

Functional Modeling of Agile Command and Control

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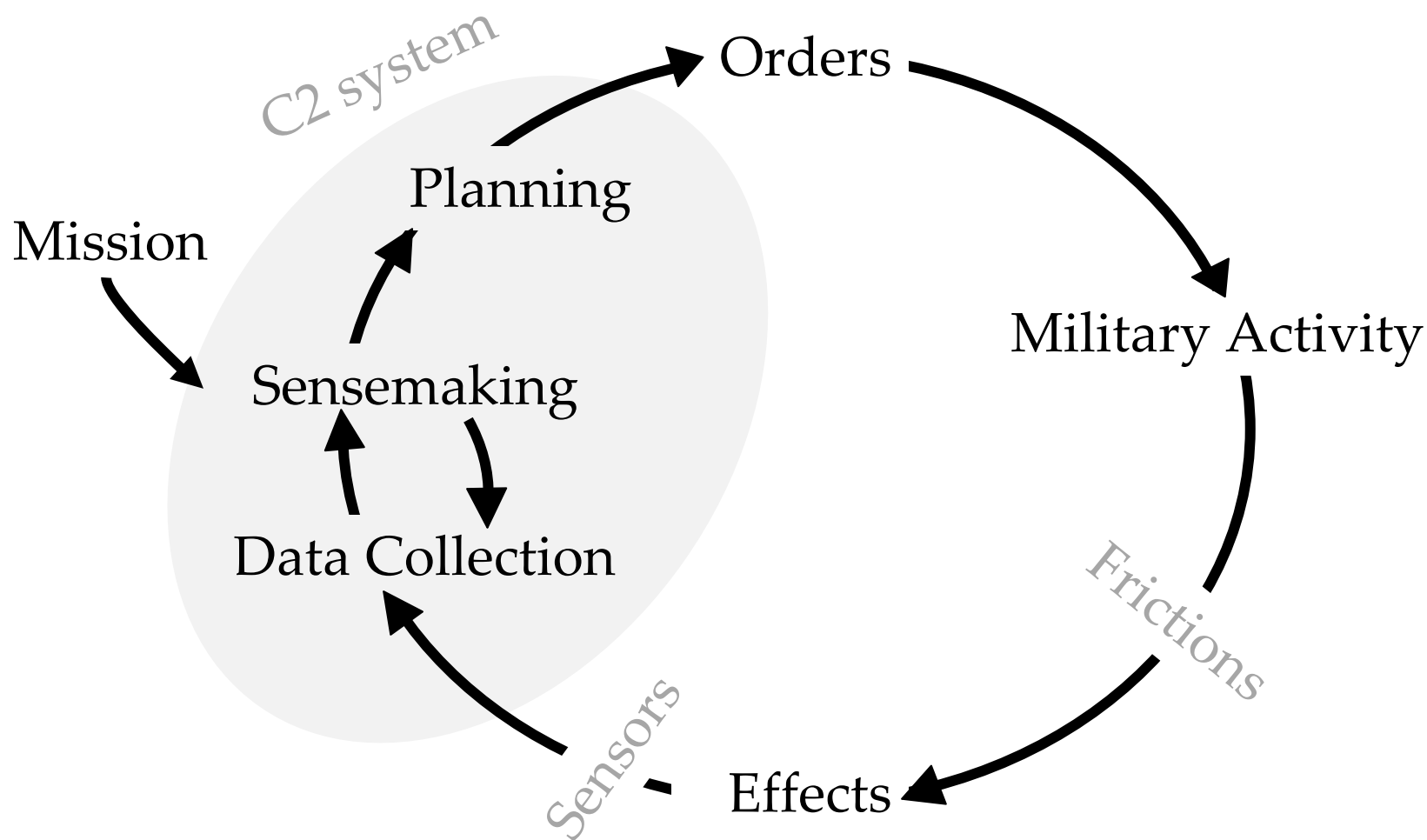
Two Challenges

- ◆ Two of the challenges to understanding agile C2 are
 - (1) the adoption of a detailed description of dynamic interdependency and associated understanding of interdependent functions (Brehmer, 2007) and
 - (2) the application of that description to both own and opponent forces' opportunities and vulnerabilities to provide for agility and resilience (Alberts, 2007)

