Tactical and operational capacity decisions in synchromodal transport

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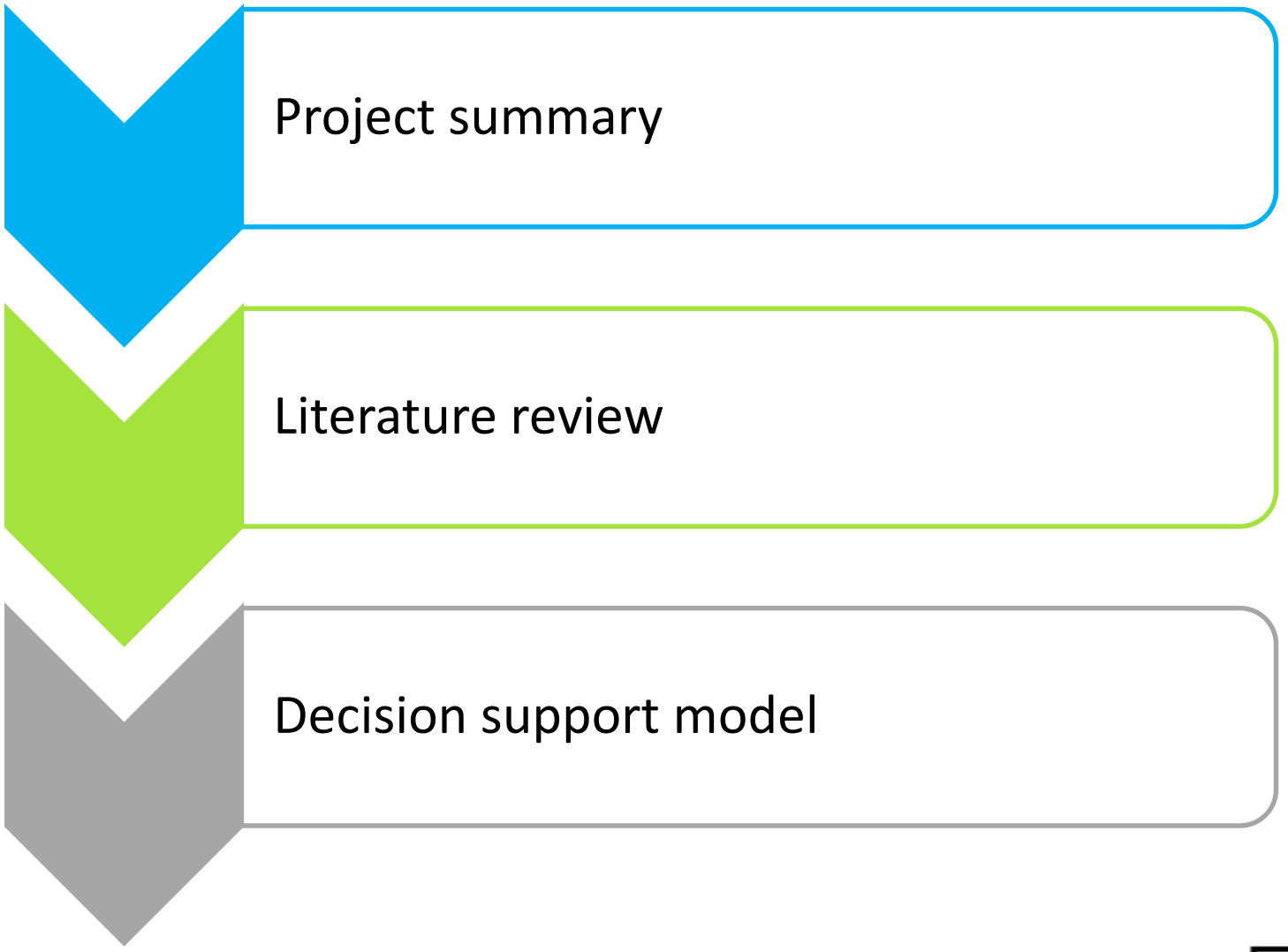
Outline



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Project summary

Support LSPs with a focus on uncertainty

How?:

- Literature review on uncertainty
- Consult LSPs to learn about their challenges
- Develop a model to tackle these challenges

