

Team Composition: Linking Individual and Team Characteristics to Team Decision-Making and Performance

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ADAPTING C2 TO THE 21ST CENTURY**

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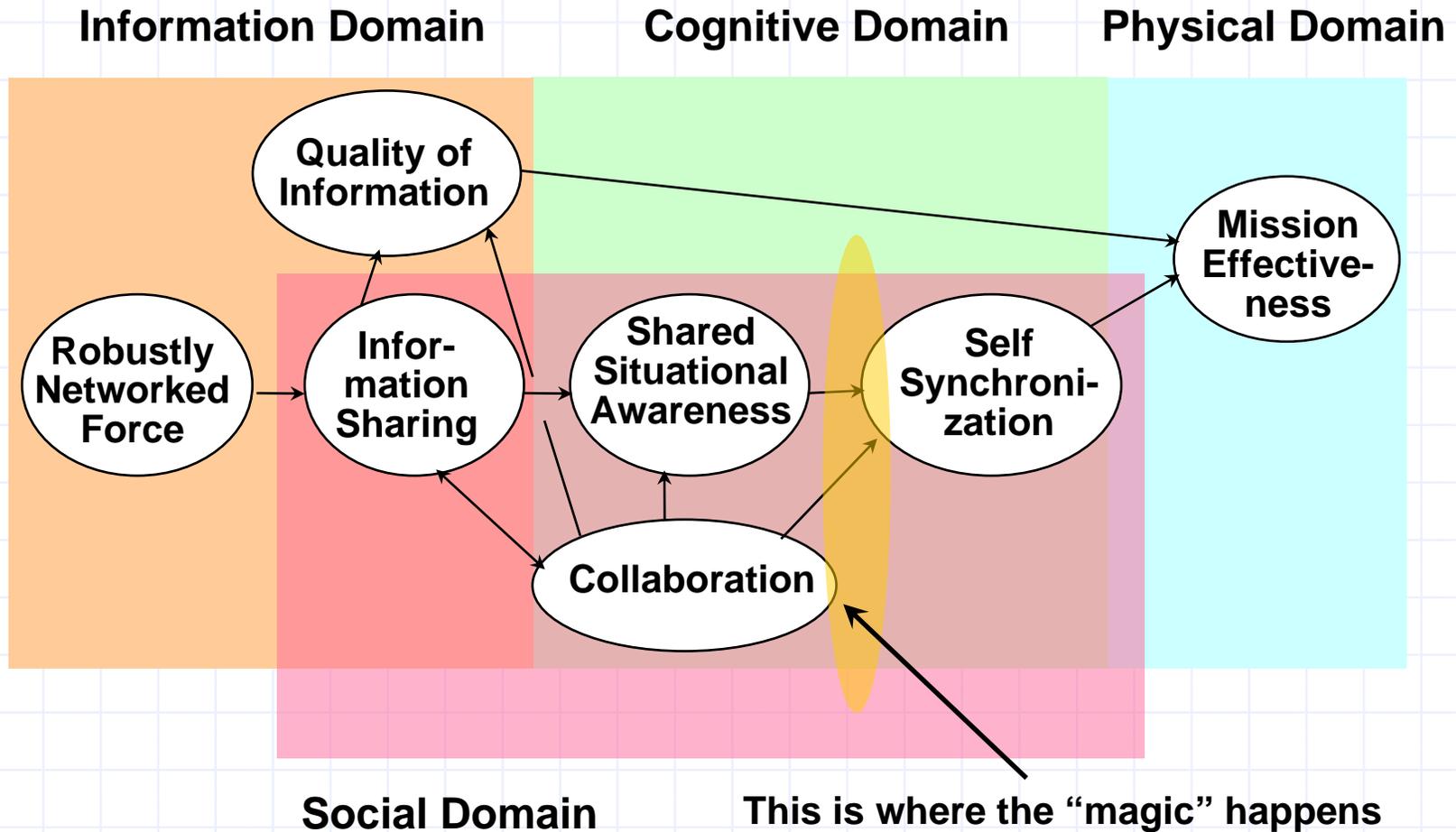
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NCW Tenets



