Anticipatory Freight Scheduling in Synchromodal Transport

Arturo E. Pérez Rivera

¡Gracias!

Thank you
Bedankt
Dankie
Danke
Dziękuję Ci
хвала
谢谢
धन्यवाद

Obrigado
Grazie
Merci
Mulţumesc
Teşekkür ederim
Terima kasih
متشكرم
شكرا

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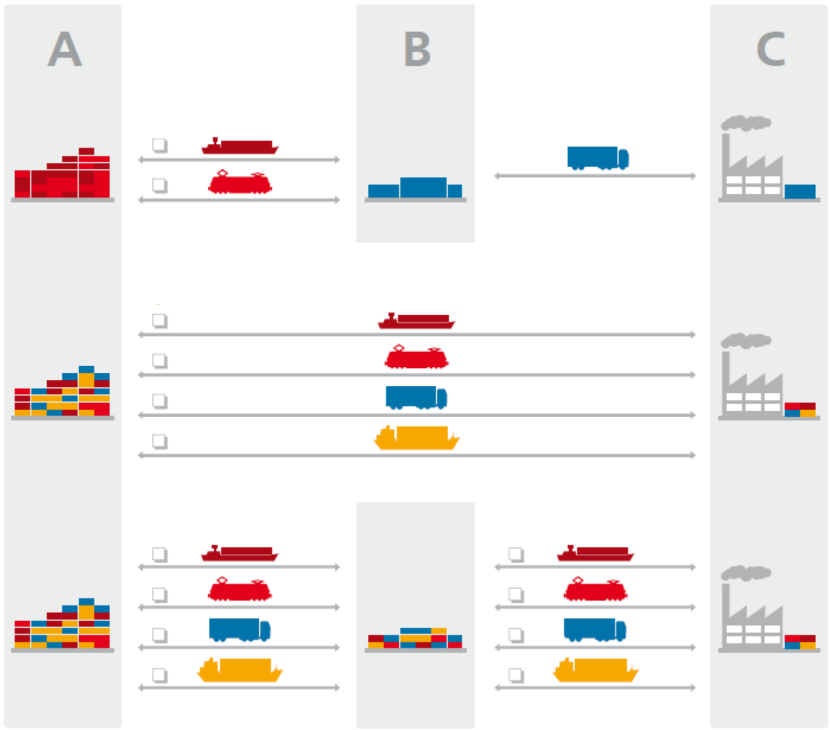
WHAT IS SYNCHROMODAL TRANSPORT?

MULTI-MODAL FREIGHT TRANSPORT WITH FLEXIBILITY IN ***MODE***, ***PATH***, *AND* ***TIME***



The flexibility of synchromodal transport:

1. ***Provides new consolidation opportunities***
2. ***Requires a network-wide and multi-period view on performance***

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

WHAT IS ANTICIPATORY SCHEDULING?