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Literature review

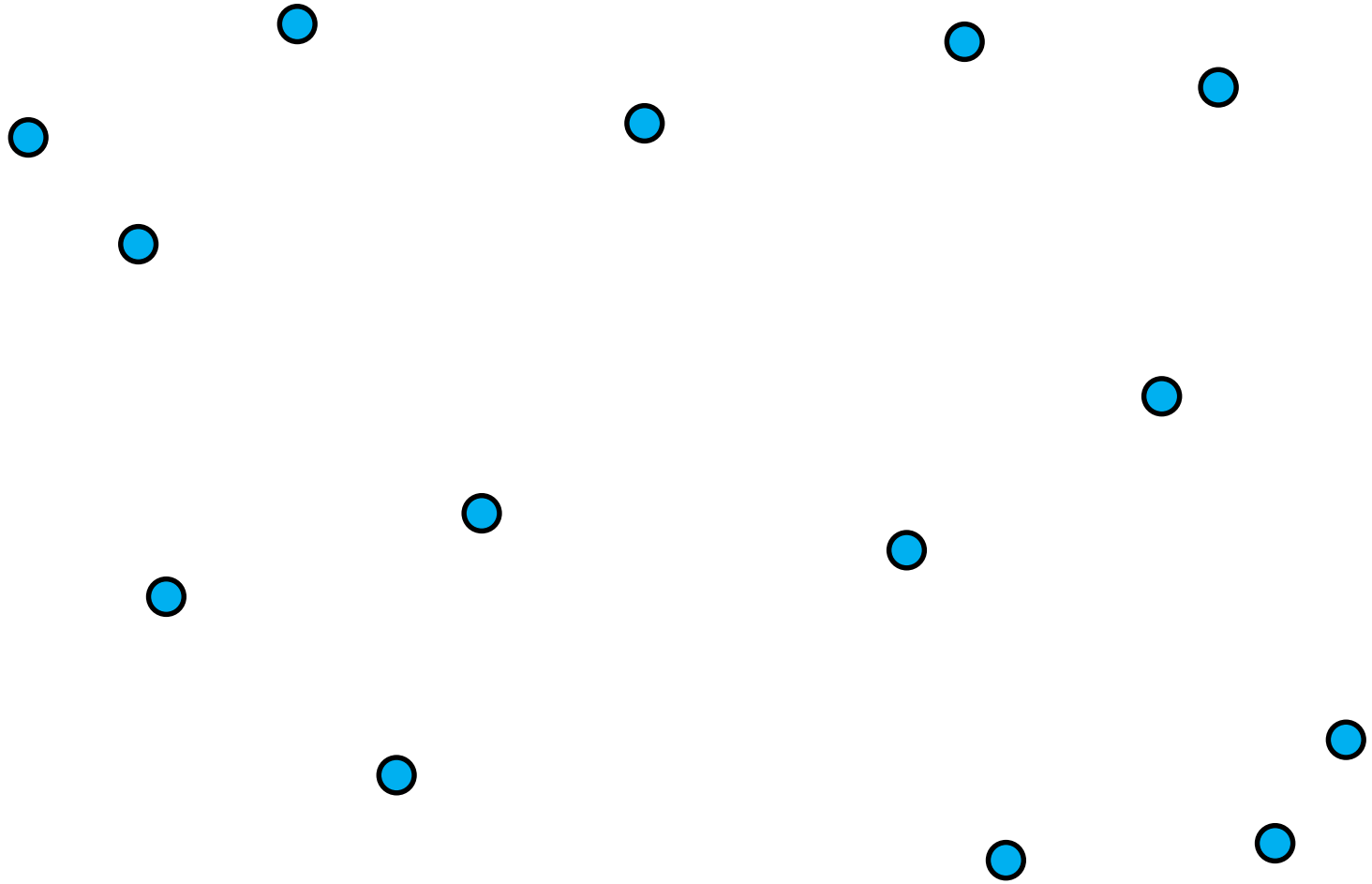
Objective:

- Most commonly studied types of uncertainty
- How to mitigate the effects of these uncertainties
- Identify research gaps

Planning levels:

