

# 21<sup>st</sup> Century Systems, Inc.

## Unique Tools for Complex Systems®

### RPAT Technicians

“A Multi-agent System for Rapid TST Decision Support”

17 June 2008

**AF071-089 Reactive Planning Against TSTs ( RPAT )**

Presented at the 13<sup>th</sup> International Command and Control Research and Technology Symposium

*SBIR/STTR DATA RIGHTS*  
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# Agenda

- Introduction to 21<sup>st</sup> Century Systems, Inc. (21CSI)
- SBIR topic review
- Initial system design
- Prototype overview
- Questions



# Introduction to 21CSI

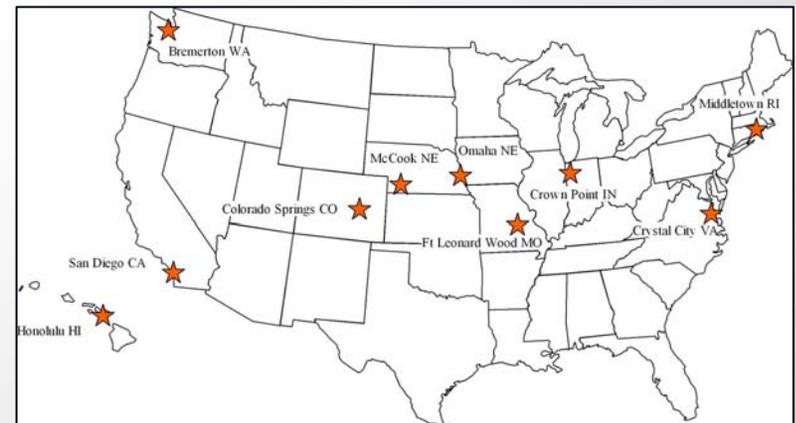
- Pioneer in Agent-based Decision Support Systems (DSS) and Situational Awareness for military applications
  - Over 30 decision support tools across spectrum of missions
    - Military force protection and C<sup>2</sup>
    - Transportation & logistics management
    - Energy assurance
    - Data mining/characterization
  - Patented, open architected, COTS software technology
- Customers
  - DoD – acquisition
    - USMC/PP&O, Army/SMDC, Navy/PEO-IWS, PEO-C4I, ...
  - DoD – research & development
    - ONR, AFRL, DARPA, AFOSR, ARL, NSWC, NRL, ...
  - NIST, DoE, Industry, Universities