Purposes

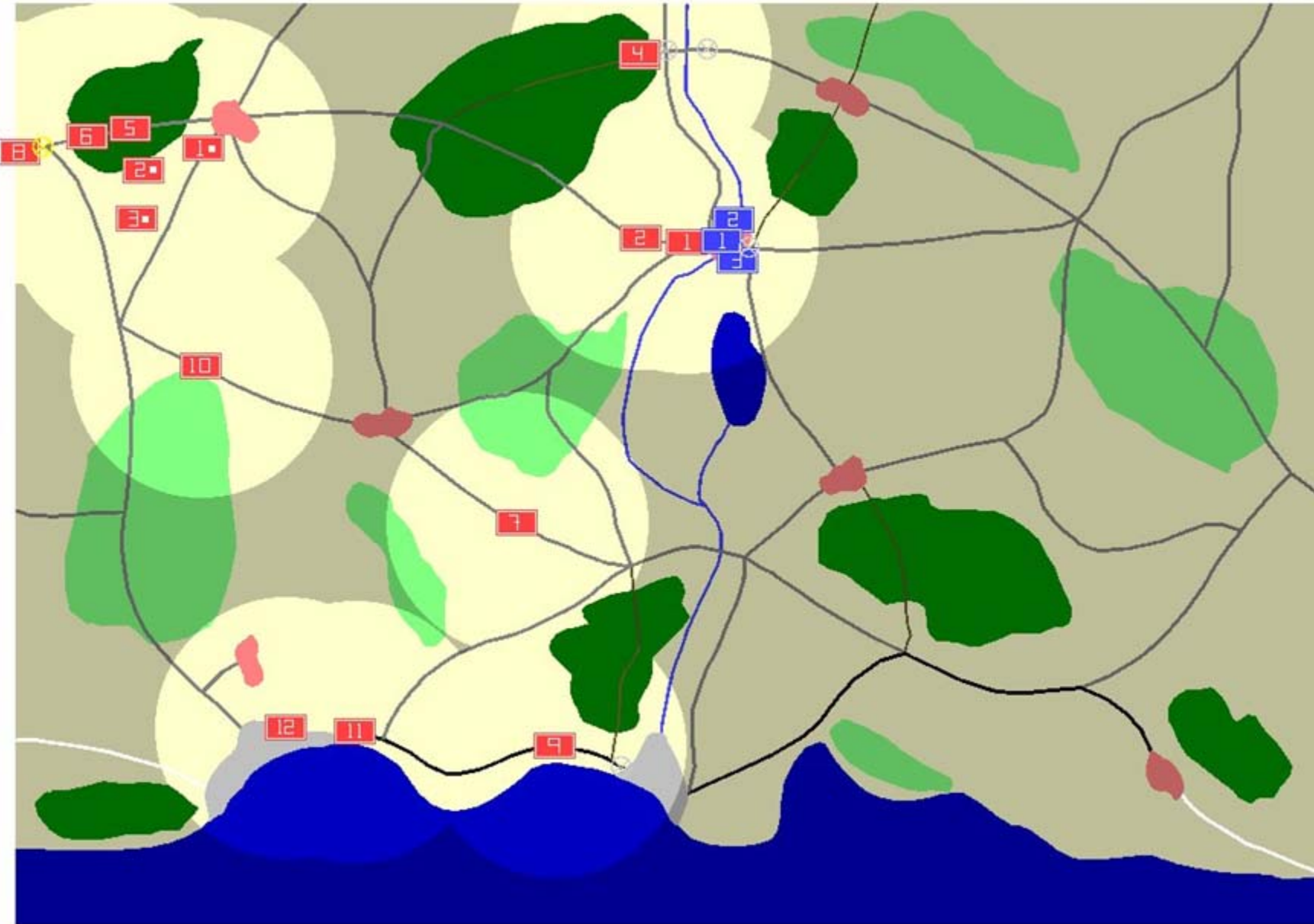
- ◆ This paper documents an approach to modeling dynamic functional interdependency.
- ◆ The Functional Resonance Analysis Method (FRAM; Hollnagel, 2004) is used to describe the C2 functions of the DOODA loop (Brehmer, 2007) and the tactical and operational functions of military activity.
- ◆ FRAM models are applied to own and opponent forces in a computer-based dynamic war-game (DKE) to reveal and characterize both agile and unsuccessful C2 practice.

