Optimal strategies to manage major disturbances
FFE (Madrid, Spain) – 21 September 2017

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Our objectives

Analysis of European best-practices for disruption management

Identification of lessons learned and recommendations

Development of a roadmap for increasing levels of automation in European railways

Study of an instance of automation increase

Source: DB Mediathek
The process has been formalised through **SysML activity diagrams**

The formalisation allows:

- The check of **system’s behavior** properties
- The analysis of **automation**
- The validation at the **European level**
Analysis of incident records

E.G. SPITTIAL (TWEEDMOUTH) FLOODING ON FRIDAY 10TH DECEMBER 2010 - London North Eastern route G

The management of this disruption follows the process formalized in the SysML diagrams

Some lessons learned:

• Generic contingency plans are not appropriate: specific responses must be provided for each incident

• **Coordination** of disruption management and emergency management is necessary

• Oral **coordination and communication** are highly important
The level of human-automation interaction is generally quite low in case of disruption.

Some recommendations for possible improvements:

• Automatic **integration** of weather forecast models in the preparation for extreme weather events

• Automatic **information** sharing: communication across organizations

• Automatic **decision support tools**: quick and optimized

• Automatic state **monitoring**
Roadmap for automation increase

First focus: different *individual aspects* of the railway system

Then, collection of relevant elements into a *unified framework*

The overall improvement of capacity and reliability will be achieved only when the *whole system* will have reached a maturity level

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<td>Radio Based</td>
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<td>Track Circuits &amp; Axle Counters</td>
<td>Augmented Train Detection</td>
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<td>Driverless</td>
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<td>GoA 1</td>
<td>GoA 2</td>
<td>GoA 3</td>
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Roadmap: GOA 1 and GOA 2
Validation through simulation

The results show that incremental improvements of automation do not necessarily show capacity improvements.

Coherent automation, as in the roadmap, yields improvements.
An instance of automation increase: delay prediction

Data-driven multivariate regression models predict delays at checkpoints

Extreme learning machines (artificial neural networks) solve the regression problems

In tests on real Italian data, the models outperform the current technique by a factor of ≈2x (on total average)
The team

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TRAFIKVERKET

oltis group

Network Rail

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SYSTRA

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LiU LINKÖPING UNIVERSITY

TECHNISCHE UNIVERSITÄT DRESDEN

IK INSTYTUT KOLEJNICTWA

AnsaldoSTS

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Thank you for your kind attention

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