SCHEDULING TODAY THINKING ABOUT WHAT HAPPENS TOMORROW

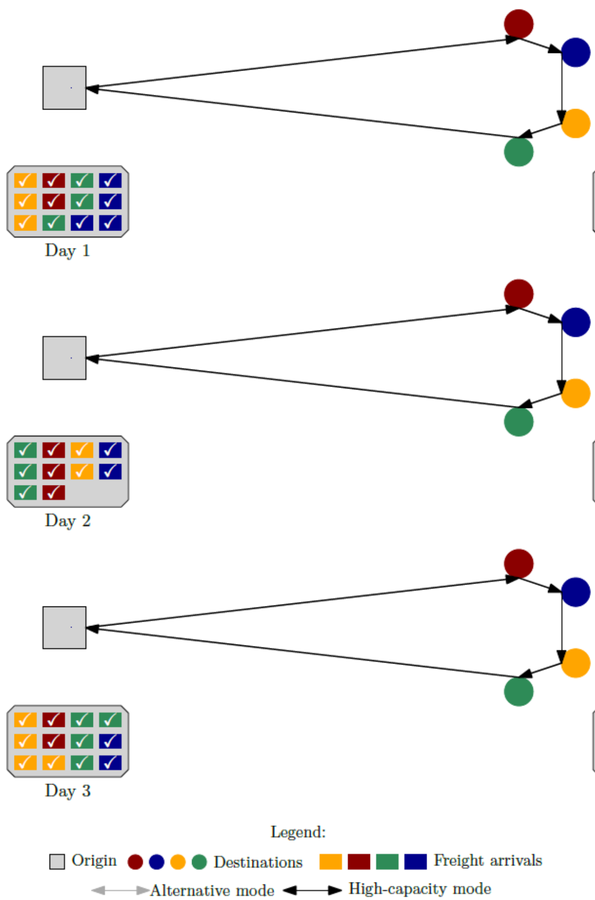


Figure 1.2: *Example of a myopic schedule*

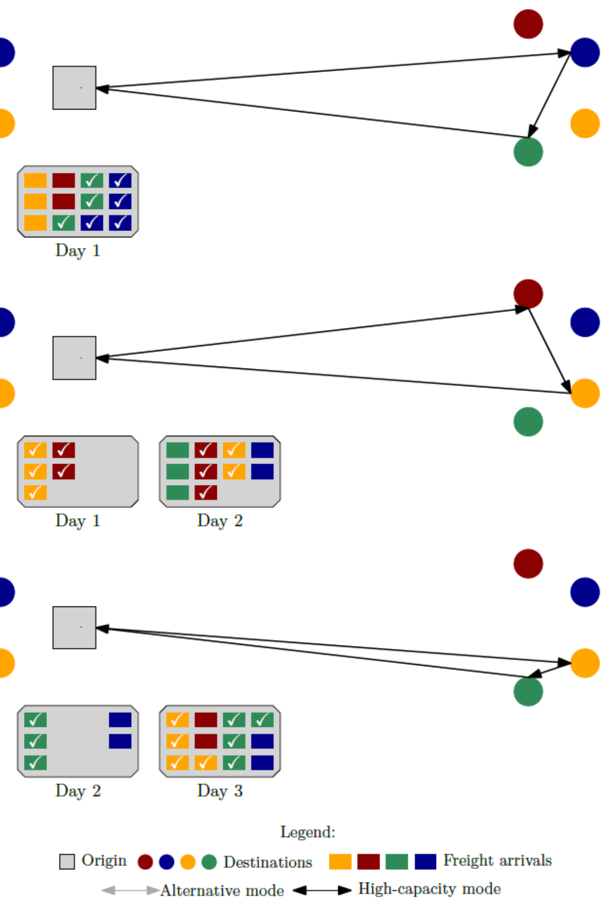
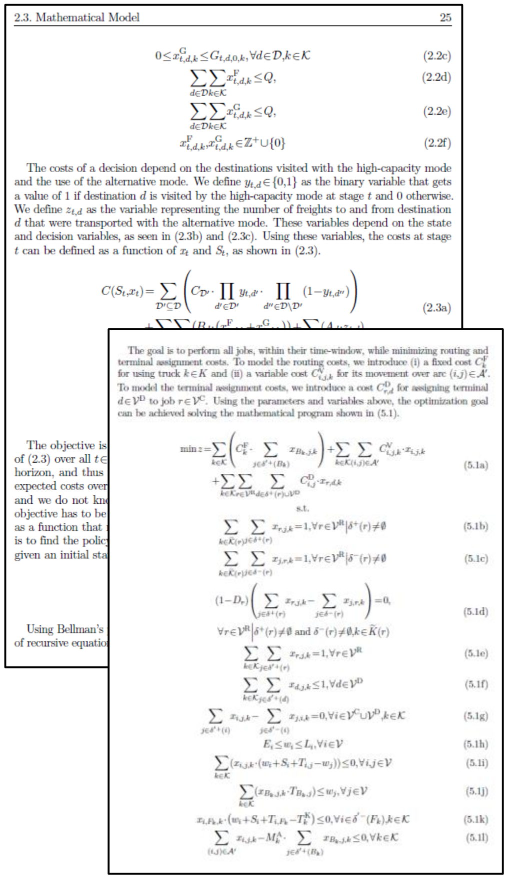


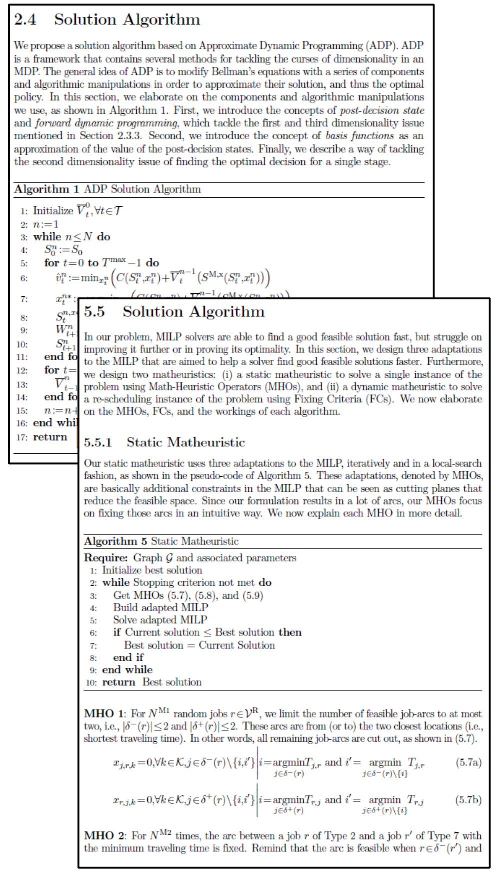
Figure 1.3: *Example of an anticipatory schedule*

HOW DO WE STUDY ANTICIPATORY SCHEDULING?

SUB-FIELD OF APPLIED MATHEMATICS CALLED ***OPERATIONS RESEARCH (O.R.)***



1. Models



2. Algorithms

Table 3.4: *Confidence intervals (at 95%) of the difference between the benchmark policy and the ADP policy*

State	I_1^L	I_2^L	I_3^L	I_4^L	I_5^L	I_6^L
C1	[-7.0%,-4.8%]	[-9.6%,-7.5%]	[-10.3%,-8.4%]	[-6.1%,-4.9%]	[-1.3%,0.0%]	[-5.9%,-4.5%]
C2	[-9.7%,-8.4%]	[-13.1%,-11.6%]	[-4.8%,-3.3%]	[-3.6%,-1.8%]	[-1.2%,0.1%]	[-11.6%,-10.4%]
C3	[-2.7%,-1.2%]	[-7.2%,-6.1%]	[-9.1%,-7.4%]	[-3.8%,-2.4%]	[0.5%,1.7%]	[-7.7%,-6.7%]
C4	[-16.0%,-13.8%]	[-26.5%,-24.6%]	[-6.2%,-4.1%]	[-12.5%,-11.2%]	[-2.2%,-0.7%]	[-8.4%,-7.6%]
C5	[-15.9%,-14.3%]	[-2.0%,-0.9%]	[-10.5%,-8.8%]	[-26.5%,-25.3%]	[-1.0%,0.1%]	[-10.3%,-9.2%]
C6	[0.5%,2.1%]	[-5.1%,-3.9%]	[-4.5%,-3.1%]	[-11.1%,-10.0%]	[-2.6%,-1.4%]	[-8.2%,-7.3%]
C7	[-4.7%,-4.0%]	[-4.3%,-3.0%]	[-25.0%,-23.5%]	[-0.6%,0.4%]	[-12.2%,-9.8%]	[-7.9%,-6.8%]
C8	[-2.9%,-1.7%]	[-17.1%,-16.3%]	[-2.5%,-1.6%]	[-7.5%,-6.7%]	[-0.9%,-0.2%]	[-3.7%,-2.9%]
C9	[-1.5%,-0.3%]	[1.8%,2.8%]	[-5.4%,-3.5%]	[-11.4%,-10.7%]	[3.9%,5.4%]	[-7.9%,-7.2%]

