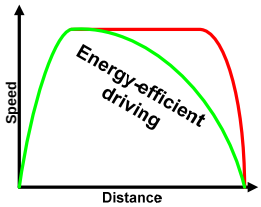
# Energy Efficient Railway Operation

Combination of train driver assistance systems and trackside systems, development of dispatching rules for a minimization of energy consumption

## Motivation

The fuel and electricity costs have been fluctuating in the past, but there is a rising tendency to be determined. So this issue is getting more interesting. The approach of the basic research project „Next Generation Operation“ of the DLR institute of Transportation Systems (DLR-TS) is to optimize the operation without changing the infrastructure.

High speed trains can coast long distances
Source: Deutsche Bahn press material




Driving strategy with usage of timetable buffer - Train is coasting and arriving on time, not earlier

## Driver assistance systems

The approach of these assistance systems is to give the driver information about the optimal driving style.

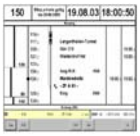
### Analysis of existing systems

There is already a lot of systems available, which support the driver in finding the optimal driving style. In the first stage of the project, these system were analyzed.

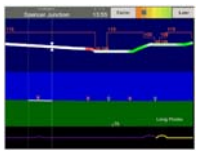
Some systems give detailed driving style recommendations, others inform the driver about the traffic situation ahead and behind. Most systems give the information permanently on a display of the on-board unit, only few systems give it discretely or outside the vehicle at the station. Some systems are taking over full control over the vehicle and supply automatic train driving (not a driverless operation).

### System examples

**RouteLint** only shows the traffic around – the driver chooses the best driving style

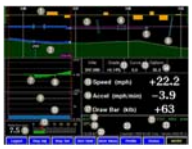


**EBuLa,** the DB driver timetable, shows with a blue point, when the train should coast to arrive ontime



**Freightmiser** calculates the optimal profile for a specified arriving time, e.g. a crossing


**ENAflex-S** works on a PDA and shows when to coast or brake



**LEADER** has also a look on the braking situation in the train to reduce the brake wear

**CATO** will help to reduce the standing times and save energy on the swedish ore line

## Integration of real-time-data

More important than the reduction of the energy consumption is the reduction of delays and the increase or maintainance of line capacity. To open the energy saving potential in a disturbed timetable, it is necessary to know about the positions and delays of other trains. A train needs to know when the signal ahead will get clear. For this real-time data has to be collected in an operation center and a forecast has to be made for the time of the signal clearance. According to this time the train can optimize the driving style. A typical case is a faster train following a delayed slower train without an opportunity to overtake. The line capacity can also increase with this method, e.g. when a train can pass a node in slower speed but without stop, after a delayed train had passed the node.

## Dispatching support

In the second stage of the project the potential for supporting dispatching solutions is determined. In some cases there is more than one possibility to solve a conflict. When the impact on the timeliness and the line capacity is similar, the solution with the lowest energy consumption should be selected.

On the figure on the right the green dot represents the case, when delayed trains follow their planned order. Dispatching reduces the total delay in almost all cases. Solution C has the best effect on timeliness, but the energy consumption is lower for the recommended solution B.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