Experimental Evaluation of Advanced Automated Geospatial Tools

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Thank You!

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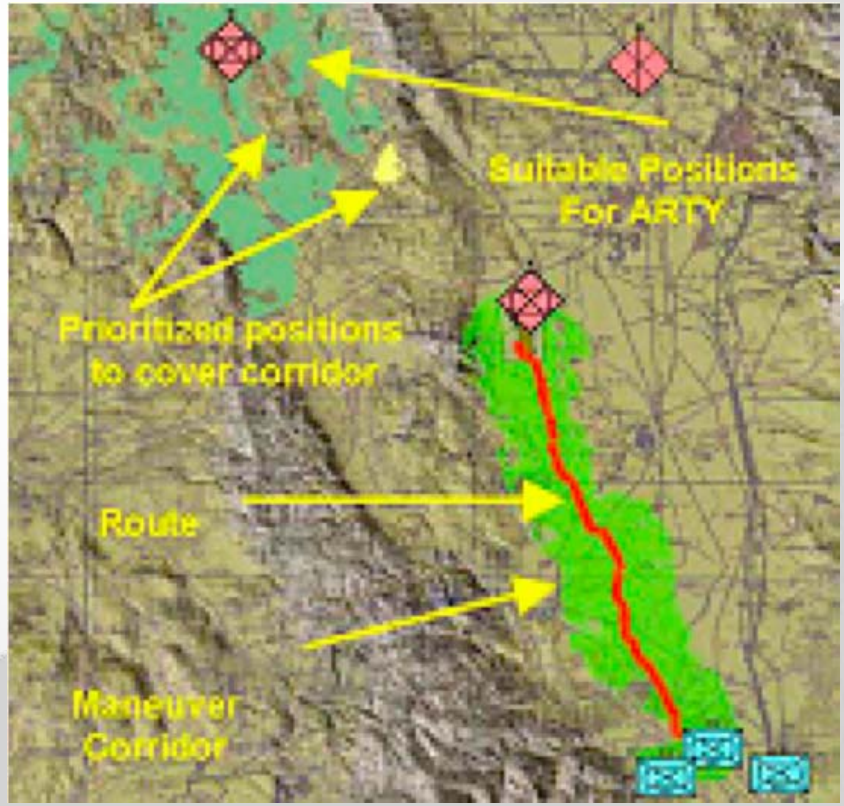
Background

- Map is focal point of command post
- Automated geospatial support tools are rapidly penetrating all command levels
- Empirical research is needed to:
  - Evaluate military value of emerging tools
  - Prioritize future tool development



Purpose of Research Program

- Sponsored by
  - U.S. Army Engineer Research and Development Center (ERDC)
  - U.S. Army Topographical Engineering Center (TEC)

- Joint Geospatial Enterprise Services (JGES)
  - Integrate, test, evaluate, and demonstrate J-GES technologies to support optimal implementation within future net-centric battle command and ISR enterprise environments.

- General Purpose:
  - Analyze relevance and measure value of data/information being exploited by users at all echelons

- Specific Purpose:
  - Assess the value-added to Military Decision Making from use of Advanced Automated Geospatial Tools (AAGT)

  - Evaluate contribution of the Battlespace Terrain Reasoning and Awareness – Battle Command (BTRA-BC) suite of geospatial reasoning tools

BTRA-BC

Objective:

- Empower commanders, soldiers, and systems with information that allows them to understand and incorporate the impacts of terrain and weather on their functional responsibilities and processes

- Products
  - Information and knowledge products that capture integrated terrain and weather effects
  - Tactical Spatial Objects (TSOs) - Predictive decision tools that exploit these products

- Some BTRA-BC products have been fielded in the U.S. Army's Digital Topographic Support System (DTSS)
  - Used by U.S. Army for terrain analysis

Current Study

- Study Objective
  - Assess the benefit of BTRA-BC tools to military planners in a complex and realistic scenario
  - Expand on results of previous experiment (presented at last year's ICCRTS)
    - COA generation vs. AA recommendation
    - Planners vs. terrain analysts
    - Can tools enable planners to do terrain analysis
- Study Method:
  - Perform experiment to compare performance with and without BTRA-BC TSOs
  - Participants performed two trials of a military planning task using CSE:
    (1) With BTRA-BC TSOs, and
    (2) without BTRA-BC TSOs

Primary Hypotheses

1. Participants who use BTRA-BC TSOs will produce military planning output *more quickly*
2. Participants who use BTRA-BC TSOs will produce a *higher quality* plans
3. Participants who use BTRA-BC TSOs will display *as good an understanding* of the impact of the given terrain on military planning
4. The quality of the output generated with BTRA-BC TSOs will be *more uniform*
5. There will be *little or no learning effect* due to evaluation design
6. *Participants will consider using BTRA-BC TSOs superior* when producing a plan with respect to speed, quality, ease and overall

Study Design

- Environment
  - Commander's Support Environment (CSE)
    - Developmental C^2 system
    - Originally a DARPA initiative
  - with and without added BTRA-BC TSOs

- Participants
  - 16 U.S. Army officers
  - Prior training and battalion level planning experience.

