Synchromodal transport with disruptions

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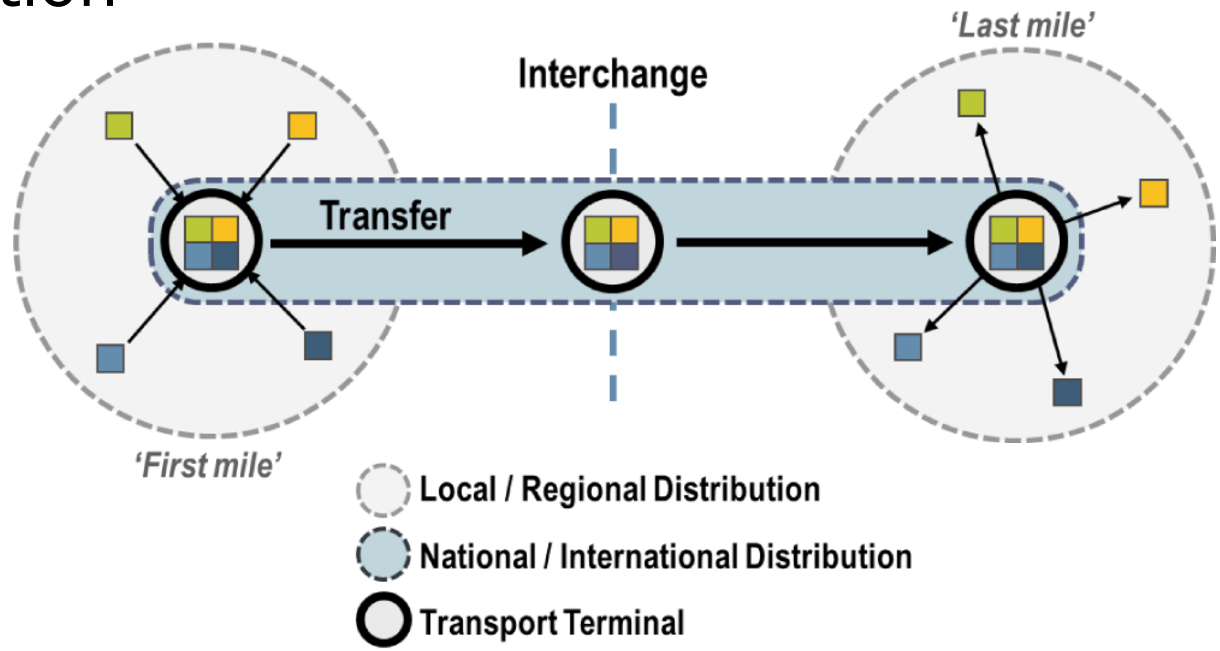
UHASSELT
KNOWLEDGE IN ACTION

Introduction



Source: transportgeography

- Multimodal: multiple transport modes
- Intermodal: same loading unit
- Synchromodal: complete integration and flexibility

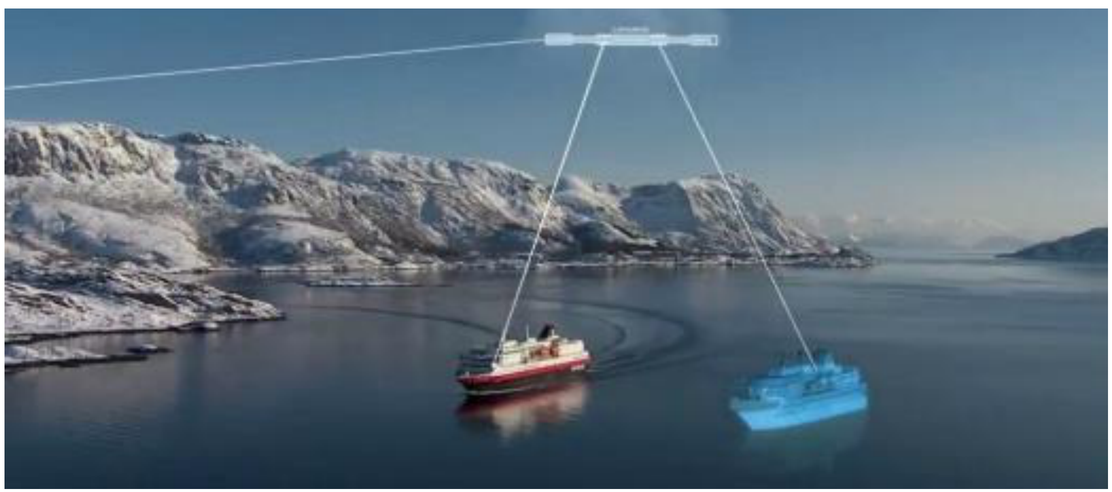
DISpATch project

- Digital twin for synchromodal transport
- Partners:

VUB mobi MOBILITY, LOGISTICS & AUTOMOTIVE TECHNOLOGY RESEARCH CENTRE

KU LEUVEN

- Objective: Facilitate synchromodal transport



Source: mfame

DISpATch

Contribution

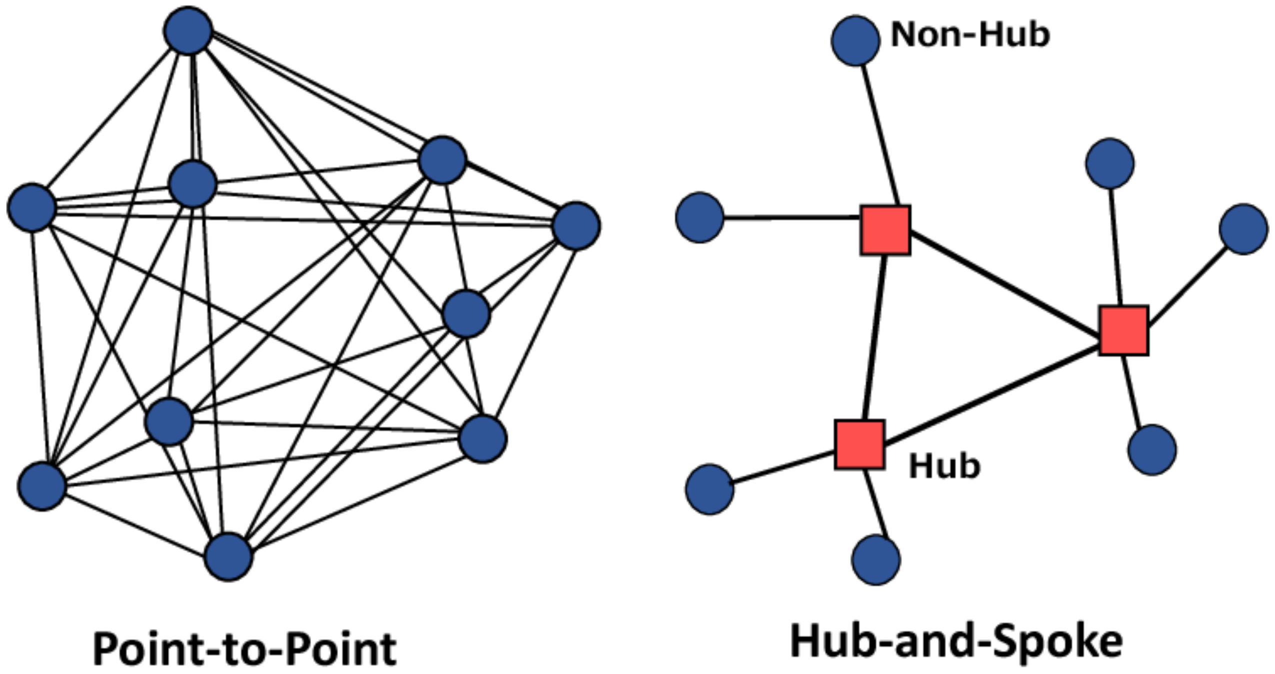
- Case study on continental synchromodal transport
- Short-term decision support to resolve disruptions
- Long-term capacity decisions

Introduction

Disruptions: *unplanned and unanticipated events that disrupt the normal flow of goods in a supply chain (Svensson, 2000)*

- Planning levels
  - Strategic: long-term investment decisions
  - Tactical: medium-term routing and scheduling
  - Operational: short-term routing and scheduling

Strategic planning



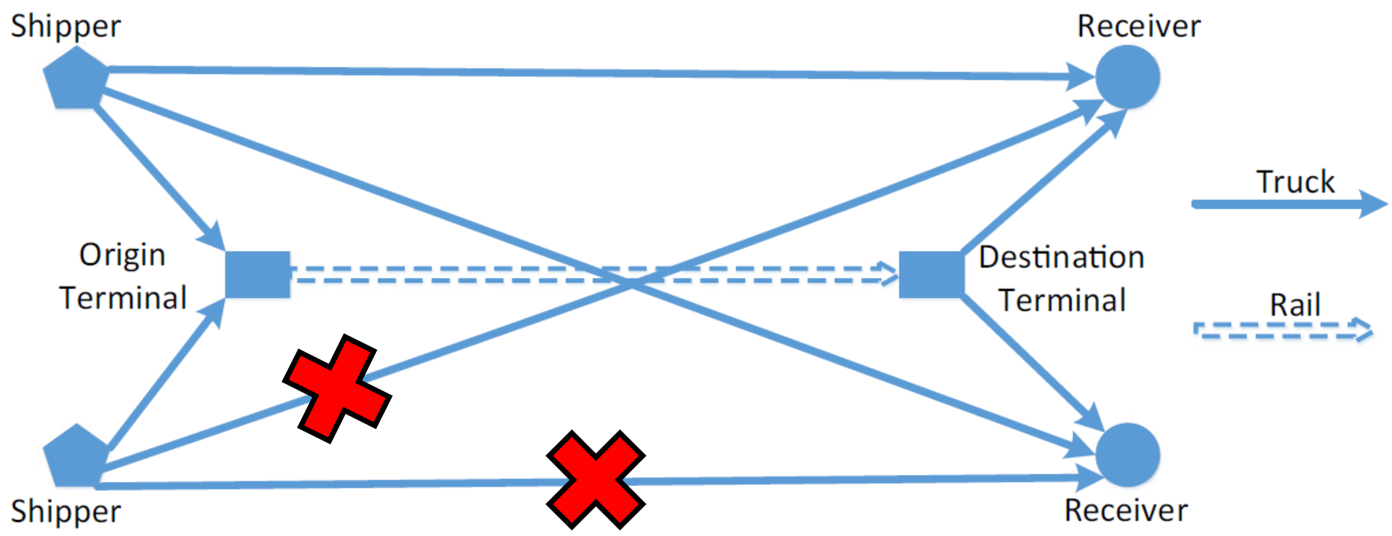
Source: Kuroki & Matsui (2018)

