Home delivery

Innovations in e-fulfillment

TNO Physics and Electronics Laboratory

ContentsOptimization problems

- **Problem situation**
- **Logistic concept**
- **Optimization problems**
- **Results**

Problem situation

E-commerce didn't bring the promised growth

Logistic causes:

- High cost of material handling / order picking
- High cost of home delivery
- Low customer service level
- Low delivery hit rate (customer is not at home)

Delivery was not focused on customer requirements:

- Customers can't influence delivery time window
- Communication with customer about delivery to late or not at all

Customer order process

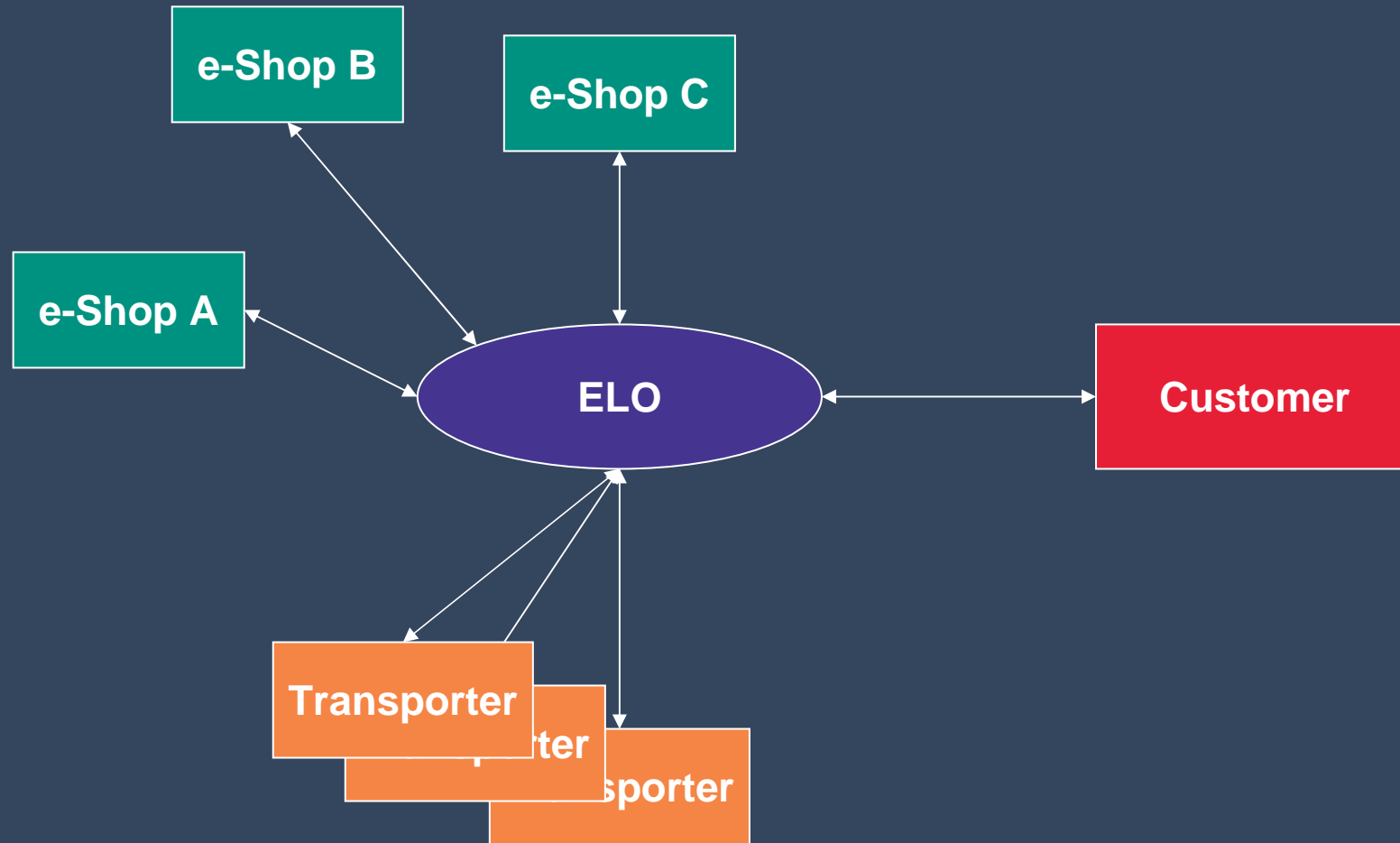| time windows	monday	tuesday	wednesday	thursday	friday	saturday
09.00-11.00			xxx			
11.00-13.00						
13.00-15.00	(red)					(red)
15.00-17.00		xxx				(red)
17.00-19.00	(red)	(red)				
19.00-21.00		(red)				