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

Hub location problem



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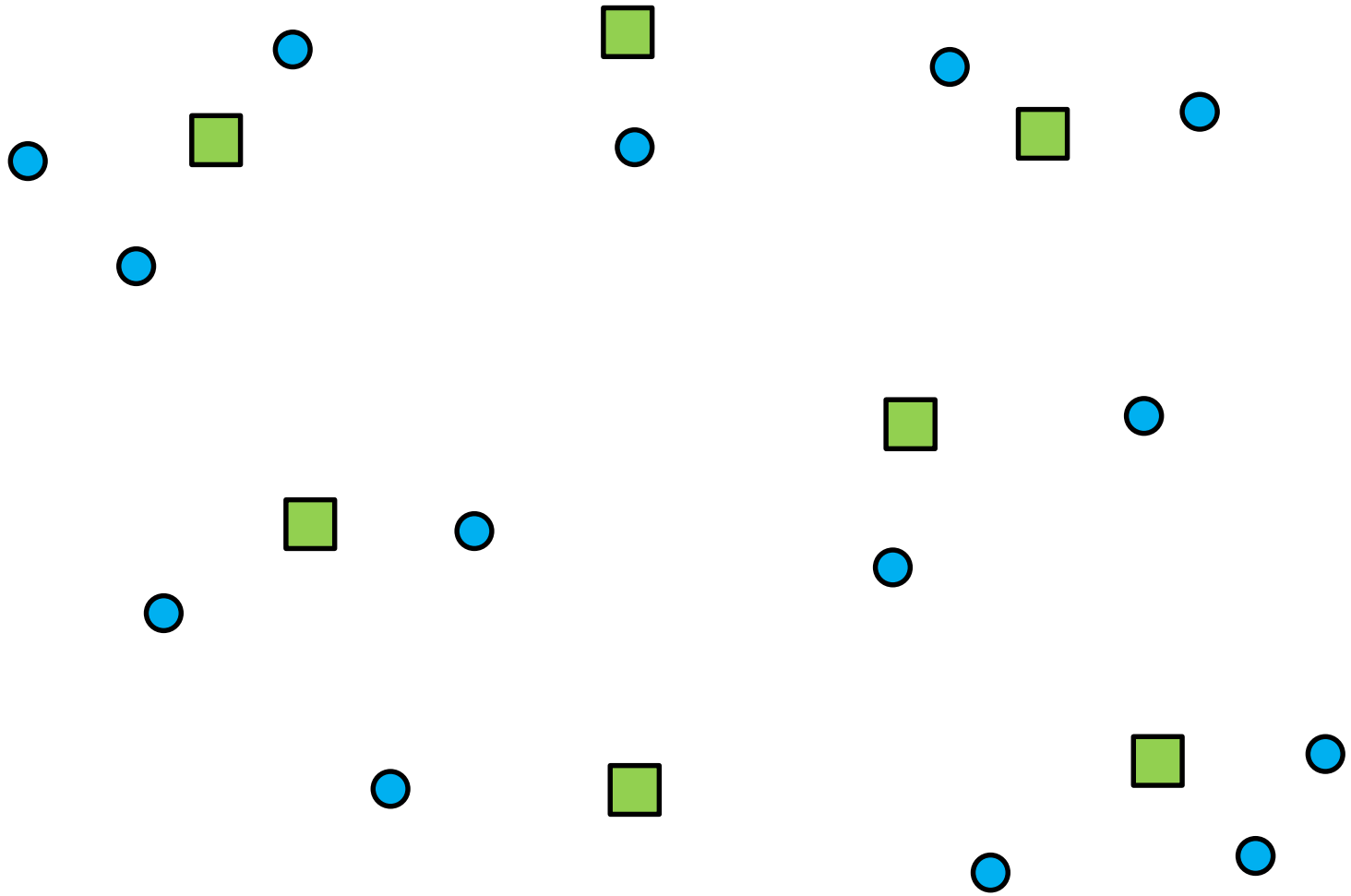
Hub location problem



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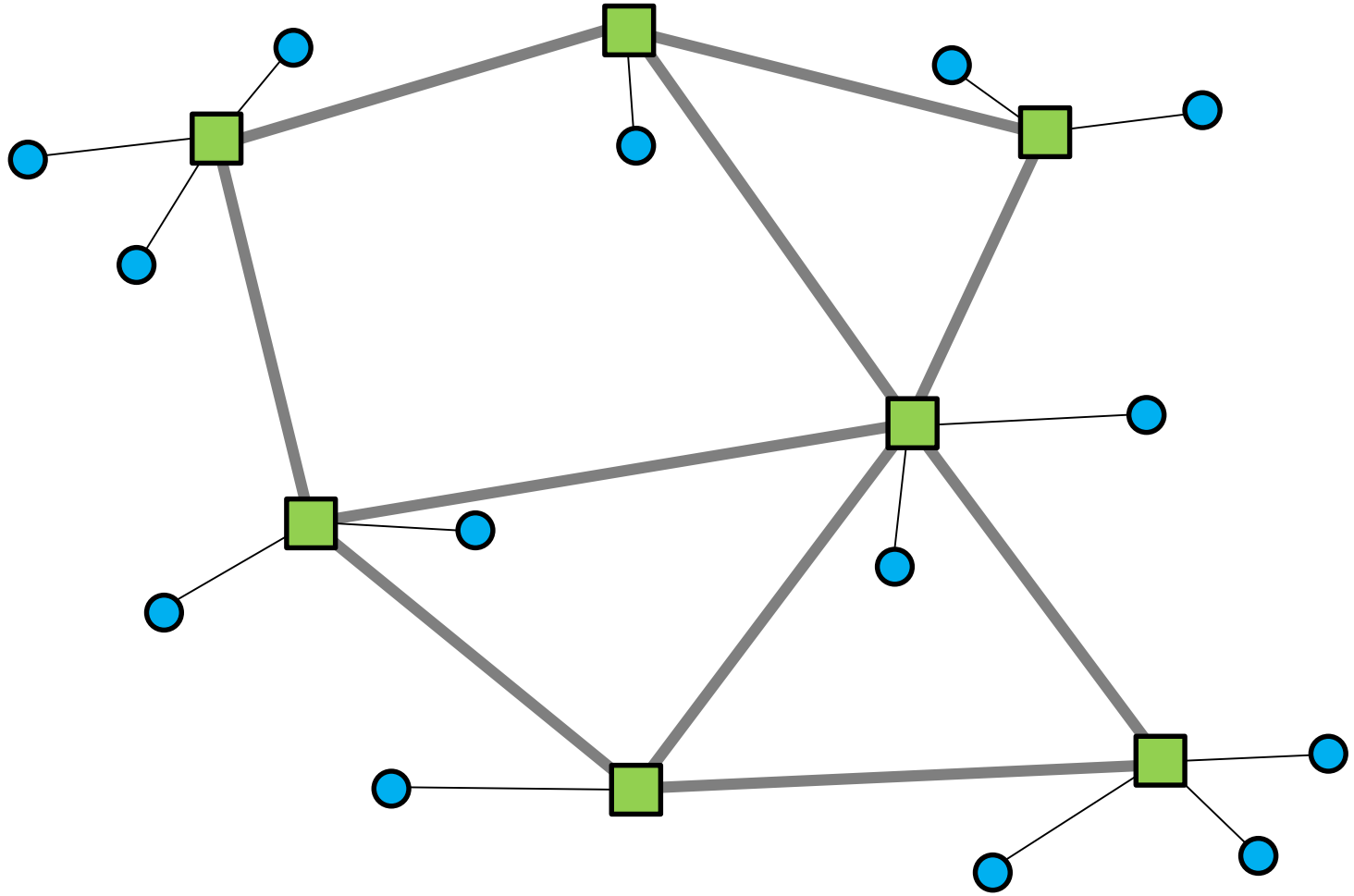
Hub location problem



