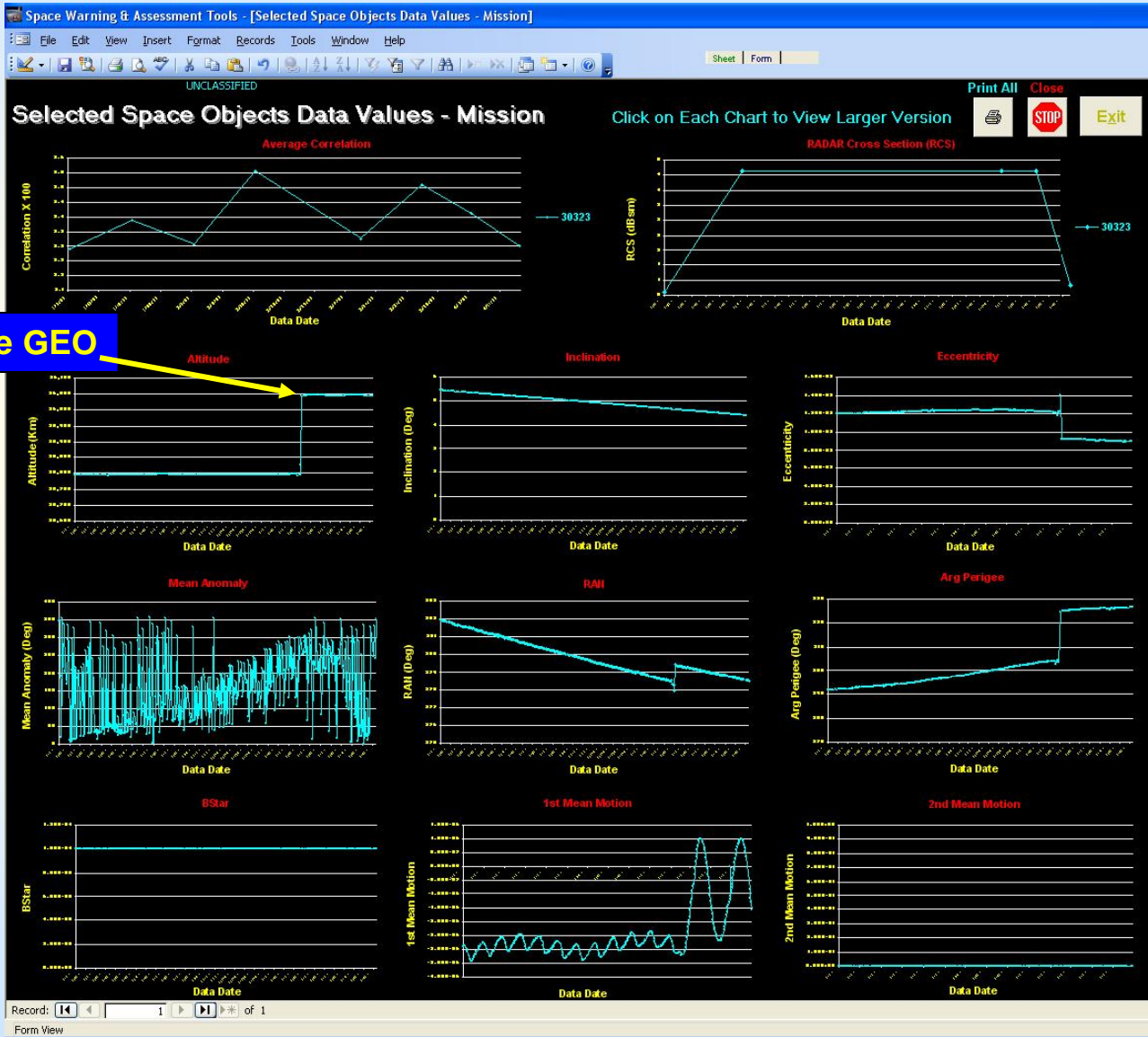
3,097 Km Loss of Average Altitude

# Beidou - MEO



SWAT 1  
SWAT 2  
SWAT 3

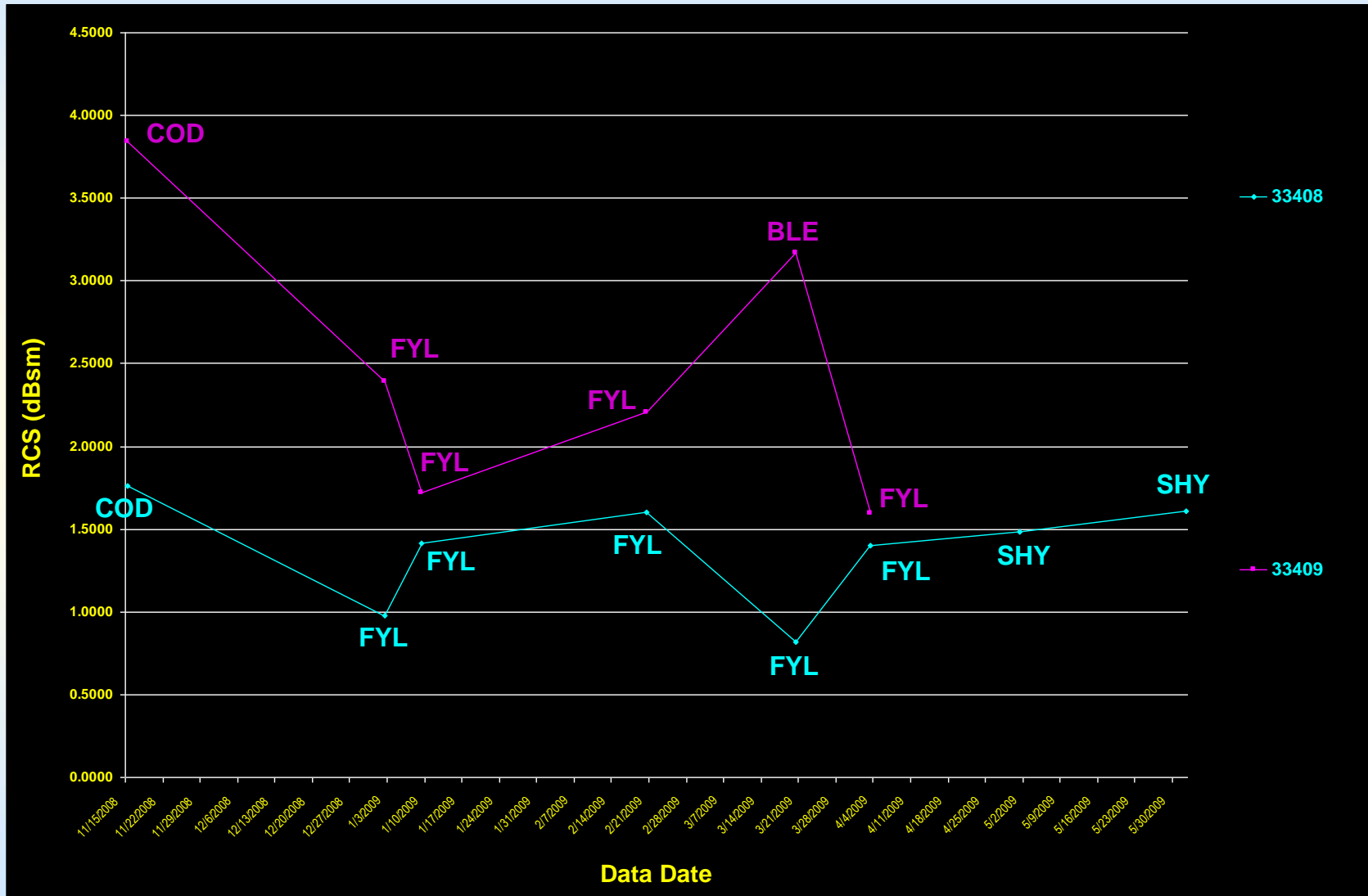
# Beidou - GEO Maneuver



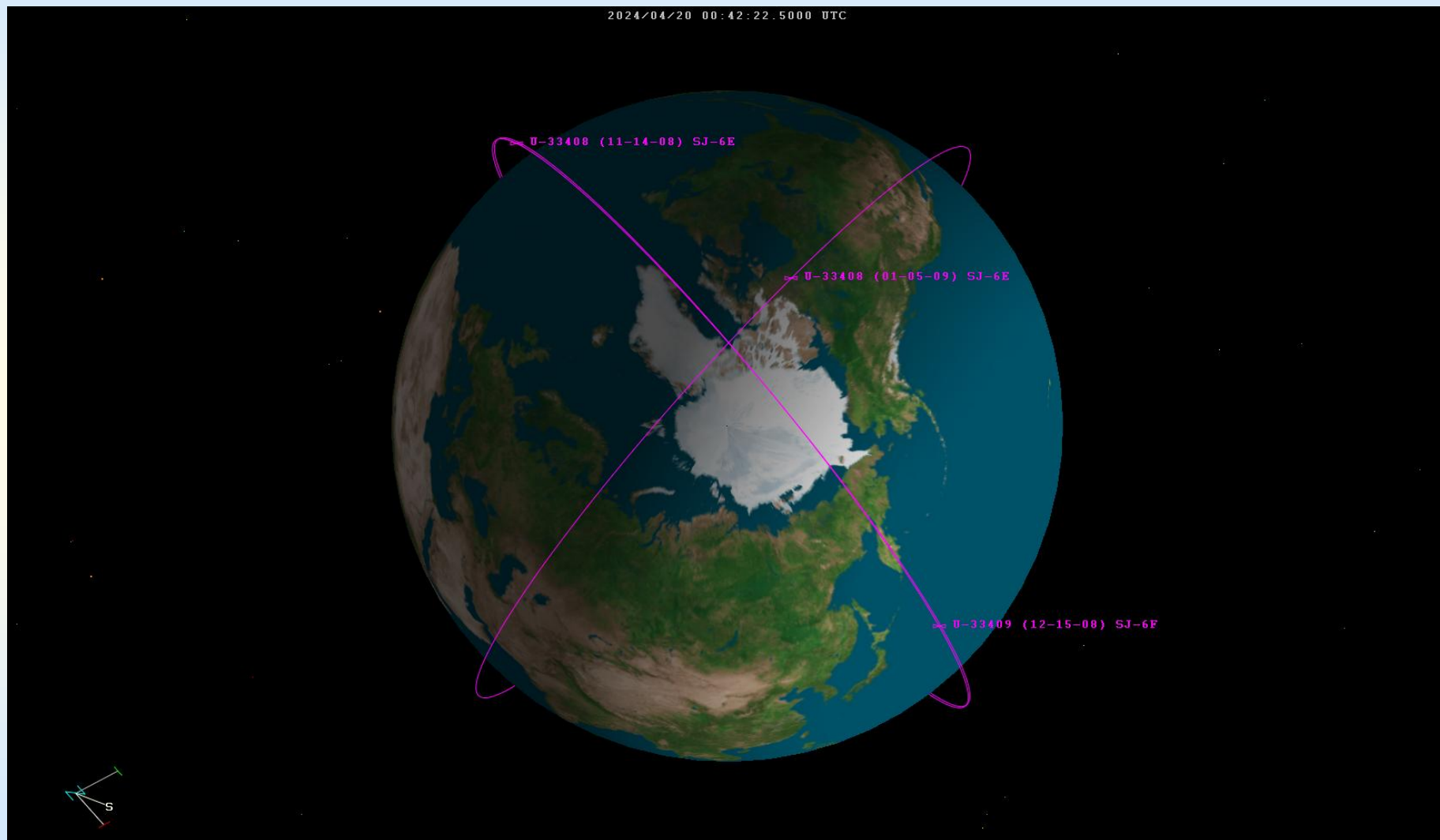
251 Km Above GEO

SWAT 1  
SWAT 2  
SWAT 3

# SJ's



# SJ's Orbits



# What Makes SWAT State Change Algorithms Different

- **SWAT Assesses All Space Objects**
  - Particular Emphasis On Potentially Threatening Space Objects Playing “Dead”
- **SWAT Analyzes 26 Characteristics of Space Objects Simultaneously**
  - Assessments Go Beyond Orbital Elements Alone
  - Simultaneous Changes (e.g. Maneuver & RCS) Increase State Change Scores
- **SWAT Compares Each Space Object To All Other Space Objects of Same Mission**
  - Discovers Unusual Characteristics Out of Norm

# SWAT State Change Benefits

- Filters 11,496 Space Objects Down to Top 10-20 With Most Activity for More Detailed Assessment by Other Space INTEL Assets
- Possible Discovery of Hidden Adversary Intent
- May Indicate Dying or Dead Satellites Before JSpOC Assessment
- Helps Evaluate Friendly Satellite Cover Stories
- **AFRL Success** – Working Now & Ready for Operational Evaluation

**SWAT Determines If Space Systems Have Changed State – Could Signal an ASAT Attack**

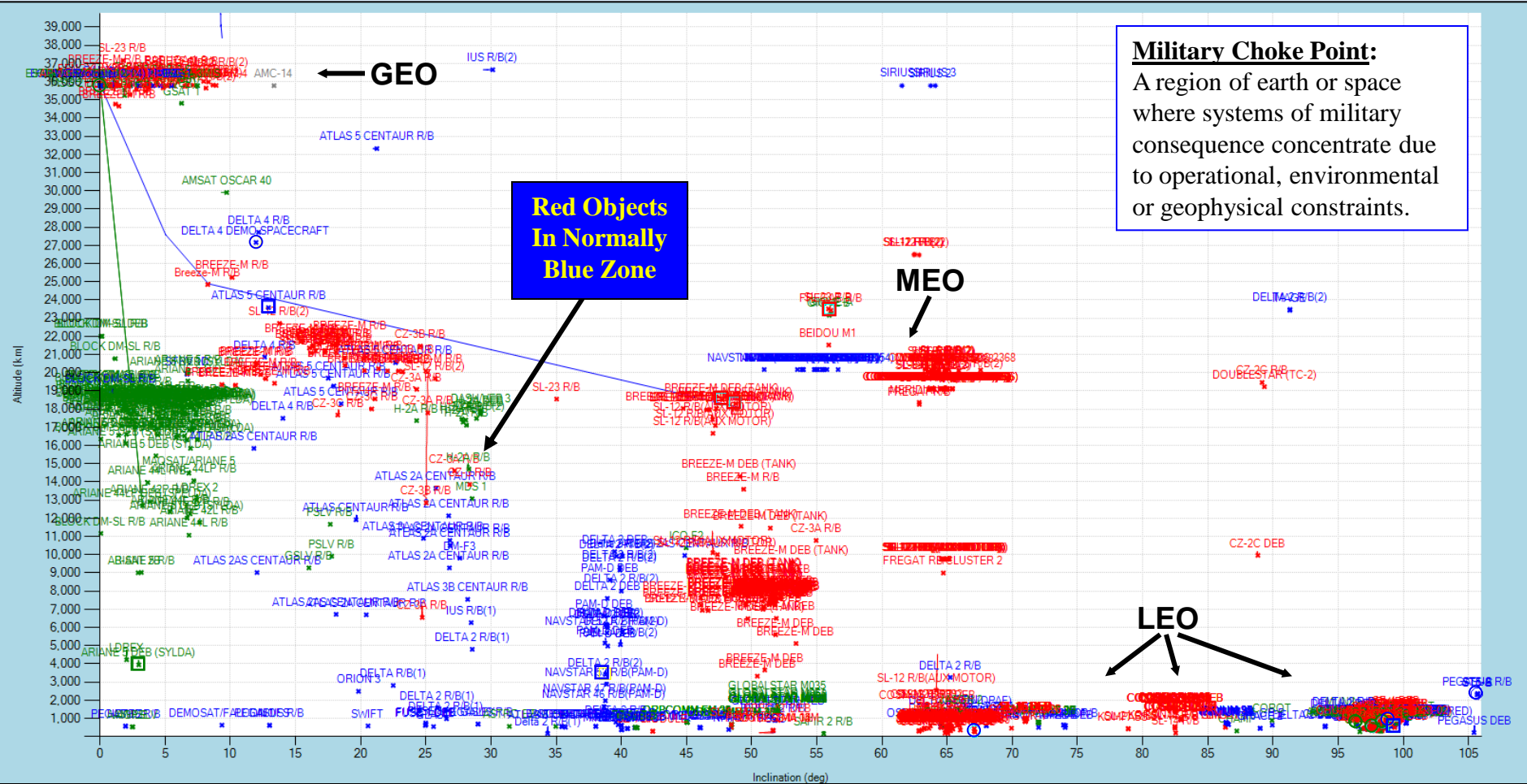


SWAT 1

SWAT 2

SWAT 3

# Satellite Attack Warning (SAW) – All Altitudes

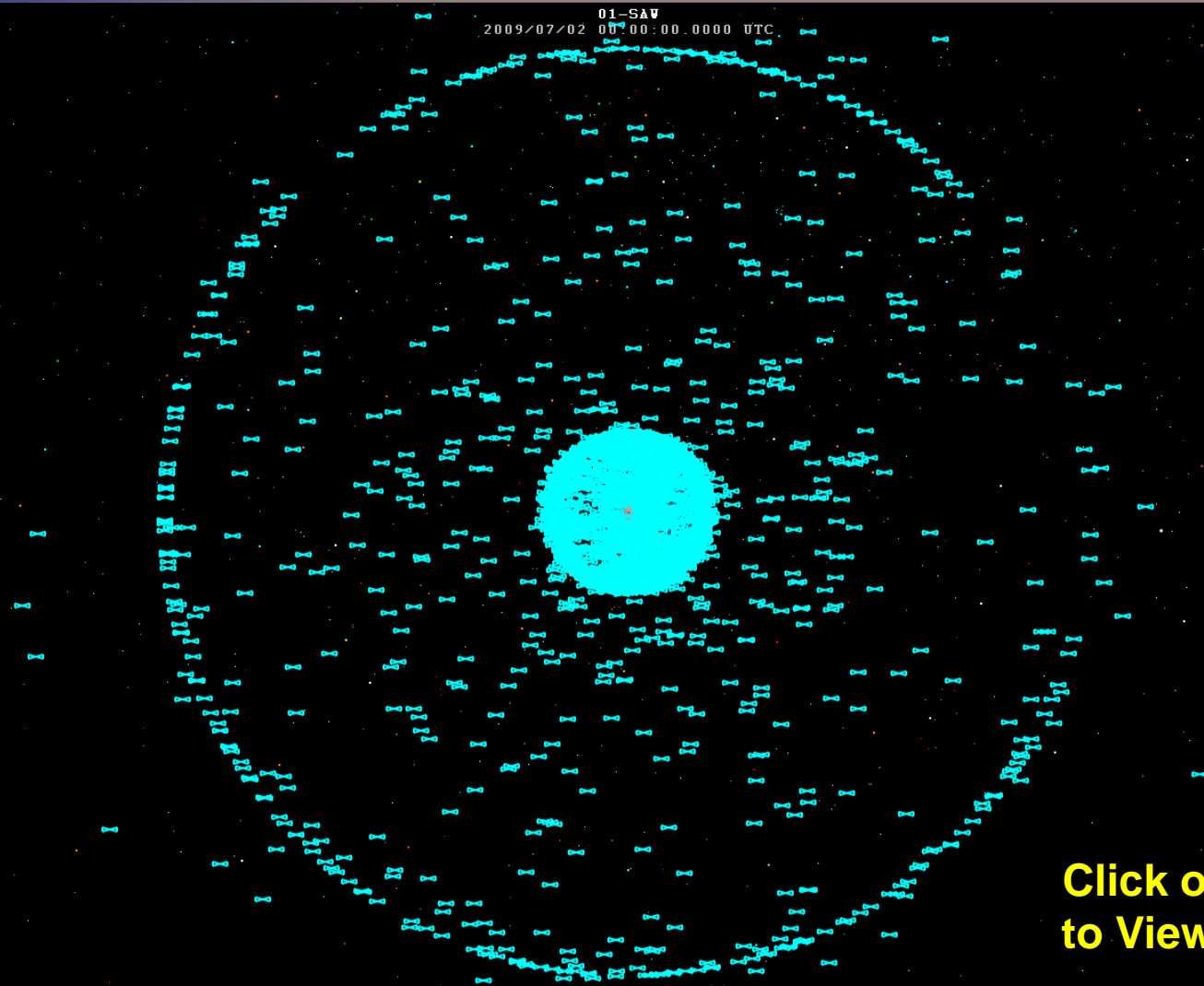


**Military Choke Point:**  
 A region of earth or space where systems of military consequence concentrate due to operational, environmental or geophysical constraints.

**Space Has Choke Points As In Terrestrial Systems – They’re Just Not Stationary**



# Traditional Orbital View

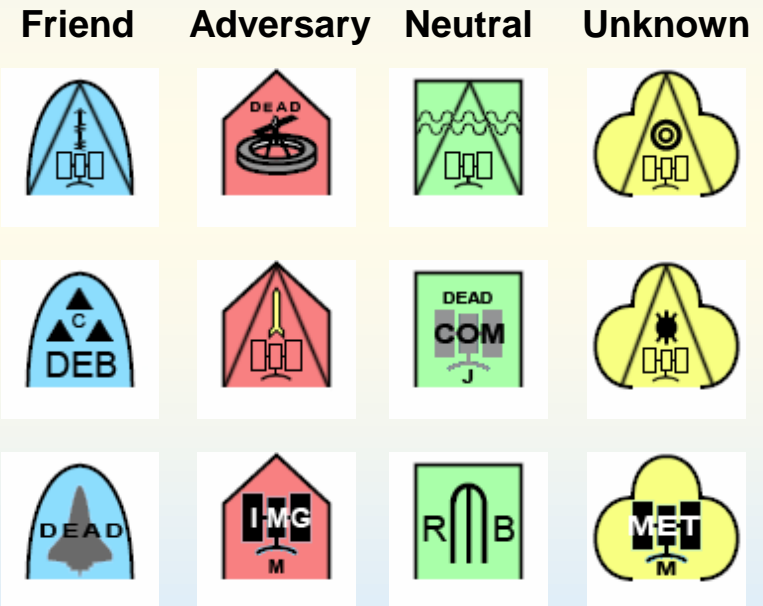


**Click on Satellites  
to View Animation**

**>12,000 Space Objects Confuses Users as to Possible Attack Patterns Developing**

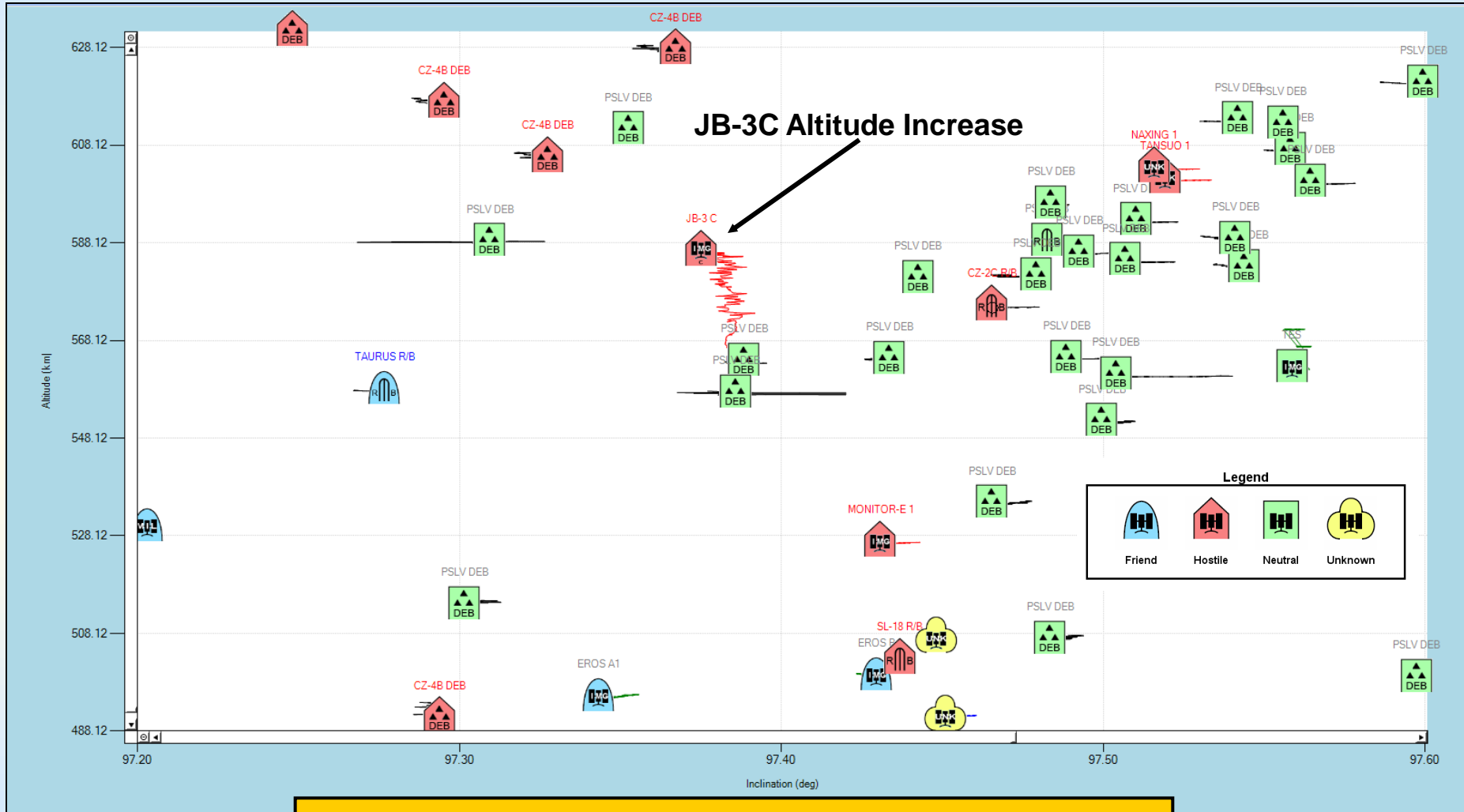
# SAW – Icons

- Based on Mil-Std-2525B
- 220 New Space Icons



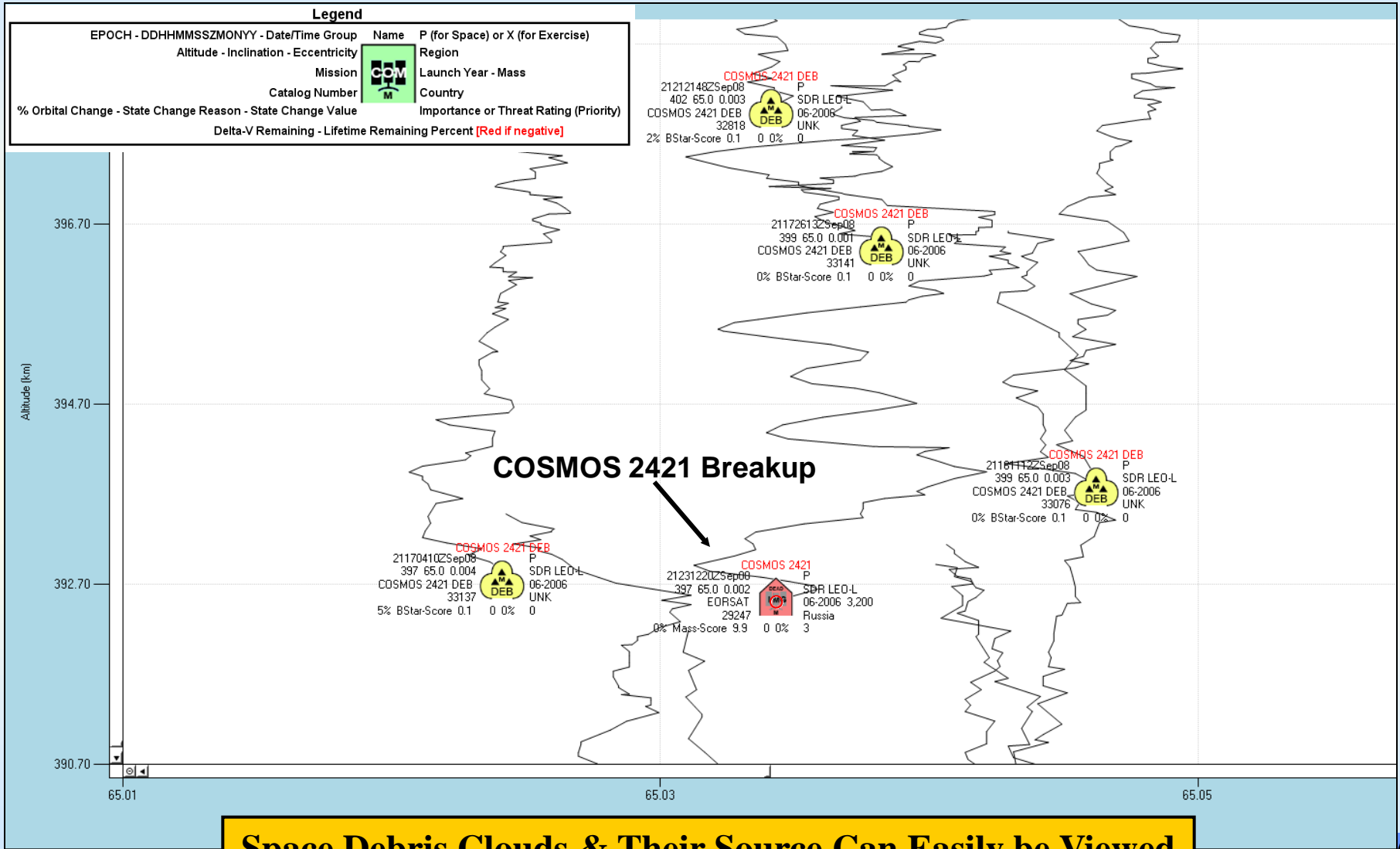
**Make SAW Maps Similar to Terrestrial Situation Maps**