Research Question and Variables

- **What team composition supports the quality of collective decision-making and team performance, i.e., what are the effects of selected relevant individual and team characteristics on team performance?**

- **Input (independent) variables**
 - ▶ **Individual characteristics**
 - ▶▶ Extraversion – Introversion
 - ▶▶ Sensing – Intuition
 - ▶▶ Thinking – Feeling
 - ▶▶ Judging – Perceiving
 - ▶▶ Locus of Control
 - ▶▶ Ambiguity Tolerance

 - ▶ **Team-specific characteristics**
 - ▶▶ Task Cohesion
 - ▶▶ Social Cohesion

- **Output (dependent) variables**
 - ▶ Team effectiveness
 - ▶ Team efficiency
 - ▶ Shared Situational Awareness

Hypotheses

Hypotheses on main effects

Hypotheses 1a – 6a (Individual characteristics):

A team's preference for (1a) Extraversion, (2a) Sensing, (3a) Thinking, (4a) Judgment is positively related to team performance.

A team's (5a) internality is positively related to team performance.

A team's (6a) Ambiguity Tolerance is related to team performance in an inverted-U-shaped way.

Hypothesis 7 – 8 (Team characteristics):

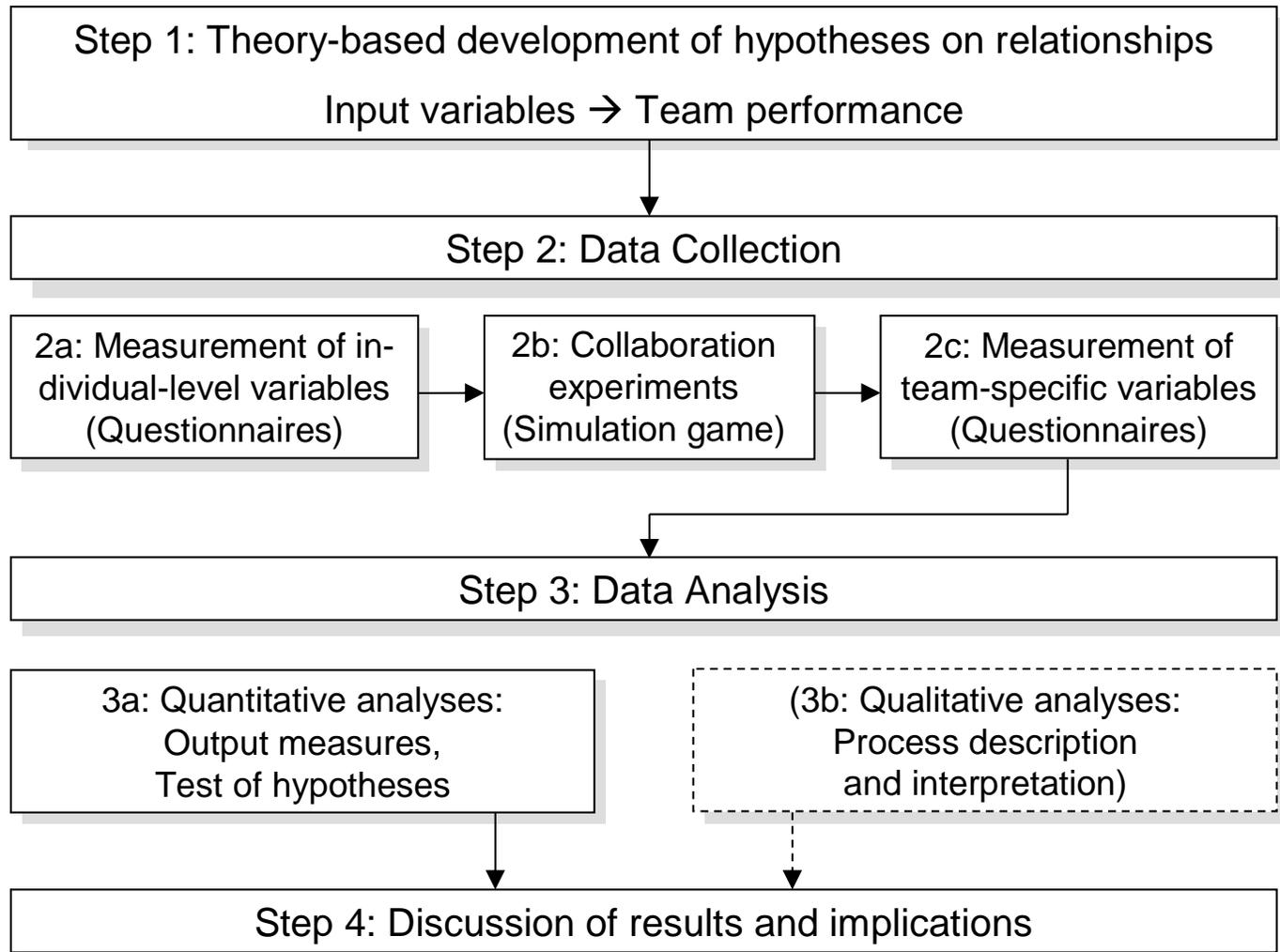
A team's level of (7) social cohesion, (8) task cohesion is positively related to team performance.

