On-street parking near intersections: effects on traffic

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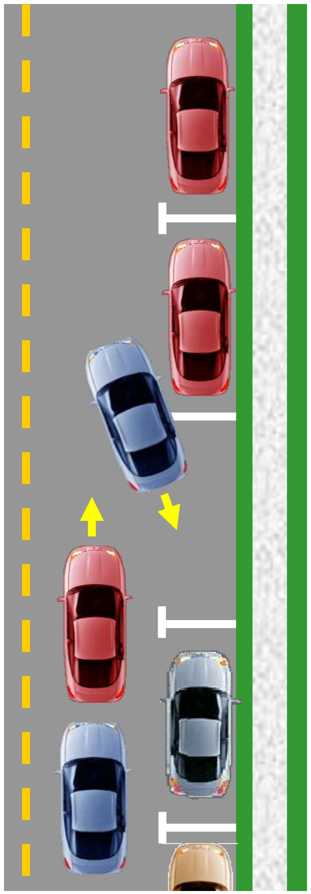
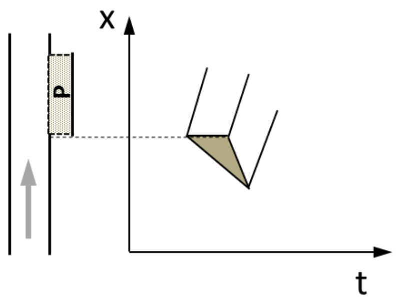
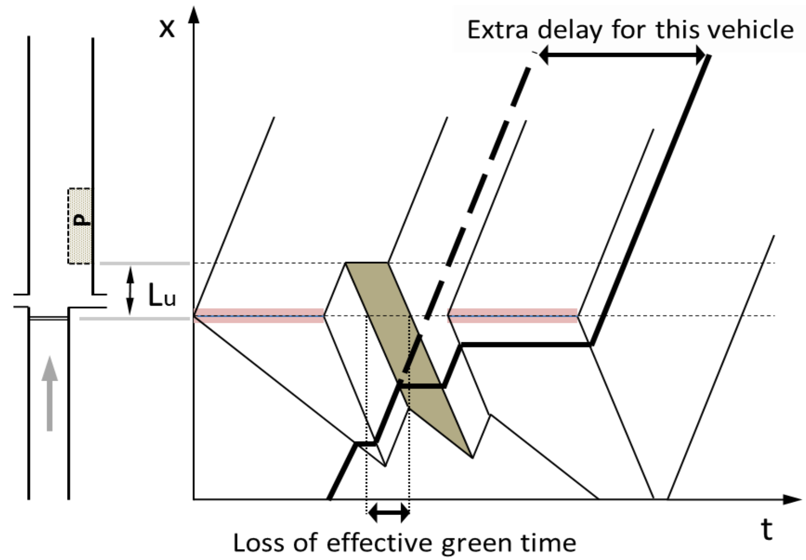
On-street parking



On-street parking



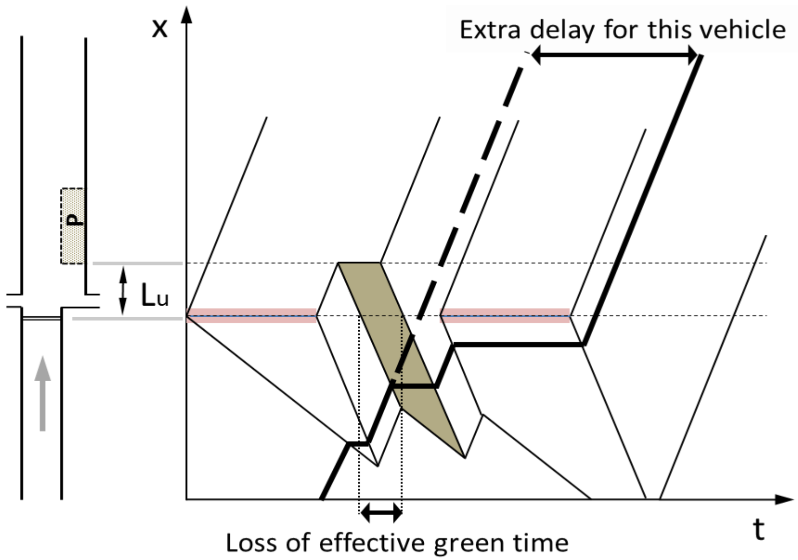
On-street parking near intersections



On-street parking near intersections

The effects of parking to traffic can be problematic when the parking is near the intersection:

