

# Optimization approaches to synchro-modal network problems

PhD Candidate:

*Riccardo Giusti*

## 1. Context

Due to its potential benefits, synchromodality has recently become relevant in freight logistics and has also been identified as a key strategy to reaching a zero-emission supply chain by 2050. Synchromodality is the provision of efficient, reliable, flexible, and sustainable services through the coordination and cooperation of stakeholders and the synchronization of operations within one or more supply chains driven by information and communication technologies (ICT) and intelligent transportation system (ITS) technologies.

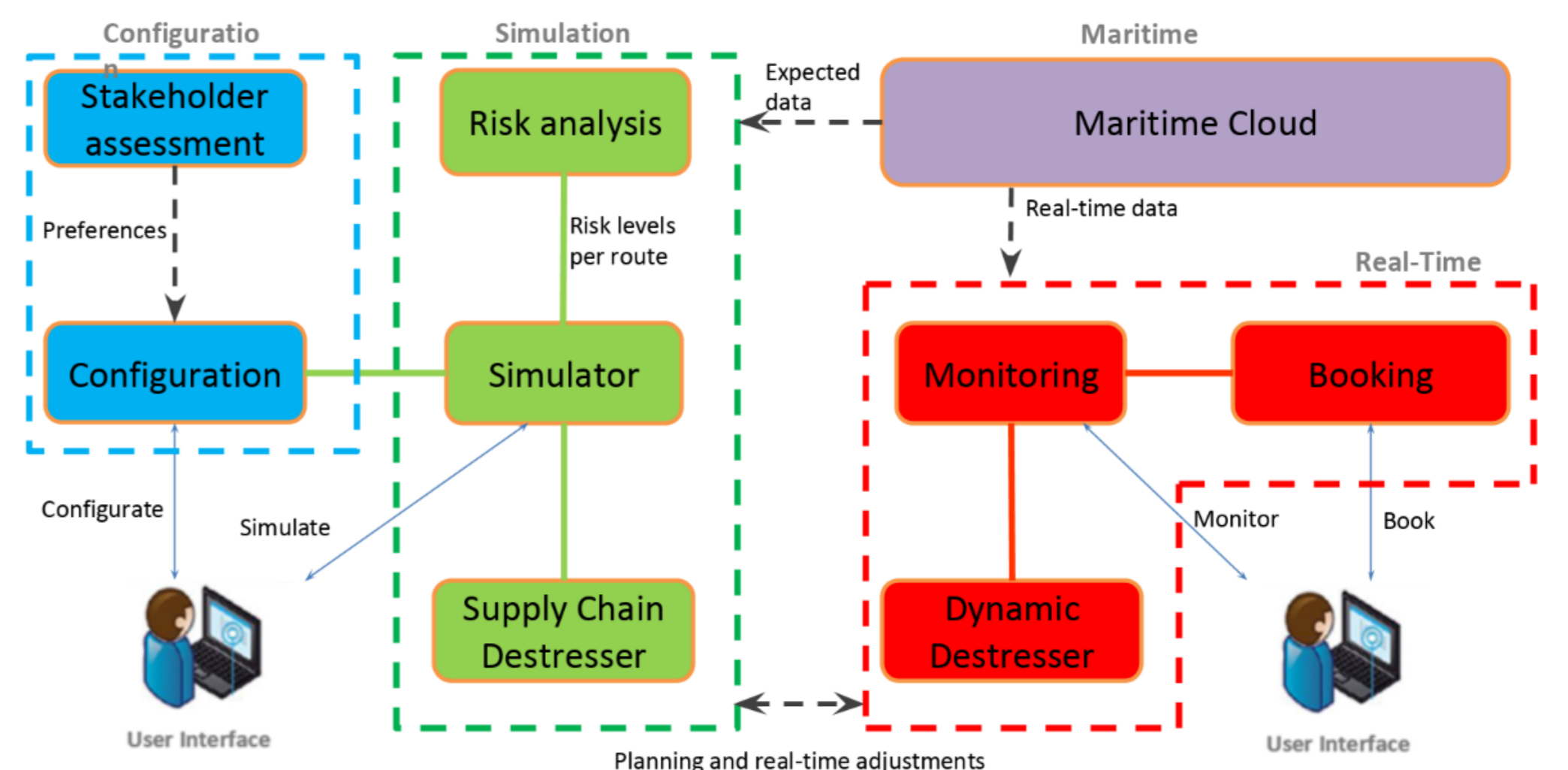


Fig. 2: The architecture of the SYNCHRO-NET platform showing the interactions between different tools

	Critical Success Factors					
	Network, Collaboration and Trust	Sophisticated Planning	Physical Infrastructure	Legal and Political Framework	Awareness and Mental Shift	Pricing, Cost, Service
Traceability	✓			✓		
Intelligent Systems		✓	✓			
Data Analytics		✓			✓	✓
Optimization		✓	✓			✓
Simulation	✓	✓	✓		✓	
Integration Platforms	✓			✓	✓	✓

Fig. 1: Critical Success Factors for the implementation of synchromodality and the enabling technologies to deal with them

## 2. Research questions

- What is synchro-modality? What are the technological requirements for its implementation?
- How can different enabling technologies be integrated within a single platform?
- How can long-term decisions be made to allow an efficient flow synchronization during operations?

