From personal to mass transit

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atra Industry Group

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40 years in transportation

- Transit network planning - VIPS
- Taxi fleet management - Taxi80
- Multi-discipline PRT research - Chalmers
- Road traffic research – KTH
- 5 PRT patents
- VP, Advanced Transit Association

Storyline

- A challenging podcar application
- Five strategies to cope with large demand
- => Mass transit with podcars

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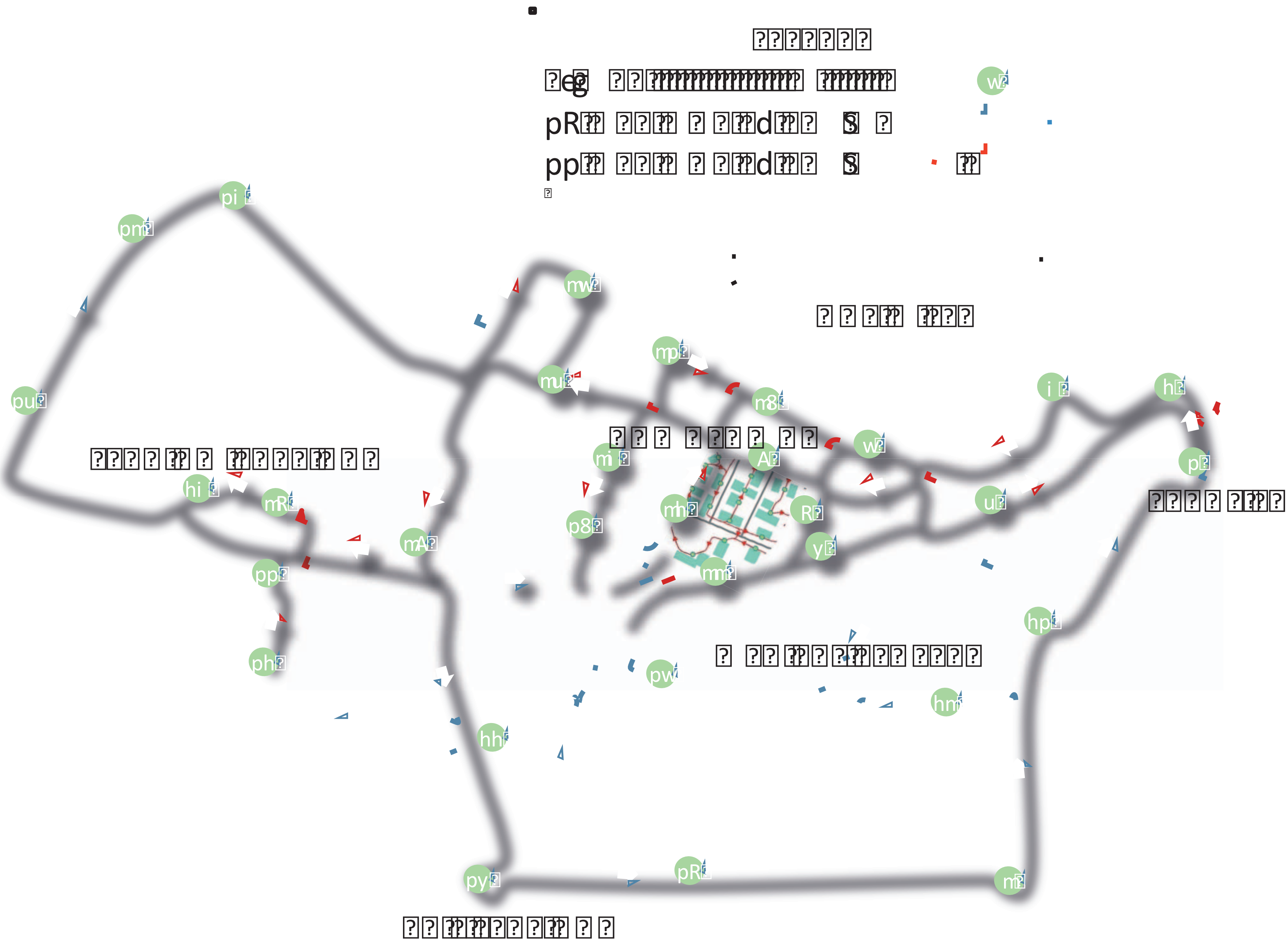
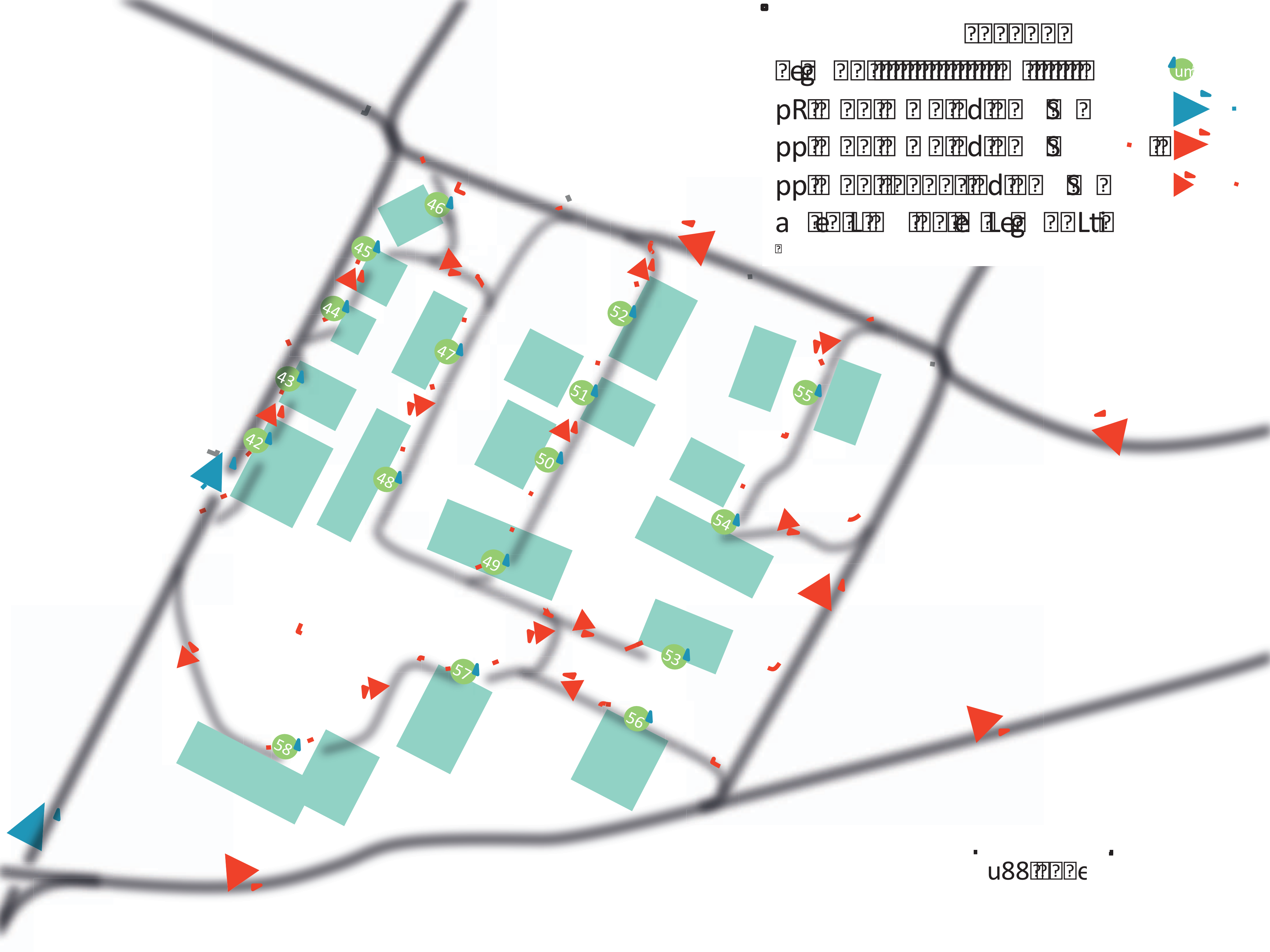
The challenge