Brehmer's DOODA loop

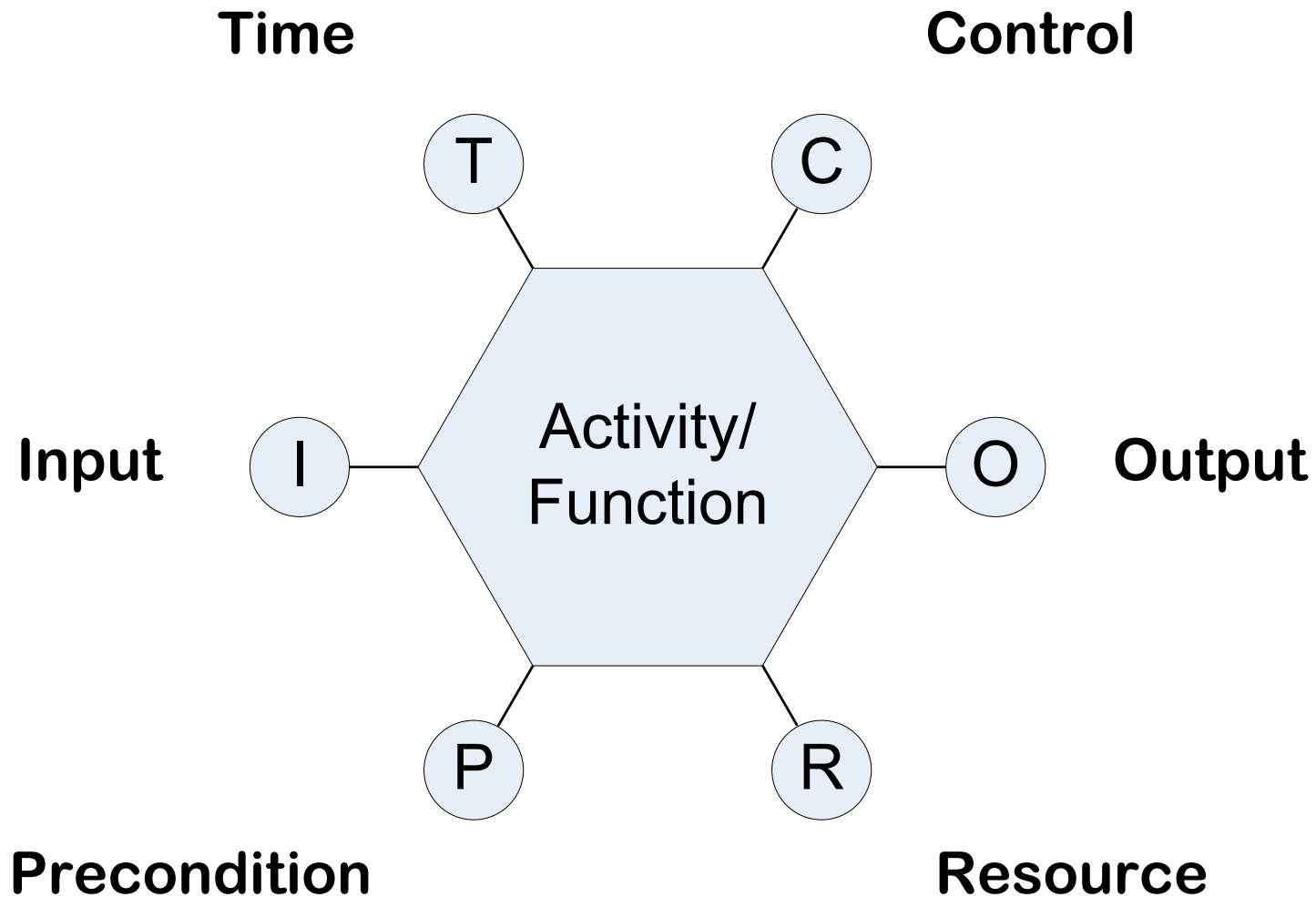


Dynamic Wargame for Experiments