- Three independent variables
  - System used (with and without BTRA-BC TSOs)
  - System Order (which system was used first)
  - Scenario Order (Which of two near identical scenarios was used first)

Study Design

- Within Participants design with respect to System used:
  - Each subject will solve a planning scenario in both conditions (with and without BTRA TSOs)
- Between Participants design
  - System Order
  - Scenario Order
  - Design was counterbalanced on scenario order and system order
- Study design minimized the number of participants to obtain required statistical power
- Training prior to trials
  - CSE (4 hours) and
  - BTRA-BC (2 hours)

Study Design (cont)

- Participants
  - U.S. Army Captains and Majors
    - Planning experience
    - Comfortable with digital systems
  - Anonymous
    - Randomly assigned participant numbers
    - Randomly assigned data designators
  - Experience Questionnaire
  - Ranked and grouped by experience
  - Randomly assigned to groups

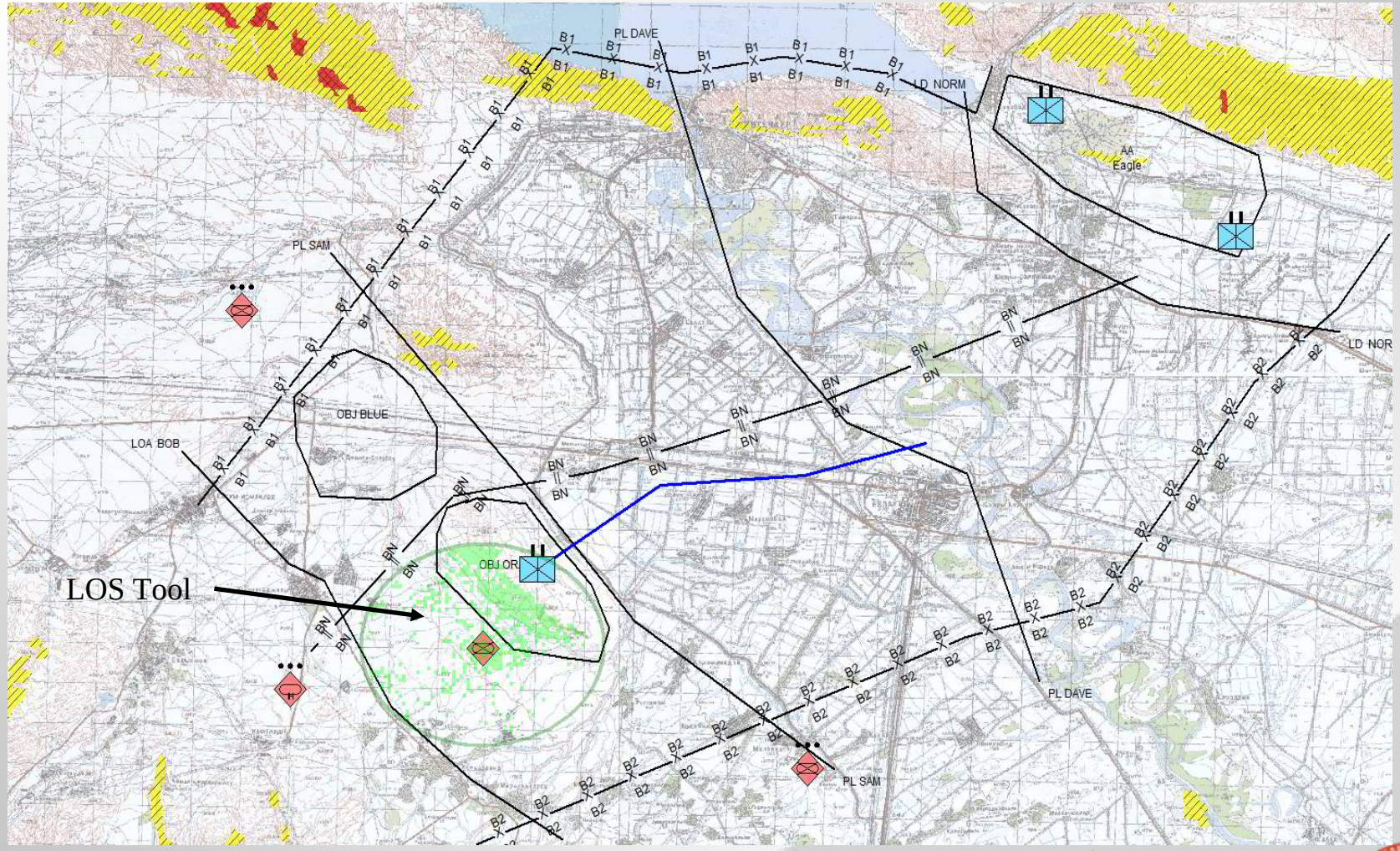
Study Design (cont)

