

Experimentation via the Use of an Executable Workflow Model to Evaluate C2 Decision Quality

Paul North
paul.north@jhuapl.edu

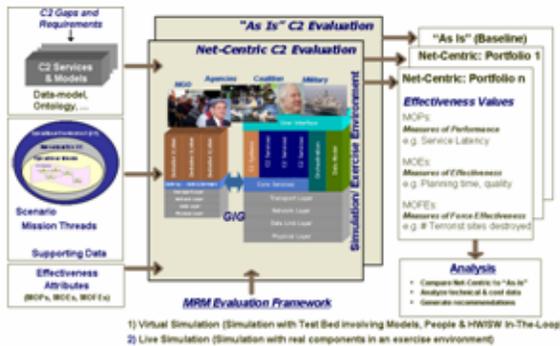
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The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Outline

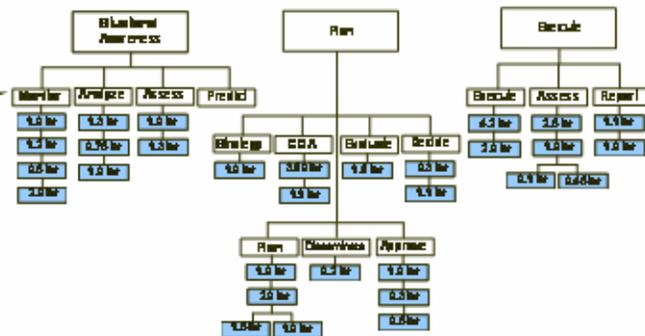
- **Overview**
- **Hypothesis & Scenario**
- **Experimentation Environment**
- **Scenario & Role Players**
- **Experimental Design**
- **Analysis Results**
- **Summary**

Net-centric C2 Evaluation: Key Elements

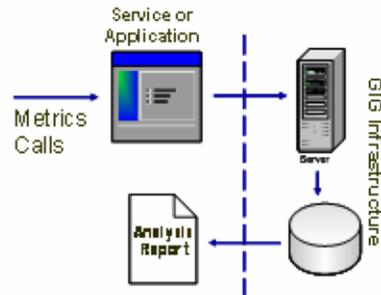
Multi-resolution Modeling Evaluation Framework



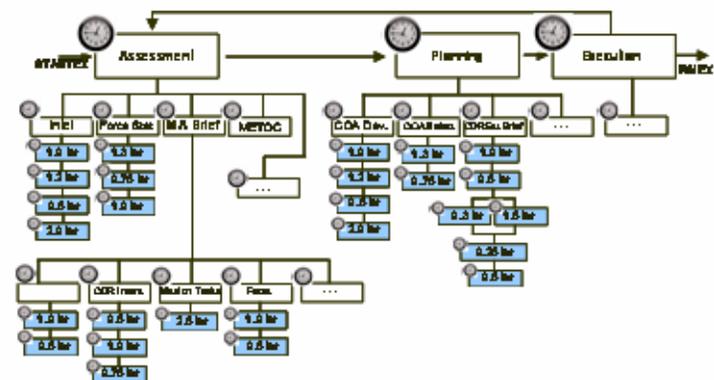
Process Decomposition & Assessment



Automated Data Collection, Analysis, & Reporting



Mission-specific Workflow Evaluation



Hypothesis used for FY07 Experiment

“Decision quality is improved with increased data consistency, data relevancy, data timeliness”

