Command without Commanders

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Outline

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The analysis of C2 as a function opens up new possibilities

- *Brehmer*: C2 is the function that provides direction and coordination
- *Alberts*: Distinguish between command as a verb and as a substantive
  - Focus and convergence
- When seen as a function, C2 does not imply that there is a commander
- Self-synchronization emerges as a possibility

Defining self-synchronization (1)

- *One example of this highly decentralized C2 calls for lower-level decisionmakers to be guided only by their training, understanding of the commander's intent and their awareness of the situation in relevant portions of the battlespace*. (Alberts, et al., 1999, p. 219)
- This definition says both too little and too much
  - It says too little in that it does does not tell us how to recognize self-synchronization
  - It says too much in that it includes preconditions for self-synchronization that are better left for a theory of selfsynchronization

Defining self-synchronization (2)

- *Self-synchronization is observed when a number of units achieve the direction and coordination necessary to handle a mission without a commander who directs and coordinates*
- Fighting forest fires as an example

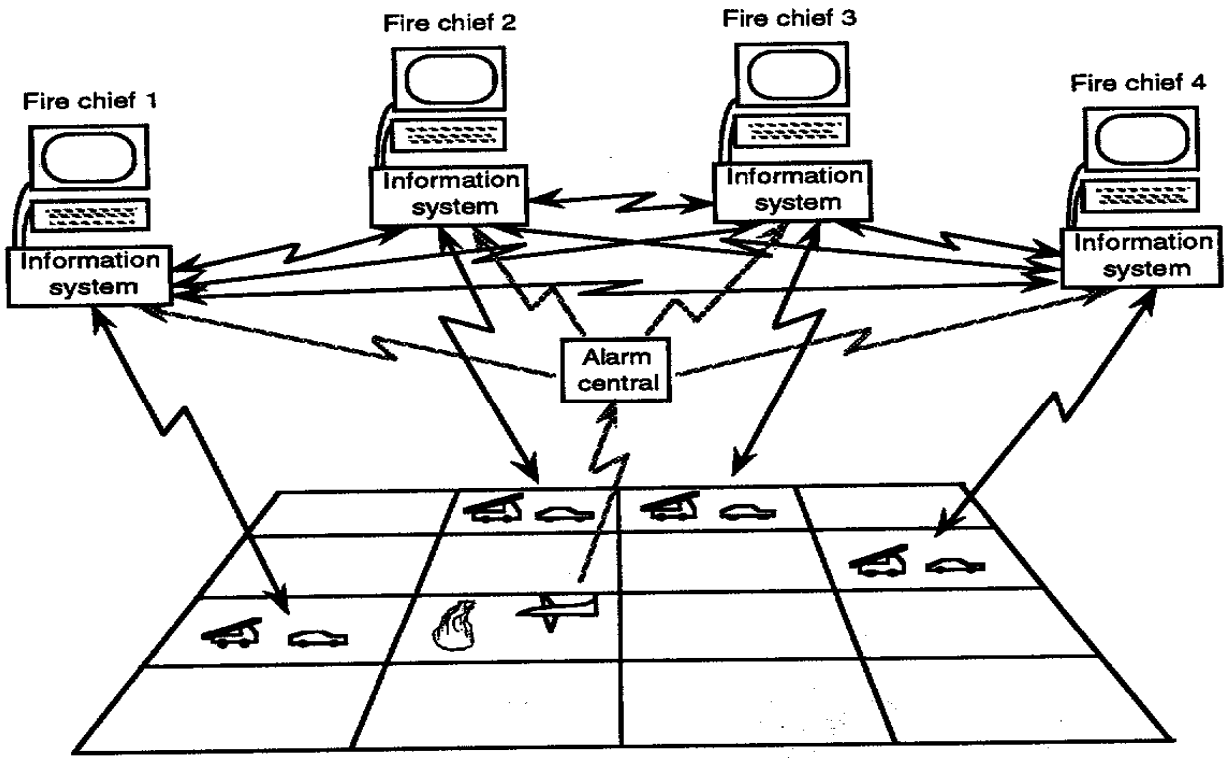
The need for a paradigm

- *A paradigm is an example that serves as a model pattern* (Dictionary.com Unabridged)
- It serves to identify examples of the phenomenon
- It defines (cf. Kuhn, 1962)
  - Fundamental questions that are asked about the phenomena of interest
  - What answers and results are relevant
  - How experiments are to be conducted
- A paradigm is not a theory, and it is never tested as such

