

Terms for analysis

Delivery types, a delivery point, and
delivery plans

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Types of parcel delivery

- **Type 1** : consumers order products online stores and the products ordered are delivered to the consumers
- **Type 2**: consumers send parcels to each other
- Parcel delivery have similarities with data communications in cell networks
- In cell networks there is more transmission capacity in a downlink direction than in a uplink direction
- Downlink direction is from a base station to a user device

Different needs

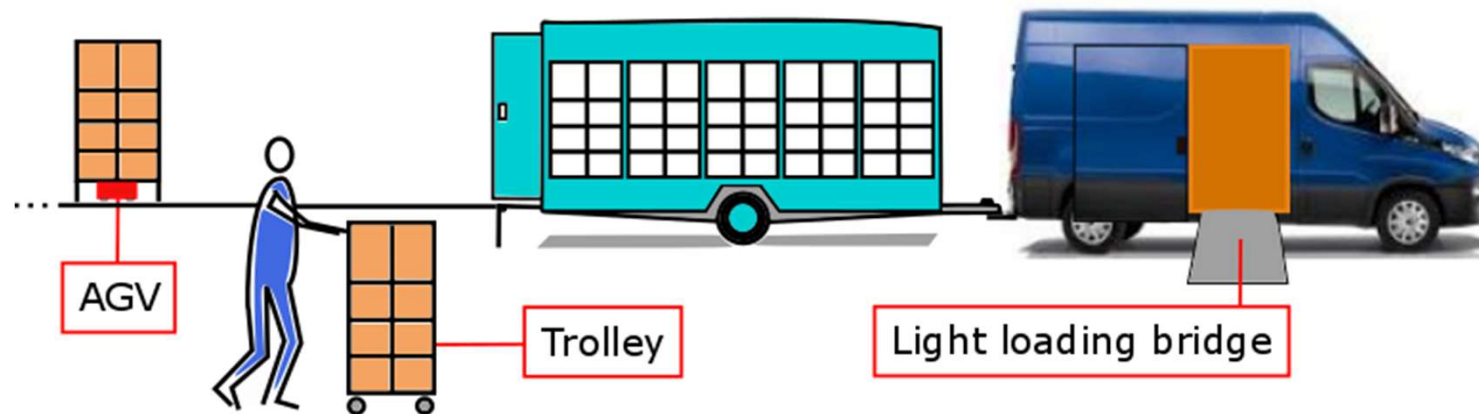
- **Type 1** - consumers order products online stores:
 - lots of parcels are delivered from the sorting hub to delivery sites but much less vice versa
 - high capacity in "downlink direction", i.e. from the sorting hub to delivery sites, is important
- **Type 2** - consumers send parcels to each other:
 - approximately the same number of parcels are delivered from the sorting hub to delivery sites than to the opposite direction
 - sender of a parcel (usually) don't know the recipient's timetable and thus there is a need for a long delivery time window

Locker system types

- Delivery trailer is a moveable locker system
 - Delivery time window is, for example, one day
 - Suits for **Type 1** delivery
- Fixed locker system
 - Delivery time window is, for example, one week
 - Suits for **Type 2** delivery
- The same delivery site may have:
 - Delivery trailer for **Type 1** delivery
 - Fixed locker system for **Type 2** delivery

