CASA Year III Demo

Year III Final Briefing and Demonstration

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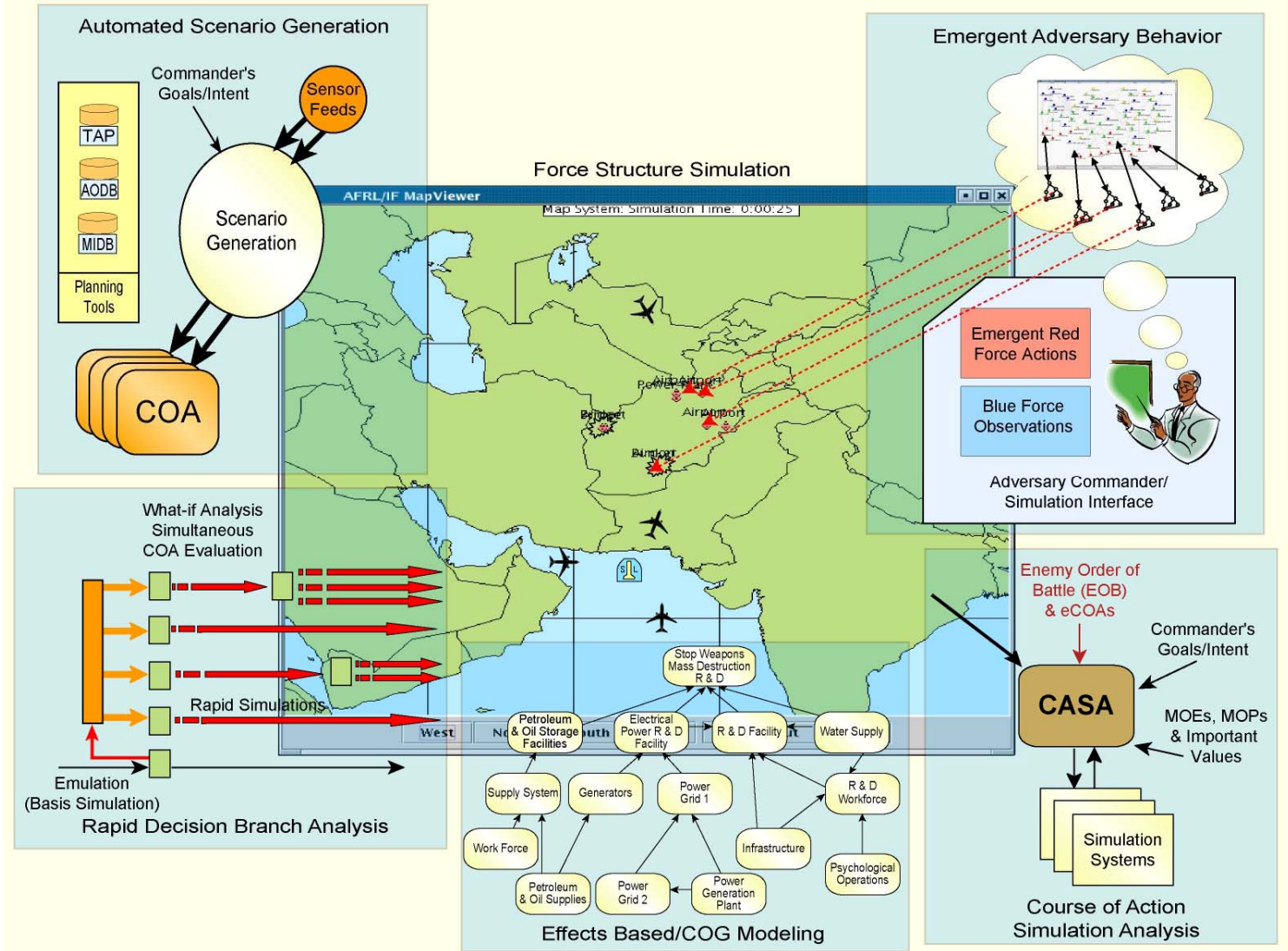
Agenda

- Overview
- CASA Focus, Efforts and Products
- Score Tailoring to Match Commander Profiles
- Alternate Scoring Implementations
- Simulation Scenario Description and CASA Demonstration
- Lessons Learned
- Future Enhancements and Conclusion

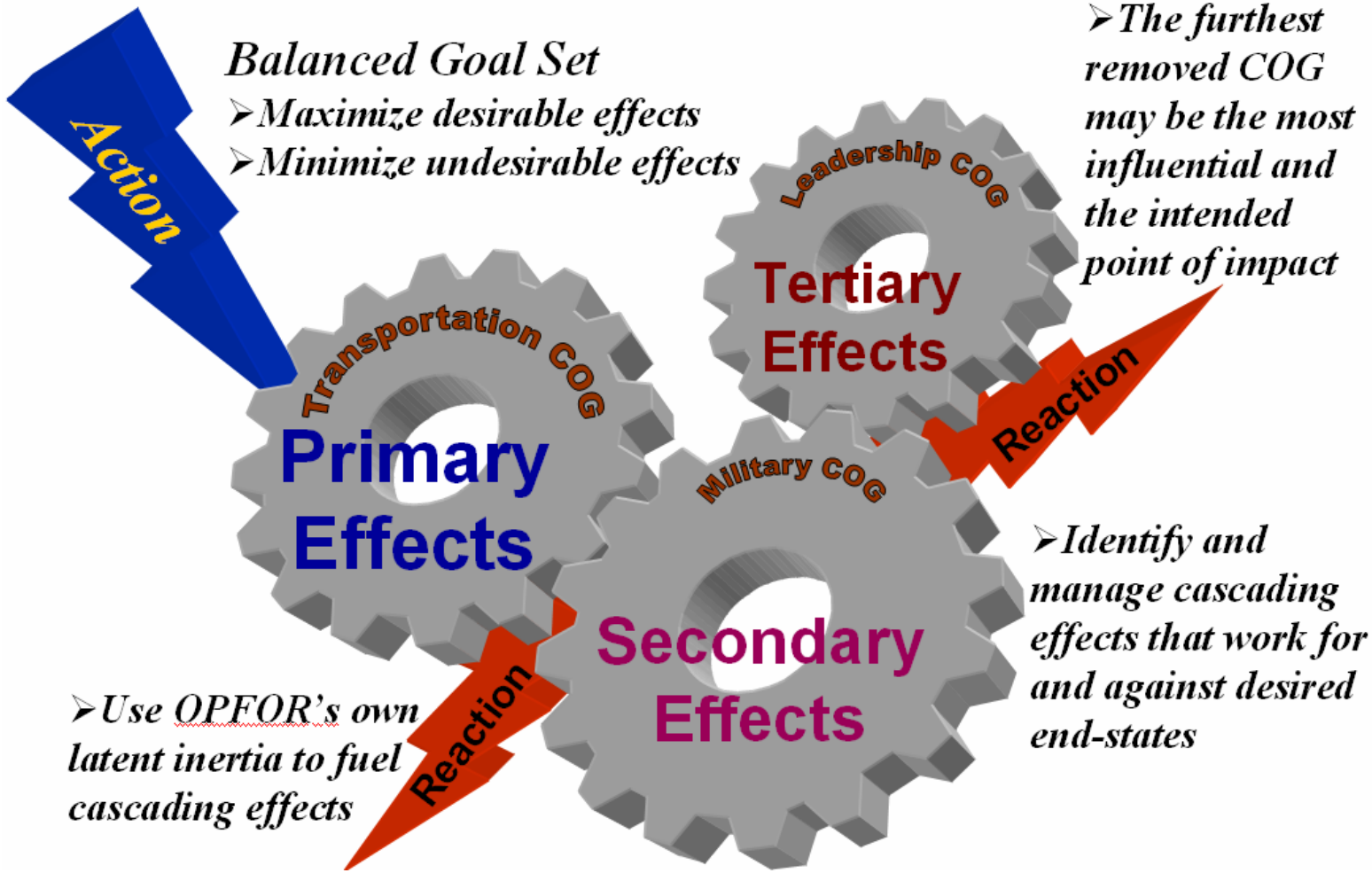
“Big Picture”