# SAW – View 1



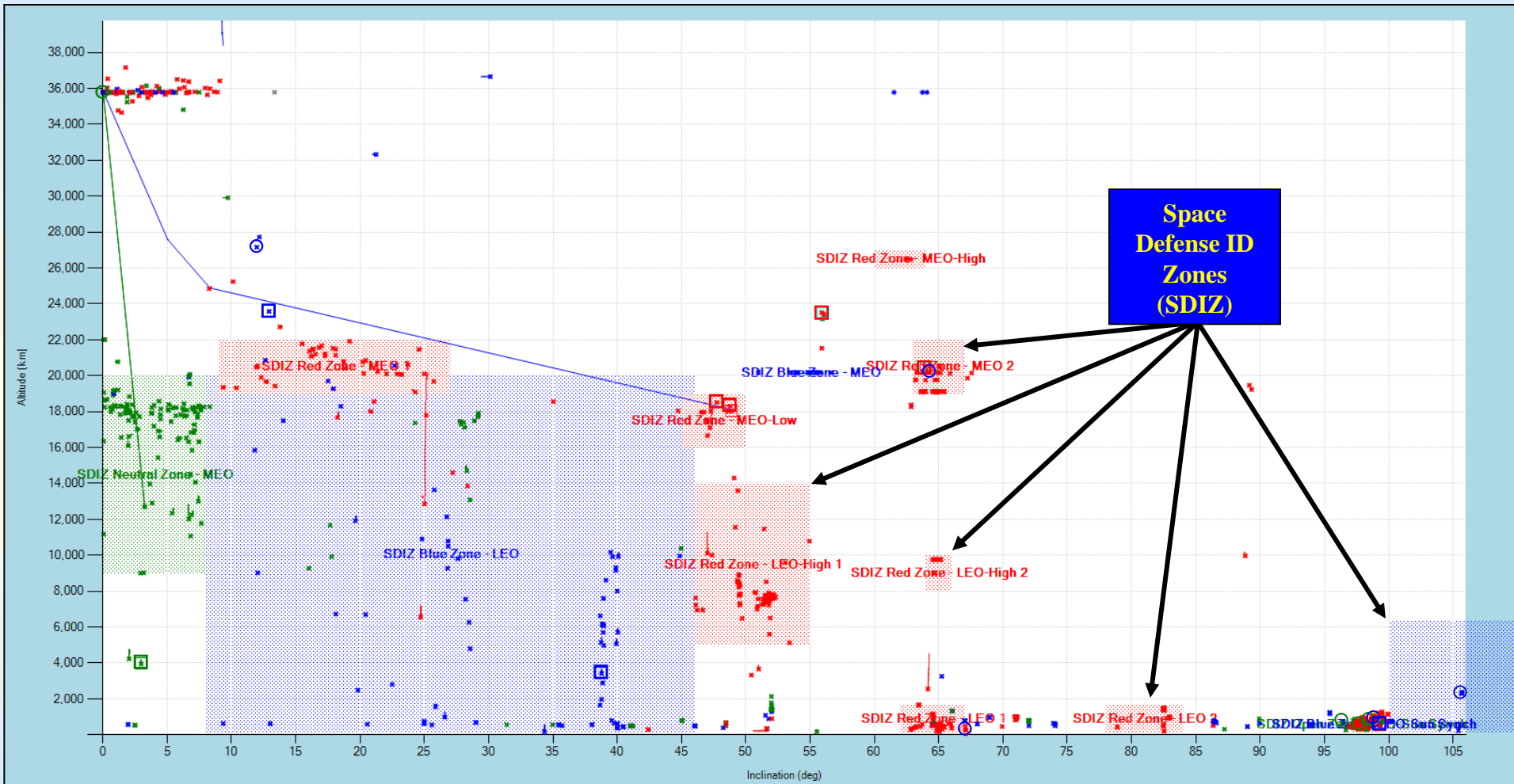
**Space Objects Orbital Changes Are Easy to Identify**

# SAW – View 2



**Space Debris Clouds & Their Source Can Easily be Viewed**

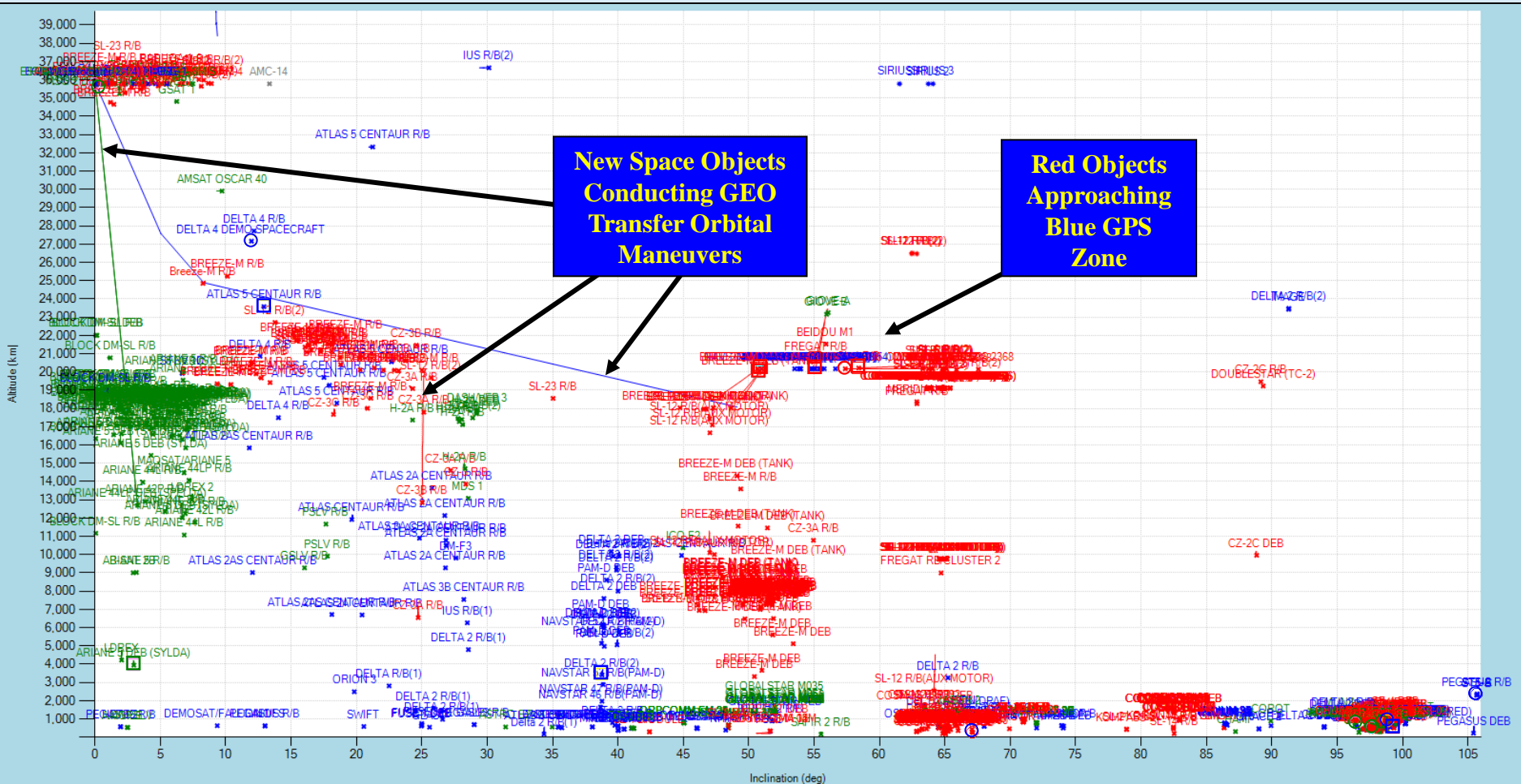
# SAW – SDIZ



**SSA Detection Zones Help Partial Out Operational Responsibility**

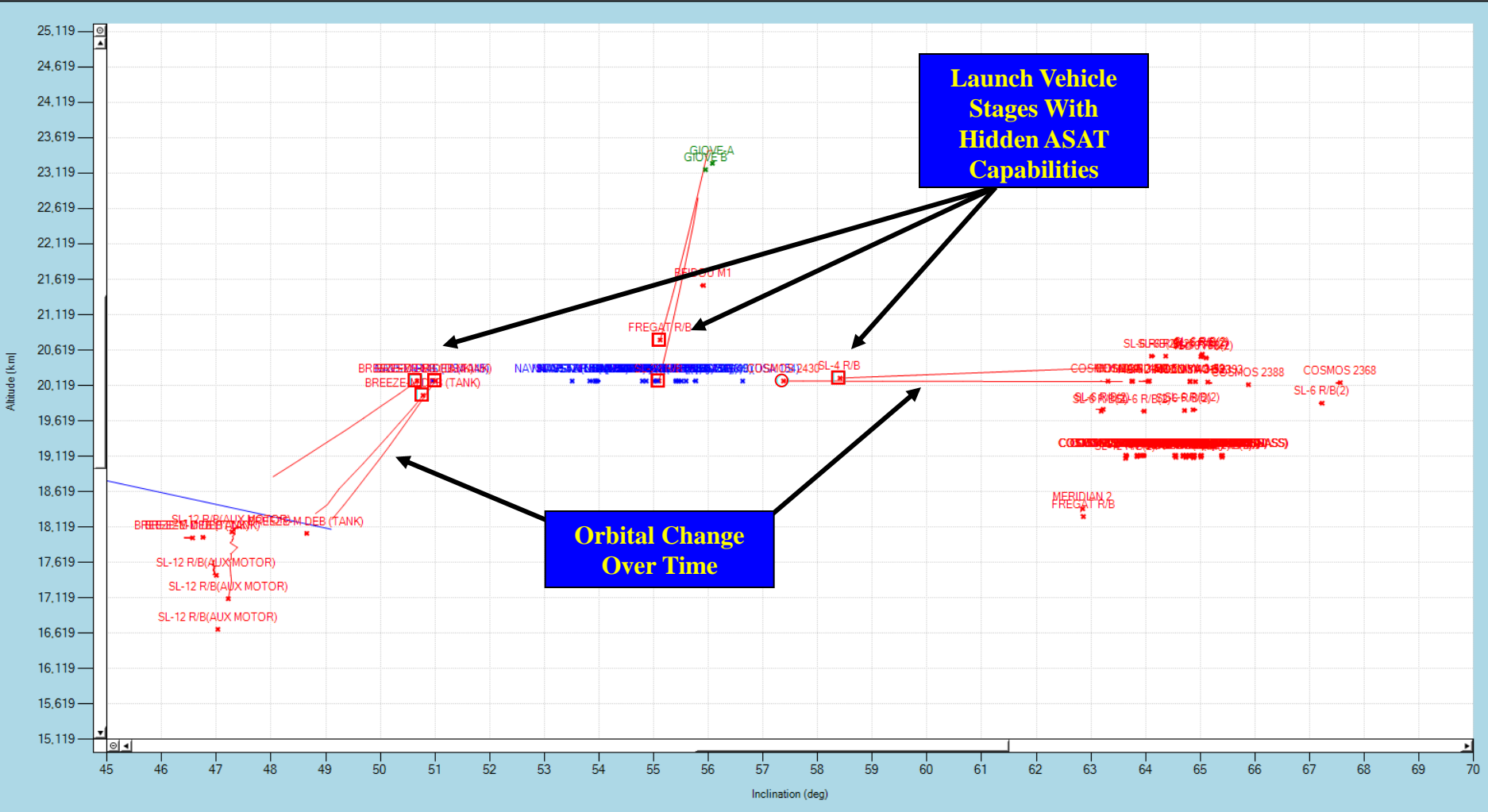
SWAT 1  
SWAT 2  
SWAT 3

# SAW – Simulated Attack Against GPS



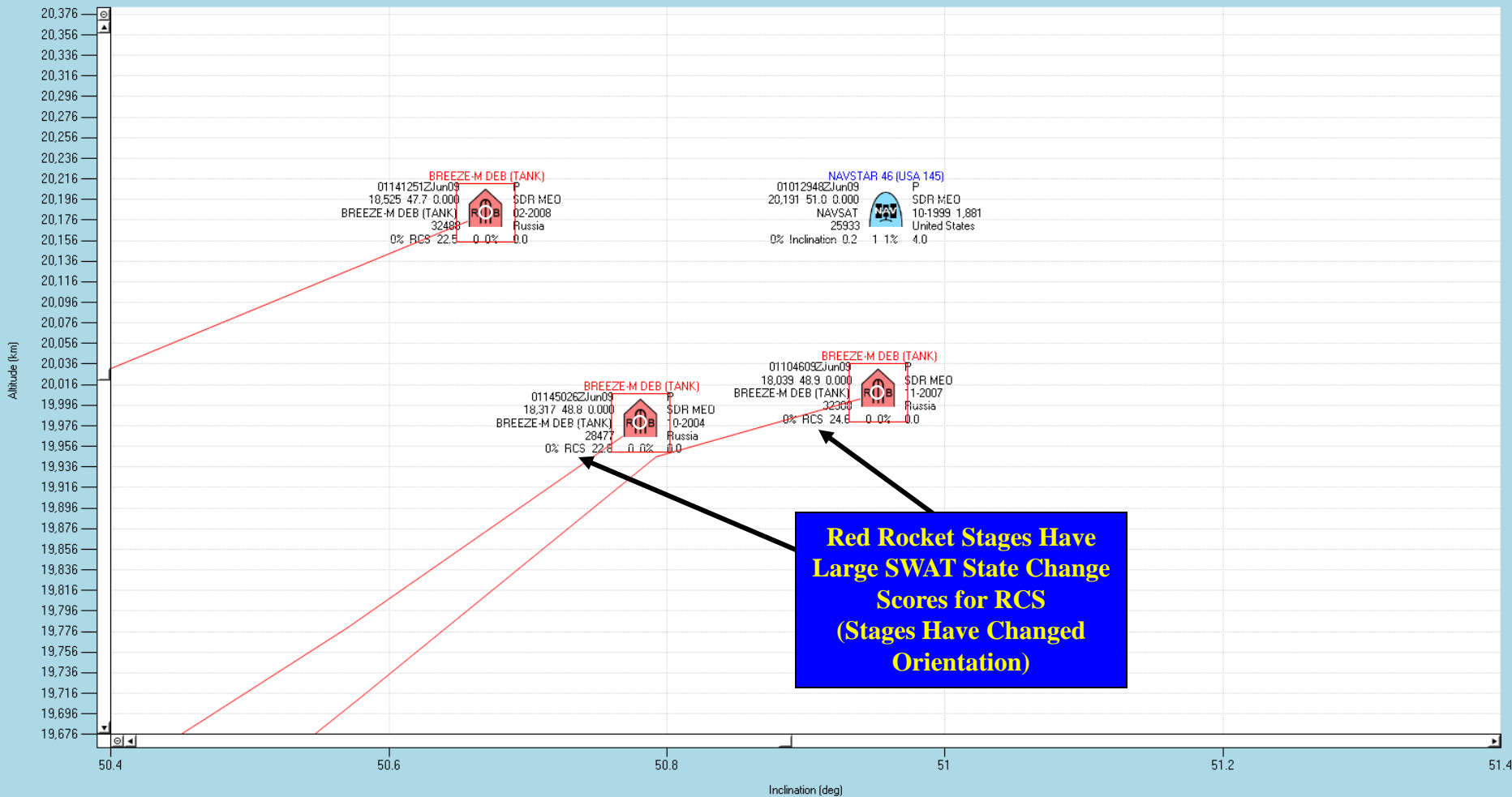
**Major Maneuvers of Space Objects are Easily Visualized**

# SAW – “Dead” Stages as ASATS



**Simultaneous Attack Maneuvers Can Easily be Detected**

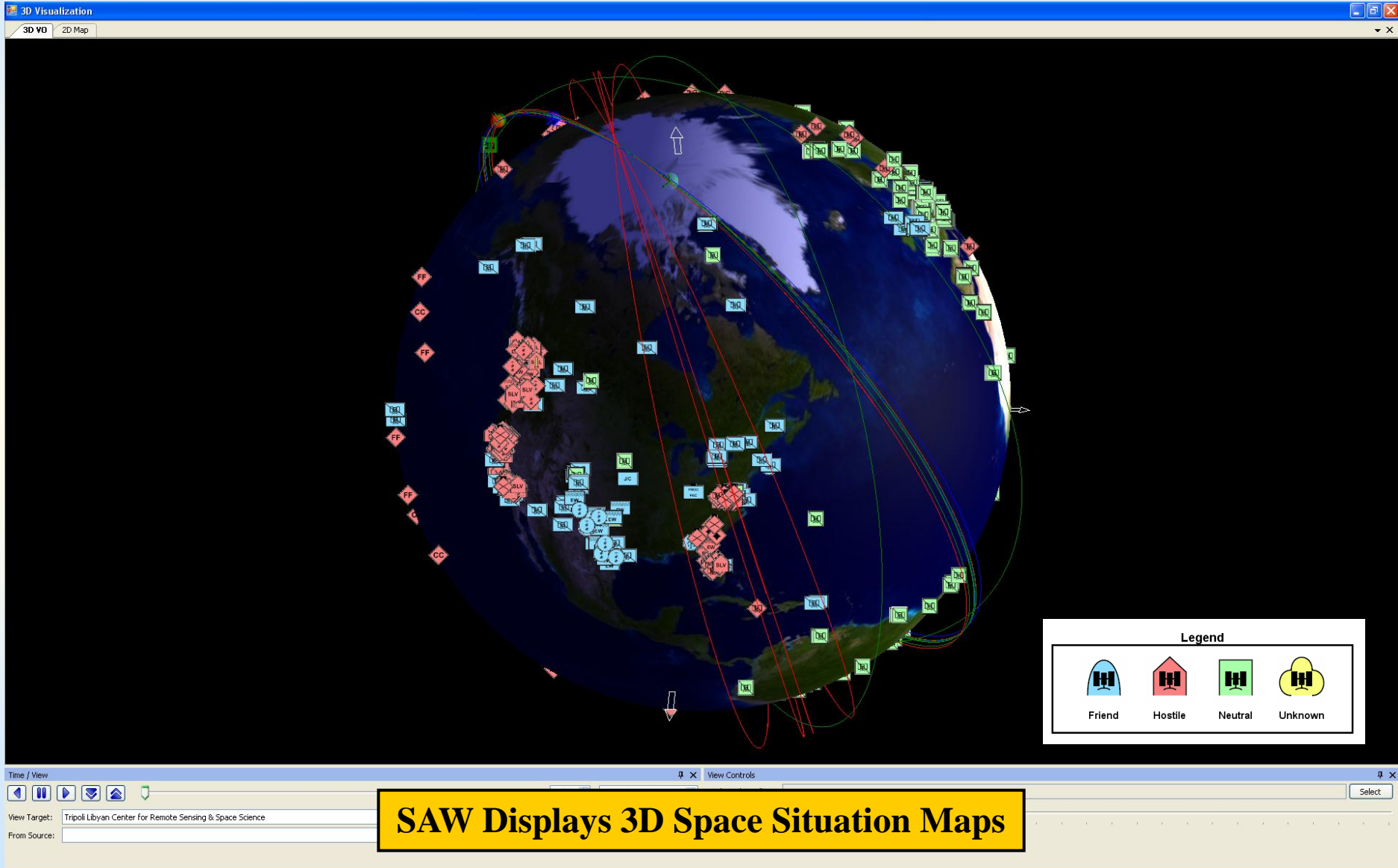
# SAW – Multiple Attacks Against One GPS



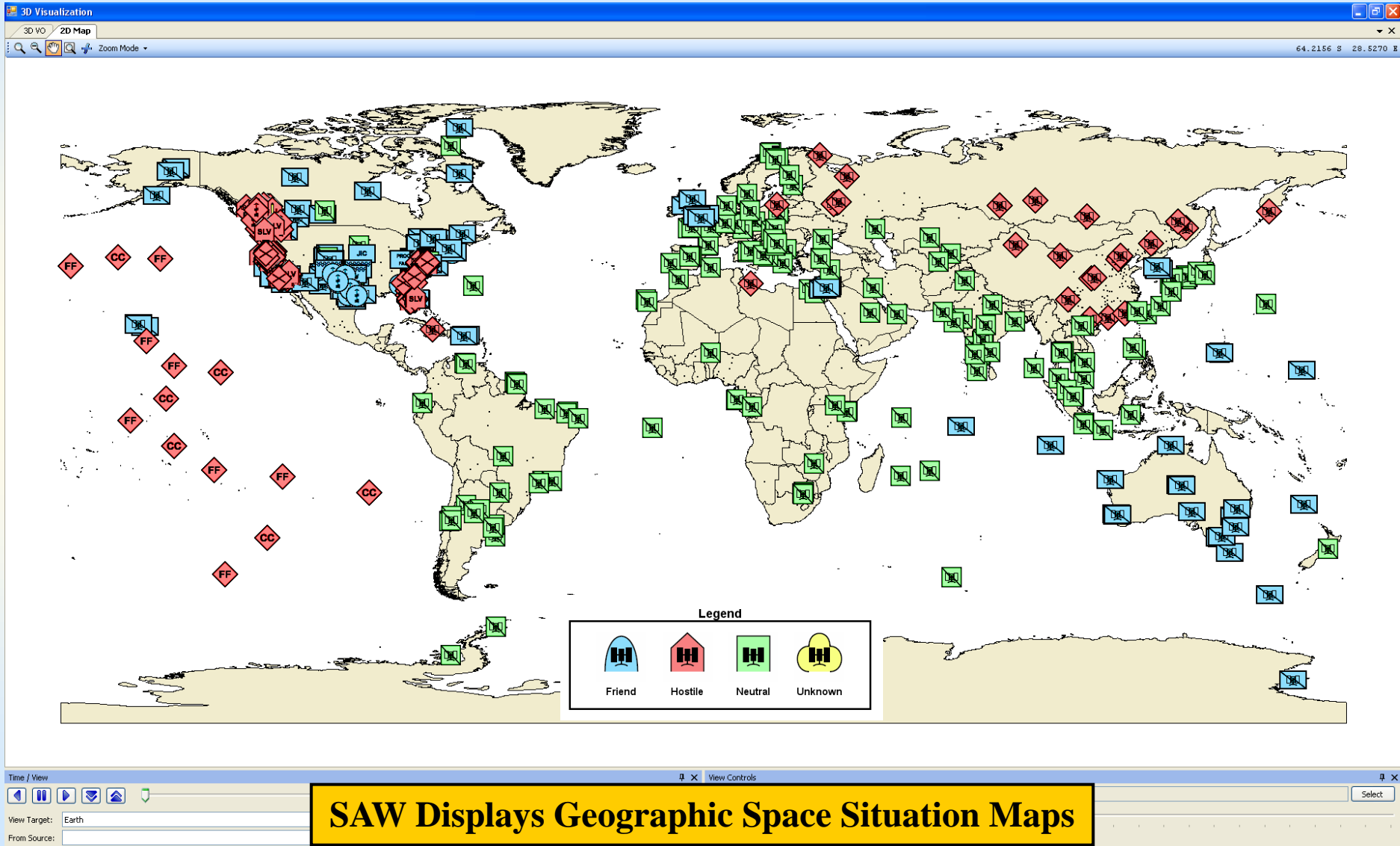
**Space Objects Playing Dead Can be Detected With Unusual Movements**



# SAW – 3D View



# SAW – Flat Map View



**SAW Displays Geographic Space Situation Maps**

# Space Web Ontology

# Space Ontology

- **1,009 Objects: Classes, Properties, Instances**
- **Most Classes Have Documented Instances**
- **Classes:**
  - **Military Objectives & Tasks (8 Levels)**
  - **Conflict Levels**
  - **Campaign Phases**
  - **Success Criteria**
  - **Success Indicators**
  - **Space Battle Zones**
  - **Space Centers Of Gravity**
  - **Space Principles of War**
  - **Space Escalation Ladder**
  - **Space NIIRS**
  - **Satellite Keep-Out Zones**

# Space Ontology Example

The screenshot displays the TopBraid Composer ME interface for editing an ontology resource. The main window is titled 'TopBraid - swat.space.control/SWAT\_Space\_Control.spin.owl - TopBraid Composer ME'. The interface is divided into several panes:

- Classes:** A hierarchical tree on the left showing the ontology structure, including classes like `rdfs:Resource`, `owl:Thing`, `NationalSecurity`, `NationalGoal`, `NationalMilitaryObjective`, `ConflictLevel-Cyber`, `ConflictLevel-Space`, `BattleZones-Space`, `CampaignPhase-Space`, `CampaignObjective-Space`, `OperationalObjective-Space`, `OperationalTask-Space`, `OperationalSubTask-Space`, `SuccessCriteria-Space`, `SuccessIndicator-Space`, `CenterGravity-Space`, `ConflictLevelOperations-Space`, `EscalationLadder-Space`, `NIIRS-Space`, `PrinciplesWar-Space`, `SatelliteKeepOutZones-Space`, `SpaceObjectCharacteristics-Space`, `TaskOptimization-Space`, `ConflictLevel-Terrestrial`, `rdfs:Property`, `rdfs:Statement`, `rdfs:Class`, `sp:SystemClass`, `spin:ConstraintViolation`, and `spin:Modules`.
- Resource Form:** The central pane shows the 'Resource Form' for the instance `AbsenceLaserDazzling-Space`. It contains various tabs and fields:
  - Record Tracking:** Record ID (UNCLASSIFIED), Record Classification (Blue), Conflict Side (Blue), WBS Tracking Number (CA.SI.S.1.1.4.1.1.1), Work Sponsor (Metatech Corporation IR&D), User Who Entered Data (Paul S. Szymanski), RDFS Comments (Absence of laser dazzling), Record Comments (Space Objectives and Tasks developed by Paul S. Szymanski), Data Source (Joint Warrior Interoperability Demonstration (JWID) 2000), Data Source Author (LTC Jim Duffy, USA), Data Source Organization (USSPACECOMJ6N), Data Source Document Number (true).
  - Course of Action Tracking:** COA Value (Was COA Authorized? true), Who Authorized COA? (JFAC), Was COA Implemented? (false), Country That COA Is Supporting (Calfon), Country That COA Is Directed Against (Orgonia), COA Political Acceptability (8), COA Probability It Will Be Required (1.0), COA Probability of Successful Completion (0.8), COA Level (COA Is Most Dangerous to Own Side), COA Is Most Effective Against Opposing Force (B), COA Is Most Probable to Be Implemented (B true).
  - Course of Action Descriptors:** COA Importance Ranking (2), COA Priority Ranking (3), COA Priority Ranking Reason (Enable coalition space-based missile warning capability), COA Descriptions (Absence of laser dazzling), COA Overall Concept (Prevent employment of Orgonian capability to interfere with medium altitude and/or geosynchronous earth orbit infrared sensors), COA Specific Definition (The degree of dominance in space of one force over another that permits the conduct of operations by the former and its related land, maritime, air, space, and special operations forces at a given time and place without prohibitive interference by the opposing force. (JP 1-02.)), COA Purpose (Protect space-based communication).
  - Course of Action Details:** COA Laws of Armed Conflict (Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies\* (1967 Outer Space Treaty)), COA Overall Acceptability (Medium), COA Diplomatic Concerns (High), COA Coalition Concerns (Medium), COA Other Limitations (World public opinion with use of space weapons), General Comments on Restrictions (Adversary must first use space weapons before Allied governments will agree to Allied employment of countering space weapons), Rules of Engagement (COA Rules of Engagement for Air: No direct attacks on space-related terrestrial targets; COA Rules of Engagement for Land: Adversary must first use space weapons before Allied governments will agree to Allied employment of countering space weapons).
- Instances:** A table at the bottom lists instances of the `AbsenceLaserDazzling-Space` class, showing their `rdfs:comment` and `RecordWBS` values.