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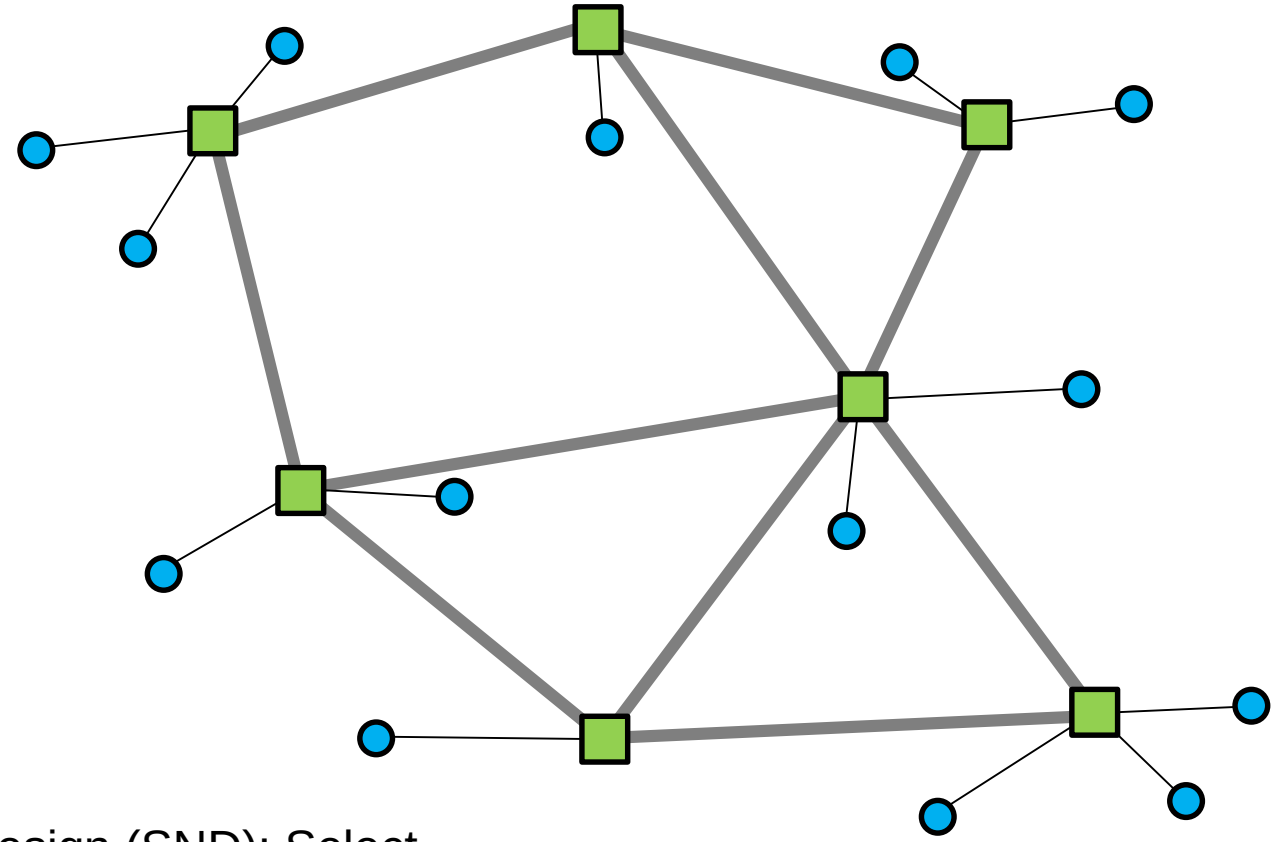
Strategic planning