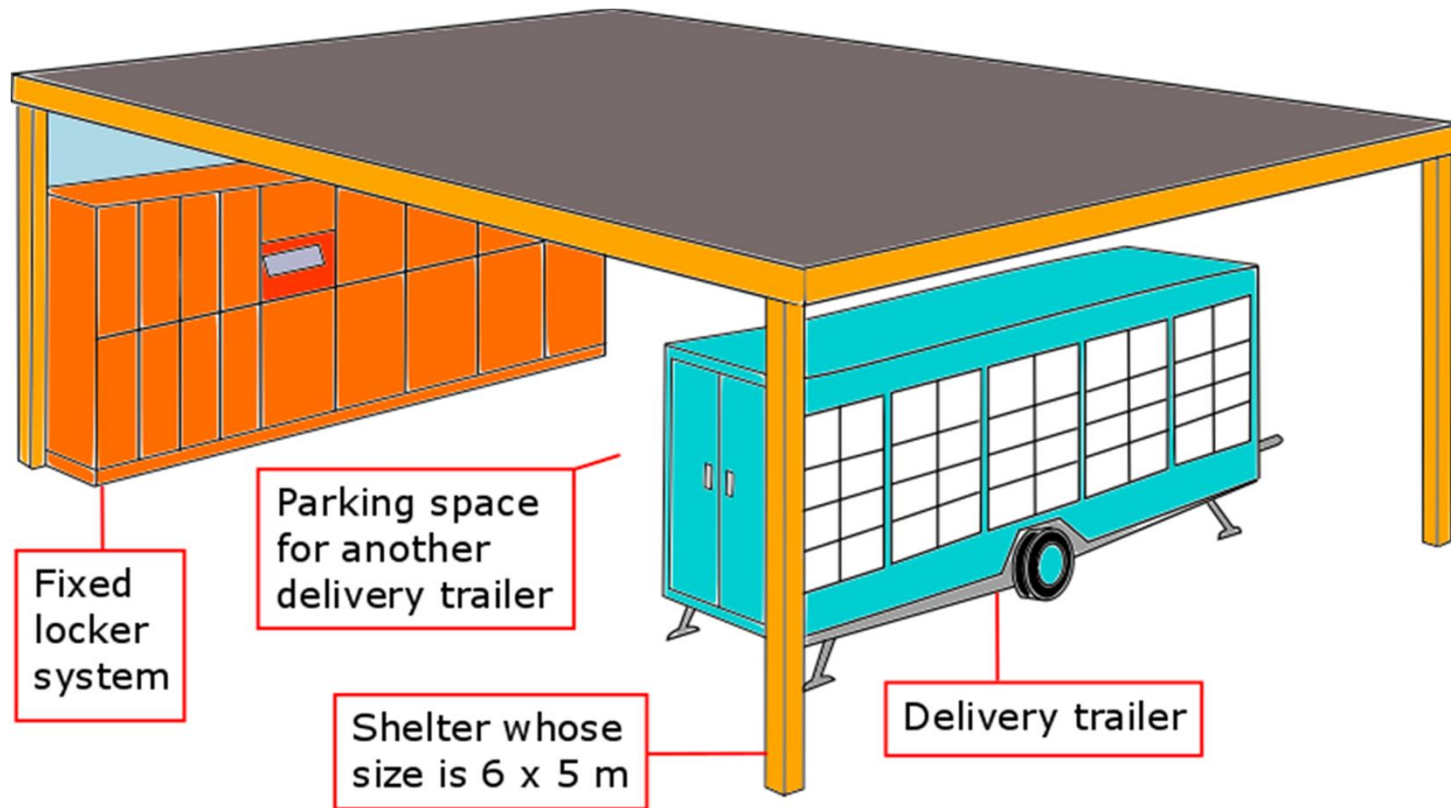
Loading of parcels

- A delivery cycle has a starting point which is, for example, a sortation hub
- A delivery vehicle is here a van
- Delivery trailer is loaded by AGVs and the trunk of the van is loaded by the van driver:



Delivery point

- Two various locker systems for consumers:



Tasks at delivery point

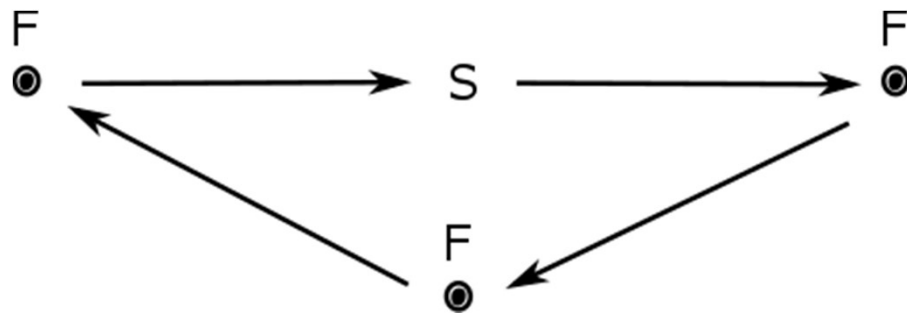
- Parking of Delivery trailer onto the parking space (see the previous page)
- Taking a trolley out of the van and filling the fixed locker system with parcels until the trolley is empty
- Collecting parcels from the fixed locker system into the trolley and moving the trolley into the van
- Decoupling Delivery trailer from the van
- Coupling the van to other Delivery trailer (its delivery time window is ended)

Delivery plans

- The following pages present delivery plans for parcels
- The volume of the van trunk is one *unit*
- Also the volume of Delivery trailer is one *unit*
- Capacities are estimated in plans in *units* and the goal is high capacity for **Type 1** delivery
- Transportations are performed within a day
- Symbols: S = starting point of the transportations, F = fixed locker system, M = movable locker system (i.e. Delivery trailer), FM = the both systems

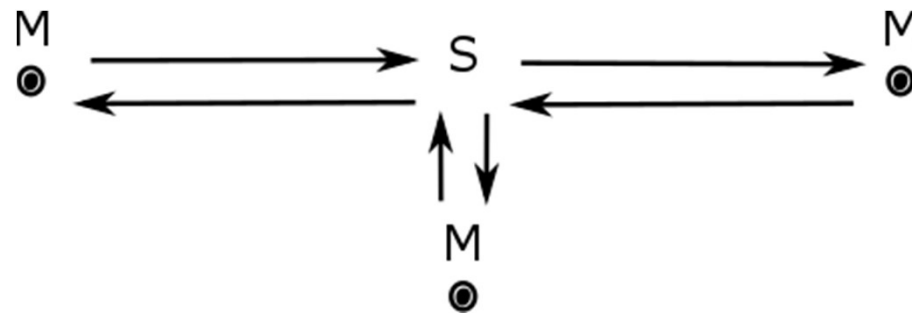
Plan 1

- Only fixed locker systems are used
- One transportation for the all three delivery sites
- Capacity of the van trunk is divided among the three fixed locker systems
- Capacity per delivery site is $1/3$ *unit* and the total capacity is $3 \times 1/3$, i.e. one *unit*



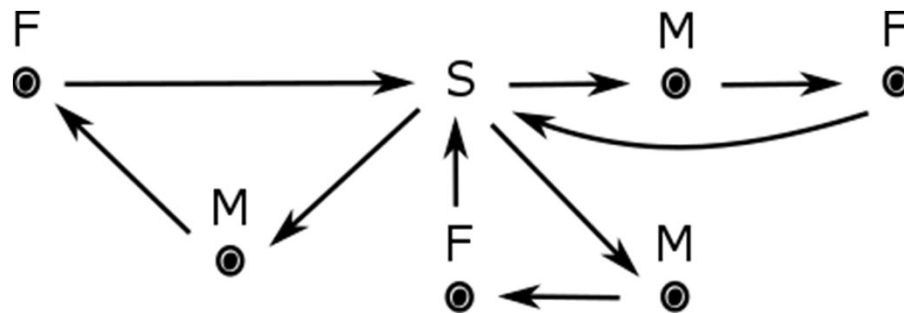
Plan 2

- Only movable locker systems are used
- One transportation per delivery site
- Capacity per delivery site is one *unit* and the total capacity is three *units* because three Delivery trailer are parked at three delivery sites
- Problem: lack of one week delivery time window



