Building flexible data download schedules for Agile Earth-observing satellites

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Résumé

Earth-observation satellites produce images of the Earth that are stored on board and then downloaded when the satellite can communicate with a ground reception station. The use of sophisticated onboard compression algorithms makes the amount of data resulting from an observation very variable. Until now, timed data download plans have been built on the ground, sent to the satellite and executed on board without any change. The current way of dealing with the data volume uncertainty is to consider maximum volumes. That makes the data download plans always consistent but also very sub-optimal since data volumes are often lower than maximum.

The data download problem that we consider is a hard scheduling problem with scheduling constraints ranging from unsharable resources to time-dependent processing times and specific constraints such as data encryption. The goal is to schedule file downloads during visibility windows, meeting the constraints while minimizing information age and promoting the fair sharing of the satellite usage between users.

The goal of this work is to share the decision-making process between ground and board by producing partially-instantiated plans on the ground which are then completed on board. On the ground, we have enough computing power and time but a high level of uncertainty about file volumes; on board, we have limited computing power and time but the uncertainty is far less prominent since many acquisitions have been already performed and their volumes are known.

We present several levels of flexibility in which decisions are distributed between ground and board and we show their advantages both from the algorithmic and operational (performance, predictability) points-of-view.

Mots-Clés: planning, scheduling, embedded systems, flexible decision, making, agile earth, observing satellites, artificial intelligence

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