# BACKUP

**“It is not the object of war to annihilate those who have given provocation for it, but to cause them to mend their ways.”  
- Polybius, History (2nd century B.C.) -**

# Principles of War

- **Objective**
- **Offensive**
- **Mass**
- **Economy of Force**
- **Maneuver**
- **Unity of Command**
- **Security**
- **Surprise**
- **Simplicity**

**Principles of War Equally Applicable to Space & Terrestrial Warfare**

# Space Principles of War Example

- Mass

- **Terrestrial:** *“Mass the effects of overwhelming combat power at the decisive place and time”*
- **Space:** Are there sufficient weapons to achieve continuous, or sustained space control. Can the adversary re-configure to avoid attack. Are the space weapons overwhelming to the military function they are trying to deny. Is there political will to implement massed space attack. Can space weapons get into position at the decisive place and time. Do we know the decisive place and time for space weapons application. Can space weapons be synchronized for employment simultaneously.

**Space Strategy Planning Has Not Had the Benefit of a Long History**



# Space Strategies Example

**Title:**

*Herd Space Personnel*

**Action:**

Destroy all Red space-related ground targets, except purposely lightly damage one ground center. Assume that key space support personnel will converge to this lightly damaged site to conduct repairs. 12 hours later, use anti-personnel weapons at this site, with destroy weapons 2 hours later.

**Desired Effect:**

Destroys Red country's most import space asset: key technically trained space personnel. Also sends message to international community that foreign personnel supporting Red space efforts will be at risk.

War Is Hell

# Space Strategies Derived From Sun Tzu

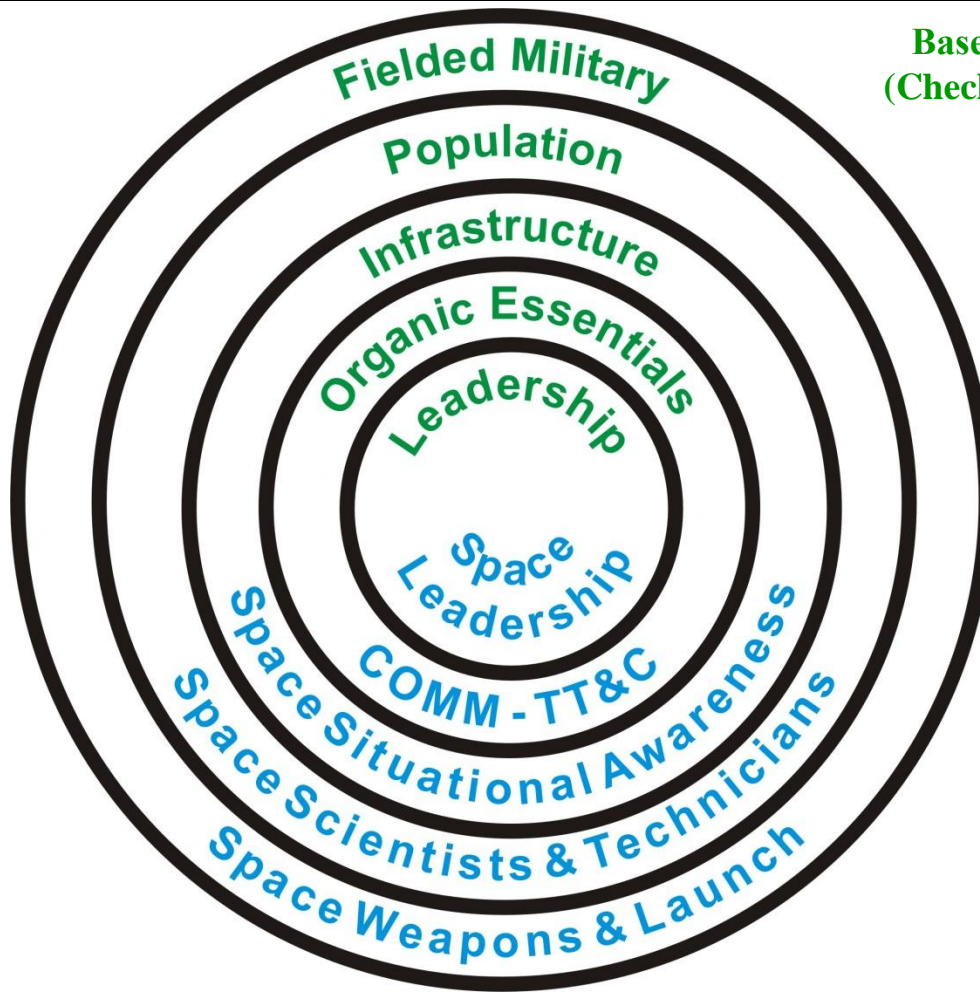
- Sun Tzu's "The Art of War" (544 BC – 496 BC) Used to Derive Modern Space Strategies
- Analysis in Progress
  - 453 Space Warfare Strategies Already Derived
  - Only 1/3 the Way Through Sun Tzu's Teachings

8	Info War
9	Force Status
10	Sun Tzu Statement 1: When able to attack, we must seem unable. When using our forces, we must seem inactive. Pretend to be weak, that he may grow arrogant.
11	Space Warfare Strategy 1: Deploy many covert space weapon systems & sensors with remote basing (air, sea, undersea, ground mobile, space, Moon).
12	Space Warfare Strategy 2: Deploy space weapons & sensors with multi-spectral camouflage coverings.
13	Space Warfare Strategy 3: Deploy space weapon systems & sensors in space with low observables coatings.
14	Space Warfare Strategy 4: Deploy space weapon systems & sensors in space with special shapes that do not readily reflect light back to the Earth.
15	Space Warfare Strategy 5: Deploy space weapon systems & sensors in space that can change attitude so they do not readily reflect light back to the Earth.
16	Space Warfare Strategy 6: Deploy covert space weapon systems & sensors in unusual orbits to avoid detection and precise targeting (highly eccentric, Lagrangian points, between geosynchronous orbits and the Moon, & beyond the Moon).
17	Space Warfare Strategy 7: Deploy covert space weapon systems & sensors that continuously change their orbits while outside an adversary's sensor coverage (e.g., maneuver over the South Pacific and the Poles). Continuous low-level thrusting may frustrate or blind sensors.
18	Space Warfare Strategy 8: Develop covert space weapon systems that hide inside innocuous space objects (civilian & science missions, space objects playing dead). Have exit doors on side of space object away from the Earth (zenith face) & most sensors.
19	Space Warfare Strategy 9: Develop some overt space weapon systems that stay in garrison, or are transported to other theaters that do not threaten the theater that one is planning to attack.
20	Space Warfare Strategy 10: Develop some overt space weapon systems that have limited technical and operational capabilities and appear to be the main space threat, but a covert weapon system is actually firing at the same time as the overt system.
21	Space Warfare Strategy 11: Develop some overt space weapon systems that have limited technical and operational capabilities and that will adorn an adversary's main spooling or counter-attacks (including SOF, HUMINT, & Cyber attacks that may take considerable time to execute).
22	Space Warfare Strategy 12: Develop some overt civil & commercial space systems that can also have space weapons capabilities (e.g., space maintenance robot).
23	Space Warfare Strategy 13: Develop a plan for space sensors to "ping" space objects according to a harmless, pre-planned schedule that does not reveal plans for a surprise attack against intended targets.
24	Space Warfare Strategy 14: Encourage allied space sensors to "ping" only space objects that are not part of an overall surprise attack plan.
25	Space Warfare Strategy 15: Do not deploy non-space forces in any threatening way, or deploy them in theaters other than those one intends to support with space weapons.
26	Space Warfare Strategy 16: Have the State Department devote considerable energy in emphasizing different political and social theaters that do not point to the intended targets and theater of the surprise attack.
27	Space Warfare Strategy 17: Have the State Department devote considerable energy in emphasizing no first use of space weapons.
28	Space Warfare Strategy 18: Have the State Department devote considerable energy in emphasizing no use of debris-causing space weapons, especially if these types of weapons will be used in the surprise attacks.
29	Space Warfare Strategy 19: Have the Military Departments devote some energy in emphasizing possessing limited, if any, space weapons capabilities.
30	Space Warfare Strategy 20: Develop alliances and treaties with more capable space partners so that you may make use of their space weapon systems in times of war.
31	Space Warfare Strategy 21: Deceive, Deny, Disrupt, Degrade, or Destroy adversary space sensors and intelligence collection capabilities. This includes use of cyber weapons and counterintelligence techniques. Cover up when adversary space intelligence collection capabilities are degraded.
32	Space Warfare Strategy 22: Shield indicators of space weapons beginning attack sequences (maneuvering, thrusters warming up, thrust plumes in space, other powering up, increased thermal signatures, new systems coming on-line, increased telemetry traffic, etc.).
33	Space Warfare Strategy 23: Fake the deaths of various satellites with covert, reserve space weapons missions, over a period of months and years before the surprise attacks.
34	Space Warfare Strategy 24: Determine the most threatening regions of space to pre-position space weapons for the best coordinated & optimized attack sequences. These are not necessarily physically close to the targets, but are close in orbital space (minimize travel time).
35	Space Warfare Strategy 25: Concentrate space forces only at the last moment before attack.
36	
37	Sun Tzu Statement 2: By discovering the enemy's dispositions and remaining invisible ourselves, we can keep our forces concentrated, while the enemy's must be divided. Let your plans be dark and impenetrable as night, and when you move, let your movement be like lightning.
38	Space Warfare Strategy 26: Develop & employ covert space surveillance systems.
39	Space Warfare Strategy 27: Only openly report space surveillance capabilities that are less capable (range, sensitivity, throughput, numbers of systems, mobility of systems, etc.) than reality.
40	Space Warfare Strategy 28: Hide space surveillance systems communications & data rate channels.
41	Space Warfare Strategy 29: Be careful of which & how many orbital elements are reported openly, so as not to give a potential adversary an idea of your space surveillance system's full capabilities.
42	Space Warfare Strategy 30: Conduct multiple fake space system maneuvers (& terrestrial mobility re-deployments) to draw away an adversary's space systems from the main point of attack.
43	Space Warfare Strategy 31: Conduct multiple small space system attacks to draw away an adversary's space systems from the main point of attack.
44	Space Warfare Strategy 32: Detect, understand & monitor both allied and adversary space choke points and centers of gravity (geographic, orbital, communications, social, doctrinal, etc.).
45	Space Warfare Strategy 33: Truly understand not only your adversary's space force status and dispositions, but also allied force status and dispositions. Do not let security restrictions obscure to competent commanders the true capabilities of your own forces, or of your allies.
46	Space Warfare Strategy 34: Concentrate anti-satellite resources only against key regions of space (sun-synchronous, part of the geo-synchronous belts, etc.) that are significant Centers of Gravity both for allied and adversary space systems. Gain space superiority by attacking key regions of space.
47	Space Warfare Strategy 35: Concentrate attacks against key regions of space only at the last moment when a shock & awe effect is warranted. For example, attack portions of the GEO belt from trans-lunar, vacant GEO belt sectors, highly eccentric orbits that are not used for communications, etc.
48	Space Warfare Strategy 36: To attack Low Earth Orbits (LEO) space systems, use low inclination (close to zero degrees) anti-satellite systems that only need to increase altitude to engage their targets (low delta-v maneuver), yet would have little adversary space system response.
49	Space Warfare Strategy 37: Employ mobile anti-satellite systems to attack adversary space systems, particularly those that can be based in regions of low or no adversary space surveillance coverage (e.g., South Pacific, South Pole, Equatorial regions, etc.), to e.g., attack Low Earth Orbits (LEO) space systems, use low inclination (close to zero degrees) anti-satellite systems that only need to increase altitude to engage their targets (low delta-v maneuver), yet would have little adversary space system response.
50	Space Warfare Strategy 38: Pre-conflict, have very visible, but relatively harmless, space control development programs, while the real space weapon systems are covertly developed.
51	Space Warfare Strategy 39: For kinetic kill anti-satellites, deploy more than one on the same booster, so that subsequent ASATs can hide in the debris clouds of the first attack. They can also act as multiple weapons on target to increase probability of kill (Pk).

Methods of War Are Eternal

# Space Centers of Gravity Model

Based On Col John Warden's  
(Checkmate) 5-Ring COG Model



Space Equivalent  
5-Ring COG Model

**Space Systems Strategic Targeting Is Similar to Terrestrial Targeting Strategies**

# Example Space Centers of Gravity

<b>Launch corridors</b>
GEO belt sectors
<b>Sun-Synchronous LEO orbits</b>
<b>GEO satellites changing orbital position</b>
Space-related command centers / commanders / INTEL Centers
Space surveillance systems
Space technicians / scientists
Electric grid serving ground space facilities
Space design and manufacturing facilities
<b>Leader's confidence in their new space technologies</b>
Blue and Red side political will to start and continue a space war
<b>Space-related decision cycle times (OODA loops)</b>
Low delta-v/transit time points in space to reach High Value Targets
Points in space with high/low coverage from space surveillance assets
<b>Regions of space and time with advantageous solar phase angles</b>
Times of high solar storm activity
On-orbit spares or launch replenishment or ability to reconstitute space capability with terrestrial systems
<b>Antipodal nodes 180 degrees from launch sites around the world</b>
Manned launch (Shuttle, Space Station) of satellites
Initial satellite checkout after launch or orbital insertion
<b>Periods of solar eclipse / low battery charge for satellites</b>
Approach trajectories outside the field of regard of the target's on-board sensors
Approach trajectories when the Sun/Moon/Earth is in the background of a target's sensors
Approach trajectories outside normally employed orbits
<b>Near a satellite's thrusters</b>
Near a satellite's high power antennas
Just after loss of contact with adversary satellite ground controllers / space surveillance assets

⋮

**SWAT Has Extensive Space Centers of Gravity Checklists**

# SWAT Automatic Determination of Red Space Attack Strategies

- **Database of Possible Red Space Attack Strategies are Linked to Checklist of INTEL Indicators of Space Systems Activities**
- **Most Probable Red Space Strategy Is Determined Based On Currently Observed INTEL Indications of Space Activities**
- **SWAT Automatically Increases Space INTEL Collection Priorities In IPB Tasking Forms Based On Probable Red Actions**

**SWAT Helps the Satellite Analyst Determine If Space Systems Are Under Attack**

# SWAT Auto Attack Assessment

Space Warning & Assessment Tools - [4.8 Course Of Action Situation]

UNCLASSIFIED

**4.8 Course Of Action Situation**

INTEL Summary Messages Detail | INTEL Summary Messages PopUp | Current Space INTEL Situation

Copy | New | Delete | Find | Close | Exit

**Most Likely Conflict Level**    % Indicators

Trans-Conflict	3.3%
Phase 0: Pre-War Buildup	0.9%
Phase Va: Joint Offensive to Capture Red C	0.4%
Phase Va: Joint Counter-Offensive to Restoi	0.4%
Phase I: Deployment/Deterrence	0.1%

**Most Likely Strategy**    % Indicators

Sweep The Skies	7.7%
Hidden Negate	7.1%

**Most Likely Tactic**    % Indicators

Mobile Laser Blinder	1.0%
Mobile Direct Ascent ASAT	0.6%
Maintenance Satellite	0.6%
Mobile Ground Jammer	0.5%
Nano LEO Mine-Paint	0.3%

NAI Number	Key Word(s)	NAI Name	NAI Category	NAI Type	Detected	Red	Blue	Gray	Comments
S.4.4.15.10.4	Shape	Small number of Red satellites changing shape	Small Number of Indicato	Short Period	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
S.4.4.15.11.1	Sequence	Red ASAT forces appearing to line up in a sequence of	Small Number of Indicato	Long Period	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
S.4.4.15.2.1	Maneuvering	Multiple Red satellites maneuvering closer to potential I	Large Number of Indicat	Short Period	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
S.4.4.15.2.7	Anomales	Multiple blue satellites experiencing anomales	Large Number of Indicat	Long Period	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
T.1.2.3.1.3.1	Laser	Red Mobile Laser Blinders Increased Attention from Civ			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.3.1.5.14	Laser Blinder	Red Mobile Laser Blinders Manufacturing Centers Incre			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.3.2.1.9	Laser Blinder	Red Mobile Laser Blinders Garrison / Storage Sites Imp			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.4.2.1.14	Jammers	Red Mobile Ground Jammers Garrison / Storage Sites Ir			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.5.2.1.45	ASAT	Red Mobile Direct Ascent ASAT Garrison / Storage Site			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.5.2.4.2	Increased Military Training	Red Mobile Direct Ascent ASAT Increased Military Train			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.7.1.23.3	Aerosols	Red Nano LEO Mine-Paint Increased Open Parts Impor			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.7.2.6.1	Training Center	Red Nano LEO Mine-Paint Increased Military Training -			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.1.2.8.1.16	Attitude	Red Maintenance Satellite Increased Interest In Satelli			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.2.4.1.10	Maintenance	Major Maneuver of Red Maintenance Satellite Towards			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
T.6.9.3.1.2.3	Military Personnel Operating TEL	Red Mobile Direct Ascent ASAT Remote Surveyed Sites			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	*				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**SWAT Helps the Satellite Analyst In Assessing Strategic Warning**

Military or national Named Area of Interest number ("S" for Strategies & "T" for Tactics)

→ SWAT 1  
SWAT 2  
SWAT 3

# Example Space Objectives

⋮ ← 5,000 Other Space Objectives

Blind Blue capabilities to observe the terrestrial battlefield
Blind Blue capabilities to observe space from terrestrial sensors
Blind Blue capabilities to observe space from space-based sensors
Spoof Blue capabilities to observe the battlefield
Deny Blue ability to launch new satellites
<b>Destroy some Blue space capability as a warning to Gray space systems support to Blue</b>
<b>Wear down Blue Defensive Counter-Space capabilities by instigating multiple false alarm attacks</b>
Attack Blue satellites before the start of the terrestrial conflict
<b>Spoof Blue perceptions of Red space strengths</b>
Conduct diplomatic offensive to restrict Blue ability to employ ASAT's
<b>Actively defend key launch corridors and orbits critical to Red conduct of war</b>
Preposition Red space assets to maximize their effectiveness at the start of the conflict
Disrupt Blue command and control capabilities for space systems
<b>Embargo Blue access to space systems</b>
Prevent Blue ability to service or re-fuel on-orbit satellites
<b>Develop propaganda campaign against Blue use of ASAT's</b>
Shape and delay Blue plans for space warfare
Deny Blue ability to achieve Space Situational Awareness
Disrupt Blue space attacks so they become uncoordinated
<b>Constantly shift points of application of space control weapons to confuse adversary response</b>
Herd Blue space communications paths to those that are more easily monitored by Red SIGINT assets
Attack key Blue space personnel and technicians
Disperse Red assets (maneuver satellites) just before launching first attack

⋮

**SWAT Has Space Objectives for Both Red & Blue Sides**

SWAT 1

SWAT 2

SWAT 3

# Example Space COA Indicators

→ Are a small number of Blue and Gray satellites experiencing anomalies over a long time period

Are a small number of Blue and Gray satellites losing contact with terrestrial controllers

Are a small number of new Red satellites appearing in orbit

→ Are a small number of Red satellites changing orientation

Are a small number of Red satellites changing shape

Are a small number of Red satellites changing thermal signatures

→ Are a small number of Red satellites concentrating towards potential Blue and Gray satellites

Are Red ASAT forces appearing to line up in a sequence of timed attacks against Blue and Gray assets

Are Red forces capable of attacking space-related terrestrial sites in Blue countries appearing to line up in a sequence of timed attacks

Are Red SIGINT assets appearing to line up in a sequence of timed operations against Blue and Gray Communications assets

→ Are there indications of Red aircraft activities that appear to concentrate on space-related terrestrial sites around the world

Are there indications of Red missile activities that appear to concentrate on space-related terrestrial sites around the world

Are there a small number of new satellite launches from Red facilities

**Many Insignificant Space Indicators May Add Up to Predicting a Major Attack**



# INTEL Indicators Example

1.2.5.1.5.21	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Wear On Roads at Sites
1.2.5.1.5.22	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Improved / New Roads at Sites
1.2.5.1.5.23	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Improved / New Parking at Sites
1.2.5.1.5.24	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Improved / New Railroad Tracks at Sites
1.2.5.1.5.25	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Improved / New Railroad Sidings at Sites
1.2.5.1.5.26	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Disturbed Vegetation / Soil at Sites
1.2.5.1.5.27	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Different Communications Patterns To / From Sites
1.2.5.1.5.27.1	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Communications Traffic To / From Sites
1.2.5.1.5.27.2	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Decreased (More Attempts to Hide) Communications Traffic To / From Sites
1.2.5.1.5.27.3	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers No Net Increase or Decrease of Communications Traffic To / From Sites, But Changed Patterns
1.2.5.1.5.27.4	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Encrypted Communications Traffic To / From Sites
1.2.5.1.5.28	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Hours / New Shifts for Personnel at Sites
1.2.5.1.5.29	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Scientists & Engineers at Sites
1.2.5.1.5.30	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Military Personnel at Sites
1.2.5.1.5.31	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Military Personnel of Higher Ranks at Sites
1.2.5.1.5.32	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Foreign Personnel at Sites
1.2.5.1.5.33	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of VIPs at Sites
1.2.5.1.5.34	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Housing Demand In Local Area
1.2.5.1.5.35	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers New / Expanded / Improved Housing Built On-Site
1.2.5.1.5.36	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers New / Expanded / Improved Recreational Facilities On-Site
1.2.5.1.5.37	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Food Intake
1.2.5.1.5.38	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Power Consumption
1.2.5.1.5.39	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Water Consumption
1.2.5.1.5.40	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Sewer Outake
1.2.5.1.5.41	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Refuse Outake
1.2.5.1.5.42	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Smoke Plumes from Sites
1.2.5.1.5.43	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Chemical Contamination at Sites
1.2.5.1.5.44	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers New or Increased Settling / Effluents Ponds at Sites
1.2.5.1.5.45	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Use of Data Processing Assets at Site
1.2.5.1.5.46	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased / Different Patterns of Thermal Images
1.2.5.1.5.47	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Large Mobile Vehicles with Erection Gantries at Sites
1.2.5.1.5.48	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Mobile Vehicles with Cooling at Sites
1.2.5.1.5.49	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Chemical Support Equipment at Sites
1.2.5.1.5.50	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Optical Test Equipment at Sites
1.2.5.1.5.51	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of RF Test Equipment at Sites
1.2.5.1.5.52	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Electrical Test Equipment at Sites
1.2.5.1.5.53	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Optical Test Stands at Sites
1.2.5.1.5.54	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of RF Test Stands at Sites
1.2.5.1.5.55	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Number of Large Mobile Vehicle Storage Sheds at Sites
1.2.5.1.5.56	Chicanean Yuan Hsi Mobile Direct Ascent ASAT Manufacturing Centers Increased Security at Sites

# Space Escalation Ladder

WBS	Conflict Phase	Terrestrial Campaign Phase	Space Campaign Phase	Weapon Type	Space Campaign Phase Full Name	Weapon Category
P.1.A.0	Pre-Conflict	Phase 0: Pre-War Buildup (Shape)	1st Wave Attacks Phase A	Pre-Conflict Deter	1st Wave Attacks Phase A - Pre-Conflict Deter	Overt Weapons Testing & Deployment; Treaties; Saber Rattling; Space Alliances; Normal Space Surveillance, Tracking & Reconnaissance Activities
P.1.B.0	Pre-Conflict	Phase 0: Pre-War Buildup (Shape)	1st Wave Attacks Phase B	Persuade; Spying; Propaganda; Avoidance Maneuvering; Increased Space Surveillance & Close Satellite Inspections	1st Wave Attacks Phase B - Pre-Conflict Persuade	Diplomatic Requests & Démarches; Economic Actions; Embargos; Legal Actions; Administrative Actions; Transmitting Propaganda Broadcasts; Jamming Propaganda Broadcasts; Increased Spying & Surveillance; Unusual Increases in Space Surveillance and Tracking Activities; Satellite Close Inspectors; Threaten Allies of Your Adversaries; Maneuver to Avoid Attacks
P.1.C.0	Pre-Conflict	Phase 0: Pre-War Buildup (Shape)	1st Wave Attacks Phase C	Hide; Covert; Cyber; Political Disruptions; Mobilize Forces; Increase Military Alert Level; Threatening Satellite Maneuvers; Increase Space Radiation; Initiate Satellite Defensive Measures; Employ Nation's Astronauts on International Space Station for Military Uses	1st Wave Attacks Phase C - Pre-Conflict Hide	Camouflage; Stop Activities; Mobility; Covert Technology Developments; Small Covert Attacks; Cyber Attacks; Provocative but False Attacks; Covert Actions in Violation of International Treaties; Cutoff Diplomatic Relations; Inspire Social Disruptions and Agitation; Employ Lethal Force Against Your Own Citizens; Mobilize Forces; Increase Military Alert Level (DEFCON); Maneuver Close Enough to Adversary Satellites to Purposely Appear as a Threat; Reveal Covert Programs to Appear Threatening; Enter Into War-Reserve Modes (Hide) for Critical Satellites; Hide Senior Leadership; Increase Radiation Environment in Orbits Used by Adversaries; Initiate Satellite Defensive Measures; Employ Nation's Astronauts on International Space Station for Military Reconnaissance and Surveillance
P.2.A.0	Trans-Conflict	Phase I: Deployment / Deterrence (Deter)	2nd Wave Attacks	Trans-Conflict Deter	2nd Wave Attacks - Trans-Conflict Deter	Linked Attacks; Demo Attacks; Alternate Country Attacks; Blockades; Major Covert Attacks; Terrorist Attacks; Summarily Execute Saboteurs; Seize & Sequester Suspected Terrorists; Alert Anti-Satellite Systems; Arm Satellite Self-Defense Mechanisms; Alert Anti-Missile Defenses; Alert Anti-Aircraft Defenses; Arm Allied Astronauts on International Space Station

