



# **HUMAN DECISION-MAKING IN NETWORK-CENTRIC WARFARE**

**SCENARIO DEVELOPMENT**

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# **HUMAN DECISION-MAKING IN NETWORK-CENTRIC WARFARE** **SCENARIO DEVELOPMENT PROPOSAL**

## **A. INTRODUCTION**

The focus of this Scenario Development Proposal is to establish required goals and address related concerns for the design, production, and operation of the research pertaining to the study of *Human Decision-Making in Network-Centric Warfare* (HD-MN-CW). Prior to scenario design the development team will need to have gained a strong understanding of Network-Centric Warfare (N-CW), Human Decision-Making (HD-M), military scenario development, and communication technologies.

It is tremendously important to take the extra time in attaining a thorough knowledge of the items listed above. Then carefully incorporate that knowledge into planning of the project's scenario structure so that we will greatly increase the quality and quantity of knowledge attained to provide solid foundation from which to continue research to measure HD-M in N-CW.

## **B. CONSOLIDATION OF RESEARCH ON:**

The following context is summary of information pertaining to HD-MN-CW. The vast majority of information was attained from the Internet so there may be a need to explore other means of gaining information on the subjects such as interviews, books, etc.

### **1. N-CW**

The basis of N-CW is the ability to exponentially increase cognition in order to maximize combat effectiveness. The most crucial aspect of military success is the speed at which it can operate. A schematic of military operation can be seen in Boyd's Observe Orient Decide Act (OODA) loop (See figure 1). The goal for N-CW is to provide the military with the ability to condense its OODA loop, thus being able to act and react faster than its opponent to achieve success. Vice Admiral Arthur Cebrowski, Director of the Pentagon's Office of Force Transformation and father of network-centric warfare, found his inspiration when he saw how retail giant Wal-Mart overran its competitors by using networked operations in a synchronized top-down demand and supply chain. The store's strategy exploited real-time awareness and information superiority to speed up transactions and increase profits. Another advantage of N-CW is the ability to aid in diminishing human error. This would lower chances of allied forces or innocent civilians from being killed.

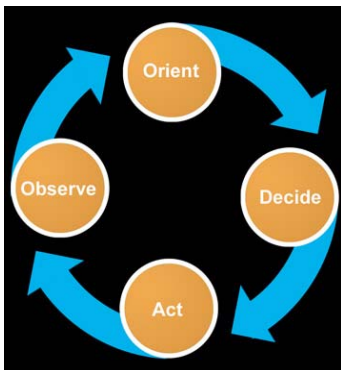


Figure 2.

One of the pitfalls of N-CW is that a clever adversary or just plain glitches in software can disable or damage networking and communication capabilities. The result of major problems would be extremely devastating due to the intelligence and defense community's reliance on networks. Therefore there it will be required to constantly provide the most advanced network security capabilities without delay so as to thwart threats against U.S. systems. Another observation to the limits of N-CW can be illustrated in the fact that human intelligence is as, or more capable of acquiring information.

## 2 HD-M

Because of time constraints associated with qualitative data analysis, attempts will be made to primarily use quantitative measures whenever possible.

An APA report in 1987 assessed the state of research on human cognition and decision-making. Its relevance to the design of military decision support systems recommended:

- Designs of decision-aiding systems typically fail to utilize research findings regarding human judgment, decision-making, and cognitive abilities
- Popular technologies have driven decision-aiding research and development rather than a systematic study of user needs driving this type of research
- Improved methods needed for testing and validating decision-aid effectiveness, and for measuring the quality of decision performance

Performance measurement scheme (Cannon-Bowers and Salas, 1997):

	Individual	Team
Process	Cognitive processes Position-specific task work skills	Information exchange Communication Supporting behavior Team leadership
Outcome	Accuracy Latency	Mission effectiveness Aggregate latency and accuracy

**Process measures** describe strategies, steps, or procedures used to accomplish a task. Process measures are useful for determining training needs and providing trainees with feedback that supports the instructional process; can identify which aspects of human performance are deficient (e.g., what specific processes lead to effective and ineffective outcomes?) This information could be made explicit to trainees, facilitating learning.

**Outcome measures** assess the quantity and quality of the end result. Outcome measures measure human performance plus variances accounted for by equipment, surrounding environment, interactions among team members, and luck.

**Information exchange.** Seeking information from all possible sources; passing information to the appropriate persons before being asked; providing “big picture” situation updates.