		DAY 1 AFTERNOON				DAY 2 MORNING				DAY 2 AFTERNOON				
SUBJ	**GRP**	**STATION**	**SCE**	**SYS**	**DESIG**	**STATION**	**SCE**	**SYS**	**DESIG**	**STATION**	**SCE**	**SYS**	**DESIG**	**CQ**
1	1	1	1	CSE	AF	BTRA Training				2	2	BTRA	AH	1
2	1	2	2	CSE	AJ					1	1	BTRA	BP	2
3	1	3	1	CSE	BB					8	2	BTRA	AM	2
4	1	4	2	CSE	AV					5	1	BTRA	AS	1
5	2	BTRA Training				1	1	BTRA	BF	4	2	CSE	BR	2
6	2					2	2	BTRA	AE	3	1	CSE	AL	1
7	2					3	1	BTRA	AC	7	2	CSE	AK	1
8	2					4	2	BTRA	AD	6	1	CSE	BE	2

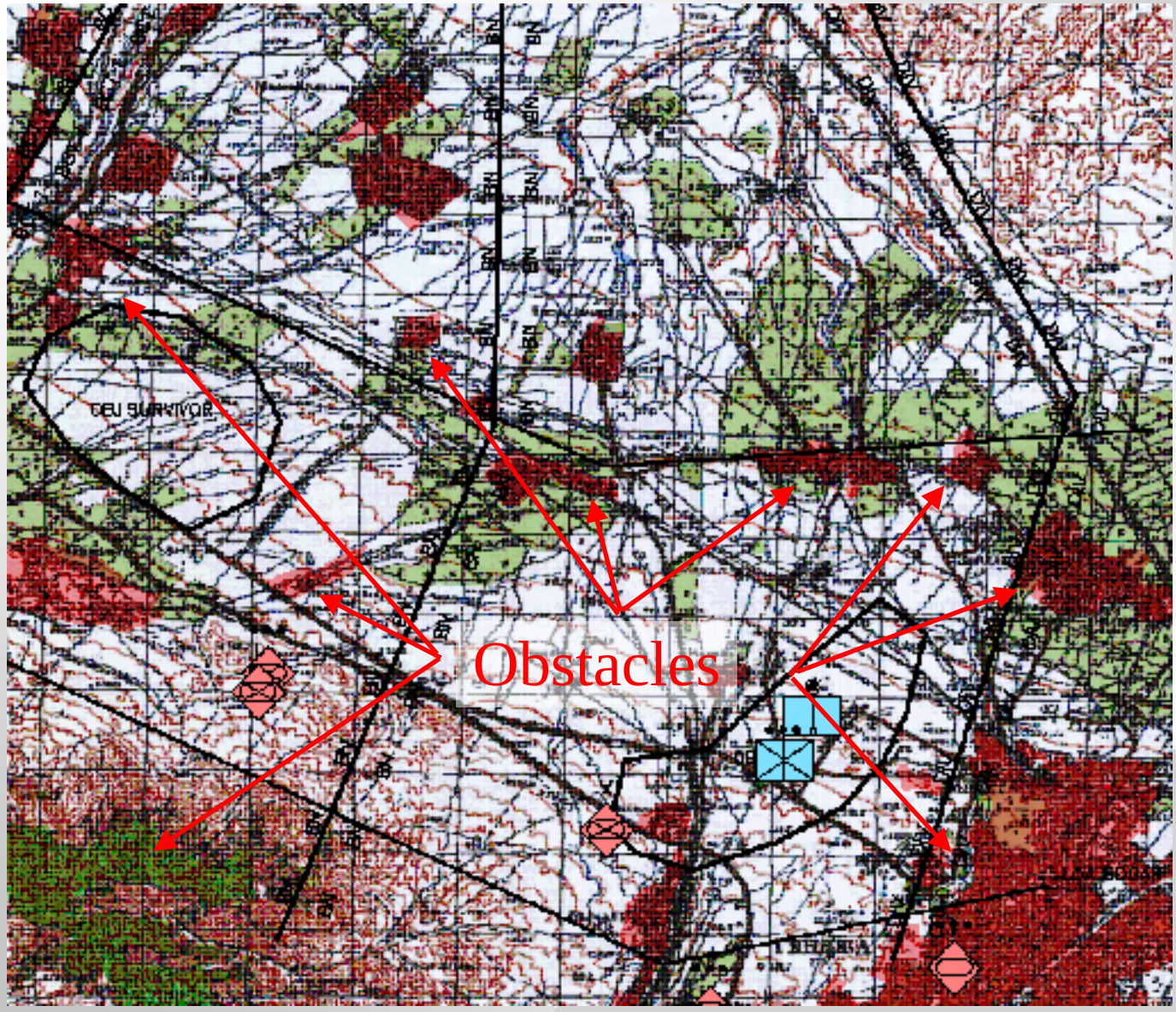
Experimental Tasks

- The evaluation scenario began with analysis of specific terrain and continued to the point of generating a plan of movement and a Course of Action (COA).
- Specific tasks :
  - Digital Plan
    - Plan movement
      - Identify Mobility Corridors (MC)
      - Categorize Mobility Corridors by size
      - Group Mobility Corridors to form potential Avenues of Approach
      - Identify Choke Points on Avenues of Approach
      - Calculate travel times and coordinate simultaneous arrival
    - Identify Engagement Areas
    - Identify Battle Positions
    - Identify Ambush Sites
    - Identify Named Areas of Interest (NAI)
    - Generate battalion graphics including subordinate echelon Areas of Responsibility

