21-23 June 2005, at US Military Academy, West Point, NY

Please complete this form 712CD as your cover page to your electronic briefing submission to the MORSS CD. Do not fax to the MORS office.

Name of Principal Author and all other author(s):

Christopher M. White, Nicholas J. Pioch

Principal Author's Organization and address:

BAE Systems
Advanced Information Technologies, Inc.
6 New England Executive Park
Burlington, MA 01803

Phone: (781)273-3388

Fax: (781)273-9345

Email:christopher.m.white@baesystems.com

Original title on 712 A/B: **Joint Effects-Based Planning using the Strategy Development Tool at JEFX04**

Revised title:_____

Presented in: **WG 17**

This presentation is believed to be:
UNCLASSIFIED AND APPROVED FOR PUBLIC RELEASE

1. REPORT DATE **22 JUN 2005**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE **Joint Effects-Based Planning using the Strategy Development Tool at JEFX04**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **BAE SystemsAdvanced Information Technologies, Inc.6 New England Executive ParkBurlington, MA 01803**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES **See also ADM201946, Military Operations Research Society Symposium (73rd) Held in West Point, NY on 21-23 June 2005 . , The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**29**	

Joint Effects-Based Planning using the Strategy Development Tool at JEFX04

73rd MORSS
WG17: Joint Campaign Analysis

June 21-23, 2005

Dr. Christopher M White

Nicholas J. Pioch

Outline

- **Background**

- **SDT Overview**

- **Joint Collaborative Planning at JEFX04**

- **Conclusions**

Background – History

- **Developing an effect-based strategy development tool (SDT)**
  - Focus is on planning air campaign operations
  - Compatible with evolving effect-based operations concepts

- **Sponsored by AFRL Effects Based Operations (EBO) Advanced Technology Demonstration (ATD)**

- **Research started in 2001**

- **Research culminated with JEFX04 EBO tools initiative**

- **Technology transition includes design inputs for**
  - Strategy Planning Tool (SPT) in TBMCS 1.1.3
  - Information Warfare Planning Capability (IWPC) 4.2

Background – Research Focus

- **Mixed-initiative approach using adversary models to guide effects-based plan refinement**
  - Start with strategic-theater-level mission
  - Analyze and model the enemy system of systems
  - Decompose mission into strategic and operational-level effects and tasks
  - Decompose further into tactical-level tasks and target sets
  - Provide indicators and collection requirements for feedback during plan execution

- **Provide tools to analyze**
  - The impact of interventions on the probability of enemy goals, beliefs or actions
  - Target system models to compare predicted outage profiles and workarounds
  - Cross-model network flow models in order to suggest tactical tasks and target sets

Strategy Development Tool Overview

- **Collaborative Joint Campaign Mission Analysis**

- **Target System Analysis**

- **Effects Based Modeling and Analysis**

- **Network-centric Effects Based Planning**

- **Effects Based COA Decision Support Tools**

- **Target Option Analysis**

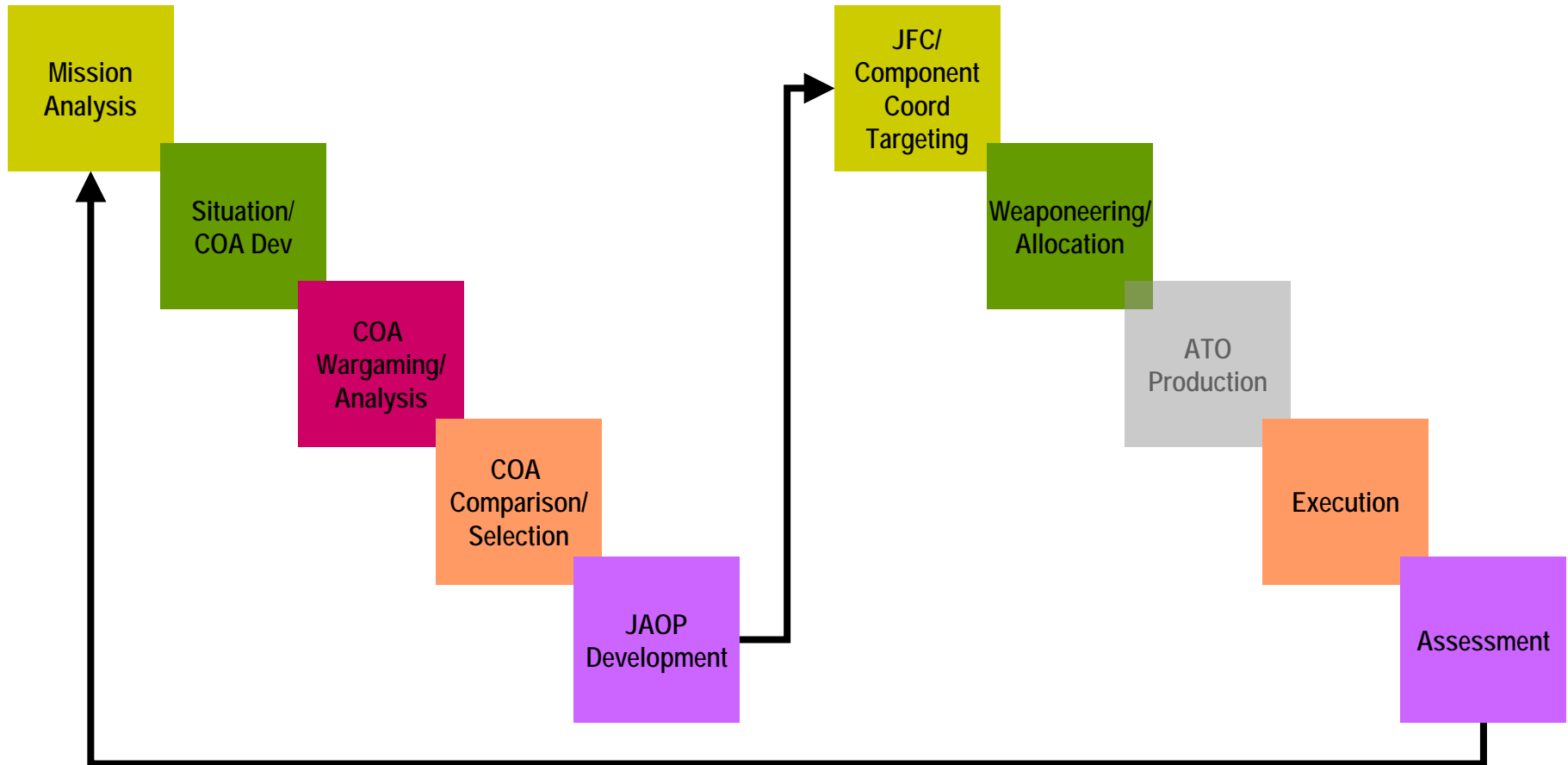- **Dynamic Coarse of Action Decision Tool**

Applying Effects-Based Operations to JP 3-30 Command and Control for Joint Air Operations