Automated Scenario Generation
Commander's Goals/Intent
Sensor Feeds
TAP
AODB
MIDB
Planning Tools
Scenario Generation
COA
Force Structure Simulation
AFRL/IF MapViewer
Emergent Adversary Behavior
Emergent Red Force Actions
Blue Force Observations
Adversary Commander/ Simulation Interface
What-if Analysis Simultaneous COA Evaluation
Rapid Simulations
Emulation (Basis Simulation)
Rapid Decision Branch Analysis
Enemy Order of Battle (EOB) & eCOAs
Commander's Goals/Intent
CASA
MOEs, MOPs & Important Values
Simulation Systems
Course of Action Simulation Analysis
Stop Weapons Mass Destruction R & D
Petroleum & Oil Storage Facilities
Electrical Power R & D Facility
R & D Facility
Water Supply
Supply System
Generators
Power Grid 1
R & D Workforce
Work Force
Infrastructure
Psychological Operations
Petroleum & Oil Supplies
Power Grid 2
Power Generation Plant
Effects Based/COG Modeling

Course of Action Simulation and Analysis (CASA)

- Define appropriate measures of merit for COAs
- Identify a very low level, fundamental and common set of characteristics that, when aggregated, can be used to describe any measure
- Provide a means of comparison for disparate approaches taken within different COAs
- Relate COA metrics to achieving the Commander's intent
- Provide drill down into results, including data visualization techniques

Driving Concept
Our Understanding of EBO



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Ontology Structure

Commander's Intent

Side {BLUE, RED, NEUTRAL}

End-State$_1$ .. End-State$_n$

Strategic Effect$_1$ .. Effect$_m$

Operational Effect$_1$ .. Effect$_p$

Operational Task$_1$ .. Task$_q$

Operational Mission$_1$ .. Mission$_r$

Measure of Merit (MoM)$_1$ .. MoM$_s$

Measure of Effectiveness (MoE)$_1$ .. MoE$_t$

Measure of Performance (MoP)$_1$ .. MOP$_u$

» Plus all the inter-relationships between these

Measures of Merit, Effectiveness, and Performance

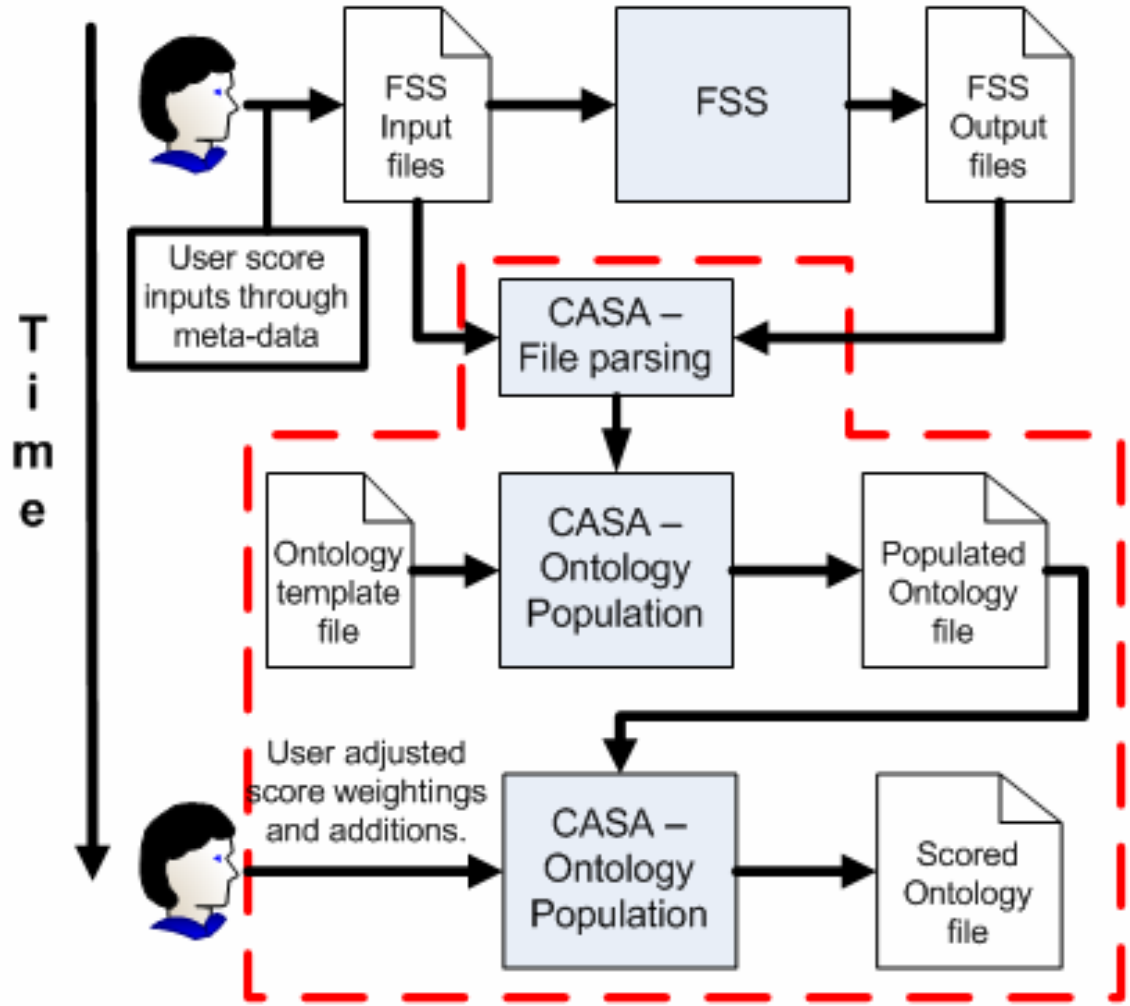
MoM (Measures level 0)	MoE (Measures level 1)	Contribution toward MoM (%)	Results	MoM Value
Timeliness	Mission Takeoff Effectiveness	20%	100%	100%
	Mission Time Over Target Effectiveness	60%	100%	
	Mission Landing Effectiveness	20%	99%	
Mission Efficiency	Mission expended planned munitions or less	50%	100%	113%
	Mission expended planned fuel or less	30%	100%	
	Mission expended planned expendable (Flares, Chaff) or less	20%	163%	
Cost	Cost of expended munitions	15%	100%	51%
	Cost of expended fuel	5%	100%	
	Cost of expended expendables	5%	163%	
	Cost of repair and replacement	75%	30%	
Mission Effectiveness	BLUE action versus targeted RED military assets effectiveness	10%	98%	98%
	BLUE action versus non-targeted RED military assets effectiveness	3%	98%	
	BLUE action versus targeted RED CTA effectiveness	10%	98%	
	BLUE action versus non-targeted RED CTA effectiveness	3%	98%	
	BLUE action versus non-targeted RED CNTA effectiveness	6%	98%	
	BLUE action versus non-targeted NEUTRAL military assets effectiveness	0%	98%	
	BLUE action versus non-targeted NEUTRAL CTA effectiveness	2%	98%	
	BLUE action versus non-targeted NEUTRAL CNTA effectiveness	6%	98%	
	BLUE action versus non-targeted BLUE military assets effectiveness	5%	98%	
	BLUE action versus non-targeted BLUE CTA effectiveness	1%	98%	
	BLUE action versus non-targeted BLUE CNTA effectiveness	6%	98%	
	RED reaction versus targeted BLUE military effectiveness	10%	98%	
	RED reaction versus non-targeted BLUE military effectiveness	2%	98%	
	RED reaction versus targeted BLUE CTA effectiveness	5%	98%	
	RED reaction versus non-targeted BLUE CTA effectiveness	2%	98%	
	RED reaction versus targeted BLUE CNTA effectiveness	5%	98%	
	RED reaction versus non-targeted BLUE CNTA effectiveness	3%	98%	
	RED reaction versus targeted NEUTRAL military assets effectiveness	0%	98%	