Study	Transit times	Demand	Hub failures	Solution method
Sim et al. (2009)	X			Heuristic
Ishfaq and Sox (2012)	X			Metaheuristic
An et al. (2015)			X	Lagrangian relaxation with B&B
Fotuhi and Huynh (2017)		X	X	Genetic algorithm
Karimi et al. (2018)		X		MILP
Shang et al. (2020)		X		Genetic algorithm

Tactical planning



Service network design (SND): Select services on an existing physical network

Network flow planning (NFP): Route freight through an existing service network

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Tactical planning: SND

Study	Transit times	Demand	solution method
Andersen and Christiansen (2009)	X		MILP
Lium et al. (2009)		X	Exact with time limit
Hoff et al. (2010)		X	Metaheuristic
Puettmann and Stadtler (2010)		X	Heuristic
Meng et al. (2012)		X	SAA, Lagrangian relaxation
Bai et al. (2014)		X	MIP
Demir et al. (2016)	X	X	SAA

Tactical planning: NFP

Study	Transit times	Demand	Capacity	Solution method
Li et al. (2004)	X			Analytic hierarchy process
Huang et al. (2011)			X	Depth-first search
Chen and Miller-Hooks (2012)	X		X	Benders decomposition, column generation
Miller-Hooks et al. (2012)	X		X	Exact
Li et al. (2015)	X	X		LP
Uddin and Huynh (2016)			X	SAA
Sun et al. (2018)	X		X	Exact
Zhao et al. (2018)	X			Genetic algorithm
Uddin and Huynh (2019)			X	MILP

Operational planning: real-time planning

Study	Transit times	Demand	Capacity	Other	Solution method
Bock (2010)	X	X			Metaheuristic
Burgholzer et al. (2013)		X	X		Simulation
Escudero et. Al (2013)	X				Genetic algorithm
van Riessen et al. (2015)				departure times and cancellations	LP
Rivera and Mes (2017a)		X			Approximate dynamic programming
Rivera and Mes (2017b)	X	X			Matheuristic
Qu et al. (2019)	X		X		MILP

Conclusion

- Managing uncertainty:
  - Trucks are preferred
  - More consolidation possibilities
  - More time between successive departures
  - Buffer capacity

- Research gaps:
  - Combine different types of uncertainty
  - Capacity uncertainty for SND
  - Integration between planning levels

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Decision support model

Decision support model for tactical and operational capacity decisions

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Objective

- Characterise decision making from the perspective of LSPs
- Company challenges:
  - How many trucks to keep?
  - How much capacity to book in advance?
  - How to deal with disruptions in real-time?

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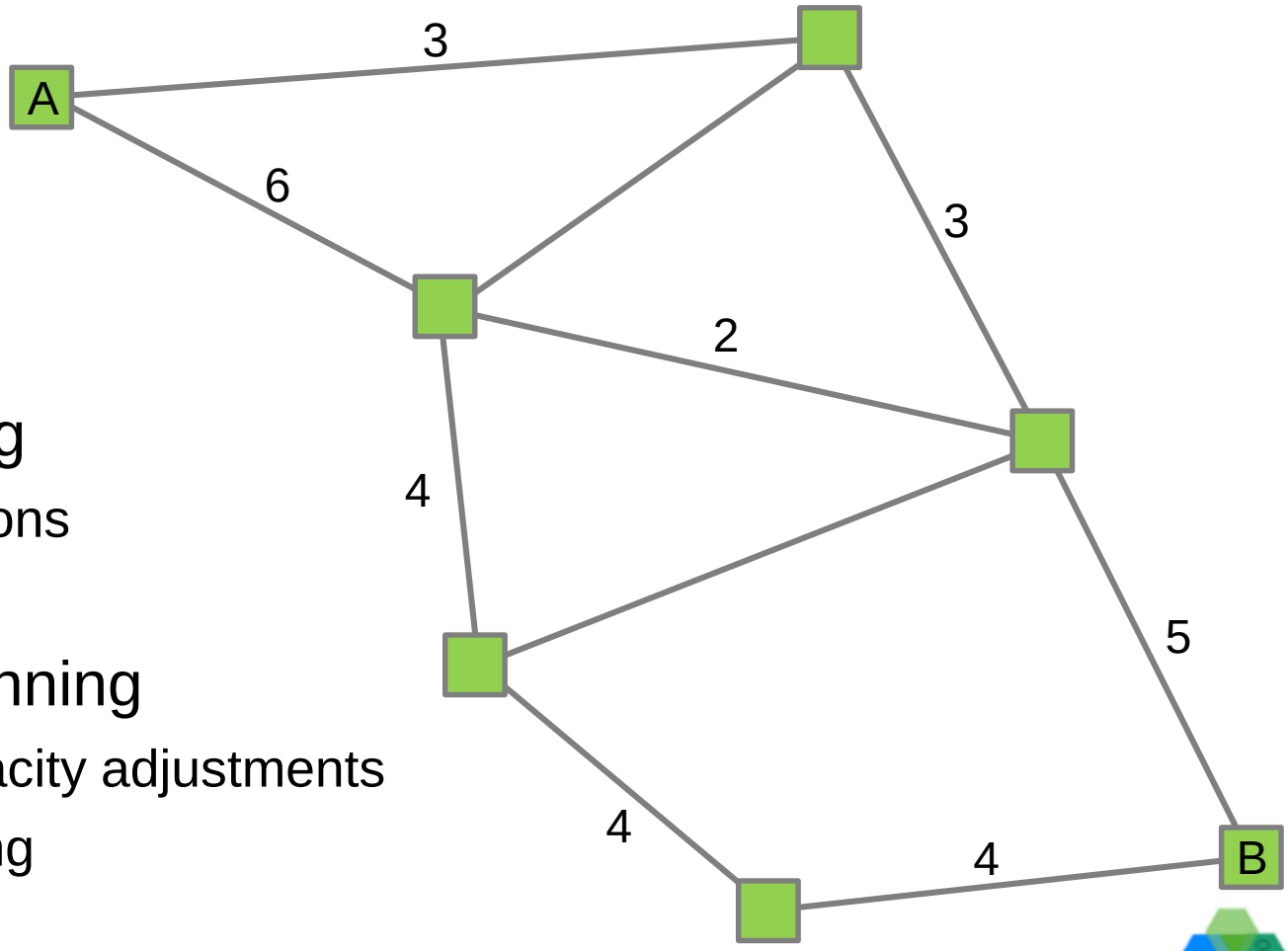
Transport planning decisions