BAE SYSTEMS

Joint Air Estimate Process

Joint Air Tasking Order Process

Mission Analysis

Situation/ COA Dev

COA Wargaming/ Analysis

COA Comparison/ Selection

JAOP Development

JFC/ Component Coord Targeting

Weaponeering/ Allocation

ATO Production

Execution

Assessment

Collaborative Joint Campaign Mission Analysis

- **Provides central repository for one time entry of mission analysis and commander's guidance data**

- **Supports real-time collaborative updates by multiple users**

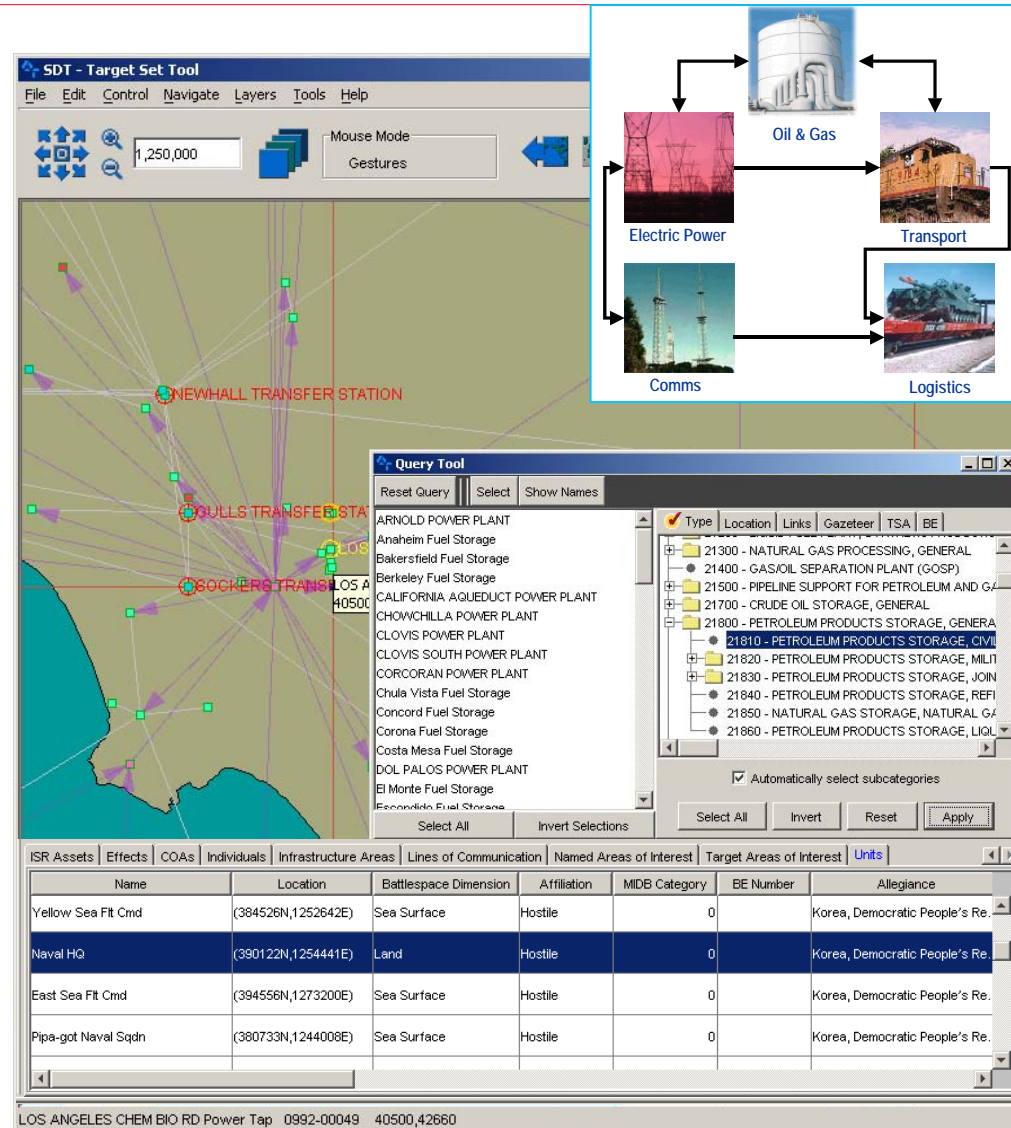- **Views of Mission Analysis data for multiple echelons and components**

Target System Analysis

- Visualize IPB data, target system nodes & links
- Query based on target category, location, name, or links
- Specify target lists for strike, no-strike, affect, do-not-affect

Effects Based Modeling and Analysis

BAE SYSTEMS

- Captures planners/analysts concept of the enemy system
  - **Red actions, goals, beliefs, resources**
  - **Positive, negative causal linkages**

- Analyzes probability of effects over time for different blue actions

- Explains blue strategy, based on impact to enemy COGs

- Exports causal chains to plan

- Supports Operational Assessment of evidence on indicators

Network-centric Effects Based Planning

BAE SYSTEMS
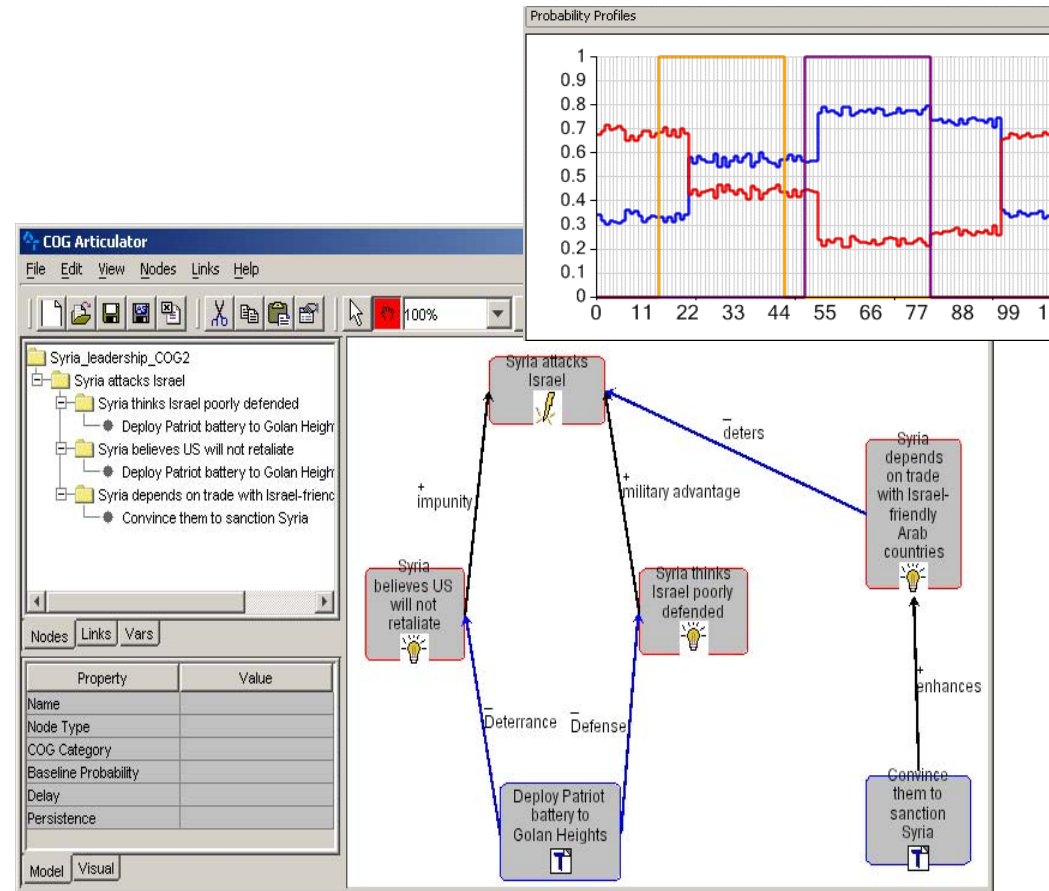
- COA development for deliberate and crisis action planning