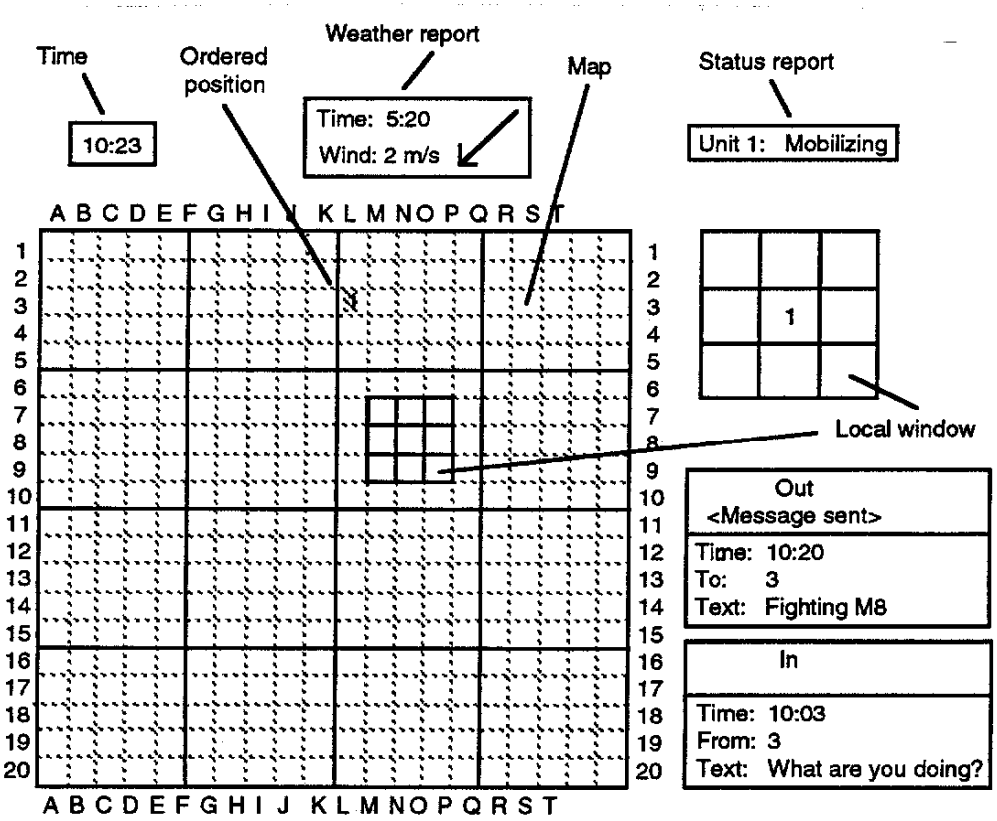
A paradigm for the study of self-synchronization

- Self-synchroniztaion is seen as a case of distributed decision making (Brehmer, 1991)
- The problems requiring distributed decuision making have five characteristics:
  - They are too large to be handled by a single unit, therefore requiring coordinated efforts from a number of units
  - The situation is dynamic requiring both planning and execution
  - Each unit own part of the resources that are needed to handle the problem, but no unit has complete control over all resources
  - Each unit has a limited view of the problem, and no unit can achieve an overall view of the problem without input from the other units
  - No unit commander has the authority to coordinate the other units