Tactical planning

- Capacity decisions

Operational planning

- Short-term capacity adjustments
- Container routing

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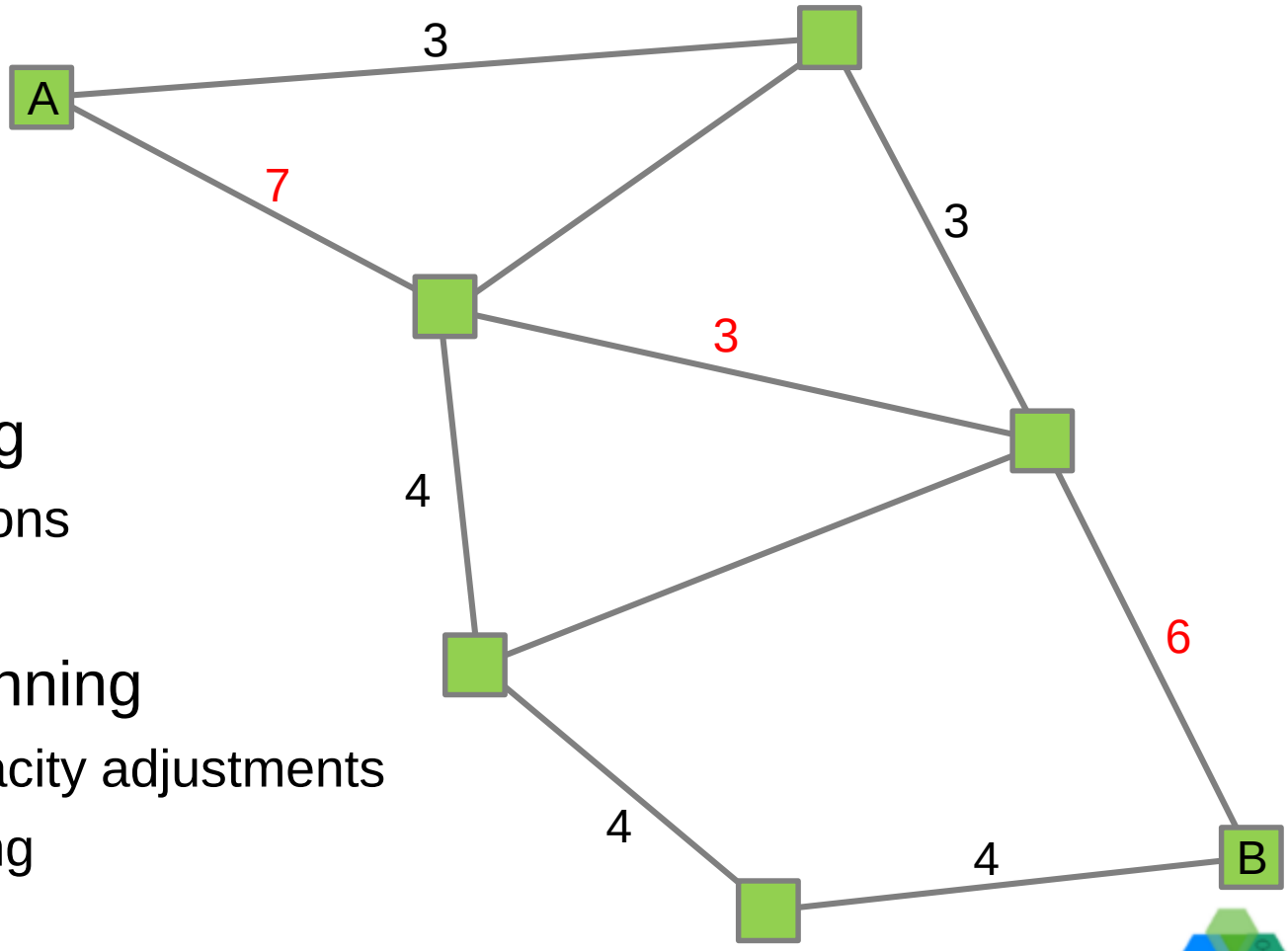
Transport planning decisions



