Scheduling Earth Observation Activities In LEO Satellites Using Graph Coloring Problem

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***Abstract*—Scheduling system of low earth orbit (LEO) satellite operations is one of the important tasks performed in satellites. Satellite specific constraints, satellite priorities, revenue of certain payloads and special operations, as well as visibility conflicts are taken into consideration while generating the operations schedules in an optimum way.**

This paper uses graph coloring problem for earth observation satellite scheduling, where as earth observing operations have to be scheduled on several resources while respecting time constraint and taking the revenue of the operations into account with the objective of scheduling as many operations as possible within its time window. Then a tabu search heuristic is proposed for this coloring problem. The computational results indicate that this approach is typically effective to generate a near optimal and feasible schedule for imaging operations of the satellite.

Keywords- LEO Satellite, Scheduling Problem, Observation Activities, Graph Coloring Problem, Tabu Heuristic

I. INTRODUCTION

The mission of an earth observation satellite is taking photographs of specific areas to perform the user's requests. Satellite Scheduling is the problem of mapping mission jobs (such as observations, etc) to resources (satellites, etc). Currently, science activities on different satellites or even different instruments on the same satellite are scheduled independently of one another. As a given request of earth observation can sometimes be satisfied by several satellites, the problem is not separable by satellites. Instead, planning must be performed simultaneously by all satellites, to help to improve the utility of the expensive resources, such as satellites.

The problem consists of selecting and scheduling a subset of requests yielding the maximal sum of revenue subject to temporal constraints and resource constraints. Satellite scheduling problem differ from traditional scheduling problems in several ways. The most obvious difference is the fact that some of the resources such as satellites are orbiting the earth.

There has been plenty of research devoted to planning and scheduling a satellite by a variety of optimization techniques. Globus et.al. present initial results of a comparison of several evolutionary and other optimization techniques such as simulated annealing, genetic algorithm and so on. They found that simulated annealing is the best search technique [1]. Frank et.al. present a constraint-based approach to solve the earth observing satellite and proposes a stochastic heuristic search method for solving it [2]. Wolfe and Sorensen indicate the genetic algorithm is a lot slower but appears to create near-optimal schedules [3]. Agness et.al. show that this is a large and difficult combinational optimization problem which could be viewed as an instance of the valued constraint satisfaction problem framework [4]. Barbulescu et.al. in [5] compare local search methods against a genetic algorithm using data from the U.S Air Force Satellite Control Network, and show the genetic algorithm yields the best overall performance on larger , more difficult problems. Lin et.al. in [6] formulate the scheduling problem as an integer-programming problem and indicate that the approach is very effective to generate a near-optimal ,

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