Measures level 2 (MoP)	Measurements and Calculated Values	Contribution toward MoP (%)	Results
Performance of Effect resulting from (BLUE action) versus (targeted RED military assets)	For "Effect": = (Desired level of "Effect" / (Actual level of "Effect")	100%	96%
Performance of Effect Duration resulting from (BLUE action) versus (targeted RED military assets)	For "Effect": = (Desired duration of "Effect" / (Actual duration of "Effect")	100%	102%
Performance of Effect resulting from (BLUE action) versus (non-targeted RED military assets)	For "Effect": = (Desired level of "Effect" / (Actual level of "Effect")	100%	96%
Performance of Effect Duration resulting from (BLUE action) versus (non-targeted RED military assets)	For "Effect": = (Desired duration of "Effect" / (Actual duration of "Effect")	100%	102%
Performance of Effect resulting from (BLUE action) versus (targeted RED CTA)	For "Effect": = (Desired level of "Effect" / (Actual level of "Effect")	100%	96%
Performance of Effect Duration resulting from (BLUE action) versus (targeted RED CTA)	For "Effect": = (Desired duration of "Effect" / (Actual duration of "Effect")	100%	102%
Performance of Effect resulting from (BLUE action) versus (non-targeted RED CTA)	For "Effect": = (Desired level of "Effect" / (Actual level of "Effect")	100%	96%

Scoring Approach

- Considerations in the approach chosen
  - Scoring must be able to produce scores for disparate COAs so they can be compared
    - Could stop a factory by dropping bombs on it or by dropping pamphlets to dissuade workforce
  - Tried to draw heavily from current practice
    - Not throw-away valuable lessons learned and refinement developed through years of practice
    - Give implemented solution increased familiarity with practitioners

Prototype Solution



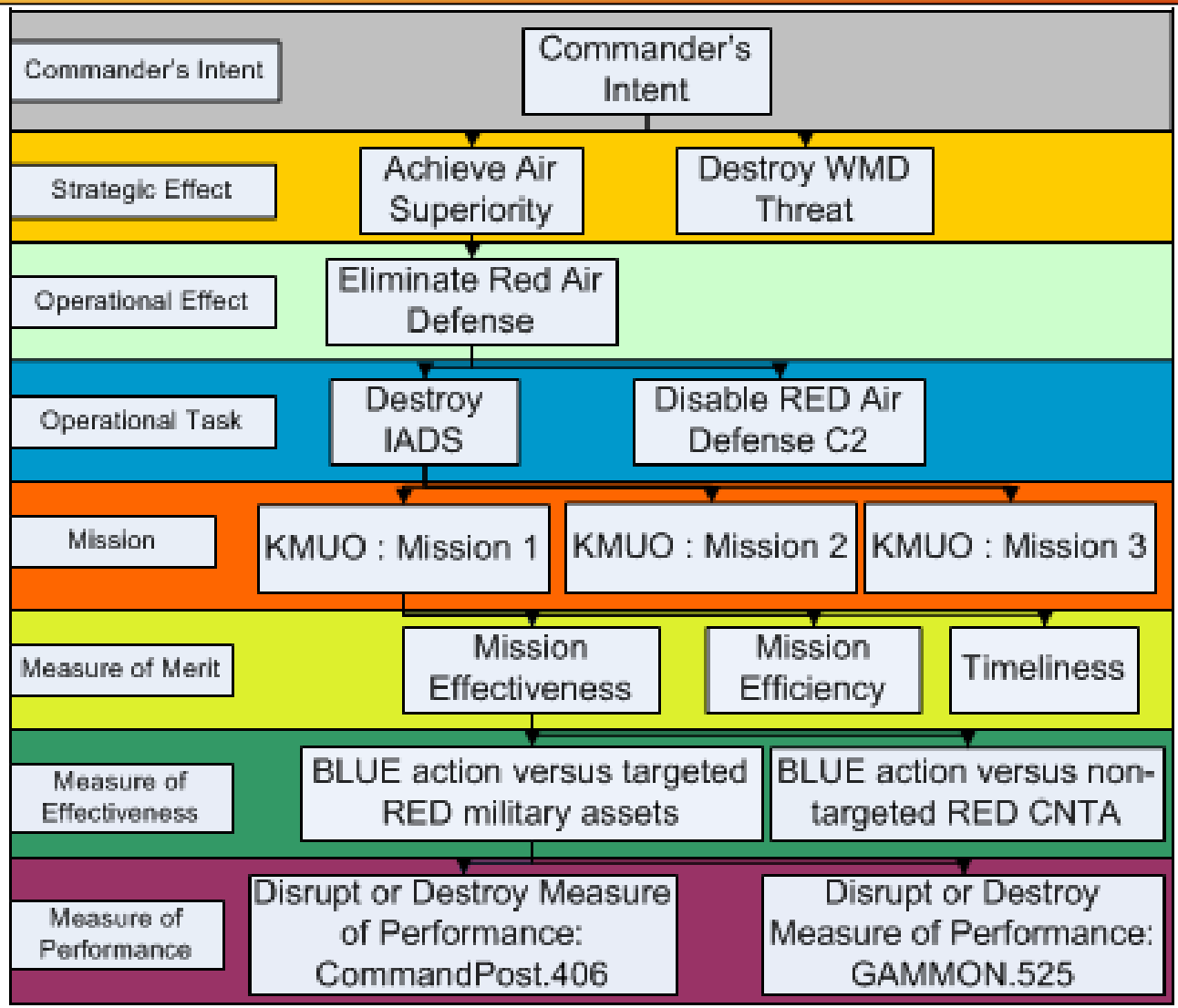
Ontology & Protégé

- Why use an ontology?
  - Provided an easy to use interface that was ideal for rapid prototyping
  - The protégé tool allowed for a basic front-end with input and display capability to be developed for “free”
  - Allowed us to focus on scoring rather than worrying about GUI issues
  - Definite disadvantages which we’ll cover later

Metrics Breakdown

- Commander's Intent
- Strategic Effect
- Operational Effect
- Operational Task
- Mission
- Measure of Merit: Efficiency; Effectiveness Timeliness
- Measure of Effectiveness: Groups MOPs
- Measure of Performance: Maps to data

Scoring Breakdown Review



Scoring MOPs

- After the breakdown has been completed the first step in scoring is to score the MOPs
  - Each MOP will be scored from 0.0 - 1.0
  - A MOP's score is based on how well its actual value achieved the desired value
  - MOPs are populated with data from the sim
  - The desired values come from either meta-data, user-entered values from the GUI or defaults

MOP Example

- We have a mission to bomb a command post
  - A MOP will be generated to score how well we achieved the bombing of the command post
  - We specify in the meta-data that we want to do between 80-100% damage to the target
  - We read from the simulation that we actually did 75% damage

MOP Example (Cont.)