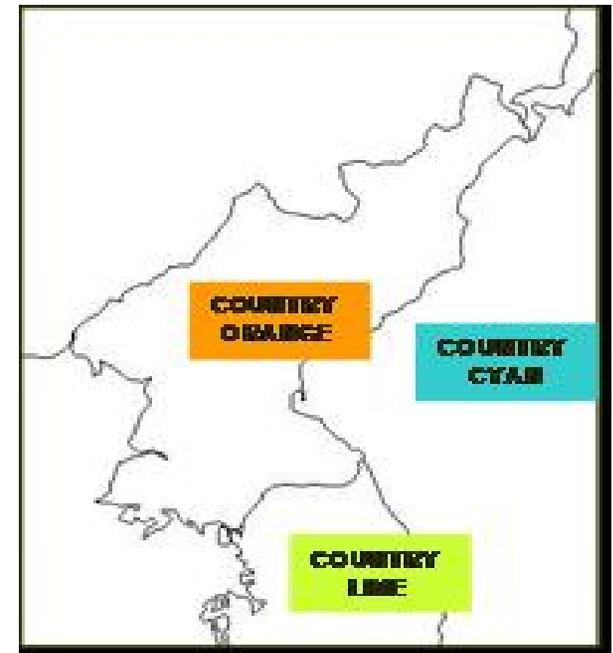
Consistency	Evenness with which data either supports, or does not support, the mission
Relevancy	Significance of the data in making a mission related decision
Timeliness	Whether required information needed to make a decision was received within the first 13 minutes (87%) of a 15 minute experiment

Partial References for Hypothesis Factors:

- **KirzI, J.E., Command and Control Evaluation in the Information Age, Studies, Analysis, and Simulation Symposium on Modeling and Analysis of Command and Control, 1999**
- **Shanteau, J., How Much information Does An Expert Use? Is It Relevant?, Acta Psychologica, 81 (1992) 75-86.**

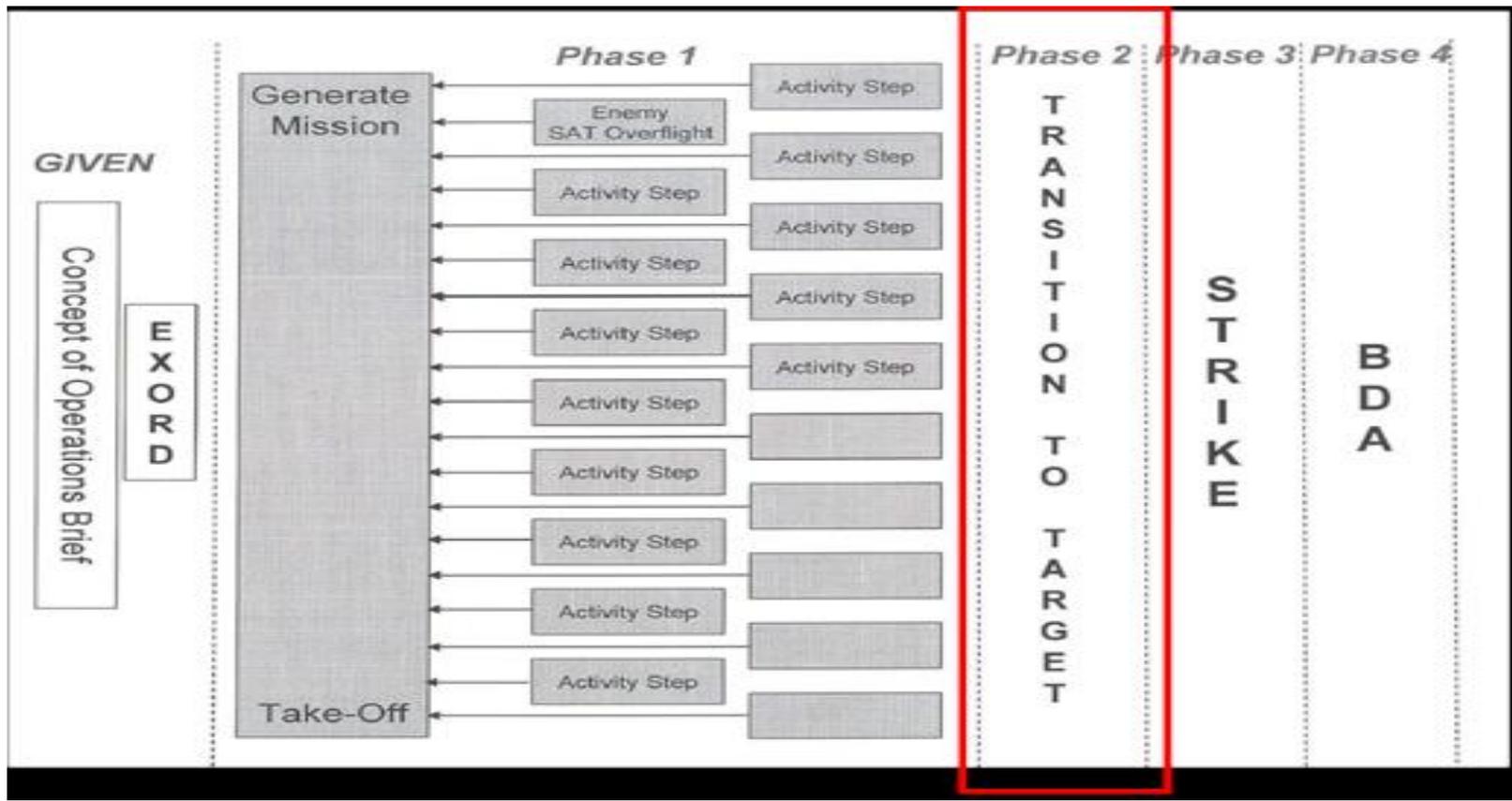
Scenario (1 of 2)