- Dense urban area in California
- Very large employers
- Severe highway congestion
- Promote non-car modes
- Transfers from Train and LRT
- Connecting buildings (horizontal elevator)

Contract with PRTConsulting

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Our tentative design

- 50 stations
- 48 kms main guideway (6 % double)
- 4 bi-level intersections out of 54
- Speeds 36 and 45 kph
- Headway 3 secs (as certified)
- 900 vehicles with 6-seats

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Morning peak hour demand

- 13 000 passengers
- 30 % of trips from 3 transfer stations
- 400 passengers from one train
- Many dispersed destinations

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Train / PRT station

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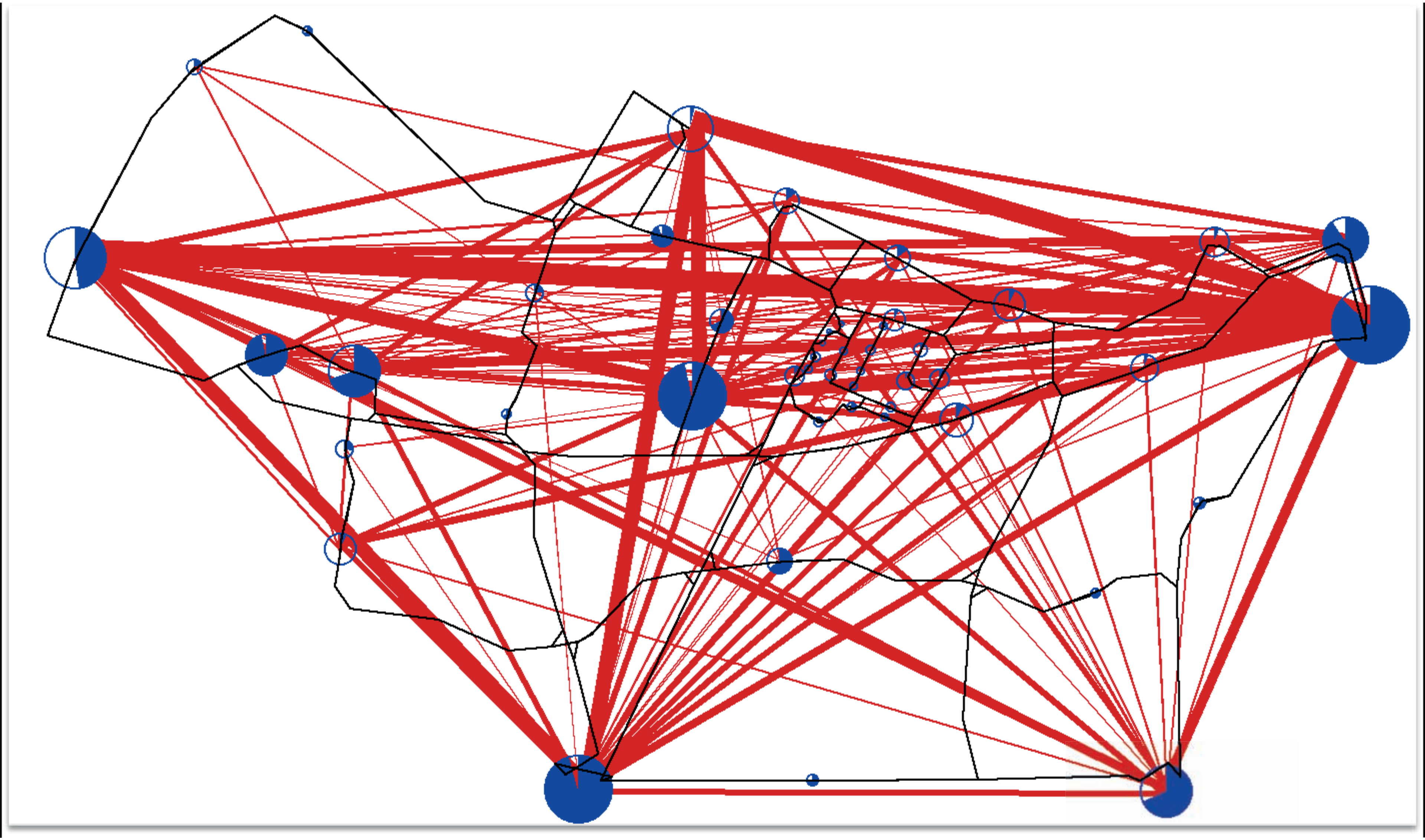
Morning peak demand 13 000 / h



Personal Rapid Transit

- Average 1.5 passengers per vehicle
- Can carry 4 800 passengers
- 24 mins waiting

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Ride-matching at departure

- System knows requested destinations
- First passenger determines destination
- Destination sign over vehicle
- System assigns vehicle when enough load (5 of 6)
- …or after max holding (1 min)