- Multiple views into a common plan supports plan development and analysis

- Real-time collaboration facilitates communication between decision-maker and planners

- Plan templates created during deliberative planning can be used for crisis action planning

- Integrated with adversary modeling and analysis tools

- Uses simplified causal modeling semantics
  - Causal strength
  - Scheduled probabilities
  - Delay, persistence

Tasks to Effects to Objectives

Planning for Assessment
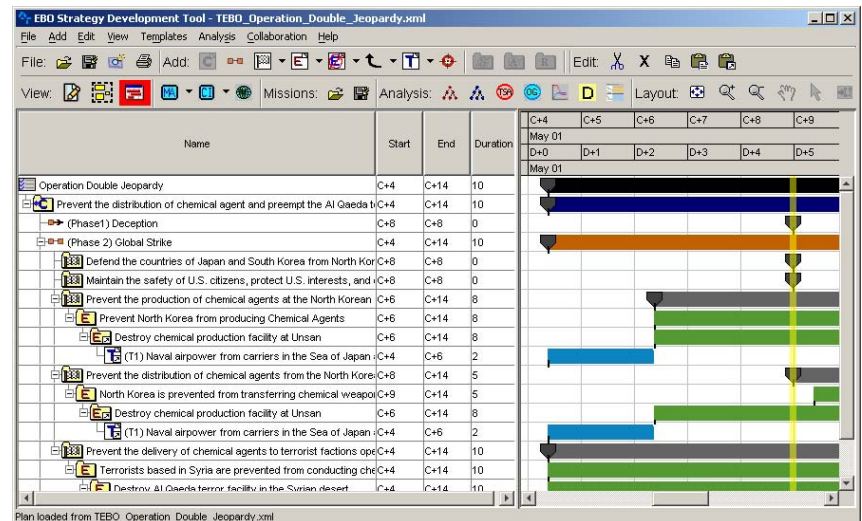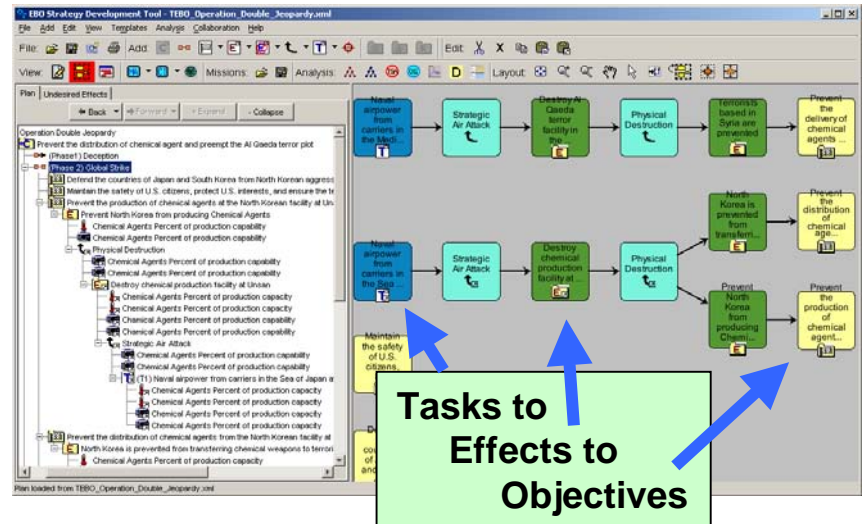
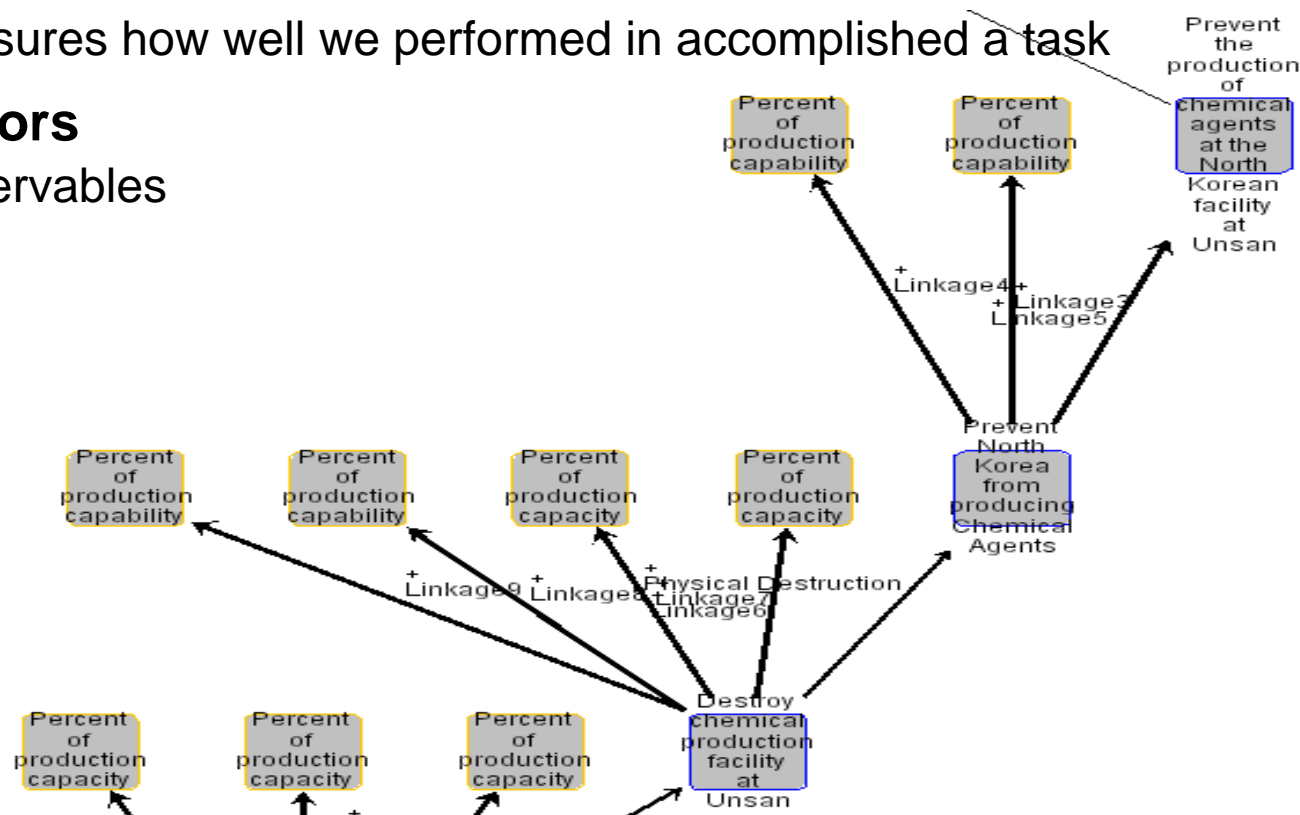- **Measures of Effectiveness**
  - Defined for each Objective and Effect
  - Measures how well we are accomplishing desired effects