- Regional tensions with Country Orange have increased
- Orange is threatening to launch ICBMs as a show of resolve; recently announced that it will conduct test launches; chemical warheads possible (Sarin)
- True intentions of Orange unknown
- Facility where launches are likely to occur is capable of supporting short, medium and intercontinental missile launches

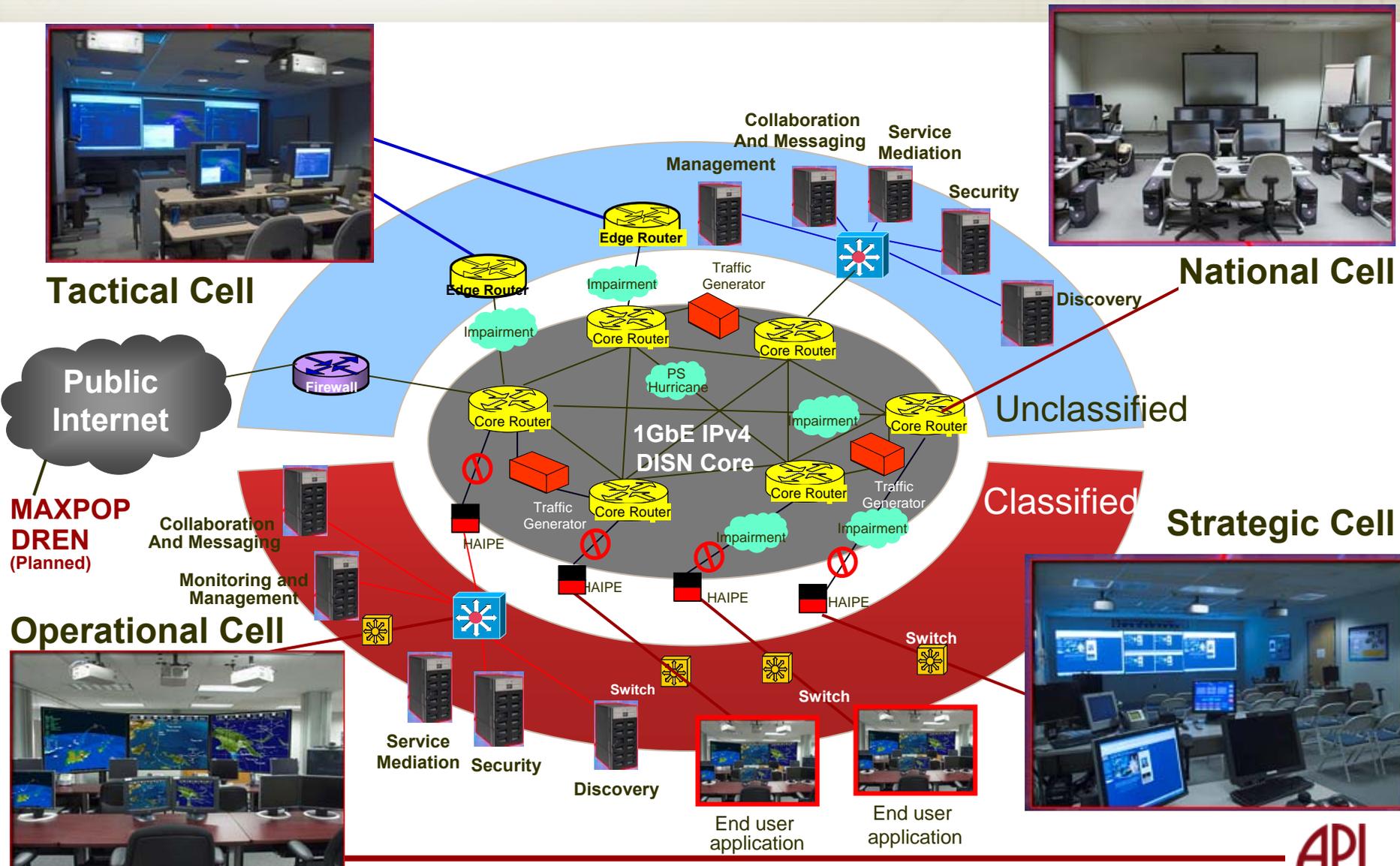


Scenario (2 of 2)

Deterrence options (e.g., non-kinetic, diplomatic) have been unsuccessful to date. Phase 2 of Global Strike Execution (Transition to Target) has been initiated; *Tomahawks are launched and loitering*

