

Decision-Making Support for Maritime Business

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ABSTRACT

A near real time multi agent based system for scheduling ocean fleets has been developed. The ocean scheduling problem has relatively low numbers of cargos and vessels to deal with but it is highly complex in terms of constraints and numbers of options. It also has a high rate of events affecting the schedule and different fleet operators have differing goals for the parameters of their schedule. This variability is dealt with by storing knowledge of this in ontology.

Categories and Subject Descriptors

H.4.2 [Information Systems Applications]: Types of Systems – decision-support, logistics.

General Terms

Management, Decision-Making, Measurement, Performance, Design, Economics.

Keywords

Multi-agents, semantic web, decision making logic, ontology, agent negotiations, virtual market, event-driven continuous planning, near real time incremental planning.

1.INTRODUCTION

Based on the multi-agent and semantic web technologies, Magenta's Ocean i-Scheduler exhibits behavior that is fundamentally different from behavior of conventional schedulers. For example, it: refers to business domain knowledge while generating schedule options; reviews and if necessary modifies previously made decisions when a problem situation changes; plans users' activities (sequences, options, iterations) taking into account user defined goals, strategies and constraints; designs and conducts experiments to improve decision making; constructs models of problem situations; explains its decisions to users and works on scheduling continuously improving the specified enterprise value without a need to be switched on by users.

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2.DEMONSTRATED FEATURES

The Ocean planning and scheduling domain is characterized by:

- Typically a few (<10) orders per day to be planned
- One vessel carries one cargo
- One voyage has one collect and one drop operation
- Refueling (bunkering) is a critical operation
- Canals (Suez, Panama) have specific logic of operation
- All vessels have their own, unique parameters
- Voyages times measured in a few to over 100 days
- Many options to consider in planning, with scope to make changes to plans
- Multiple objectives for fleet schedule (minimize idle days, minimize days when ship carries ballast rather than cargo, and maximize voyage profits etc.)

The Ocean i-Scheduler uses agents operating in a virtual market place to generate options for assigning cargos to ships and options for dealing with events that affect the schedule. Events that can be handled include:

- arrival of new cargo
- cargo parameters changed
- vessel late
- vessel early
- cancel cargo
- vessel breakdown
- re-schedule cargo
- owner events such as Off-hire or Dry-dock

The system has agents representing vessels, ports, cargoes, and customers. They operate in a virtual market and use ontology to understand parameters of the fleet, ports and canals, and to understand the objectives of the fleet as a whole. Events are planned by creating a new agent to represent that event. Vessels which are potentially affected by the event are selected. For each selected vessel a new variant of the schedule is built. The variants are built using a journey time matrix and a set of scheduling algorithms. The scheduling algorithms are hierarchical in nature. First an 'Open Slot' search is carried out. Is there a vessel available to take the cargo at the desired time? If not is it possible to 'Shift' an existing cargo in time so that the vessel can then take the new cargo? If not is it possible to 'Swap' the cargo with another cargo and then reschedule the replaced cargo? This can involve a deep combinatorial analysis of swap options. The variants are ranked according to the decision making logic (DML) in the ontology. The DML is user adjustable and can be weighted towards optimizing several objectives as described above.

The agent negotiations are an auction type competition for resources. The market has a concept of virtual money that the

agents use in their negotiations. Demand agents bid for resources using their money. Decisions are made based on all agents trying to achieve the best return for themselves. The agents are created and destroyed on demand as events occur and new schedules accepted.

This incremental planning approach to new events allows near real time responses to events (typically options are generated in a few tens of seconds) and presents a human scheduler with a set of ranked options to choose from.

2.1 System Features Based on the Multi-Agent and Semantic Web Technologies

- Near real time incremental planning
- Decision making logic for defining user-specific preferences. This would typically be a trade of between minimizing costs, maximizing revenue, and maximizing customer service or service level agreements.
- Support of ocean-specific constraints (e.g. sizes of vessels versus port capabilities and canal sizes)
- Key Performance Indicator (KPI) calculation mechanism (fleet, vessel and voyage KPIs) and possibility to define, store and add new KPIs in ontology
- Event-driven continuous planning of fleet resources as demands (new orders) and fleet events occur
- Scheduling/rescheduling vessels according to “maximize profit of the fleet as a whole” criteria
- Support of scheduling of majority of ocean fleet events.

2.2 User Interaction with the System

- Rich visual and text based reports
- Support of main users: executive team, scheduler team, chartering team, IT team;
- Decision making audit trail that keeps records;
- Decision making queue that provides strong visualizations, simulations and analytics to help users compare schedule options, drill into details, consider how to overcome potential constraints and then make decisions that will be immediately be updated into fleet schedule;
- Web-based UI with multi-user environment.

3. RELATED PROJECT

The first commercial customer for Magenta’s Ocean i-Scheduler is Tankers International (TI), one of the largest VLCC (Very Large Crude Carriers) oil tanker pools in the world which is using Magenta’s multi-agent technology to schedule its fleet in real time. The oil transportation market is extremely volatile with transportation costs fluctuating on a daily basis. Therefore, TI has to be able to deal with unexpected circumstances and operate from

an optimized schedule. The Magenta’s Intelligent Fleet Scheduler allows TI to assess potential cargoes in the marketplace, match these against its vessels’ specifications and calculate voyage profitability. Within TI scheduling system, Magenta’s multi-agent technology works by allocating a single agent to each element of entire fleet. Unlike other traditional systems, agents are also able to resolve conflicts as they are not bound by rigid rules and work around problems. Furthermore, having presented the best solutions to the operations team, the agents continue to work to provide alternative solutions to ensure that any unforeseen factors, such as changing freight rates or vessel positions, are reacted to dynamically.

The multi-agent Intelligent Fleet Scheduler allows Tankers International to

- Dynamically schedule ships in a fleet to respond to new cargo opportunities in real time; plan/re-plan to find options and suggest a decision, support decision-making process for planning and implementing of these plans; react to unforeseen changes in contracts, coming of new contracts or canceling of existing ones; enable cooperation of several vessels for executing of one order;
- Capture scheduling knowledge that was previously kept in the head of one scheduling specialist;
- Simulate complex dynamic solutions on the market of oil transportation for the estimation of effectiveness of made decisions: “what-if”?
- Simulate individual behavior models of tankers, ports, routes and orders: agents find knowledge about these objects in their ontologies and flexibly adapt themselves to the current situation.

4. CONCLUSIONS

The following features provided by using the multi-agent technology will be demonstrated during the demo session:

- Near real time scheduling;
- Capturing of business domain knowledge and decision-making logic in the ontology;
- Scheduling engine supports complex planning features in a flexible way: canal passage, bunkering operation;
- Support of wide range of fleet events;
- Powerful mechanisms for KPIs calculation;
- Easy to play “what-if” games;
- Current workflow allows analyzing/comparing options and market opportunities;
- Web-based user-specific reports and dashboards
- Teamwork support.