Tactical planning

- Capacity decisions

Operational planning

- Short-term capacity adjustments
- Container routing

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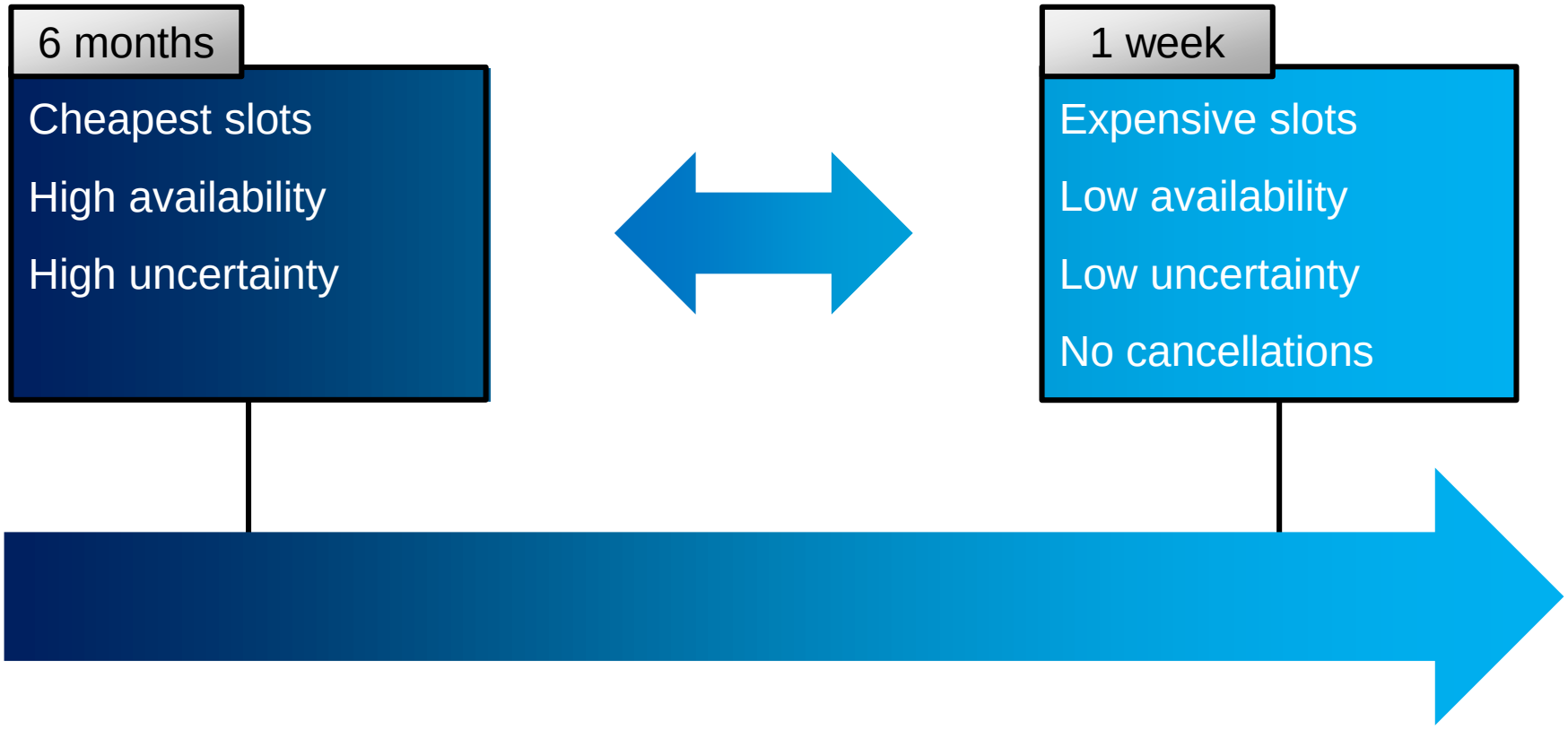
Planning timeline