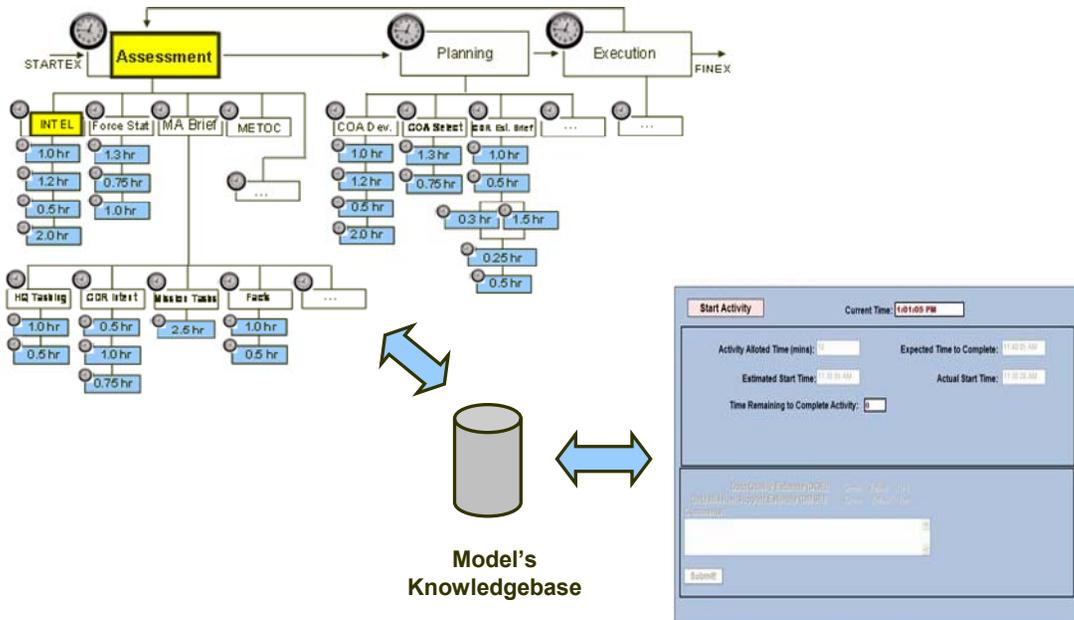


APL GIG Test Bed



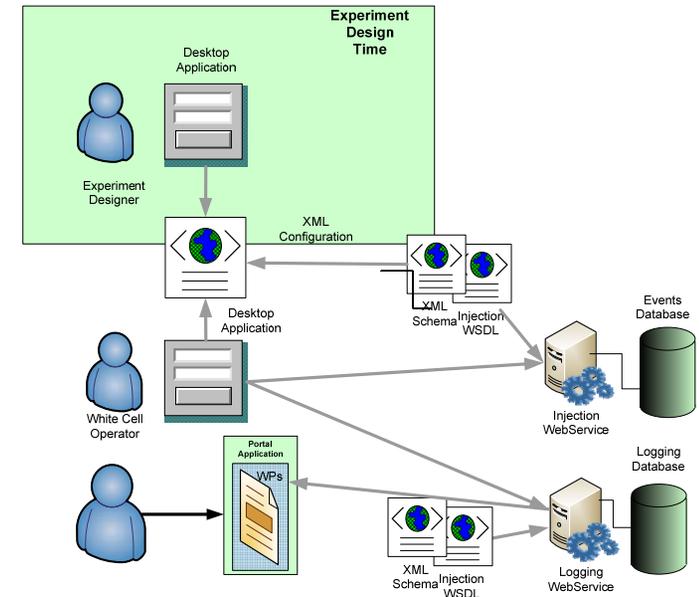
Experiment Tool Set (2 of 2)

Workflow Model/GOC-CE Interface



Tracks and displays, via GOC-CE, mission