Commentary on: Peer-to-Peer Planning for Space Mission Control

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Introduction

This paper by Javier Barriero, Grailing Jones Jr, and Steve Schafer focuses on making multiple continual planners interact to manage activities in an International Space Station (ISS) demonstration scenario. The main premise of the paper is that different planning disciplines motivate different planning domains (and possibly algorithms), and these planning processes interact to manage the global system. In the case of the demo scenario, two planners were used:

- Europa for crew planning and
- Aspen for power planning.

The crew planner focuses on maintaining the On-Board Short Term Plan with a one-week horizon. This plan has a stable outline that repeats daily for each astronaut. Within this daily routine certain activities, like medical conferences and maintenance, repeat regularly. There are also specific payload and other complex activities that are inserted into these routines. One objective in crew scheduling is to keep the plan as stable as possible to maintain a good quality of life for the crew, but some times external events happen that affect the schedule.

The power planner focuses on managing the generation, conditioning, and supply of power in the ISS. This plan typically repeats on each 92 minute orbit with special modes controlling the solar panels in different situations like during insolation, eclipse, extra vehicular activity (EVA), docking maneuvers, waste dumps, and collision avoidance maneuvers.

These two planners affect each other and can cause changes in each other's schedules. An EVA is scheduled in the crew planner, but if it can affect power to the point where the power planner has to shed loads, which affects other crew activities. Within the reported demo scenario, each planner has an agent wrapper, and these agents negotiate over needed changes.

The demonstrated system was implemented in C++ using a CORBA middle-ware infrastructure. This demonstration showed that much of the burden of maintaining an on-board short-term plan can be automated – enabling the management of larger systems by an operations staff. Finally, this system was demonstrated to controllers at JSC and received favorable comments.

Lingering Questions

How well will things scale to more mission control disciplines?

While the demo scenario only involved two planners, the paper lists fourteen interacting ISS mission control disciplines. According to Milind Tambe (1), maintaining coordination among three or more complex agents gets quite difficult. The two in he example scenario were complex enough, but fourteen ISS mission control disciplines were listed in the introduction.

How will the agents interact on different time scales?

The demo focuses on just the one-week on-board short-term plan, but different planning processes start months in advance and are not continual.

What about tightly interacting plans?

The demo had rather loosely interacting plans, but a related paper discusses a case where the EVA planner and the power planner tightly interact to replace a DC-to-DC converter unit.

Conclusions

This paper was quite well written, and is just full of interesting detail underlying the continual maintenance of short-term plans as they are executed. Fitting this into the larger context of the ISS planning process should be interesting since it deals with other non-continual planning processes.

References

Milind Tambe: Towards Flexible Teamwork. J. Artif. Intell. Res. (JAIR) 7: 83-124 (1997)

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