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Ride-sharing morning

- In relations with >1 party per minute
- 7 % of relations have 60 % of all trips
- 48 % of passengers matched
- Average load 3.9 passengers
- 11 400 passengers carried
- 11 minutes waiting

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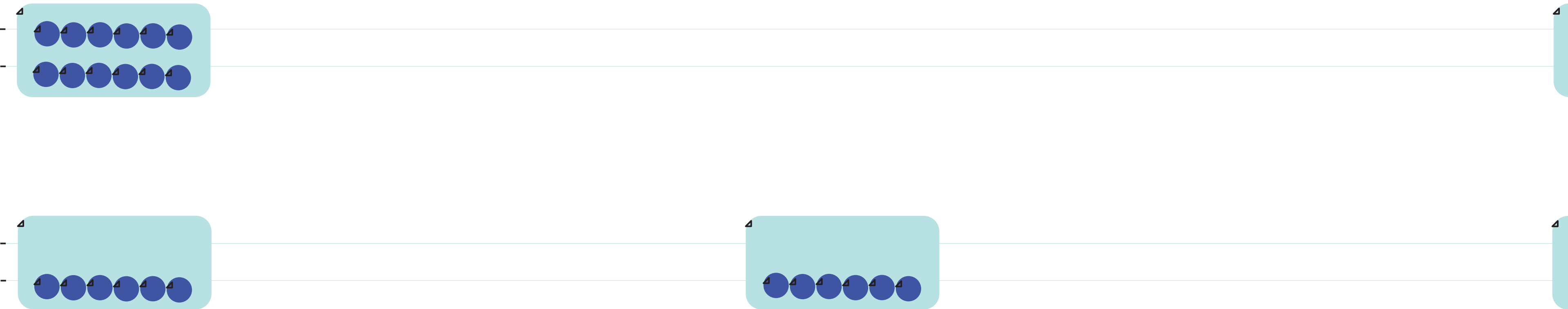
Evening peak most challenging

- Many small origins
- Less opportunities for matching
- 43 % of passengers matched (48)
- 10 800 passengers carried (11 400)

Standing passengers?

- Vehicle for 6 seated + 6 standing
- Limited braking => double headway
- Same capacity
- Longer station ramps

Same capacity without standees



Coupled vehicles

- Coupled in station
- Decouple in switches to different destinations
- Safe distance between couples
- 2 x line capacity at departure
- Average 1.5 en route

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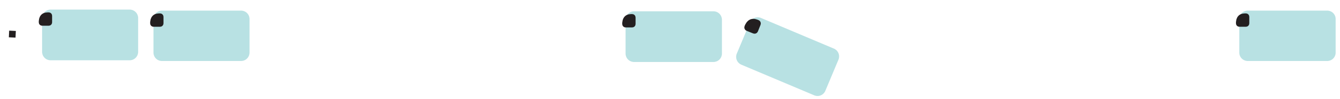
Vehicle pair can safely split apart

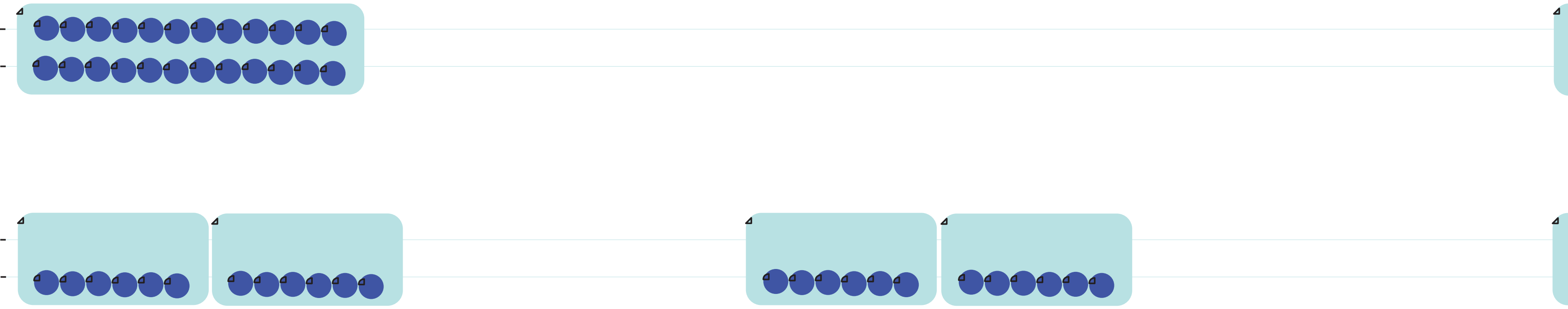


- Can serve different destinations
- More load with two destinations
- Each vehicle goes non-stop

Larger vehicle?

- 24 passengers including standees
- 6 sec headway
- Couple 2 x 6 seated has same capacity
- …and can split up en route

Coupled vehicles better than big



- Can serve 4 destinations

Electronic or mechanical coupling

Ride-sharing plus coupling

- 13 200 passengers carried evening (10 800)
- 5 mins waiting (11)
- Better – but still too much waiting

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Sharing to 2 destinations

- 26 % of departures for 2 destinations
- 58 % of passengers matched (48)
- 13 300 passengers carried
- 3.5 mins waiting (5)

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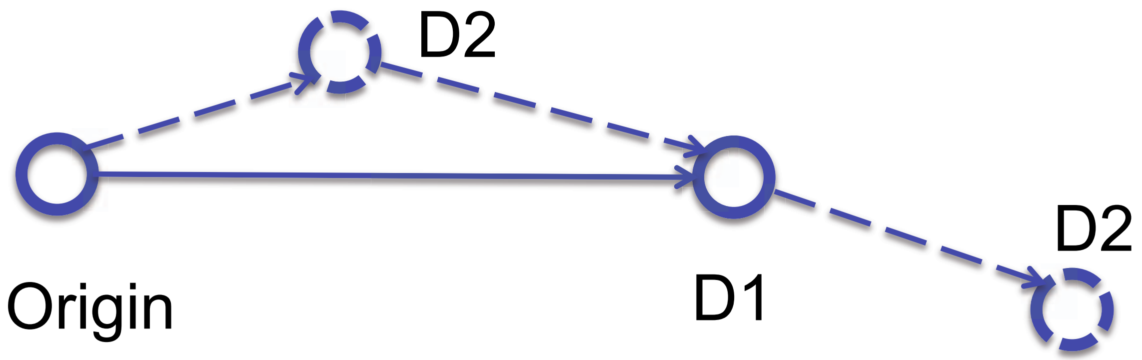
Second destination before or after