- **Measures of Performance**
  - Defined for each Task
  - Measures how well we performed in accomplished a task

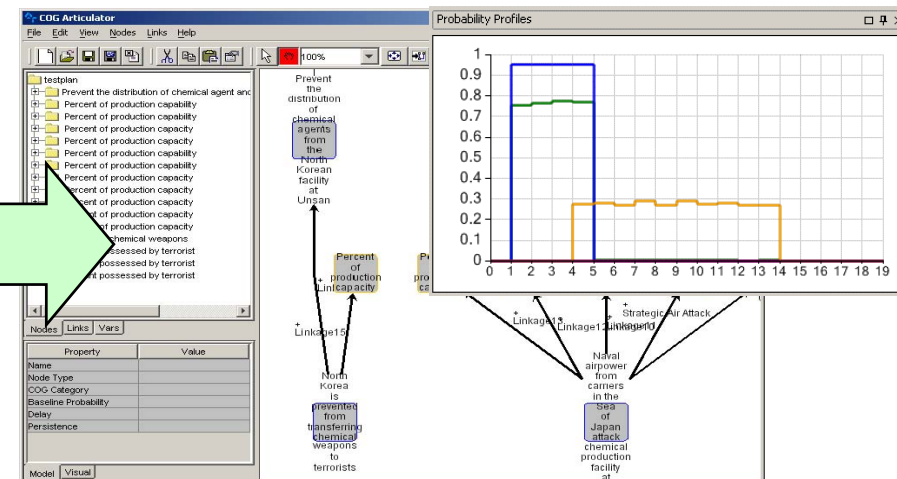- **Indicators**
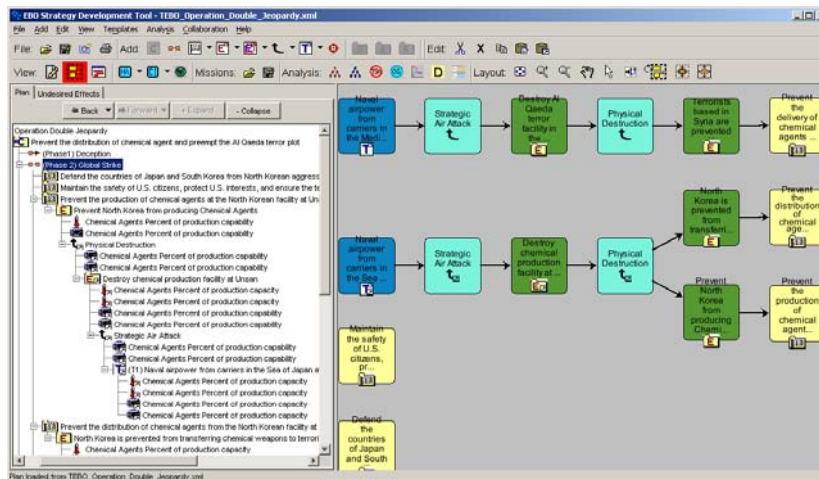 - Observables

Effects Based COA Decision Support Tools

BAE SYSTEMS

- COA Comparison Matrix supports decision making process

- Integrated COA analysis tool
  - Analyzes Probability/Timing of actions and effects

- Operational Assessment of plan progress
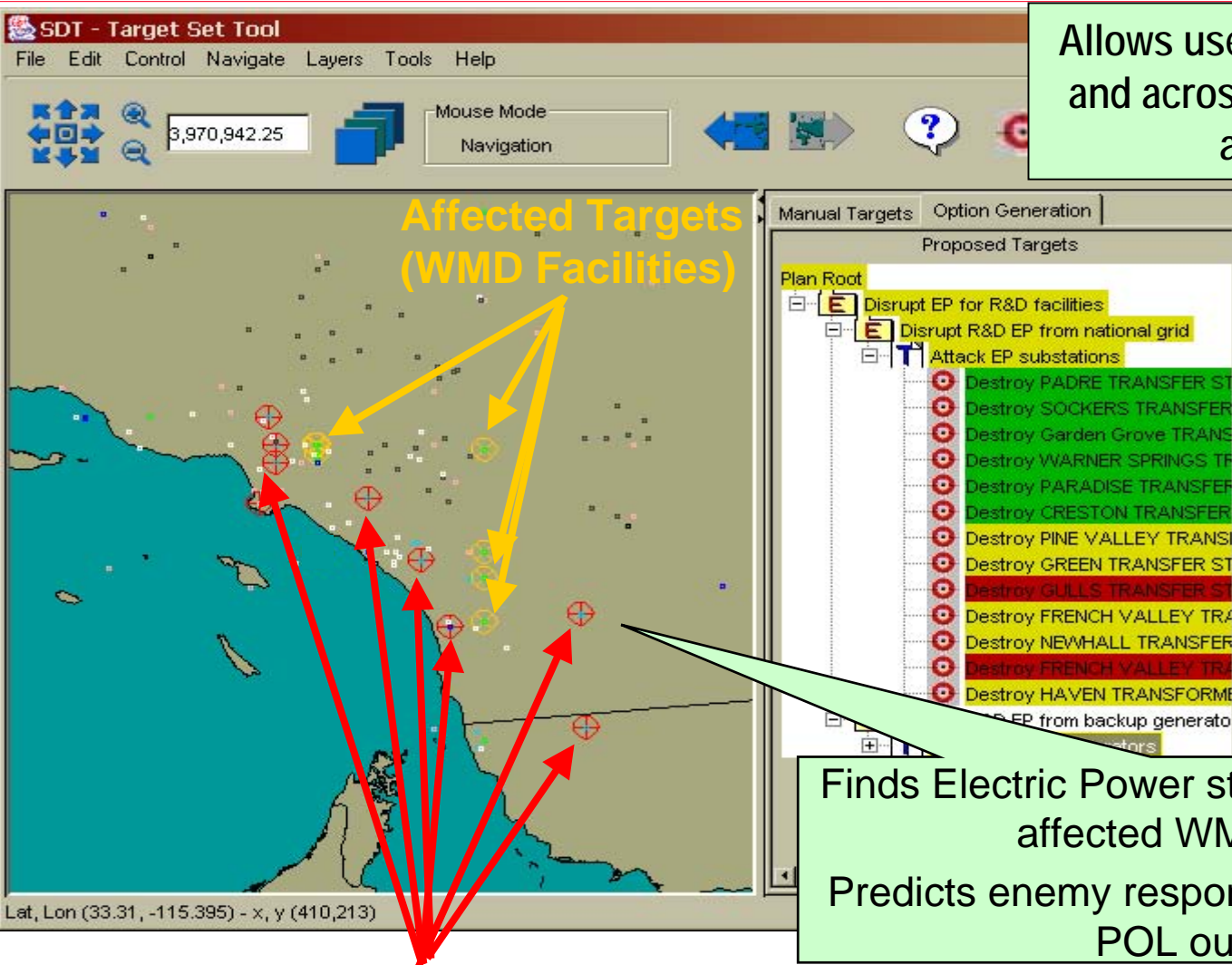
Target Option Analysis