- A **capacity loss** of the intersection can be caused
- Long delay for individual cars
- The delay can continue to the other links, more vehicles can be affected



The delay and capacity loss depend on many conditions:

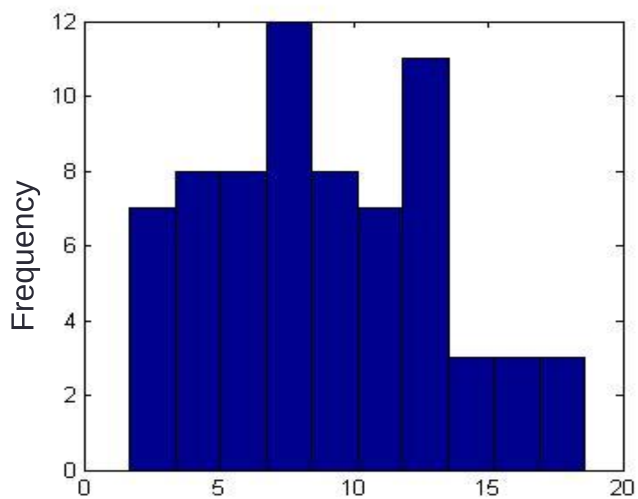
- Traffic flow
- Signal control
- Parking skills
- Distance to the intersection

On-street parking in Zurich

Duration of this maneuver:

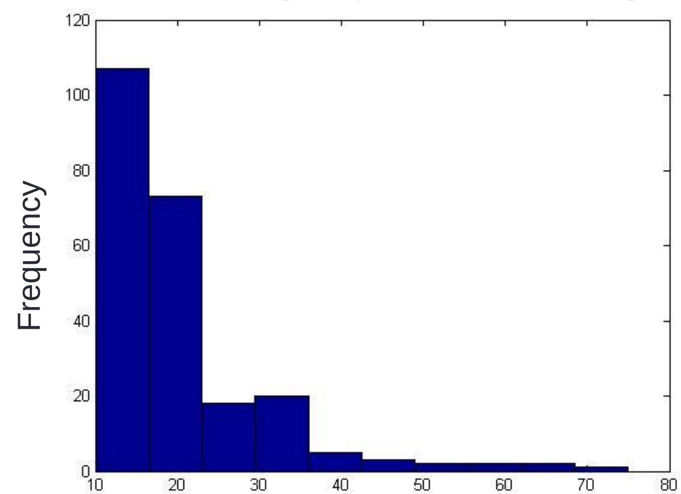
3-18s From the data we collected in the center area of City Zurich (120 pieces of “park in” data), other references suggest 6-16s or on average 18s

(source “Micro-simulation study on the effect of On-street parking on vehicular flow”, “Traffic and highway engineering”)



Duration of maneuvers (in seconds)

Distance of this on-street parking to intersection (only central area):