- Known values
  - Desired: 80-100%; Actual: 75%
- Score function
  - First calculate the desired range: 20
  - If actual value is within the desired range a score of 1.0 is generated
  - If outside of desired range, the score is: 1-(amount outside of range / desired range)
    - 1-((80-75)/20) == 1-(5/20) == .75

MOP Example (Cont.)

- Desired: 70-100%; Actual: 70%
  - Actual is in range so score is 1.0
- Desired: 70-100%; Actual: 65%
  - 1-((70-65)/(100-70)) == .83
  - Notice that this score is higher than the first example due to the larger range
  - The range of desired values affects the tolerance of the score calculation
    - This was done to minimize data entry and complexity
    - Couples two independent pieces of data into one
    - This would ideally be user definable in a full system

Score Roll-up

- Once all MOPs are scored, the higher-level scores can be calculated
- Every score-able measure is comprised of a weight and a value
- The score of a higher-level measure is the weighted average total of its constituent measures

Score Roll-up Example

- The mission to bomb the command post has three measures of merit
  - Efficiency MOM: value = .973; weight = .05
  - Effectiveness MOM: value = .793; weight = .7
  - Timeliness MOM: value = .625; weight = .25
  - Value of mission = (.973*.05) + (.793*.7) + (.625*.25) = .76
  - If the weights specified do not sum to 1 they are normalized such that they do sum to 1

Influences

- Mechanism to adjust score outside of the straight roll-up
- Influences provide a means to ensure actions that you wanted to happen did occur and to bias the score accordingly (and vice versa)
- They operate as a multiplier on a specific measure in the score breakdown that is applied contingent upon certain conditions being met

Influences (Cont.)

- If you had an operational task whose goal was to disable a certain center of gravity (communications), you could add an influence to ensure that goal was met
  - Missions could all score well but still leave communications intact
  - Without an influence the operational task would score well even though its true goal was unmet
  - With an influence the conditions would fire and the multiplier could bias the score accordingly

Influences (Cont.)

- Only applied if their conditions are met
  - Currently implemented as a series predefined states on specified assets
  - All conditions specified must be true for the influence to fire (“AND” logic)
  - “OR”s can be handled by specifying multiple influences
  - Ideal solution is to provide for Boolean logic on the conditions, but GUI limited implementation

Influences (Cont.)

- Influences operate as a multiplier on the score
  - Commutative
    - Ordering not important if multiple influences are applied
- We considered alternatives to using a multiplier but ran into pit-falls
  - Incrementing or decrementing by specific amounts tended to hide the results of the sub-measures
    - Lead to many cases where score was capped at either 0 or 1

Scoring Assumptions

- One of the driving goals in the prototype solution was to allow for the creation of a reasonable score without specifying every detail in metadata
  - This was achieved through assumptions
    - e.g. destroying civilian non-targetable assets is bad; destroying opposing military targets is good
  - Tried to minimize the number of assumptions while still giving a reasonable score

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Commander's Preference

- CASA's basic scoring reflects a COA's "goodness" from a balanced, "typical" viewpoint
- Using a preferences template allows command staff to remove COAs that a Commander will likely reject
- COA results viewed from Aggressive and Conservative viewpoints would likely differ due to personal preferences and style

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Bayesian Network

- Analyzed a Bayesian network approach to scoring as an alternative
- Utilized Netica software from Norsys for the network modeling
- Developed a simple subset of a COA for comparison

Bayesian vs. Ontology

- Pros
  - Easy to see big picture for small data-sets
  - Flexibility to customize scoring using equations
- Cons
  - Even medium sized data-sets become unwieldy
    - No hierarchy to facilitate information partitioning
  - Greater difficulty in analyzing the network to find score drivers
  - Data as compared to information

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Demo Approach

- Demo starts with escalating tensions and ends when Red yields or launches WMD
- Blue OOB varies between 3 COAs
  - Restrain - stresses EBO cascading effects
  - Pinion - provides balanced approach using incremental kinetic force to achieve goals
  - Overwhelm - Use high Ops tempo and heavy kinetic force to rapidly neutralize threat
- Red OOB remains constant, but reactions to Blue COAs provide variability

Blue COAs

- Vignette 1 Series: Operation Restrain (8 days)
  - Focus on EBO effects: minimize kinetic force
    - Monitor traffic with ISR and jam C2 at employment sites
    - Reduce traffic: Strike POL COG: Transport vehicles
      - POL needed to support MIL/civilian travel and power; travel will be constrained with very limited civilian traffic
      - Simplify identifying and interdicting military traffic, especially WMD movement
    - Reduce traffic: Strike Transportation COG
      - Create bottlenecks and delays; reduce/eliminate WMD Production->Storage transport; reduce/eliminate WMD Production/Storage->employment sites
      - Give civilians a reason to stay home / off roads – increase absenteeism from WMD facilities
      - Simplify identifying and interdicting military traffic, especially WMD movement
    - Standoff jamming of likely trusted sites
      - Premise SIGINT from ground based networks is available; we will receive all C2 and can decode
    - Use EC-130E to constrain information to populace and create pressure on Leadership
    - Pamphlets telling workers to stay away and also Radio and TV broadcasts
    - Precision strikes at WMD factory access points to limit ability to deploy and strengthen message to populace, as deemed needed
  - If deployment of WMD detected in route to employment sites, then DEAD as necessary and interdict sites, transport, trusted troops