status, decisions on Mission Support & Data Quality

MSEL Injector Tool



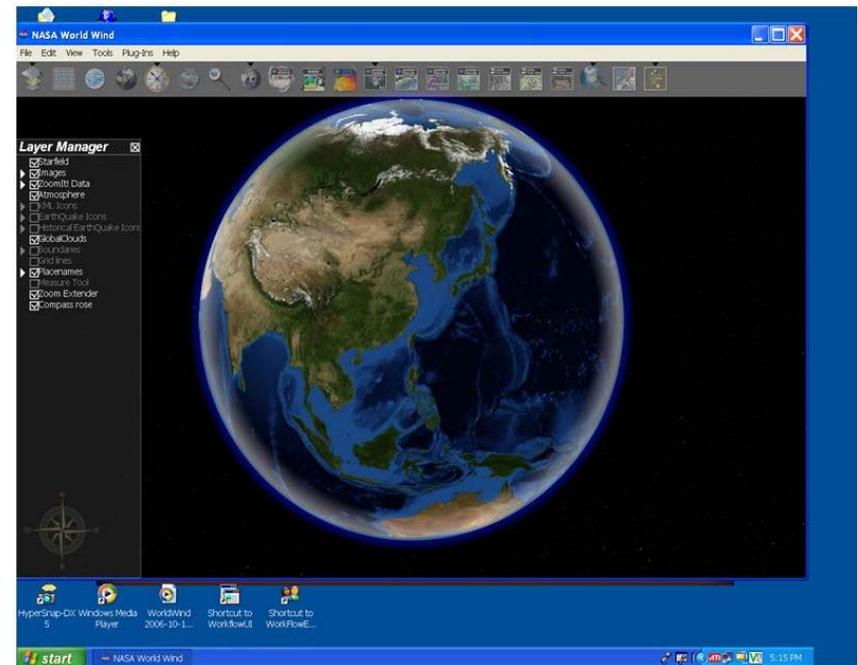
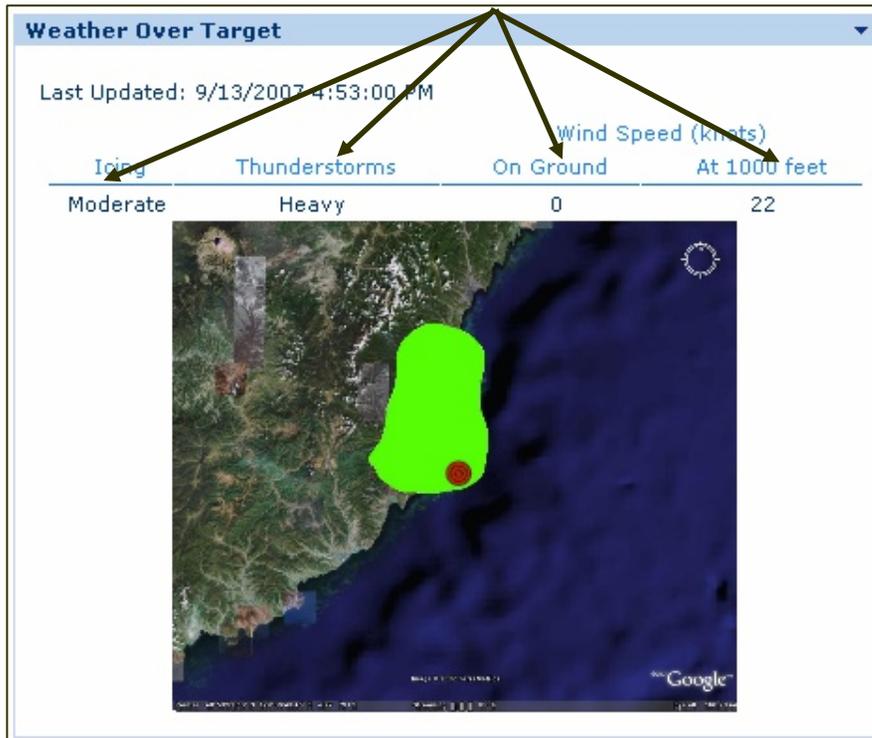
Injects scenario events into GOC-CE for each war fighter role player