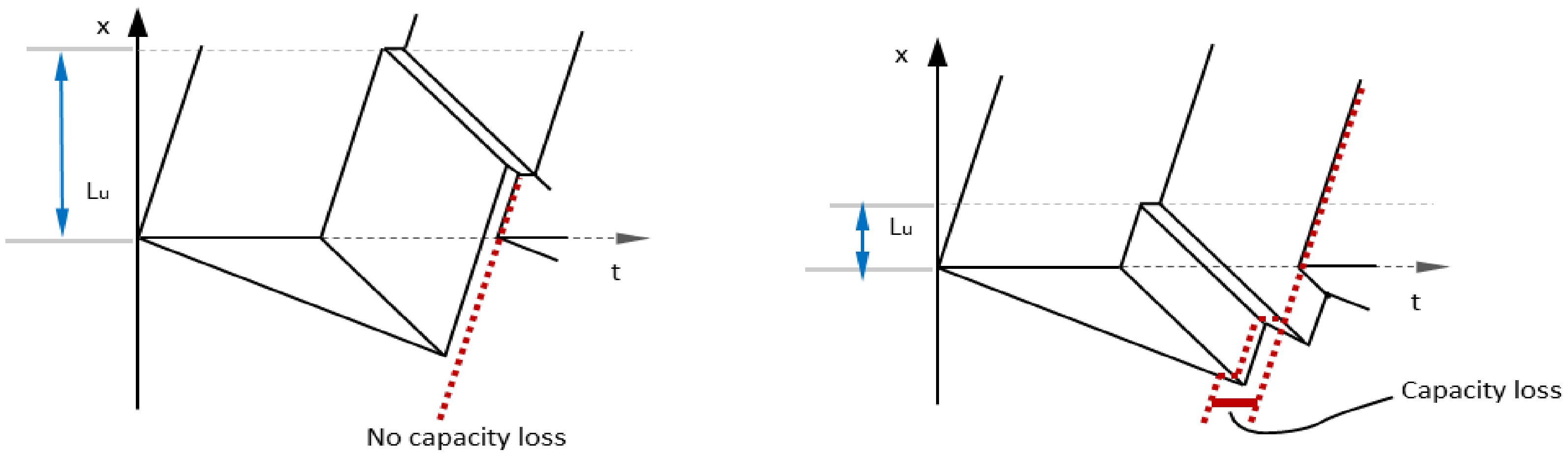
Distance from parking stall to stopping line of the upstream intersection

P

Lu

Capacity loss

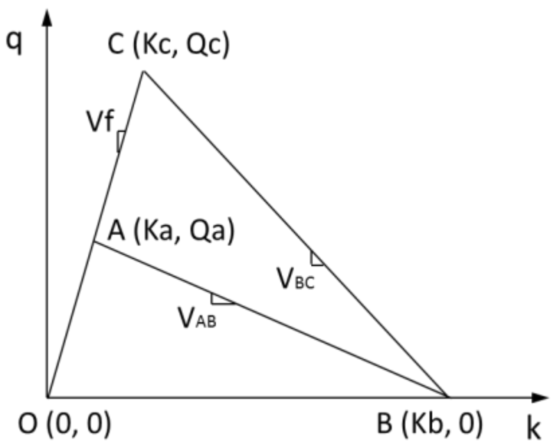
The additional delay is avoidable, but the capacity loss is.



In this study, we aim to find out the condition of Lu to guarantee no capacity loss at the intersection.

Assumptions

Traffic states



$$\beta = \frac{V_{AB} \cdot (V_{BC} - V_f)}{V_{BC} \cdot (V_{AB} - V_f)}$$

Signal control Cycle C, green signal G, red signal R

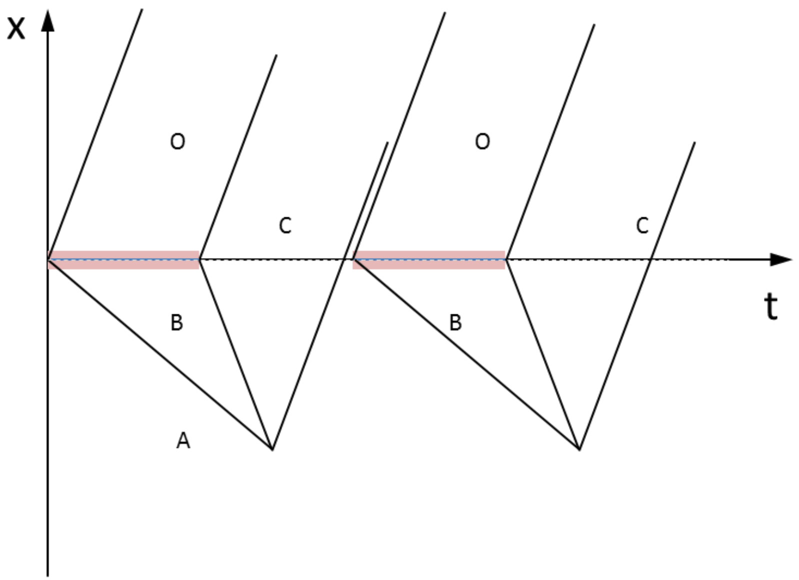
$$\alpha = \frac{G}{C}$$

Parking maneuver The duration of the maneuver is P and P<G. Following vehicles stop when parking happens.

