
Knowledge Superiority Parameter – a Metric for Network Centric Warfare (NCW)?

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Report Documentation Page

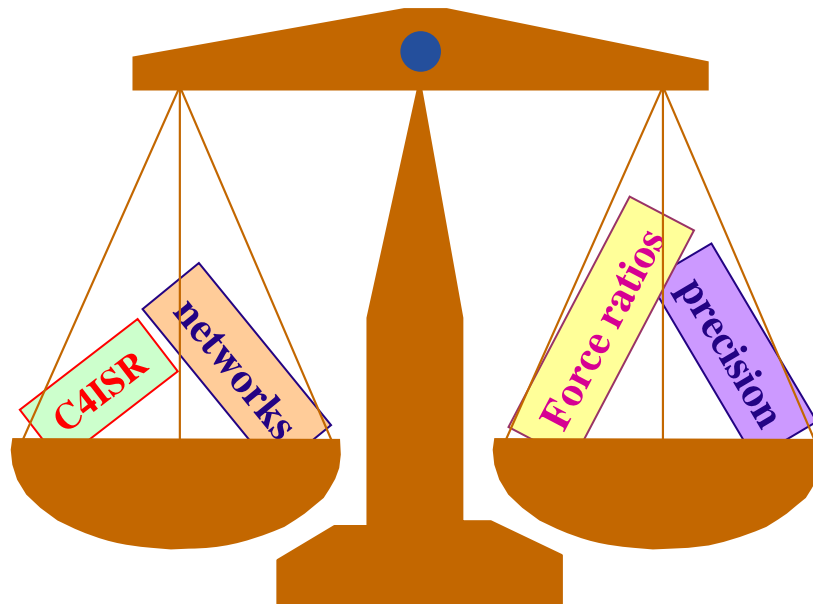
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The Problem?

- NCW concepts include the primacy of information and its exploitation using technology.
- Evaluating the military worth of knowledge derived from information is, however, a major challenge for the international OR community.



Lanchester Equations Reformulated

In 2001 Darilek et al introduced knowledge-enhanced Lanchester equations in an effort to gain insight into the potential contribution of knowledge to combat operations. They:

- Regarded knowledge as taking account of both the quality and value of information.
- Introduced a knowledge superiority parameter, Γ , determined from the maximum number of enemy a unit encounters in a combat cycle,

$$\Gamma = \frac{K_B}{K_R}$$

where K_B is the knowledge blue forces have of red forces and K_R is the knowledge red forces have of blue forces. These knowledge factors represent the knowledge available from external sources.

The NCW Case

- The question arises as to whether the linear or square Lanchester law applies for NCW.
- Darilek et al. noted that if the number of encounters is directly proportional to a side's external knowledge then for a blue victory:

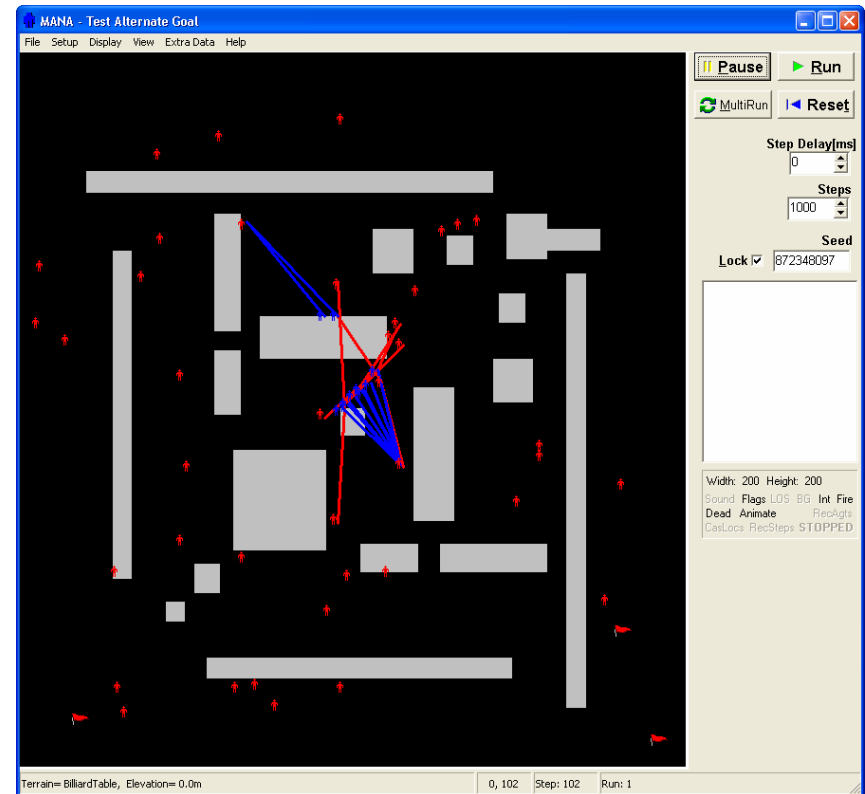
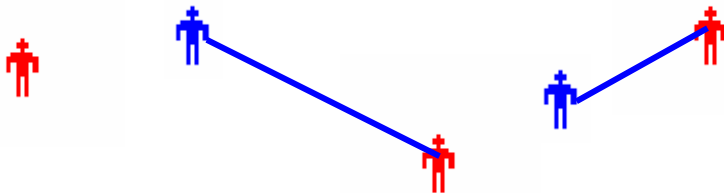
$$\frac{M}{N} \Gamma > \frac{R}{B} \quad \text{where} \quad \Gamma = \frac{K_B}{K_R}$$

and M and N are the effectiveness of the Blue and Red forces respectively.