Data Providers for This Experiment

Weather & Air Track Services

METOC service provided icing, thunderstorms, and wind speeds at target data

Cooperative Engagement Capability (CEC) Air Track service provided red and blue force air tracks in CollabSpace environment



Roles

Participants

- **METOC (weather)**
- **Blue Force Tracking (BFT)**
- **Target Status**
- **Strike Asset Status**
- **Support Asset Status**
- **BDA Status (Battle Damage Assessment)**
- ***Joint Task Force Commander***

Responsibility of each role is to evaluate **data quality** and **mission support status** throughout scenario execution, based on scenario data, defined mission parameters, and established Tactics, Techniques and Procedures (TTPs)

Event Control: Basis for role player stimulus

- Scenario is decomposed into a set of **time-ordered events**, i.e. a Master Scenario Event List (MSEL)
- For each experiment, a set of events is created for each role based on an **experimental design**
- The experimental design causes the data provided to a role player to vary based on degree of **consistency, relevancy, and timeliness**
- Events are injected into the experimental environment via an **automated MSEL Injector** application
- Events are exposed to the role players via a role player-specific web page in a **portal-based, collaborative environment** referred to as the Global Operations Center Collaborative Environment (GOC-CE)

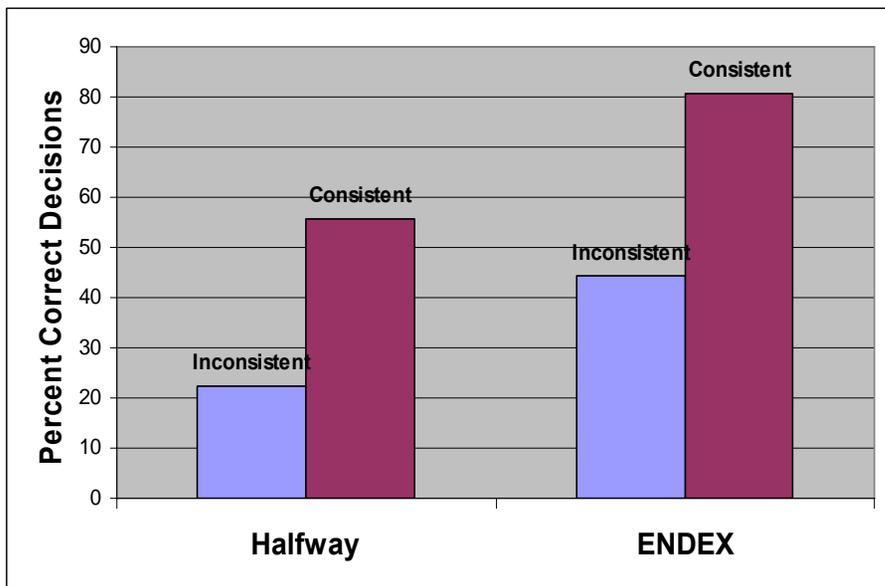
Experimental Design Description

- The experiment was based on a **4x6 factorial design** involving 12 experimental runs
- Each run consisted of 6 data points (one for each functional area) for both
 - Data Quality Estimate (DQE)
 - Data Mission Support Estimate (DMSE)
- 12 runs with 6 data points each yielded **72 independent observations**
- Each of the 12 runs was conducted over a 15-minute time period
- Event data with **controlled degrees of completeness, consistency, timeliness, and relevancy** were created to support each of the 72 observational runs
- **Answers** regarding the “Green, Yellow, or Red” status of Data Quality and Data Mission Support were designed into the MSEL injects and therefore, were **known in advance** for each of the 72 observational runs

