Strategic and Operational Planning Problems in CityLogistics

Sustainable CityLogistics Conference

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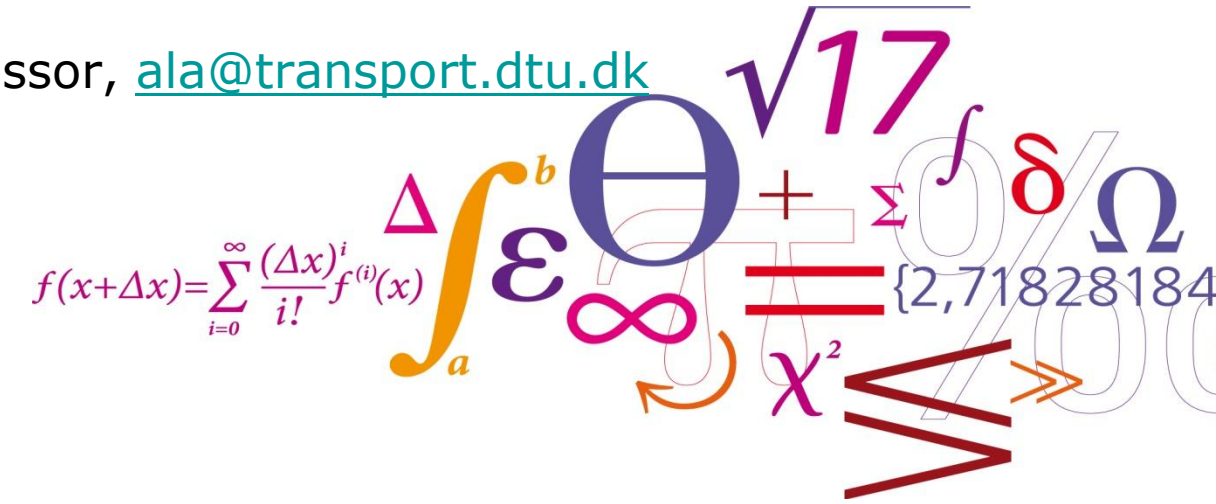

DTU Transport
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Agenda

- Definition of the CityLogistics
  - Seen from a transport optimisation point of view
- Planning and optimisation problems
  - Strategic, tactical, operational and real-time levels
- A closer look at the cross-docking sub-problem
- Simulation of real-time operations in CityLogistics
- Closing and questions

DTU Transport

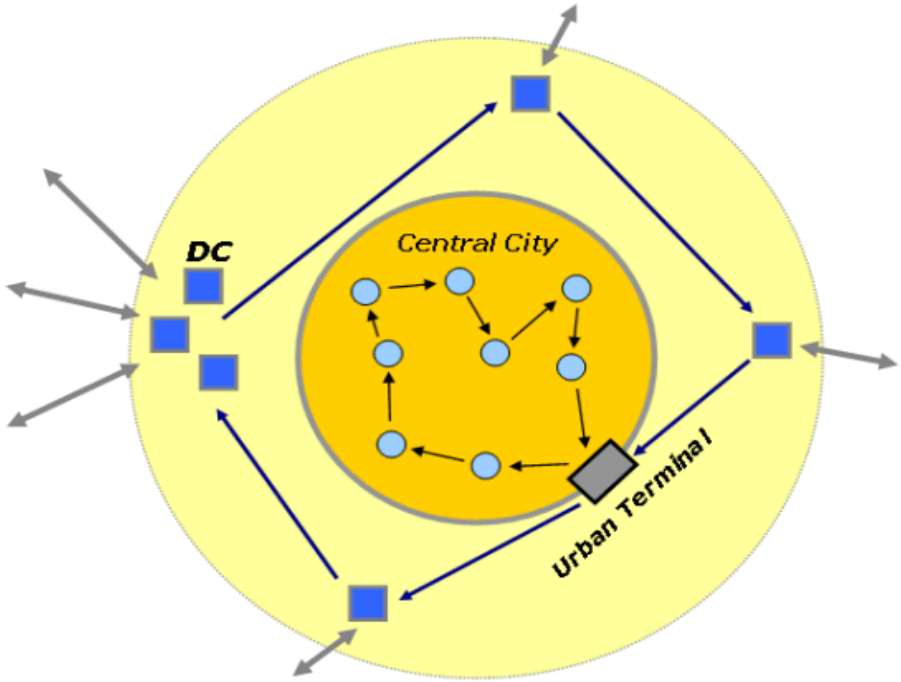
- The Department of Transport, DTU
  - Research, teaching, public sector consulting and innovation within traffic, transport and logistics
  - Approx. 80 employees

  - Organisation:
    - Transport Modelling
    - Decision Modelling
    - Transport Economy
    - Traffic Safety
    - ModelCenter
    - Logistics and Intelligent Transport Systems

CityLogistics (CL) – What?