Dynamic COA Decision Aid
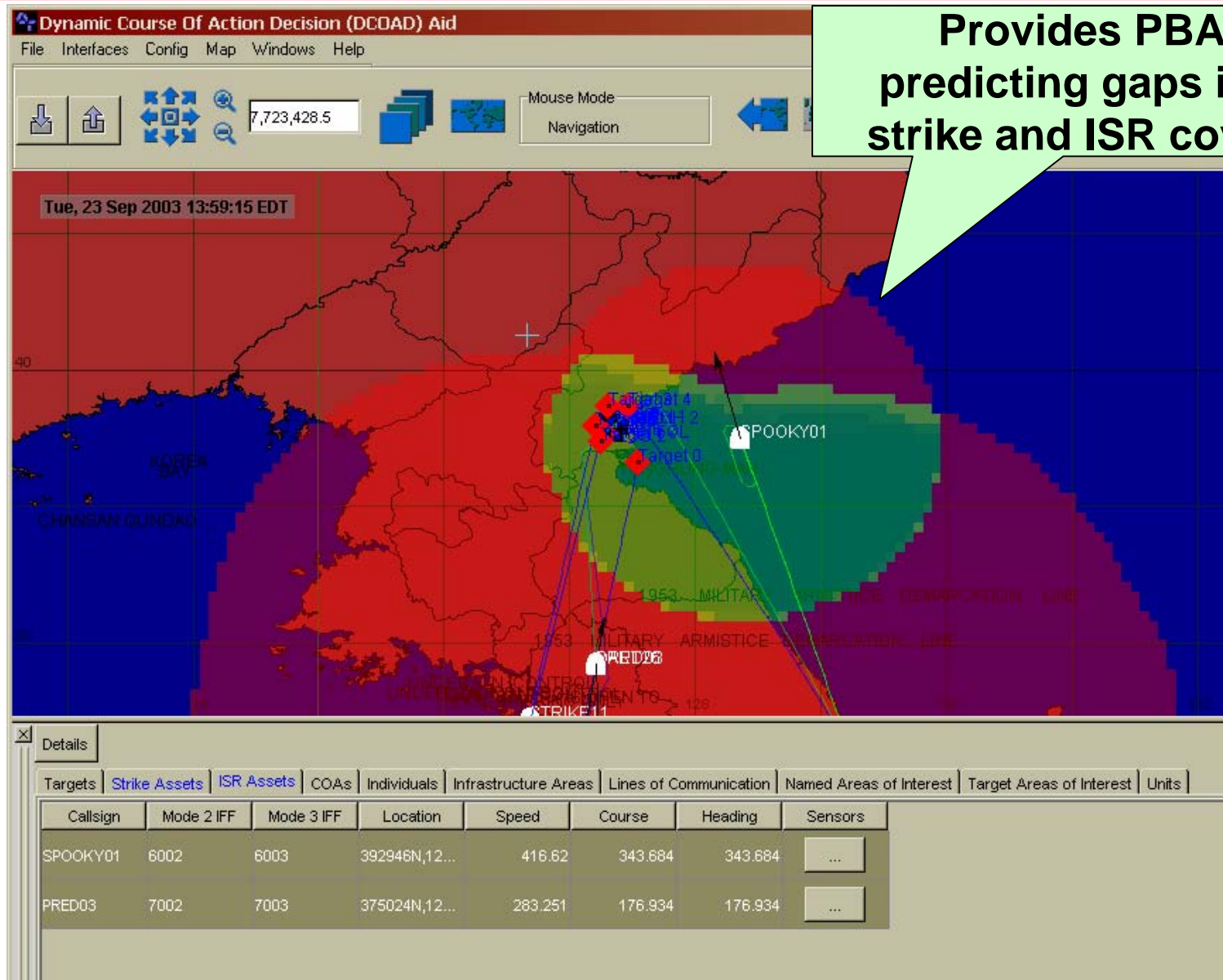
DISTRIBUTION A. Approved for public release; distribution unlimited.

Outline

- **Background**

- **SDT Overview**

- **Joint Collaborative Planning at JEFX04**

- **Conclusions**

Joint Expeditionary Forces eXperiment '04

- **Biannual joint experiment to**
  - Evaluate new tools and processes
  - Drive improvements to TTP, doctrine
  - Primarily focused on Air Operations Center

- **Distributed Operations**
  - Nellis AFB (AF)
  - Hurlburt AFB (Ground)

- **3 Focus Areas in JEFX '04**
  - Effects-based Operations
  - Predictive Battlespace Awareness
  - Network-Centric Infrastructure

- **Our EBO tools played in AFRL's EBO-PBA initiative**
  - Significant changes between Spiral 2, Spiral 3, Main Ex
  - Joint Air-Ground Branch Planning occurred during Main Ex
  - Ground component introduced to EBO tools during Main Ex

Applying Effects-Based Operations to JP 3-30 Command and Control for Joint Air Operations

BAE SYSTEMS

Joint Air Estimate Process

- Mission Analysis
- Situation/ COA Dev
- COA Wargaming/ Analysis
- COA Comparison/ Selection
- JAOP Development

Joint Air Tasking Order Process

- JFC/ Component Coord Targeting
- Weaponeering/ Allocation
- ATO Production
- Execution
- Assessment

Main Ex Planning Process

- **Joint Forces Commander developed campaign objectives, effects, and commander's guidance**

- **Assigned effects to components (i.e., JFACC, JFLCC)**

- **Each component developed plan for achieving effects**

- **Components planned in parallel coordinating efforts at multiple points**
  - End of Mission Analysis
  - During COA development
  - For wargaming, COA comparison, and selection

Collaborative Planning - JFACC

- **4 computers provided to team for developing branch plan**

- **Used real-time synchronous collaboration for Mission Analysis**

- **Team developed 2 independent COAs specifying**
  - Operational Objectives, Tactical Objectives, Effects, Causal Links, and Tactical Tasks
  - Measures of Effectiveness and Measures of Performance

- **Used mixture of real-time synchronous collaboration and passing of plan fragment updates as collaboration capability degraded due to bandwidth issues**