**Space Actions May Be Conducted Pre-Conflict**

# Space Escalation Ladder (Cont.)

WBS	Conflict Phase	Terrestrial Campaign Phase	Space Campaign Phase	Weapon Type	Space Campaign Phase Full Name	Weapon Category
P.3.A.1	Trans-Conflict	Phase II: Halt Incursion (Seize Initiative)	3rd Wave Attacks Phase A1 – Gnd Based	From Terrestrial Partial Temporary Kill	3rd Wave Attacks Phase A1 – Terrestrial-to-Space Partial Temporary Effects	Delay, Deny, Covertly Assassinate Adversary Diplomatic Ambassador
P.3.A.2	Trans-Conflict	Phase II: Halt Incursion (Seize Initiative)	3rd Wave Attacks Phase A2 – Gnd Based	From Terrestrial Total Temporary Kill	3rd Wave Attacks Phase A2 – Terrestrial-to-Space Total Temporary Effects	Disrupt
P.3.B.1	Trans-Conflict	Phase III: Air Counter-Offensive (Dominate)	3rd Wave Attacks Phase B1 – Space Based	From Space Partial Temporary Kill	3rd Wave Attacks Phase B1 – Space-to-Space Partial Temporary Effects	Delay, Deny
P.3.B.2	Trans-Conflict	Phase III: Air Counter-Offensive (Dominate)	3rd Wave Attacks Phase B2 – Space Based	From Space Total Temporary Kill	3rd Wave Attacks Phase B2 – Space-to-Space Total Temporary Effects	Disrupt
P.4.A.1	Trans-Conflict	Phase IV: Joint Counter-Offensive to Restore Friendly Pre-Conflict Status (Stabilize Borders)	4th Wave Attacks Phase A1 – Gnd Based	From Terrestrial Partial Permanent Kill	4th Wave Attacks Phase A1 – Terrestrial-to-Space Partial Permanent Kill	Degrade
P.4.A.2	Trans-Conflict	Phase IV: Joint Counter-Offensive to Restore Friendly Pre-Conflict Status (Stabilize Borders)	4th Wave Attacks Phase A2 – Gnd Based	From Terrestrial Total Permanent Kill	4th Wave Attacks Phase A2 – Terrestrial-to-Space Total Permanent Kill	Destroy
P.4.B.1	Trans-Conflict	Phase V: Joint Counter-Offensive to Capture Adversary Capitol (Enable New	4th Wave Attacks Phase B1 – Space Based	From Space Partial Permanent Kill	4th Wave Attacks Phase B1 – Space-to-Space Partial Permanent Kill	Degrade
P.4.B.2	Trans-Conflict	Phase V: Joint Counter-Offensive to Capture Adversary Capitol (Enable New	4th Wave Attacks Phase B2 – Space Based	From Space Total Permanent Kill	4th Wave Attacks Phase B2 – Space-to-Space Total Permanent Kill	Destroy
P.5.A.0	Trans-Conflict	Phase VI: Defend Against Adversary Counter-Attacks Against Friendly Homeland (Defend Friendly Citizens)	5th Wave Attacks	Space-Manned Permanent Kill: Kill Adversary Astronauts	5th Wave Attacks - Space-Manned Permanent Kill	Degrade, Destroy: Kill Adversary Astronauts on International Space Station
P.6.A.0	Trans-Conflict	Phase VI: Defend Against Adversary Counter-Attacks Against Friendly Homeland (Defend Friendly Citizens)	6th Wave Attacks	Space-to-Earth Permanent Kill	6th Wave Attacks - Space-to-Earth Permanent Kill	Degrade, Destroy
P.7.A.0	Trans-Conflict	Phase VII: Defend Against Adversary Use of Nuclear Weapons in Space (Defend Friendly Military)	7th Wave Attacks	NBC Use - Space	7th Wave Attacks - NBC Use - Space	Degrade, Destroy
P.8.A.0	Trans-Conflict	Phase VIII: Defend Against Adversary Use of NBC Against Friendly Military Targets (Defend Friendly Military)	8th Wave Attacks; Phase A – Military Targets	NBC Use - Space & Terrestrial	8th Wave Attacks Phase A – NBC Use - Space & Terrestrial - Military Targets	Degrade, Destroy
P.8.B.0	Trans-Conflict	Phase IX: Defend Against Adversary Use of NBC Against All Friendly Targets (Defend Friendly Military & Civilians)	8th Wave Attacks; Phase B – Civilian Targets	NBC Use - Space & Terrestrial	8th Wave Attacks Phase B – NBC Use - Space & Terrestrial - Civilian Targets	Degrade, Destroy
P.9.A.0	Post-Conflict	Phase X: Post-Hostilities (Reconstruction & Stabilization)	9th Wave Attacks	Post-Conflict Deter	9th Wave Attacks - Post-Conflict Deter	Diplomatic Requests; Economic Actions; Legal Actions; Administrative Actions; Jamming Propaganda Broadcasts

**Space Provides Finer Gradations & Thus Better Control During Conflict Escalation**

SWAT 1

SWAT 2

SWAT 3

# COA Reactions Example

Time Sequence	Category	Actor	Target	Escalation Ladder	Probability of Occurrence	WBS	Action	Reaction
35	Satellites	Califon	Newmex	P.4.A.1	8	N.S.R.3		Newmex Bicudo Large LEO Photo Satellite is permanently partially blinded when over flying the disputed oil fields
35A	Political	Newmex	Califon	P.1.C.0	1	N.S.R.3.0	➔	Do nothing to increase escalation ladder
35B	INTEL	Newmex	Califon	P.1.A.0	10	N.S.R.3.1		Determine if degradation is caused by natural events, equipment failure or human actions, whether intentional or unintentional
35C	Forces	Newmex	Califon	P.1.C.0	9	N.S.R.3.2		Increase military alert level (DEFCON)
35D	Ground Stations	Newmex	Califon	P.1.A.0	9	N.S.R.3.3	➔	Contact other Newmexian space-related ground facilities to determine if multiple ground outage incidents are occurring
35E	Satellites	Newmex	Califon	P.1.A.0	9	N.S.R.3.4		Contact other Newmexian TTC ground facilities to determine if multiple satellite outage incidents are occurring
35F	Satellites	Newmex	Califon	P.1.A.0	9	N.S.R.3.5		Check with Newmexian supreme military command to determine if other military incidents are occurring to Newmexian and allied forces
35I	Space Surveillance	Newmex	Califon	P.1.B.0	10	N.S.R.3.8	➔	Increase surveillance and tracking for new and suspicious space objects
35J	Satellites	Newmex	Califon	P.1.B.0	10	N.S.R.3.9		Increase mission identification and country of origin determination for new and suspicious space objects (Space Object Identification - SOI)
35K	Satellites	Newmex	Califon	P.1.B.0	10	N.S.R.3.10		Increase signals intelligence collection on new and suspicious space objects
35L	Satellites	Orgonia	Califon	P.1.B.0	10	N.S.R.3.11		Maneuver Orgonian Abragh Nano LEO Inspector Satellite close to Newmex Bicudo Large LEO Photo Satellite for close inspection to help determine origin of mission degradations
35M	Satellites	Newmex	Califon	P.1.B.0	9	N.S.R.3.12		Increase satellite imagery, OPIR and RADAR surveillance and signals intelligence collection of Newmexian border areas
35N	Satellites	Newmex	Califon	P.1.B.0	8	N.S.R.3.13		Increase satellite imagery, OPIR and RADAR surveillance and signals intelligence collection of Newmexian internal areas
35O	Satellites	Newmex	Califon	P.1.B.0	10	N.S.R.3.14		Increase satellite imagery, OPIR and RADAR surveillance and signals intelligence collection of internal Califon activities
35P	Satellites	Newmex	Califon	P.1.B.0	9	N.S.R.3.15		Increase satellite imagery, OPIR and RADAR surveillance and signals intelligence collection of Califon allied activities
35Q	Forces	Newmex	Califon	P.1.A.0	9	N.S.R.3.16		Increase critical infrastructures defenses and surveillance
35AG	Political	Newmex	Califon	P.1.C.0	5	N.S.R.3.32		Cutoff diplomatic relations with Califon
35AP	Political	Newmex	Califon	P.1.B.0	9	N.S.R.3.41		Increase world attention to the problems of orbital space debris in order to slow down Califon's launching of new satellites
35BB	Political	Newmex	Califon	P.1.A.0	10	N.S.R.3.53		Engage in negotiations for space treaties and mutual defense pacts with other countries to increase space defense protection
35BC	Political	Newmex	Califon	P.1.A.0	10	N.S.R.3.54	➔	Publicly declare that any use of space weapons against Newmexian satellites will have a corresponding attack on the aggressor's space facilities associated with this attack, whether they be research centers, launch facilities, space surveillance sites, or command and control centers
35BD	Political	Newmex	Califon	P.1.B.0	9	N.S.R.3.55		Publicly declare that any use of space weapons against Newmexian satellites will have a corresponding attack on the aggressor's and their allies space facilities associated with this attack, whether they be research centers, launch facilities, space surveillance sites, or command and control centers
35BE	Forces	Newmex	Califon	P.1.C.0	8	N.S.R.3.56	➔	Initiate multiple false starts, threatening space and terrestrial maneuvers, etc. to induce your adversaries to begin constant satellite maneuvering, so as to waste their on-board fuel reserves before actual conflict starts
35BF	Forces	Newmex	Califon	P.1.C.0	8	N.S.R.3.57		Initiate random military orders, communications traffic, re-deployments and satellite maneuvers to confuse potential adversaries of your immediate plans and goals
35BG	Forces	Newmex	Califon	P.1.C.0	7	N.S.R.3.58		Launch or maneuver a new mysterious satellite that comes close to critical Califon satellites, to make Califon pause in its military execution plans, to show resolve, and as a warning to Califon to back down
35BH	ASAT	Newmex	Califon	P.1.B.0	10	N.S.R.3.59		Jam Califon propaganda broadcasts from their communications satellites directed at Newmexian dissidents
35BI	ASAT	Newmex	Califon	P.1.C.0	10	N.S.R.3.60		Initiate operational deployment of Newmexian Anti-Satellite (ASAT) systems

# COA Reactions Example (Cont.)

Time Sequence	Category	Actor	Target	Escalation Ladder	Probability of Occurrence	WBS	Action	Reaction
35BJ	ASAT	Newmex	Califon	P.3.A.1	8	N.S.R.3.61		Attack Califon Darapi Large LEO Photo Satellite with a Lagoa Mobile Ground Jammer-RF that temporarily denies Califon access to its intelligence collection capabilities, to show resolve and as a warning to Califon to back down
35BK	ASAT	Newmex	Califon	P.4.A.2	6	N.S.R.3.62		Attack Califon Darapi Large LEO Photo Satellite with an Ouro Space Launch ASAT Ground Mobile Missile that permanently destroys it, to show resolve and as a warning to Califon to back down
35BL	ASAT	Orgonia	Califon	P.3.A.2	9	N.S.R.3.63		Attack Califon Darapi Large LEO Photo Satellite with an Orgonian Dimbahah Nano LEO Mine-Paint that temporarily denies Califon access to its intelligence collection capabilities (covers lenses with temporary paint), to show resolve and as a warning to Califon to back down
35BM	Cyber	Newmex	Califon	P.2.A.0	9	N.S.R.3.64		Attack Califon Jeanton Large Ground Fixed Command Center with a cyber attack that temporarily disables its ability to command forces, to show resolve and as a warning to Califon to back down
35BN	Forces	Newmex	Califon	P.3.A.2	5	N.S.R.3.65		Attack Califon Jeanton Large Ground Fixed Command Center with Newmexian Irece SOF forces that permanently disables its ability to command forces, to show resolve and as a warning to Califon to back down
35BO	Forces	Newmex	Califon	P.2.A.0	5	N.S.R.3.66		Attack a Califon terrestrial system of similar military and economic value to deter Califon from further aggression
35BP	Forces	Newmex	Califon	P.1.C.0	10	N.S.R.3.67		Attack by cyber means the Califon facility that caused the Newmex Bicudo Large LEO Photo Satellite to be temporarily or permanently damaged
35BQ	Forces	Newmex	Califon	P.2.A.0	5	N.S.R.3.68		Attack by Newmexian Irece SOF forces the Califon facility that caused the Newmex Bicudo Large LEO Photo Satellite to be temporarily or permanently damaged
35BR	Forces	Newmex	Califon	P.4.A.2	3	N.S.R.3.69		Attack by the Newmexian Air Force Califon's facility that caused the Newmex Bicudo Large LEO Photo Satellite to be temporarily or permanently damaged
35BY	Industrial	Newmex	Califon	P.1.A.0	10	N.S.R.3.76		Prepare any remaining satellite launch facilities for rapid reaction capabilities enabling quick satellite launches
35BZ	Satellites	Newmex	Califon	P.1.A.0	9	N.S.R.3.77		Increase on-orbit spares for critical satellites
35CA	Satellites	Newmex	Califon	P.1.A.0	9	N.S.R.3.78		Increase on-orbit satellite decoys to confuse Califon and its allies' space surveillance networks
35CB	Satellites	Newmex	Califon	P.1.C.0	8	N.S.R.3.79		Initiate war-reserve modes for critical Newmexian satellite assets that begin to maneuver and reduce RADAR and optical signatures to avoid Califon and its allies' space surveillance networks
35CC	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.80		Recharge Newmexian satellite batteries on-orbit
35CD	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.81		Refuel Newmexian satellites on-orbit
35CE	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.82		Refuel Newmexian space support sites backup generators
35CF	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.83		Maneuver Newmexian space weapons (space-based and terrestrial-based) into optimized offensive and defensive positions
35CG	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.84		Deploy Newmexian space support assets (space-based and terrestrial-based) into optimized offensive and defensive support positions
35CH	Satellites	Newmex	Califon	P.1.C.0	9	N.S.R.3.85		Maneuver and deploy space control assets that later enable sealing off the Earth from adversary satellites, in order to fix these adversary space assets into a steady state that cannot be changed from the ground. This would include positioning for jamming, spoofing and cyber attacks, along with denying an adversary the ability to launch new satellites
35CI	Launch	Newmex	Orgonia	P.1.A.0	8	N.S.R.3.86		Request Orgonia provide satellite launch support from its Nuwayr Space Launch Ground Mobile Systems for Newmexian satellites
35CJ	Forces	Newmex	Califon	P.1.A.0	10	N.S.R.3.87		Explore non-space mission replacements for reduced satellite capabilities
35CP	Forces	Newmex	Califon	P.1.C.0	9	N.S.R.3.93		Increase surveillance, protection and defenses of space systems terrestrial terminals, command and control sites, space sensor sites, launch sites, space weapons marshaling areas, research centers and factories
35CQ	Environmental	Space	Space	P.1.B.0	9	N.S.R.3.94		Increase surveillance of solar events to better determine if potential satellite outages are caused by natural or human intents
35CR	Forces	Newmex	Califon	P.1.C.0	10	N.S.R.3.95		Determine if Califon and/or their allies have terrestrial forces maneuvering or deploying to operational locations and appear to be pre-positioning for attack
35CS	Satellites	Newmex	Califon	P.1.C.0	10	N.S.R.3.96		Command critical Newmexian satellites to initiate defensive measures (spinning, close shutters, increased heat transfer, etc.)
35CT	Satellites	Newmex	Califon	P.1.B.0	9	N.S.R.3.97		Maneuver critical Newmexian satellites beyond the range of potential threats
35CU	Satellites	Newmex	Newmex	P.1.A.0	10	N.S.R.3.98		Conduct a full battery of diagnostic testing on Newmexian satellites to determine if intermittent failures are a possibility
35CV	Launch	Newmex	Califon	P.1.A.0	9	N.S.R.3.99		If critical Newmexian satellites are permanently damaged, then launch other satellites with similar capabilities
35CW	Forces	Newmex	Newmex	P.1.A.0	10	N.S.R.3.100		Determine the effects on the overall space system mission of any space systems degradations
35CX	Forces	Newmex	Newmex	P.1.A.0	10	N.S.R.3.101		Modify previously planned space strategies and tactics due to current adversary and their allies' actions
35CY	Satellites	Newmex	Califon	P.1.A.0	10	N.S.R.3.102		Increase training for satellite operators that allows them to recognize intentional attacks and respond promptly

SWAT 1  
SWAT 2  
SWAT 3

# SSA Requirements Study

- **Reviewed Doctrine Docs, Joint Pubs, Air Force Glossaries, Air Force Instructions, Air Force Pamphlets, Army Field Manuals, National Defense University Handbook, and Multiservice Procedures**
  - 55 Total Documents Analyzed
- **Terrestrial Intelligence Preparation of the Battlespace (IPB) Principles Extrapolated to Space**
  - ~1,900 Different Space Control / SSA Requirements

**SWAT Baselines Space Control/SSA Requirements From Fundamental Military Doctrine**

# Example SSA Requirements Matrix

⋮

Is the weapon system preparing/powering up for use?

INTEL Derived From	INTEL Requirements	INTEL Indicators	Resolution Requirements	Space NIIRS	Detection Means	Technologies
Basic Characterization	<b>Satellite Current Orientation Attitude</b>	Satellite Current Cross Section	1.2 - 2.5	4	Imagery or RADAR	Optical or RADAR
Basic Characterization	Satellite Has Changed Attitude From Spinning or 3-Axis Stability	Satellite Cross Section Change	2.5 - 4.5	3	Optical or RADAR Cross Section	Optical or RADAR
Detailed Characterization	Satellite Current Weapons Suite Pointing Direction	Satellite Weapons Suite Image	0.20 - 0.40	7	Imagery	Optical
Exquisite Characterization	Satellite Delta-V Remaining Capability	Satellite Telemetry Indicates Propulsion Tank Fluid Level	N/A	N/A	RF Signal Monitoring	RF Receivers
		Satellite Propulsion Tank Thermal Image	0.20 - 0.40	7	Imagery	Optical-IR
Exquisite Characterization	<b>Satellite Propulsion Tank Fluid Status</b>	Satellite Telemetry Indicates Propulsion Tank Fluid Status	N/A	N/A	RF Signal Monitoring	RF Receivers
		Satellite Propulsion Tank Thermal Image	0.20 - 0.40	7	Imagery	Optical-IR
Exquisite Characterization	Satellite Current On-Board Processor State	Satellite Telemetry Indicates On-Board Processor State	N/A	N/A	RF Signal Monitoring	RF Receivers
Exquisite Characterization	Satellite Propulsion Tank Internal Pressure	Satellite Telemetry Indicates Propulsion Tank Internal Pressure	N/A	N/A	RF Signal Monitoring	RF Receivers
Detailed Characterization	Satellite Current Detailed Thermal Signature	Satellite Thermal Image	0.20 - 0.40	7	Imagery	Optical-IR

⋮ ← 1,900 Other SSA Requirements

**SSA Requirements Linked to Sensor Resolutions**

# SSA Requirements Tracking

Space Warning & Assessment Tools - [SSA Requirements Summary]

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## SSA Requirements Summary

Record Number: 3713 | Implement | Breakpoint: | Use | Requirement Priority: |  
 Record Sequence: 107 | Confirmed | Scenario Name: Baseline | Updated | Requirement Weight 1: 8 |  
 Requirement #: 3.3.1.1.1.15.1.1.1 | Use to Plan | STO Name: STO-1 | Requirement Weight 2: |  
 Tracking #: | Analysis Name: COA-1 | Satellite Priority: 10 | Total Weight: 8.0% |  
 Record Date: 2/27/2008 11:05:01 AM | Completion Date: | Completed |  
 Data Source: Paul Szymanski | Requirement Category: | How Exploit: |  
 Source Category: SSA\_1 | Exploitation Category: | INTEL System: System-4

Update Data | All Off | JSpOC On | Current On | Excel-All | Excel-1 | V-1 | Statistics | Copy | New | Delete | Find | Close  
 All On | SWAT On | Comptd On | Excel-Select | Excel-2 | V-2 |  
 Other On | Range |

How Linked to Space IPB  
 Ownership |  Endurance  
 Mission |  Status  
 Other Requirement |  Mobility |  Support To Space  
 Terrestrial Sensors |  Reach |  Support From Space  
 Space Based Sensors |  Timelines |  Vulnerabilities

Show: 1 2 3 4 5 | INTEL Technique: 1 2 3

Level 1: Evaluate the Adversary  
 Level 2: (3) Determine the current adversary situation  
 Level 3: Composition  
 Level 4: Generic satellite characteristics  
 Level 5: Characteristics that uniquely identify it and distinguish it from other space vehicles  
 Level 6: Attitude control sensors  
 Level 7: Type  
 Level 8: Earth Sensor  
 Level 9: Location on space object  
 Level 10:

Desired End Effect: |  
 Red Military Significance: |  
 Blue Military Significance: |  
 Data Utility: |  
 Broad INTEL Requirement: |  
 Detailed INTEL Requirements: Satellite Earth Sensor Location  
 INTEL Derived From: Exquisite Characterization  
 INTEL Indicators: |  
 Success Criteria: |  
 NIIRS Definition | Space NIIRS: 9  
 Resolution Requirements: <0.10 Meters | Min: 0.01 | Max: 0.02 | Calc Range: 2.79346337 Km  
 Required Technology: Optical | Optical: | RF: | Min: | Max: |  
 Main Detection Means: Imagery | Secondary Detection Means: |  
 Responsibility: |  
 Main Comments: |  
 Secondary Comments: |

SSN # 20924 | Satellite Name AMC-23 | Operational Mission COMM-CIVIL - Active | Mission Score |  
 Recommended Satellite Face to Observe: Plus Z | Primary  
 Recommended Satellite Face to Observe: | Secondary  
 Best Space Object Face to Observe Required Data:  
 X-Face Y-Face Z-Face  
 Plus: 0 0 1  
 Minus: 0 0 0  
 Actual Space Object Face Observed:  
 X-Face Y-Face Z-Face  
 Plus: | | |  
 Minus: | | |  
 Face Score: 0.0%  
 Recommended Minimal Required Lighting: High | Solar Illumination Definition  
 Actual Lighting: Low |  
 Previously Known Data | Currently Discov  
 Previously Known: Value: | Currently Known: Value: |  
 How Known: | How Known: |  
 Data Source: | Data Source: |  
 Data Quality: | Data Quality: |  
 Data Confidence: | Data Confidence: |  
 Intelligence Collection Procedures  
 Requirement: P1 P2 P3 P4 P5 P6 P7 P8 P9

Requirements Completed

Space Object Catalog Number	Percent Completed
1	44.7%
2	43.0%
3	43.4%
4	44.5%
5	43.0%
6	43.7%
7	44.5%
8	44.3%

Required Observation Resolution

Space NIIRS Quality Factor	Number of Requirements
1	170
2	100
3	360
4	100
5	300
6	900
7	660
8	710
9	1,650

Recommended Satellite Faces to Observe

Category	Number of Requirements
1	60
2	160
3	490
4	750
5	3,590

SSA Requirements Linked to Military Requirements

Record: 80 of 5190  
 Satellite Characterization Collection Requirement (links to space IPB) dealing with space system vulnerabilities to man-made and natural effects



# NIIRS Space Equivalents Defined

NIIRS Rating	GRD (m)	Terrestrial Examples	Space Equivalent Examples
0		Interpretability of the imagery is precluded by obscuration, degradation, or very poor resolution	Satellite features in shadow
1	9	Detect the presence of aircraft dispersal parking areas.	Characterize very large (e.g., International Space Station) space object.
2	4.5 - 9.0	Detect the presence of large (e.g., Boeing 737, 747, Airbus A-300, MD-80) aircraft.	Characterize large (e.g., GEO Communications satellite) space object.
3	2.5 - 4.5	Detect medium-sized aircraft (e.g., F-15). Identify an ORBITA site on the basis of a 12 meter dish antenna normally mounted on a circular building.	Characterize medium (e.g., DMSP) space object.
4	1.2 - 2.5	Identify the wing configuration of small fighter aircraft (e.g., F-16). Detect large (e.g., greater than 10 meter diameter) environmental domes at an electronics facility.	Detect if large (e.g., TDRS) solar panel has deployed.
5	0.75 - 1.2	Distinguish between single-tail (e.g., F-16) and twin-tailed (e.g., F-15) fighters. Detect automobile in a parking lot. Identify the metal lattice structure of large (e.g. approximately 75 meter) radio relay towers.	Determine large (e.g., TDRS) solar panel design configuration. Determine satellite attitude/spin rate. Determine if satellite has broken up into large pieces.
6	0.40 - 0.75	Detect wing-mounted stores (i.e., ASM, bombs) protruding from the wings of large bombers (e.g., B-52). Identify the spare tire on a medium-sized truck.	Determine existence of medium-sized (TDRS SGL Antenna) satellite antennas.
7	0.20 - 0.40	Identify antenna dishes (less than 3 meters in diameter) on a radio relay tower. Identify individual 55-gallon drums. Detect small marine mammals (e.g., harbor seals) on sand/gravel beaches. Detect small marine mammals (e.g., harbor seals) on sand/gravel beaches. Identify ports, ladders, vents on electronics vans. Identify ind	Determine attitude of medium-sized (TDRS SGL Antenna) satellite antennas. Determine large area degradation of solar panel optical quality.
8	0.10 - 0.20	Identify the rivet lines on bomber aircraft. Detect horn-shaped and W-shaped antennas mounted atop BACKTRAP and BACKNET radars. Identify windshield wipers on a vehicle. Identify limbs (e.g., arms, legs) on an individual. Identify individual horizontal and	Determine medium-sized (TDRS SGL Antenna) satellite antenna damage.
9	<0.10	Identify screws and bolts on missile components. Detect individual spikes in railroad ties. Identify individual rungs on bulkhead mounted ladders. Identify vehicle registration numbers (VRN) on trucks.	Detect orbital thruster damage. Detect if optical covers have been removed.