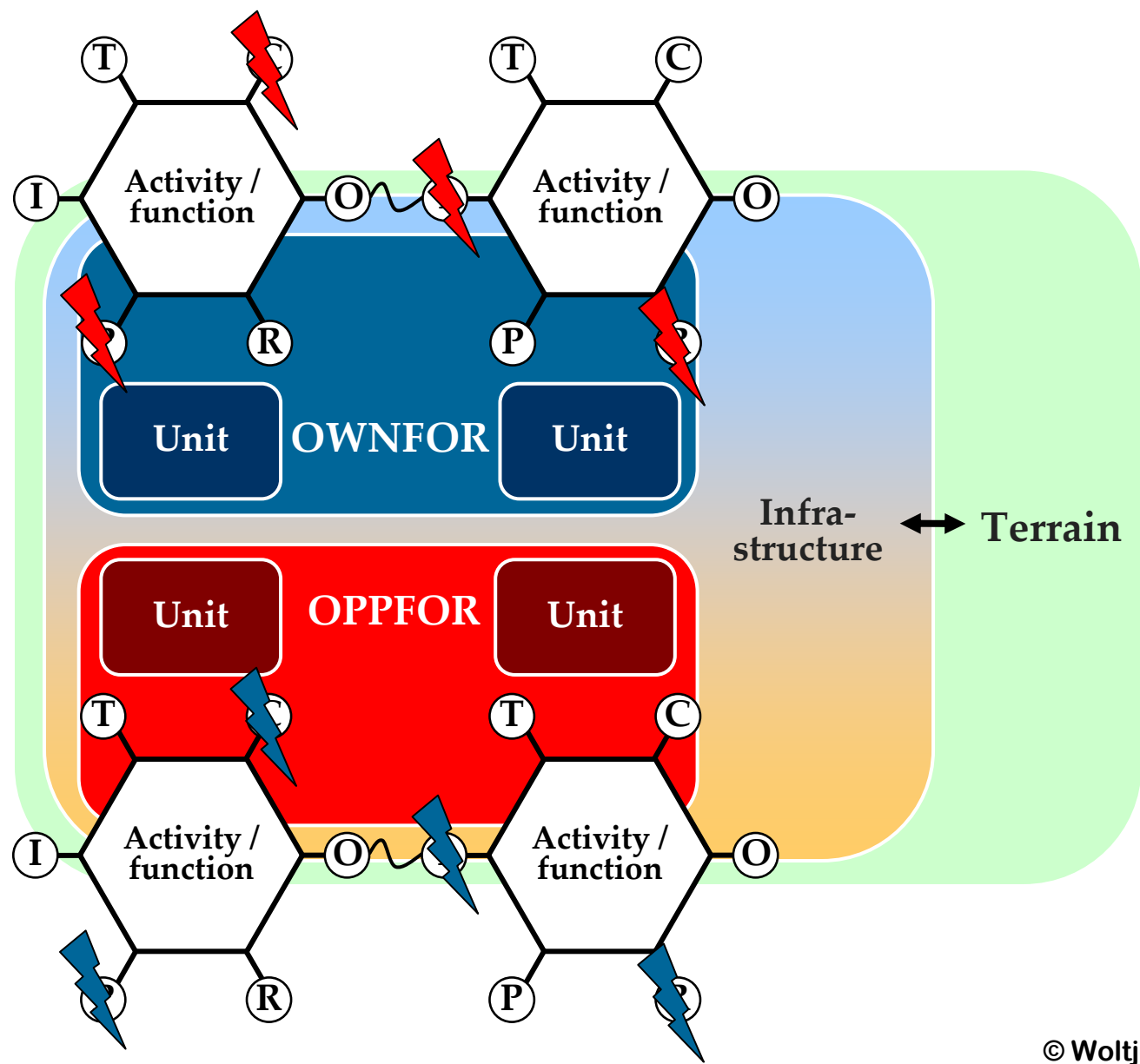
DKE (Kuylenstierna *et al.*, 2002)



FRAM Functional Unit (Module)