- Detours within 20 %

Allow boarding to same destination

- When stopped to drop off
- Waiting passengers to same destination
- Destination sign over vehicle
- No reason not to allow boarding

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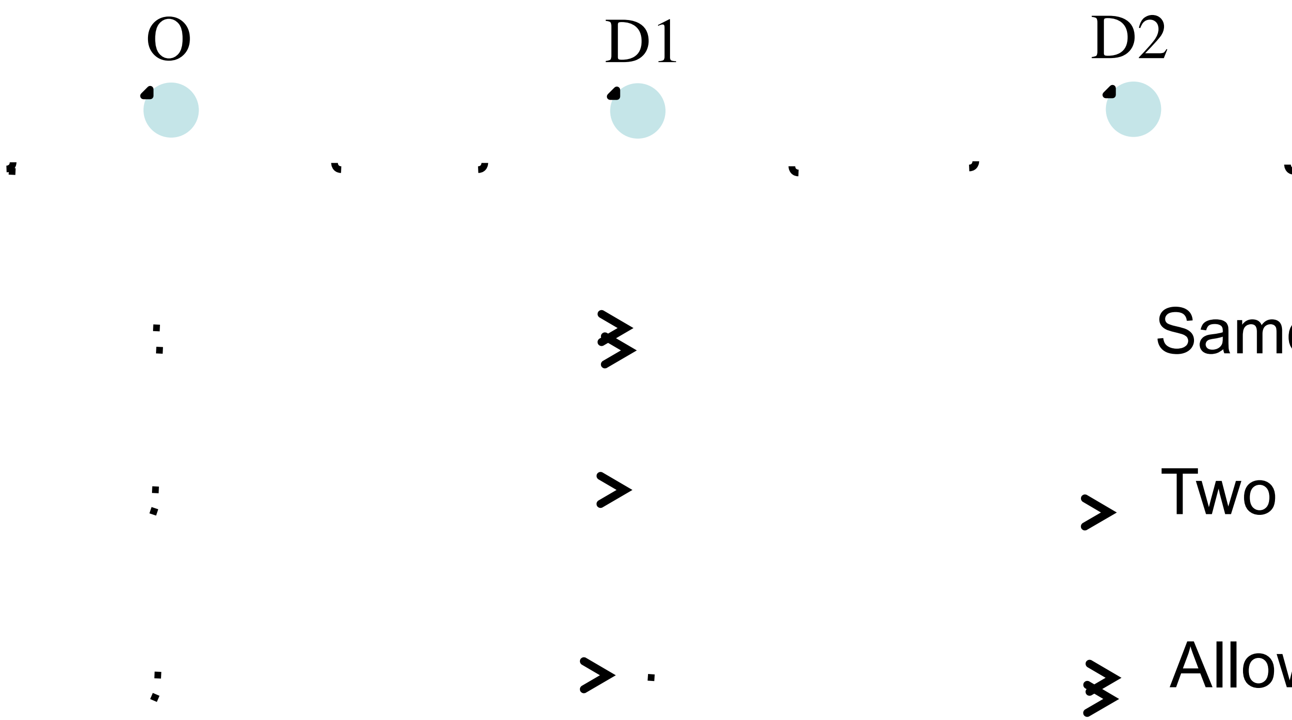
Ride-sharing patterns



Same O & same D

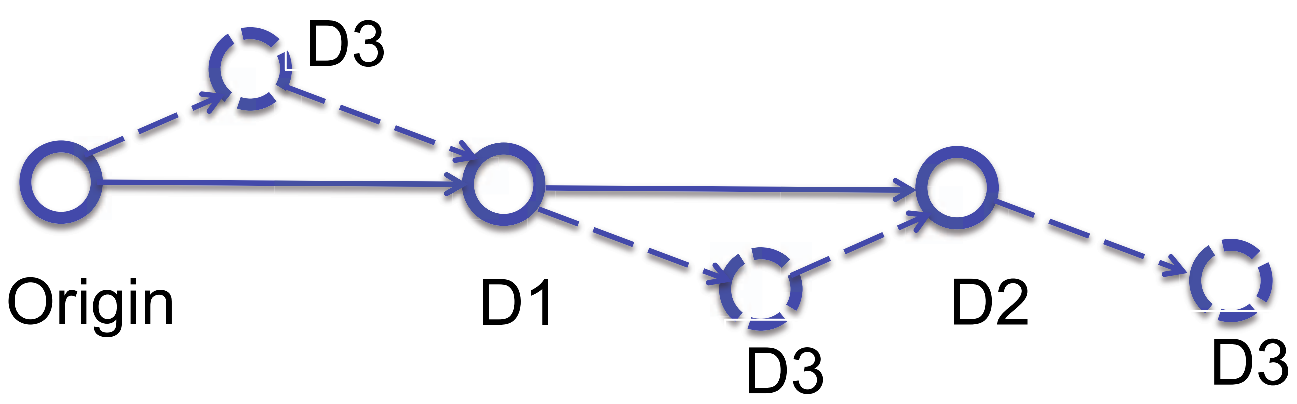
Two destinations

Allow boarding

Sharing to 3 destinations

- 59 % of passengers matched
- 1.2 destinations average
- 13 400 passengers carried
- 3.3 mins waiting (3.5)

Adding a third destination

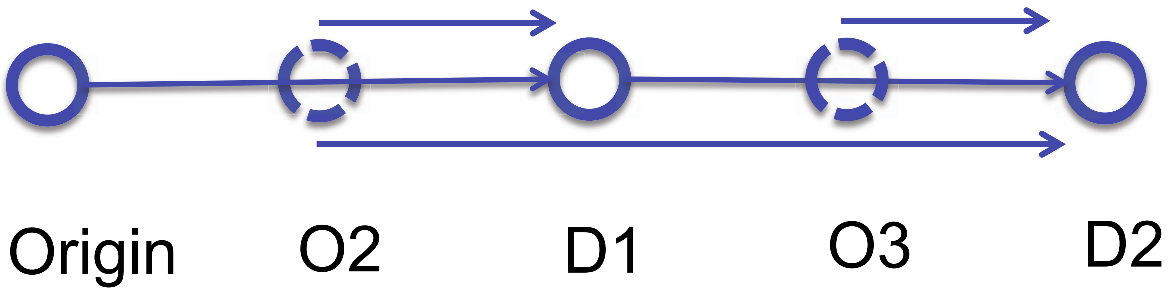


- Before, between or after

Matching many-to-few

- Evening demands more difficult to match
- Multiple pick-ups to common destination (transfer)
- First passengers determine destinations and route
- Stopping en route to pick up for same destinations

