

Underground re-scheduling for maximizing the use of regenerative braking energy

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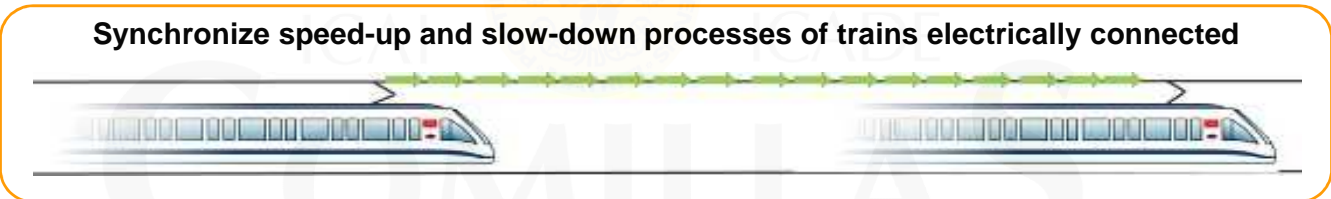
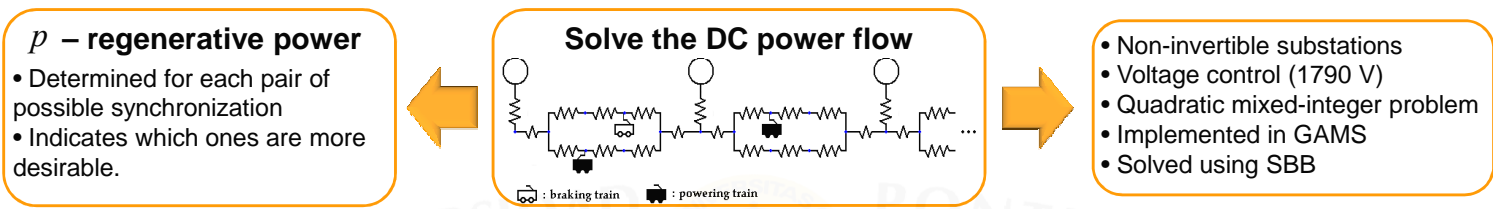
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During the recent years there is an increasing interest in designing strategies to reduce the energy consumption in railways lines. With the existing infrastructure and the trains nowadays in service it is possible to reduce consumption optimizing the traffic operation with insignificant investment. Particularly, most trains are equipped with regenerative braking systems. The objective of this project is to reduce energy consumption in Metro de Madrid (Spain) by means of maximizing the use of regenerative braking energy. Metro de Madrid has a DC electric system, with non-invertible substations and without accumulators. Thus this regenerative braking energy can be used:

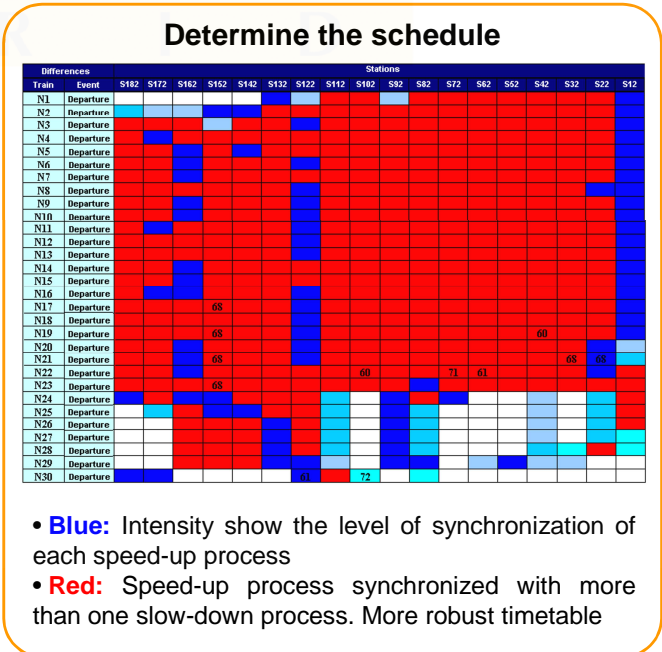
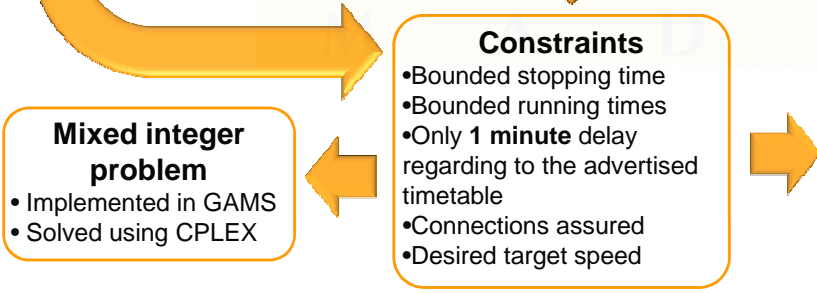
- To feed the auxiliary services of the train
- By other train demanding energy in the same electric section

Schedule re-design:

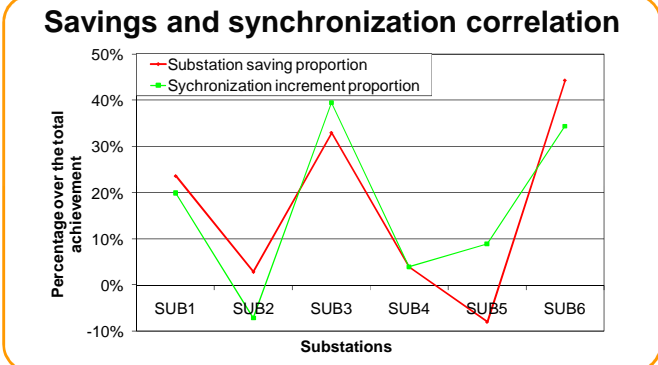
Power determination



Schedule model



Implementation (2009)



Results

Correlation between energy savings and synchronization increment of **75.2%**
 Measured energy savings in electrical substations **3.5%** (with only one minute margin)