Similar to AFRL SORS (Space Object Rating Scale)

NIIRS = National Imagery Interpretability Rating Scale

**Space NIIRS Based on Equivalent Terrestrial NIIRS Definitions**

# SWAT Automatic Space Object Classification

- **Unknown Space Object Characteristics Compared to Selected Space Objects In SID + SPARKS Databases**
- **98% of the Time the Correct Mission for the Unknown Object is Within the Top 3 Choices SWAT Automatically Makes**
- **SWAT Has Corrected NORAD Satellite Catalog Mistakes In Mission Assessments**

**SWAT Helps the Satellite Analyst In Determining Surveillance Tasking Priorities**

# SWAT Auto Space Object ID

Space Warfare Analysis Tool - [RSO Mission Assessment]

File Edit View Insert Format Records Tools Window Help

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## RSO Mission Assessment

Weight Scenario Name: **Baseline**

Mission: **COMM-CIVIL**  
Country: **Spain**  
Sat Name: **AMAZONAS**

**Total Accuracy: 99%**

Comments:

Use	RSO Name	Most Likely Mission	% Indicators	Comments
<input checked="" type="checkbox"/>	RSO-0047	COMM-CIVIL	61%	
<input type="checkbox"/>	RSO-0047	SCIENCE	28%	
<input type="checkbox"/>	RSO-0047	COMM-JOINT	26%	
<input type="checkbox"/>	RSO-0047	COMM-MIL	25%	
<input type="checkbox"/>	RSO-0047	EARTH-RES	22%	
<input type="checkbox"/>	RSO-0047	COMM-TEST	21%	
<input type="checkbox"/>	RSO-0047	METSAT	20%	
<input type="checkbox"/>	RSO-0047	MSL-WARN	18%	
<input type="checkbox"/>	RSO-0047	NAVSAT	15%	
<input type="checkbox"/>	RSO-0047	REMOTE-IMG	12%	
<input type="checkbox"/>	RSO-0047	GEODETTIC	12%	
<input type="checkbox"/>	RSO-0047	COMM-MOBIL	9%	
<input type="checkbox"/>	RSO-0047	ELINT	8%	
<input type="checkbox"/>	RSO-0047	MILITARY	8%	
<input type="checkbox"/>	RSO-0047	OCEANOGRPHY	8%	

Mission	Accuracy
COMM-MIL	100%
COMM-MOBIL	100%
COMM-TEST	100%
COMM-WX	100%
ASTRONOMY	100%
EARTH-RES	100%
TECHNOLOGY	100%
METSAT	100%
MILITARY	100%
OCEANOGRPHY	100%
RADAR-IMAG	100%
REMOTE-IMG	100%
SCIENCE	100%
DISASTER	100%
NAVSAT	67%

Definition

### Satellite Description

Object Name	RSO-0047	Score	
Delta-V			
Drift Rate	-0.015	99%	
Stabilization			
RCS Value	21.179796	57%	
Visual Mag			
Shape			
Length	2.4	80%	
Width	35	80%	
Height	2.9	86%	
Mass	4545	60%	
Power			

### Optical Properties

Optics	<input type="checkbox"/>	Score	
Radar	<input type="checkbox"/>		
COMM	<input checked="" type="checkbox"/>	100%	
Retro	<input type="checkbox"/>		
Flashing	<input type="checkbox"/>		
Spin Rate			
Flash Period			

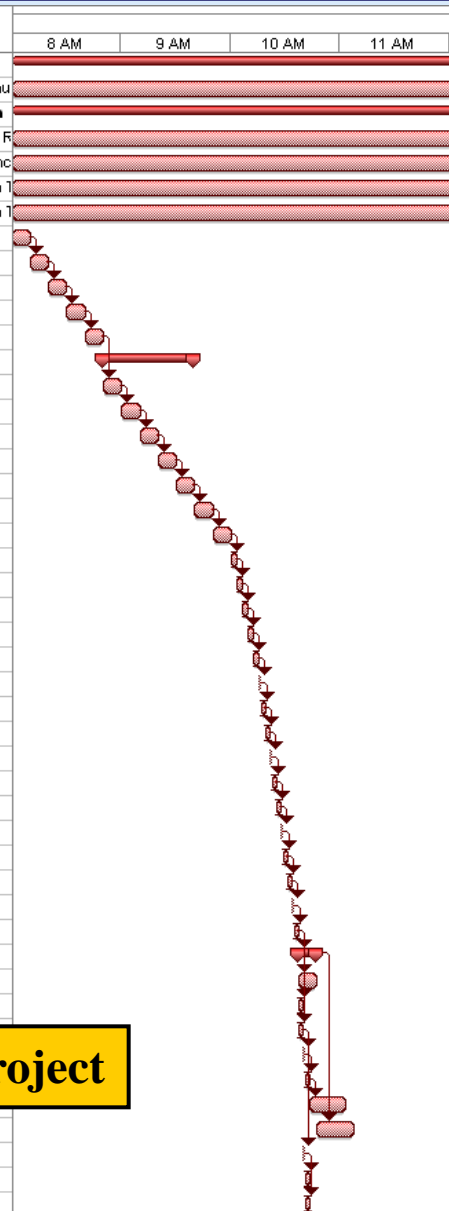
### Two Line Element Set

1st Mean Motion	-0.00000287	67%	Inclination	0.0197	89%
2nd Mean Motion	0	100%	RAN	33.6118	66%
BStar	0.0001	84%	Eccentricity	0.0002577	99%
Altitude (KM)	35,795		Arg Perigee	51.0278	66%
Period (Min)	1.436.1		Mean Anomaly	240.5558	76%
Period (Hrs)	23.9365		Mean Motion	1.00269313	90%

**SWAT Helps the Satellite Analyst In Narrowing Choices for New Space Objects ID**

# Scenario Partial Example 1

Weapon	INTEL Type 1	INTEL Type 2	WBS Code	Name
<b>Mobile Direct Ascent ASAT</b>	<b>IMIHT</b>	<b>SIGIHT</b>	<b>8</b>	<b>Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Launch Situation</b>
Mobile Direct Ascent ASAT	IMINT	SIGINT	8.1	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Launch Profile Does Not Look Like IRBM Surface-to-Surface Lau
<b>Mobile Direct Ascent ASAT</b>	<b>MASIHT</b>		<b>8.2</b>	<b>Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - No Detrimental Weather Conditions for Launch</b>
Mobile Direct Ascent ASAT	MASINT		8.2.1	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - No Detrimental Weather Conditions for Launch - No Heavy R
Mobile Direct Ascent ASAT	MASINT		8.2.2	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - No Detrimental Weather Conditions for Launch - Low Chan
Mobile Direct Ascent ASAT	MASINT		8.3	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Newmanian Satellite Approaching from Over the Horizon Within T
Mobile Direct Ascent ASAT	MASINT		8.4	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Newmanian Satellite Approaching from Over the Horizon Within T
Mobile Direct Ascent ASAT	IMINT		8.5	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - TEL Removed from Shelter / Camouflage
Mobile Direct Ascent ASAT	IMINT		8.6	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Vehicle Chucks / Levelers / Stabilizers Extended
Mobile Direct Ascent ASAT	IMINT		8.7	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Seals Removed
Mobile Direct Ascent ASAT	IMINT		8.8	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - TEL Erects Missile
Mobile Direct Ascent ASAT	IMINT		8.9	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - TEL Moves Away from Missile
<b>Mobile Direct Ascent ASAT</b>	<b>ELIHT</b>	<b>COMIHT</b>	<b>8.10</b>	<b>Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Final Checks &amp; Tests</b>
Mobile Direct Ascent ASAT	ELINT	COMINT	8.10.1	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Test Missile Sub-Systems
Mobile Direct Ascent ASAT	ELINT		8.10.2	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Test Launch Control Vehicle to Missile COMM
Mobile Direct Ascent ASAT	COMINT		8.10.3	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Test Space Center to Launch Control Vehicle COMM
Mobile Direct Ascent ASAT	COMINT		8.10.4	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Test Command Center to Space Center COMM
Mobile Direct Ascent ASAT	IMINT	SIGINT	8.10.5	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Launch Rehearsal
Mobile Direct Ascent ASAT	FISINT	TELINT	8.11	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Calibrate Inertial Guidance System
Mobile Direct Ascent ASAT	COMINT		8.12	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Receive Final Target Orbital Elements
Mobile Direct Ascent ASAT	FISINT	TELINT	8.13	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Upload Final Target Orbital Elements
Mobile Direct Ascent ASAT	IMINT	MASINT	8.14	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Top-Off Seeker Coolant
Mobile Direct Ascent ASAT	FISINT	TELINT	8.15	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Arm Batteries
Mobile Direct Ascent ASAT	IMINT	FISINT	8.16	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Hard-Point Attachments Released
Mobile Direct Ascent ASAT	FISINT	TELINT	8.17	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Booster Separation Squibs Armed
Mobile Direct Ascent ASAT	HUMINT	COMINT	8.18	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Countdown Sequence Initiated
Mobile Direct Ascent ASAT	FISINT	TELINT	8.19	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Functions Transferred to Internal Power
Mobile Direct Ascent ASAT	COMINT	HUMINT	8.20	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Authenticated Launch Codes Received
Mobile Direct Ascent ASAT	ELINT	HUMINT	8.21	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Officer Selects Missile from Battery
Mobile Direct Ascent ASAT	ELINT	HUMINT	8.22	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Officer Inserts Key Into Launch Control Console
Mobile Direct Ascent ASAT	ELINT	HUMINT	8.23	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Officer Lifts Cover from Launch Switch
Mobile Direct Ascent ASAT	ELINT	HUMINT	8.24	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Officer Operates Launch Switch
Mobile Direct Ascent ASAT	IMINT	MASINT	8.25	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Engine Started
Mobile Direct Ascent ASAT	FISINT	TELINT	8.26	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Begin Thrust Chamber Pressure Buildup
Mobile Direct Ascent ASAT	IMINT	MASINT	8.27	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Hold-Down-Bolts Fired
Mobile Direct Ascent ASAT	IMINT	MASINT	8.28	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Umbilicals Released
<b>Mobile Direct Ascent ASAT</b>	<b>IMIHT</b>	<b>MASIHT</b>	<b>8.29</b>	<b>Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Launch</b>
Mobile Direct Ascent ASAT	IMINT	MASINT	8.29.1	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Launch - Plume Present
Mobile Direct Ascent ASAT	MASINT		8.29.2	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Launch - Loud Auditory Signal
Mobile Direct Ascent ASAT	IMINT	MASINT		
Mobile Direct Ascent ASAT	IMINT	MASINT		
Mobile Direct Ascent ASAT	IMINT	MASINT		
Mobile Direct Ascent ASAT	MASINT			
Mobile Direct Ascent ASAT	FISINT	TELINT	8.33	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Telemetry Data Links Increased Bandwidth
Mobile Direct Ascent ASAT	MASINT		8.34	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile Flies Through Atmosphere
Mobile Direct Ascent ASAT	FISINT	TELINT	8.35	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Site Personnel Staring Up at the Sky
Mobile Direct Ascent ASAT	FISINT	TELINT	8.36	Koronean Tubul Mobile DA ASAT Attack Against Newmanian Goy En LEO Photo Satellite - Missile First Stage Shutdown



**Battle in the Blue Scenario Time Lines in Microsoft Project**

# Scenario Partial Example 2

## US Tactical Objective S2-8. Deny North Korea space-based surveillance and reconnaissance information

Purpose: Deny North Korea ability to gather information on coalition forces using space-based assets

### Success Criterion:

#### S2-8.1: North Korea unable to receive space-based surveillance and reconnaissance information

Concept: Increase time and resources required for North Korea to gather information on coalition strength and force disposition

#### *Tactical Tasks:*

##### *S2-8.1.1: Prevent North Korea forces from gathering ISR information using indigenous space-based assets*

*Concept: Eliminate North Korea surveillance and reconnaissance assets affecting the Coalition operations*

#### *Success Indicator:*

IND: North Korea surveillance and reconnaissance interrupted

IND: Coalition space-based surveillance and reconnaissance capability remains uninterrupted

##### *S 2-8.1.2: Prevent North Korea forces from acquiring third-party/commercial ISR information*

*Concept: Deny North Korea ability to purchase/obtain ISR data from third-party/Commercial sources*

*Deny third party capability to image selected protected areas*

#### *Success Indicator:*

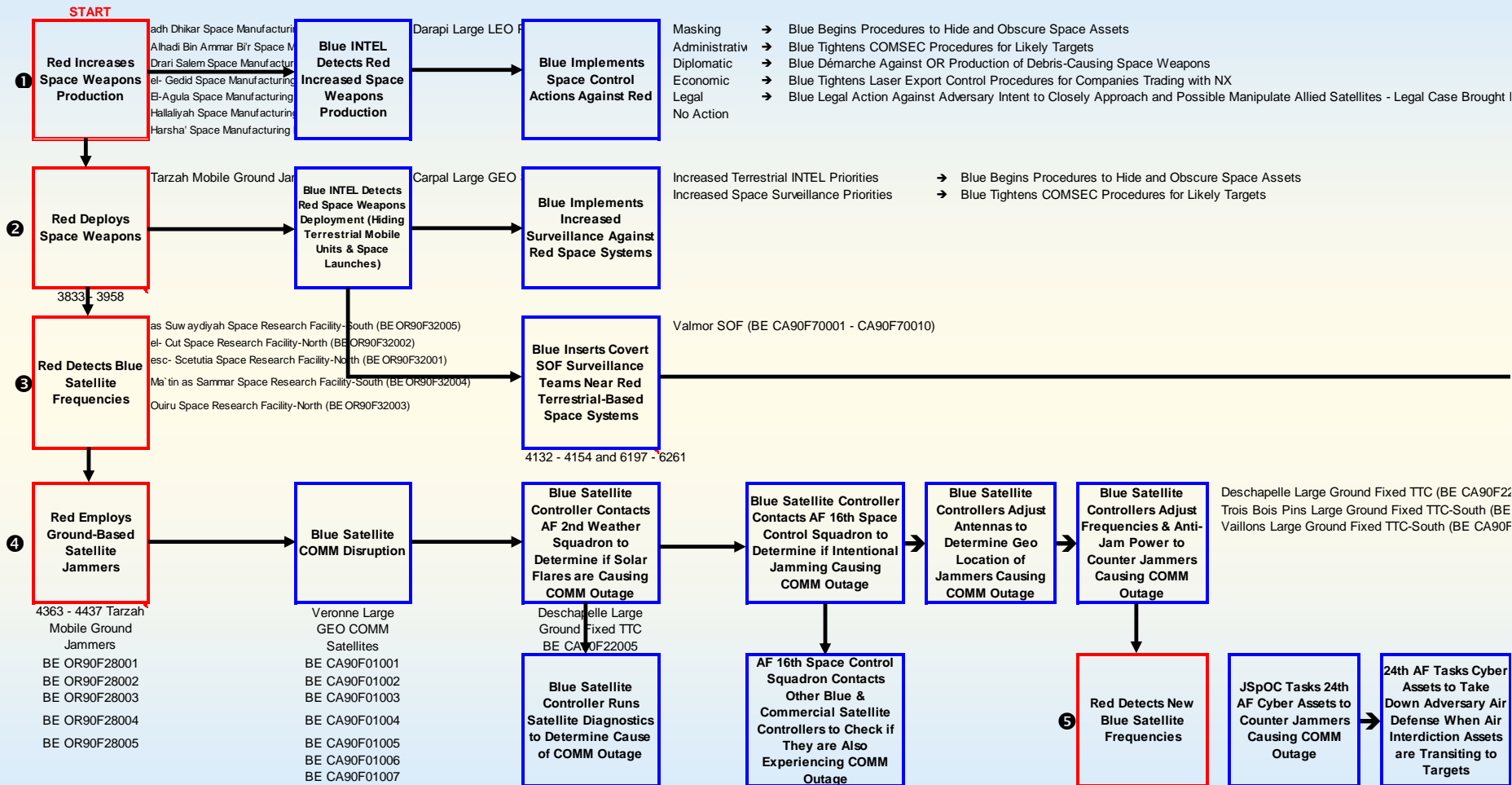
IND: No commercial source sells North Korea ISR data

IND: Third parties unable to pass ISR data to North Korea

IND: Third party unable to collect ISR data over selected protected area

**Space Objectives Available Also**

# Scenario Partial Example 3



Detailed Space Control Scenario Available for Analyses

# Auto Space Scenario Generation Tool

Space Warning & Assessment Tools - [Scenario Systems Templates]

File Edit View Insert Format Records Tools Window Help

Sheet Form

Type a question for help

## Scenario Systems Templates

System Public Name: UNK Nano Satellite

System Name: CA Nano GEO Mine-Shrapnel Category: Satellite Record #: 874 Use:  Add: Add AOR

Short / Formal Name: CA\_NMS\_G\_S Cambry RN Type: Nano Satellite Record Date: 6/16/2008 2:04:35 PM GEO

Non-Target: Links N/L Sub-Type: Space Mine Scenario Name: Operation Bear Claw Red

Grd Name: Country: Califon CA90F09 BE Base Satellite ASAT-Mine-Fr Icon Model: U.MineA.nsm System Color

In Budget

	Min	Baseline	Max
System Quantity	10	41	50
Procurement Priority	5.0	5.3	8.0
Military Value	3.0	5.2	6.0
Procurement Cost	\$1 M	\$2 M	\$5 M

1 Is Best 10 Is Best

Now

	Min	Baseline	Max
System Age	1	2	3

10 Yr  20 Yr  30 Yr

	Min	Baseline	Max
LAT	0.0	0.0	0.0
LONG	0.0	0.0	0.0
Altitude	0	0	0
Max Range	0	0	0

Bandwidth-Space-Gnd: C-Band

Bandwidth-Space-Space: Ku-Band

Bandwidth-TTC-Gnd: S-Band

Bandwidth-TTC-Space: S-Band

Surveil Min Elev: 0

Base:  Kinetic

	Min	Baseline	Max
Surveillance-RCS	0.0	0.0	0.0
Surveillance-Mag	0.0	0.0	0.0
Visibility to RF	0.05	0.08	0.20
Visibility-RCS	0.0	0.0	0.5
Visibility to Optical	0.05	0.20	0.50
Visibility-OCS	16.0	19.5	22.0

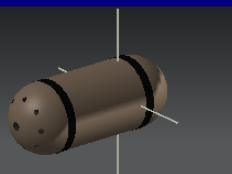
Vulnerability-Hit: 0.80 0.92 0.99

Vulnerability-Laser: 0.70 0.83 0.85


Vulnerability-Jammer: 0.70 0.71 0.90

Kill-Type: Kinetic

	Min	Baseline	Max
Kill-Pk-Permanent	0.50	0.55	0.85
Kill-Pk-Temporary	0.10	0.19	0.20
Kill-Temporary-Time	24	69	72
Kill-Power	0	0	0
Kill-Shots	1	1	1
Kill-Time	1	1	1

Icon: 

	Min	Baseline	Max
SMA	42,160	42,167	42,170
Eccentricity	0.0000	0.0019	0.0070
Inclination	0.0	2.2	5.0
RAAN	0	267	359
ARG	0	52	359
Anomaly	0	317	359
EPOCH-Year	2008	2008	2008
EPOCH-Month	6	6	6
EPOCH-Day	1	1	1
EPOCH-Hour	0	0	0
EPOCH-Minute	0	0	0
EPOCH-Seconds	0.0000	0.0000	0.0000

Photo: 

System Description: Nano-sized space mine with optical and electronic sensors that maneuvers close to a target satellite, then detonates a pellet shrapnel cloud.

Comments:

Weapon Effects:

- Power
- Propulsion
- Thermal
- Attitude
- COMM
- LEO
- MEO
- Structure
- Antennas
- Optics
- Solar Panels
- IT&C
- HEO
- Trans Lunar

Indicator-1: 5 Very Small space object is detected 0.10 0.22 0.40 Indicator 1 Probability of Detection

Indicator-2: 4 Space object has small optical payload system on-board 0.60 0.25 0.90 Indicator 2 Probability of Detection

Indicator-3: 3 Space object is maneuvering a lot 0.50 0.69 0.80 Indicator 3 Probability of Detection

Indicator-4: 1 Space object is conducting RPO's against high-value space assets 0.50 0.60 0.80 Indicator 4 Probability of Detection

Indicator-5: 2 Space object orienting itself towards high-value space assets 0.60 0.78 0.90 Indicator 5 Probability of Detection

Indicator-6: 6 Space object is changing attitude 0.60 0.85 0.90 Indicator 6 Probability of Detection

Indicator-7: 7 Space object has not been previously cataloged 0.10 0.22 0.40 Indicator 7 Probability of Detection

Indicator-8: 8 SIGINT traffic indicates military space system 0.10 0.27 0.80 Indicator 8 Probability of Detection

Indicator-9: 0 Indicator 9 Probability of Detection

Indicator-10: 0

Record: 14 of 24 (Filtered)

View this data in spreadsheet format

FLTR NUM

## Quick Generation of Alternative Space Scenarios

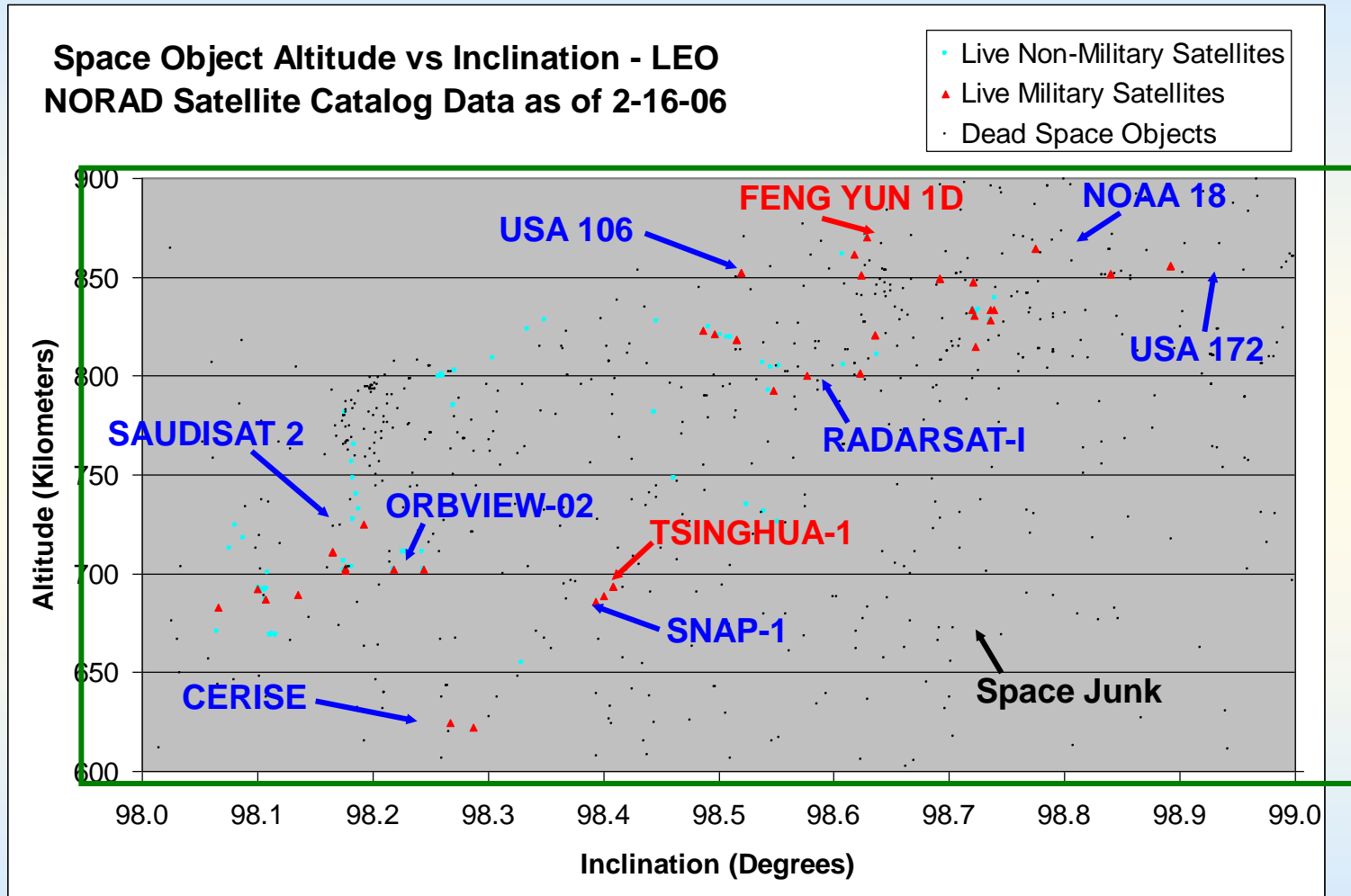
# Example Space INTEL Message

```
FM: SATAC //
TO: USAF AFMC AFRL/RDTE //
INFO: USAF AFMC AFRL/RIEA //
UNCLASS //
EXER / Operation Bear Claw //
SWAT T.2.4.1.7.5.6.9 / INTSUM / SATAC / 11155335ZMay10 //
NA / FM 15153618ZMay10 TO 15155255ZMay10 / High Confidence //
Maneuver //
UNITID/ATK: UNK Nano Satellite (85) / BEN: UNK / CTY: UNK / MSN: UNK //
AOR: SDR LEO-S / LOC: NA //
EPOCH: 08153.00000000 / SMA: 7360.64060211182 / ECC: 3.42001691657305E-03 / INC: 99.1599548578262 //
RAN: 349.577767577191 / ARG: 30.6482817736223 / ANOM: 351.45193870978 //
UNITID/TGT: UNK Large Satellite (443) / BEN: UNK / CTY: UNK / MSN: UNK //
AOR: SDR LEO-S / LOC: NA //
EPOCH: 08153.00000000 / SMA: 7346.96979999542 / ECC: 1.30284271150827E-03 / INC: 98.4710093259811 //
RAN: 28.6831902525877 / ARG: 322.748763662227 / ANOM: 140.650247049581 //
GENTEXT: Multiple space objects are maneuvering in space, some towards critical blue satellites. //
EST CONFLICT LVL: Phase 0: Pre-war Buildup / CONFID: Low //
EST RED STRATEGY: UNK / CONFID: Low //
EST RED TACTIC: Mobile Laser Blinder / CONFID: Low //
REF1: T.2.4.1.7.5.6.9 / REF2: T.2.4.1.8.5.1.4 / REF3: T.2.4.1.9.5.3.1 //
```

