# Addendum 6: Solving Problems that Matter. A Solver Selection for Ster V3

## Goal

The goal is to find the right solver for Ster. To establish which Solver suits our business needs best, Ster organizes a contest with a few 3rd-party Solver products. The commercial Solvers will be compared on a benchmark, where price and quality (performance) are objectively tested.

## Scope PoC

Ster will use the Solver for two related optimization problems. Ster needs to calculate multiple optimal (financially) break schedules per day. When the initial composition of a break is finalized, an appropriate fitting sequence for these spot positions needs to be additionally determined.

First - Ster needs to calculate optimal break fulfilment. Matching available commercial airtime to packages sold. Based on the inventory prediction (estimated ratings), running campaign results and the requirements (constraints) of those packages. This is done by the Spot Scheduler, which creates optimal breaks during an overnight batch process.

Second - After all the Radio and TV break schedule compositions are calculated, a secondary optimization cycle creates 'quality' breaks. This is done by the Break Arranger, which suggests an optimal spot positioning sequence, to the planning department. The Break Arranger handles a set of constraints and conflicts concerning the specific break. Example: fixed positions (first, last position in a break) and conflicts (e.g. two car commercials in a break, but not in consecutive order). An average high-volume break, (e.g. after the 8 o'clock news) contains about 25 to 32 commercials. Providing too much complexity and too many possible combinations in a specific break.

Both optimization challenges have been captured in generic Phyton models, of which output can be given to a Solver for optimization. In those models, all requirements are translated into hard and soft constraints, which translate to set of objective values calculated.

## License

The selected solver will become an integrated part (API) of the current (STARlight) order management system. Therefore, the proposed solution ideally fits the architectural DTAP-principles of the current ERP setup. Ster needs a license structure that matches a dedicated production (P) environment, and a staging area that consists of three (DTA) environments for development and testing purposes.

| Environment | License | Use | Machines | # |
|---|---|---|---|---|
| P | Single-Machine, Unlimited-Use<br>Solver on a dedicated machine, dedicated VM.<br>Serving Prod environment only | Production | P = Prod | 1 |
| DTA | Single-Machine, Compute Server, Limited use<br>Solver on a shared machine, dedicated VM.<br>Serving 3 environments (DTA). | Non-production | D = Dev (HdH)<br>T = ACC (TP/HO)<br>A = UAT (TP/HO) | 3 |

A Cloud Solution connected to the production environment is explicitly not excluded from the tender, as long as it is clearly explained how this would be implemented.

During the Proof of Concept, Ster is happy to work with trial- or educational licenses for testing purposes only.

## Business case

Objective performance measurement is based on maximizing yielding while occupying as few spot positions as possible. Leaving capacity for additional (new) incoming orders in the running month. Ster faces two possible business scenarios. In a given month could Ster be sold out, before the month starts. A scenario where demand exceeds Inventory capacity (available GRPs and seconds) and all capacity has been pre-ordered (initial request). To maximize turnover in such a busy month it is important to keep the *total campaign overscores* as low as possible. Because overscores (measured in GRP) cannot be billed to the requesting advertiser, but potentially could have been sold to another customer. While in quiet months, where capacity is abundant, a possible overscore is less relevant. In a scenario where Ster is not sold out, it is important to keep the *total campaign underscores* as low as possible. As an underscore means Ster doesn't fully utilize the committed advertising budget.