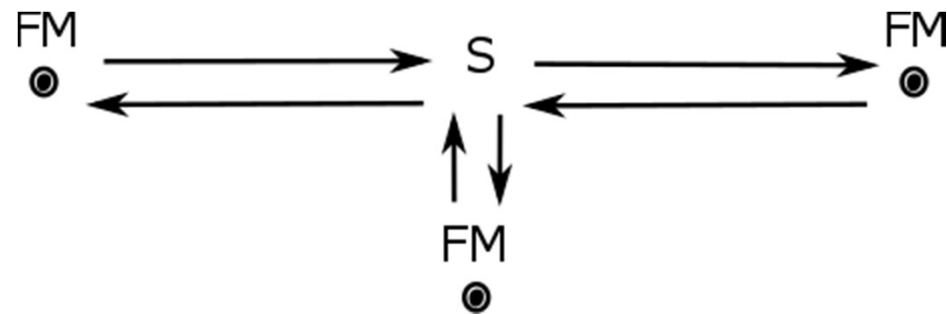
Plan 3

- The both locker system types are used
- One transportation per delivery site
- Solves the problem of Plan 2
- The total capacity is four *units* assuming that it is the sum of the total capacities of Plan 1 and Plan 2
- Problem: the number of stops is high (six stops)



Plan 4

- The both locker system types are used in the three delivery points (marked with FM)
- One transportation per delivery site
- Solves the problem of Plan 3 (now only three stops)
- The total capacity is four *units* assuming that it is the sum of the total capacities of Plan 1 and Plan 2

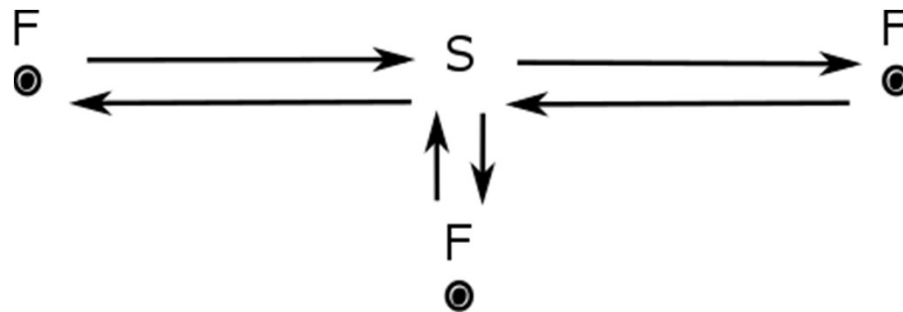


Other delivery plans

- The following pages present delivery plans 5 and 6
- Assumptions are the same as in the previous plans
- Plan 5 explains the problem related to *fixed* locker systems and *one week* delivery time window
- Plan 6 explains the problem related to *movable* locker systems and *one day* delivery time window

Plan 5

- Only fixed locker systems are used
- One transportation per delivery site (per day)
- Because of the one week delivery time window, many of the lockers are occupied for days
- The total capacity cannot be much more than one *unit*, because there is not enough empty lockers



Plan 6

- Only movable locker systems are used
- One transportation per delivery site (per day)
- Each delivery site has seven Delivery trailers,
- Investment cost for 21 trailers is high and the trailers need at least 21 parking spots