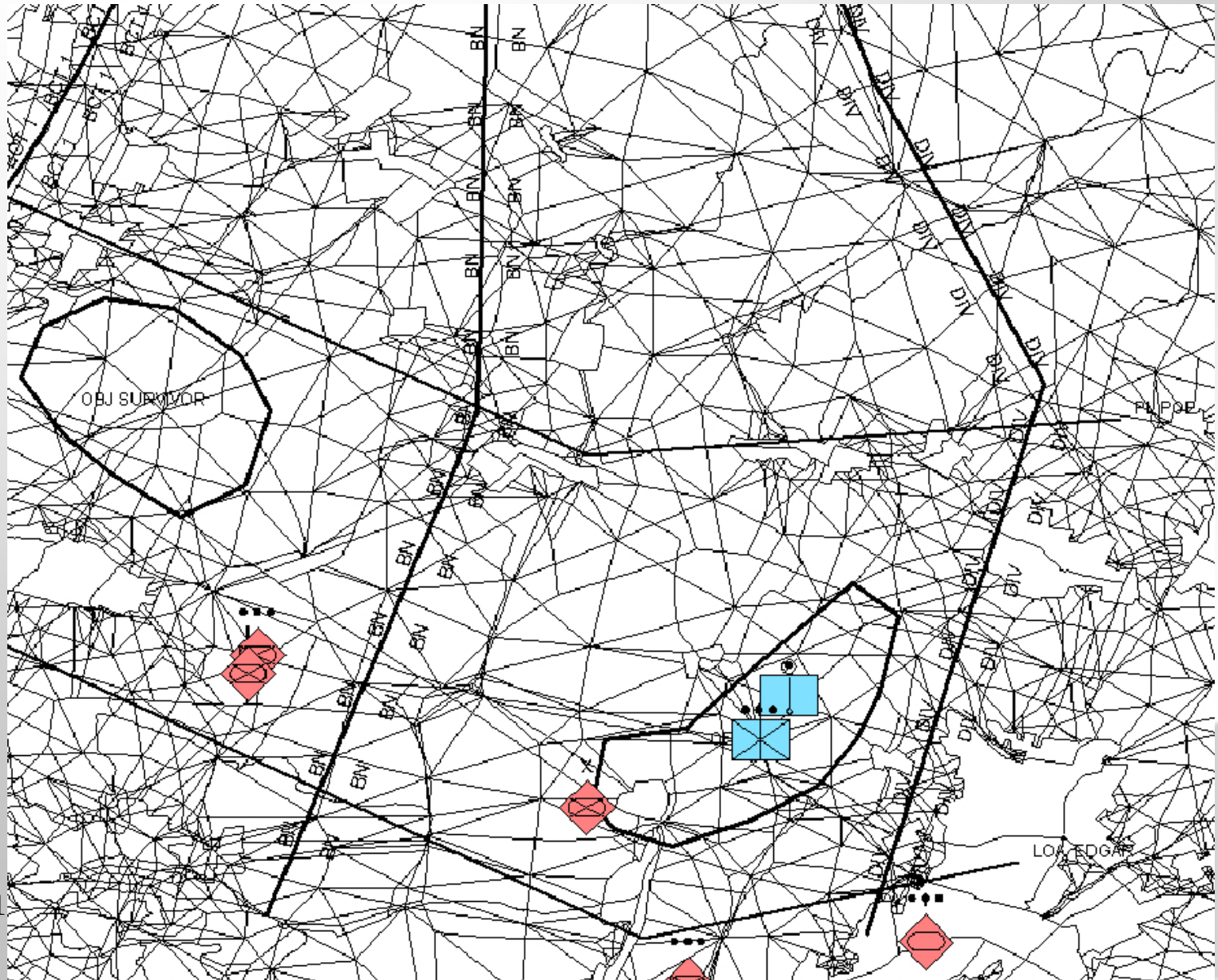
Without BTRA-BC TSOs



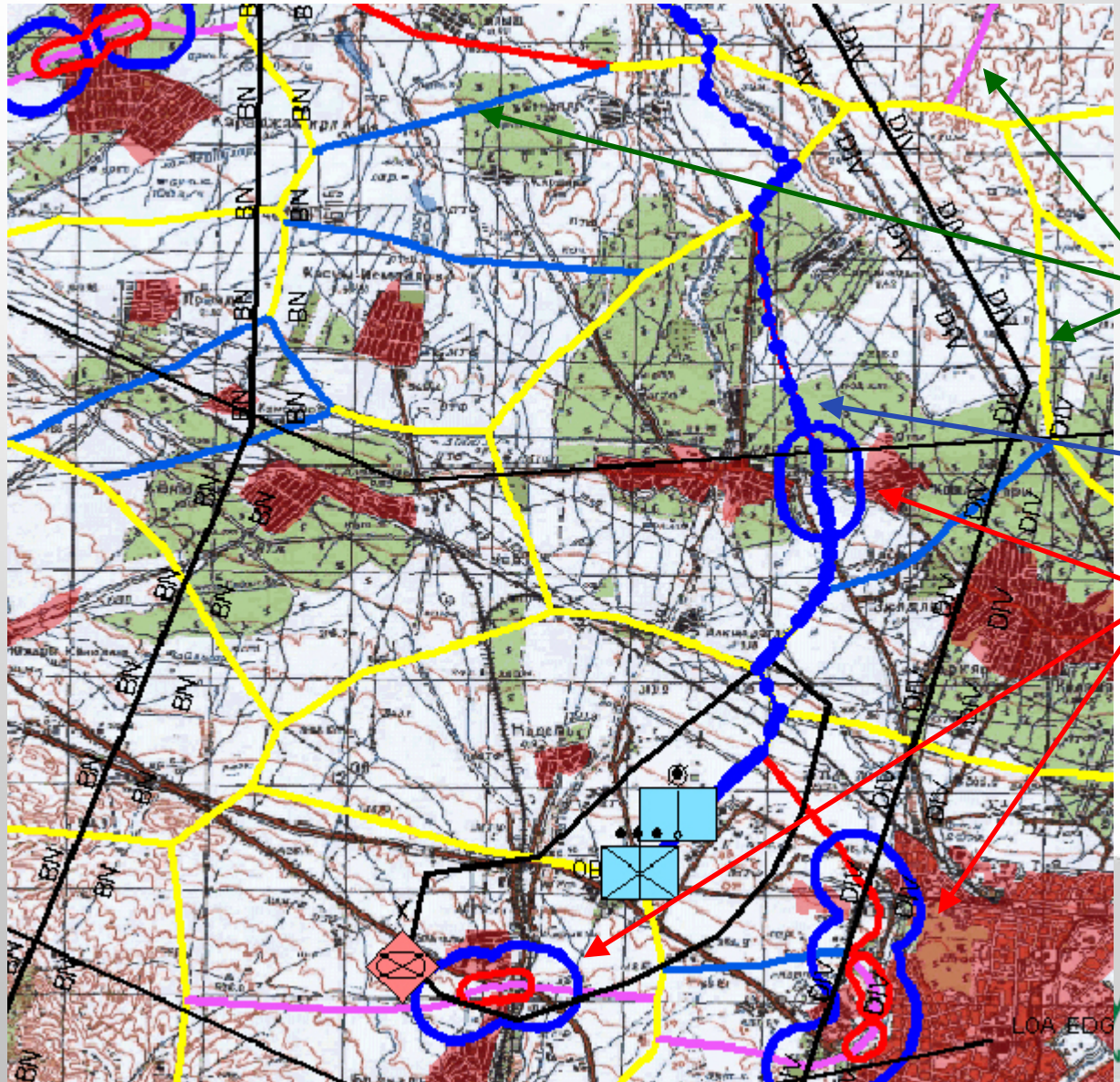
BTRA-BC Obstacle TSO



BTRA-BC Maneuver Network TSO