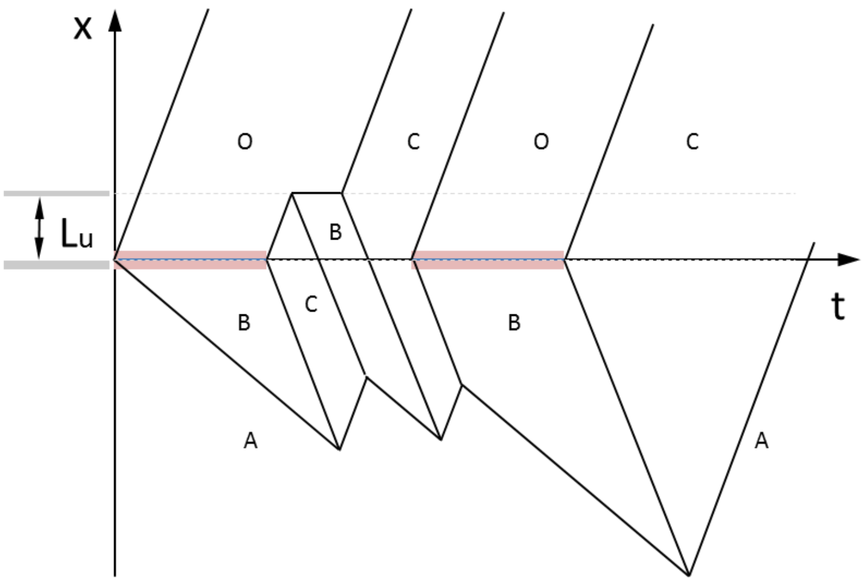
$$\delta = \frac{P}{C}$$

On-street parking near intersections

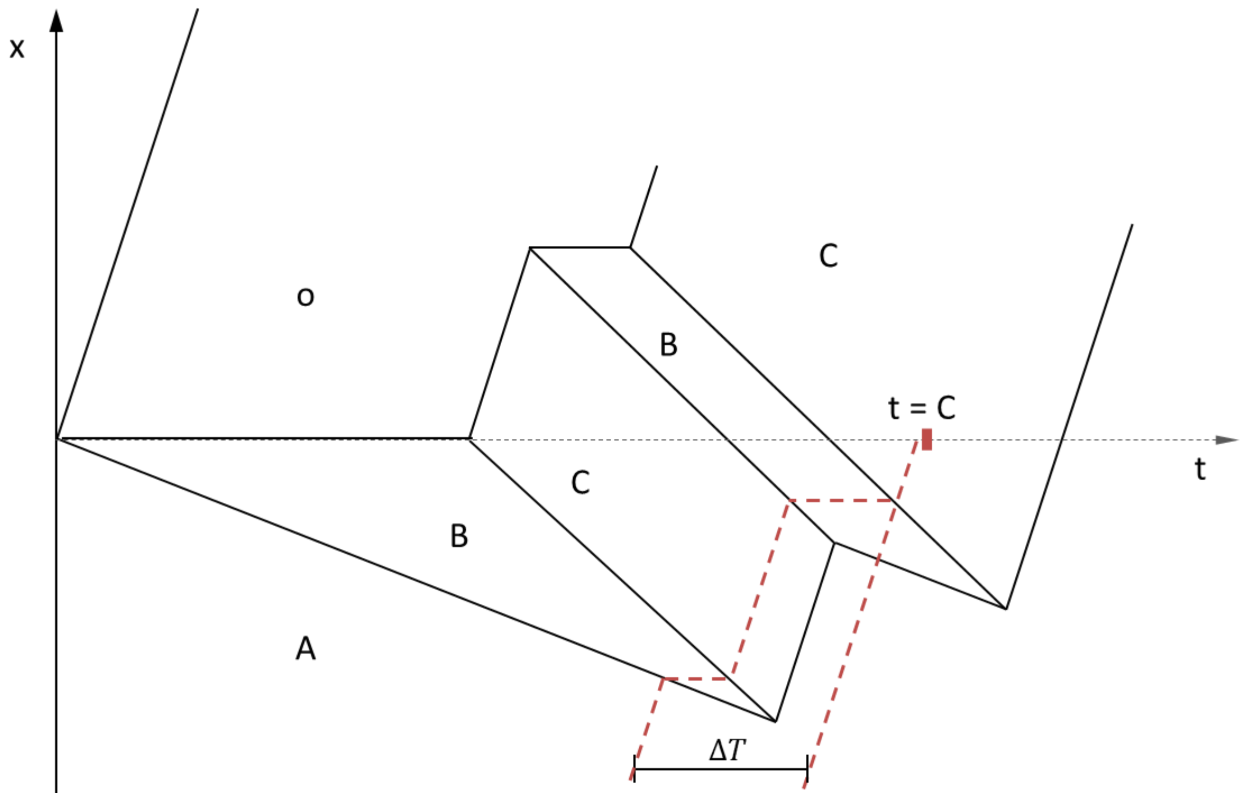
Without parking



With parking



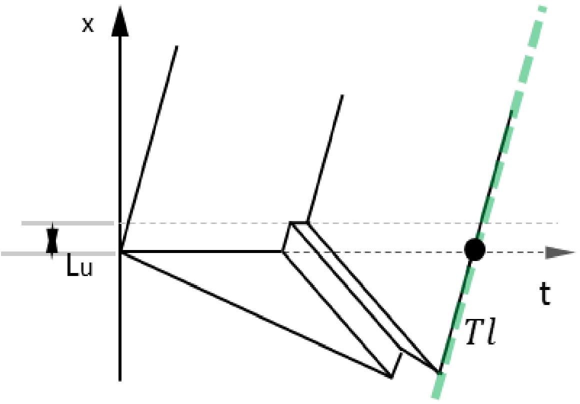
The capacity loss of the intersection



$$Capacity\ loss = Qa \cdot \Delta T$$

Question 1

Under what condition, Lu becomes influential to the capacity of the intersection?