- Basic idea:
  - Consolidation of goods between the senders, operators and customers

- The challenge:
  - Integration of stake holders' requirements so that a fully efficient and agile logistics system is created



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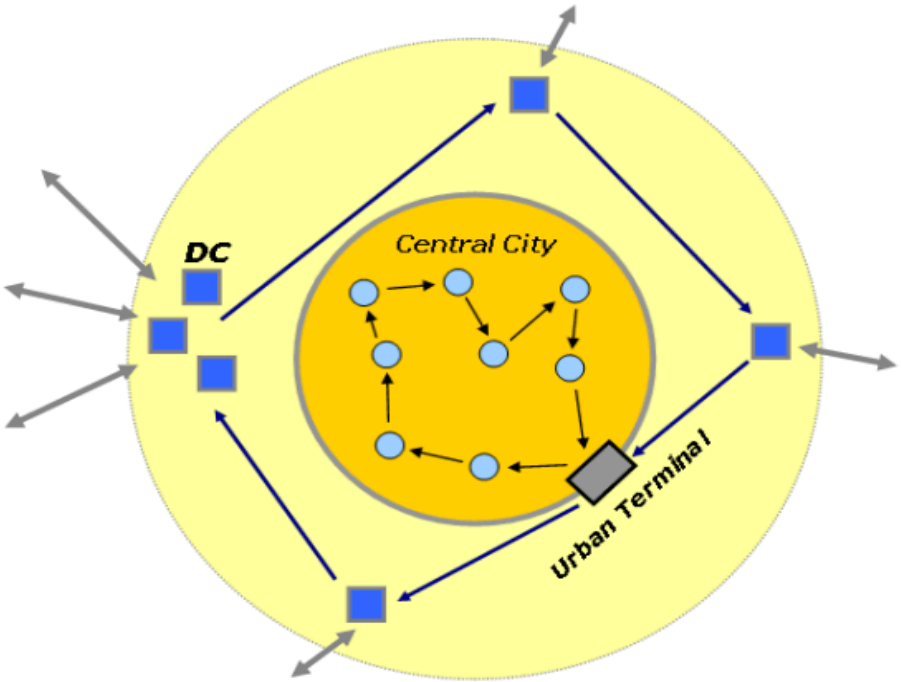
CityLogistics (CL) – Why?

- Goals:
  - Reducing congestion – improving mobility
  - Reducing emissions, local pollution, noise
    - Contributing to the CO2-reduction goals
  - Improving urban life conditions

- ALSO:
  - Avoiding punishing activities in the city centres
    - "The empty city centres"



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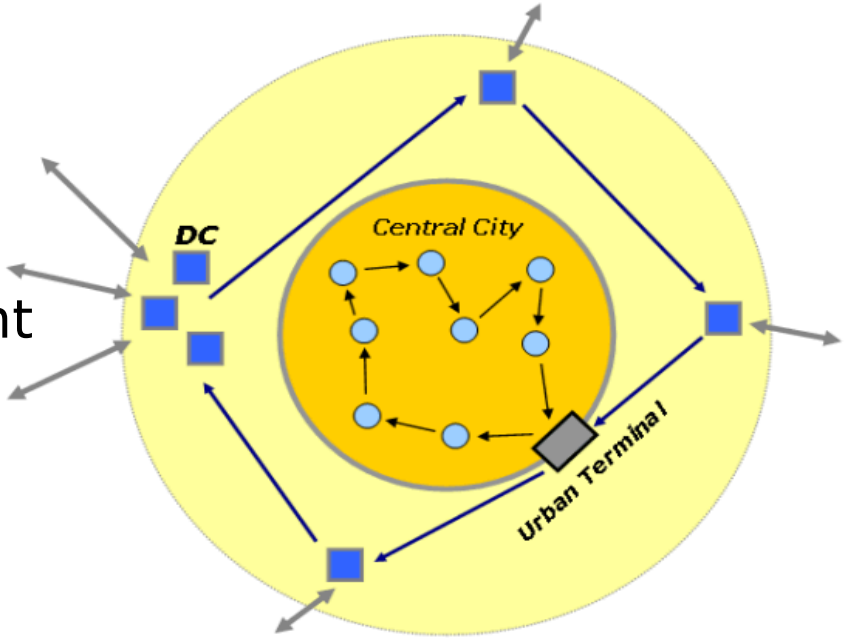
Drivers for CityLogistics (CL) – How?

