Scalable Multiple Robot Task Planning with Plan Merging and Conflict Resolution

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Inroduction

This demo introduces a domain-independent approach to deploy a factored planning method and coordinate heterogeneous multiple robot systems, while executing complex plans. The system deploys the Coalition Formation then Planning framework in a real-world multiple robot system and evaluates plan merging algorithms.

Architecture

The architecture incorporates external
- Domain independent planners; and
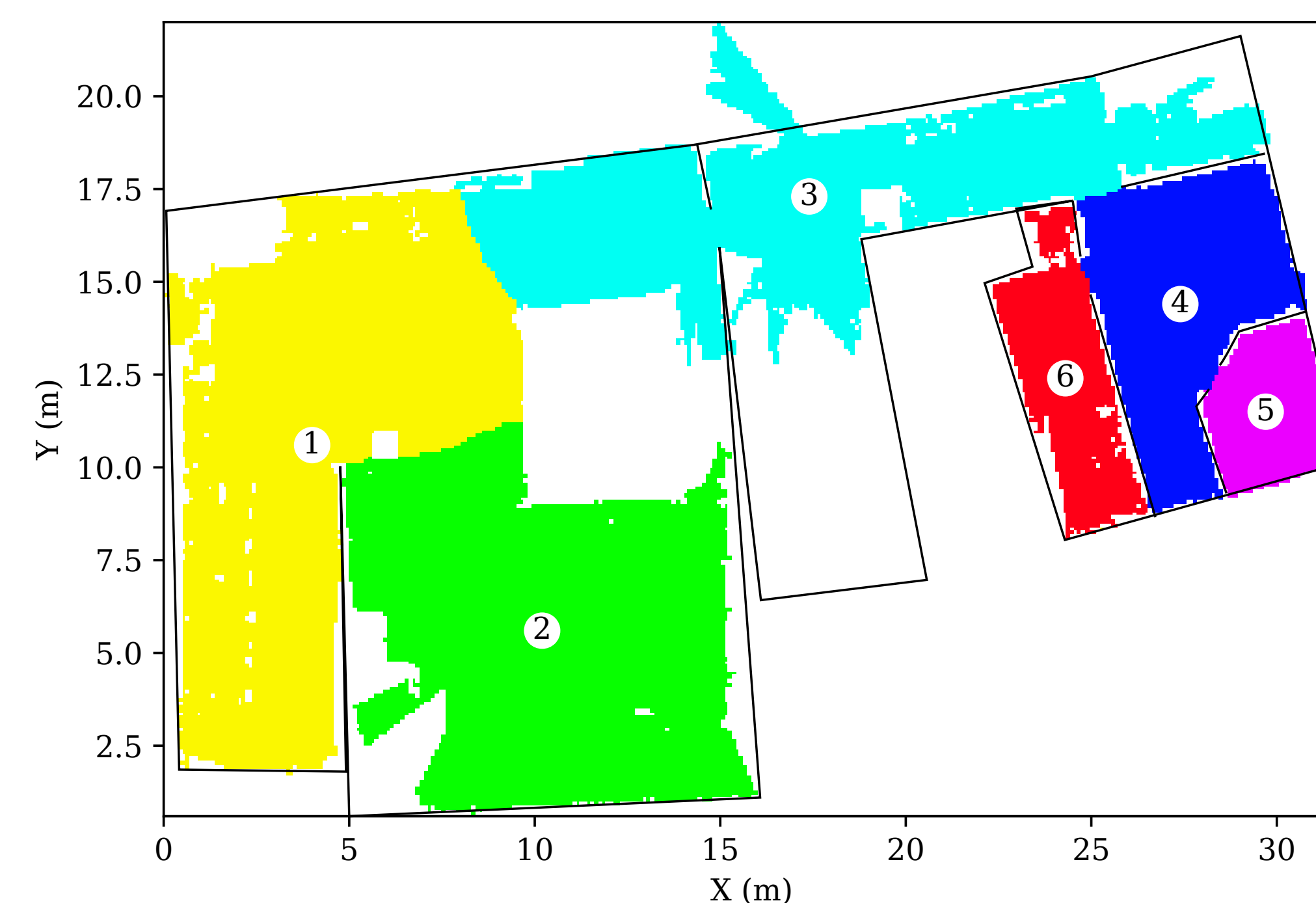- Coalition formation algorithms.