BTRA-BC Tier 1 TSOs

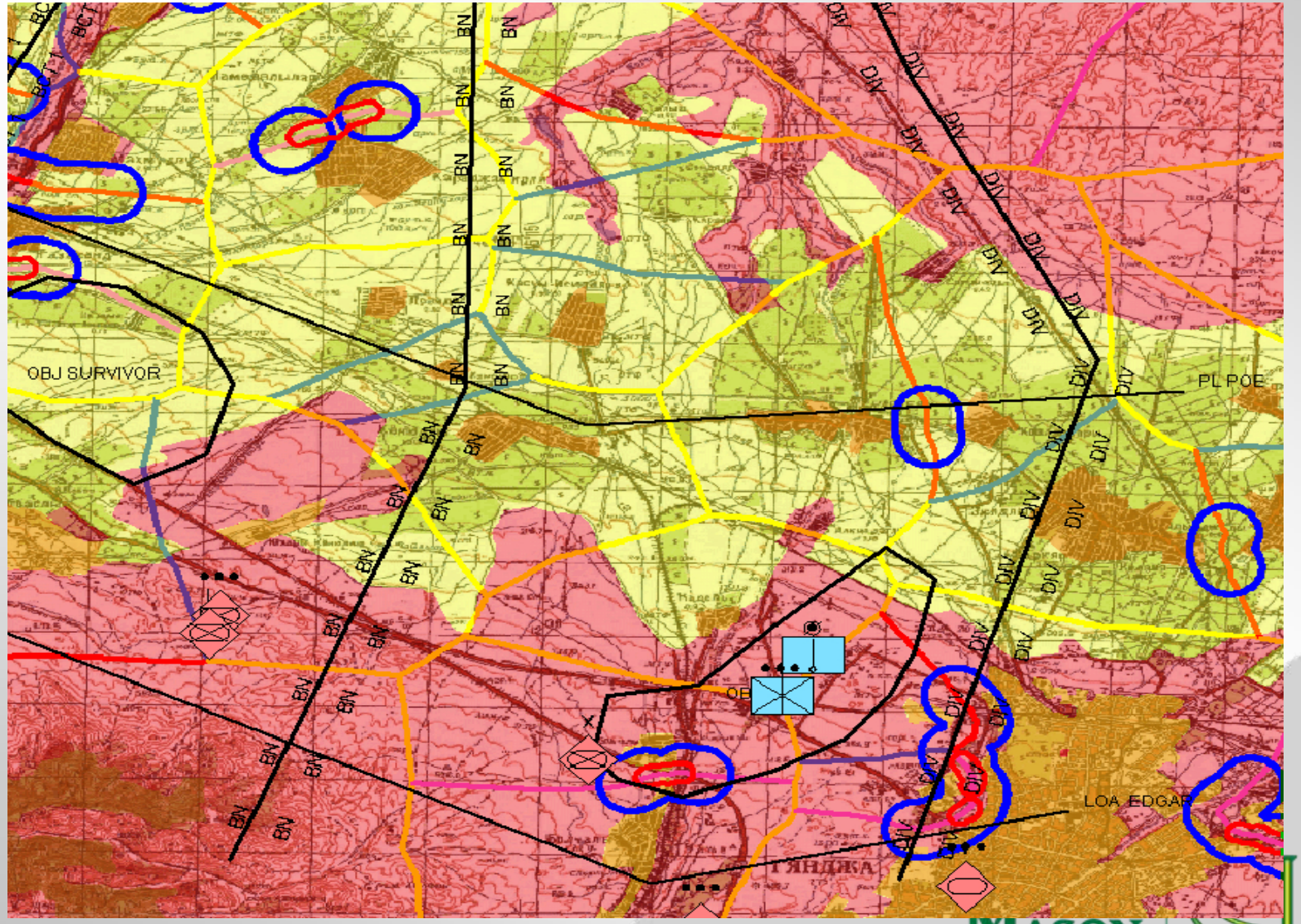


Mobility Corridors

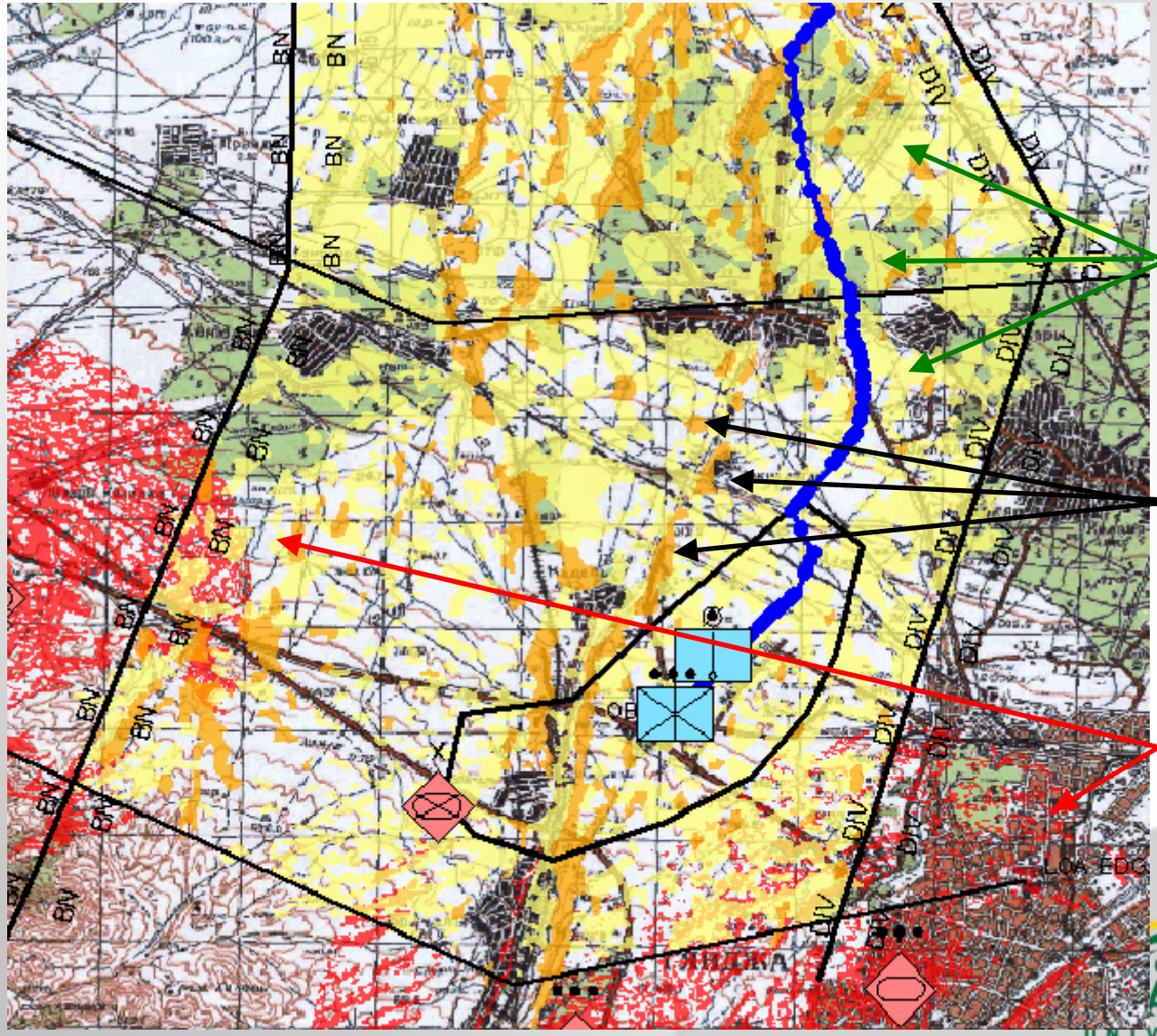
Route

Chokepoints

BTRA-BC Concealment TSO



BTRA-BC Tier 2 TSOs



Battle Positions

Hide Positions

Engagement Area

Experimental Tasks (cont)

- Specific tasks (cont)
  - Operation Order
    - Commander's Intent
    - Concept of Operations
      - Explanation of graphics
      - Impact of terrain on mission
  - Terrain Understanding Questionnaire
  - System Comparison Questionnaire