**INTEL Messages Automatically Generated & E-Mailed**



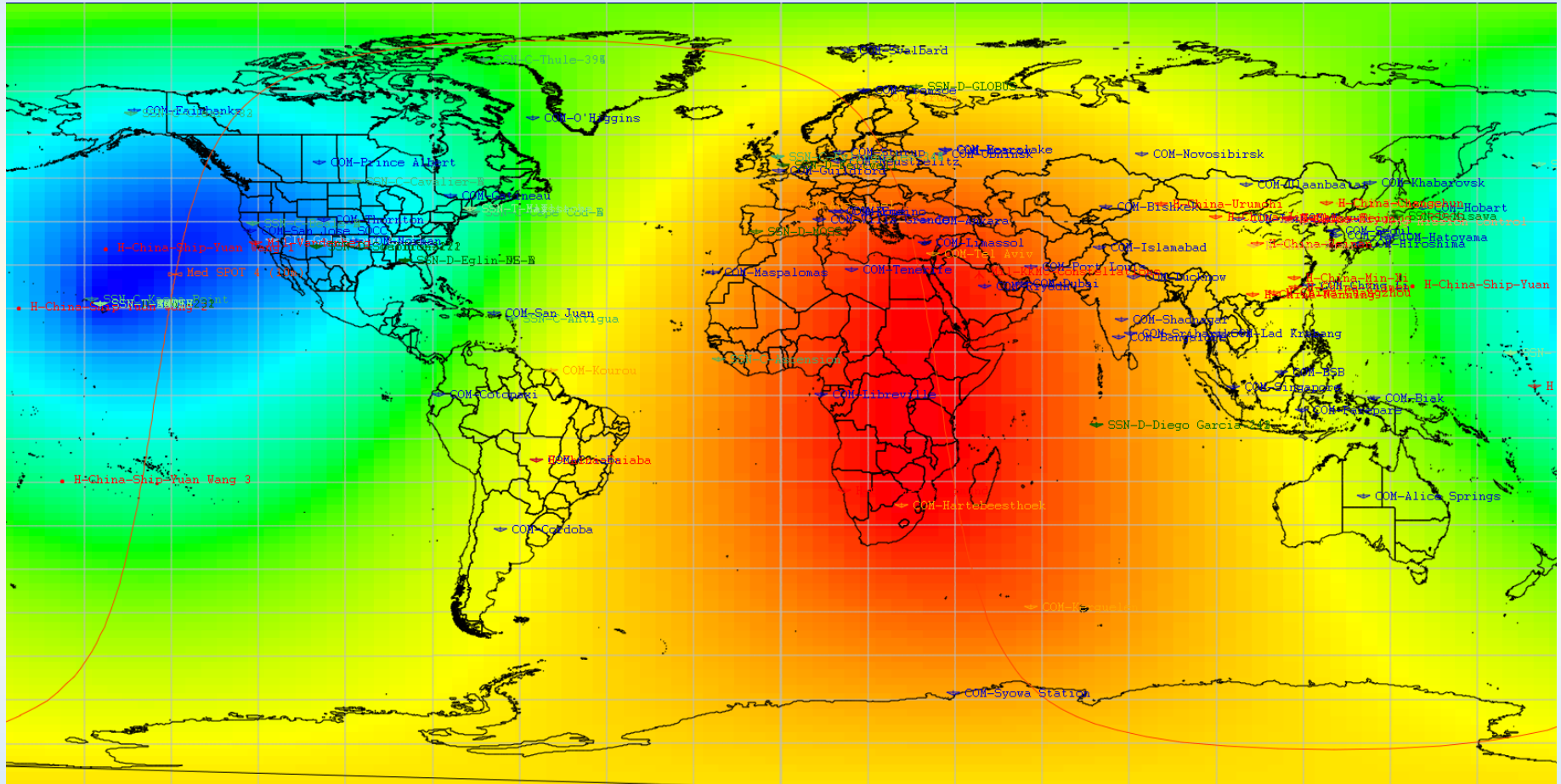
# Space Choke Points



  Hohmann Maneuver Envelope at 100 M/Sec Delta-V

**There are Many Potential Sources of Attack**

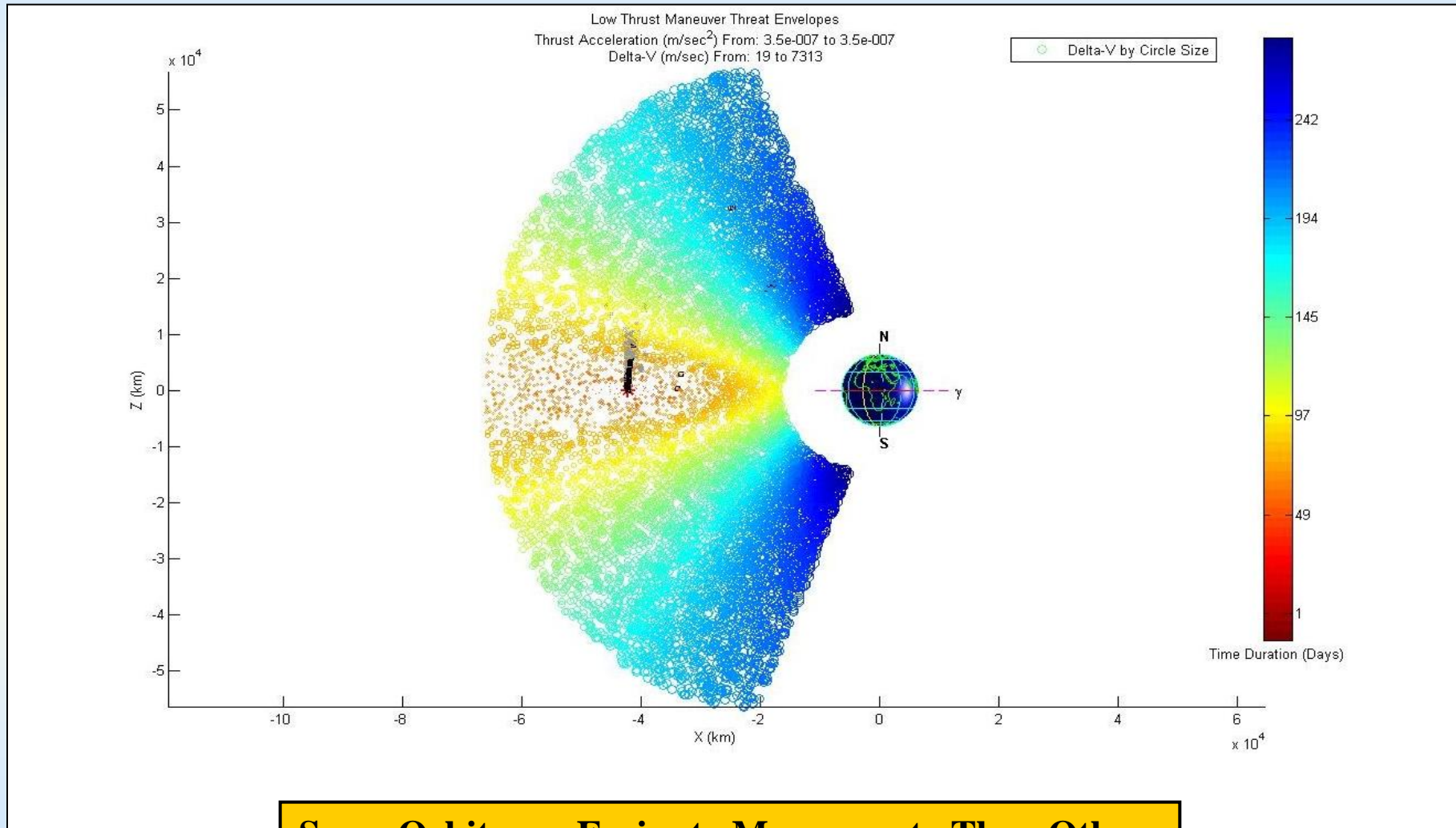
# Example Attack Locations Optimized for Space Surveillance



**Some Parts of a Satellite's Orbit May Be More Vulnerable than Others**

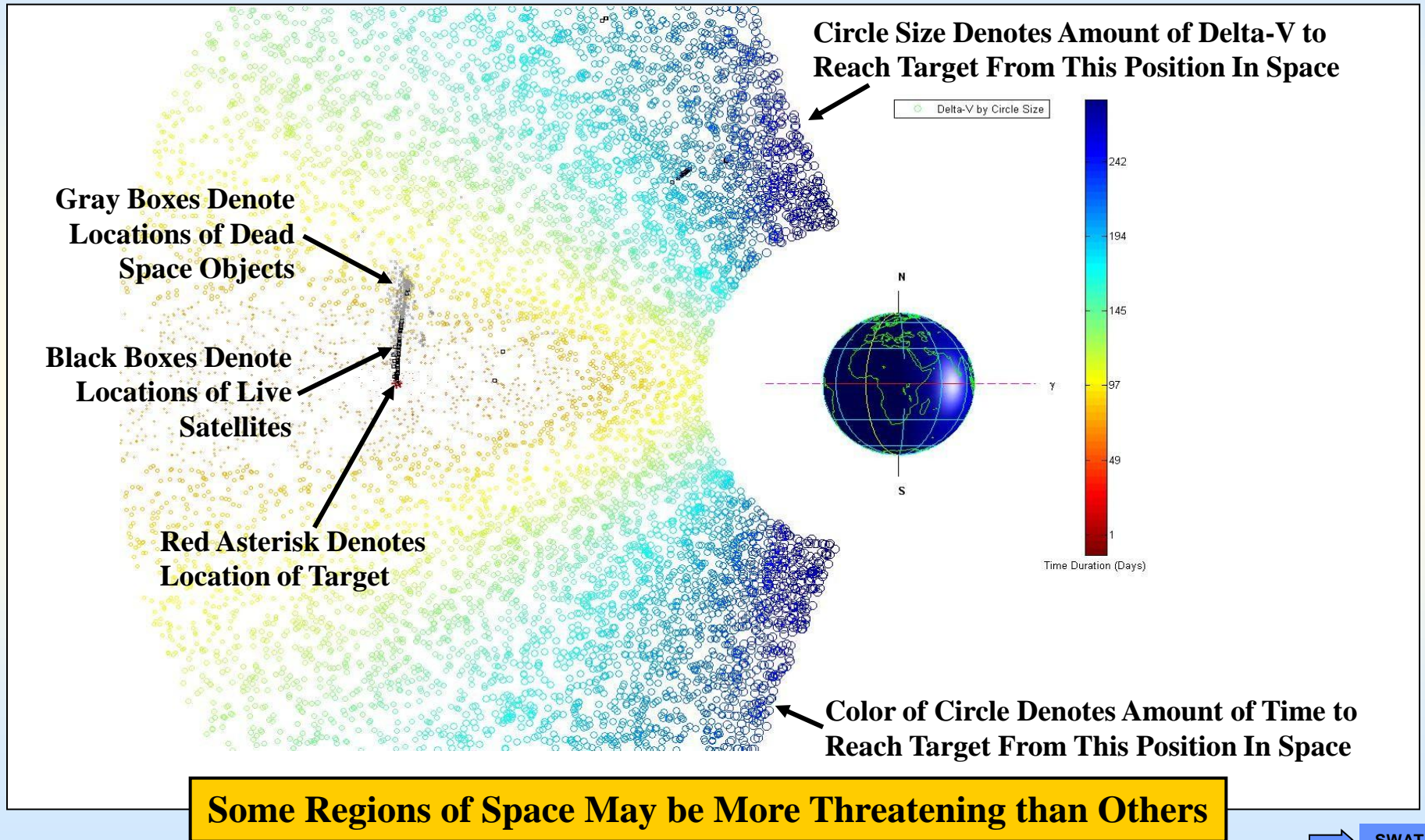
➔ SWAT 1  
 SWAT 2  
 SWAT 3

# Example Threat Envelope View 1



**Some Orbits are Easier to Maneuver to Than Others**

# Example Threat Envelope View 2

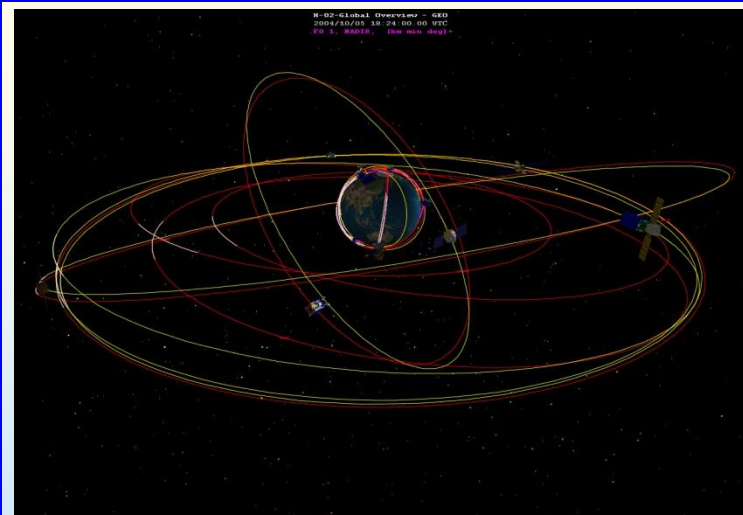
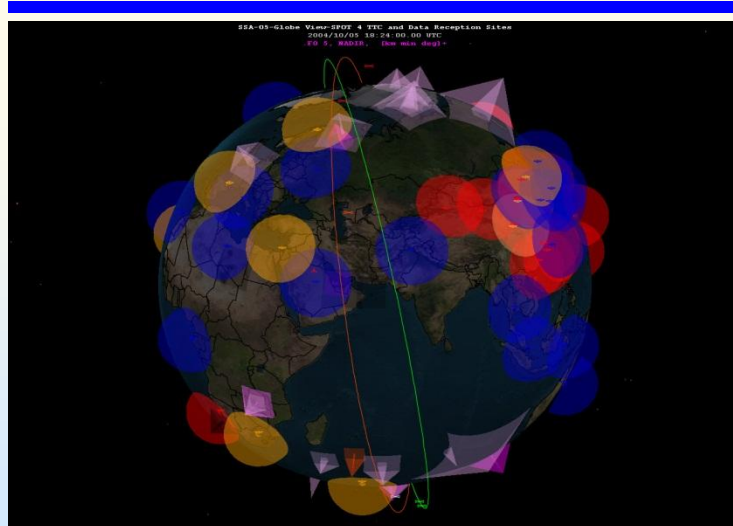
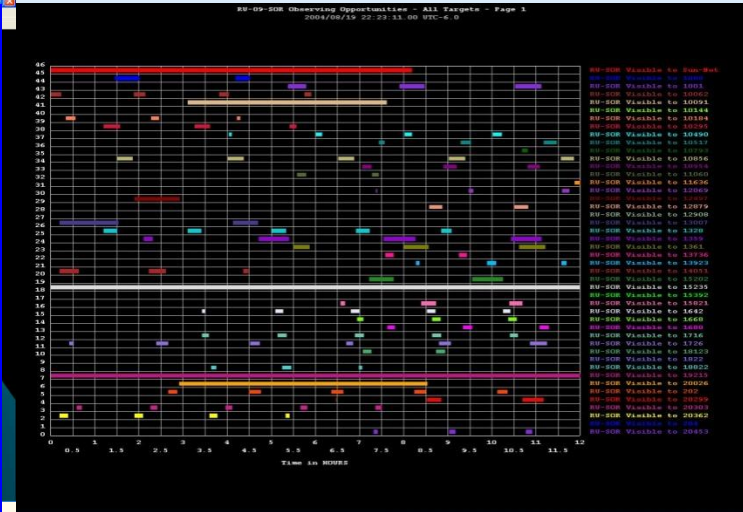
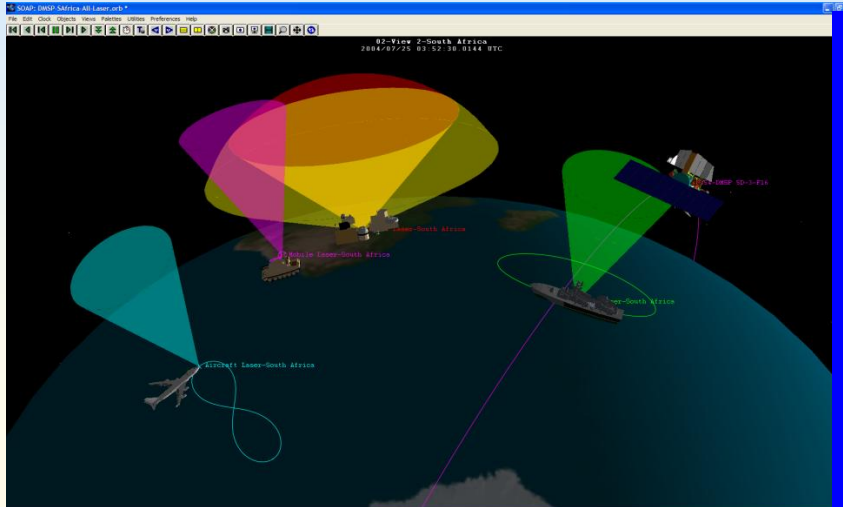


SWAT 1

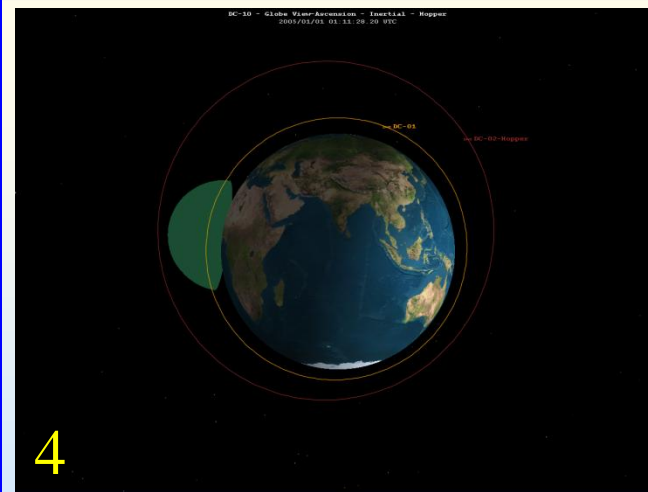
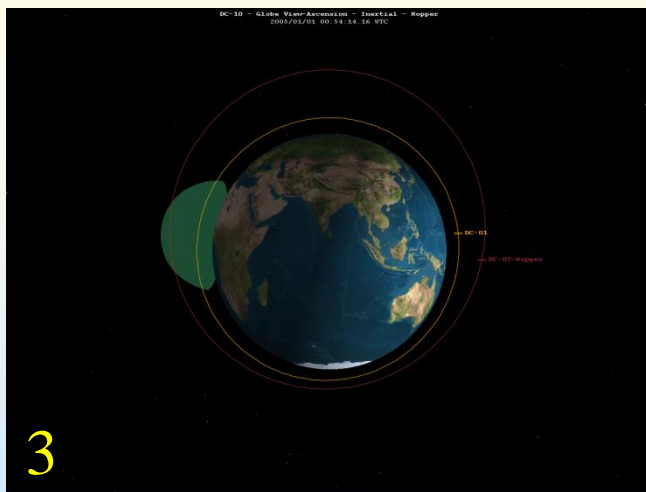
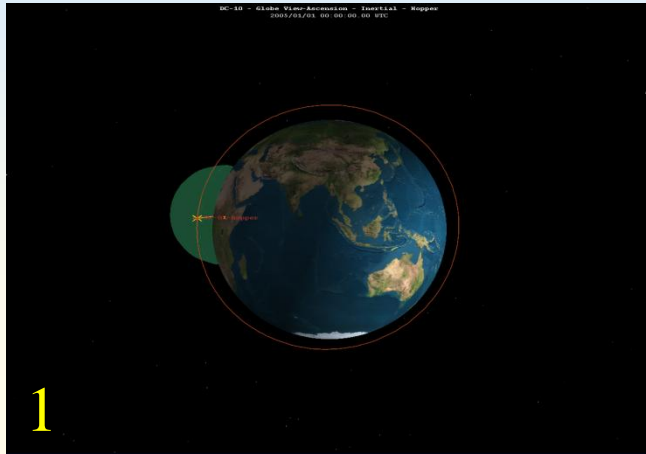
SWAT 2

SWAT 3

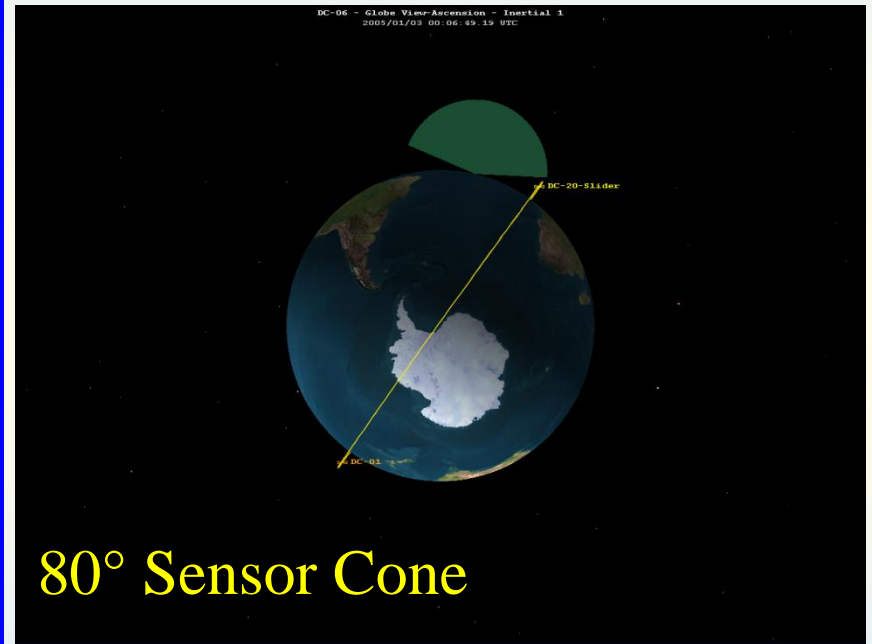
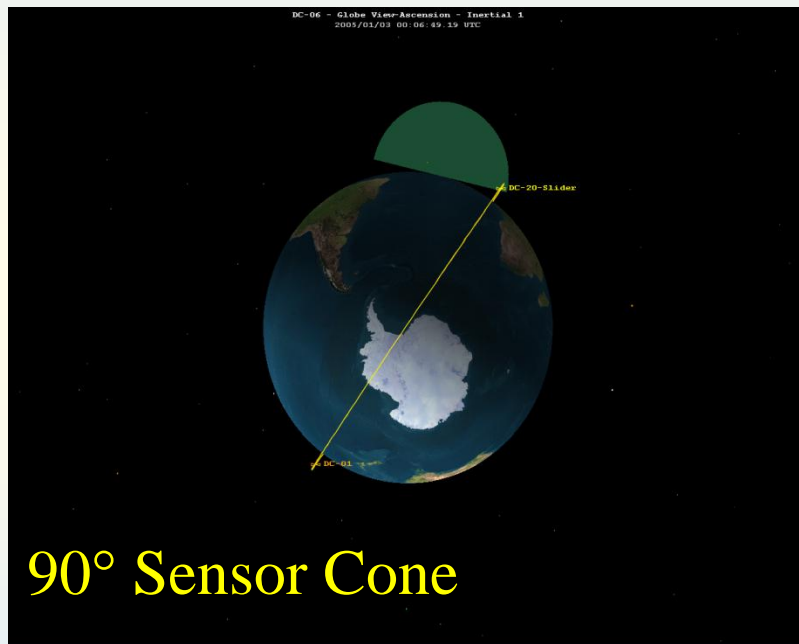
# ASAT Range / Access Assessments



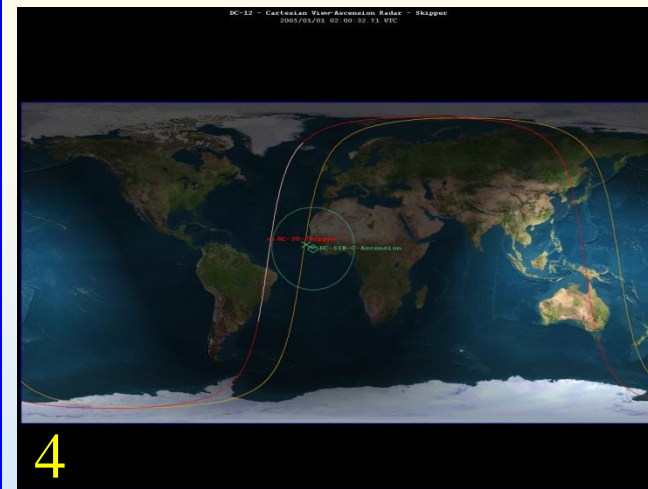
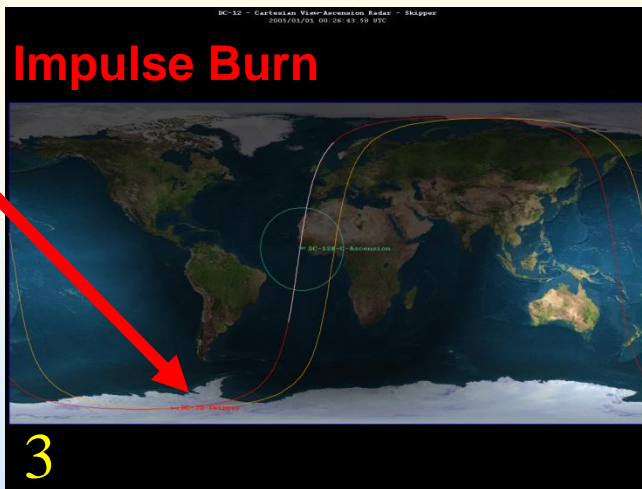
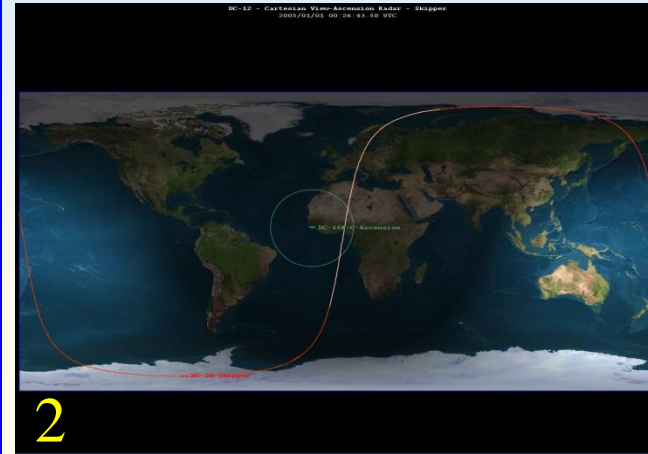
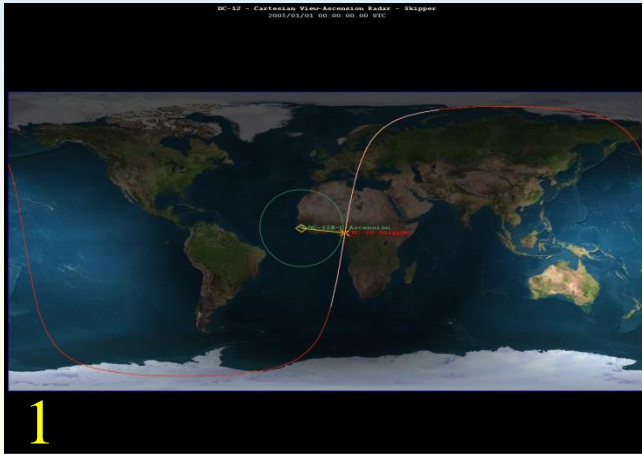
# Avoid Space Radar - Hopper