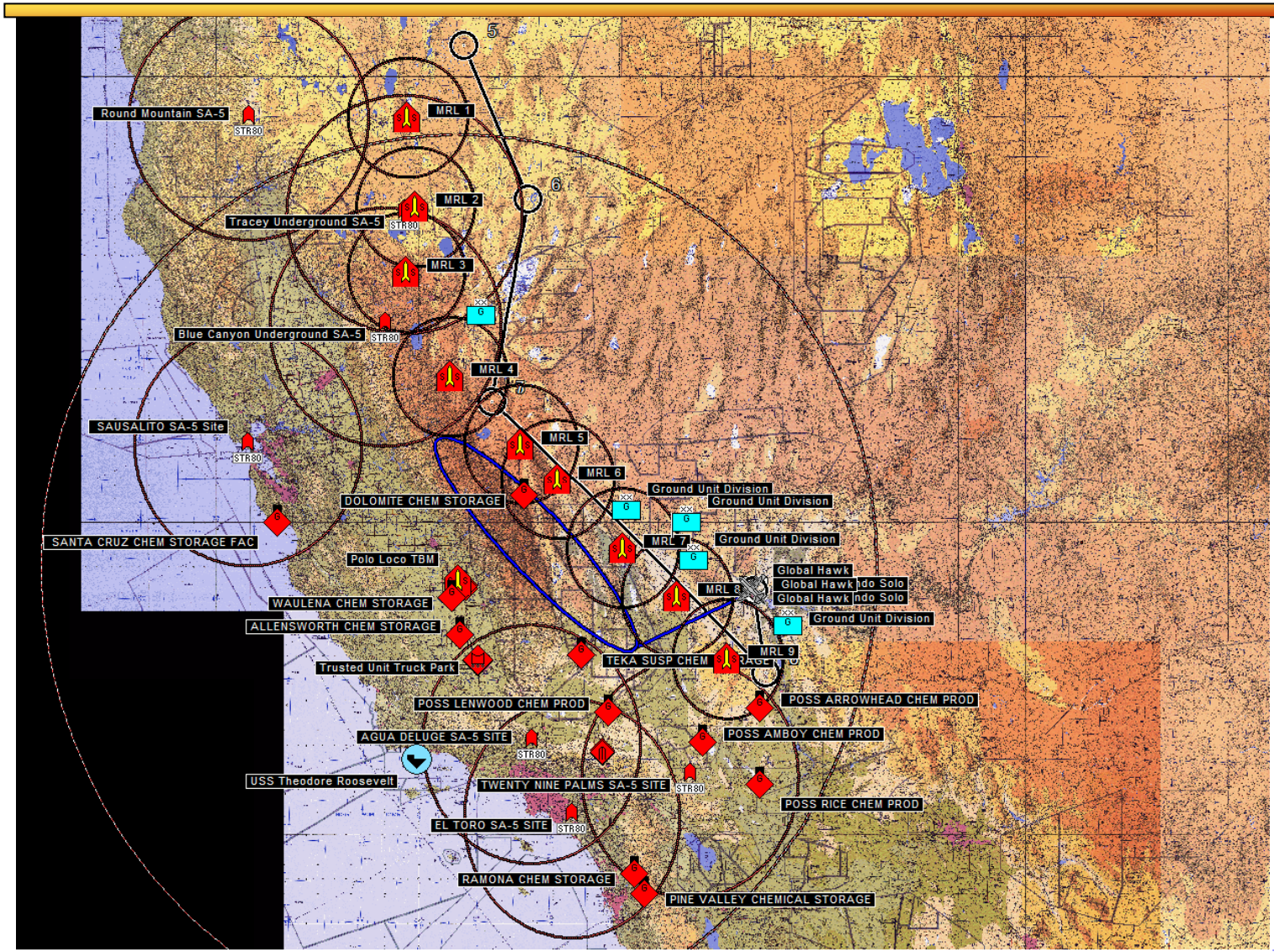
Blue COAs

- Vignette 2 Series: Operation Pinion (4 days)
  - Gain / Maintain Air Superiority; DEAD
  - Inform Leadership of timetable before further actions will be taken
  - Use EC-130E to constrain to inform populace that WMD facilities are at risk for targeting
  - Use ISR to monitor WMD production and storage facilities, and known/likely MRL and TBM sites
  - Deny WMD deployment and employment
    - If WMD movement detected in route to/from facilities or trusted units, interdict shipments in transit and their intended employment site
  - Disrupt, disable & destroy WMD Infrastructure until Red yields
    - Precision Strike power, access to WMD facilities, and WMD Transport
    - Use standoff jamming to eliminate RF C2
    - Steadily disable/destroy WMD infrastructure (in order)
      - Communication relays
      - WMD deployment capabilities
      - WMD employment capabilities
      - WMD storage
      - WMD production

Blue COAs

- Vignette 3 Series: Operation Overwhelm (24-36 Hours)
  - Disable/Destroy C2 and Power COG
  - Gain and Maintain Air Superiority; DEAD
  - Disable/Destroy military transport / deployment capabilities
    - Transportation COG
  - Disable/Destroy WMD employment capabilities
    - Trusted MRL Units
    - Trusted TBM Units
  - Disable/Destroy WMD deployment capabilities
    - WMD transportation vehicles
  - Disable/Destroy WMD infrastructure
    - Destroy WMD Storage facilities
    - Destroy WMD Production facilities

General Force Laydown



Year 3 COA Results

	Conservative	Typical	Aggressive
Overwhelm	0.88735867	0.8983078	0.8766911
Pinion	0.86579984	0.8911031	0.8708272
Restrain	0.78576326	0.9665829	0.8980264

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Lessons Learned

- The Ontology approach (and specifically Protégé) was ideal for rapid prototyping, but too limited for a fully developed system
  - Lack of control over information display results in a cluttered and hard to navigate GUI
  - Protégé API not suited to handling large amounts of data present in evaluating COAs
- Bayesian Network scoring provides for a flexible but complex approach
  - Works well for small networks
  - Too complicated to easily represent large amounts of data

Lessons Learned (Cont.)

- Assumptions made for “typical” cases are needed for simplification, but must be used judiciously
- Developing the score is only half the battle
  - Must also be able to present information in a way that facilitates analysis and COA refinement
- Need to collect as much data as possible to open up scoring possibilities and facilitate analysis

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Future Enhancements

- Create custom front end
  - Divorce data storage from information presentation to allow for display of more relevant information
  - Allow for development of custom tools to facilitate data entry and analysis
- Move to relational database backend
  - Speed up searches and data access
  - Faster results will enable screening of many COAs (Selection of auto-generated COAs)

Future Enhancements (Cont.)

- Expose scoring assumptions to user
  - Allows power-users to have more control over the system
  - Basic tenets that are true for blue-force COA scores could be reversed to model asymmetrical warfare
  - Allow for (some) expansion of the scoring logic without need for program modification

Future Enhancements (Cont.)

- Score the same COA multiple times with different seeds to the simulation
  - Provide a means to automatically score and report statistics on a series of runs
  - Provides a sense of robustness about the COA
  - Avoids rejecting or accepting a COA due to extraordinary results produced by one simulation run

Future Enhancements (Cont.)

- Collection of additional data points for scoring
  - Munitions and fuel expended could be accounted for in the scoring of the COA
  - Collateral damage and disruption of civilian services could be collected and scored as the simulation environment expands in detail

Conclusions

- The CASA effort succeeded in producing a methodology and prototype toolset for scoring disparate COAs
- The current approach provides significant capabilities for operator control of the scoring process at all contexts and levels
  - Templates used to reduce data input burden to operators
  - Some assumptions/calculations cannot be user controlled due to Protégé limitations

Conclusions (Cont.)

- Tailoring of scoring process to particular Commander style preferences was accomplished
  - Currently only Aggressive, Typical, and Conservative available, but any number can readily be implemented and made available
- Other scoring approaches researched, with special attention to Bayesian networks
  - Current approach is more straightforward to use and has a better human interface

Open Discussion

Backup Slides

Red Commander's Intent

- Purpose
  - Expand influence and control within the region; gain concessions from neighboring countries
- Problem Statement
  - Orangeland (OL) has lost significant land holdings to neighboring nations in the (distant) past; current regime blames foreign interference at border areas as the cause of these losses.
  - Foreign powers continue to meddle in the autonomy of OL and its rightful claim to stolen border areas. Chief of these is the US, who threatens to deploy military forces into the region to support its allies.
  - US is becoming increasingly hostile and making unreasonable demands of OL, including arrogantly demanding that OL disarm all WMD and relinquish this powerful capability to protect itself and its allies.
  - US is claiming that failure to resume disarmament talks will result in US actions against OL.

Red Commander's Intent (Cont.)

- Method
  - Maintain WMD production
  - Prepare for WMD deployment to trusted units
    - Primary deployment is from storage facilities
    - Backup deployment is directly from production facilities
  - Deployment schedule
    - Begin deployment to all trusted units D+0
    - Supply all trusted sites concurrently making preemption impossible
    - Make incremental shipments to all sites rather than completing any subset of sites
    - Continue deployment until all sites are at maximum
  - Maintain vigilance wrt strikes against WMD capabilities
    - Immediate deployment if 50% of WMD storage destroyed
    - Employment by trusted units as ordered

Red Commander's Intent (Cont.)