The operationalization



What the participants see: The interface



Dependent variables

- Effectivesness: the amount of forest lost to fire
- Time to extinguish the fire
- Communication among units

A first step towards a conceptualization of self-synchronization

- Guiding assumptions
  - A force starts with an understanding of its mission
  - The force has the ability to translate this understanding into tasks to be solved to accomplish the mission
- In D3FIRE
  - The participants know that their mission is to fight fires whereever they appear
  - They understand that fire spreads in the direction of the prevailing wind
  - They understand the need to coordinate their efforts to be able to fight the fire as a whole

Hypotheses

- The guiding assumptions suggest a number of hypotheses and questions for experimental investigation
  - An overall view of the fire and the positions of the other units will facilitate self-synchronization
    - Is it possible to achieve the necessary view from communication among the units?
    - Synchronization takes time. Information should be future-oriented, e.g., have the form of intentions

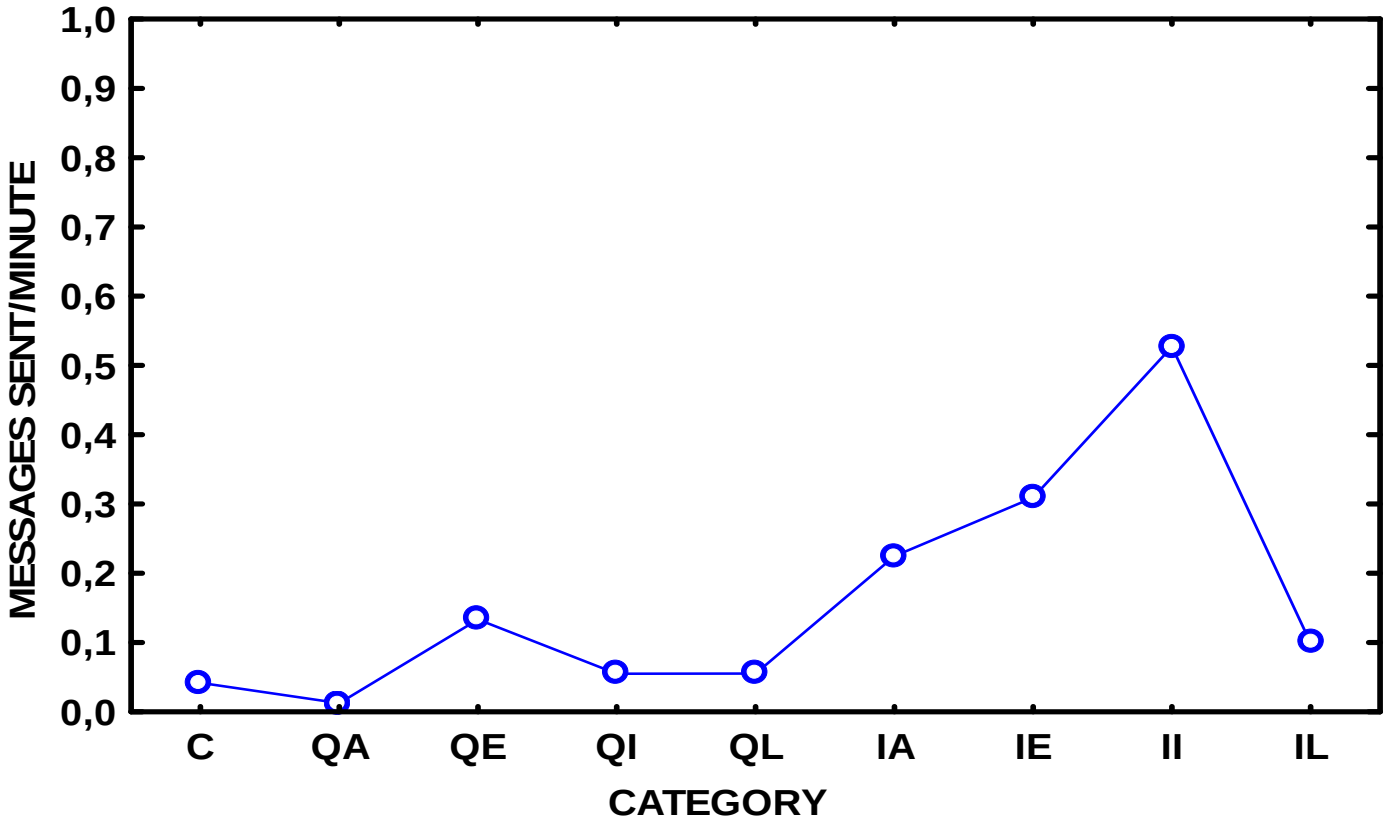
Empirical demonstration: 4 Experiments

- Experiments with D3FIRE
- Self-synchronization must be given an operational definition. This requires an adequate control condition. A no-communication condition was chosen as a control in all experiments.
- In all conditions, the participants were university students, male and female, 20-30 years old.
- They worked in teams of four participants.
- They were given 20 minutes of practice and then worked on three experimental fires
- Number of cells lost to fire is the measure of performace
- There are six or four teams in each experiment
- No significance tests are performed, Cohen's d is used as a measure of effect throughout the series of experiments

Experiment 1: The effects of being networked

- Compared a condition with six teams where each participant was free to communicate with everybody else to a no communication condition also with six teams
- The participants received a message from a spotter plane about when and where a fire had started. They were limited to what they could see in their ”windows” and what they could receive from communication with the other participants in the team (if communication was allowed)
- The teams in the experimental condition performed better than those in the control condition (68.3 vs. 82.7, Cohen’s d = 0.84, a strong effect)
- This provides a demonstation of self-synchronization

Message traffic



Experiment 2: Making one of the participants a commander