**Communication.** Using proper phraseology; providing complete internal and external reports; avoiding excess chatter; ensuring communications are audible and ungarbled.

**Supporting behavior-** Correcting team errors; providing and requesting backup or assistance when needed.

**Team initiative/leadership.** Providing guidance or suggestions to team members; stating clear team and individual priorities.

**Measurements of HD-M**, type of measurement, and manner of attainment:

- **Quantitative** [number of communications (objective)] (*observation*)
- **Qualitative** [usefulness of information (subjective)] (*observation and post de facto interview*)
- **Type** [what form of communication was used (objective)] (*observation*)
- **Emotion** [psychological aspect. i.e. participant sounded stressed, confident, optimistic, pessimistic, etc (subjective)] (*observation and post de facto interview*)
- **Bias** [was there a particular reason the participants acted as they did (subjective)] (*observation and post de facto interview*)
- **Foresight** (Recognition Primed Decision-Making) [able to have foreseen scenario possibilities and react faster, more confidently, and correctly (subjective)] (*post de facto interview*)
- **Experience** [able to react faster, more confidently, and correctly due to experience (ties in with bias and foresight) (subjective)] (*post de facto interview*)

### 3. LATEST IN MILITARY SCENARIO DEVELOPMENT

Appropriate military scenarios are required to ensure that communications networks under study are realistic and credible. Military scenarios usually include a description of the current historical, political, military, social, and economic situations. Goals of scenarios should be to infuse into the scenario as much realism as possible, while maintaining a degree of control. Scenario development framework includes three major categories: (i.e. political/military/cultural situation), capabilities of players (friendly forces, opposing forces, and non-combatants), and environment (geography, terrain).

- Force Structure: Force structure information is required to distinguish, segment, and geographically position friendly, allied, and enemy forces for scenario execution.
- Phase Timelines: The timelines serve to guide execution of events through deployment, presence, hostilities, joint-force entry, force build-up, combat operations, etc (Sleevi, 2002).
- Computer based “clocks” for scenarios are almost always run at four or six times normal speed.

In N-CW the potential flexibility is so great that centralized orchestration or management, however lightly exercised, becomes a limitation. When units have shared awareness- they can themselves avoid wasting efforts on enemy units that other friendly forces are engaging, or even shooting at each other. They can also render mutual support without higher-echelon coordination, fixed physical relationships to each other, or restrictive doctrine (Rubel, 2001).

## C. SCENARIO DEVELOPMENT

### 1. COMMUNICATIONS STRUCTURE

#### a. NEAR-FUTURE COMMUNICATIONS

The desire of the Near-Future communications category is to provide the participants with current as well as near-future forms of communication available to the type/size unit we decide upon for the scenarios.

#### 1. Possible Forms and Descriptions of Communication

1. Low bandwidth at lower echelons limits types of data from field
2. Limited bandwidth of C2 systems causes exclusions of other input (bottlenecking)
3. Sequential presentation of critical info
4. De-synchronizing of relevant information flow
5. Timeliness & availability of Info
6. Decision timetables
7. Decision timelines padded to include comms penalty
8. Pt to pt xfer of info vs multicast/eavesdrop
9. Multi node relay & trans-modal processing, sneaker net (i.e. video to voice)
10. MOTOROLA's
11. GPS
12. JTRS                      Joint Tactical Radio System
13. AM Radio
14. VLF Radio
15. LF Radio
16. FM Radio
17. VHF Radio
18. UHF Radio
19. SHF Radio
20. EHF Radio
21. SATCOM                      Satellite Comm,
22. Email
23. TV                              CNN, FoxNews, MSNBC, CBS, ABC, etc
24. Satellite Imagery
25. UAV
26. Telephone (land-line)
27. Analog (cellular) phone
28. Digital (cellular) phone
29. Video-Conferencing
30. PRC-119
31. SINCGARS
32. Limited real-time interface
33. Complex graphics not practical
34. SATCOM links only at the highest level
35. Single pt data access channel
36. Limited distributed capability
37. Linear fall off of comms capability = linear fall off of data flow

**2. Possible Forms of Denial and or Disturbances of Communication** (to Blue or Red forces depending on desired effects toward HD-M)

1. Line of site and structure disturbances
2. Poor networking integrations/coordination
3. Weather interference [audio and video (i.e. UAV & satellite)]
4. Power (battery) shortcomings

5. Enemy destruction, sabotage, interference
6. Spool up time for certain communications
7. EMI, Electromagnetic Interference
8. Lines (power, phone, cable, DSL) down

**3. Vision.** A sketch of the Near-Future Communications would look like:

Operations

Audio: tactical radios, SATCOM, Mobile subscriber type equipment.