# Avoid Space Radar - Slider



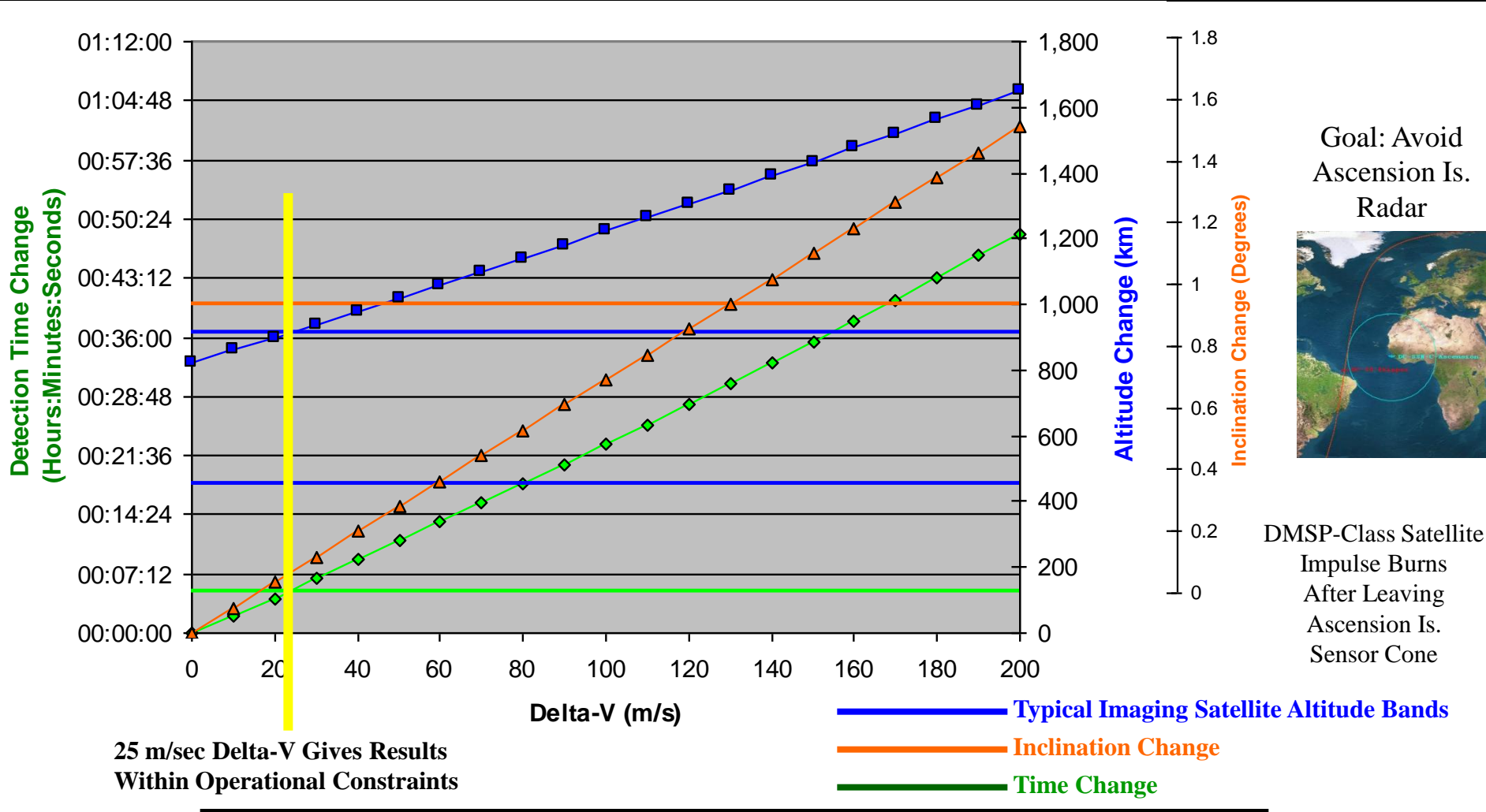
# Avoid Space Radar - Skipper



2.6 Km/Sec Impulse Burn



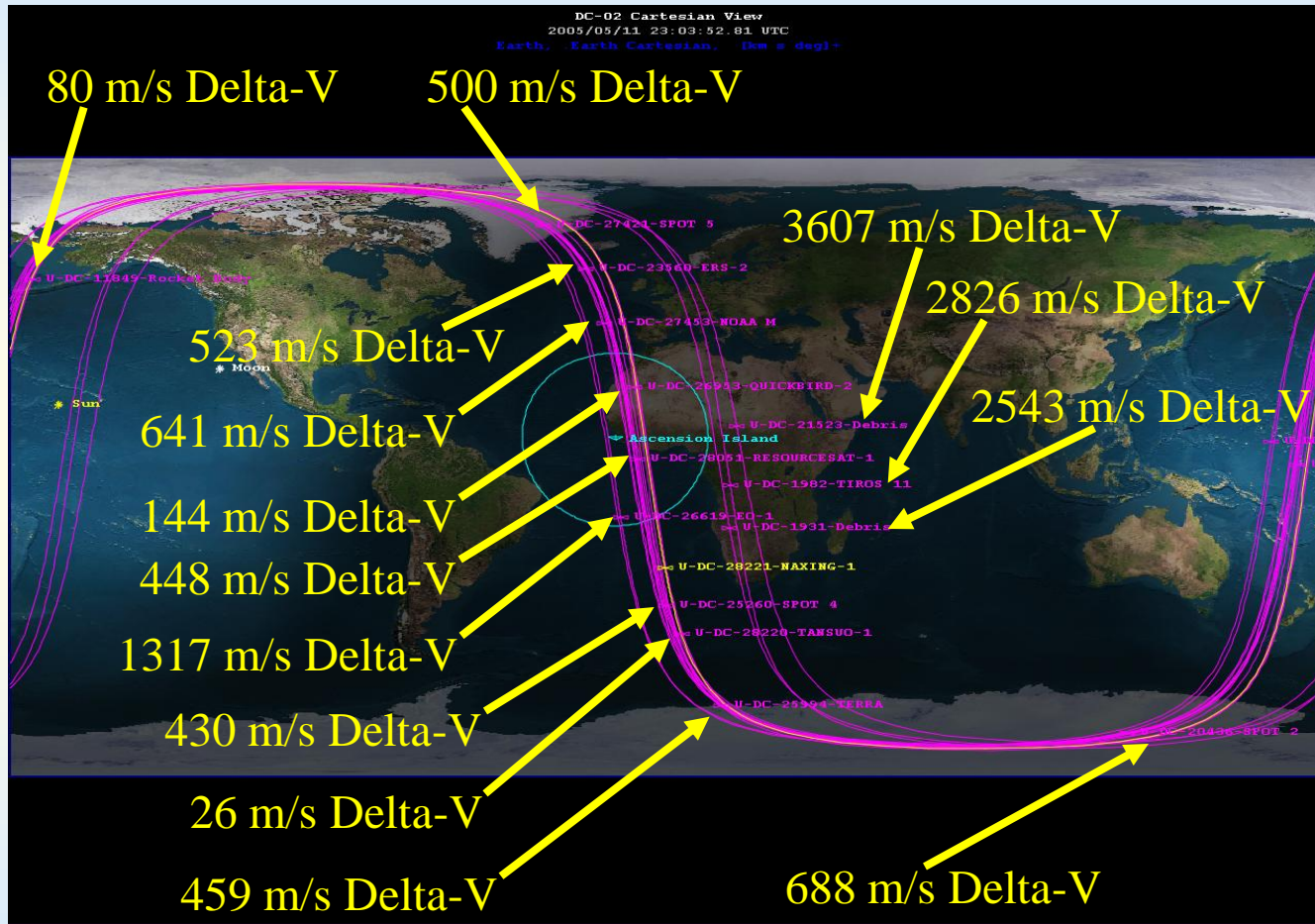
# One Impulse Maneuver Effects



**Small Maneuvers Can Confuse NORAD Space Object Tracking**

SWAT 1  
SWAT 2  
SWAT 3

# Hide Satellite Among Others



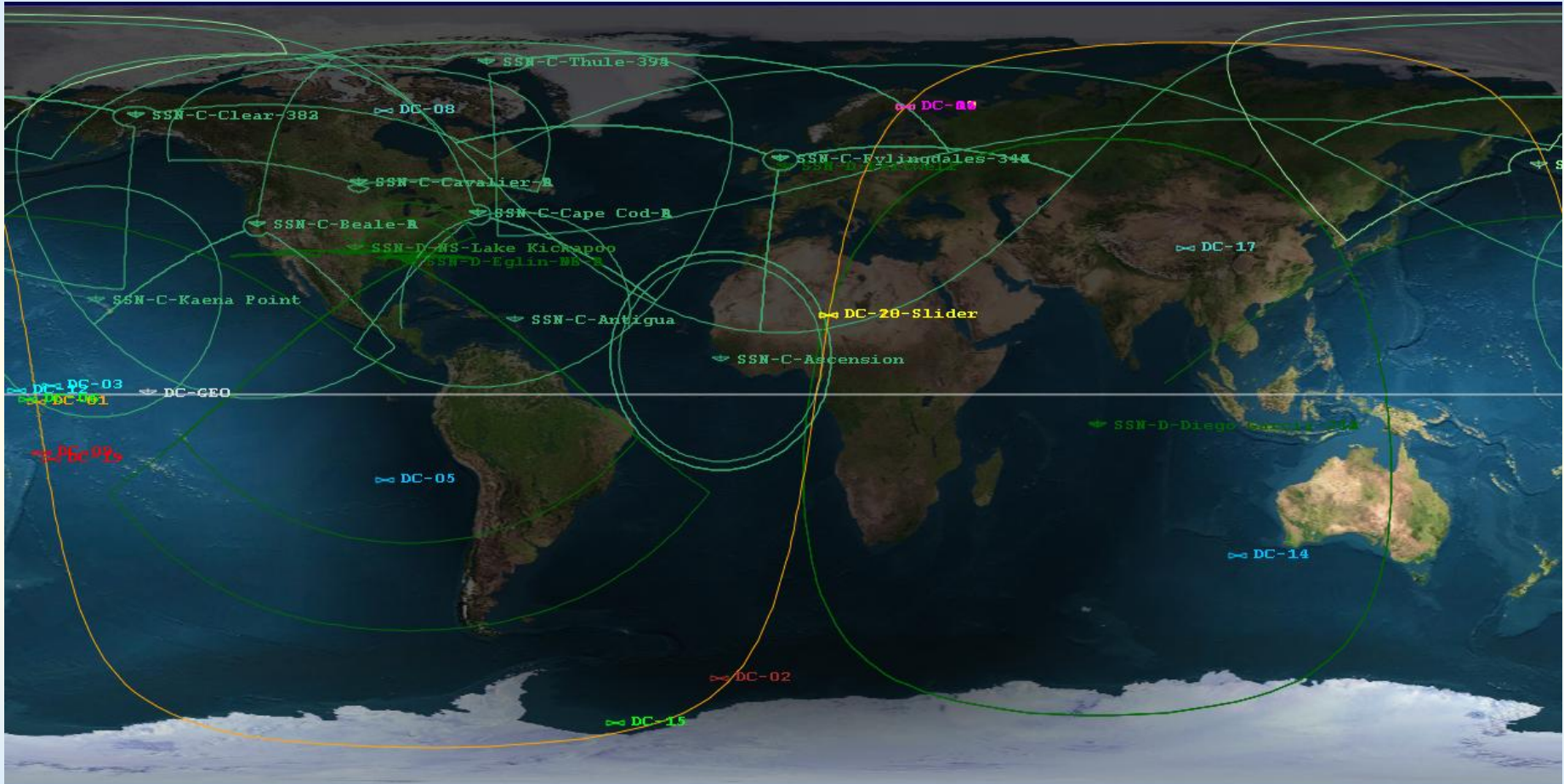
**Goal: Appear Like Nearby Satellite**

**Delta-V Required for 2-Burn Hohmann Transfer Rendezvous**

**Satellites Can Maneuver to Confuse Targeting Assets**

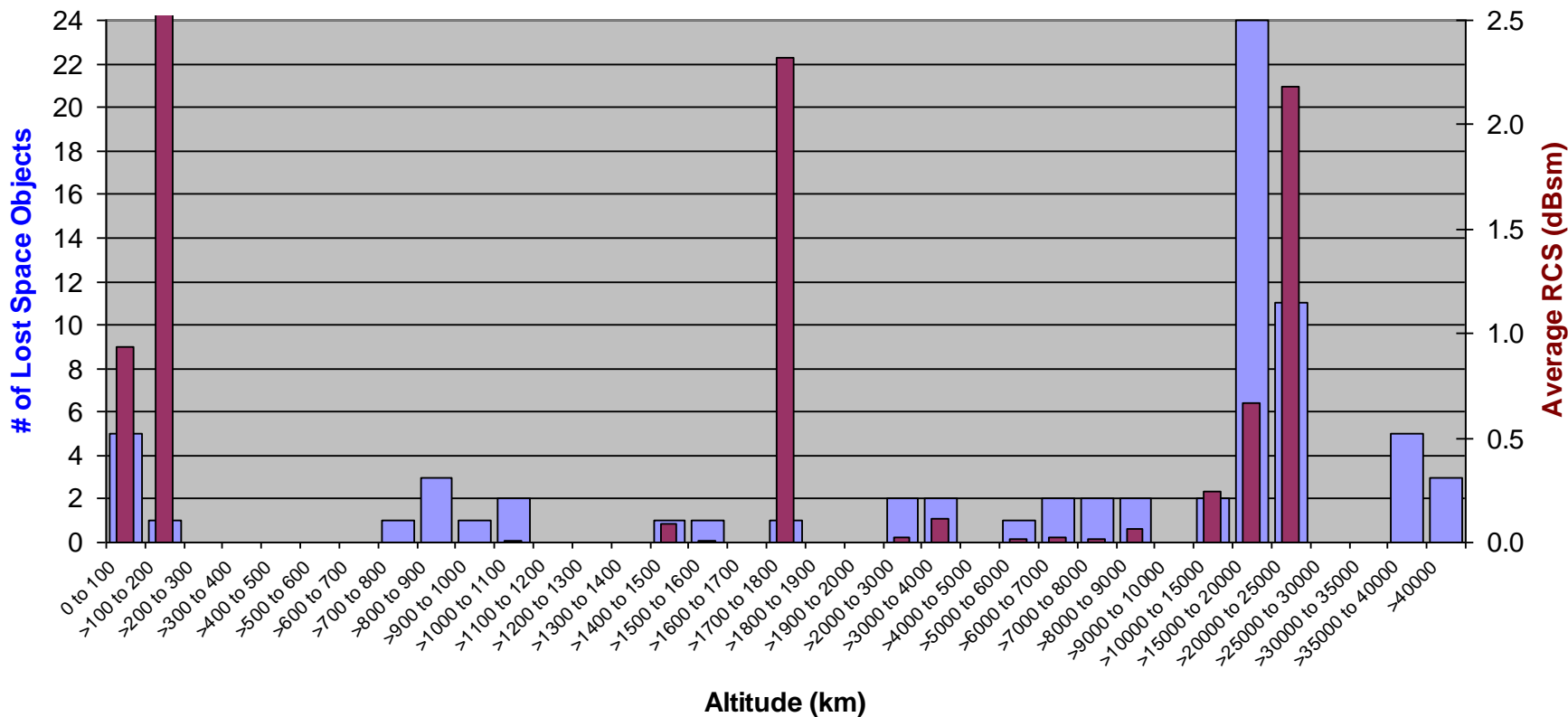
→ SWAT 1  
 SWAT 2  
 SWAT 3

# Space Surveillance Network



# JSpOC Catalog Missing Space Objects

Number of Lost Satellites By Altitude and RCS



SWAT 1  
SWAT 2  
SWAT 3

# Optical Data Impact

- **Optical Data Formatted & Imported**
  - SOR Color Photometry GEO Catalog
  - Maui Russian Data
  - Belgian Astronomical Association Flashing Space Objects
- **State Change Analysis Runs (22 Time Periods)**
  - With Optical Data - 39 Hours Total Processing Time
  - Without Optical Data - 29 Hours Total Processing Time
- **Optical Data Had a Significant Impact on State Change Rankings**
  - 33% of Space Object Change Scores Increased (Increased State Change Detected)
  - 50% of Space Object Change Scores Decreased
    - Addition of Optical Data Helped Stabilized Erratic Data?
  - 17% of Space Object Change Scores Unchanged

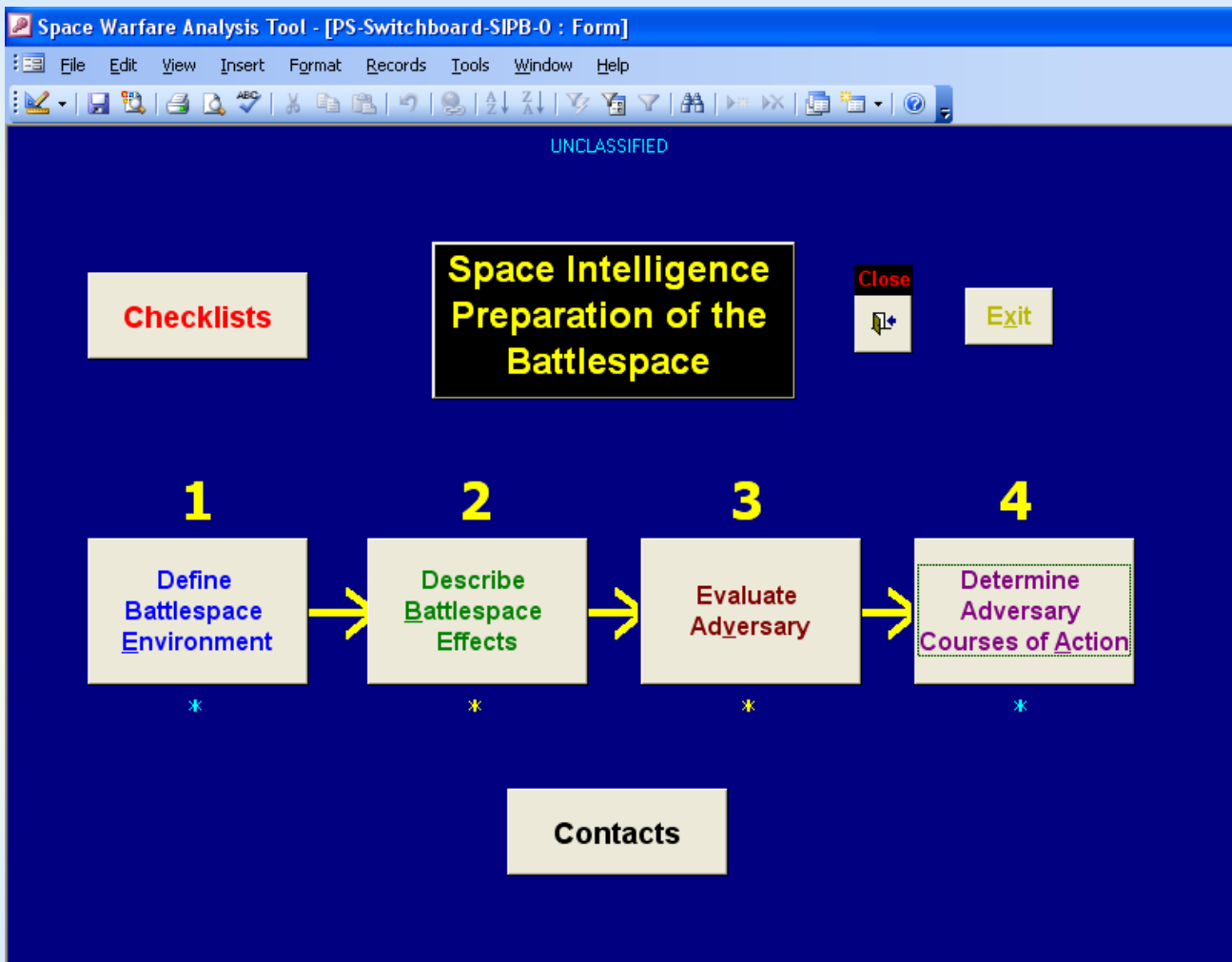
# Example Optical State Changes - 1

SATCAT No	SatName	Mission	Country	Orbit	Comments
15774	SL-12 R/B(AUX MOTOR)	Rocket Body	Russia	SDR LEO-H	Flash Period (5.7) significantly less than other SL-12 R/B(AUX MOTOR) SSN: 15338 (15)
25415	ORBCOMM FM 19	COMM-MOBIL	ORBCOMM	SDR LEO-H	Visual Magnitude much dimmer (9) than other satellites of its class (Iridium - 6.5 ; GLOBALSTAR - 5.5)
25116	ORBCOMM FM 9	COMM-MOBIL	ORBCOMM	SDR LEO-H	Visual Magnitude much dimmer (9) than other satellites of its class (Iridium - 6.5 ; GLOBALSTAR - 5.5)
16191	METEOR 3-1	METSAT	Russia	SDR LEO-H	<b>Visual Magnitude much dimmer (6.7) than most other satellites of its class (5.3 - 5.8) [possibly because it is a new model; METEOR 3 vs. METEOR 1 or 2]</b>
15930	COSMOS 1670	RORSAT	Russia	SDR LEO-H	Visual Magnitude slightly brighter (6) than other satellites of its class (5.6)
11084	COSMOS 1045	OCEANOGRPY	Russia	SDR LEO-H	<b>Visual Magnitude slightly dimmer (6) than five other satellites of its class (5.5); note object is extremely stable in its orbit</b>
11671	COSMOS 1151	ELINT	Russia	SDR LEO-L	Visual Magnitude slightly dimmer (5.5) than most other satellites of its class (5.2 - 5.4)
25396	TMSAT	EARTH-RES	Thailand	SDR LEO-S	Visual Magnitude much dimmer (9) than other satellites of its class (4.5 - 6.9)
17199	ARIANE 1 DEB	ARIANE 1 DEB	France	SDR LEO-S	Flash Period much higher than other ARIANE 1 DEB
27430	HAIYANG 1	METSAT	China	SDR LEO-S	<b>Flash Period more than doubles on 6/16/2008</b>
21935	SL-12 DEB	SL-12 DEB	Russia	SDR MEO	<b>Radical change in Flash Period</b>
13080	COSMOS 1341	MSL-WARN	Russia	SDR MEO	Visual Magnitude slightly dimmer (5.5) than most other satellites of its class (1 - 5). Flash Period much lower (3.4) than others of its class (7 - 47)
21855	COSMOS 2179 (GLONASS)	NAVSAT	Russia	SDR MEO	Visual Magnitude very much dimmer (10.9) than other satellites of its class (1.5 - 3)

# Example Optical State Changes - 2

SATCAT No	SatName	Mission	Country	Orbit	Comments
17083	GORIZONT 13	COMM-CIVIL	Russia	SDR GEO	Along with GORIZONT 7, GORIZONT 13 is the dimmest GORIZONT in the sky (13) vs. visual magnitude of 6 for other GORIZONT's
16667	COSMOS 1738	COMM-CIVIL	Russia	SDR GEO	Visual Magnitude slightly dimmer (13.2) than many other satellites of its class (5.5 - 12.5)
16650	BRAZILSAT 2	COMM-CIVIL	Brazil	SDR GEO	Visual Magnitude much brighter (1 - flash) than other satellites of its class (4 - 14)
23267	COSMOS 2291	COMM-MIL	Russia	SDR GEO	Visual Magnitude much brighter (6) than other satellites of its class - US (11 - 11.6)
20523	INTELSAT 603	COMM-CIVIL	INTELSAT	SDR GEO	Along with 21653 (INTELSAT 605) Visual Magnitude much brighter (3) than other satellites of its class (6 - 14.7). At the time, the Intelsat 6 series were the largest commercial spacecraft ever built.
15946	RADUGA 16	COMM-CIVIL	Russia	SDR GEO	Visual Magnitude slightly dimmer (13.8) than many other satellites of its class (5.5 - 13.2)
26069	COSMOS 2369	ELINT	Russia	SDR LEO	Along with 28352 (another ELINT) Visual Magnitude slightly brighter (4.5) than most other satellites of its class (5 - 5.6)
15398	COSMOS 1610	NAVSAT	Russia	SDR LEO	Visual Magnitude slightly brighter (4) than other satellites of its class (5 - 10)
22971	SL-14 R/B	SL-14 R/B	Russia	SDR LEO	Visual Magnitude much dimmer (9.8) than other satellites of its class (5 - 6.5)
11165	COSMOS 1066	METSAT	Russia	SDR LEO	Visual Magnitude slightly dimmer (6.7) than other satellites of its class (5.3 - 6.4)

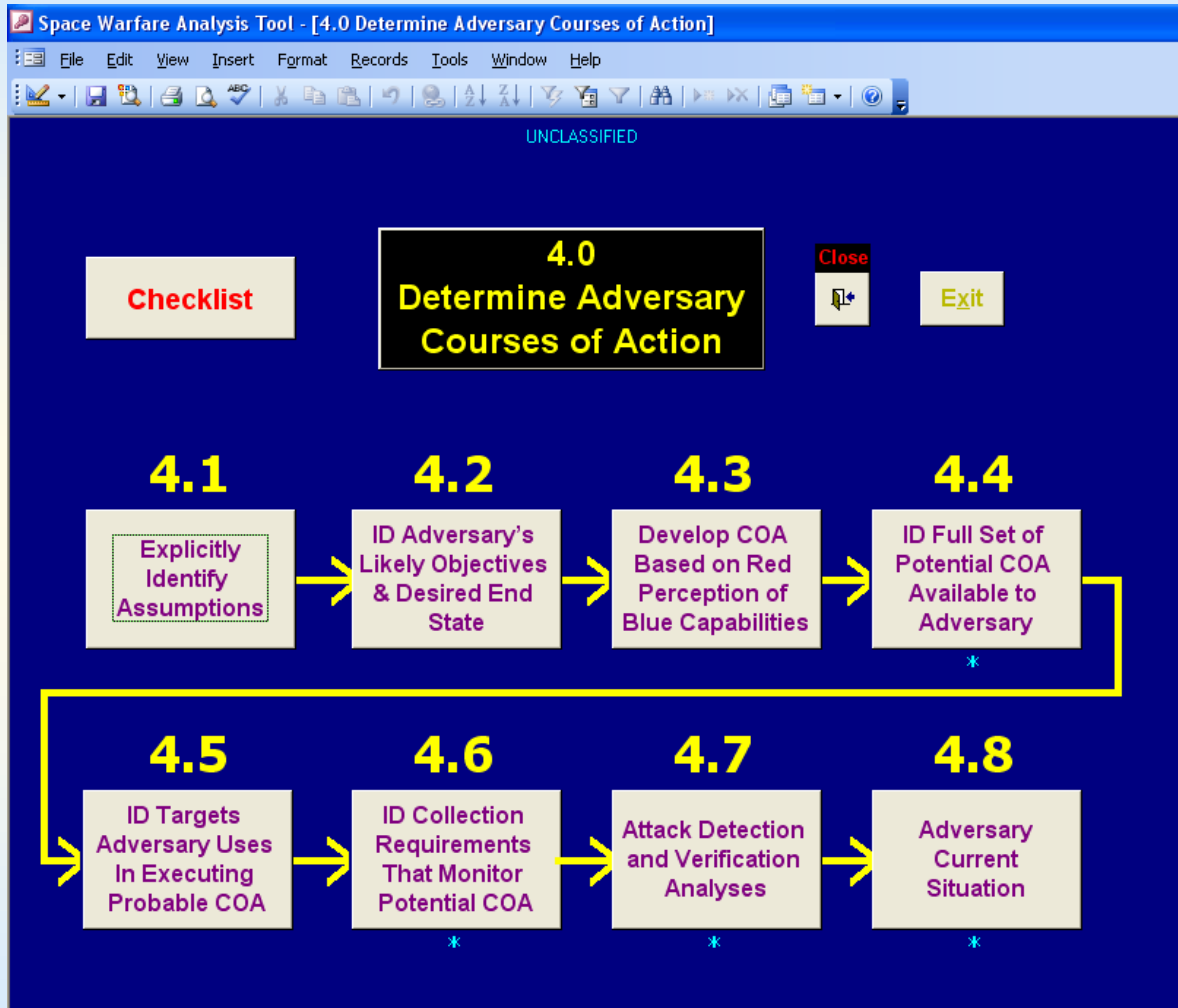
# SWAT Space IPB User Interface Example 1