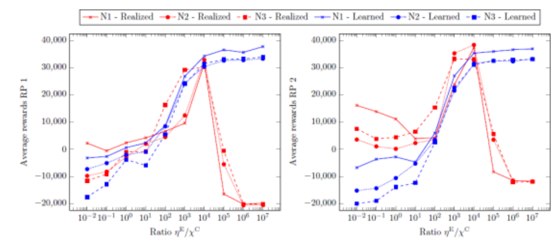


Figure 4.5: *Comparison of average rewards (over all modifications) under different ratios η^E/χ^C*

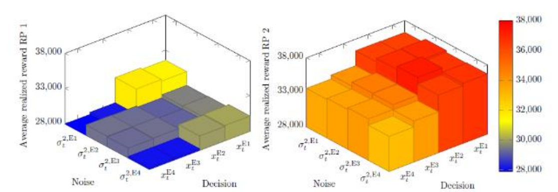
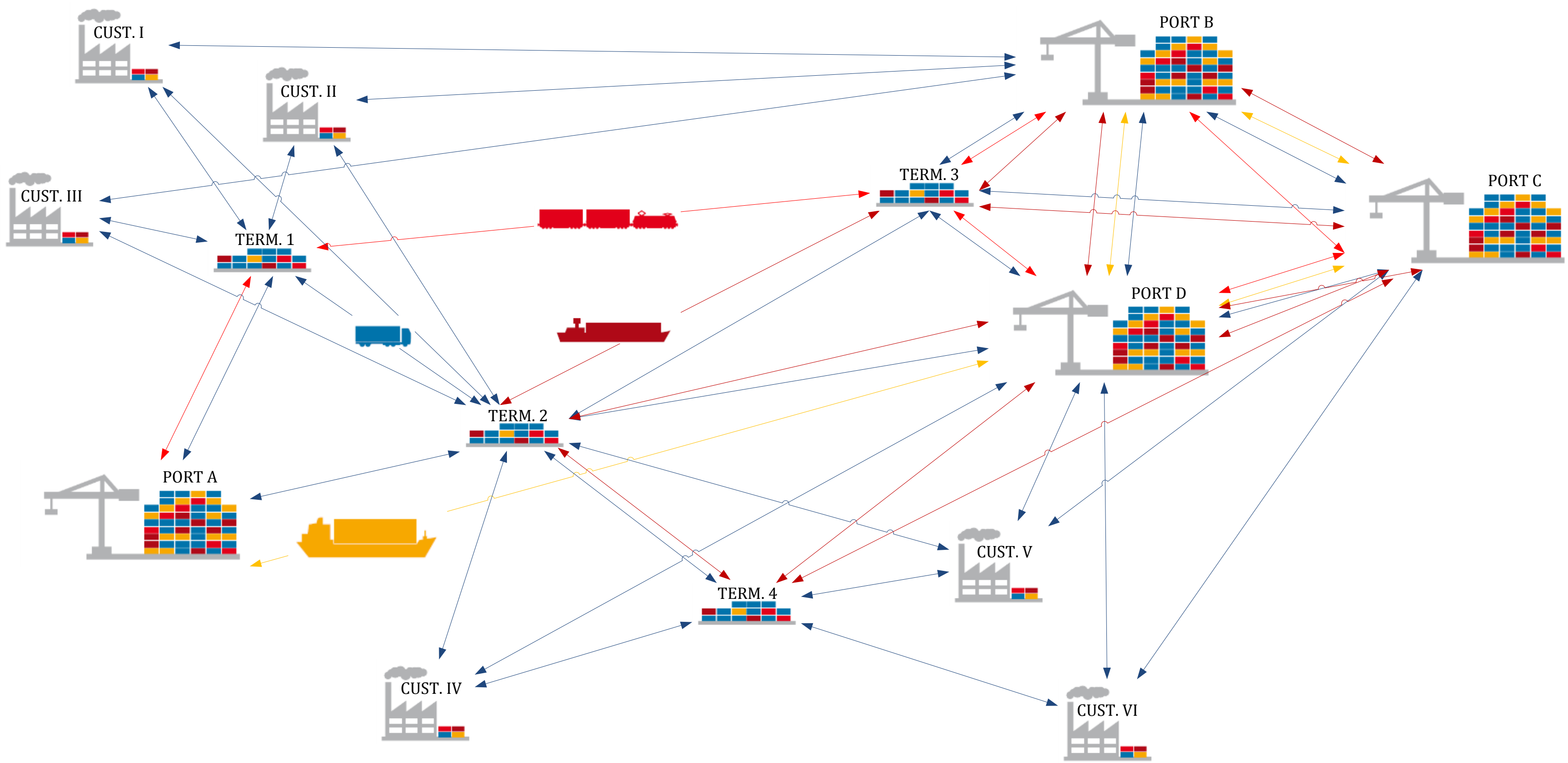


Figure 4.6: *Comparison of average rewards (over all networks) for our proposed VPI modifications*