Hypotheses on moderator effects

Hypotheses 1b – 6b:

The higher a team's heterogeneity in (1b) Extraversion, (2b) Sensing, (3b) Thinking, (4b) Judgment, (5b) Internality, (6b) Ambiguity Tolerance is, the lower will be the correlation between the team's average in this variable and team performance.

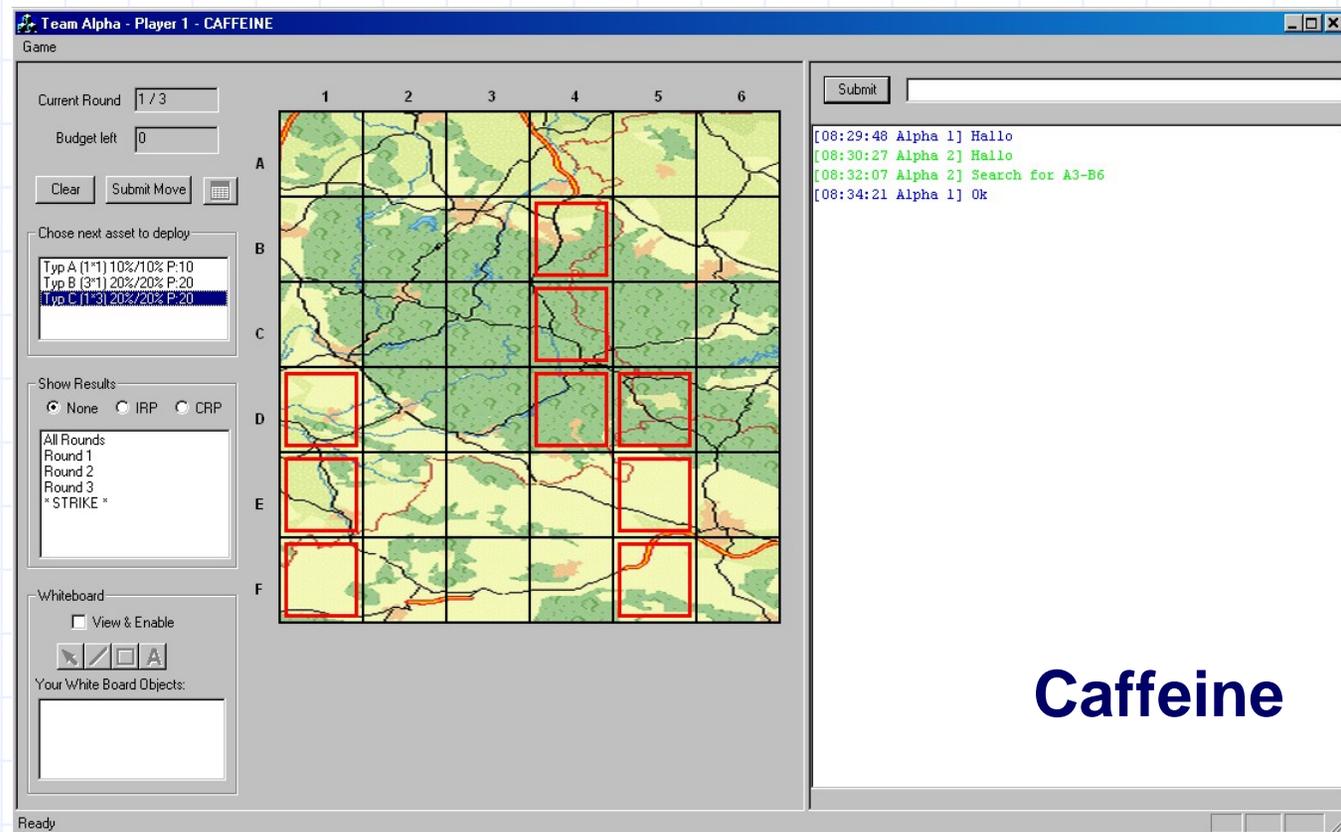
Research Design



Measurement of Collaboration

CAFFEINE:

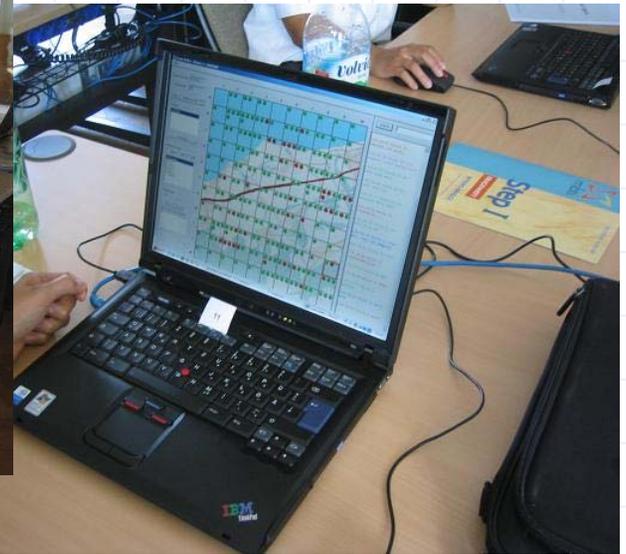