- Method (Cont.)
  - While US is in theater
    - Minimize use of offensive kinetic force
    - Maximize use of defensive kinetic force using SAMs to defend and control OL airspace.
  - Order WMD employment immediately if
    - Unable to defend RED homeland from BLUE air power (US gains Air Superiority)
    - WMD infrastructure is 80% destroyed (Use-or-loose)
    - Multiple trusted WMD employment sites are attacked (Use-or-loose)
  - Acceptable Risks
    - War with US and its allies
    - Moderate collateral damage against OL civilians
  - Exit Criteria
    - US driven from theater
    - Reclaim lost OL border areas and other concessions

RED Order of Battle

- Continue escalation of threats but avoid open military confrontation with neighboring nations until US exits theater
- Continue stockpiling of WMD
- Deploy WMD to trusted sites
  - Trusted sites are all forward deployed to avoid fratricide issues
  - MRL trusted sites deployed with strike capabilities of 40 Km across borders
  - TBM sites with strike capabilities 300 Km across borders
- Do not employ WMD unless absolutely necessary
  - Use defensively against invasion – use against military targets only
  - Begin border offensive in cases of significant WMD losses (80% of infrastructure) due to preemptive US led actions – use against military targets and urban centers
- Prevent preemptive strikes that threaten to eliminate valuable WMD assets
- Empower field commanders to defend against possible invasion using WMD assets
- Prepare for offensive into border areas once US led coalition is force out of theater

Blue Commander's Intent

- Purpose
  - Create regional stability and reduced threat to US forces in region
- Problem Statement
  - Orangeland's pursuit of WMD delivery capabilities pose a significant threat to regional allies of the US and could be used to deny US forces deployment into the region. The US will not act complacently given the current escalation of danger to its allies and general regional de-stabilization due to Orangeland's development and potential deployment and use of WMD.
  - Orangeland is assuming an increasingly hostile position and is now refusing diplomatic attempts to discuss and negotiate WMD disarmament. This combative behavior must be reversed, with ally and US diplomatic channels empowered to negotiate WMD disarmament from a position of strength.
  - Failure to immediately reestablish diplomatic relations and disarmament talks will result in US actions to disrupt, disable or destroy Orangeland WMD production, WMD transportation to and from storage facilities, and deployment to WMD to MRL, and TBM sites within striking range of ally or US forces.
- Method
  - Minimize destruction of civilian infrastructure to achieve ends
  - Avoid pushing Orangeland into a WMD "use-or-lose" standing
  - Prevent WMD deployment and/or employment by any means necessary
- Acceptable Risks
  - Threat to US forces - LOW
  - Collateral damage to civilians in Orangeland - LOW
- Exit Criteria
  - Orangeland's WMD no longer poses a threat to regional states
  - Orangeland WMD disarmament successfully negotiated and verified

Psy-Ops and Jamming Cascading Effects

- None
  - Full workforce at WMD production and storage
- Propaganda and Jamming of commercial media
  - 80% workforce at WMD production and storage
- Propaganda and Jamming of commercial media plus effects to Transportation, Power and POL
  - Subtract additional 10% for Limited disruption to each
  - Subtract additional 10% for complete disruption to each

C2 Cascading Effects

- Limited-thru-full C2 capabilities
  - Periodic WMD deployments from storage to trusted employment sites
  - Employment HOLD unless instructed
    - Employment orders
      - 80% WMD infrastructure neutralized
      - Loss of control of airspace
  - Integrated ADS in operation (higher Pk)
- No C2 capabilities
  - Employment TIGHT
    - Fire only if fired upon
  - Full WMD deployments from storage to trusted employment sites via all available transports (transport orders delivered by courier with time lag)
  - Standalone ADS operation (lower Pk)

POL Cascading Effects

- Full POL delivery
  - Civilian traffic at normal (100%)
    - Casual: 20% ; Commercial:70% ; Emmergency:10%
  - Military traffic at normal (100%)
  - Power production at normal (100%)
- Limited POL delivery
  - Civilian traffic at 40%
  - Military traffic at 80%
  - Power production at 70%
- No POL delivery
  - Civilian traffic stopped except for emergency (10%)
  - Military traffic at 30%
  - Power production at 40% ; emergency production (local, e.g., hospital) at 100%

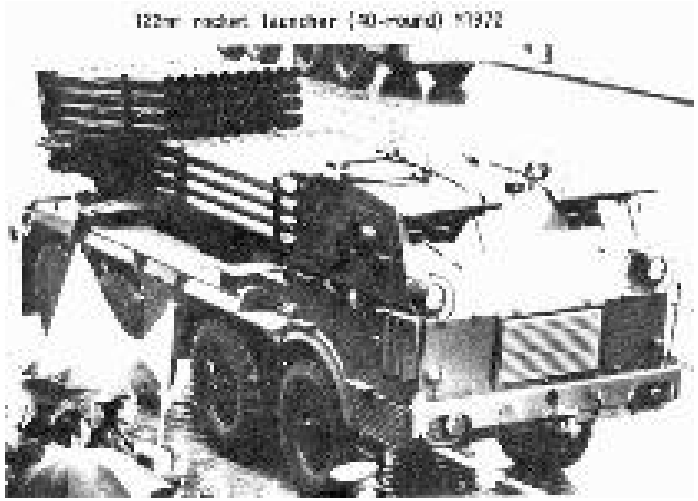
Transportation Cascading Effects

- Full
  - Civilian (includes commercial POL delivery) and military at normal (100%)
- Limited
  - Civilian
    - Casual: 10% ; Commercial: 25% ; emergency: 10%
  - Military
    - Local: 40% ; remote: 10%
  - Power production reduced to 50% normal (rationing)