- ***Through regulation***
  - Challenges with competition issues
  - Conflicts with EU law on free trade access
- ***Through motivation/incentives***
  - Indirectly via for instance intelligent road charging schemes
  - Value-added services
    - Handling of waste etc. (including return logistics)
    - Operators moves the goods directly into the shops (”the last 3 steps”)



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CL – Advantages and Disadvantages? (I)

- Socio-economic interests versus interests of private companies

- Politicians, municipalities/regions, authorities, interests organisations etc.
  - Goal: minimising the transport impacts in the cities

- Retailers, shippers/producers, carriers and the customers (residents)
  - (Understandable) reluctancy against bringing in an extra step in the distribution/supply chain

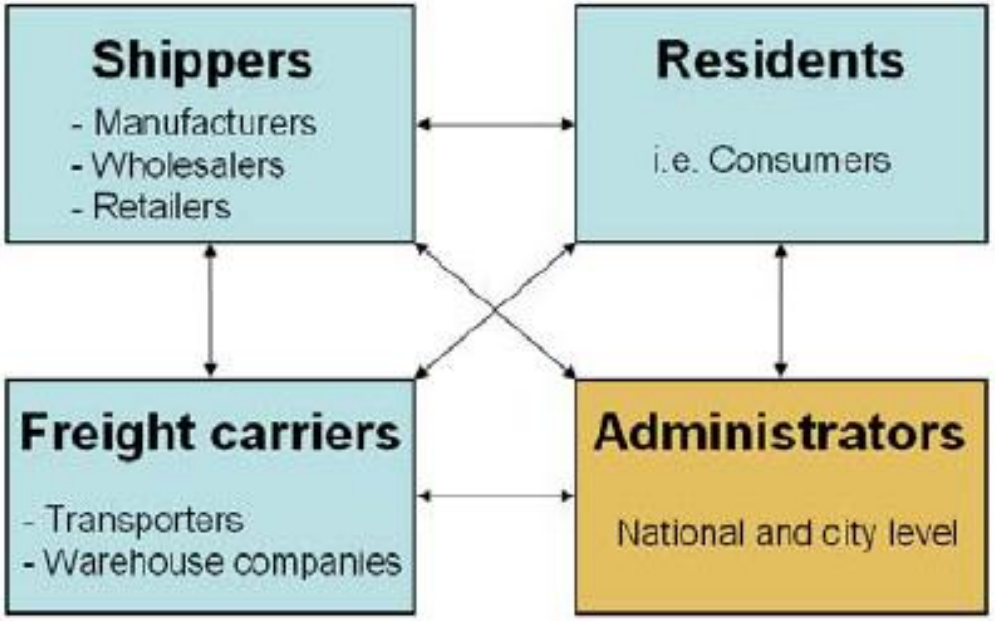


Figure: Taniguchi et al. 2008

CL – Advantages and Disadvantages? (II)

- Important not only to analyse what the societal gains are of implementing a CL concept
- Detailed studies of advantages and disadvantages for each stake holder
- NEEDED: Simulation studies of a large-scale CL system with realistic data/components in each step of the supply chain