The robots coordinate at a high level during plan execution.
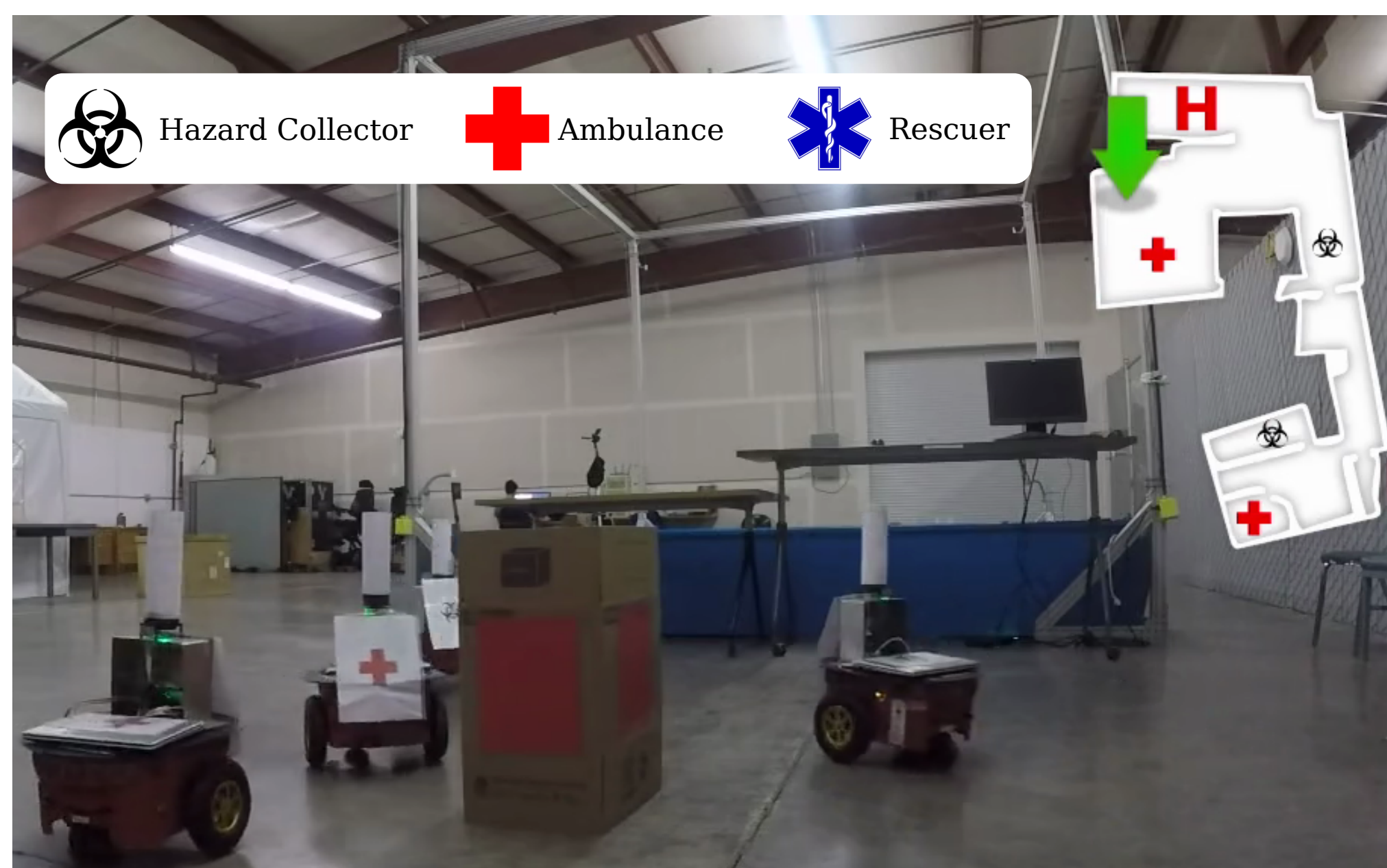
Experiments and Results

Plan merging algorithms evaluated with simulated real-world mission and multiple robots with specific capabilities.

Map partitioned with Voronoi segmentation, resulting in a topological map for high-level planning.