## 3. Methodology

- We implemented an ICT platform, called SYNCHRO-NET, containing different tools based on the enabling technologies. The main one is a route-optimization tool with a multi-attribute search engine based on distance, trip duration, and emissions.
- We design different mixed-integer linear programming models to solve tactical decisions problems concerning a logistics network managed with synchromodality. We also addressed uncertainty in those problems with stochastic programming.

## 4. Conclusions

We contribute by providing new methodologies for integration platforms and optimization, two important enabling technologies to implement synchromodality. However, some effort is still required to address critical success factors and develop a more efficient and sustainable supply chain. The implementation of synchromodality still requires great effort from experts working in technology and other fields to ensure that synchromodality would become a widespread reality.

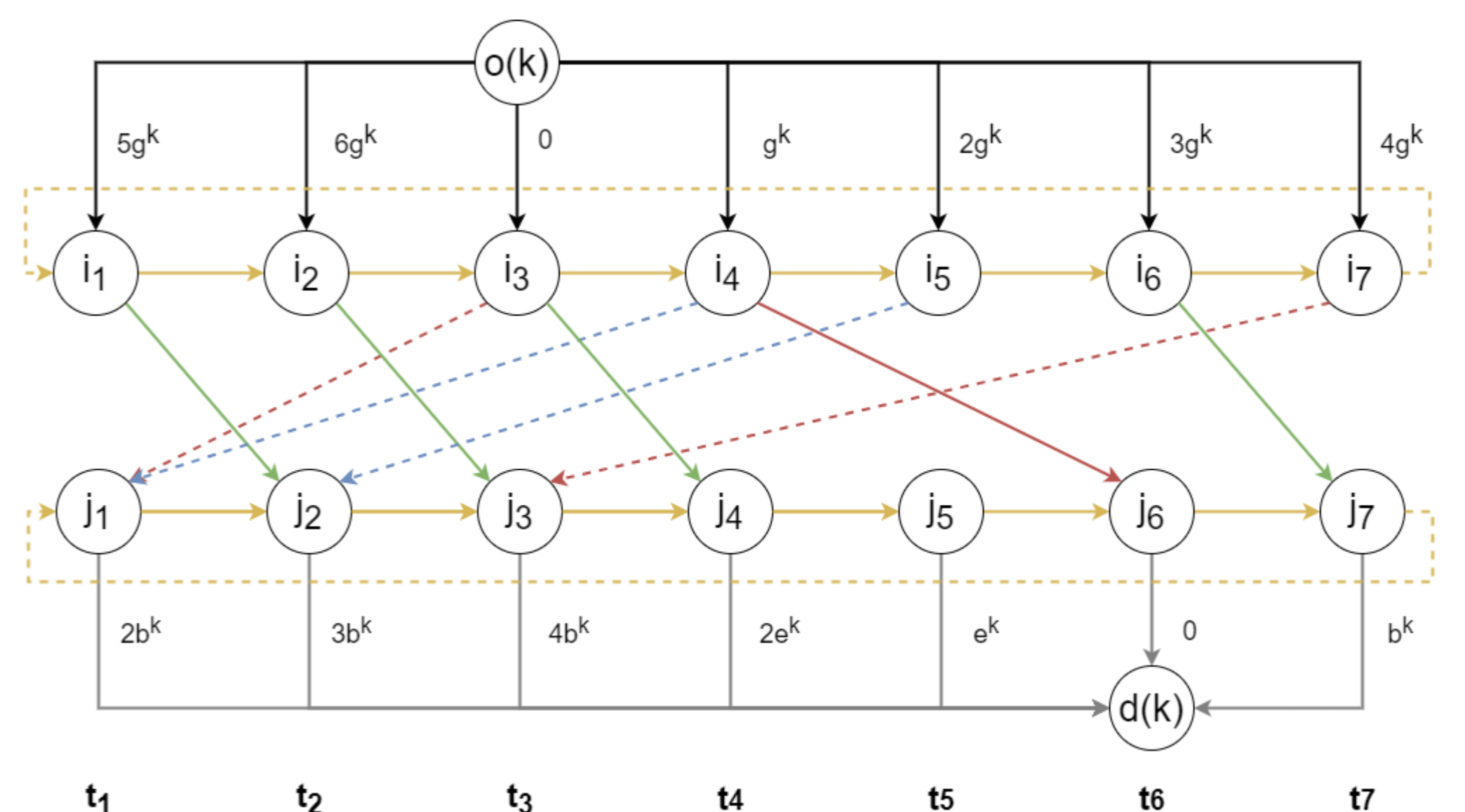


Fig. 3: A time-space multi-network representation of a logistics network consider to design a model for selecting the nodes and the arcs used for shipping

## 5. References

- R. Giusti, D. Manerba, R. Tadei. Smart Steaming: A New Flexible Paradigm for Synchromodal Logistics. *Sustainability*. 13 (9):4635. 2021
- R. Giusti, D. Manerba, R. Tadei. Multiperiod transshipment location-allocation problem with flow synchronization under stochastic handling operations. *Networks*. 2021; 78: 88– 104
- R. Giusti, D. Manerba, G. Bruno, R. Tadei. Synchromodal logistics: An overview of critical success factors, enabling technologies, and open research issues. *Transportation Research Part E: Logistics and Transportation Review* 129, 92-110. 2019
- R. Giusti, C. Iorfida, Y. Li, D. Manerba, S. Musso, G. Perboli, R. Tadei, S. Yuan. Sustainable and de-stressed international supply-chains through the SYNCHRO-NET approach. *Sustainability* 11 (4):1083. 2019