Stop en route to pick up



- Route fixed to one or two destinations
- Check waiting passengers en route
- Pick up for same destinations
- No passenger makes more than two extra stops

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Stop to pick up

- Picking up 2 000 passengers out of 13 400
- 0.3 intermediate stops per passenger
- 4.5 passengers per vehicle (3.9)
- All vehicles full (6) on max link
- 2.9 mins wait (3.1)
- +10 % ride time

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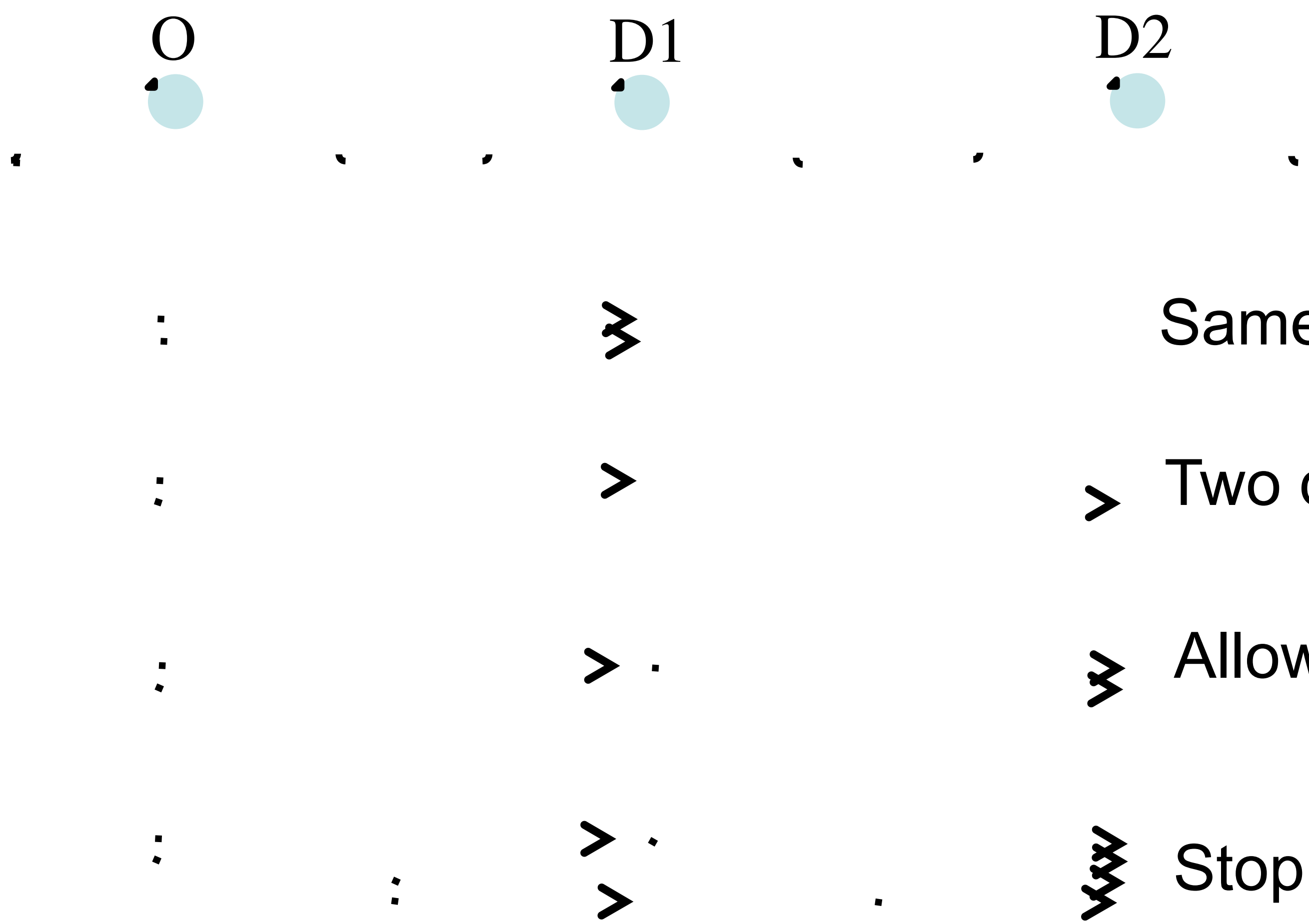
Ride-sharing patterns



