1. Introduction

Multi Agent Systems (MASs) consist of autonomous entities called agents that coordinate with each other to solve complex problems. Delegate MAS [1] is a bio-inspired coordination mechanism that is inspired from social insects that live in colonies, like ants and termites. It is geared at large-scale and dynamic coordination and control applications, such as decentralized traffic management and logistics. Agents in Delegate MAS are selfish in that they maximize the utility for their own objectives. Experience with Delegate MAS shows there could be additional benefit if agents would work in coalitions/teams. Using coalitions, the agents could handle dynamism in much better way and in more stressful situations. In this work, we present an empirical study in which we investigate whether to reduce selfishness of Delegate MAS, adding coalitions increases Delegate MAS performance. We used dynamic Ready Mixed Concrete delivery (RMC) problem as a case study. The empirical study includes defining input scenarios of our case study into unique characteristics. We have found that adding coalitions increases the stability of schedules of trucks. With respect to research in agent coalitions, our work is closely related to Ramchurn's work [2].

2. Case Study: Dynamic RMC

Dynamic RMC is a scheduling problem that is subcategory of pickup and delivery problems in logistics. Scheduling for RMC problem in a dynamic environment is a challenge because the information changes in real-time. There are hard constraints while devising truck schedules due to the perishable nature of concrete. For instance, the time between the successive deliveries of an order may not exceed 30 minutes. Consider a truck is broken down during its delivery to an order, and the construction is already in progress. This introduces a dynamic event. A new truck needs to be scheduled which also has to abide by the constraint of not exceeding the time beyond 30 minutes from the last delivery. A software to generate feasible schedules is required that optimizes resource utilization.

3. Approach

We address dynamic RMC problem by developing decentralized software for scheduling trucks. It is a MAS simulation, in which Order agents and Truck agents generate schedules by coordinating with each other. Delegate MAS is used as a coordination mechanism, which makes agent behave selfishly. We analyzed that Truck agents may need to work in coalitions, rather than selfishly. Inspired by theories of agent coalitions, on top of Delegate MAS, we defined commitments and conventions for our agents. The Truck agents that commit to make deliveries for an order make a coalition with commitments. In case of a dynamic event such as a truck breakdown, the agents in the coalition would follow the associated convention and thus collectively handle dynamism in the constrained environment. Figures 1 and 2 give some insight into our decentralized software.

4. Results and Discussion

A Thorough evaluation is conducted to investigate the two coordination mechanisms; Delegate MAS Sole (DMS) and Delegate MAS Coalitions (DMC). RMC instances are defined into characteristics of Scale, Dynamicity and Stress. Typically a Scale of 15 with Dynamicity 20% means 15 trucks are operating having 20% chance of truck breakdown during the day. Stress indicates load of deliveries. Stress value of 1.0 is affordable for a given scale.

Results show that both mechanisms generate identically optimized schedules but using coalitions truck schedules are less often disturbed. With the increase of Stress, DMS is more unpredictably disturbed as compared to stable pattern of DMC. We conclude that using coalitions, trucks have relatively stable schedules during the day.

References