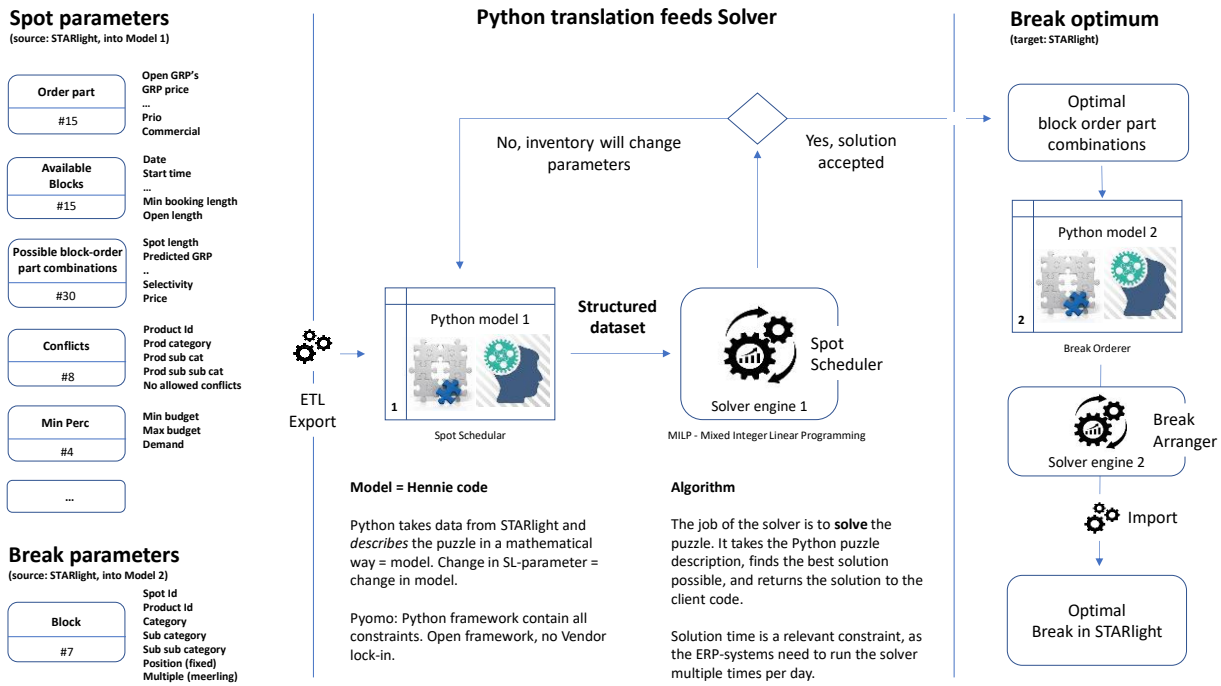
The model includes some soft constraints that further enhance the quality of the advertiser's schedules. For example, by giving priority to a better spread of spots across channels or weekdays. By being able to adjust these constraints regularly, Ster gains detailed insights into its revenue capabilities, which enables better strategic decision-making. To be able to have several yielding optimizations per day with different soft-constraint settings, the solver must compute the outcomes within a few minutes.

## Workflow and STARlight integration

The Python Models retrieve data from the Ster ERP sales order back-office (STARlight). This data is processed by the two models in the Pyomo Framework. This framework provides Ster a generic integration point to test multiple application solutions (Solvers) with similar simulation runs and fixed data sets. The optimization is done in two stages:

| | | |
|---|---|---|
| 1) | Spot Scheduler | Initiates break fulfillment.<br>Creates 'best' composition possible based on break-order parts, conflicts, etc. |
| 2) | Break Arranger | Initiates commercial break ordering.<br>Takes a composed break, and optimally reshuffles spot positions based on a limited set of constraints. Creating a 'quality' break. |

The proposed solver results will be (re)integrated into the existing STARlight back-office.




## Ad 1) Spot Scheduler – calculates a solution 1 time per day – overnight batch process

The first goal (objective) is to create the best possible selection of break-order part combinations available. Best, in this case, means: maximizing revenue while maintaining a quality airtime schema for every advertiser. The model is subject to a myriad of requirements and constraints, such as maximum break length, conflicts, min/max GRPs of an order part, available commercial airtime, and so forth. After the model is created and solved, it returns the best solution (within a given time limit) to the ERP system (STARlight).