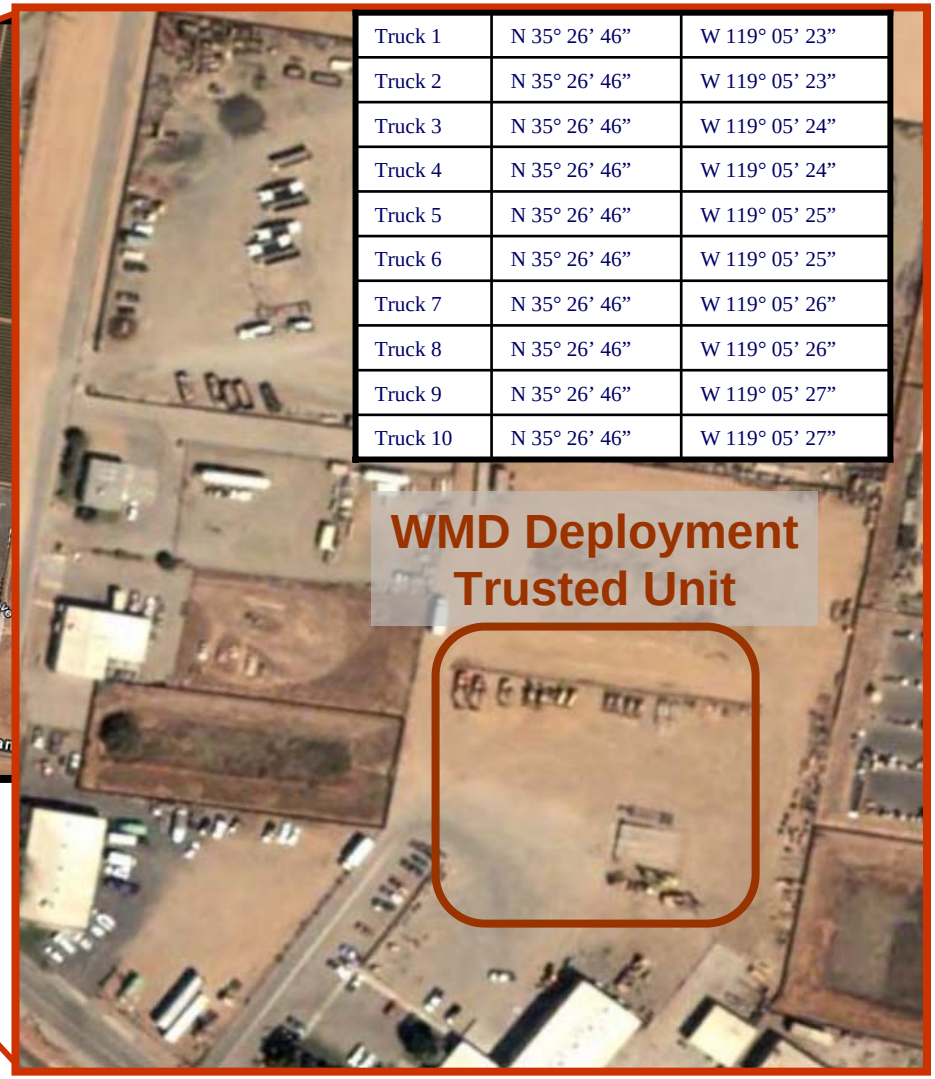
MRL and TBM Assets

MRL 9	N 35° 28’ 10”	W 115° 24’ 17”
MRL 8	N 35° 42’ 53”	W 116° 57’ 37”
MRL 7	N 36° 09’ 57”	W 116° 09’ 17”
MRL 6	N 37° 29’ 21”	W 117° 55’ 32”
MRL 5	N 37° 52’ 59”	W 118° 28’ 05”
MRL 4	N 38° 38’ 37”	W 119° 31’ 05”
MRL 3	N 39° 48’ 44”	W 120° 10’ 15”
MRL 2	N 40° 32’ 40”	W 120° 02’ 09”
MRL 1	N 41° 32’ 43”	W 120° 09’ 02”

TBM Start	N 36° 20’ 06”	W 119° 23’ 50”
TBM Stop	N 36° 22’ 37”	W 119° 23’ 04”



WMD Facilities and Transport Assets



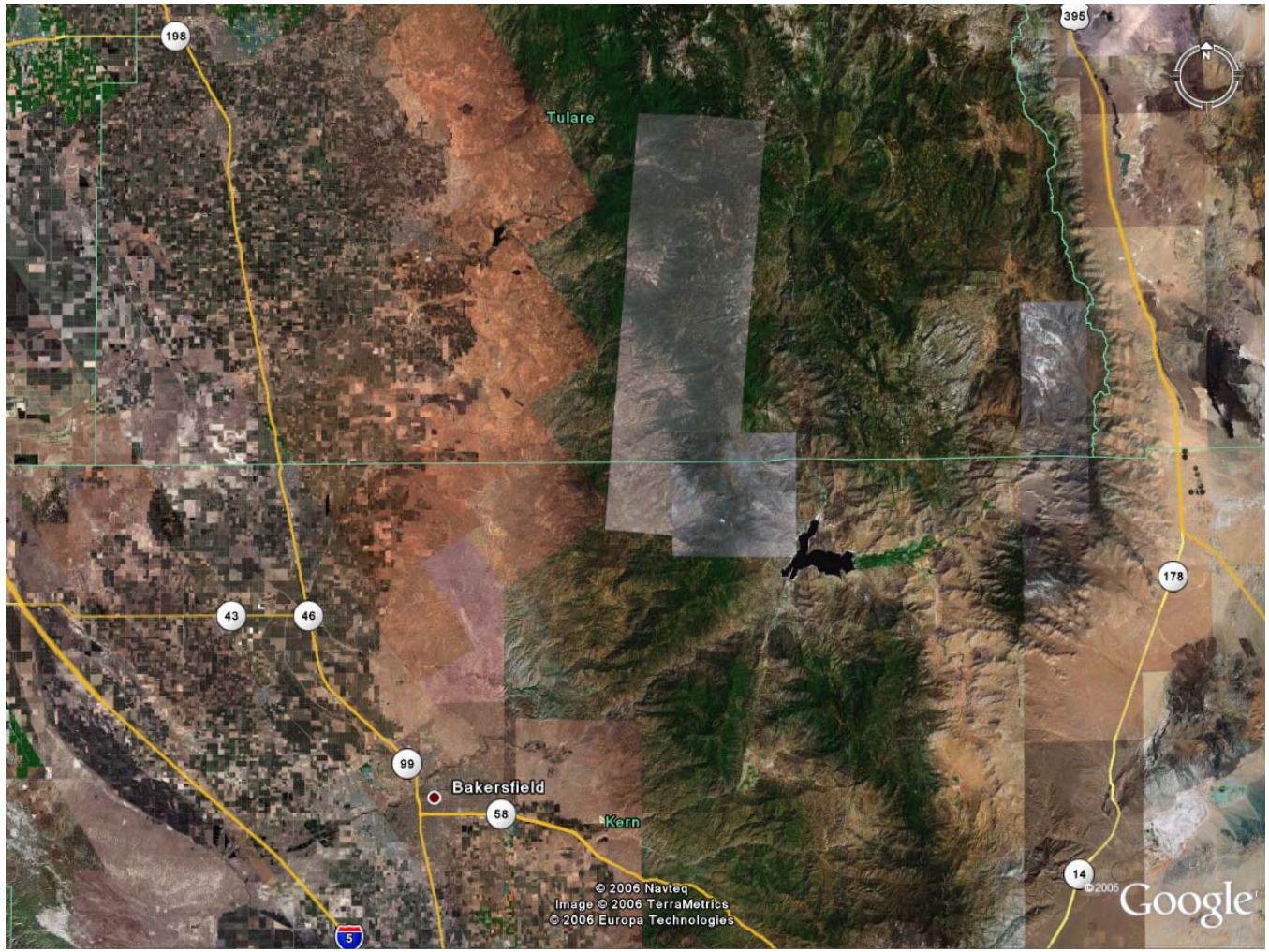
Truck 1	N 35° 26’ 46”	W 119° 05’ 23”
Truck 2	N 35° 26’ 46”	W 119° 05’ 23”
Truck 3	N 35° 26’ 46”	W 119° 05’ 24”
Truck 4	N 35° 26’ 46”	W 119° 05’ 24”
Truck 5	N 35° 26’ 46”	W 119° 05’ 25”
Truck 6	N 35° 26’ 46”	W 119° 05’ 25”
Truck 7	N 35° 26’ 46”	W 119° 05’ 26”
Truck 8	N 35° 26’ 46”	W 119° 05’ 26”
Truck 9	N 35° 26’ 46”	W 119° 05’ 27”
Truck 10	N 35° 26’ 46”	W 119° 05’ 27”

POL Facilities and Transport Assets

POL Production Area (center)	N 33° 46’ 33”	W 118° 17’15”

Truck 1	N 33° 46’ 16”	W 118° 14’ 07”
Truck 2	N 33° 46’ 16”	W 118° 14’ 07”
Truck 3	N 33° 46’ 16”	W 118° 14’ 07”
Truck 4	N 33° 46’ 16”	W 118° 14’ 07”
Truck 5	N 33° 46’ 16”	W 118° 14’ 07”
Truck 6	N 33° 46’ 16”	W 118° 14’ 07”
Truck 7	N 33° 46’ 16”	W 118° 14’ 07”
Truck 8	N 33° 46’ 16”	W 118° 14’ 07”
Truck 9	N 33° 46’ 16”	W 118° 14’ 07”
Truck 10	N 33° 46’ 16”	W 118° 14’ 07”