3. Analyses

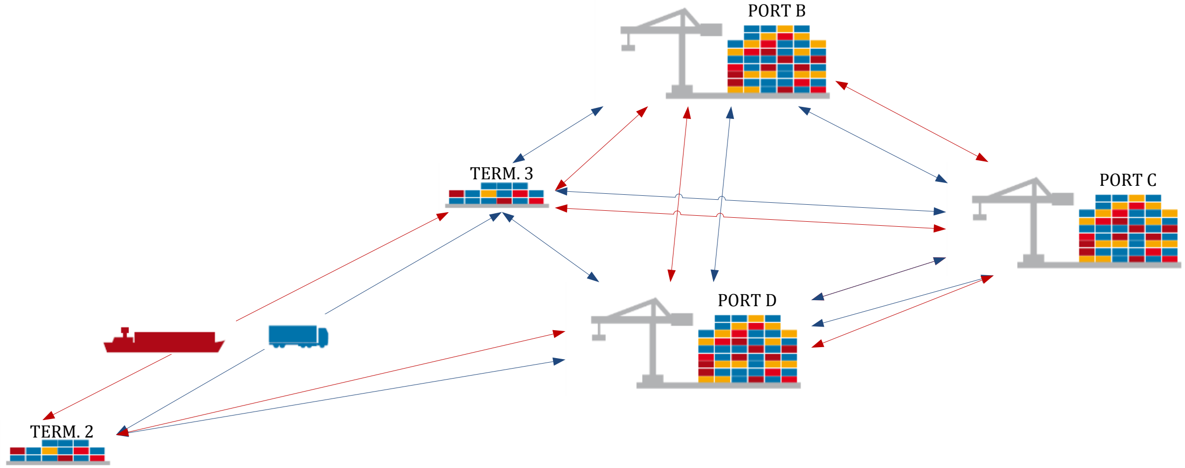
WE DESIGN ANTICIPATORY SCHEDULING METHODS FOR SYNCHROMODAL TRANSPORT USING OPERATIONS RESEARCH



**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

I – LONG-HAUL TRANSPORT

ROUND-TRIPS OF A SINGLE HIGH-CAPACITY MODE

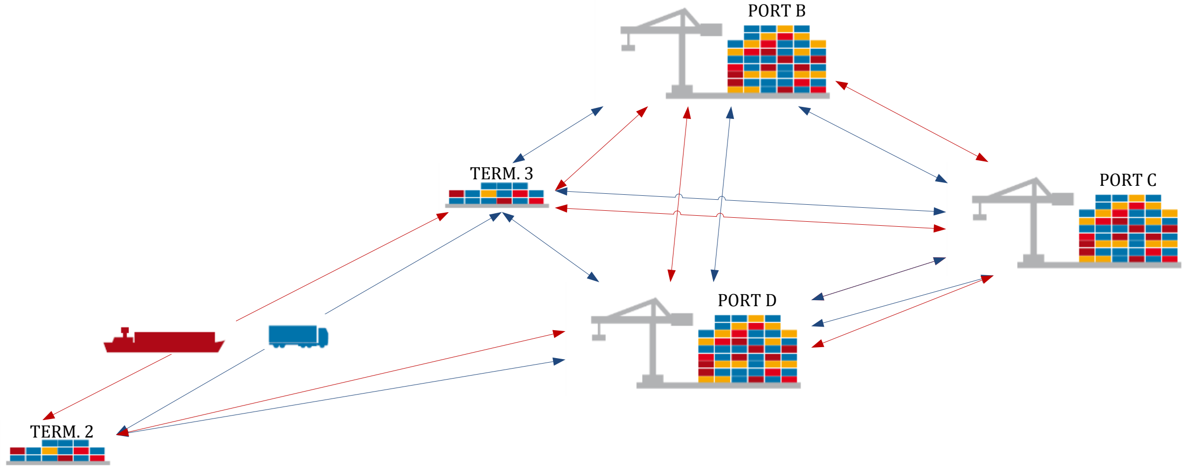


Challenge: to balance the consolidation and postponement of freight transport through ***time***.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

I – LONG-HAUL TRANSPORT

ROUND-TRIPS OF A SINGLE HIGH-CAPACITY MODE

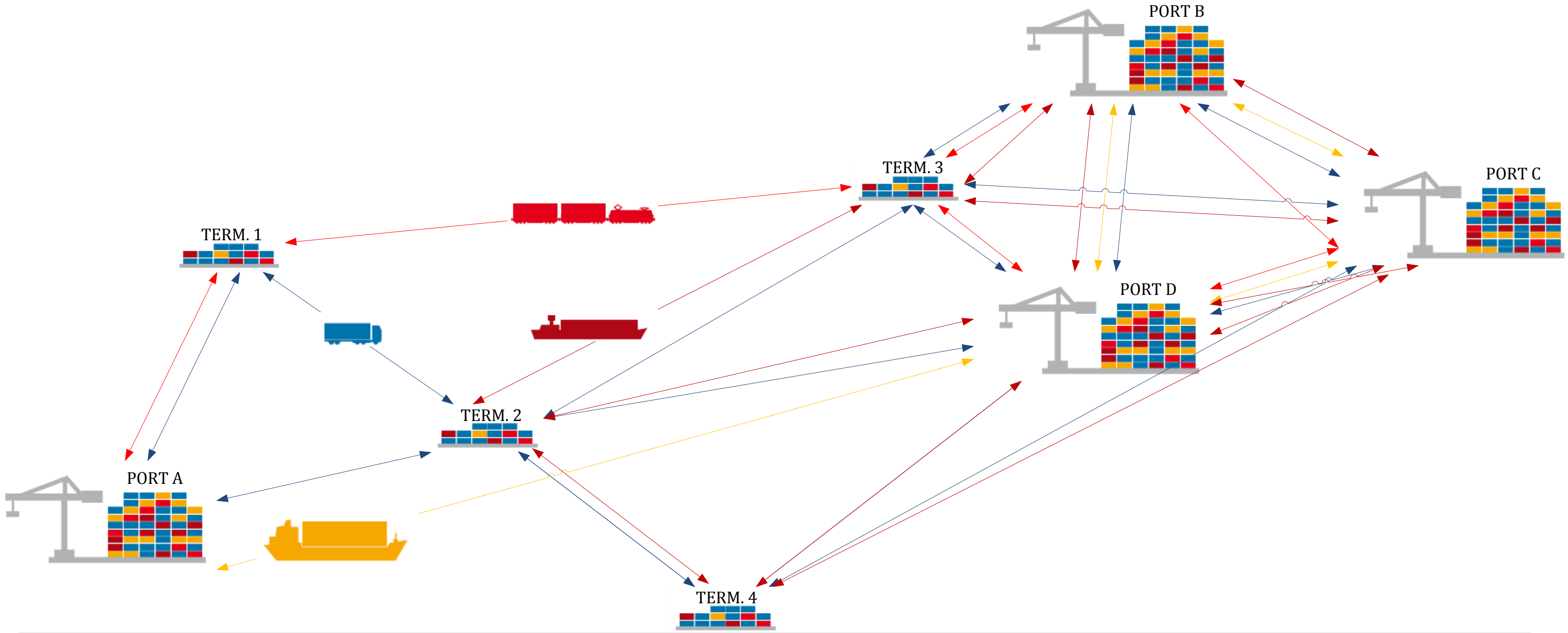


Results: Our method achieves up to **26% savings**, especially with **unbalanced destinations** and **pre-announced orders**.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