- Compared the networked condition from Experiment 1 with a networked condition where one of the participants in each team had been given the role of commander and the other team members were instructed to obey his/her commands. There were six teams in each condition.
- Performance was worse when there was a commander (74.6 vs. 68.3, Cohen's d = 0.52, a moderate effect)
- May be due to problems of handling the dynamics (Brehmer, 1997)

Experiments 3: Blue force tracking

- Participants in the blue force tracking condition were given information on their screens about the positions of other units, but were not allowed to communicate, and they received no information about the fire, except for what they could see in their ”windows”. Their performance was compared to that in the standard no communication control condition. There were four teams in each condition
- Participants in the blue force tracking condition performed better than those in the control condition (74.8 vs. 82.7, Cohen’s d = 0.45, weak to moderate effect)
- Participants in a networked, full communication condition performed better than the participants in the blue force tracking condition (68.3 vs. 74.8, Cohen’s d = 0.60, a moderately strong effect)
- This suggests that more useful information was communicated in the full communication condition than in the blue force tracking only condition

Experiment 4: Augmented blue force tracking

- Participants in the augmented blue force tracking condition were given information about the position of the other units and their intentions in the form of an indication of the cell to which they had ordered their unit to travel. Their performace was compared to that of a standrad no communication control condition.
- Performace was better in the augumented blue force tracking condition than in the control condition (63.6 vs. 82.7, Cohen's d = 1.06, a strong effect) and better than the participants in a networked, full communication condition (63.6 vs. 68.3, Cohen's d = 0,27, a weak effect)
- These results suggest that augmented blue force tracking added very little to what was achieved by ordinary communication

Conclusions from the experiments

- The results of the experiments agree with our expectations
- They demonstrate the positive effects of networking and of communicating intentions
- There was no effect of blue force tracking alone, but then there was no friendly fire either

General conclusions

- The present paradigm offers a means for the study of self-synchronization
- It differs from ELICIT in that it examines actual coordination. ELICIT studies the effects of communication of shared situational awareness.
- D3FIRE is only one possible operationalization. For example, DKE, a two-sided computerized war game, offers an alternative to those who need a more active opponent than a fire

Questions and/or comments?