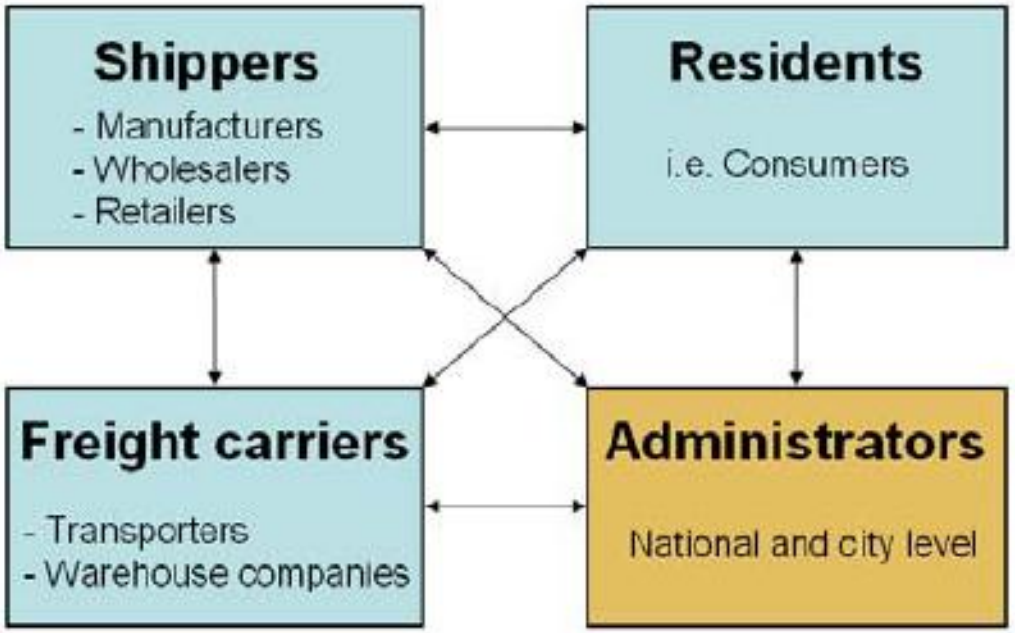
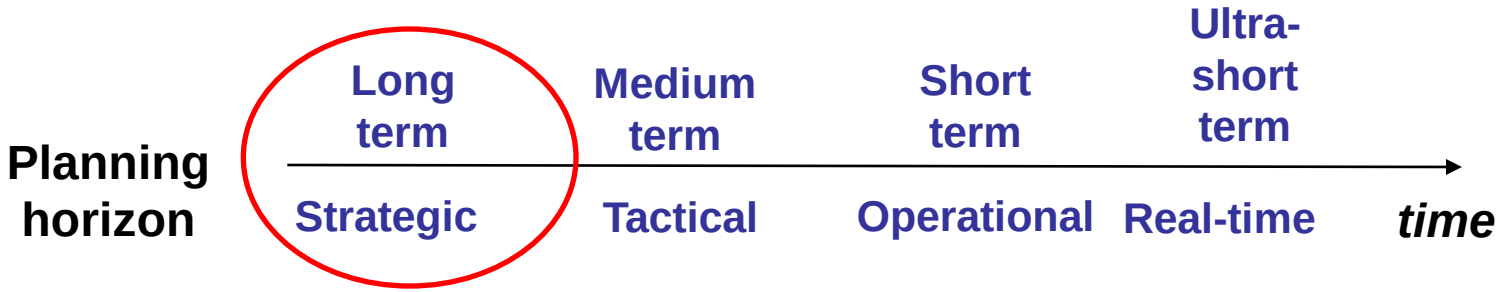


Figure: Taniguchi et al. 2008

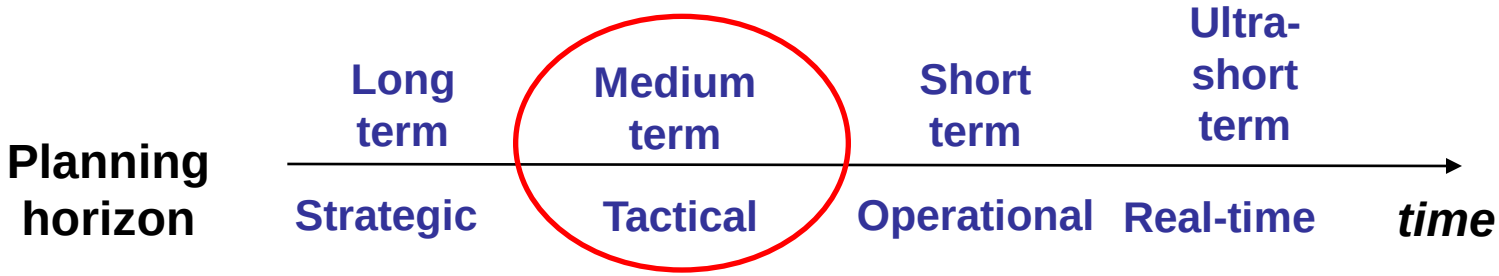
CL – The strategic planning level



- The high-level design of the CL-system
- Analyses of possible locations of the distribution centres