II – LONG-HAUL TRANSPORT

MULTIPLE HIGH-CAPACITY MODES WITH TRANSFERS

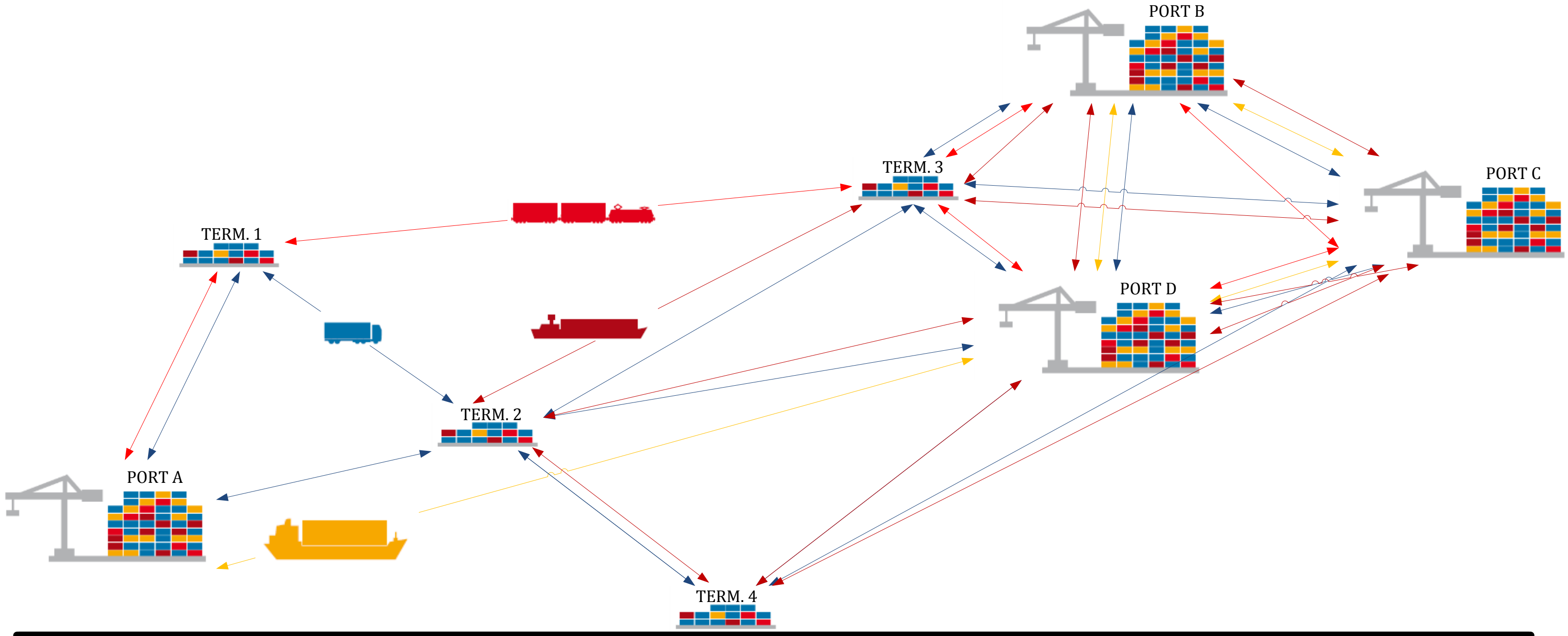


Challenge: To balance the consolidation and postponement of freight transport through ***time and space***.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