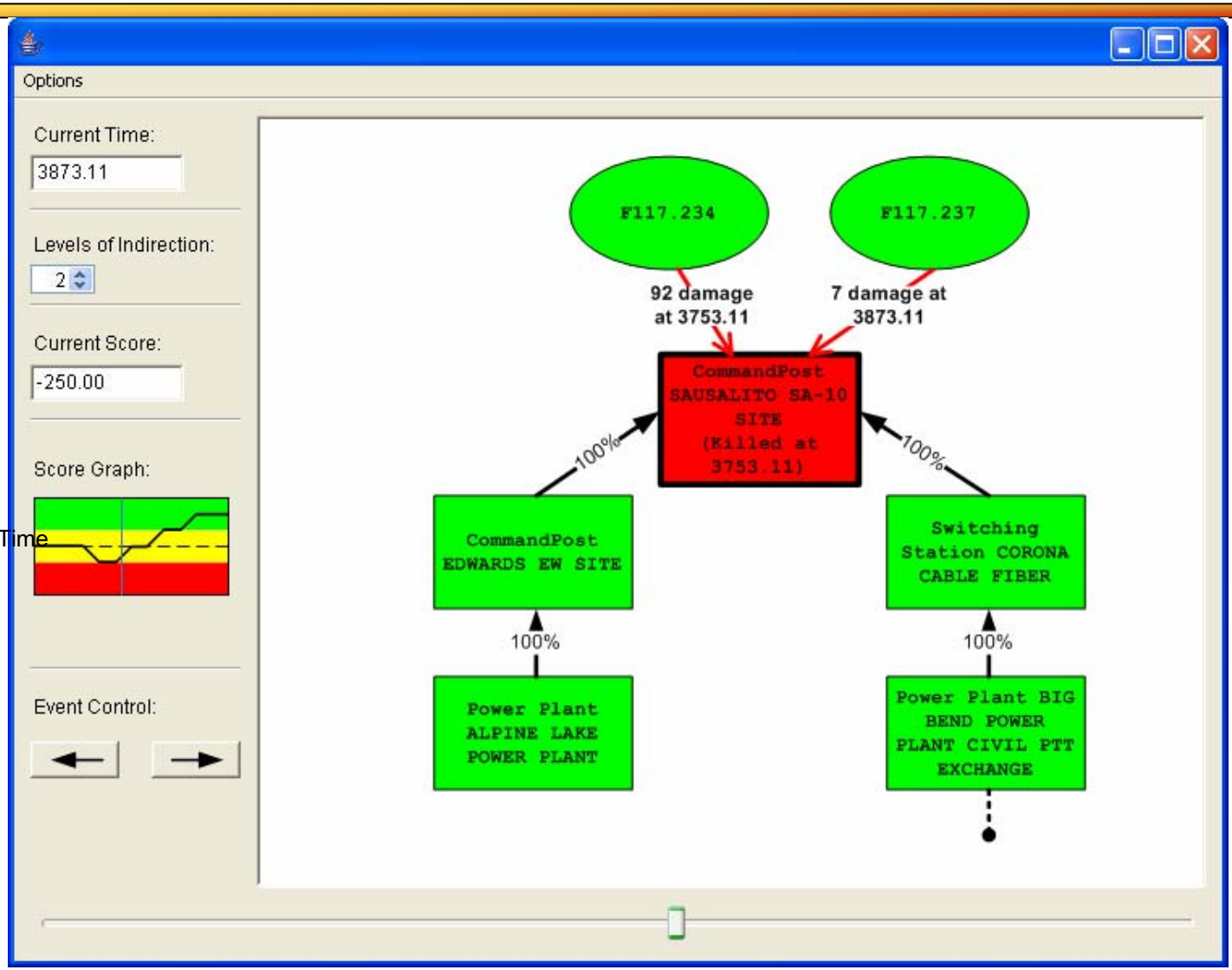
Transportation COG Details



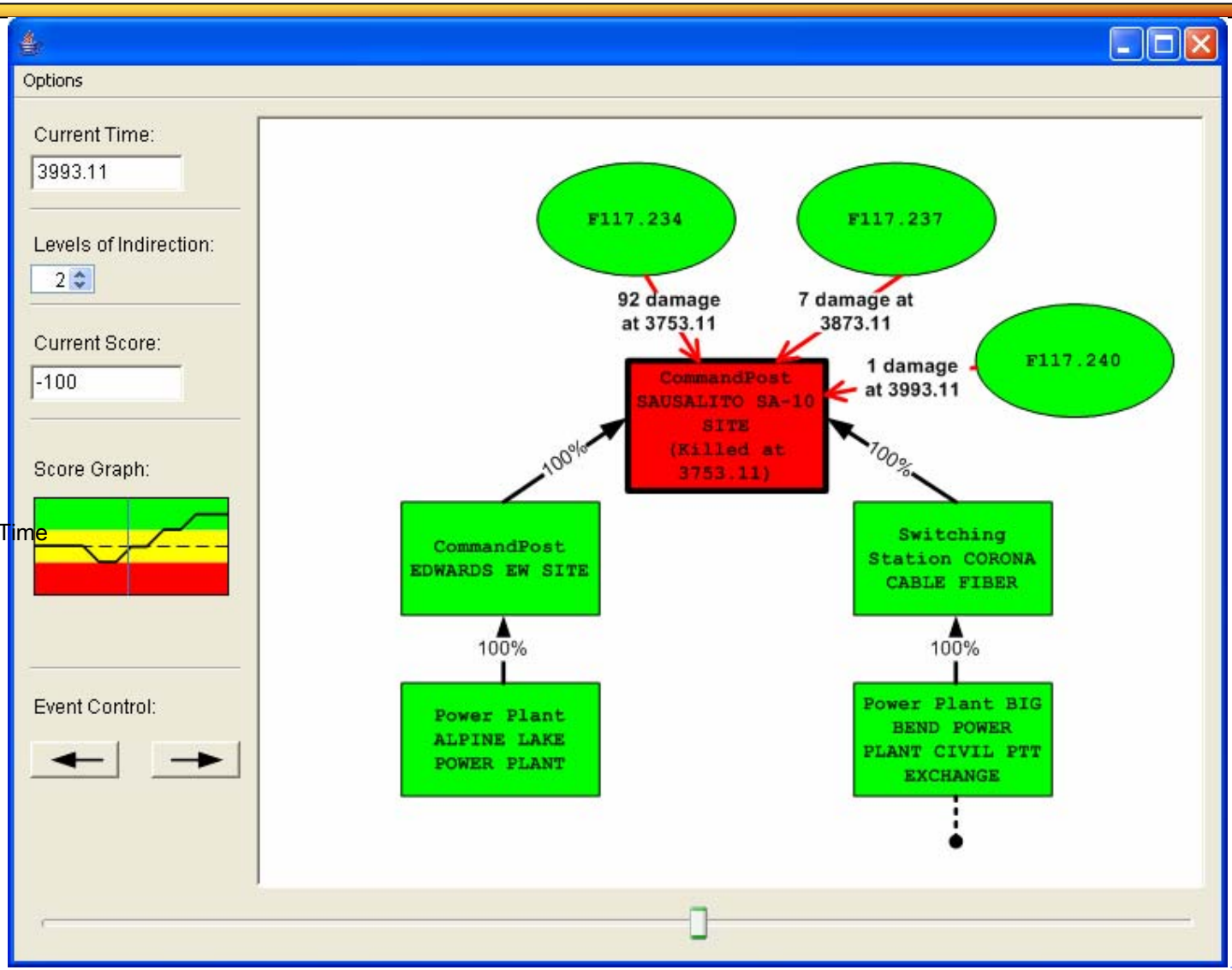
Transportation COG:

- Highway 5
- Highway 99
- Highway 395
- Highway 58

Graphical Analysis Tool



Graphical Analysis Tool



Graphical Analysis Tool