## Ad 2) Break Arranger – always returns a solution, within 6 seconds – after submit (push on button)

The second goal (objective) is the best possible order of spots in a break. Creating a  so called quality break. Every spot gets a number (variable) that determines its place. Number one will be broadcasted first, number two second, and so on. The Solver objective is to minimize the sum of the penalties resulting from the break order parameters (multiple spot distances and conflicts). The model takes 3 constraints into account:

- Fixed positions - hard constraint. For most breaks, the first and last positions are sold, so fixed.
- Multiple spots - hard constraint. Multiple spots belong together. There should be at least one spot-position (other commercial) between them, and at most three. The less the better, so the sum of the distance between all multiple spots, is the first penalty for the Solver.
- Conflicts - soft constraint. Products within the same product category (product subcategory, or product sub-subcategory) should have a minimum distance from each other. For example, two products with the same sub/subcategory would ideally have a distance of at least seven (six spots between them). If the spread (distance between spot positions) is smaller, the solver gets a penalty. The sum of all conflict penalties gives the second penalty score.

## PoC - Method Spot Scheduler

In the PoC we will be calculating spot schedules for March 2022. For which 5 different datasets are available. Representing an average TV month. These datasets follow each other in time, where each subsequent dataset is a week older than the previous one.

The first dataset is an actual representation of February 22th on which day the initial (first) calculation for March was done. By February 22th the entire month of March was completely pre-ordered, and therefore sold out. Spot booking request (changes) continue to come in during the March period, but diminish in numbers towards the end of the month. The second dataset is from March 1st and allows spots to be (re)booked starting March 2nd. The next set is from March 9 and so on, each set being of the upcoming week. The suggested package-break combinations optimum is the Solver outcome and feed for the package_break table of the ERP system for further processing.

| Dataset | Path | Time for Solver processing |
|---|---|---|
| 22 feb | SaveSchedularDB_20220222-T22-3-vooraf.xml | 60 min |
| 1 mar | SaveSchedularDB_20220301-T22-3-vooraf.xml | 30 min |
| 8 mar | SaveSchedularDB_20220308-T22-3-vooraf.xml | 30 min |
| 15 mar | SaveSchedularDB_20220315-T22-3-vooraf.xml | 20 min |
| 22 mar | SaveSchedularDB_20220322-T22-3-vooraf.xml | 20 min |

### Poc - Method Break Arranger

Ster provides .mps files containing the spot data of 2.112 commercial breaks. Each break differs in length. A long break contains 28-30 spots, while a short break consists of 12-15 spot positions. Arranging spots in a break has to be carried out relatively quickly (4-10 sec.) because during a business day approximately 250 breaks (3 TV channels, 6 Radio channels) have to be structured into an appropriate spot sequence.

## Terminology

This document contains media specific terminology. Therefor a descriptive table is provided.

| | |
|---|---|
| Airtime | Measured in second<br>The average commercial duration is 20 sec.<br>Airtime is sold in 5, 10, 15, 20, 30, 40, and 60-second intervals. |
| Break | Commercial break.<br>Scheduled airtime between two Radio or TV programs. |
| Commercial | The actual content of a spot position. Also known as ‘creative’ or ‘clip’.<br>A uniquely identified (ID) audio or video file. |
| Campaign | Commercial campaign. Defined by the advertiser. A camping consist of one or more orders. Bought and planned by a media agency, or marketing department of customer (advertiser). A campaign can run for multiple months, consisting of multiple orders and suborders, in which one or more commercials can be used. |
| Order | Sales order.<br>Coming from a media agency or advertiser direct. |
| Suborder | A order consists of one or more suborders.<br>A suborder covers multiple time periods (weeks in month), alternating spots (running commercial A and B) and different media types (Radio, TV). |
| Spot<br>(single spot, main spot) | Sold airtime. Measured in seconds.<br>A spot has a defined position in a break. A main spot is followed by a tag-on spot, a single spot doesn’t have a tag-on. |
| Multiple Spot | Main spot + tag-on |
| Tag-on | Short related commercial (reminder) to main or lead commercial.<br>The average tag-on is 5 sec. |