Functions and Adversarial C2



Example function: Move

| Move | Description | Essential Variables |
|---------------|--|---|
| Input | OWNFOR Unit | OWNFOR.Unit.Position, OWNFOR.Unit.TargetPosition |
| Output | <p><i>WHILE Active :</i> OWNFOR Unit's TacticalStatus is Moving OWNFOR Unit Position's Owner is OWNFOR OWNFOR Unit Position is changing</p> <p><i>AT FinishingTime :</i> OWNFOR Unit's Position has changed OWNFOR Unit Positions' Owner is OWNFOR</p> | Coordinate().Owner OWNFOR.Unit.Position and .TacticalStatus |
| Preconditions | OWNFOR Unit's TacticalStatus is not Fighting OWNFOR Unit's TacticalStatus is not Firing Artillery | OWNFOR.Unit.TacticalStatus |
| Resources | OWNFOR Unit's Fuel | OWNFOR.Unit.FuelLevel |
| Time | <p><i>Performance Time is a function of</i> OWNFOR Unit's Movement Type, OWNFOR Unit Position's Terrain Type, OWNFOR Unit's Fuel Level, and OWNFOR Unit Fuel Level's Speed Constant</p> | OWNFOR.Unit.MovementType, Coordinate().TerrainType, OWNFOR.Unit.FuelLevel |
| Control | Subordinate | OWNFOR.RoleAllocation |

Tactical & Operational

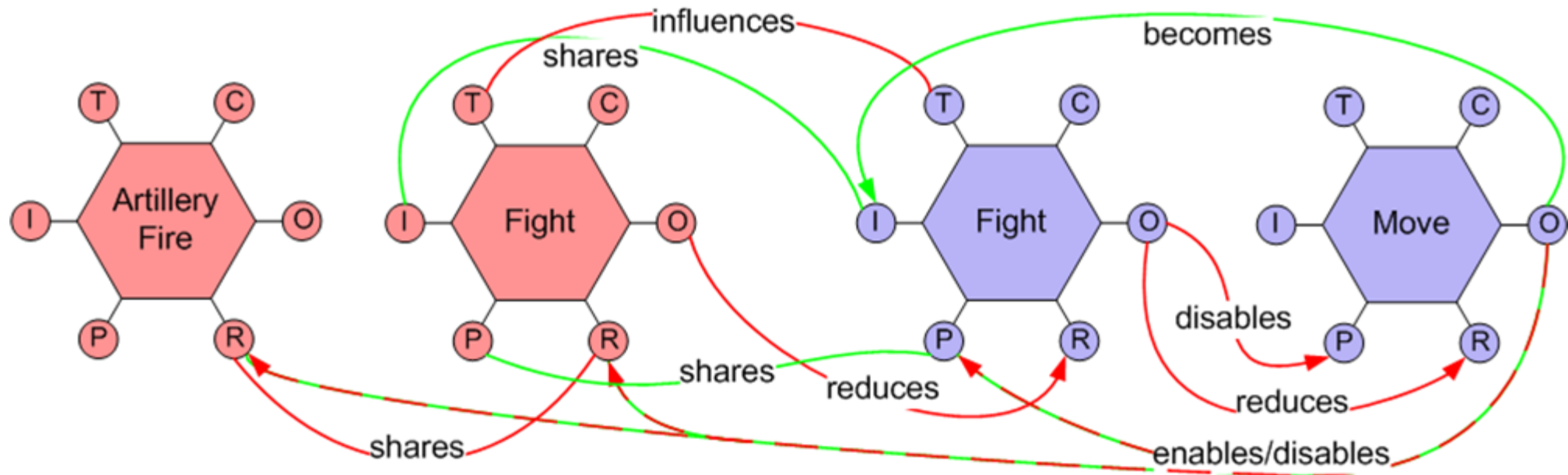
Tactical Functions

- Move
- Fight
- Artillery Fire
- Manage Resources

Operational Functions

- Take
- Keep
- Secure Road
- Raid
- Bypass
- Place Blockade
- ...