Measures

- Time to complete scenario (H1, H5)
  - Objective
  - Significant in prior experiment
  - Possibly less significant in more complex planning
- Quality of solutions as judged by expert evaluators (H2, H4, H5)
  - Subjective
  - 45 criteria in 15 categories
  - 5 point Likert Scale
  - Independent SMEs
- Scores on a questionnaire evaluating subject understanding of the terrain (H3, H5)
- Scores on a questionnaire evaluating subjective perception of w/ BTRA-BC (H6)
  - 5 point Likert scale
  - Scale Normal and Reversed

Summary

- Extension of successful previous experiment
- Expanded to evaluate:
  - Planners ability to evaluate the effects of terrain using BTRA-BC TSOs
  - Effect of automated tool on decision-making in a complex and realistic scenario
- Measures and tasks are critical in designing an experiment that will evaluate the desired criteria
- Results will be used to guide the direction of the further development of BTRA-BC

Next Experiment in the Series

- Object: Assess the value of Buckeye's 4-inch resolution imagery and DTED 5 elevation data
- Examining accuracy of data vice effectiveness of tools
- Experimental Design
  - Platoon / reinforced squad
  - Iraqi city where CIB1 and Buckeye data are available
  - Planning task: Evaluation of potential sites for Vehicle Control Point (VCP)
  - Environment CSE
  - Participants: 16 infantry E6-E7 or O2-O3 with experience in-country

Questions?

Project Status

- Conducted experiment with first 8 participants
- SME's have evaluated plans from first group
- Conducting preliminary analyses
- Waiting on second 8 participants

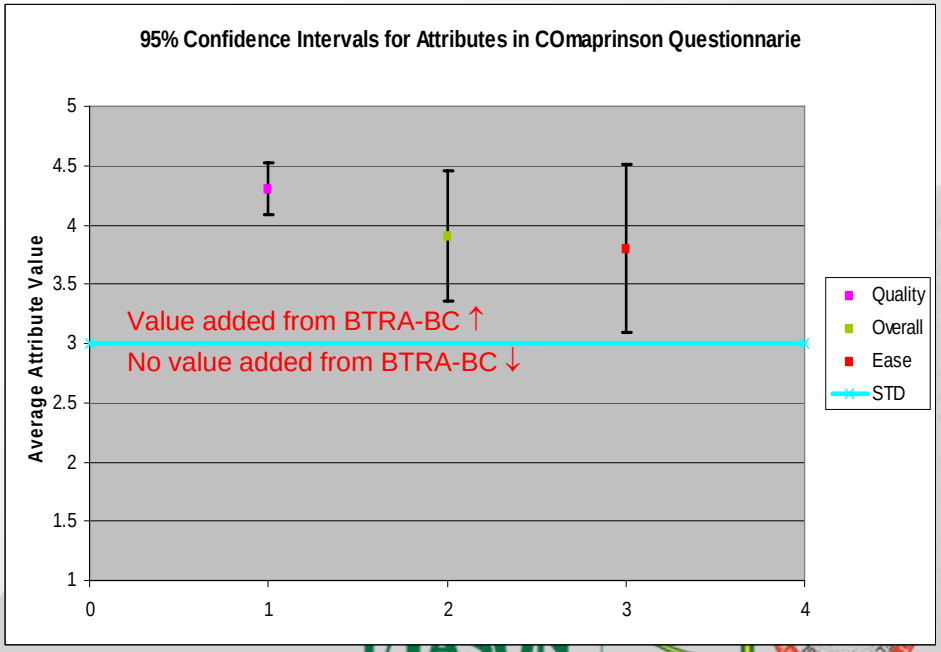
Preliminary Results: Time to Solution

- Average time to scenario completion (H1)
  - w/ BTRA: 147.5 minutes
  - w/o BTRA: 143 minutes
  - No statically significant evidence that the average times are different

- Learning effect (H5)
  - Preliminary data suggests that participants had a faster time, on average, for the second system used.
  - Preliminary data suggests that there is statically significant evidence there may be a learning effect (0.05)

Preliminary Results: Subjective Perception (H6)

There is strong statistical evidence that:

1. Subjects believe they can produce an output of *higher quality* w/ BTRA-BC than w/o BTRA-BC
2. Subjects believe that overall CSE with BTRA-BC was superior to CSE w/o BTRA-BC

The results provide marginally significant evidence producing a plan using CSE with BTRA-BC TSOs was easier than with BTRA-BC TSOs.