Collaborative Game for First Experiences in a Networked Environment
Software for assessment of distributed team performance



Caffeine

Setting

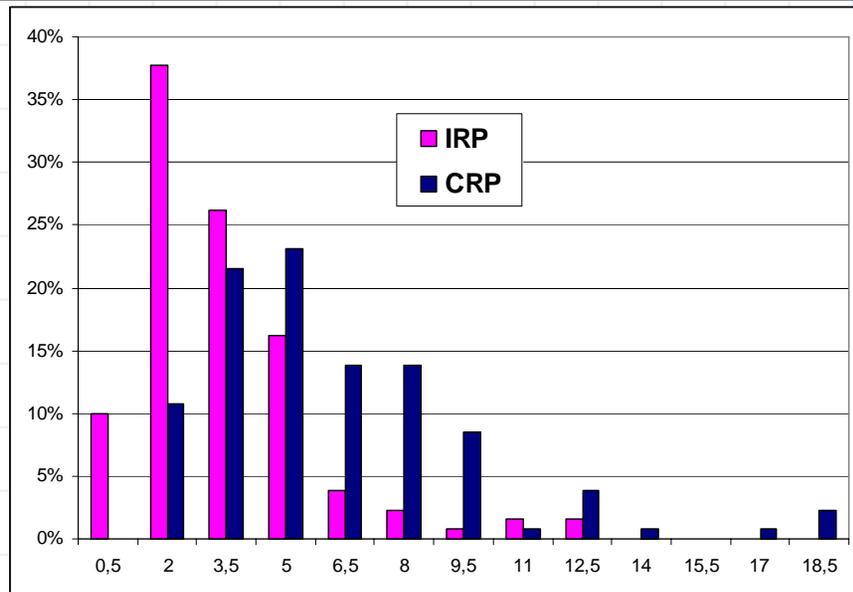
- Teams of four locally distributed individuals
- Local computer networks
- Goal: Collaborative solution of a predefined team task
- Two different conditions: Common Result Picture (CRP) vs. Individual Result Picture (IRP)