Video: none

Digital info: ABCS/C2PC type maneuver control systems. Operational graphics, friendly unit locations, enemy locations or templates, digital messaging (free text and formatted). Maintains the common tactical/operational picture

Intel

Audio: same as above

Video: UAV feed

Digital info: ASAS-type system. Enemy forces information, locations, terrain and environmental databases and analysis, messaging as above

Fire Support

Audio: same

Video: possible links to smart missiles (EFOG-M) but probably none

Digital info: Digital fires info net, AFATDS-type fire planning and C2 tools

CO/Commander Node \*

Audio: same

Video: possible links to smart missiles (EFOG-M) but probably none

Digital info: Digital fires info net, AFATDS-type fire planning and C2 tools

\* Depends on how pure of team, distributed, decision-making is desired for this experiment. If so, then the answer is no, if the scenario is to more closely simulate the military then there is a need for an ultimate decision-maker.

**b. INTERMEDIATE COMMUNICATIONS**

This category will simply contain communication means that are in between the Near-Future category and the Future category. This list will exclude some forms of communication expected to be from the Near-Future category and includes some technologies which may be available from the Future category.

**1. Possible Forms and Descriptions of Communication.** The types of disturbances in Intermediate Communications

**2. Possible Forms of Denial and or Disturbances of Communication** (to Blue or Red forces depending on desired effects toward HD-M)

The types of disturbances for the Intermediate Communications will be similar to those in the Near-Future but less obtrusive.

**3. Vision.** A sketch of the Intermediate Communications would look like:

Operations

Audio: tactical radios, SATCOM, WIN-T tactical internet.

Video: WIN-T video

Digital info: ABCS/C2PC type maneuver control systems. Operational graphics, friendly unit locations, enemy locations or templates, digital messaging (free text and formatted). Maintains the common tactical/operational picture

Intel

Audio: same as above

Video: UAV feed

Digital info: ASAS-type system. Enemy forces information, locations, terrain and environmental databases and analysis, messaging as above

Fire Support

Audio: same

Video: possible links to smart missiles (EFOG-M) but probably none

Digital info: Digital fires info net, AFATDS-type fire planning and C2 tools

CO/Commander Node \*

Audio: same

Video: possible links to smart missiles (EFOG-M) but probably none

Digital info: Digital fires info net, AFATDS-type fire planning and C2 tools

**c. FUTURE COMMUNICATIONS**

The vision for the future communications category is to provide the participants with unlimited access to immediate real-time information. The result is for them to have the instantaneous and continual cognition of the battlefield. Network & bandwidth will no longer be a limiting factor. The only limiting factor will be the human's own ability to receive, prioritize and process information. Gigabit wireless Local Area Networks (LANS) and fast (12m bps t) data transfer rates with digital tactical radios at the platform or individual level.

**1. Possible Forms and Descriptions of Communication**

1. FalconView
2. Battlefield Visualization

3. Information synchronicity
4. J-VMF                      Joint-Variable Message Format
5. GIG                        Global Information Grid
6. ASW                        Advanced SATCOM Wideband
7. NAVISSI (w/ GPS)
8. NIU                        Network Interface Unit
9. NFN                        Naval Fires Network
10. Near simultaneous data stream
11. All channels of data available all the time
12. Multipoint Multi-user access
13. Straight through data transfer – no mode change
14. Real-time working interface
15. Visualization & audio up & down
16. Information synchronicity

**2. Possible Forms of Denial and or Disturbances of Communication** (to Blue or Red forces depending on desired effects toward HD-M)

Reality dictates that even in the future there will never be “perfect” communication but for this experiment we will seek to portray just that; undisturbed, undeniable, real-time, communications.

**3. Vision.** A sketch of the Future Communications would look like:

All Nodes

Audio: tactical radios, global “cell phone” type point to point link, network intercom or voice over IP system

Video: Point to point video teleconference (CUSEE Me type system), UAV and Recon Footage, Access to commercial broadcast.

Digital info: Common C4ISR digital information system with common tactical picture. 3D collaborative visualization system (spaceball operated, based on 3D terrain mapping, allowing user to zoom in and out, left, right, up, down, and visualize terrain constraints from any angle).