- Hub location problems
- Hubs are intermodal terminals

Strategic planning

study	objective	# hubs	uncertainty	solution method
An et al. (2015)	minimise costs	variable	hub failures	Lagrangian relaxation with B&B
Berman et al. (2007)	minimise costs	fixed	hub failures	greedy local-search with improvement step
Fotuhi and Huynh (2017)	minimise costs	variable	demand and hub failures	genetic algorithm
Ishfaq and Sox (2012)	minimise costs	variable	transit times	metaheuristic
Karimi et al. (2018)	minimise costs	variable	demand	MILP
Marianov and Serra (2003)	minimise costs	variable	arrival rates	greedy local-search with improvement step
Sim et al. (2009)	minimise longest path	fixed	transit times	greedy local-search with improvement step
Snyder and Daskin (2005)	minimise costs	fixed and variable	hub failures	Lagrangian relaxation with B&B

Tactical planning



Source: Uddin and Huynh (2019)

- Network Flow Planning: Route flows on existing network
- Service Network Design: Select services to route flows

Tactical planning

Study	Problem	objective	Uncertainty	solution method
Chen and Miller-Hooks (2012)	NFP	maximise served demand	capacity	Benders decomposition and column generation
Huang et al. (2011)	NFP	minimise deviations	capacity	depth-first search
Li et al. (2004)	NFP	minimise risk, mean and variability of costs	costs and transit times	Analytic hierarchy process
Li et al. (2015)	NFP	minimise costs	demand and transit times	exact LP
Meng et al. (2012)	NFP	maximise profit	demand	Sample average approximation and Lagrangian relaxation
Miller-Hooks et al. (2012)	NFP	maximise served demand	capacity	exact
Sun et al. (2018)	NFP	minimise costs and emissions	capacity and transit times	exact
Uddin and Huynh (2016)	NFP	minimise costs	capacity	sample average approximation
Uddin and Huynh (2019)	NFP	minimise costs	capacity	MILP solver
Zhao et al. (2018)	NFP	minimise costs	transit times	genetic algorithm
Andersen and Christiansen (2009)	SND	minimise costs and maximise quality	transit times	MILP solver
Bai et al. (2014)	SND	minimise costs	demand	MIP solver
Hoff et al. (2010)	SND	minimise costs	demand	metaheuristic
Lium et al. (2009)	SND	minimise costs	demand	exact solver with time limit
Puettmann and Stadtler (2010)	SND	minimise costs	demand	heuristic

Operational planning

- Real-time planning
- Recovery actions:
  - Rerouting
  - Outsourcing
- Empty container and vehicle repositioning

− Increased interdependence causes more disruptions

+ Increased flexibility to handle disruptions

Operational planning

Study	Problem	objective	Uncertainty	solution method
Burgholzer et al. (2013)	replanning	minimise transport time	capacity	simulation
Bock (2010)	replanning	minimise costs	transit times	metaheuristic
Qu et al. (2019)	replanning	minimise costs	transit times	MIP
Van Riessen et al. (2015)	replanning	minimise costs	departure times and cancellations	LP
Pérez Rivera and Mes (2017)	replanning	minimise costs	demand	approximate dynamic programming
Di Francesco et al. (2013)	empty container repositioning	minimise costs	disruptions	stochastic integer programming
Lam et al. (2007)	empty container repositioning	minimise costs	demand	approximate dynamic programming
Topaloglu (2007)	empty vehicle repositioning	maximise profits	demand and transit times	approximate dynamic programming
Topaloglu and Powell (2006)	empty vehicle repositioning	maximise profits	demand	approximate dynamic programming

Case study

- Logistics service provider
- Goal: Ship more by synchromodal transport

- Problems:
  - How to deal with disruptions in real-time?
  - Remaining truck capacity needed?

Case study

- Tactical decisions
  - Train slots to book in advance
  - Number of trucks
- Operational decisions
  - Real-time routing
  - Short term capacity increases
  - Outsourcing
- Operational model to make tactical decisions

Model

- Determine the long-term train and truck capacity at which costs are minimised

- Minimise total costs
  - Variable transport and transfer costs
  - Fixed capacity costs
  - Outsourcing costs
  - Extra capacity costs