**SWAT Space IPB Major Steps Based on Joint Doctrine**

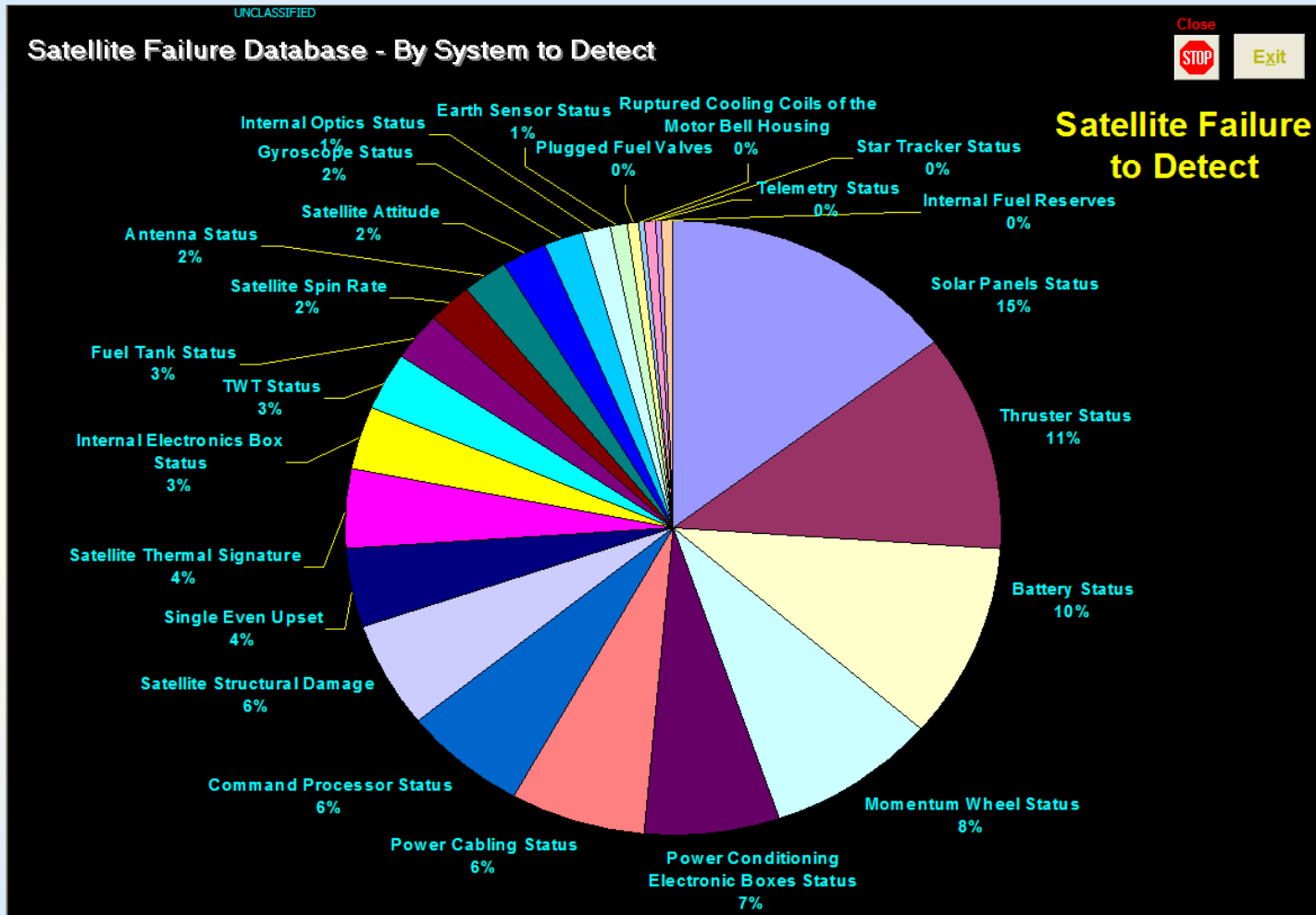


# SWAT Space IPB User Interface Example 2



**SWAT Space IPB Sub-Steps For Determining Red COA**

# Satellite Failures Database



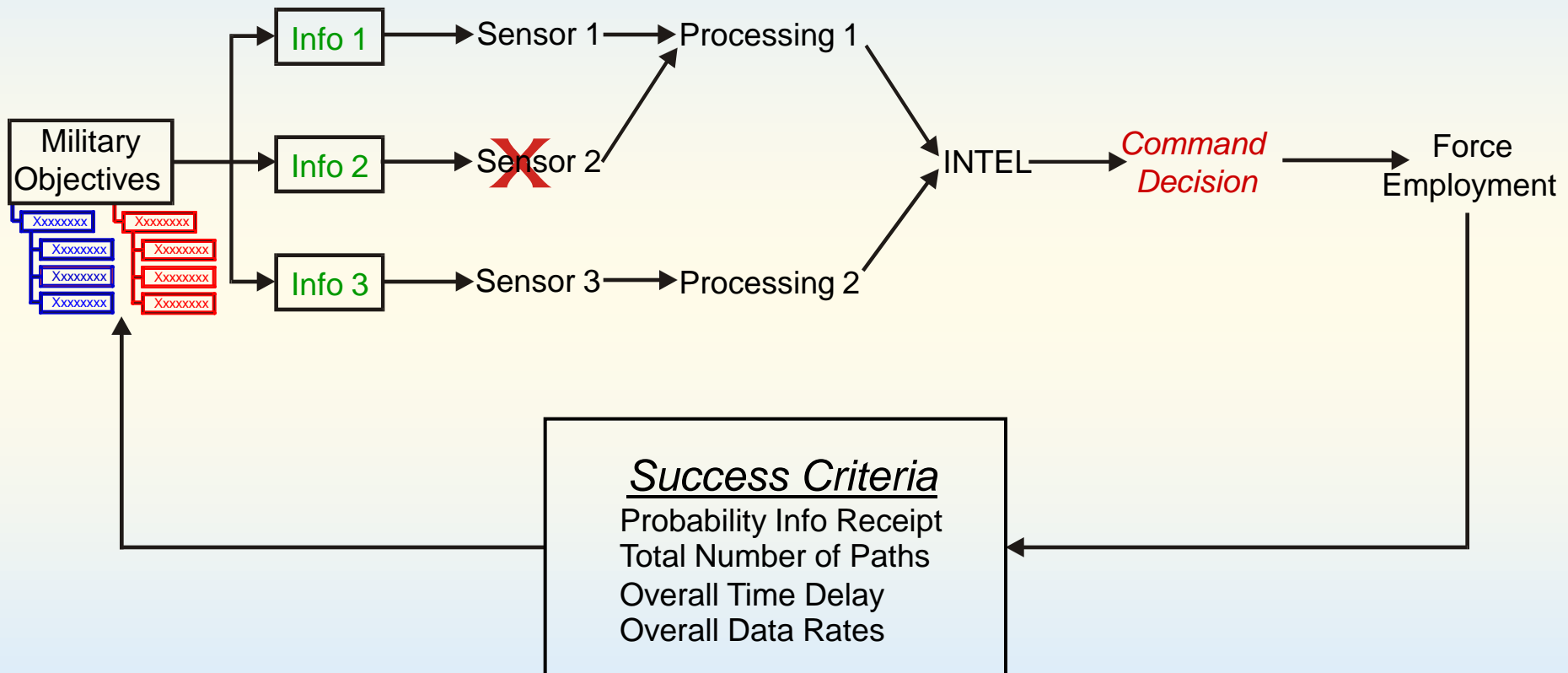
Satellite Failures Data Help Space Analyst Determine If Natural or Man-Made Attack

# Space Info Choke Points Network Analyses

- **SHIVA (Space Highest Information Value Assessment )**
  - AFRL (Phillips Site) Concept Development
  - SWC (SIDC) Support
  - PC-Based In Microsoft Access
  - Performs Links & Nodes Network Analysis Showing Value of Information to the Warfighter
  - Can Conduct Red Or Blue Targeting/Vulnerability Analyses
  - Algorithms & Software Validated by RAND

**SHIVA Can Show the Value of Space Systems**

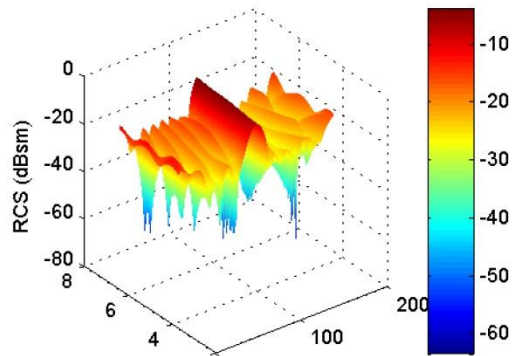
# SHIVA Methodology



**SHIVA Calculates All Possible Paths Between Sensors and Shooters**

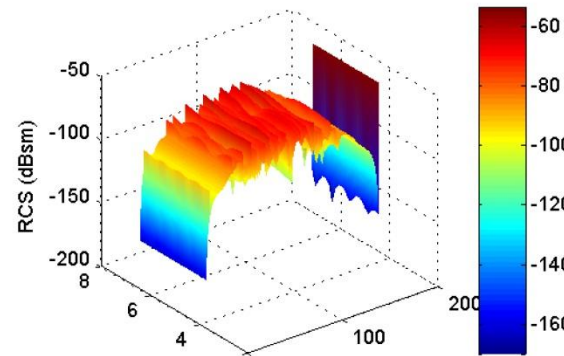
# Example SWAT Satellite RADAR Cross Section

Lucernhammer Micro\_1\_C RCS Polarization WV Data



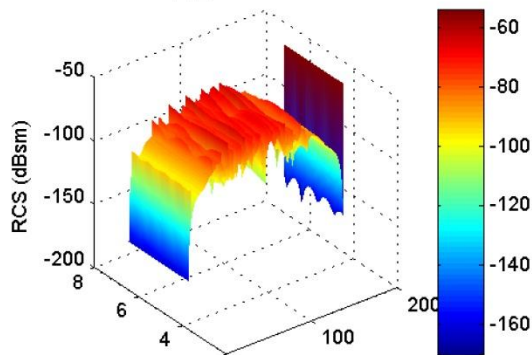
Frequency (Ghz) 2 0 100 200

Lucernhammer Micro\_1\_C RCS Polarization HV Data



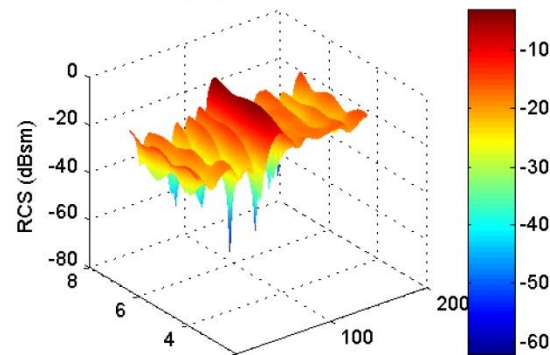
Frequency (Ghz) 2 0 100 200

Lucernhammer Micro\_1\_C RCS Polarization VH Data

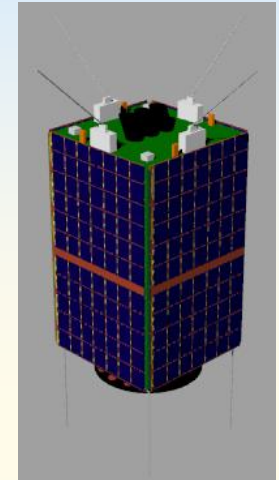


Frequency (Ghz) 2 0 100 200

Lucernhammer Micro\_1\_C RCS Polarization HH Data



Frequency (Ghz) 2 0 100 200

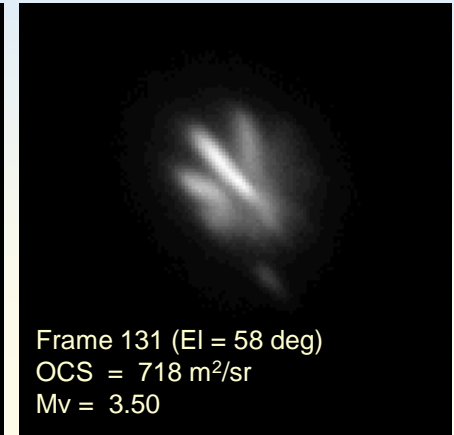
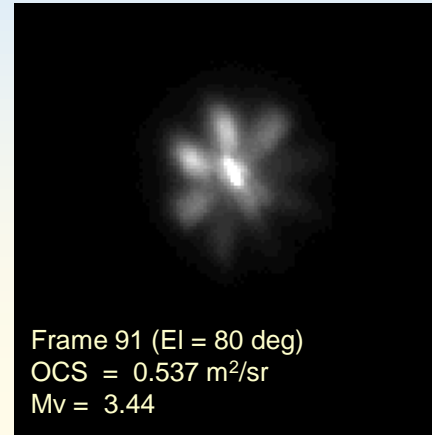
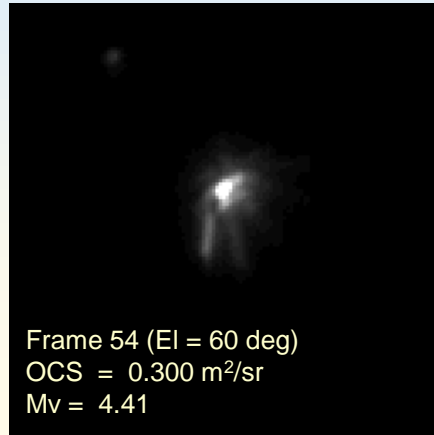
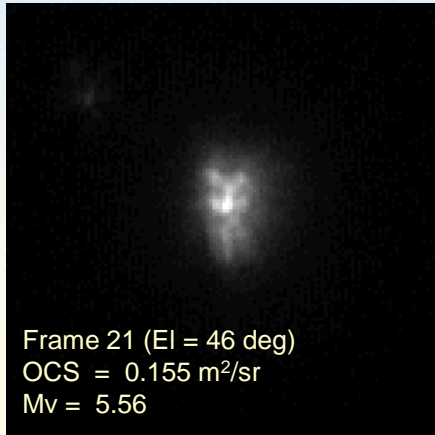


Satellite Model Used  
In Calculations

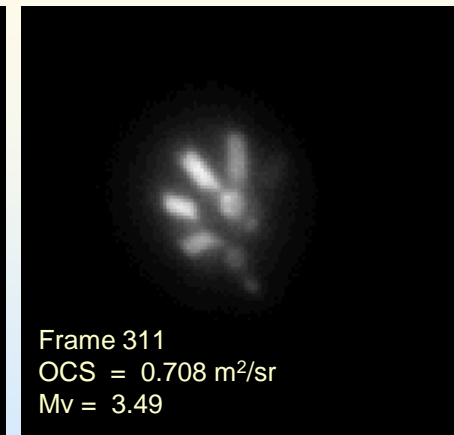
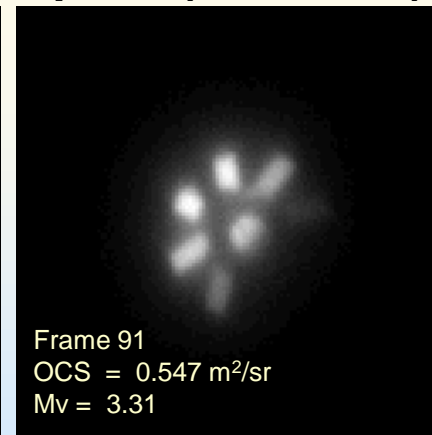
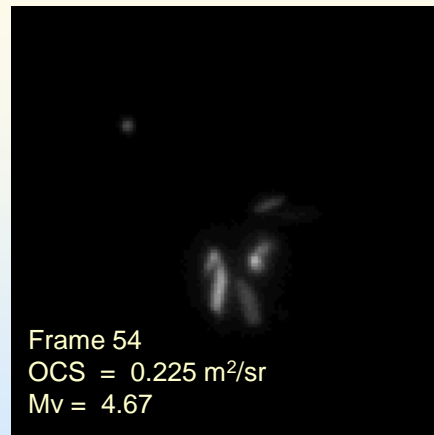
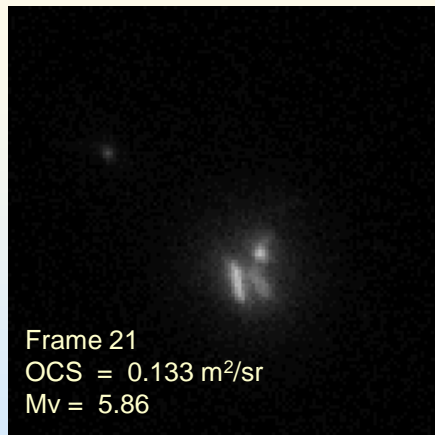
**Radar Cross Section Calculations Can be Performed on SatAC Models**

# Example Satellite Optical Cross Section

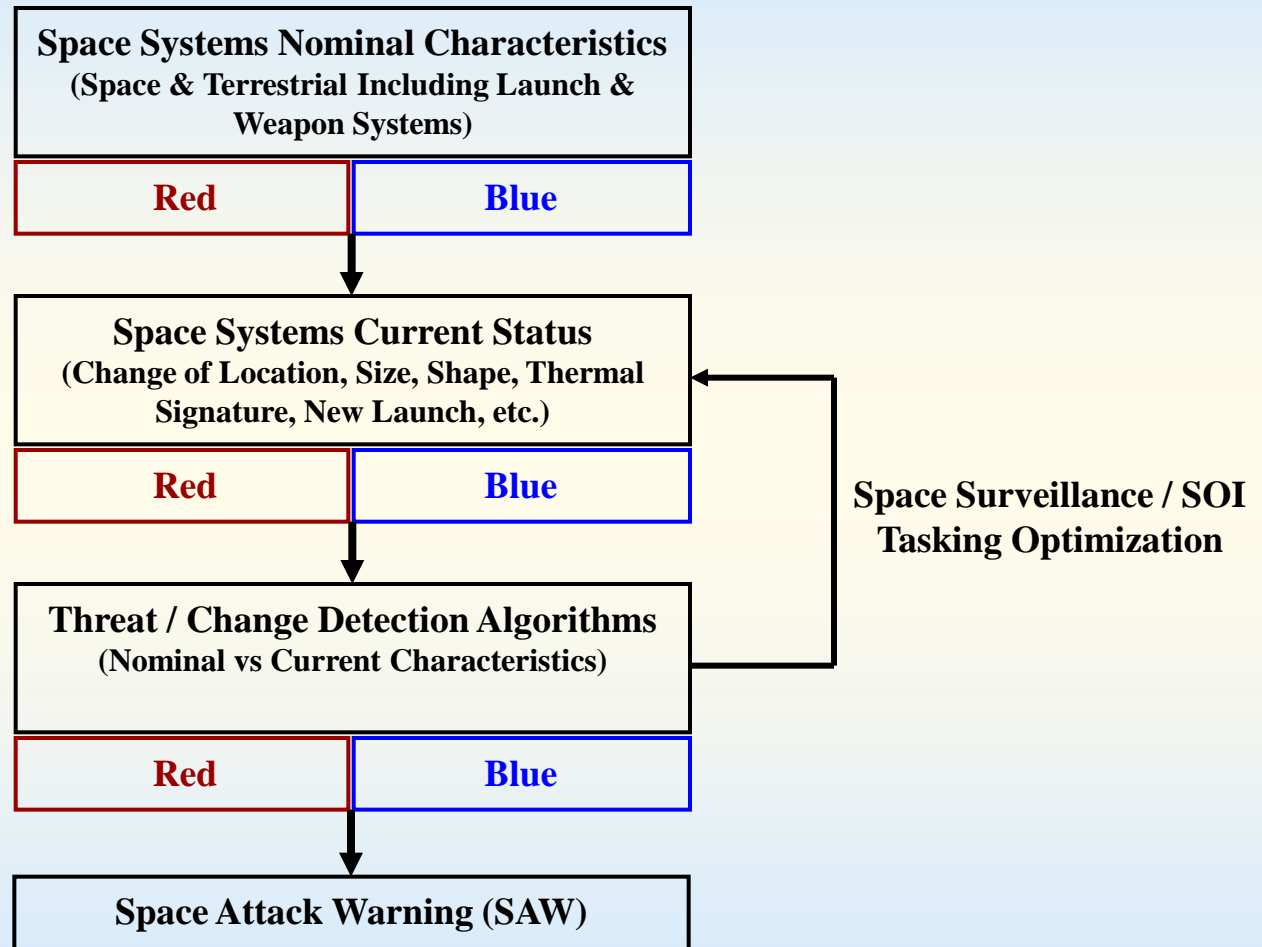
## SOR Field Data from JD 104, 2000



## TASAT Simulation w/ pose (11, -15, -1)

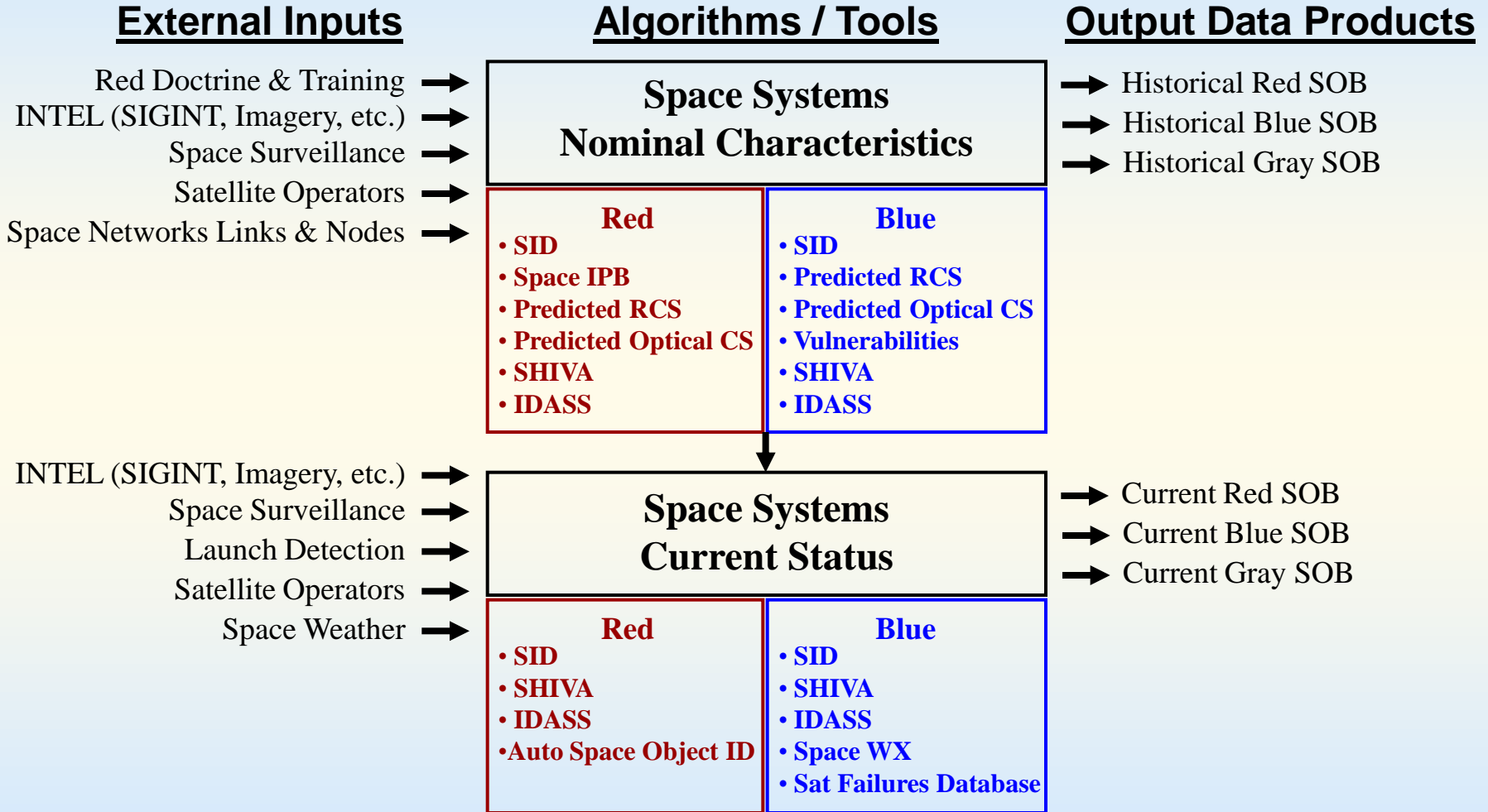


# SSA & SAW Integrated Concept



**Predict an Adversary's Intentions & Next Moves Against Space Systems**

# SSA & SAW Detail 1



**Space Characteristics Databases Critical for Attack Detection**

SWAT 1  
SWAT 2  
SWAT 3



# SSA & SAW Detail 2

## Internal Inputs

## Algorithms / Tools

## Output Data Products

**SID**



**SWAT Threat / Change Detection Algorithms**

<p style="text-align: center;"><b>Red</b></p> <ul style="list-style-type: none"> <li>• Auto Sat Change Detection</li> <li>• Auto Red COA ID</li> <li>• Space Threat Envelopes</li> <li>• Space Choke Points Maps</li> <li>• Sensor Site Weight Maps</li> <li>• Hidden Satellite Prediction</li> <li>• Satellite Attack Timelines</li> </ul>	<p style="text-align: center;"><b>Blue</b></p> <ul style="list-style-type: none"> <li>• JSARS</li> <li>• SHIVA Space Targeting</li> </ul>
---	---

- ➔ Most Probable Red COA
- ➔ Red Attack Timelines
- ➔ Direction of Attack
- ➔ Space Object ID & Status
- ➔ Most Vulnerable Regions of Orbital Space
- ➔ Space Sensor Optimized Tasking

INTEL Indicators vs Red COA's



**Space Attack Warning (SAW)**

Space Systems Importance



Space Weapons Reach



Space Systems Vulnerability



<p style="text-align: center;"><b>Red</b></p>	<p style="text-align: center;"><b>Blue</b></p> <ul style="list-style-type: none"> <li>• Space Principles of War</li> <li>• Space COG Model</li> <li>• Space COA's List</li> <li>• Space Escalation Ladder</li> <li>• SHIVA Space Targeting</li> </ul>
---	---

- ➔ Space Strategies Inputs
- ➔ Candidate Red Target List
- ➔ Impact on Blue Space

**Space Object Change Detection Critical for Attack Warning**

SWAT 1  
SWAT 2  
SWAT 3

# Focused Long Term Challenges Linkages

FLTC's



Space Tools



Space Control Tools / Algorithms

Number	Focused Long Term Challenges	Space Control Tools / Algorithms							
		Auto Space Object Classification	Auto Red COA ID	Space IPB Generation Support	Satellite Database & Statistics	Satellite Failures Database	Space INTEL Tasking Prioritization	Space Blue COA Generator	Space Control Scenario
<b>FLTC #1 Anticipatory Command, Control and Intelligence (C2I)</b>									
PS 1.1	Discover Threatening Systems & Objects	X	X	X	X	X	X		
TC 1.1.4	Define the behavior of potential threat entities	X	X	X	X	X	X		X
TC 1.1.5	Assessment of both current and most likely future situations	X	X	X	X	X	X		X
PS 1.2	Predict Adversary Behaviors	X	X	X	X	X	X		X
TC 1.2.1	Development of expected futures, their impacts and potential threats	X	X	X	X	X	X		X
TC 1.2.2	Identifying decision/leverage points for center of gravity analysis		X	X	X	X	X	X	X
TC 1.2.3	Generating and evaluating outcomes		X	X	X	X	X	X	X
TC 1.2.4	Visualization methods of adversary models of future states		X	X					
TC 1.2.5	Ensuring awareness of adversary deceptive behaviors	X	X	X	X	X	X		X
PS 1.3	Perform Near Real-Time Decision Management	X	X	X	X	X	X	X	
TC 1.3.1	Generating multiple courses of action		X	X			X	X	
TC 1.3.5	Generate nondeterministic, nonlinear causal linkages under ambiguous conditions	X	X	X	X	X	X	X	
TC 1.3.9	Develop automated target development and weaponing tools	X	X	X	X	X	X	X	
<b>FLTC #2 Unprecedented Proactive Intelligence, Surveillance and Reconnaissance (ISR)</b>									
PS 2.3	Assure Closed-Loop C2ISR Sensing and Processing (anticipatory)	X	X	X	X	X	X		
TC 2.3.1	Accurately detecting all space objects	X	X	X	X	X	X		
TC 2.3.4	Exquisitely characterizing all high-value objects for vulnerability assessment	X	X	X	X	X	X	X	
PS 2.6	Provide Comprehensive Space Situational Awareness	X	X	X	X	X	X		
TC 2.6.2	Timely understanding of newly launched space objects & change/threat detection	X	X	X	X	X	X		
TC 2.6.3	Comprehensively characterizing and assessing all space objects	X	X	X	X	X	X		
TC 2.6.5	Collaborative tools for integration of multisensor space object recognition	X	X	X	X	X	X		
<b>FLTC #5 Assured Operations in High-Threat Environments</b>									
PS 5.2	Detect and Defeat Threats Through Defenses	X	X	X	X	X	X		
TC 5.2.2	Identifying, characterizing, and reporting all spacecraft threats and/or attacks	X	X	X	X	X	X		

PS = Problem Statement

TC = Technology Challenge

**Tool Development Focused On Satisfying War-Winning Requirements**

# Proposed SWAT Future Developments

- **Evolve Most Threatening Regions of Space Displays (SAW)**
  - Develop Delta-V vs. Transit Time Maps
  - Display Non-RPO Attack Modes (Iridium 33 vs. Cosmos 2251)
  - ✓ **IMPACT: Increased Ability to Predict Space Attacks, & Help Prevent Terrestrial War; Also, Better Optimized Tasking of INTEL Sensors**
- **Expand SWAT Space Game Developments**
  - Develop Lists of Best Red Space Attack Strategies Assuming Certain Types of Weapon Systems
  - Determine the INTEL Indicators of These Types of Attacks
  - ✓ **IMPACT: Increased Ability to Predict Red Space Intentions, & Help Prevent Terrestrial War; Also, Better Optimized Tasking of INTEL Sensors**
- **Auto Space Missile Launch Identification**
  - Adapt Proven SWAT State Change Algorithms to Automatically Predict Satellite Launch Times & Missions Using SIGINT Data
  - ✓ **IMPACT: Automated Space Launch Typing Allows Faster Threat Mitigation Timelines Translating to Better War-Winning Space Strategies**

**Small Investment Leveraged Into War-Winning Space Control / SSA Battle Management**