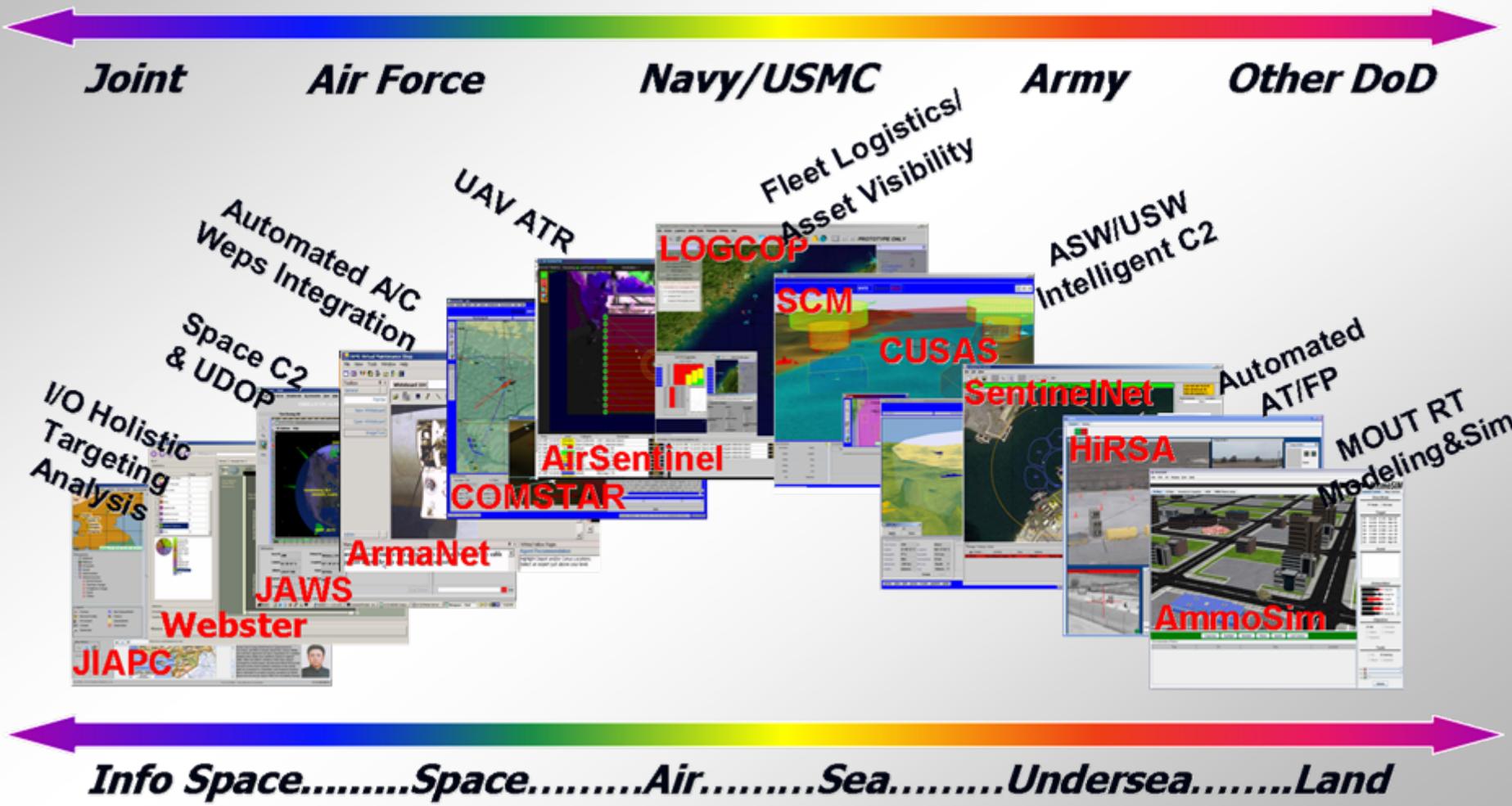
# Company Profile

- Founded in 1996
- Over 140 employees strong
- Selected in 2005 and 2006 as an Inc. 500 company
- Offices in HI, WA, CO, NE, MO, IN, VA, RI
- Tibbetts awardee for 2006
- Top Secret Facility Clearance