## 2. SCENARIO STRUCTURE

Prior to the scenario development a great number of questions need to be answered in order to sufficiently support the goals set forth in the *Human Decision Making in Network-Centric Warfare* proposal. The goals for the project raise concerns on how to:

- A. Maintain simplicity for ease of design, production, and operation of the scenarios (operational concerns require consideration for the researchers as well as the participants).
- B. Focus on the end result of attaining scenarios that simplify and enable quality data collection and analysis.
- C. Reduce the necessity that participants will require extensive knowledge of the network-centric warfare or how other services operate.
- D. Reduce confusion of what is required during the testing and how to react to the scenarios.
- E. Support the projects desire to measure Human Decision-making.
- F. Incorporate (as desired) relevant programs at GTRI including FalconView and Battlefield Visualization.
- G. Incorporate distributed decision-making into the scenarios requiring the participants to communicate and formulate decisions collectively.
- H. Incorporate guidelines/catalysts to expedite decision-making so as to simulate actual combat or emergency situations.
- I. How to vary the three different communications segments so as to accurately illustrate the different configurations and capabilities in *Near-Future*, *Intermediate*, and *Future* communications.

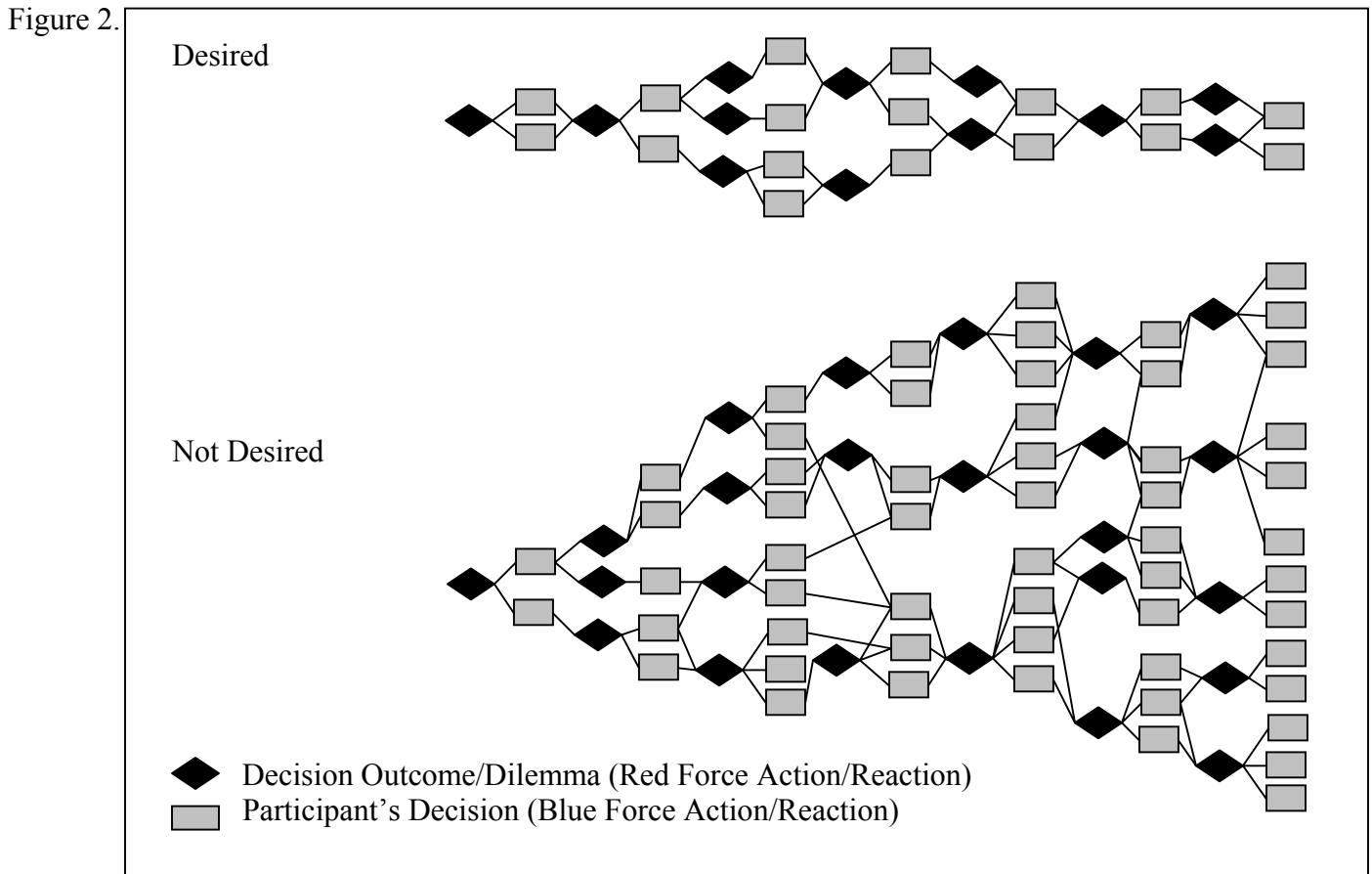
These concerns will be addressed throughout the *Characteristics* and *Candidate Decisions* sections below.