- Only high-level forecasts of expected order mass
  - Modeling of service networks (aggregated level)

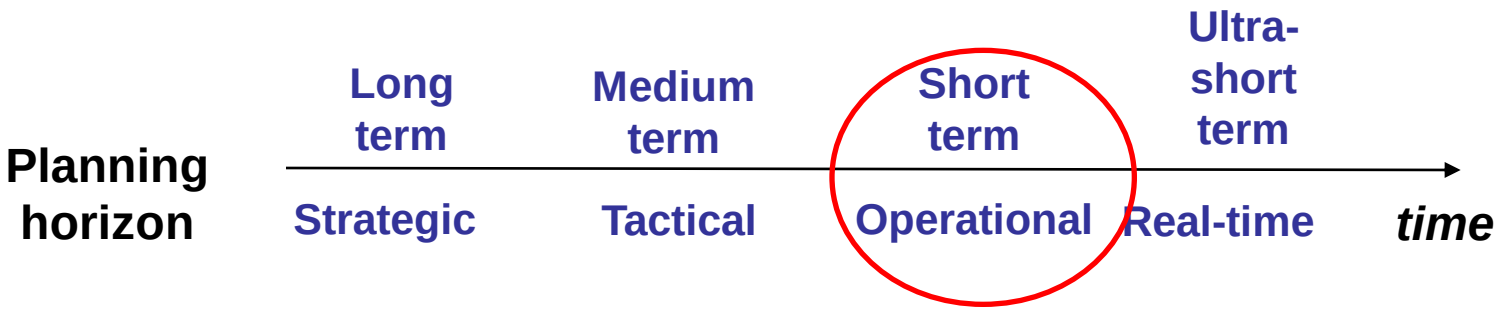
CL – The tactical planning level



- High-quality and detailed forecasts of the order mass

- Design of the service network (timetables/schedules)
  - Fix routes for the route planning
  - High-level planning in the terminals

CL – The operational level



- Specific orders now given (changes may still occur)