- **Customer order through the internet**
- **Customer provides his location**
- **Pick a time window**

e-Logistics Organizer (ELO)

- **Customer can control time delivery time window at order acceptation**

- **Final delivery time window is set at this moment**

- **Take future orders into consideration**

- **Influence customer through incentives**

- **Combination of customer orders with a time window and without time windows**

Role for the e-Log Organizer

e-Shop B

e-Shop C

e-Shop A

ELO

Customer

Transporter

porter

sporter

Advanced order acceptance process

time window	monday		tuesday		wednesday		thursday		friday		saturday	
09.00-11.00	- € 4	- € 6		- € 2	XX	- € 2		- € 2				- € 2
11.00-13.00												
13.00-15.00		- € 2	XX	- € 6		- € 2		- € 2				- € 2
15.00-17.00			- € 4									
17.00-19.00		- € 2	XX	- € 6		- € 2		- € 2		- € 2		- € 2
19.00-21.00												

Time window for your delivery will be

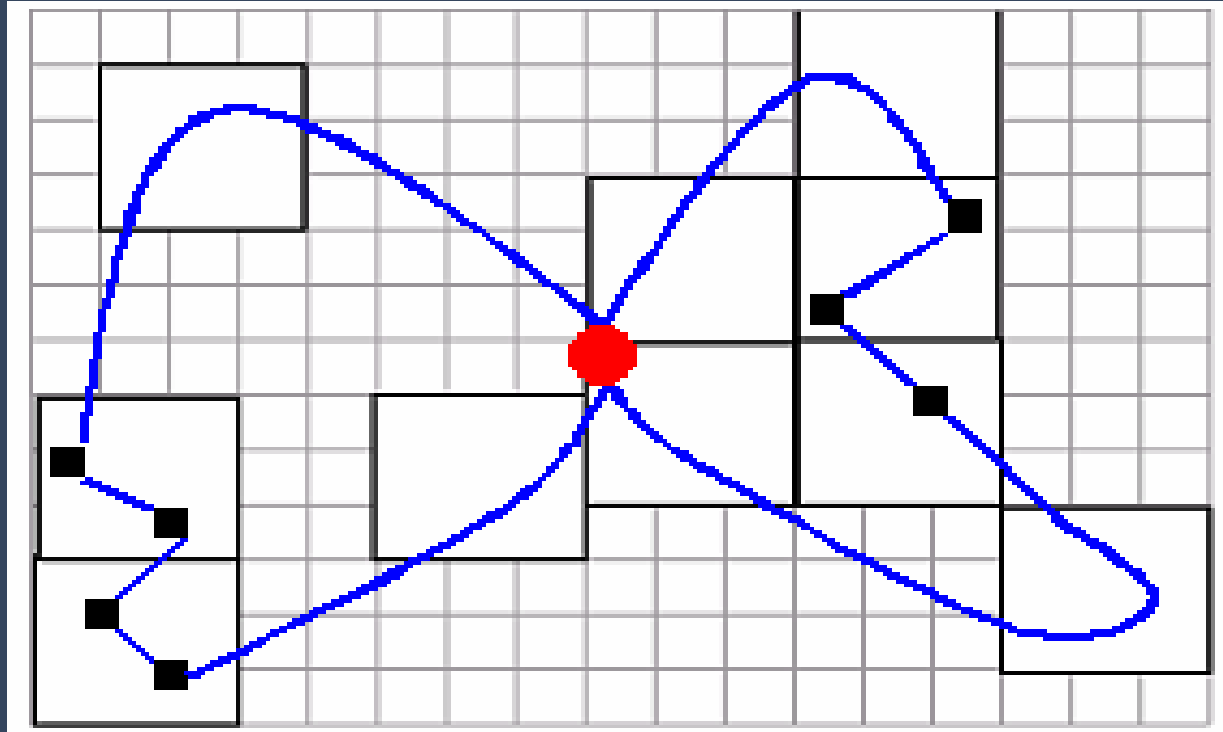**Tuesday between 13.00 – 15.00**

On-line planning problems

1. **How to color the agenda considering current and expected future orders**

2. **Choosing between the different customer selected time windows**
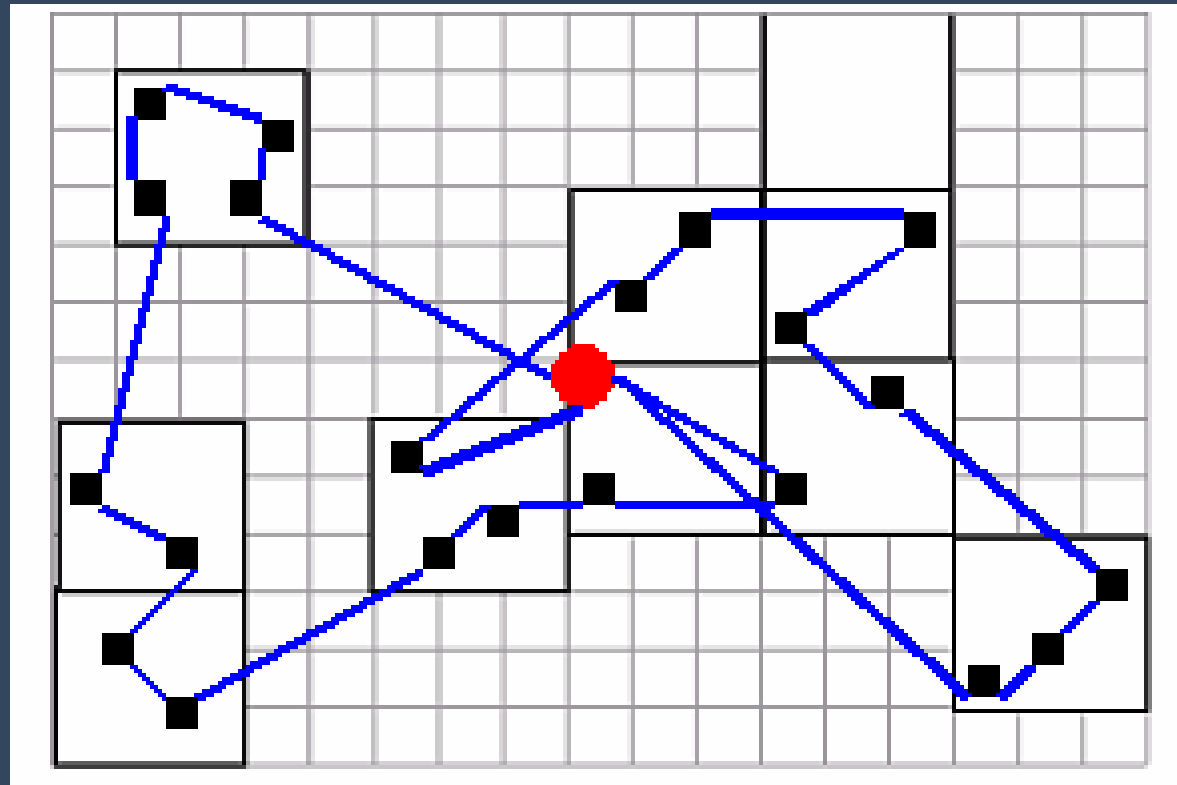
Basic routes before real order acceptance
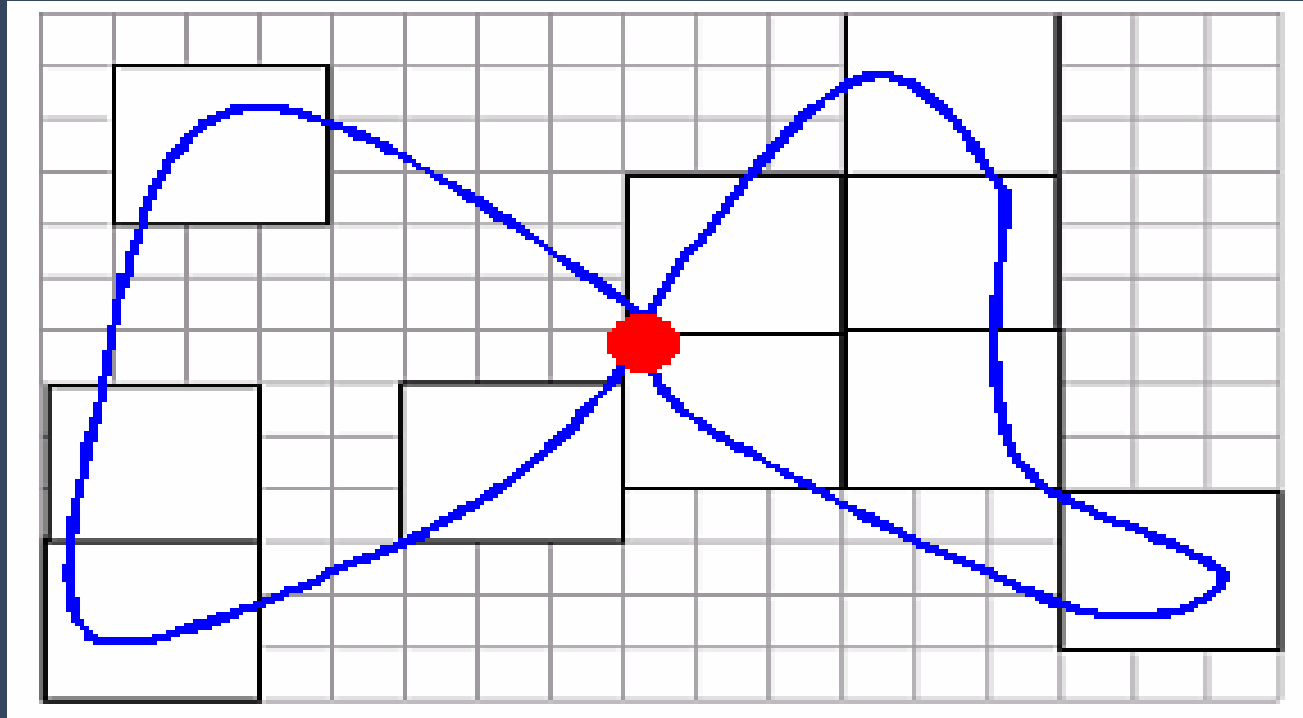
- **Well spread out but efficient**
- **Flexible**
- **Taking region characteristics into account**

