SmartOCCR

Smart Information and Decision Support for Railway Operation Control Centres

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Outline

• Introduction
• Smart Disruption Information
• Smart Decision Support
• Main lessons
• Conclusions
Disruption management: Situational Awareness, Decision, Execution

- 1\textsuperscript{st} phase: Fast response, rapid new feasible plan, smooth transition
- 2\textsuperscript{nd} phase: Operations according to new plan, prediction disruption end
- 3\textsuperscript{rd} phase: Fast transition to normal situation
Introduction

Smart Disruption Information
- Availability disruption data
- Analysis disruption types
- Modelling disruption length
- Prediction disruption length

Focus
- Track Circuit failures
- Switch failures

Smart Decision Support
- Analysis disruption phases
- Analysis disruption measures
- Computation disruption timetable
- Computation transitions

Focus
- Full blockages
- Infrastructure allocation

✓ Integration
1. **Smart Disruption Information**
Smart Disruption Information

Approach

• Nonparametric (Copula) Bayesian Netwerk
  ▶ Per disruption type
  ▶ Determining influence factors (with available data)
  ▶ Modelling dependencies

• Applied to track circuits and switches

• SAP data + additional data (weather data, geographical data)

• Example data track circuits
  ▶ Training data: 1920 failures (2½ year; 01-2011/06-2013)
  ▶ Test data: 339 failures (½ year; 05-2014/10-2014)

• Time components disruption length
  ▶ Latency time (time from start disruption to contractor at scene)
  ▶ Repair time (contractor at scene to failure repaired)
Example
• 1 July 2014 in Sloterdijk
• Disruption 51 + 101 = 152 min

Estimate
1) 104 min (initial)
**Smart Disruption Information**

**Bayesian Network: conditionalized (basic info)**

**Example**
- 1 July 2014 in Sloterdijk
- Disruption 51+101=152 min

**Estimate**
- 1) 104 min (initial)
- 2) 134 min (basis info)
Smart Disruption Information

Bayesian Network: conditionalized (after diagnosis)

Example
- 1 July 2014 in Sloterdijk
- Disruption 51 + 101 = 152 min

Estimate
1) 104 min (initial)
2) 134 min (basis info)
3) 150 min (diagnosis)
2. *Smart Decision Support*
Smart Decision Support

Approach

• Computation of feasible disruption timetable with optimal short-turning stations for all relevant trains for full blockages

• Conceptual framework
  - Isolate disruption area with minimal impact to adjacent areas
  - Schedule short-turned trains to opposite train paths
  - Prevent shunting and big delays by short-turning on earlier station
  - Integrate transitions in computation of disruption timetable for 2nd phase

• Multi-station multi-phase short-turning model
  - Assuming scheduled train paths at start disruption
Smart Decision Support

Optimization problem

Multi-station multi-phase models
- Optimizing trade-off between (partial) train cancellations and delays
- Optimal short-turning stations depending on station capacity
- Optimal continuation of trains from both sides after end disruption
- Adjusted dwell time for short-turning trains
- Adjusted running and blocking times for alternative station routes
- Conflict-free platform track allocation of all (short-turning) trains
- Conflict-free station routes
- Possible retiming departure times and/or reordering trains
Smart Decision Support

Example: full blockage Geldermalsen

- Geldermalsen (Gdm)
- Zaltbommel (Zbm)
- Primary short-turning station
- Secondary short-turning station
- Den Bosch (Ht)
- Den Bosch Oost (Hto)
- Tilburg (Tb)
- Vught (Vg)
Smart Decision Support

Example: blockage Geldermalsen
Smart Decision Support

Example: blockage Geldermalsen (different solution)
Smart Decision Support

Example: track occupation Den Bosch normal
Smart Decision Support

Example: track occupation Den Bosch disruption
Conclusions
Conclusions

SmartOCCR: Smart Disruption Length

• General results
  - Disruption data lack detail (failing element, repair details)
  - Relatively small effect of each variable
  - Strong effect of joint variables
  - Still big uncertainty (range) by rough data
  - The more information about a disruption, the better the prediction

• Recommendations
  - Improve registration (by contractors) of details about failure and repair for better understanding and prediction of disruption length

• Future research
  - Point estimate from (wide) disruption length distribution & updates
  - Impact optimistic and pessimistic estimates on operations and travellers
  - Application to other disruptions (signals, rolling stock, etc.) with experts
Conclusions

SmartOCCR: Smart Decision Support

• General results
  - Rapid decision after disruption occurrence decreases transitions
  - Process times change with route, platform track, and short-turning
  - Microscopic model computes adapted running and dwell/short-turn times
  - Conflict-free disrupted timetable improves performance and information
  - Short-turning stations are optimized per train line

• Recommendations
  - Make available validated standardized data (infrastructure, routes, signalling logic, timetable) for quick configuration of models

• Future research
  - Partial obstructions of corridors and stations
  - Impact on travellers and evaluation of priorities (weight factors)
  - Automated decision support of disruption measures
  - Dynamic (real-time) computation of disruption measures