### a. CHARACTERISTICS

The characteristics of the projects scenarios must create solutions to the above stated concerns for this project. The proposed initial concepts for the following scenario characteristics are:

**Type:** Storyline base in order provide more control over the experiment by reducing unnecessary and unrelated confusion with the participants. The most difficult part of a storyline is the

maintaining the scenario along a certain path. This will have to be done by reducing the participants' decisions on the overall outcome of the scenarios storyline or by constraining the possible decisions. The goal is to avoid a scenario storyline that becomes too difficult and uncertain because the possibilities have branched out toward infinity (See figure 2).



**Participant number:** Three (Possibly four). Two participants would be too few to provide many team aspects of HD-M for observation and four would be too many for initial scenario and research development. If additional role players are required at times throughout the scenarios those characters will consist of the researchers. Participants will receive relevant information to their area of responsibility and provide general input to the group and make specific recommendations for actions involving their area. The job descriptions of the three participants will be:

#### 1. Operations Node

- Control maneuver forces (air and ground)
- Coordination between services/assets/units
- Synchronization of operations
- Friendly force Situational Awareness (SA) (status, location, etc)
- Maintains Common tactical/operational picture

## 2. Intelligence Node

- Enemy force SA (status, location, etc)
- Enemy force expected actions
- Reconnaissance and surveillance planning
- Reconnaissance & Surveillance (R&S) asset tasking and control
- Red SA for Common tactical/operational picture

## 3. Fire Support Node

- Fire support asset visibility (status, location, etc)
- Air support, NGF support
- Fire support planning
- Execution of fires (trigger puller)

## 4. CO/Commander Node\*

- Makes final decisions on course of action
- Manages information from other three nodes
- Delegates tasks for other nodes

**Participant Type:** The future goal is to attain participants of junior and senior military experience in order to provide a diverse (within the military) range of understanding and experience in military decision-making. However, for the initial proposal it is more likely that GT/GTRI staff and students with (on average) minimal understanding of military organization, communication, chain of command, etc. Additionally there will be no participant limitations on age, gender, education, race, creed, etc.

**Location of Participants:** The participants will be segregated from each other in order realistically portray physical (and sometimes emotional) distance of those involved in combat or emergency response.

**Size of unit:** For this project's purposes the unit that will be employed throughout this scenario(s) will be generalized so as to avoid confusion in the participants. The project will consist of the standard blue (friendly) forces and red (enemy) forces. Our "Blue force" will be based on a Marine Expeditionary Unit (MEU) consisting of:

- 2200 Personnel
- 3 Infantry Units (Company sized, i.e.120 soldiers)
- 1 Small Mechanized/Armored Unit (approx. 20 vehicles)
- 1 1/2 Helicopter Squadron
- 1/2 Tactical Aircraft Squadron (6 aircraft)
- Artillery Fire Unit

**# of Trials:** The immediate notion would be to have the participants proceed through the scenario(s) three different times. They would participate one time each with *Near-Future*, *Intermediate*, and *Future* communication setups. The experiments will need to be counterbalanced in some manner so as to provide for unbiased research.

Note: Since there are 3 forms of communications and 3 necessary scenarios at 18 possible variations each, the result is 324 possible solutions for counterbalancing. We will need to figure out how to counterbalance with

only necessary variations. Specifically there is a need to avoid the participants being more successful in their decision-making because of prior experience of a particular scenario.

**Time Criteria:** Set up the scenarios so that the participants' decision-making closely reflect real lifetime criteria's concerning decisions but still abbreviated for the necessity of the experiment. For instance some decisions require immediate response while other require thoughtful consideration and information/situation awareness. Possibilities in timing may include:

- **Lump Sum\*** : Providing the participants with a single portion of time for them to use as they deem necessary.
- **Individual \***: Providing them with certain amounts of time for varied.
- **Time vs. Space:** Requiring them to reach a decision prior to a particular event (i.e. subordinate, adjacent, or enemy unit, or weapon system reaching a certain location.
- **Combination:** Some combination of afore mentioned possibilities.