II – LONG-HAUL TRANSPORT

MULTIPLE HIGH-CAPACITY MODES WITH TRANSFERS

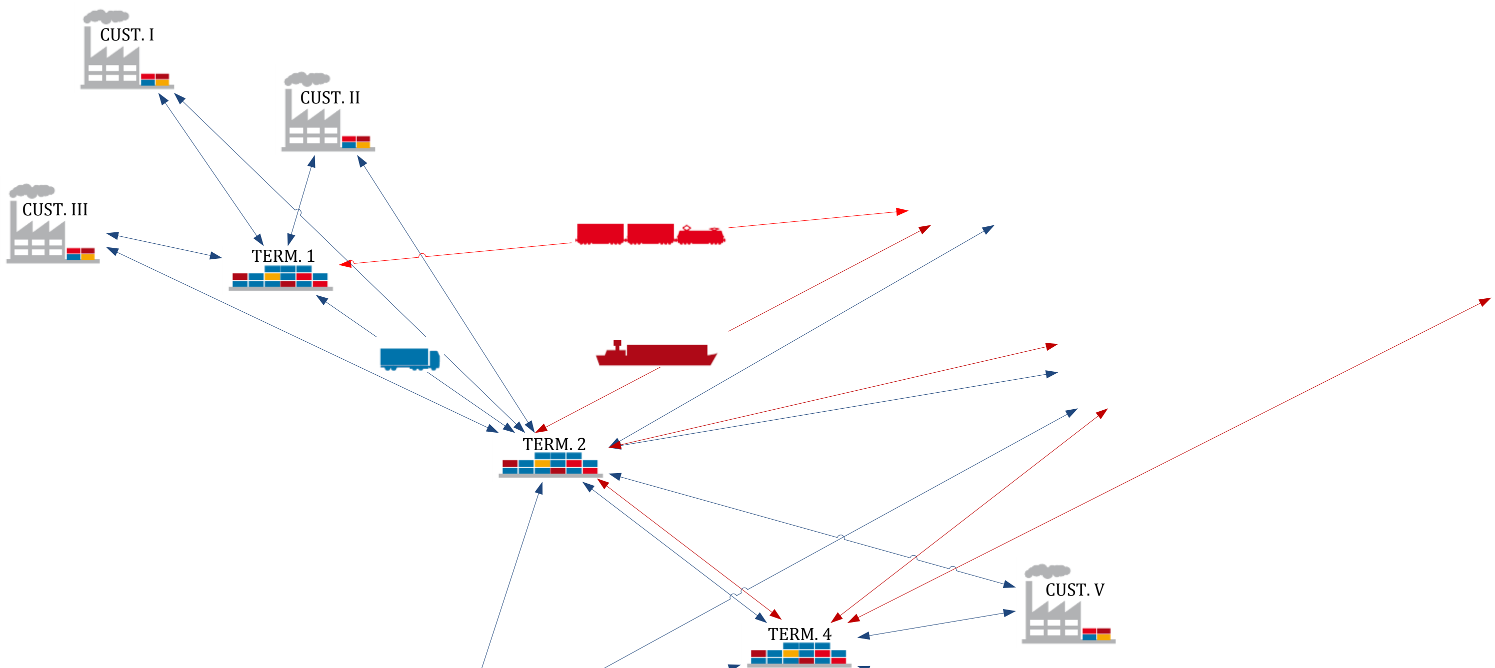


Results: Our method achieves more than **20% gains** with **long time-windows**, but *no gains* with *short time-windows*.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

III – DRAYAGE TRANSPORT

MULTIPLE LOW-CAPACITY MODES

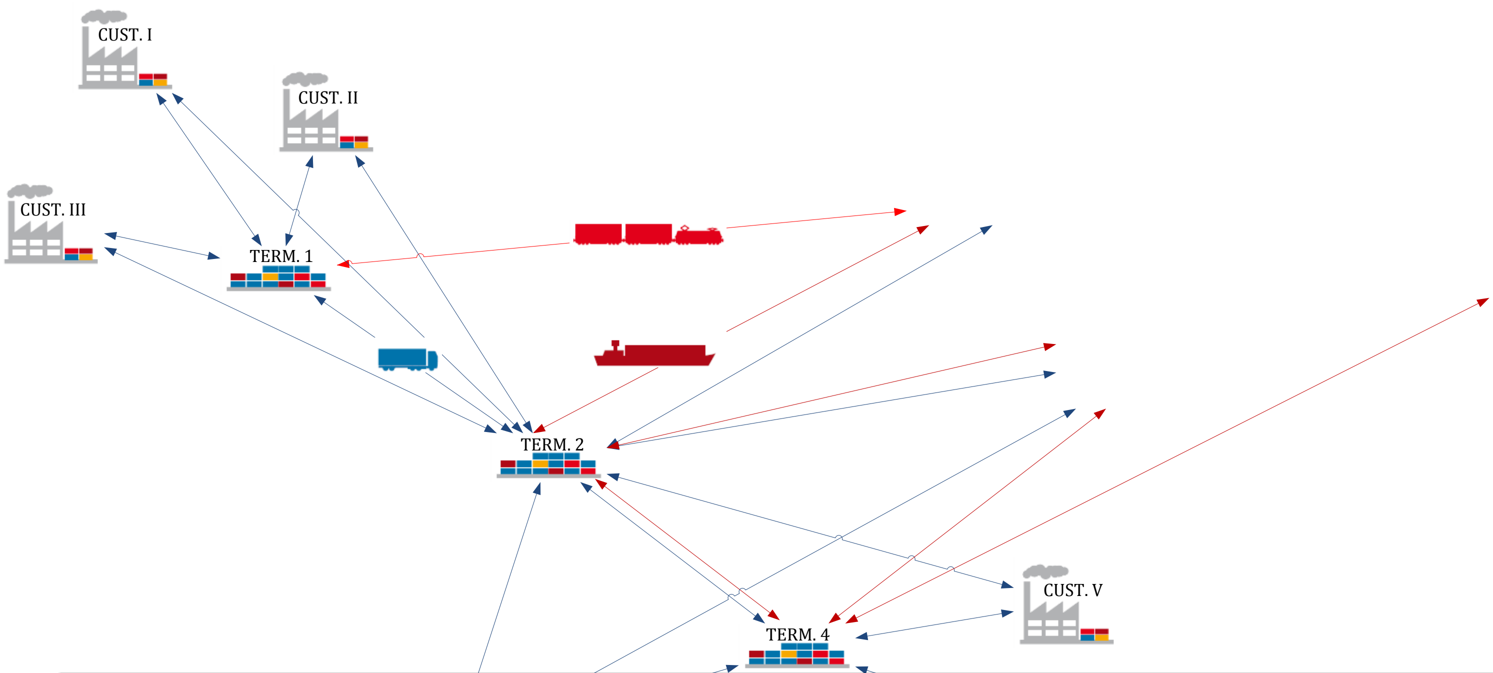


Challenge: To weigh the immediate routing costs against the ***terminal assignment*** costs.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