1. Tasks allocated using a dynamic programming coalition formation algorithm

2. Solved individually using the Actions Concurrency and Time Uncertainty Planner

The plan execution outcomes:
- **Success**: All robots completed their tasks and returned to the base; and
- **Failure**: Robots collided or failed to finish within a one-hour time limit.
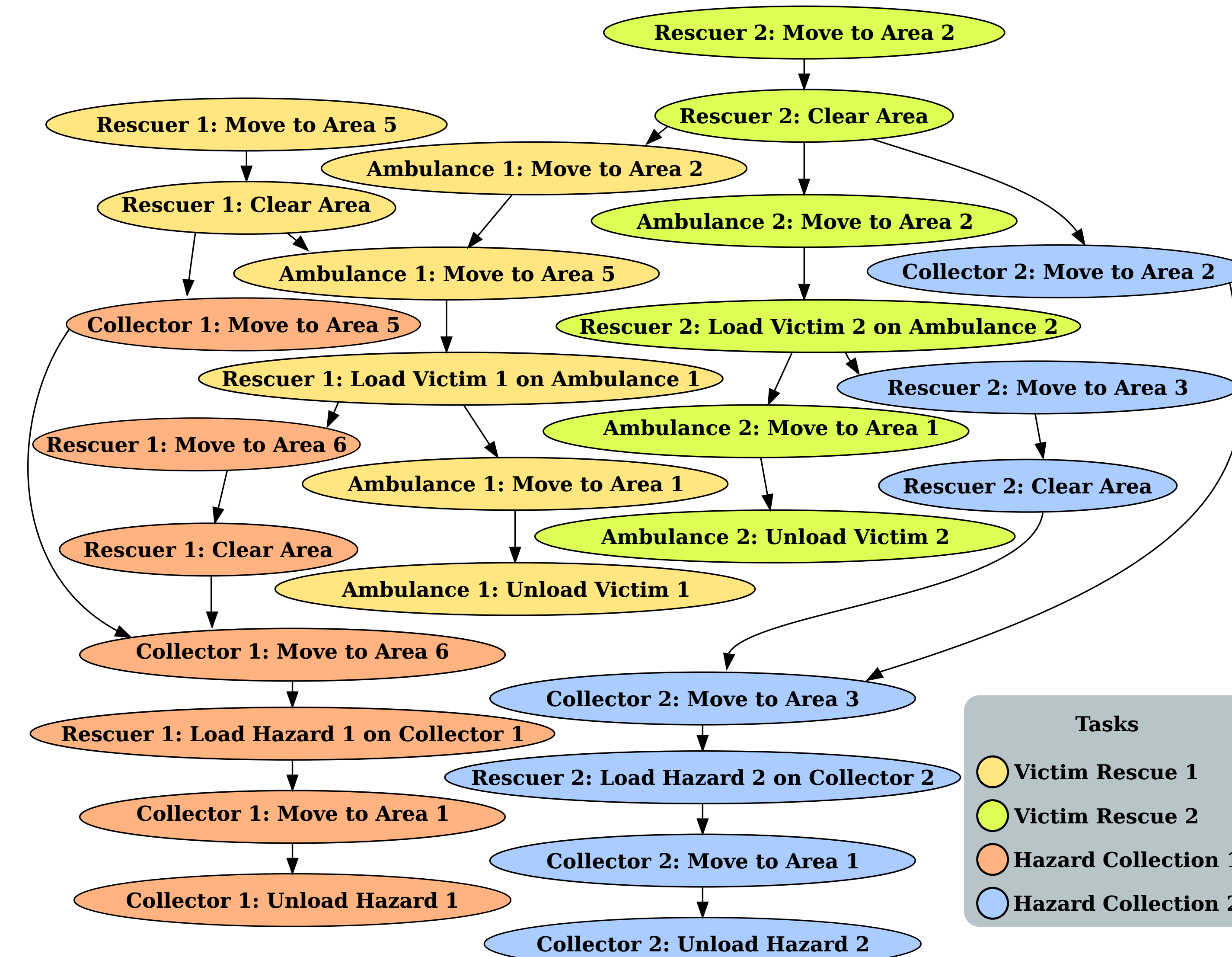
Independent variables:
- Serial Algorithm,
- STA Algorithm, and
- TCRA* Algorithm

Dependent variables:
- The rate of success; and
- The makespan.

The TCRA* algorithm maximized simultaneous action execution and resulted in the shortest plan execution duration. STA and the Serial Algorithm resulted in longer plan execution duration.

Table 1: Multiple Robot Makespan Descriptive Statistics.

Algorithm	Model	Transitive Closure	Success	Mean	Std. Dev.	Median
TCRA*	Direct	No	5/10	12m46s	00m51s	12m49s
		Yes				
	Transitive	No				
		Yes				
STA	Direct	No				
		Yes				
	Transitive	No	6/10	15m56s	00m28s	16m01s
		Yes	8/10	18m26s	01m02s	18m10s
Serial	N/A	N/A	7/10	25m40s	01m22s	26m00s