Comparing CRP and IRP

	Minimum		Maximum		Average		s. d.		T ^a
	CRP	IRP	CRP	IRP	CRP	IRP	CRP	IRP	
Hits	12	9	20	20	24.3	21.1	3.4	4.2	- 8.52**
Fail	0	0	14	20	4.5	7.4	3.3	4.5	7.60**
Time (sec.)	135	158	1053	1599	452	643	177	258	9.45**
Chat	0	0	65	156	17.6	28.4	12.8	19.0	9.18**
Budget	0	0	485	385	165	125	96.0	86.0	- 5.26**
TEF	0.5	0.0	17.8	11.7	5.4	2.6	3.4	2.2	-10.13**
SSA	1.46	1.38	4.00	4.00	3.2	2.7	0.58	0.69	- 7.44**

^a T-Tests for paired samples; ** p < .01



Variable Intercorrelations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1. Extraversion – Introversion	(.81)																	
2. Sensing – Intuition	.28**	(.67)																
3. Thinking – Feeling	.34**	.25**	(.81)															
4. Judging – Perceiving	-.33**	-.22*	-.16 ⁺	(.82)														
5. Locus of Control (internal)	-.06	.07	-.06	-.13	(.74)													
6. Ambiguity Tolerance	.04	.28**	.17 ⁺	-.15 ⁺	.05	(.76)												
7. Intellectual ability numeral	-.01	-.06	.19*	.06	-.08	-.07	(.92)											
8. Intellectual ability figural	-.14	-.18*	-.14	.07	-.07	-.05	.28**	(.71)										
9. Social Cohesion	.19*	.15 ⁺	.10	-.14	.20*	.11	-.06	-.00	(.86)									
10. Task Cohesion	.15 ⁺	.15 ⁺	.09	-.06	.16 ⁺	.08	-.10	.03	.88**	(.81)								
11. Age	.00	-.09	-.07	.12	-.40**	-.05	.04	.02	-.14	-.09								
12. Females in the team	.17*	.14	.03	.05	-.04	.21*	-.19*	-.04	.08	-.02	-.16 ⁺							
13. Task effectiveness CRP	.03	-.02	-.02	.18*	.18*	-.01	-.02	.01	.31**	.36**	-.15 ⁺	.04						
14. Task effectiveness IRP	.14	.15 ⁺	.08	-.01	.09	.09	-.06	.11	.45**	.55**	-.14	-.09	.38**					
15. Task efficiency CRP	.22*	.07	.07	.08	.19*	-.04	.06	-.06	.27**	.24**	-.19*	.04	.69**	.25**				
16. Task efficiency IRP	.20*	.08	.03	.01	.11	.07	-.07	.08	.31**	.39**	-.18*	.03	.25**	.68**	.44**			
17. SSA CRP	-.03	.03	.03	.10	.15 ⁺	.05	.11	.03	.39**	.47**	-.11	-.11	.77**	.40**	.50**	.22*		
18. SSA IRP	.15 ⁺	.17 ⁺	-.01	.06	.17 ⁺	.05	.01	.21*	.46**	.54**	-.16	-.06	.38**	.73**	.28**	.51**	.43**	

Pearson correlation coefficients are reported; scale reliability scores are reported in the principal axis;
Significance levels (two-sided): ⁺ p < 0.10; * p < .05; ** p < .01

Regression Results (CRP)

Independent and Control Variables	Task effectiveness			Task efficiency			Shared Awareness		
	R ²	β^a	T	R ²	β^a	T	R ²	β^a	T
(Absolute term)			.18			.01			-.24
Extraversion – Introversion		.15	1.44	.30	3.07**		.04		.40
Sensing – Intuition		-.02	-.20	.03	.26		.05		.46
Thinking – Feeling		-.01	-.13	-.01	-.12		.01		.09
Judging – Perceiving		.26	2.74**	.22	2.38*		.16		1.67+
Locus of Control internal	.10	.18	1.88+	.16	.17	1.81+	.08	.13	1.35
Ambiguity Tolerance		.02	.22	-.03	-.38		.08		.85
<i>Intellectual ability numeral</i>		-.02	-.23	.07	.78		.09		.89
<i>Intellectual ability figural</i>		.03	.28	-.04	-.44		.02		.17
Age		-.11	-1.10	-.16	-1.69+		-.09		-.91
Number of females		-.01	-.12	-.03	-.28		-.14		-1.48