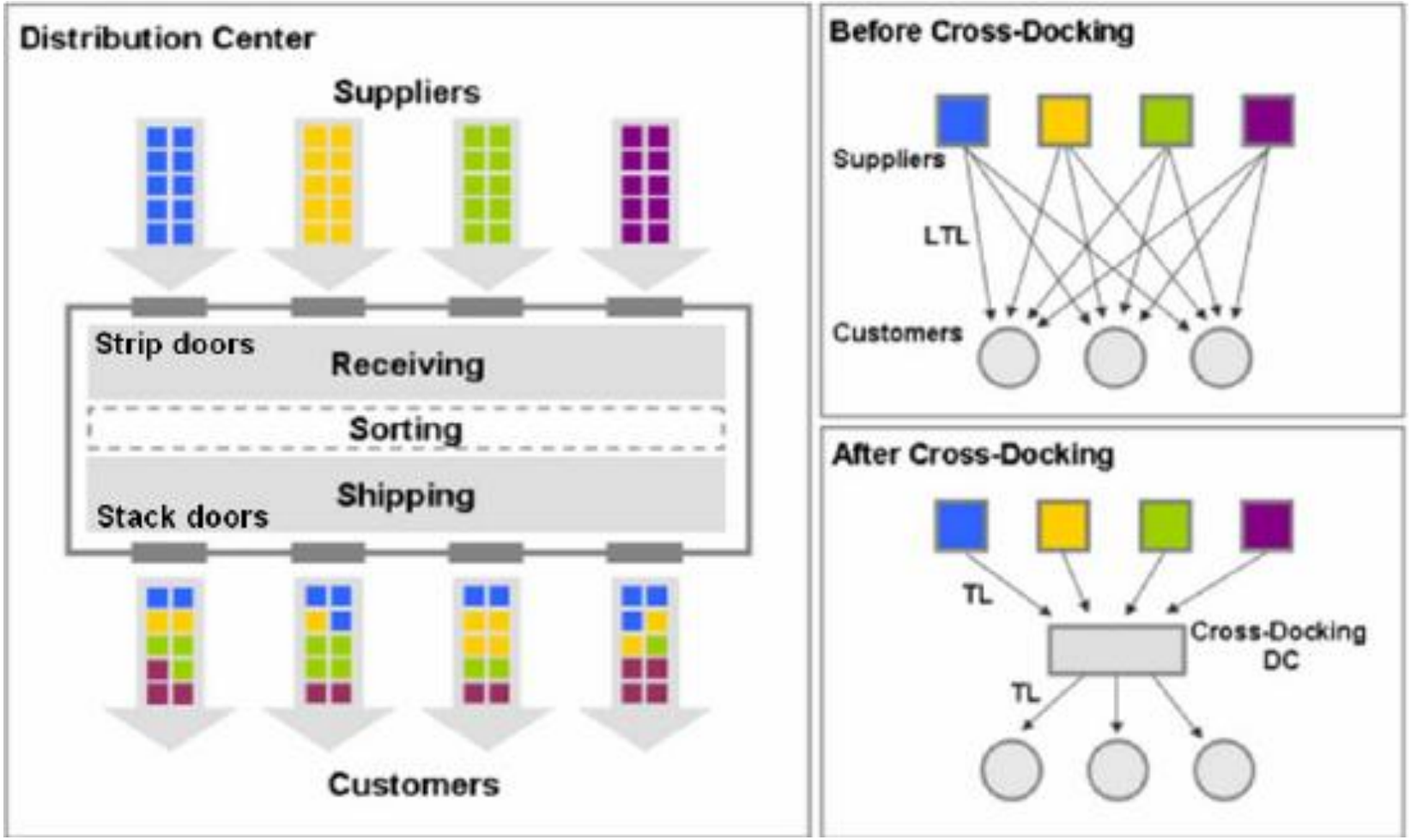
- Detailed plans:
  - Routes for the vehicles (and the goods booked)
  - Schedules for drivers and terminal crew, etc.

CL – The ultra-short term

- Control and dynamic updates of route plans, crew schedules in terminals etc.

- Updates from the infrastructure kan trigger re-planning processes
  - Examples:
    - Reduced speed in certain road segments due to congestion, bad weather etc.
    - Complete close-down of road segments due to accidents (or similar)
    - And so on (Murphy's law)

Cross-docking – a central component in CL



Cross-docking – Challenges

- Longer cycles for the goods
  - Goods via the CD terminal
- Manning and operating the CD terminal
  - Labour costs –> not all operations can be automatised
- Complex coordination of in- and outgoing goods
- Producers/operators: Reluctancy against ”sharing” a CD with competing companies