- **Merged JFLCC plan fragments at specified times**

Collaborative Planning - JFLCC

BAE SYSTEMS

- **Team used an average of 3 computers for developing branch plan**

- **Used real-time synchronous collaboration for Mission Analysis and COA development**
  - Mission Analysis screens developed for AF were sufficient for Army use
  - Army equated Causal Link to Purpose for associating Tasks with Effects and Objectives

- **Viewed JFACC plan via screen sharing**

- **Merged plan fragments into JFACC plan at specified times**
  - Bandwidth limitation made it more desirable to develop plans locally and then merge

Collaborative Planning Findings

- **JEFX04 demonstrated a prototype real-time synchronized collaboration capability**

- **An enhanced system would need to provide better support for bandwidth limitations and a larger number of simultaneous collaboration systems**

- **Need added support for Army planning needs such as**
  - Developing a COA Sketch
  - Developing a synch matrix
  - Providing a list of target nominations
  - Assigning resources to tasks
  - Specifying the Method for accomplishing a task
  - Performing mission analysis
  - Multi-echelon planning

System of Systems Modeling

- **Dep. Ops Assessment Chief**
  - Built and analyzed complex models (250 nodes, 300 links)
  - Iterative process using OAT to analyze incremental model changes
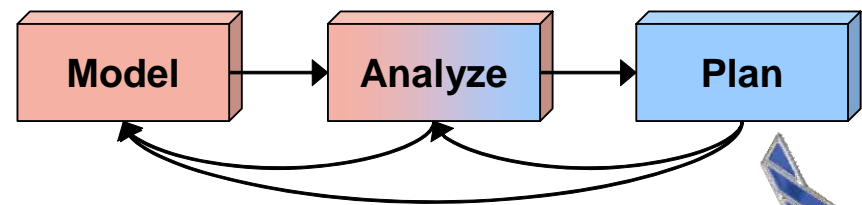
- **Findings**
  - Need unified tool for both model authoring and analysis
  - Need hierarchical navigation, visualization for large models
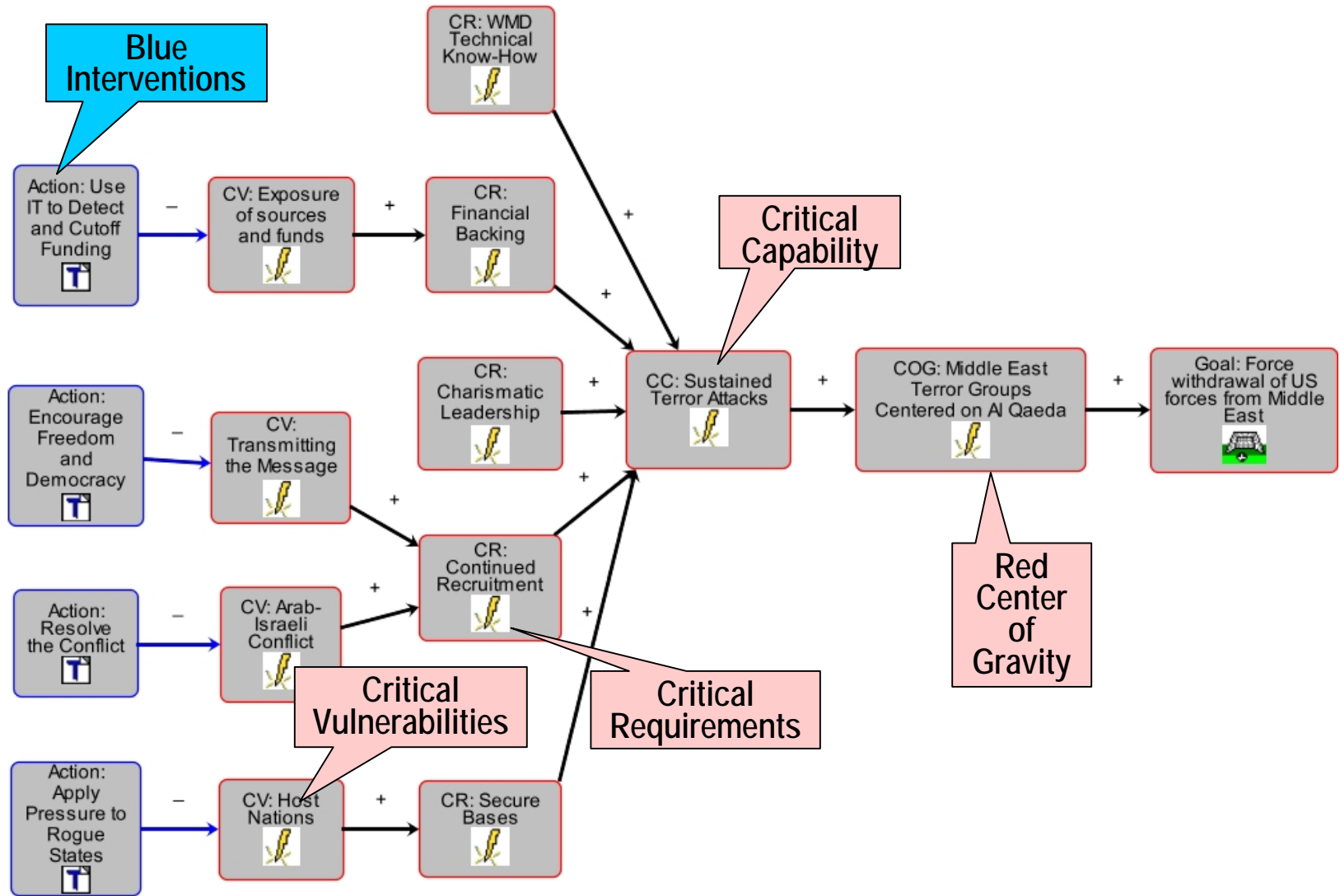
- **Observations**
  - Other users skeptical of model validity, additional workload
  - Models did not inform planning, but were used to validate the plan
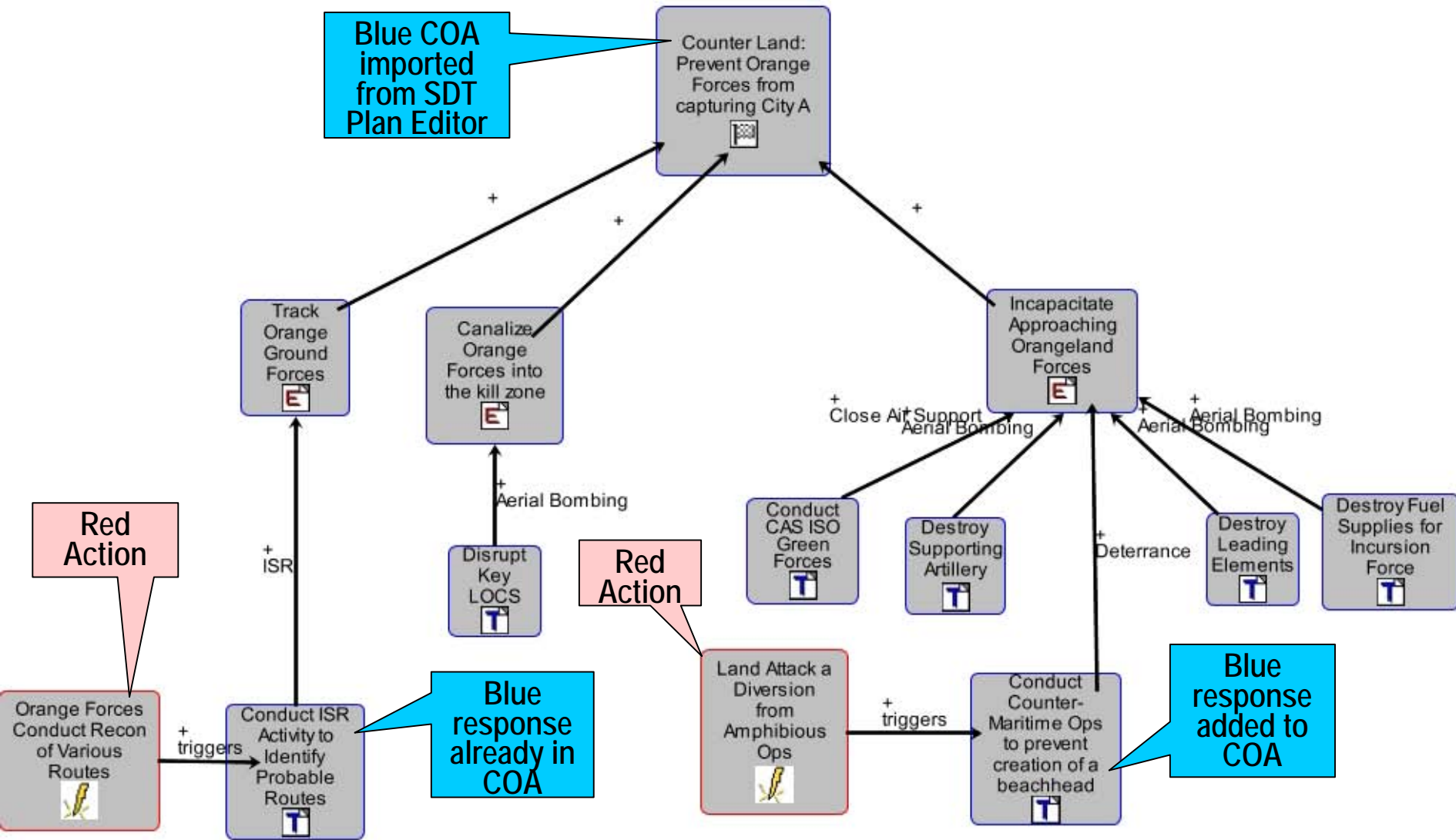