Acceptance of orders

- **m-VRPTW**

- **Insertion heuristics**

- **Basic routes slowly adapt to real orders**

The final routes

Coloring the agenda

- **Insertion cost for each time window**
- **Color the best green**
- **Impossible time windows are red**

time window	monday	tuesday	wednesday	thursday	friday	saturday
09.00-11.00	5	35	30			
11.00-13.00	20	22	24			
13.00-15.00	-	3				
15.00-17.00	15	7				
17.00-19.00	25	6				
19.00-21.00	16	17				

Customer behavior

time window	monday		tuesday	
09.00-11.00	1	1	7	7
11.00-13.00	1		7	
13.00-15.00	1	1	6	1
15.00-17.00	1		1	
17.00-19.00	1	1	6	1
19.00-21.00	1		1	

- **Preference matrix**

time window	monday		tuesday	
09.00-11.00	1+2	1+3	7	7
11.00-13.00	1		7	
13.00-15.00		1	**xx**	1+3
15.00-17.00	1		1+2	
17.00-19.00	1	1	**xx**	1+3
19.00-21.00	1		1	

- **Incentives influence preferences**

Information poor orders

- **Final planning the day before distribution**
- **Placed into "holding list" in order of priority**
- **Preference for time windows with highest hit rate**

Implementation:
- **Real routes (without expectations)**
- **Insertions heuristics**

Optimization

Local search within routes

Tabu search

- **"Holding list" (Hoong Chuin Lau e.a.)**
- **Neighborhood structure**
- **Find the best solution in neighborhood**
- **Objective function: hit rates and time**

Preliminary results

- **Basic routes decreases driving time with 20%**
- **Customer incentives an extra 10%**
- **Small influence in directing customers already gives this improvement**

Further research

- **Basic routes**

- **Insertion on more than travel time**

- **Agenda building and coloring (different strategies)**