III – DRAYAGE TRANSPORT

MULTIPLE LOW-CAPACITY MODES

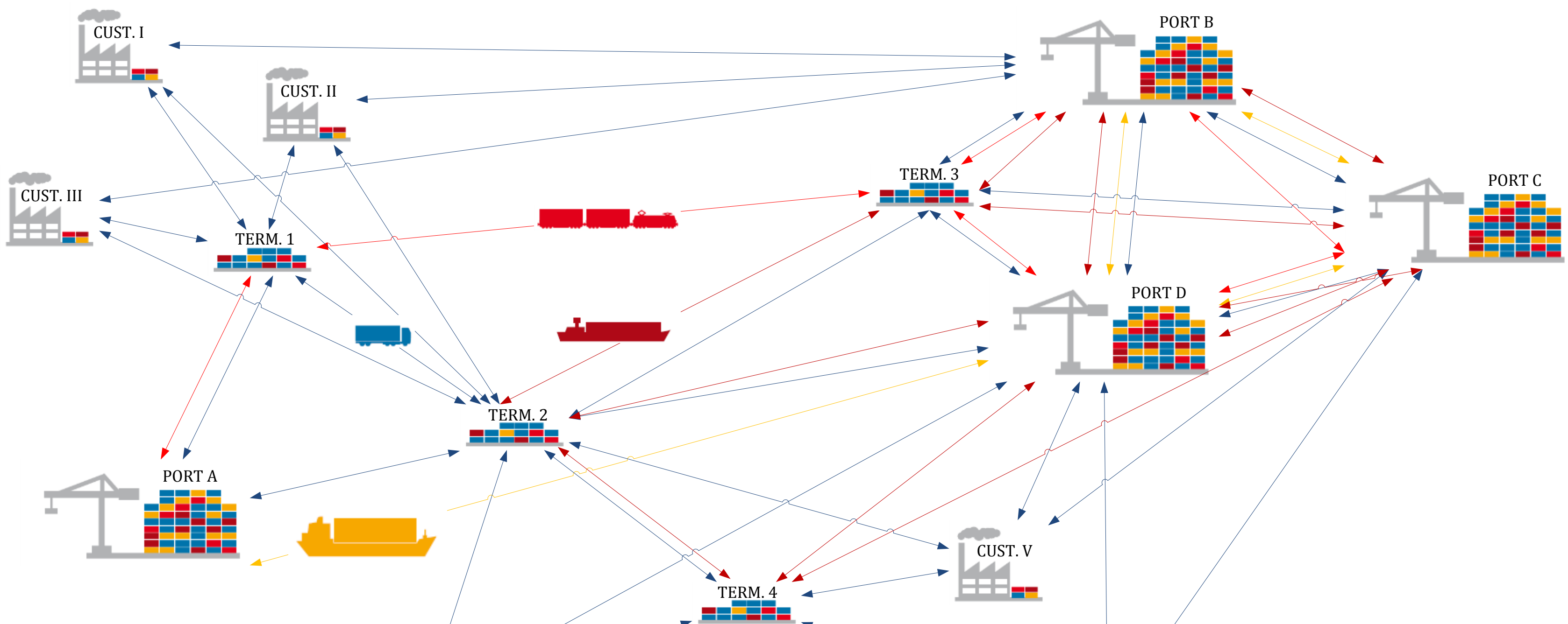


Results: Our method achieves up to **4% savings**, especially with **clustered locations** and **short time-windows**.

**Source of artwork: European Container Terminals (ECT) – The future of freight transport (2011).*

IV – INTEGRATED LONG-HAUL AND DRAYAGE TRANSP.

THE ENTIRE NETWORK

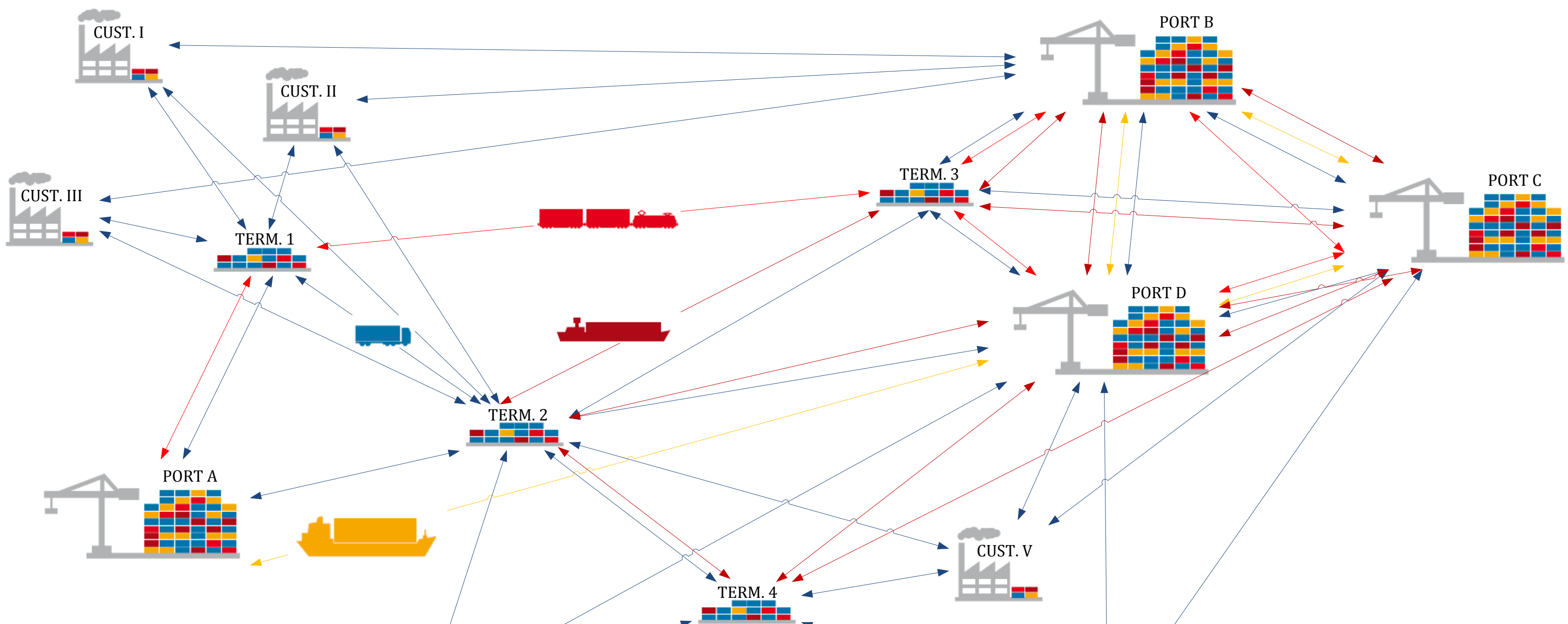


Challenge: To optimize ***network-wide performance through time*** long-haul and drayage transport schedules

**Source of artwork: Europe Container Terminals "The future of freight transport". www.ect.nl*

IV – INTEGRATED LONG-HAUL AND DRAYAGE TRANSP.