Same origin & destin

Two destinations

Allow boarding

Stop to pick en route

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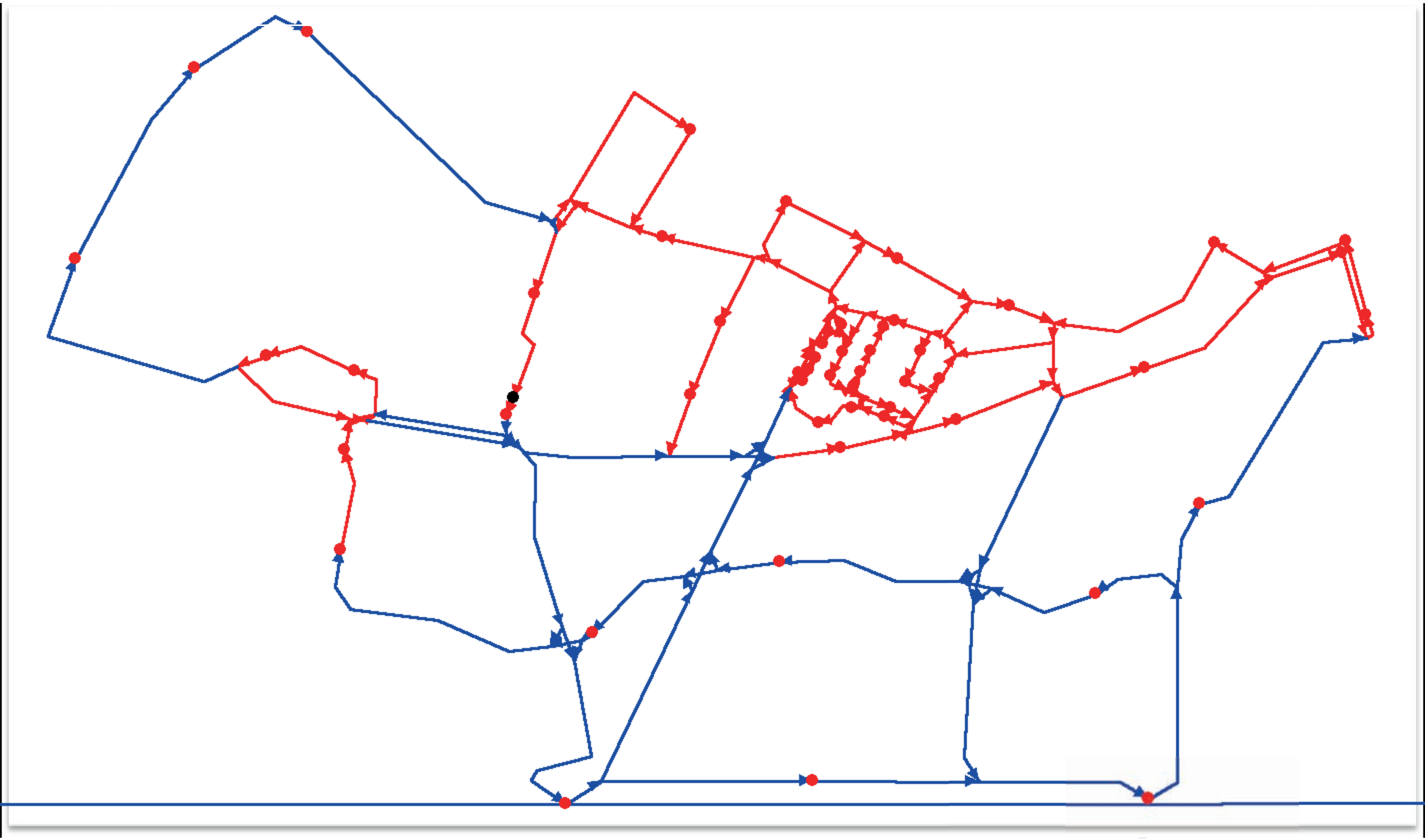
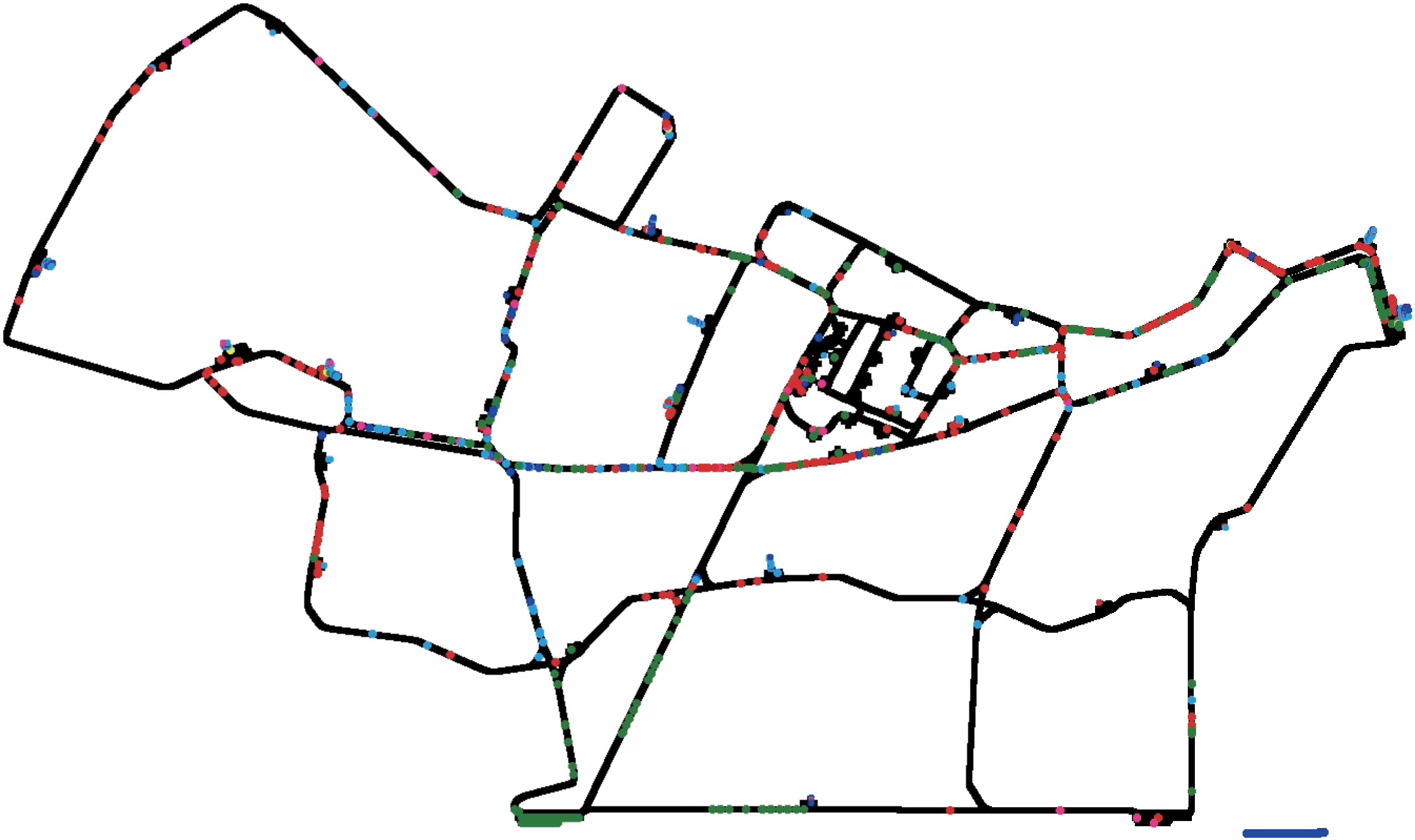
Network high/low speed + train