Tl
The last car to be delayed by the shock wave arrives to the intersection at time Tl.

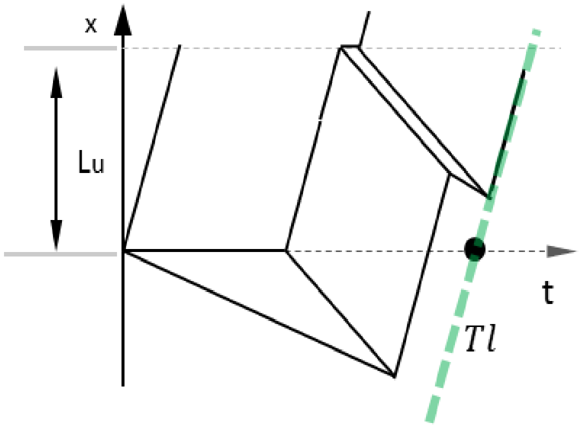
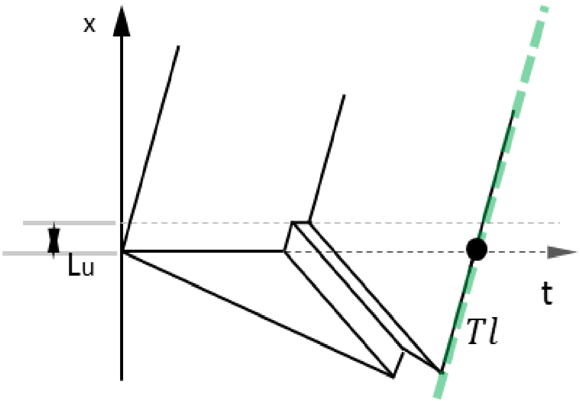


Figure on the right depicts two time-space diagrams with different values of Lu, but the same value of Tl. Also it can be seen that as long as $C > Tl$, no capacity loss will arise.