# Spectrum of 21CSI Agent-based Tools





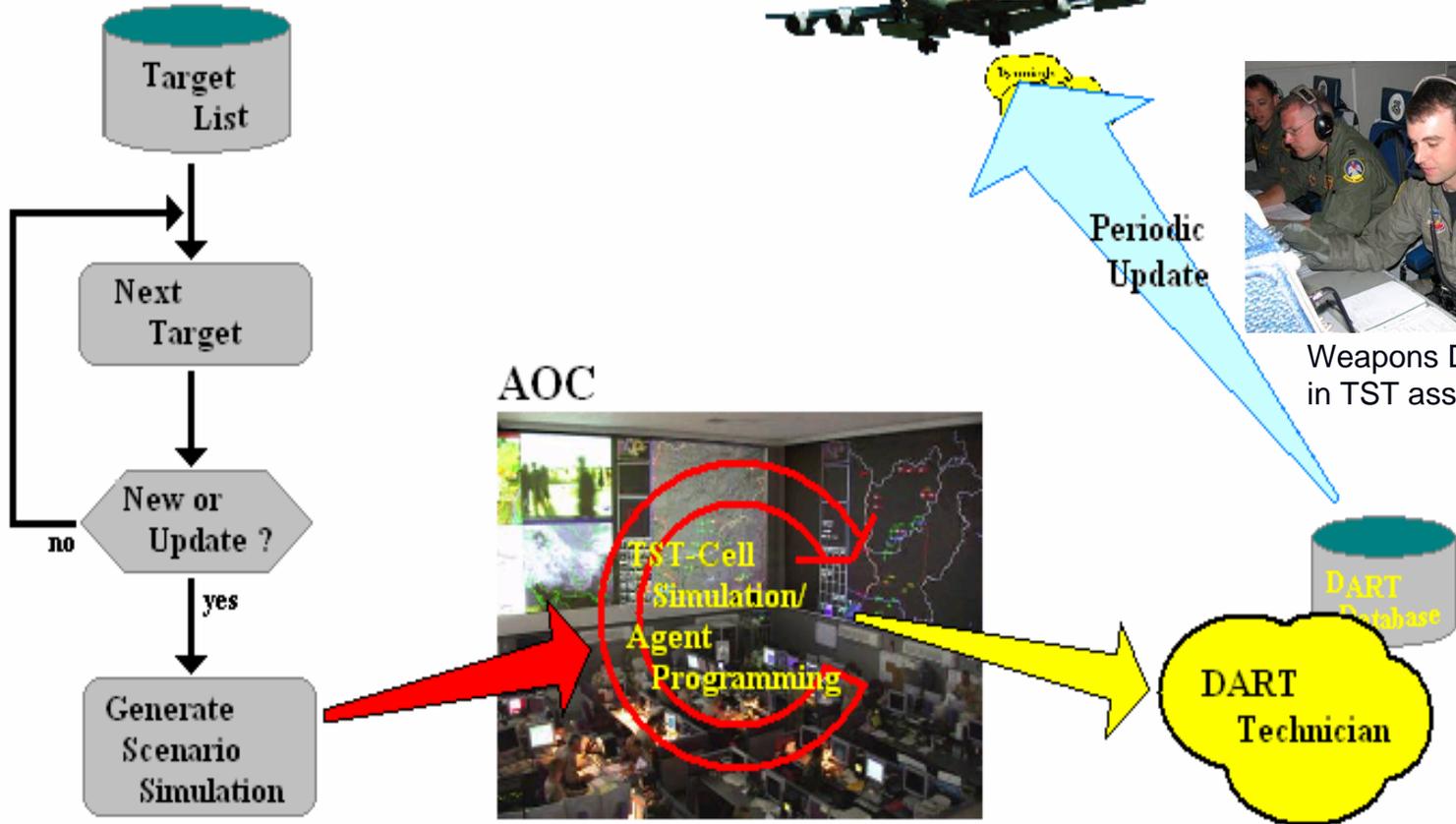
# SBIR Topic

## AF071-089 Reactive Planning Against TST (RPAT)

- ***Automated TST process on-board the AWACS platform*** will allow the Warfighter to quickly react within the vulnerability window of fleeting, high payoff targets of opportunity.
- Systems capability that ***reduces the decision process time (permission/confirmation, Go / No-Go)*** currently existing within airborne combat operations against time-sensitive target (TST).
- Determine where ***automation and machine-to-machine communications will expedite the decision process.***

- JFC's guidance & objectives

- RPAT Technicians in aircraft update DARTs using all information



- RPAT Technicians in AOC prepare DARTs

DART: Decision Agent for Rapid TST



# Initial system design

***Define the system/software architecture*** that will allow RPAT Technicians to be seamlessly integrated within existing flight segment (AWACS) and ground segment (AOC), and within constraints of communication links.

- Decision Agent for Rapid TST (**DART**)
  - Authorization for TSTs Go / No-Go at the AWACS level
- RPAT Technicians demonstration
- Performance Metrics



# Focus for RPAAT within TST Kill Chain

- Find – Detect & report emerging target
  - AOC-ISR/Platform-surveillance/crosstold
- Fix – Precise location that satisfy the PID
  - AOC-ISR/Platform-surveillance/crosstold
- Track – Maintain continuous situational awareness
  - Platform-MC SD WD/AOC-ISR
- Target – Formulate options for desired EBO
  - Platform MC SD/AOC-COD
- **Engage – Implement COA to prosecute TST**
  - Platform SD WD/AOC
- Assess – Were the desired effects achieved?
  - Platform SD WD /AOC-ISR

**Seamless and reliable real-time Go / No-Go  
TST engagement decision processing**



# Examination areas for RPAT Technicians integrated into Control Function

## **Monitoring for plan updating**

- Surveillance (e.g., active-passive tracking, flight plans)
- Communications (e.g., tactical data traffic, crosstold data, controlled aircraft status)
- System performance (mission computer, data networks, comm)
- ATO updates and ACO/ACP