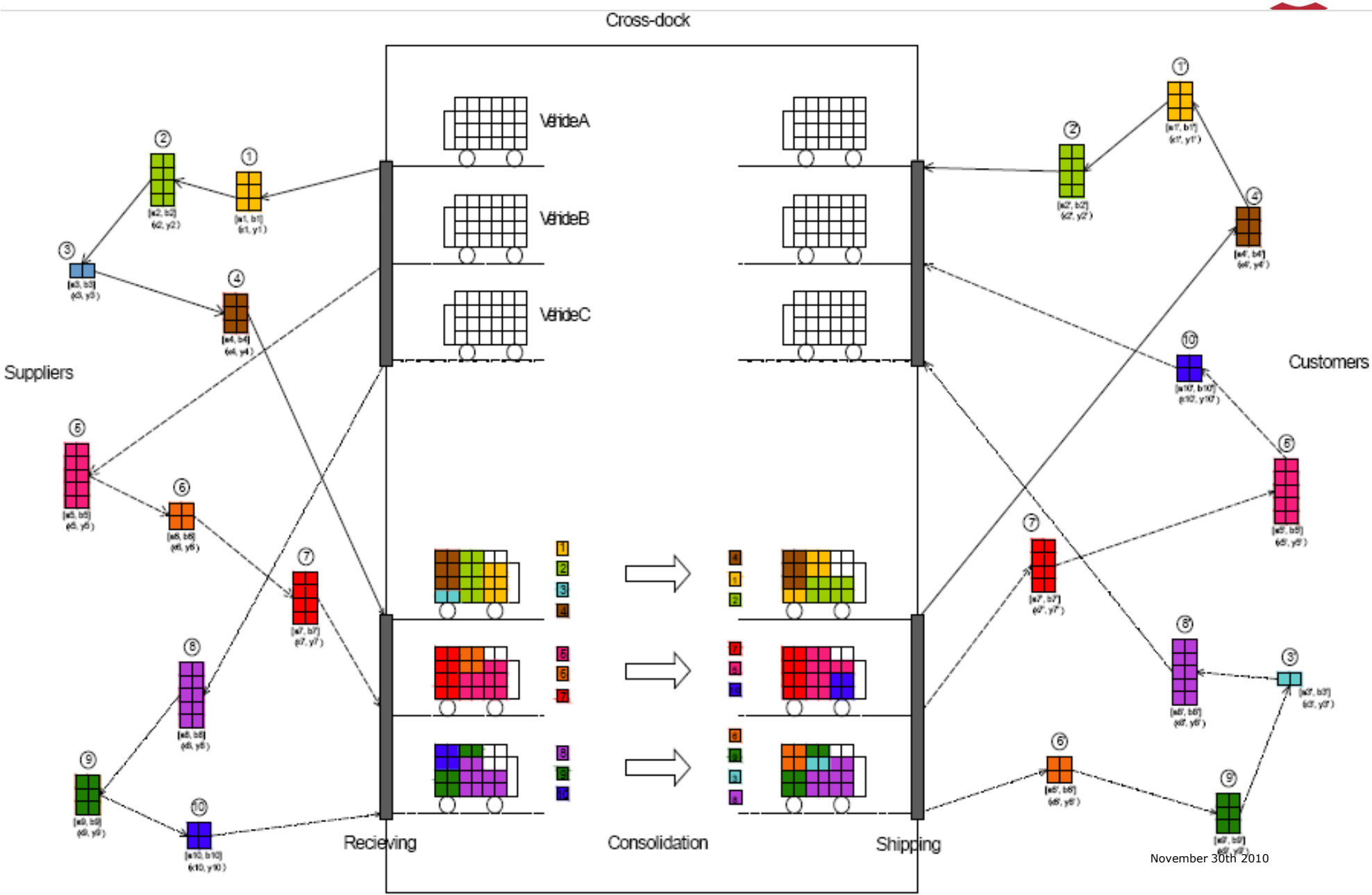
Cross-docking and transport optimisation

- Relatively new topic within the transport optimisation community (only few research papers)

- The CD-concept has been known in more than 20 years

- Examples of research within the CD-problem domain:
  - Physical lay-out of a CD
  - Location analyses
  - Gate (dock allocations) – assigning doors to the trucks
  - Route planning for the in- and out-going trucks