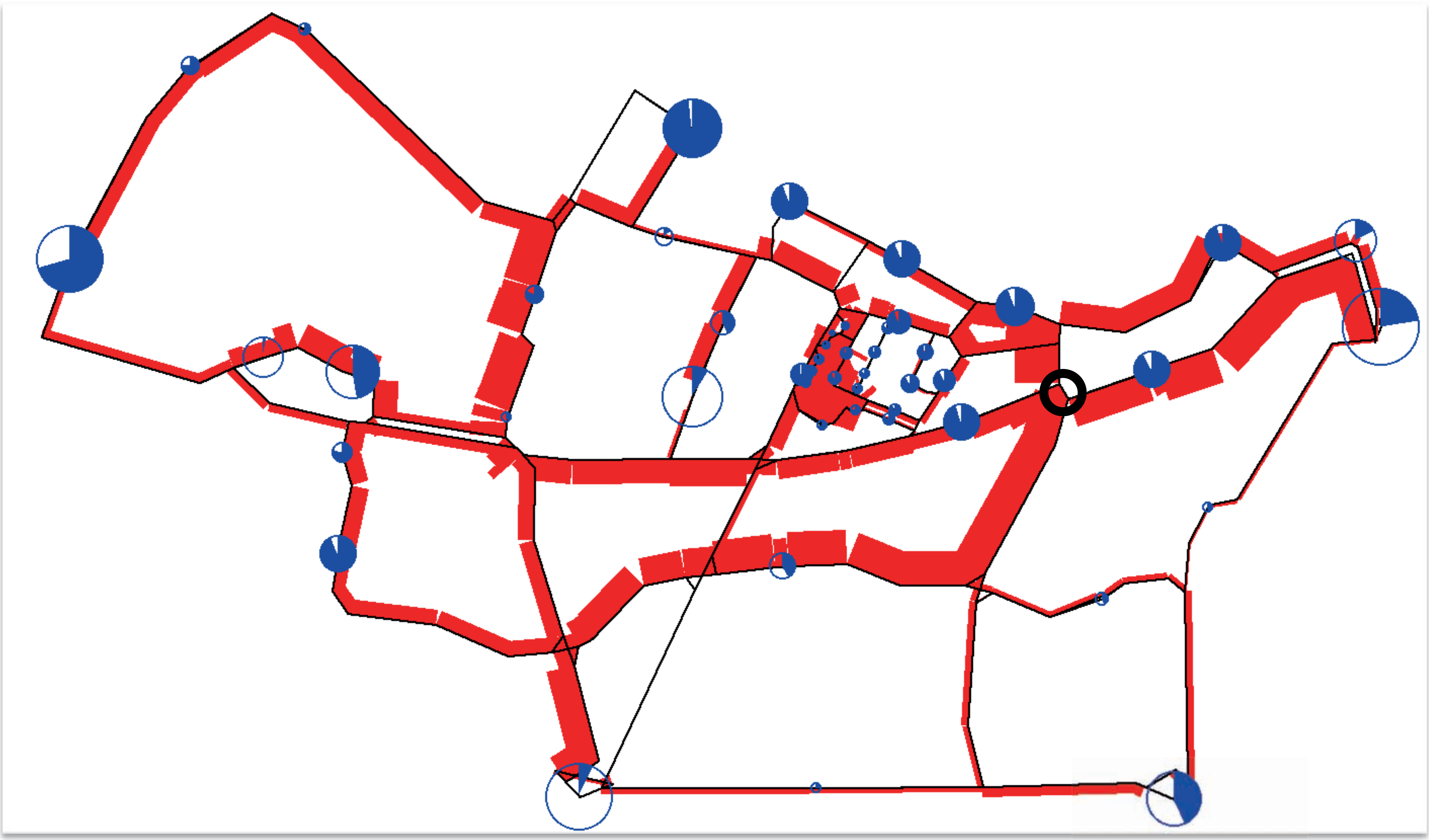


Animation 10 x real speed

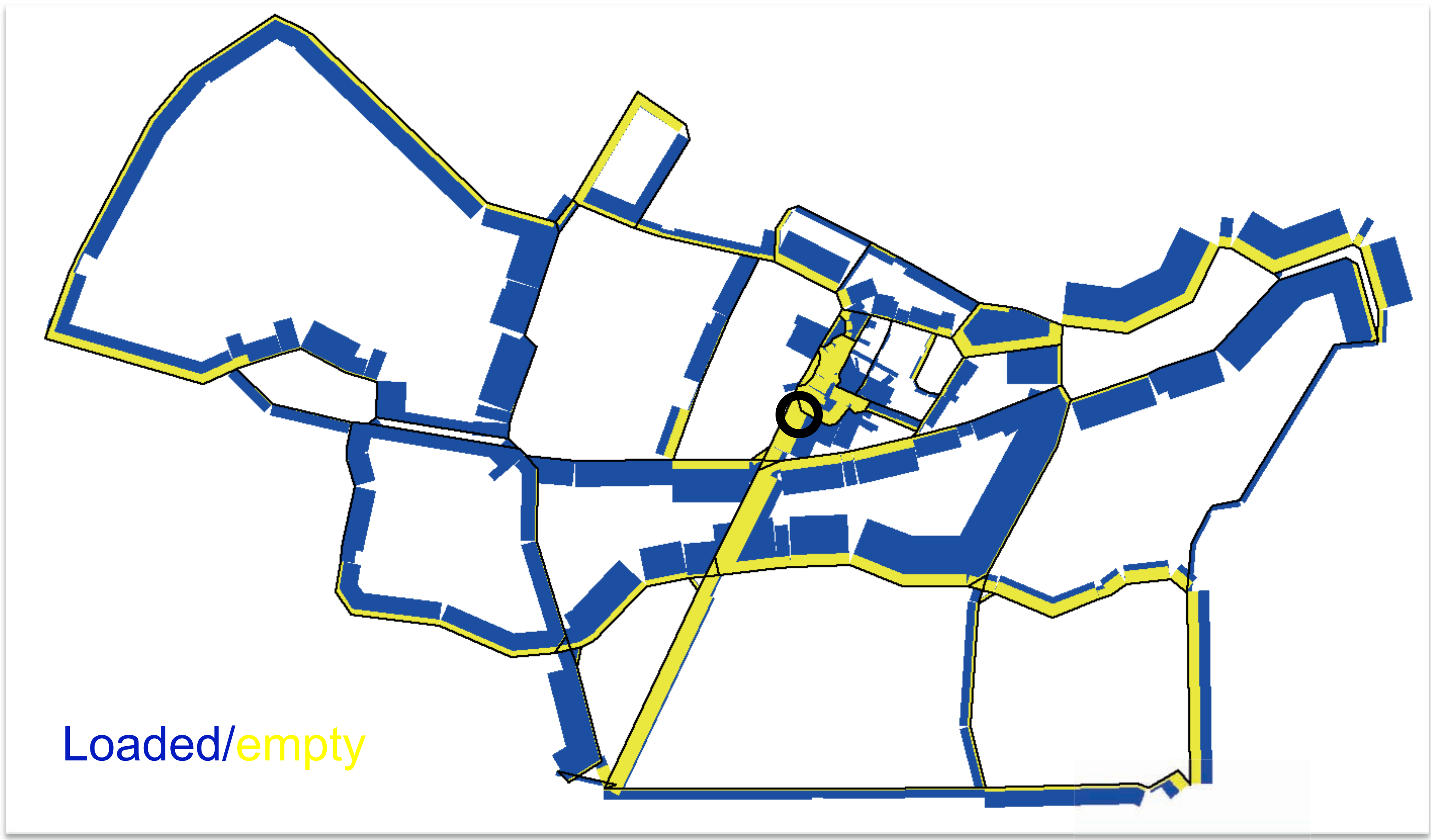
- Empty vehicle
- 1 passenger
- 2
- 3
- 4 or more
- Load/unload
- Couple