- We contend that a NCW approach enables encounters through the external knowledge that is obtained and hence this condition applies.

Agent-Based Distillations (ABDs)

- Similar to a cellular automata model.
- Agents are described by a number of variables.
- Agents behaviour is determined by these.
- Results of behaviours dependant on agents and environment.



Linking of Lanchester Equations with ABDs

- ‘Hook and crook’ approach to linking parameters such as SSKP to the theoretical Knowledge Superiority Parameter (KSP) through force-exchange ratios.
- ABDs provide a stochastic approach to determining force-exchange ratios for various sizes of forces and SSKP.
- Reformulated Lanchester equations link SSKP to KSP through force-exchange ratio.



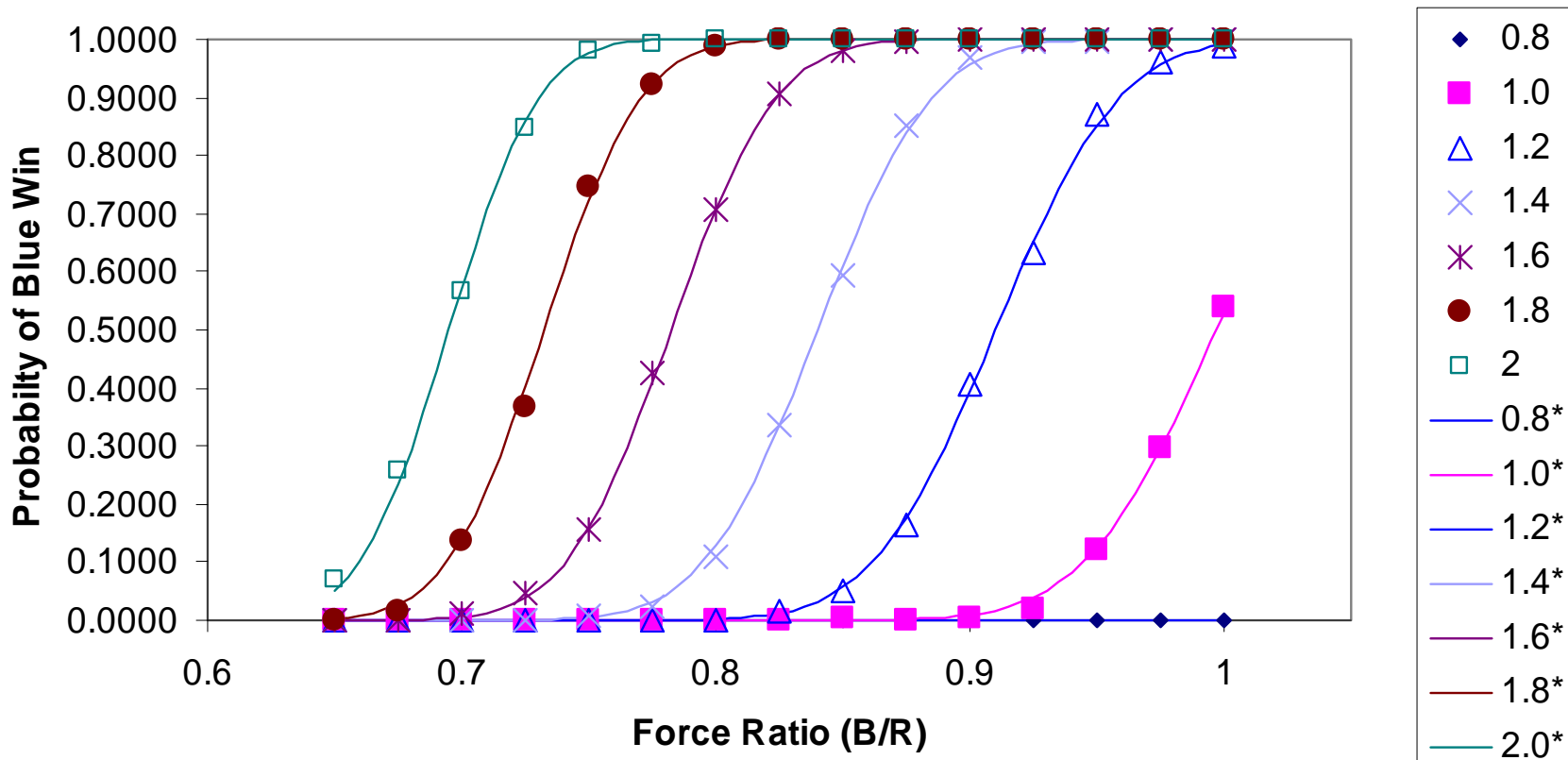
$$\frac{M}{N} \Gamma > \frac{R}{B}$$

The MANA Scenario

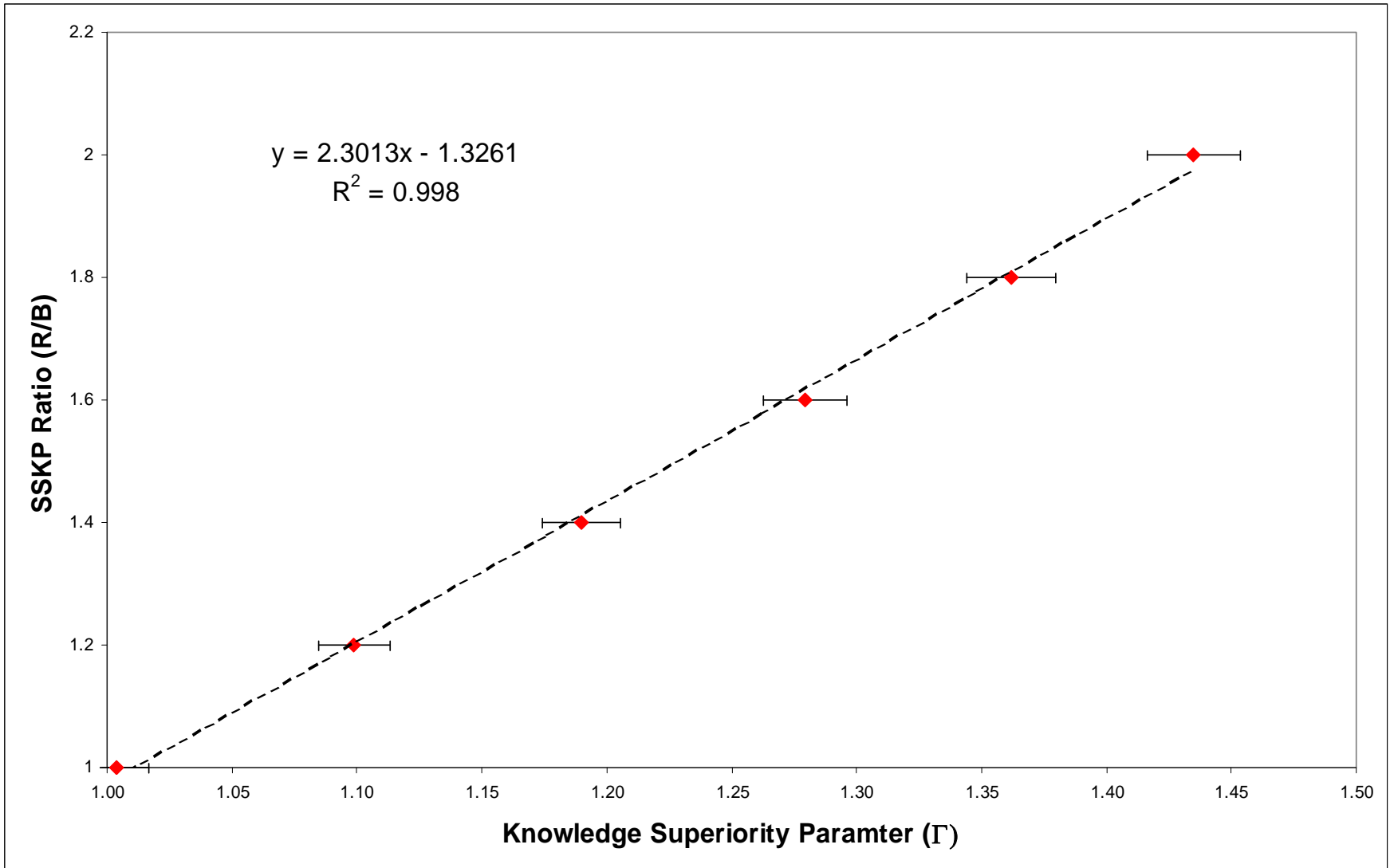
- ‘Lanchester-like’ modelling, i.e.:
 - no terrain;
 - random movement;
 - randomly distributed.
- Opposing forces given same abilities (but to varying degrees).
- Sensitivity to force size was examined.
- Broad ‘scoping’ runs followed by detailed grid pattern of:
 - 210 runs (7 SSKPs, 15 force ratios),
 - each with 500 Monte Carlo simulations.
- Winner was the side that increased its force ratio.

Results from MANA

**MANA Data and Fit(*):
Probability Blue Win vs Force Ratio (B/R)
for various SSKP ratios (B/R)**



Knowledge Superiority Parameter versus SSKP



In Summary

- Strengths
 - Establishes relationship between Γ and SSKP.
 - Simple approach where results can be readily obtained.
- Weaknesses
 - Relationship between Γ and other C4ISR measures is unclear.
 - Meaning of Γ in terms of situational awareness.
- Future Work
 - Exploration of Γ in terms of C4ISR metrics.
 - Linking of Γ to other measures of weapons effectiveness.