\* (Amount of times would be decided from pilot studies).

## **b. CANDIDATE DECISIONS**

**1. General Candidates.** The most successful and appropriate scenario(s) would probably be a combination of several of the following:

**a. Amphibious Invasion/Over The Horizon (OTH)**

**b. Airborne Assault**

**c. Embassy Protection/Evacuation**

**d. Humanitarian Relief**

**e. Nation-Building/Supporting Democracy**

**f. Strategic Theater**

**g. Homeland Security**

- 1. Boarding Party** (Container ship attempting to enter U.S. with possible radioactive material)
- 2. Assisting Border Patrol with locating illegal aliens**
- 3. CAPs**
- 4. Emergency response**

**2. Individual Candidates for Participant Action/Reaction (Blue Forces).** The individual candidates will be further detailed as the scenario development progresses. This will include information regarding who, what, why, when, and how that particular candidate needs to be considered for employment. Also listed will be the benefits and risks associated with its employment or tabling.

**a. Task Reconnaissance:**

- **UAV**, to pt A or B, or A, B, or C, etc.
- **Ground Element**, Yes/No, foot or vehicular, and to pt A or B, or A, B, or C, etc.
- **Request Satellite Imagery**, Yes/No, what type, and to pt A or B, or A, B, or C, etc.

**b. Decisions:**

- **Drop/No Drop**, (Airborne, Aerial Re-supply, Psychological leaflets, or humanitarian aid)
- **Air strike**, Go/No Go to pt A or B, or A, B, or C, etc.

- **Lay Land Mines**, Yes/No and to pt A or B, or A, B, or C, etc.
- **Evacuate non-combatants**, Yes/No, by ground or air
- **Provide Riot Control**, Yes/No and where
- **Adjust MOPP Level** Yes/No
- **Send Tactical Removal of Aircraft and Personnel (TRAP) team**, Yes/No
- **Bulk-up Rear Area Security**, Yes/No and where
- **Enter into Military Operations Urban Terrain/City Environment (MOUT) or remain outside.**
- **Adjust Rules of Engagement (ROE)/Amend Requirements for use of Deadly Force**, Yes/No
- **Establish Cordon**, Yes/No
- **Order CAS Mission**, Yes/No and where
- **Order Artillery Fire**, Yes/No, what type, and to pt A or B, or A, B, or C, etc.
- **Continue Assault or Stop and Setup Defensive Perimeter**, Yes/No
- **React to Threat or Wait**, Yes/No and what type
- **Preparatory Fires**, Yes/No
- **Emplace a Checkpoint**, Yes/No what type, and to pt A or B, or A, B, or C, etc.
- **Provide Medical Support**, Yes/No and where
- **Order Electronic/Information Attack**, Yes/No and where

**c. Maneuvers:**

- **Position Mechanized Units**, Yes/No and where
- **Attack**, Yes/No and where
- **Counterattack**, Yes/No what type, and to pt A or B, or A, B, or C, etc.
- **Maneuver around enemies flank**, Yes/No
- **Withdrawal**, Yes/No and to pt A or B, or A, B, or C, etc.
- **Setup Ambush**, Yes/No and to pt A or B, or A, B, or C, etc.
- **Commit Reserves**, Yes/No and to pt A or B, or A, B, or C, etc.
- **Feint**, Yes/No what type, and to pt A or B, or A, B, or C, etc.

**3. Individual Candidates for Enemy Action/Reaction (Red Forces).**

- a. Sabotage at Base Camp
- b. Sniper Assassination of one of the Nodes
- c. Air, Artillery, Naval, Ground destruction or disablement of:
  - One of the Nodes
  - One or more forms of “Blue” communication
  - Re-supply Efforts
- d. Shoot down of one or more aircraft
- e. Surround/Flanking of an infantry, armor unit
- f. Assault on forward operating base or airfield
- g. Threat of or attack on a U.S. Embassy
- h. Retreat of forces
- i. Defensive Posture Set
- j. Terrorist Action in Civilian Town

- k. Commitment of Atrocities on Local Civilians
- l. Threat of or actual NBC Attack
- m. Electronic/Information Attack