## **Reactive plan generation**

- Combat target, attack options
- A/C performance constraints, clean and tanked fuel
- Weapon pairing to target type, vulnerability to threats
- Divert guidance and profile selection
- ATO gain/loss

## **Weapon assignment**

- Alarms and alerts to WD
- Confirmation and permission



# TST Reactive Planning Analysis and Requirements

- Relate decomposed TST functions to agent support areas and set the requirements for “best capable” asset to assign to the TST (e.g., effectiveness, response, range, accuracy, threat)
- Define system concept and architecture with embedded systems for critical tasks, information requirements, functional hierarchies, allocation by ground/flight components
- Consider migration approach from ground segment, flight segment, and planned communications links capability



# *RPAT Technicians* concept – a Compressed Decision Process

- Each RPAT Technician type is characterized by its domain support needs, the span of available data resources, its planning and action time requirements, intelligent process and learning capability, “knee-jerk” reaction time, and its reasoning capability.
- At the action point (e.g., perhaps support of a Weapons Director making aircraft TST assignment) is the DART. The DART is central to our concept for rapid reaction to TSTs, or Decision Agent for Rapid TST. Each DART is fast acting rule-based decision support for assignment recommendation.



# DART intelligent software agent:

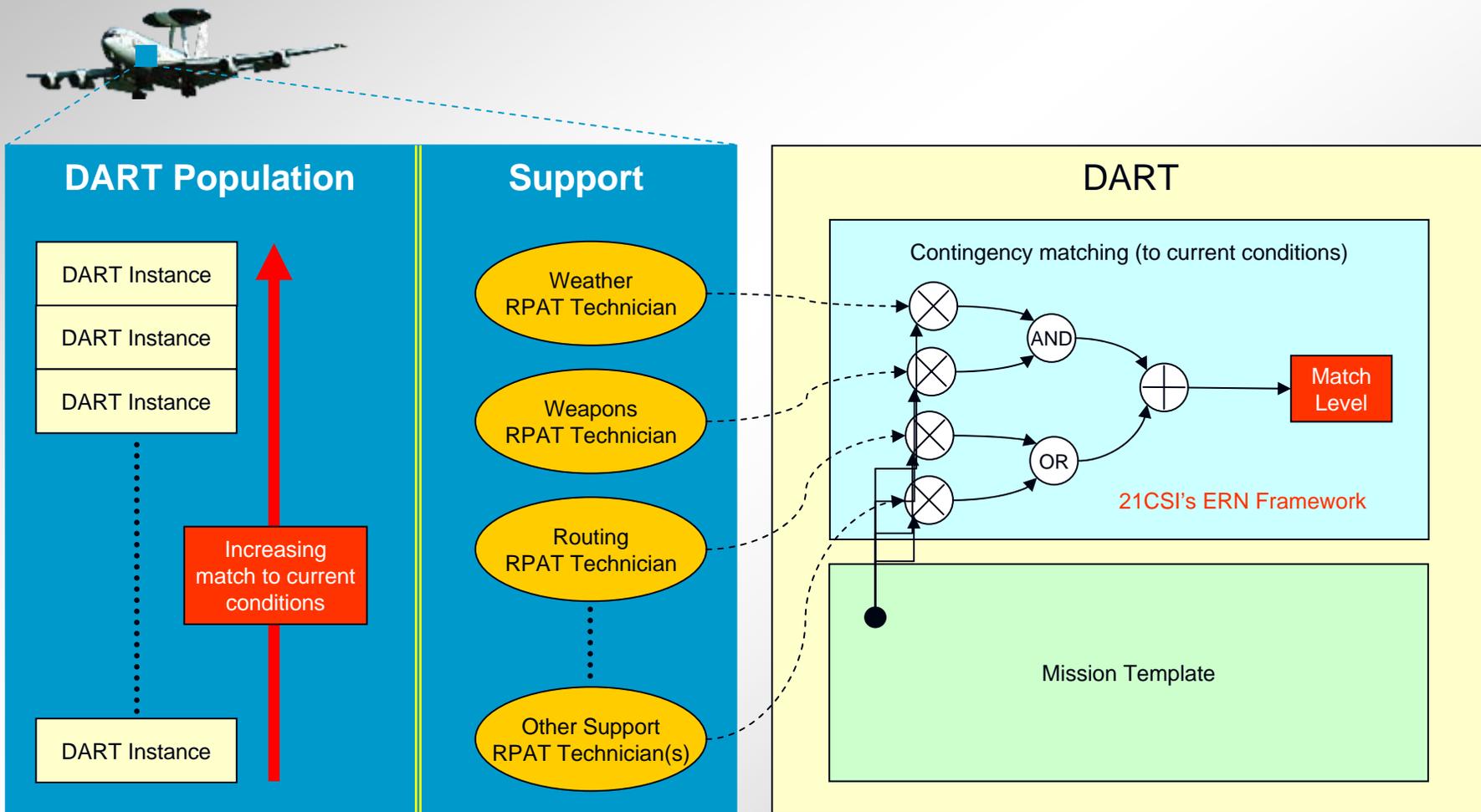
- Created in the AOC with a simulated F2T2AE process
- Uploaded to/operates on C2 airborne platforms
- Onboard execution by RPAT Technicians continuously evaluate DART contingencies
- When its TST is identified and tracked, it communicates electronically with RPAT Technicians
- Communicates with AOC or onboard data sources for solutions to significant unresolved contingencies
- Support Weapons Director's real-time Go / No-Go decision