Question 1

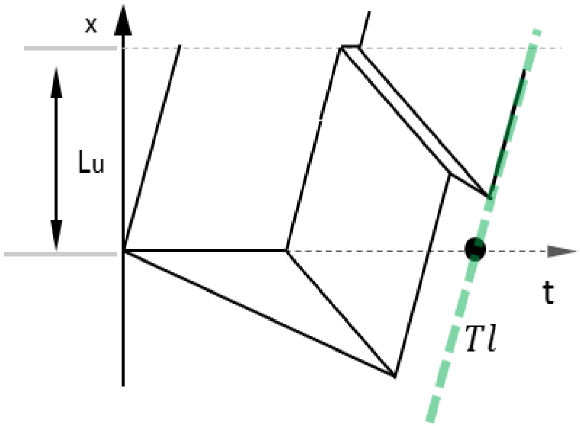
Under what condition, Lu becomes influential to the capacity of the intersection?



The basis to generate a capacity loss:

$Tl > C$ ⇒ $\delta > \alpha - \beta$

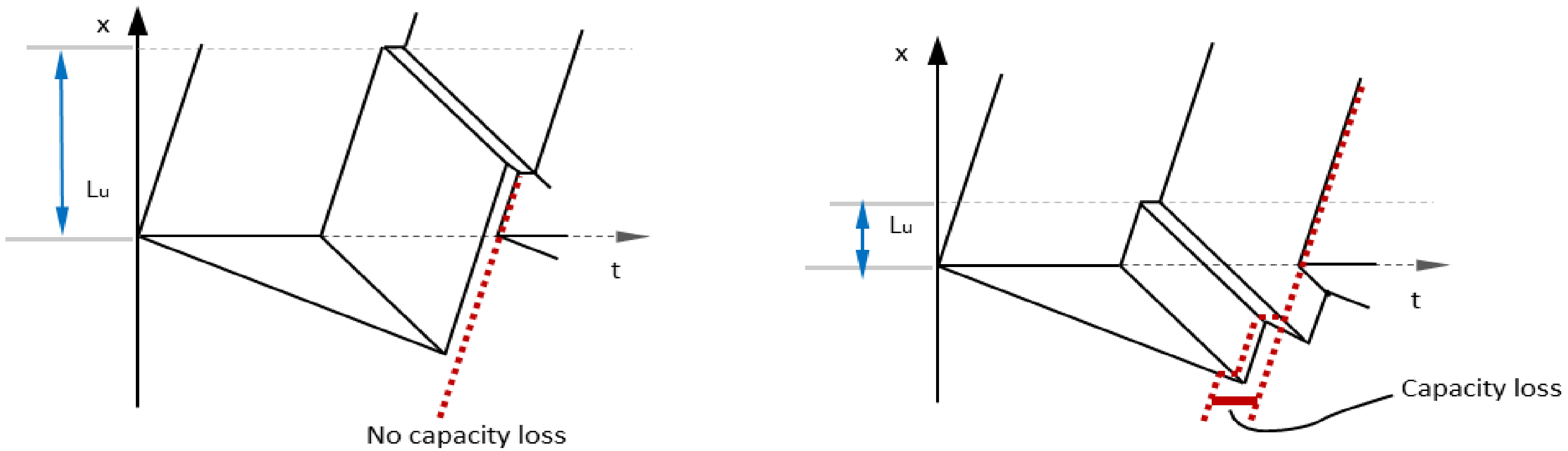
$$\frac{P}{C} > \frac{G}{C} - \frac{V_{AB} \cdot (V_{BC} - V_f)}{V_{BC} \cdot (V_{AB} - V_f)}$$



If this condition is satisfied, Lu becomes influential to the capacity of the intersection