Links between tactical functions

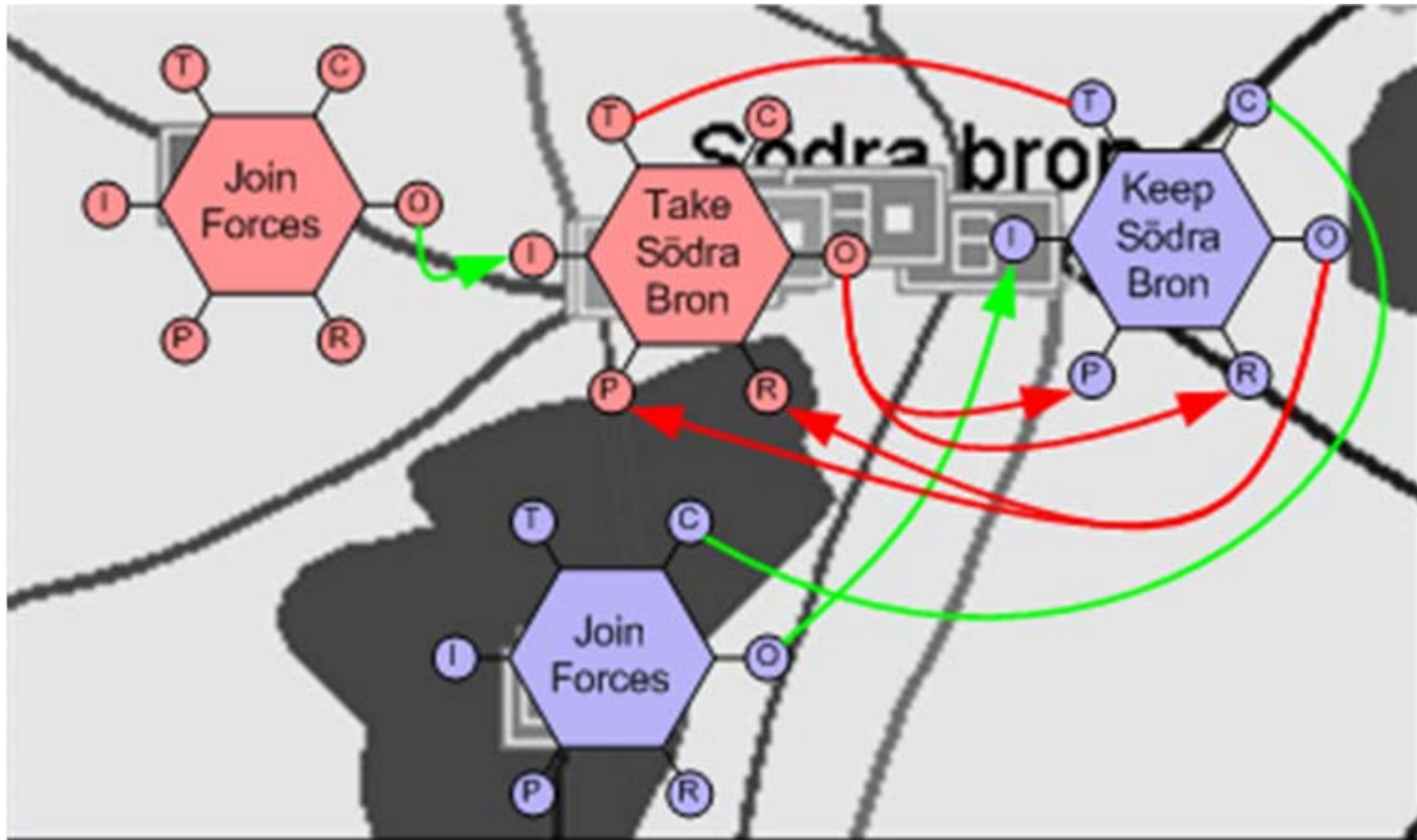


Example battle

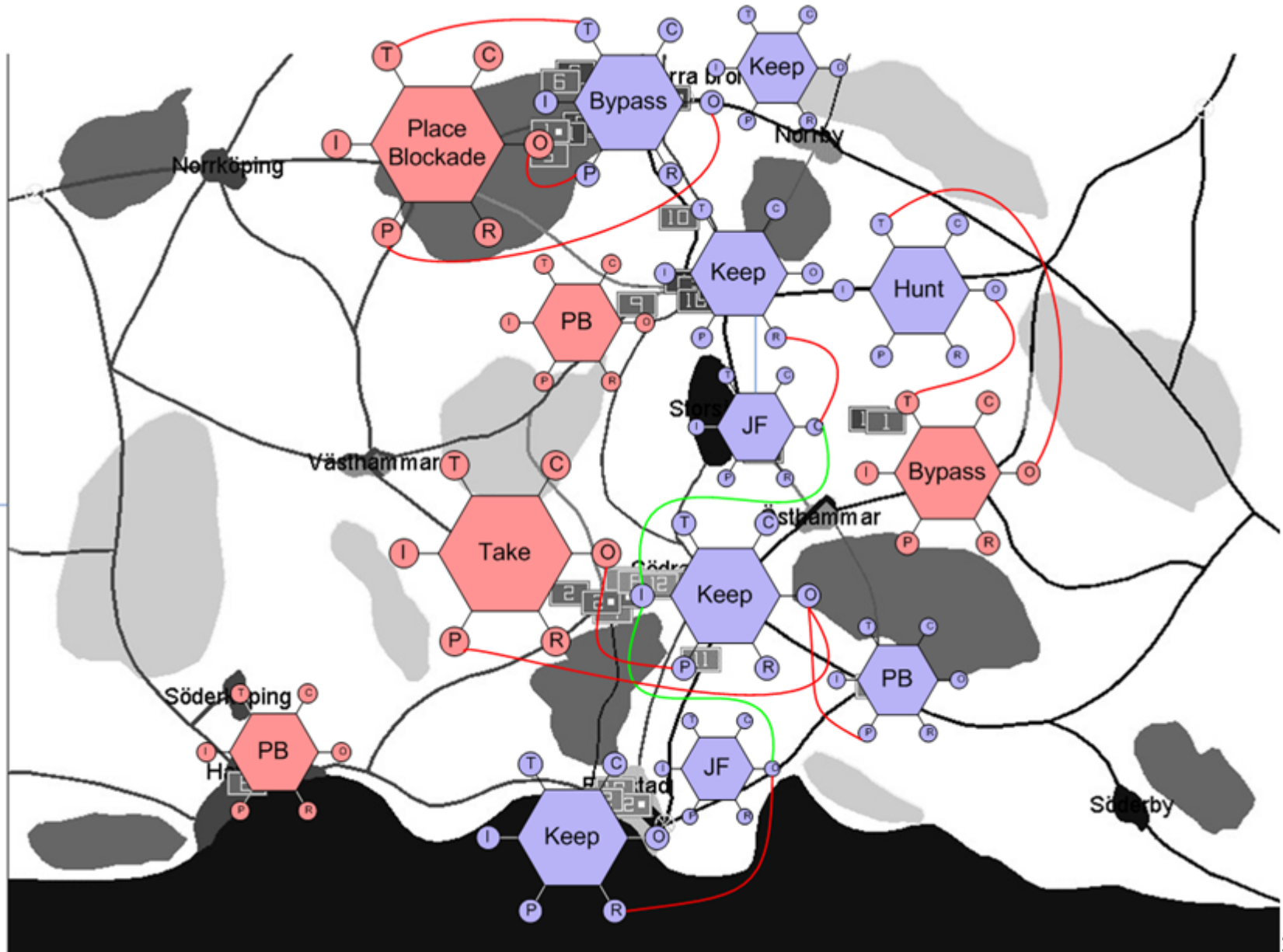


| Unit | Operational Function | Tactical Function | Target | Target state change | Armor (change) | Stamina (change) | Attack (change) |
|--------|----------------------|-------------------|--------|---------------------|----------------|------------------|-----------------|
| LbArt3 | Keep Södra Bron | Artillery Fire | LrStr8 | Disturbed, Loss | 5 (-1) | 5 (-1) | 9 (-1) |
| LbArt3 | Keep Södra Bron | Artillery Fire | LrStr7 | Disturbed | 6 (0) | 6 (0) | 10 (0) |
| LbArt3 | Keep Södra Bron | Artillery Fire | LrStr6 | Unchanged | 6 (0) | 6 (0) | 10 (0) |