# DART Technician Architecture

- Mission template
  - Required resources (Weapon, Delivery platform)
  - Environmental constraints (Weather)
- Contingency matching (ranking)
  - ERN/Subjective-Logic and JBOSS Rules (formerly Drools)
  - Glue that links mission template to other Technicians
  - Result is a measure of the match between DART's requirements/constraints and current resources/environment

# DART Technician Architecture





# Prototype Overview

- Limited scope to airborne segment of the system
- Implement selection of DART and go/no-go decision by user
- Changing of operational situation over time
  - Ex: Target moving near and through a no-fire-zone
- Implementation of DART
  - Hand crafted (since creation would normally take place at ground segment)
  - Retrieves updated situational data and re-rates accordingly



# Scenario Setup

- Assets
  - AWACS and escort orbiting in the north-west
  - Two aircraft (“bombers”) attacking planned targets
- Targets
  - Terrorist hideout in the north
  - Weapons depot in the south
- Other
  - Hospital with surrounding designated no-fire zone
  - Unknown contact moving south-southwest



# UI Overview

The screenshot shows the RPAT software interface with the following components and callouts:

- Scenario Time:** A yellow callout box pointing to the time display '18:00:00' in the top toolbar.
- Scenario Map:** A yellow callout box pointing to the 'Simulator Map' window, which displays a green terrain map with targets labeled 'Terrorist Hideout Target', 'Hospital Area one', and 'Weapons Depot Target'.
- Go Button:** A yellow callout box pointing to a green checkmark icon in the top right corner of the window.
- List of DARTs in system:** A yellow callout box pointing to the 'Dart View' window, which contains a hierarchical list of targets and their attributes.

**Dart View List:**

- DART 4 Small Building, Light construction
- DART 5 Medium Building, Reinforced
- DART 3 Light Moving Ground Target, GPS Guided Weapon
  - Rating: .875
    - BDU (75%, 0%, 25%)
    - ROE
      - Rating: 1.000
      - TST
        - Rating: 1.000
        - WEAPON
          - Rating: .875
            - BDU (75%, 0%, 25%)
- DART 2 Light Moving Ground Target, Camera Guided Weapon
- DART 1 Light Moving Ground Target, Laser Guided Weapon

# UI Overview

The screenshot displays the RPAT software interface with the following components:

- Simulator Map:** A green map area with various targets. A yellow callout labeled "DART Match Rating Indicator" points to a green circle on the map. A yellow callout labeled "DART Match Rating Number" points to the text ".875" in the Dart View panel.
- Dart View Panel:** A tree view showing target details. A yellow callout labeled "DART Match Components" points to the sub-items (BDU, ROE, TST, WEAPON) under "DART 3".

**Dart View Panel Content:**

- DART 4 Small Building, Light construction
- DART 5 Medium Building, Reinforced
- DART 3 Light Moving Ground Target, GPS Guided Weapon
  - Rating: .875
    - BDU (75%, 0%, 25%)
    - ROE
    - Rating: 1.000
    - TST
    - Rating: 1.000
    - WEAPON
    - Rating: .875
      - BDU (75%, 0%, 25%)
- DART 2 Light Moving Ground Target, Camera Guided Weapon
- DART 1 Light Moving Ground Target, Laser Guided Weapon

# Scenario Start

The screenshot displays the RPAT software interface. The main window is titled "RPAT ©2007 21CSI Inc." and includes a menu bar with "File" and "Scenario". Below the menu bar is a toolbar with icons for file operations and a digital clock showing "18:00:00".