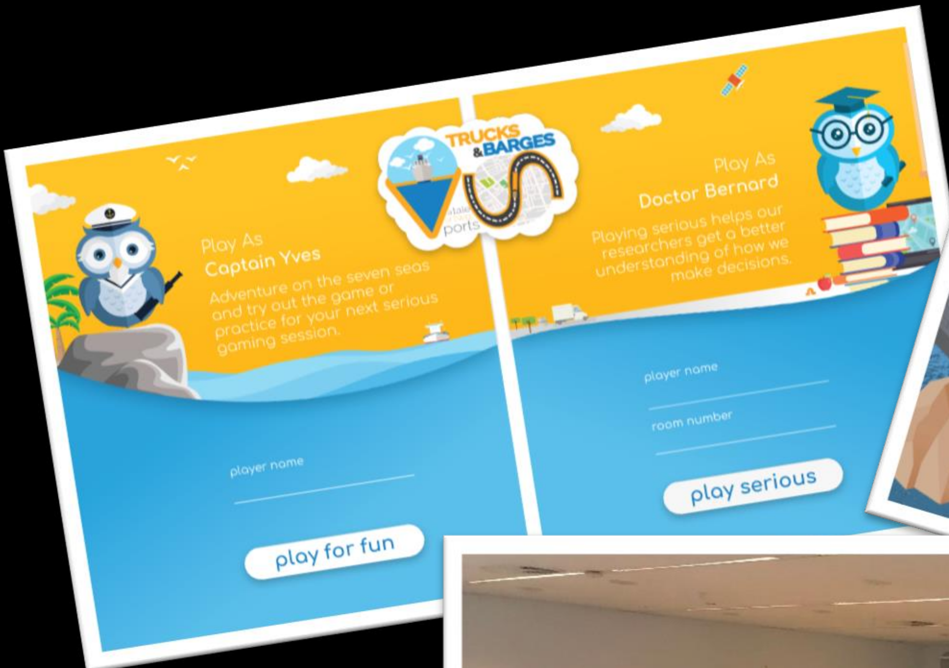
THE ENTIRE NETWORK

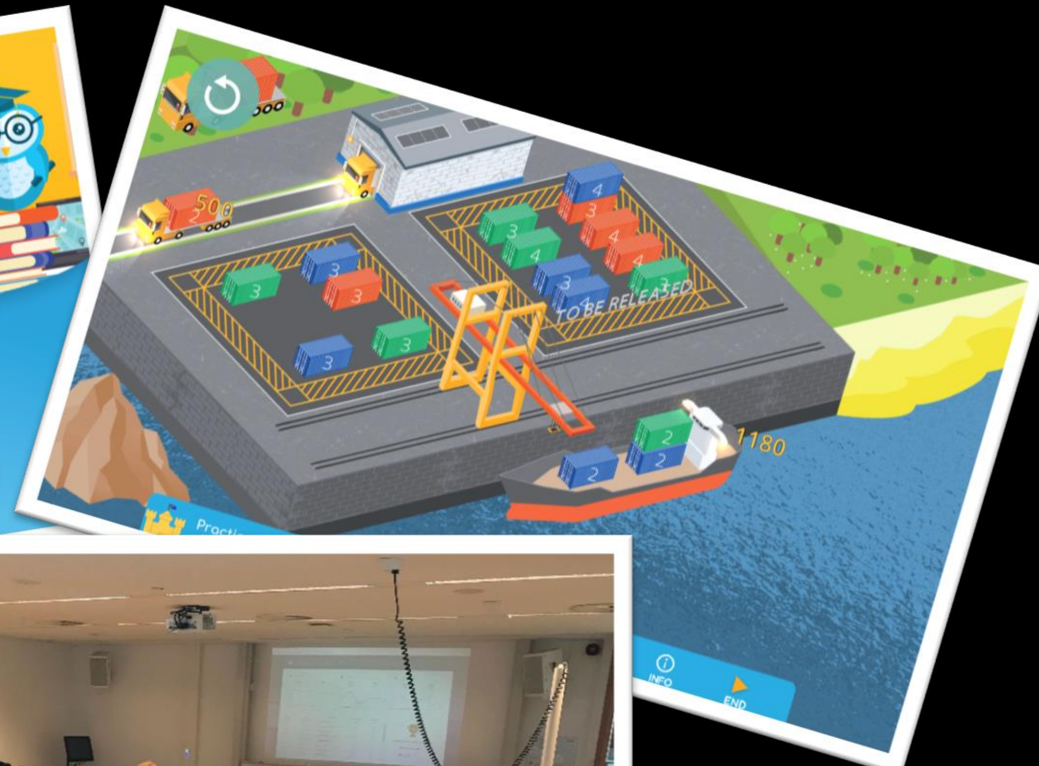


Results: Our method achieves up to **38% savings network-wide**, but it may sacrifice the performance of one part.

**Source of artwork: Europe Container Terminals "The future of freight transport". www.ect.nl*

RAISING AWARENESS – SERIOUS GAMING





TAKEAWAYS

- We design anticipatory scheduling methods for synchromodal transport to take advantage of the new consolidation opportunities that appear over the network and over time.

- Using our methods pays off the most with pre-announced freights that have long-time windows, and the least with urgent freights and balanced networks.

- Integrating anticipatory scheduling methods of drayage and long-haul transport improves the performance of the network as a whole, but might sacrifice the performance of one of the processes.

Reception @ Rico Latino (De Heurne 19b) – 21:00 – I hope to see you all there!

Arturo E. Pérez Rivera

arturo.perezrivera@gmail.com

Paranymphs:

Javier A. Morán M. and Rick van Urk