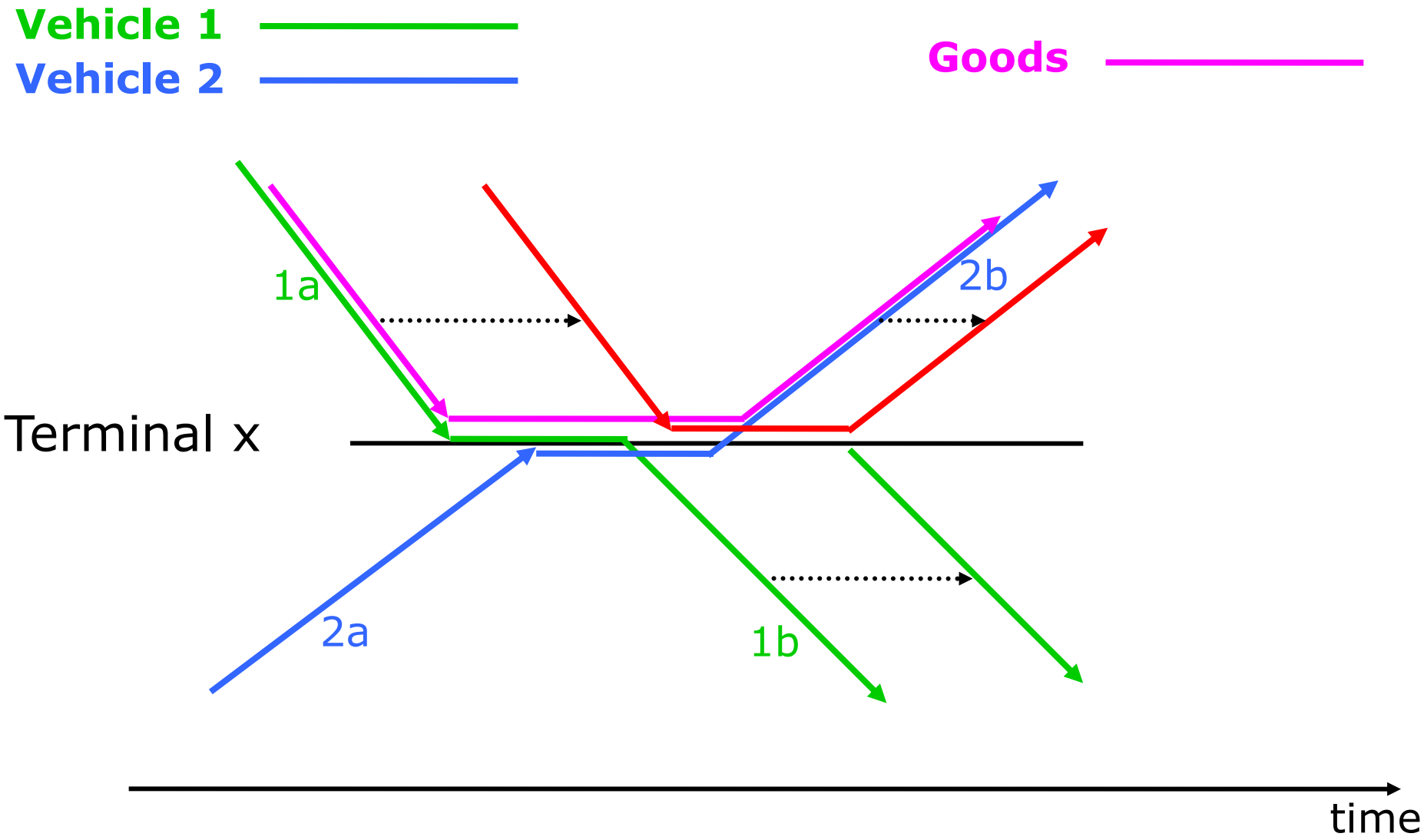
Route planning and Cross-docking



Simulation studies in CityLogistics (I)

- Robust plans are vital for the operational performance of a CL-system
  - Coordination between in- and out-going flows in the CD-terminal
  - Risk of ”domino effects” in case of disruptions
    - A delayed in-coming vehicle can cause several out-going vehicles
      - => example

A simple example of a late in-coming truck



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- Robust plans are vital for the operational performance of a CL-system
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  - Risk of ”domino effects” in case of disruptions
    - A delayed in-coming vehicle can cause several out-going vehicles
    - Re-planning may be necessary
  - Parallels to the airline industry’s challenges with hub-spoke networks

Simulation within CityLogistics (II)

- Simulation studies may help;
  - provide an assessment of the consequences
  - provide the planners with feed-back on needs for further slack in route plan and crew schedules
  - train (newly hired?) planners in dealing with disruptions

Simulation within CityLogistics (III)

- Specific projects:
  - Simulating Cross-docking terminal operations with disruptions
    - Use generated data (customer locations, orders, lay-out of the CD etc.)
    - Implemented a simulation framework in the simulation modelling package Arena
    - Generated disruption scenarios
  - Simulation of internal operations in the CD
  - Studies on how the CD-terminal performs during disruption

Consolidation at the sender level

- CL does not necessarily have to be based on Distribution Centre
- "Consolidation" and "Coordination at the sender level
  - Vendor Managed Inventory systems
- Collaborative logistics
  - Competing entities work together – buys and sells free capacity to each other

Closing

- The underlying planning problems in a CL system are by themselves interesting seen from a research perspective
  - The integration af these into one system add tremendously to the overall complexity of the planning problems

- Important to perform detailed studies of the impacts of implementing a CL system for all stake holders

Thank you for your attention!