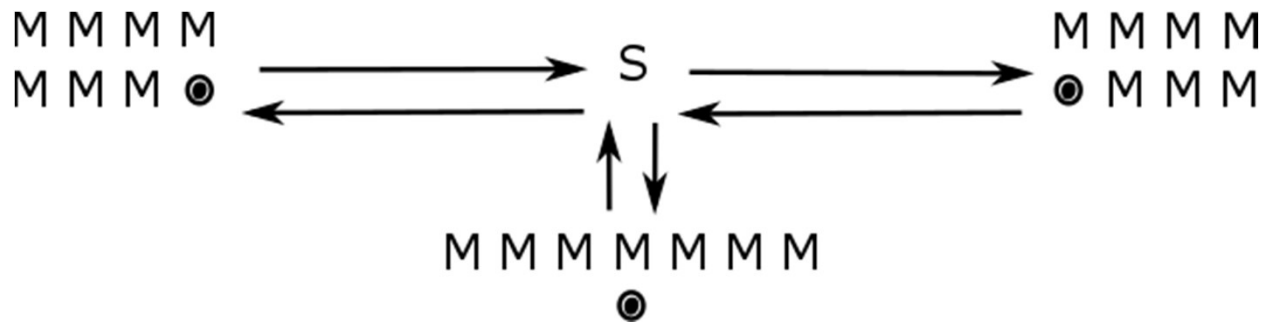
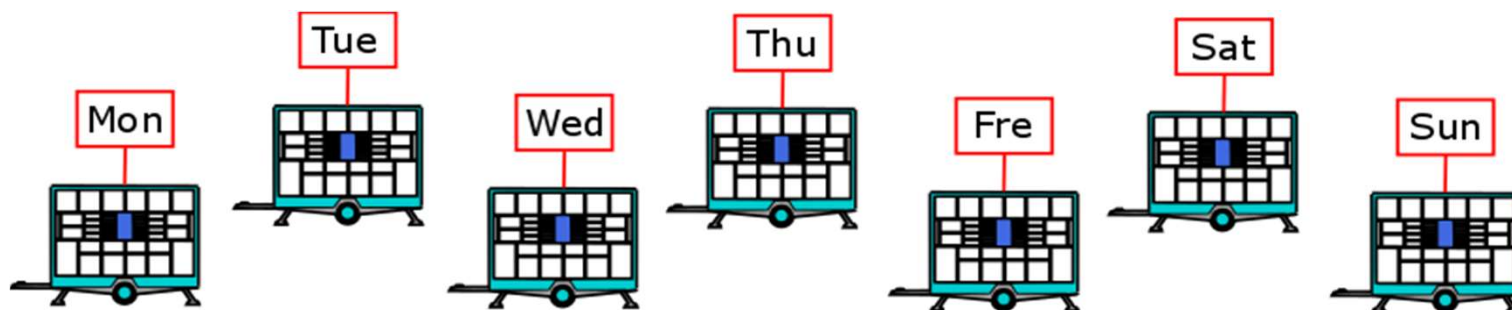


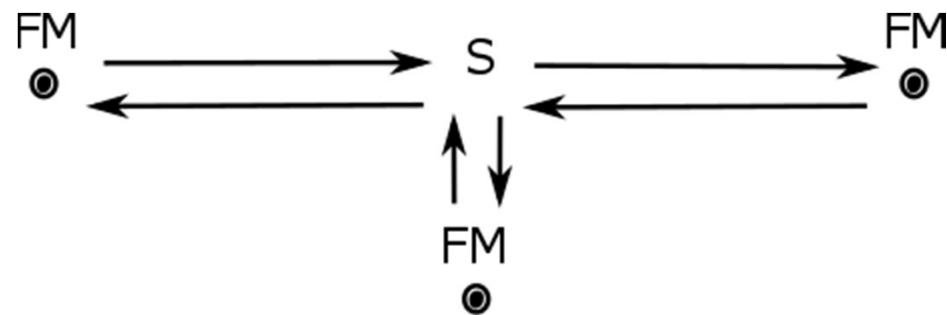
Illustration of Plan 6

- One Delivery trailer for each week day (Mon – Sun)
- Each trailer is small-sized and can be transported by a car, for example, by a taxi
- Each day a trailer, which has located at the delivery site the longest time, is replaced with another trailer



The best plan

- The best plan is in many cases plan 4 wherein the both locker system types are used
- Delivery points (marked with FM) reduce the number of stops and increases the delivery effectivity
- It is reasonable to utilize existing fixed locker systems to minimize the investment costs



Summary

- One week delivery time window makes logistics inefficient (as illustrated in plans 1 and 5)
- For **Type 1** delivery (when consumers order products online stores) the delivery time window could be shorter than a week
- In plans 3 and 4 the delivery capacity is four times greater than in plan 1
- Logistics can be substantially enhanced by using Delivery trailers