Califon System of Systems
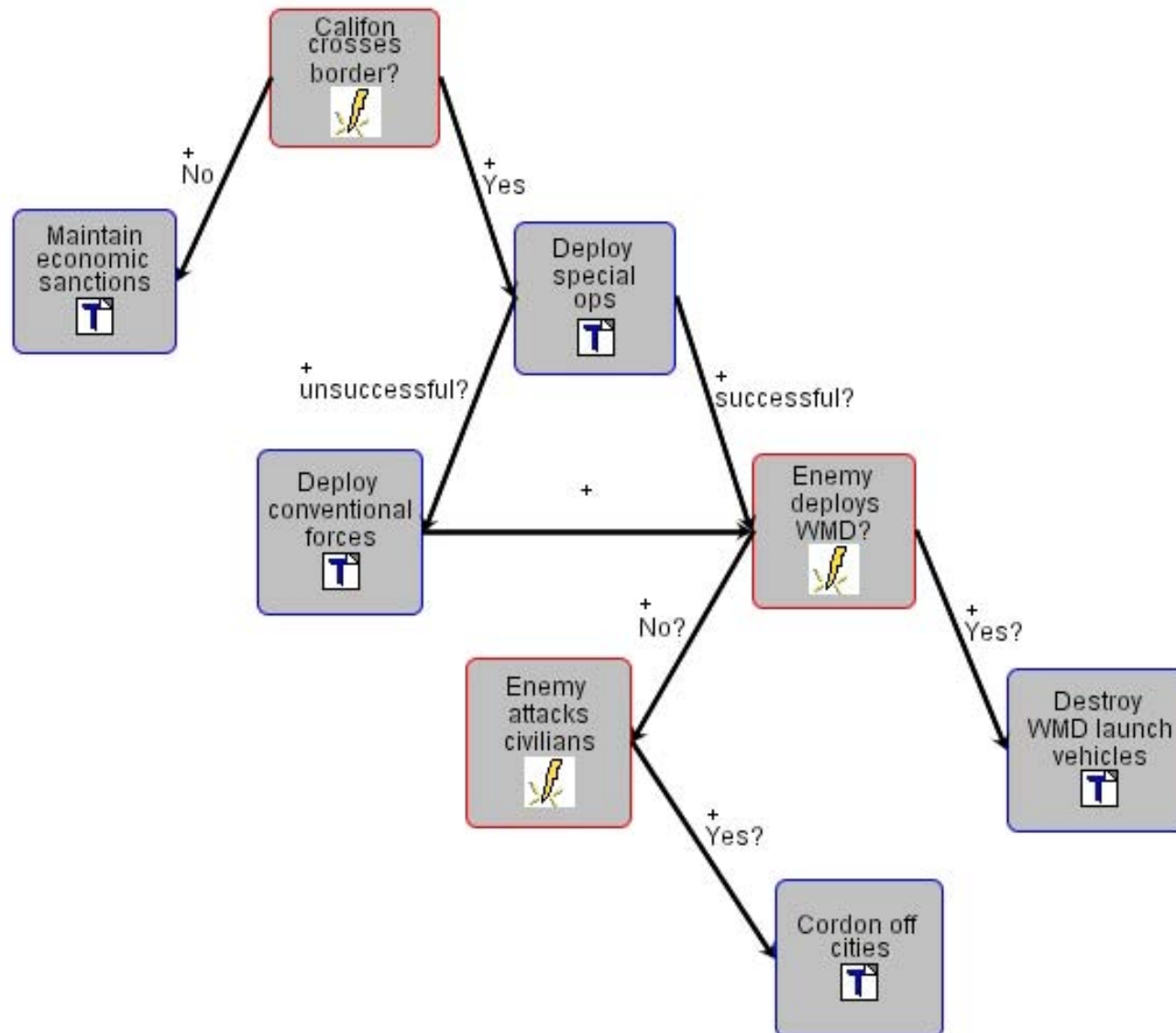
Leadership · Fielded Forces · Infrastructure · Economy