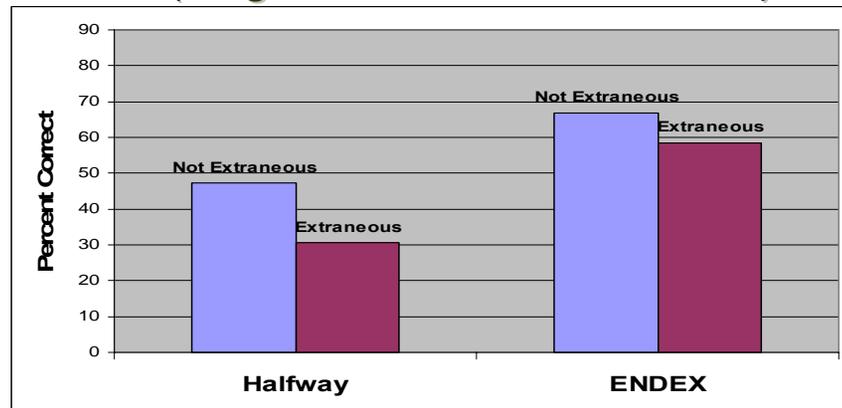
Analysis Results

Decision Quality – Mission Support Decision

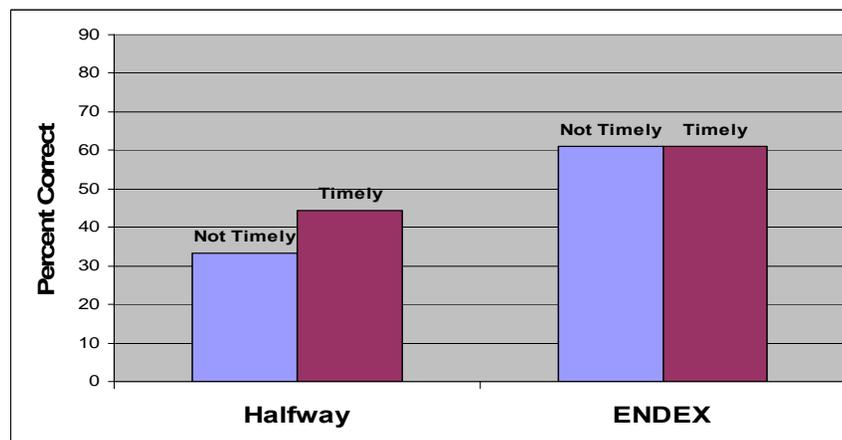
Data Consistency



Data Relevancy (Degree of Extraneous Data)



Data Timeliness



- Mission Support decisions significantly better with consistent data (confidence >98%)
- Neither Data Timeliness nor Data Relevancy had significant effect

Analysis Results

Human Factors (in situ observations and surveys)

Response	Significant Factors	Probability Value	Explanation
Mental Demand	Consistency	0.991	Mental Demand increased significantly with inconsistent data
Physical Demand	None	N/A	Physical Demand didn't differ significantly over factor levels
Temporal Demand	Consistency	0.981	Significantly higher time stress with inconsistent data
Performance	None	N/A	Participants' perceived performance same across all factor levels
Frustration Level	Time, Cons*Time	0.959 0.937	Participants significantly more frustrated with untimely data and when data is both untimely and inconsistent
Situational Understanding	None	N/A	Quantity of data understood didn't differ significantly over factor levels
Situational Understanding - Evaluation	None	N/A	Ability to evaluate data didn't differ significantly over factor levels

Summary

- **Successfully validated our experimentation framework**
- **Demonstrated the value of an executable workflow model by visualizing workflow and performing automated data capture**
- **Experimentation infrastructure worked as expected and will be used to support more comprehensive C2 experimentation in FY08 and beyond**
- **Successfully tested our hypothesis and demonstrated that independent variables such as data consistency can have a significant effect on decision quality**