The interface is divided into two main panels:

- Simulator Map:** A green map area with several key locations marked:
  - Terrorist Hideout:** A red circular target labeled "Terrorist Hideout Target".
  - Weapons Depot:** A red circular target labeled "Weapons Depot Target".
  - Hospital:** A brown irregularly shaped area labeled "Hospital Area One".
  - Unknown Contact:** A yellow crosshair symbol.
- Dart View:** A panel on the right showing a hierarchical list of targets and weapons:
  - DART 4 Small Building, Light construction
  - DART 5 M
  - DART 3 L
  - Rating: 1.000
  - TST
  - Rating: 1.000
  - WEAPON
  - Rating: 0.75
  - DART 2 L
  - DART

Yellow callout boxes with leader lines point from the text labels to the corresponding elements on the map and in the Dart View panel.

# Scenario Start

**AWACS and escort**

**“Bombers” attacking targets**

**Dart View**

- DART 4 Small Building, Light construction
- DART 5 Medium Building, Reinforced
- DART 3 Light Moving Ground Target, GPS Guided Weapon
  - Rating: .875
    - BDU (75%, 0%, 25%)
  - ROE
    - Rating: 1.000
  - TST
    - Rating: 1.000
  - WEAPON
    - Rating: .875
      - BDU (75%, 0%, 25%)
- DART 2 Light Moving Ground Target, Camera Guided Weapon
- DART 1 Light Moving Ground Target, Laser Guided Weapon

# TST Appears

**RPAT ©2007 21CSI Inc.**

File Scenario

18:00:19

Simulator Map

Terrorist Hideout Target

Hospital Area Zone

Weapons Depot Target

**Dart View**

- DART 3 Light Moving Ground Target, GPS Guided Weapon
- DART 2 Light Moving Ground Target, Camera Guided Weapon
- DART 1 Light Moving Ground Target, Laser Guided Weapon
  - Rating: .040
  - BDU (0%, 90%, 10%)
  - WEATHER
  - TST
  - WEAPON
  - ROE
    - Rating: .050
  - Bomber 1
  - Paveway II GBU-12
  - Truck
- DART 5 Medium Building, Reinforced
- DART 4 Small Building, Light construction

Some DARTs match to varying degrees

This DART would violate the RoEs (Attack in No Fire Zone)

Contact identified as a TST

Some DARTs don't match the TST type

# All DARTs violate RoE

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File Scenario

18:00:26

Simulator Map

Dart View

**All 3 DARTs now violate RoE**

- DART 1 Light Moving Ground Target, Laser Guided Weapon
  - Rating: .036
  - BDU (0%, 90%, 10%)
  - TST
  - WEAPON
  - ROE
  - Bomber 2
  - JDAM GBU-31(V)3/B
  - Truck
- DART 2 Light Moving Ground Target, Camera Guided Weapon
  - Rating: .033
  - BDU (0%, 90%, 10%)
  - WEATHER
  - TST
  - WEAPON
  - ROE
  - Bomber 2
  - Maverick AGM-65G
  - Truck
- DART 3 Light Moving Ground Target, GPS Guided Weapon
- DART 4 Small Building, Light construction
- DART 5 Medium Building, Reinforced

Map Labels: Terror Hideout, Hospital Area Zone, Weapons Depot Target

# TST Response Selected

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File Scenario

18:00:45

Simulator Map

Dart View

- DART 1 Light Moving Ground Target, Laser Guided Weapon
- DART 3 Light Moving Ground Target, GPS Guided Weapon
- DART 2 Light Moving Ground Target, Camera Guided Weapon
- DART 5 Medium Building, Reinforced
- DART 4 Small Building, Light construction

Terrorist Hideout Target

Hospital Area

Weapons Depot Target

No-fire Zone

DART 1 approved as response

TST clears No-fire Zone

Asset redirected to attack TST



# Questions?



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