250+ Nodes
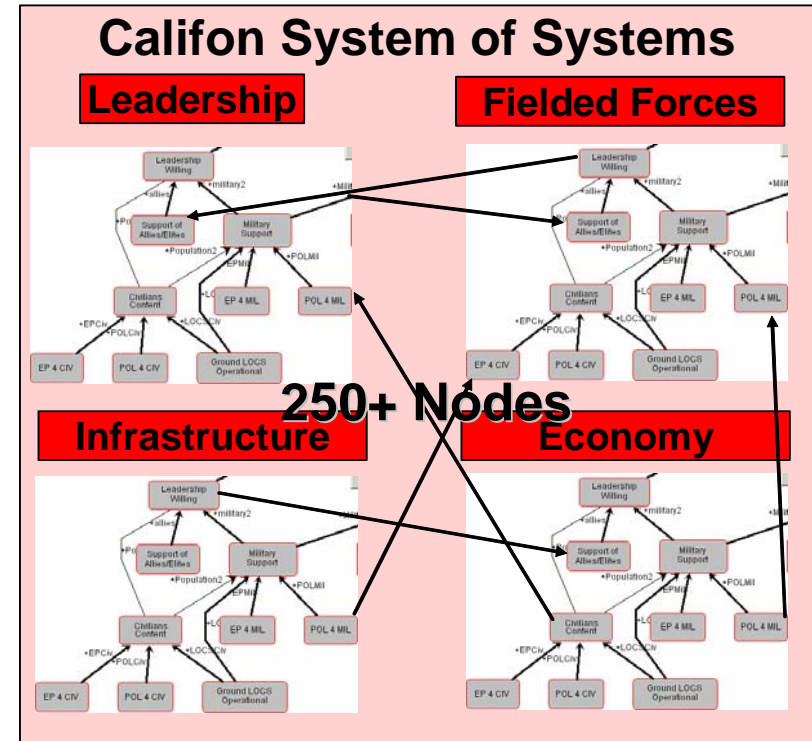
Iterative Modeling Process:

Model → Analyze → Plan

Novel Uses: Strange COG Models

Novel Uses: Blue-on-Red Wargaming

Novel Uses: Decision Tree Wargaming

Effects Based Modeling Findings

- **Appeals to power-users with modeling experience**

- **Majority of AOC Strategy Team users uncomfortable with added complexity**

- **Some came to appreciate the value of causal models for effects-based planning**

- **Need further research in:**
  - Qualitative modeling and analysis
  - Visualization techniques for predictive EBO

Model Analysis Findings: 3 Use Cases

1. **Spiral 2 & 3: Predict impact of blue interventions on red model**
   - Used extensively by Dep OAT Chief
   - Intel inputs from ISR Division

P(Red Deploys WMD) Without Interventions

P(Red Deploys WMD) With Interventions
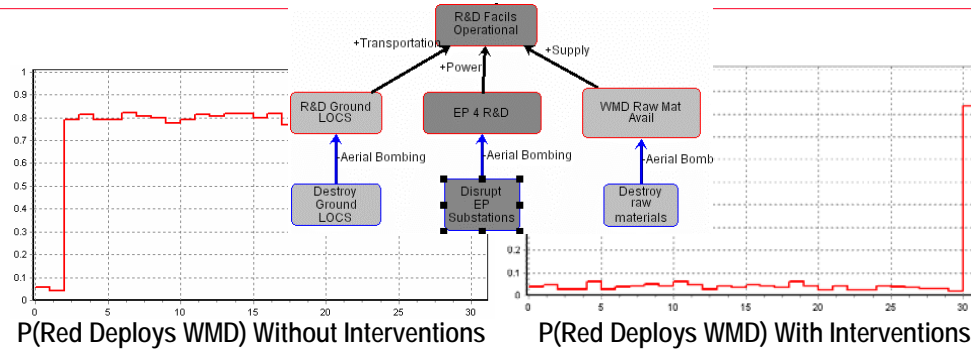
2. **Main Ex: Predict blue COA prob. profiles w/out red model**
   - Used to compare probability and timing of two alternate COAs
   - Reinforced JFACC's COA1 selection based on earlier effect achievement

Logical Plan Representation

Bayesian Network Representation
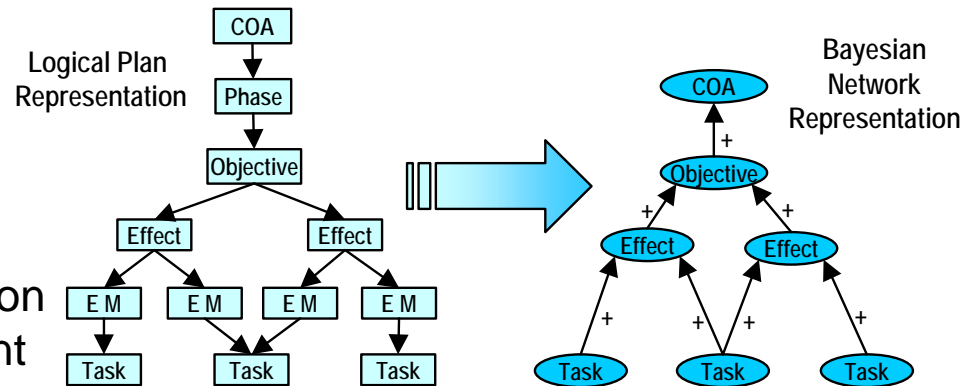
3. **Main Ex: Revise probabilities based on indicator evidence**
   - Delegated to junior lieutenant not familiar with model
   - Change in probabilities difficult to explain due to red model complexity

Evidence Probability

Indicator Evidence

Original Probability

Conclusions
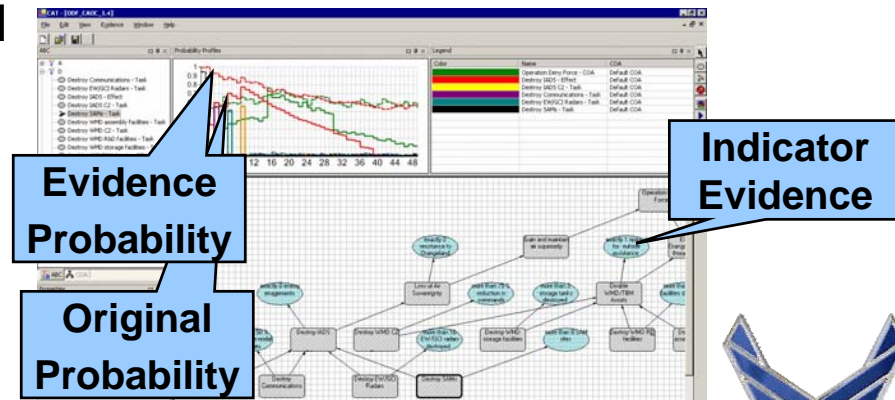
- **SDT provided EBO support for joint planning during JEFX04**

- **Real-time transparent synchronous collaboration is essential to planning**

- **Air Force and Army planning have some unique requirements that need to be met in a joint system**

- **Effects based modeling and analysis only appeals to a select few power users**

- **EBO ATD JEFX04 lessons learned can be valuable for future Joint EBO related efforts**