^a Standardized Beta (regression weights); Significance levels: + p < 0.10; * p < .05; ** p < .01

Results (Task efficiency)

Main effects: Team performance (Task efficiency) is positively related to a team's preference for

(1a) Extraversion: **significant relationship contrary to hypothesis**

(2a) Sensing: **not supported**

(3a) Thinking: **not supported**

(4a) Judgment: **significant relationship contrary to hypothesis**

(5a) Internality: **supported**

(6a) Ambiguity Tolerance*: **not supported**

Team performance is positively related to

(7) social cohesion: **supported**

(8) task cohesion: **supported**

Moderator effects: The correlation between team average in a variable and team performance (Task efficiency) will be the stronger, the higher the team's homogeneity in this variable is.

(1b) Extraversion: **supported***

(2b) Sensing: **not supported**

(3b) Thinking: **not supported**

(4b) Judgment: **not supported**

(5b) Internality: **not supported**

(6b) Ambiguity Tolerance: **not supported**



Discussion and Implications (1)

Extraversion – Introversion

A strong tendency for Extraversion may be a disadvantage for team efficiency if only text chat is available as a communication medium.

Use of specified types of communication media require explicit consideration of personnel selection and training strategies.

Judging – Perceiving

Cognitive flexibility and willingness to adapt to changes in a complex and dynamic environment may be superior to acting in a decisive manner and training to reach conclusions quickly. This implies reconsideration of staffing policies and cultural change in order to adapt to scenarios of the 21st century.

Locus of Control

Agile organizations imply broad allocation of decision rights to self-organizing networked teams. Team members need to believe in their control over the outcomes of their actions. Leadership thus needs to provide teams with appropriate performance feedback and to support the emergence of a sense of team efficacy.

Discussion and Implications (2)

Social cohesion

Social cohesion may be a strong promoter of team performance even in randomly compiled “ad hoc” teams, implying that from the very beginning social cohesion is an invaluable asset for performance and bonding should be promoted in a sensible way.

Task Cohesion

Task cohesion, in particular shared commitment to the team goal and the super-ordinate mission purpose, strongly supports team performance. The more future C2 relies on delegating decision rights to “the edge”, the more training needs to focus on developing a sense of understanding of the significance of the mission.

Limitations and Suggestions for Future Research

- Sample characteristics: Homogeneous personality characteristics of the sample limit the significance of the results.
- Team composition: Random team selection precluded a controlled composition of teams to permit systematic variation of independent variables such as homogeneous and heterogeneous teams. Future test series should schedule evaluation of individual characteristics of participants so that results are available in time for focussed team selection.
- Findings require further qualification on the basis of a qualitative evaluation of the observed collaboration processes.
- Future research needs to provide answers to questions such as
 - the role of increasing task complexity,
 - the impact of intercultural differences on collaboration in multinational teams and between teams of different nations,
 - the role of mission-specific training and/or field experience of team members.



Measuring Shared Situational Awareness

$$SSA = \frac{\sum_i x_i}{\sum_{\{i|x_i \geq 1\}} 1}$$

i = index of cells

x_i = number of players designating cell i to contain a target

- SSA measure adopted from Stahl and Loughran (2002).
- SSA becomes a maximum (equal to the number of players in the team), if all players nominate the same set of cells as target cells.
- No shared awareness if each player nominates a unique set of cells as containing targets (SSA = 1).

Measuring Task Efficiency

$$TEF = \frac{(2 * hit - fail)^2}{time}$$

- Equation assumes that task effectiveness described by the numerator accounts for both targets being hit and, to a lesser degree (expressed by the higher weight for hit), countermanding risks associated with potential collateral damage when non-target areas/cells are being hit.
- Squaring the net gain accounts for the additional cost per shot, in the sense of time and effort to be spent for successful targeting, as the number of shots increases.
- Assuming time to be the decisive resource determining task efficiency, rather than the number of shots fired or the reconnaissance budget spent, reflects the importance of time sensitive targeting in a dynamic operational environment.

