



## Exploring Collaboration in Large Groups of Autonomous Systems

MP018-1 demonstrates that in large groups of autonomous systems (AS), interactions and conflicts between several task/group factors (e.g. structure, actors, goals, resources) introduce a level of complexity that must be managed to ensure effective collaborative flow. Mechanisms to identify, address, avoid and resolve conflict (a key component of collaboration) are discussed in detail. Following this, further obstacles for collaboration in mixed (i.e. AS and human) groups are outlined and some of the drawbacks of contemporary approaches to overcome these obstacles (i.e. employing humans in a primarily supervisory capacity) are also discussed. MP018-2 proposes a conceptual framework in which coordination and communication processes mediate the relationship between conflict mechanisms and group/task structural factors and resources. By systematically exploring this framework within a plausible implementation scenario characterised by coordination, communication and conflict, a comprehensive list of 48 capability requirements is proposed to enable large homogenous groups of AS to identify, address, avoid and resolve conflict.

### Aim

To identify and understand capability requirements for collaboration in large homogenous and heterogeneous groups of autonomous systems (N<=100)

### Approach

These papers represent an initial exploratory exercise conducted to identify key capability requirements for large groups of autonomous systems as well as a conceptual framework to guide future empirical work

### Outcomes

- A comprehensive list of 48 capability requirements for large groups of autonomous systems to identify, address, avoid and resolve conflicts.
- Refinement of a conceptual framework relating group/task structural factors to conflict mechanisms

### Current work

Building on previous work in MP003 which developed and tested capability requirements for autonomous systems (AS) engaged in small group collaborations, current work on MP018 has:

**Described** some of the benefits of large mixed collaborative groups, such as the potential to achieve:

- Improved and more efficient task/group:

Coordination    Management    Performance

- Increased flow – i.e. full group immersion in the task and a feeling of energised focus and full task involvement

**Identified** several pertinent characteristics of large group collaborations for consideration, including:

- Structure** (e.g. group, task, organisational)
- Actors** (i.e. AS, humans)
- Goals** (e.g. implicit/explicit)
- Actions** (i.e. activities necessary for task completion).
- Resources** (i.e. other requirements for task completion)
- Spatial/temporal distribution** (e.g. co/remote location, intermittent communication)

**Demonstrated** the level of complexity that ensues when these factors complement, interact and/or conflict with each other

**Explained** some of the costs of contemporary approaches to manage this complexity, in which humans have been employed in a supervisory capacity. Including financial costs (e.g. operator training), cognitive costs (e.g. reduced situation awareness) and task costs (e.g. delays, errors)

**Highlighted** the importance of understanding conflict mechanisms when studying large group collaborations

#### Proposed

1. A conceptual framework for future consideration of large collaborative groups of autonomous AS (see figure 1 opposite)

2. Potential mechanisms and associated capability requirements for AS to:

Identify, address, avoid and/or resolve conflict

Change to mission

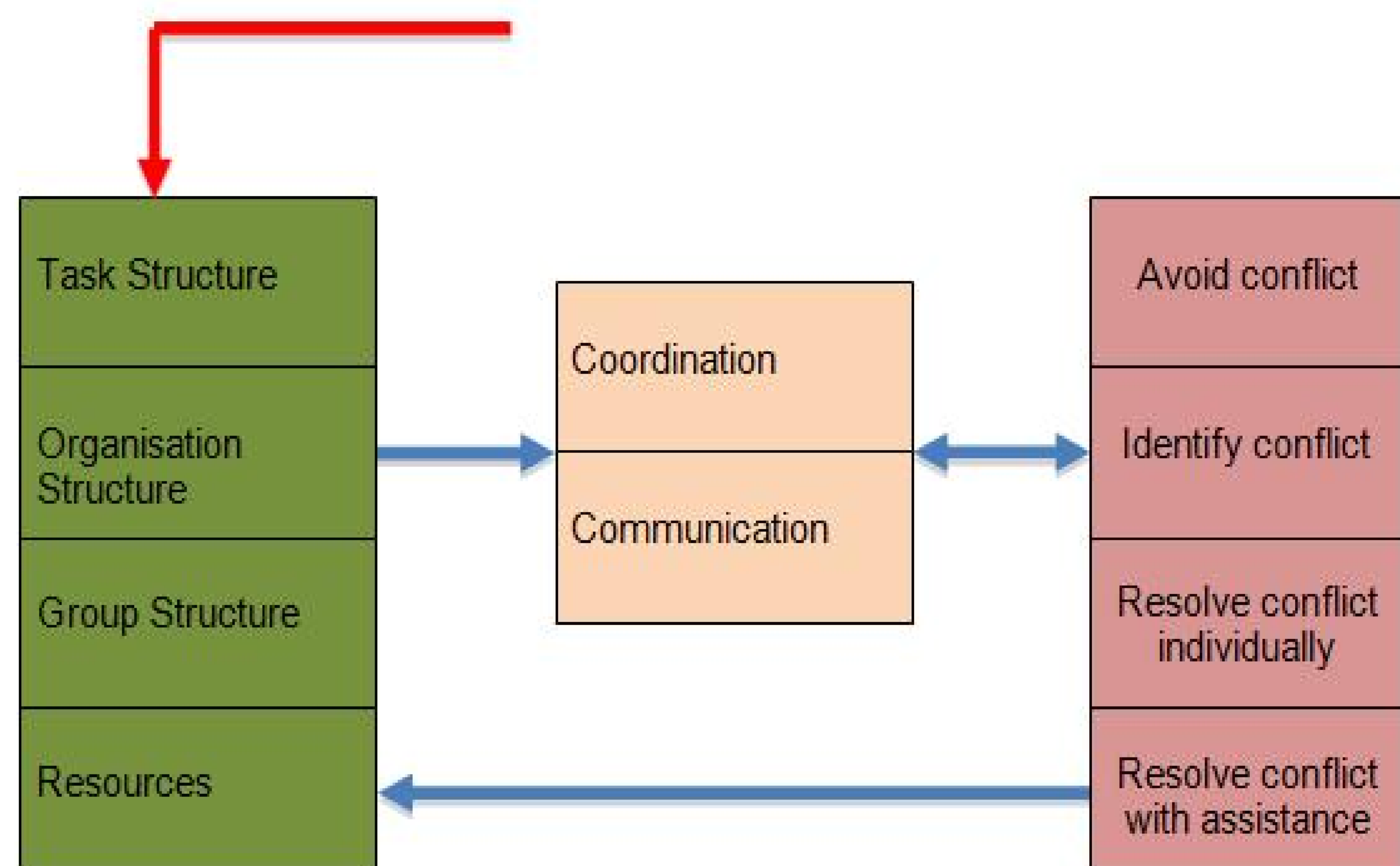


Figure 1 : conceptual framework for future consideration of large collaborative groups of autonomous systems

### Future work

It is anticipated that future work on MP018 will:

1. Systematically **test** the effects of perturbations within each stage of the above framework using large groups of simulated AS. This will involve varying:

- task structure (e.g. implicit/explicit goals and sub-goals)
- group structure (e.g. joiners/leavers, spatial/temporal distribution of actors)
- organisational structure (e.g. type of structure, level of autonomy)
- available resources (e.g. fuel, processing power, communications bandwidth)
- communication (e.g. continuous/intermittent, data abstraction level)
- co-ordination (e.g. task/group scheduling)

2. Based on testing these perturbations, **demonstrate** the utility of the previously proposed capability requirements for conflict mechanisms

3. As necessary, **re-assess** and/or **refine**:

- Proposed conflict mechanisms and/or capability requirements for these
- Framework structure, content and/or pathways

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