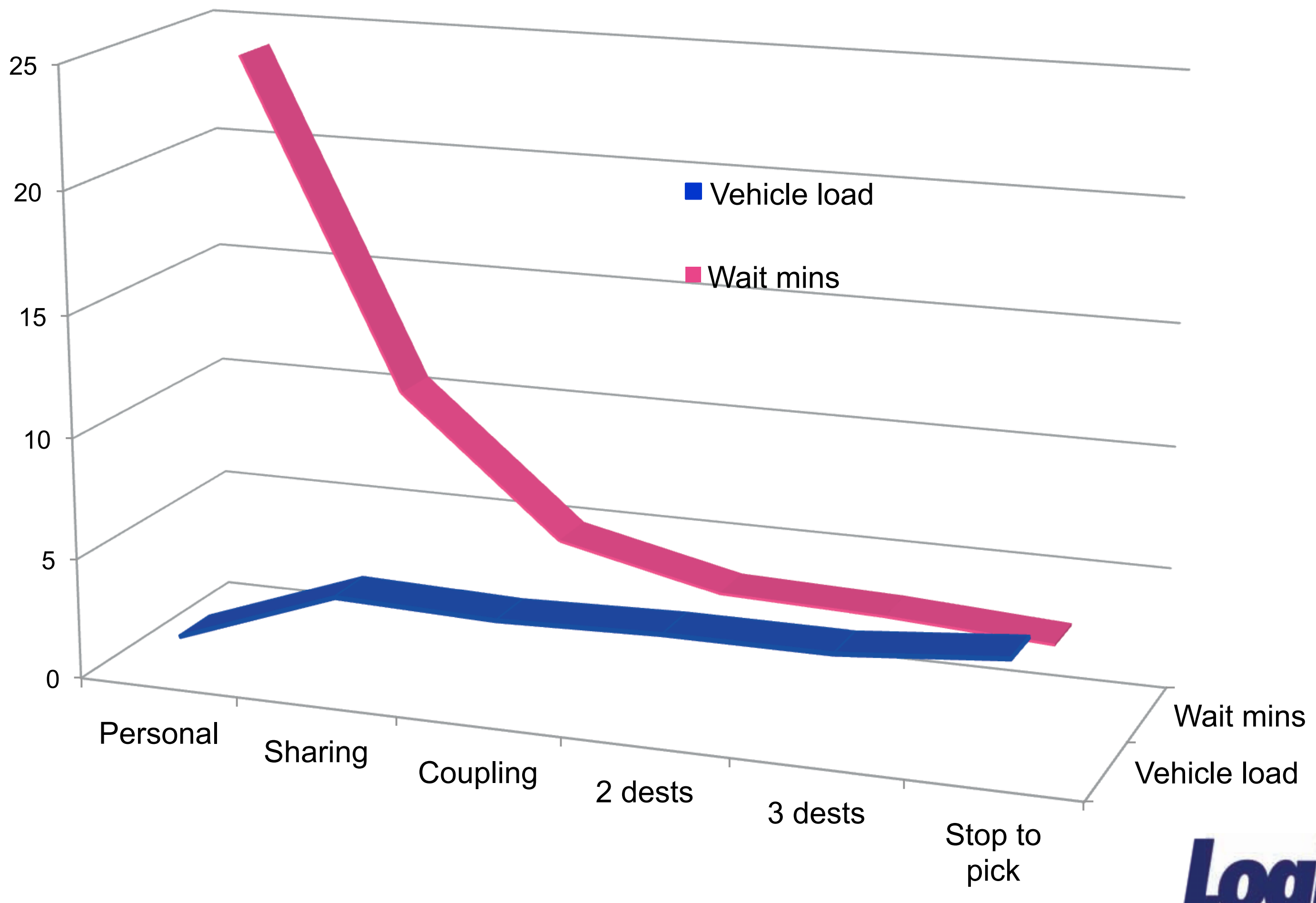
13 400 trips evening peak (6 000 link)



910 vehicles (1800 vph on link)



Less waiting with more ride-sharing



All strategies combined

- Up to 1 800 vph on link (average coupling 1.5)
- Up to 6 passengers per vehicle
- Up to 6 000 pph on link, 13 400 in network
- 85 % of vehicles running with passengers
- 8 % running empty
- 7 % in stations

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APM for same capacity

- Stopping on-line => double travel time
- Can only serve 30 out of 50 stations
- Minimum headway 90 secs (40 deps/h)
- To achieve link flow 6 000 pphpd
- Needs to load 6000 / 40 = 150 passengers

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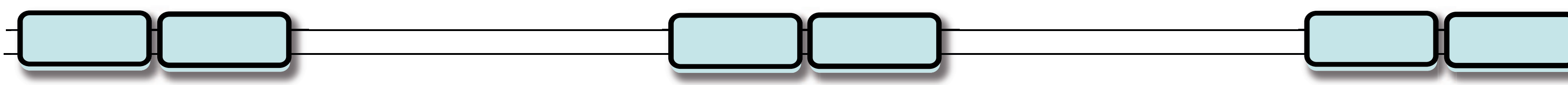
APM or LRT

200 pass / 90 sec * 75 % load = 6 000 pph corridor

PRT



6+6 pass / 3 sec = 14 400 pph (all paired & full)

Case 6 000 on link, 13 400 in network

Conclusions

- Apply ride-sharing and pick-ups during peaks
- On demand, almost non-stop (0.3 extra stops)
- Slightly longer trips (+10 %)
- Can handle mass transit flow
  - 6 000 pph on link, 13 000 in network
- Not always Personal, but very Efficient
- Mass Rapid Transit, but faster & cheaper

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