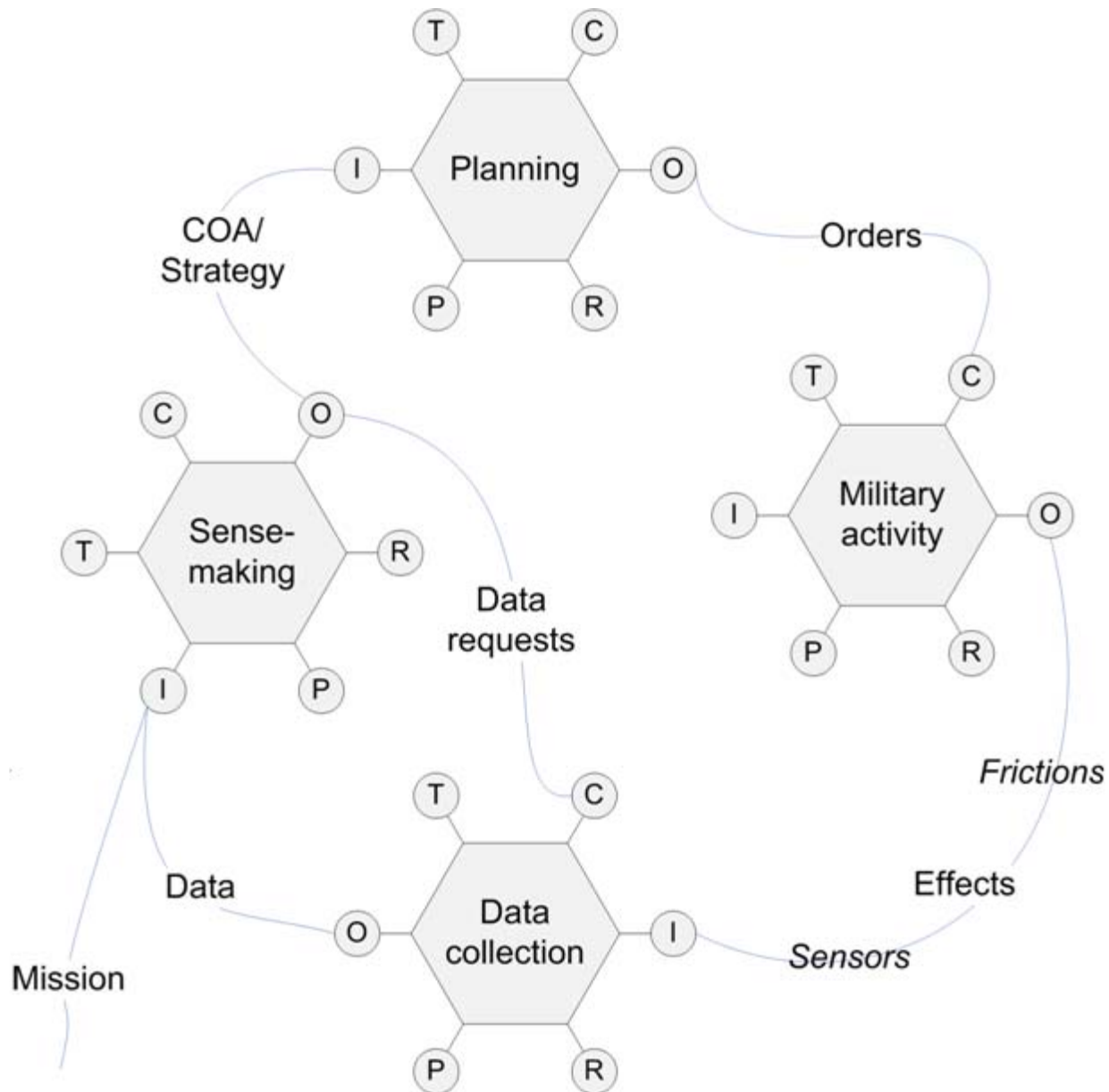
Example battle



Trial modeled with FRAM, overview



DOODA in FRAM



Summary

- ◆ FRAM models address the two challenges:
 - (1) the adoption of a detailed description of interdependency and associated understanding of interdependent functions (Brehmer, 2007) and
 - (2) the application of that description to both own and opponent forces' opportunities and vulnerabilities to provide for agility and resilience (Alberts, 2007).

Conclusions (1)

- ◆ FRAM's way of functional modeling is suitable for modeling functions at various levels.
- ◆ Brehmer's DOODA loop may be developed into detailed specifications of functions through FRAM, for understanding interdependencies.
- ◆ FRAM has the potential to describe and analyze functions involved in adversarial C2, in order to identify strengths and weaknesses in function performance on both sides.

Conclusions (2)

- ◆ The FRAM methodology has been successfully extended to allow for the description of military activity and steps have been taken to describe the link to command and control functions.
- ◆ Data collected during a war-game experimental simulation may be used to develop a functional model, and can be organized in a functional manner following the FRAM function description.

Future Work

- ◆ The method may be a useful tool for retrospective evaluations of simulated and actual operations that seek to understand the functions that shaped performance in battle.
- ◆ The method may be a useful planning tool for analyzing own and opponent strengths and weaknesses.
- ◆ The method could be refined by conducting studies of simulated and actual military operations, in order to reach its full potential.