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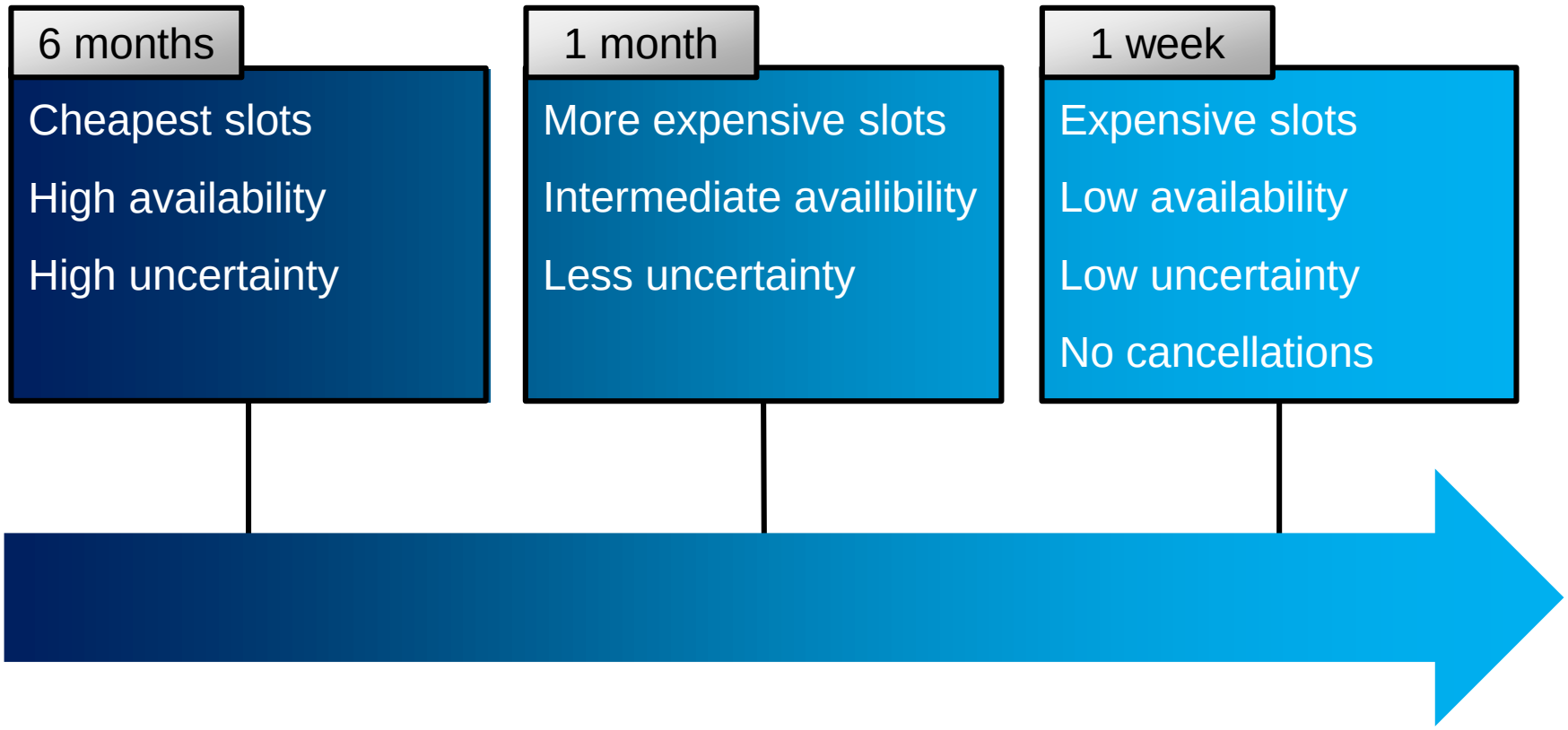
Planning timeline



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Demand uncertainty

- How much is known in advance?
- How well can demand be estimated at each stage?
- What demand forecasting methods are used?

Other types of uncertainty

- Transit times
- Available capacity at each stage
- Disruptions:
  - Frequency
  - Duration

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Three-stage model

	Long term	Medium term	Short term
Decisions	• Book capacity	• Book additional capacity • Cancel existing bookings	• Book additional capacity • Route orders
Objective	Minimise sum of: • Capacity costs • Expected costs of additional capacity • Expected penalty costs	Minimise sum of: • Capacity costs • Expected costs of additional capacity • Expected penalty costs	Minimise sum of: • Capacity costs • Penalty costs
Constraints	• Available capacity to book	• Available additional capacity	• Available additional capacity • Time-window constraints

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Inputs

- [ ] Demand at each stage
- [x] Disruption data
- [x] Costs
- [ ] Available capacity

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Next steps

- Mathematical formulation
- Develop a solution method
- Apply the model with company data

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Thank you

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Dispatch website: http://dispatch-project.be/

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