Question 2

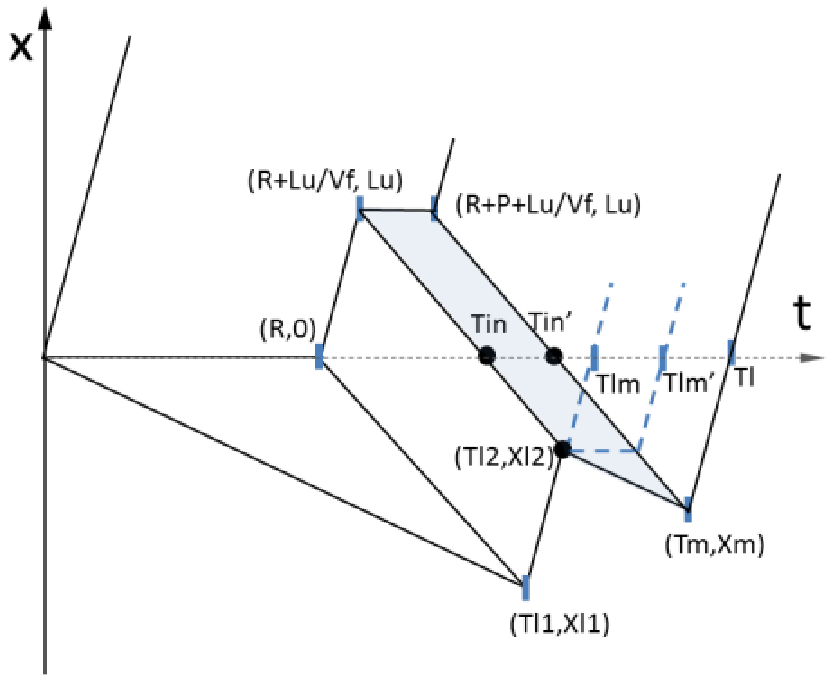
- **What is the minimum Lu required to guarantee no capacity loss at the intersection?**



Two examples are provided in Figures above to show cases in which Lu leads to capacity loss or not. In the left graph, no capacity loss is experienced while a capacity loss is experienced in the right graph, based only on the different values of Lu.

Question 2

- **What is the minimum Lu required to guarantee no capacity loss at the intersection?**



Tm
The maximum reach of the shock wave caused by parking maneuver.

Tin
The back of the queue reaches the intersection at time Tin.

A capacity loss can be generated when those conditions are met

$$\begin{cases} Xm < 0 \\ Tin < C \end{cases}$$

Also $Tl > C$ as discussed

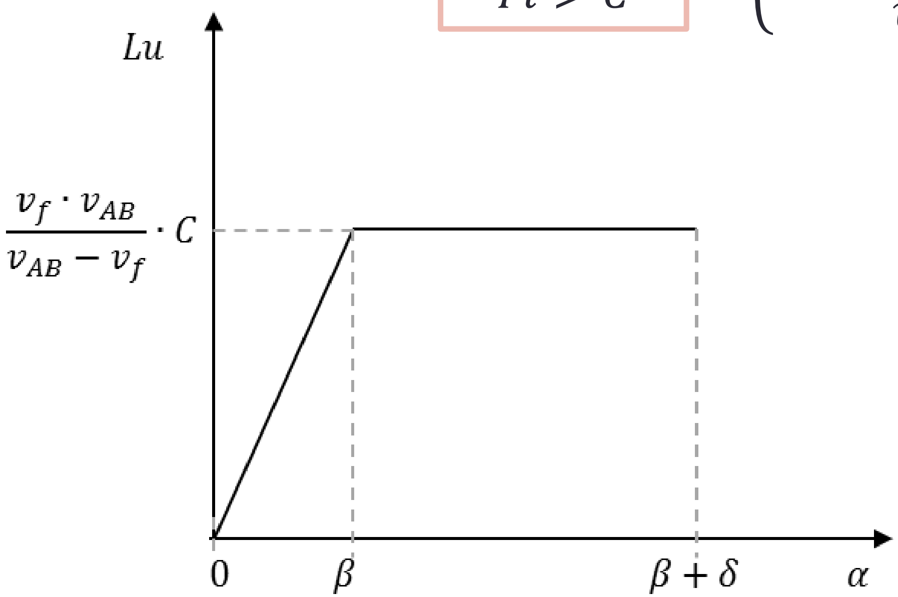
Question 2

- **What is the minimum Lu required to guarantee no capacity loss at the intersection?**

$$\begin{cases} Xm < 0 \\ Tin < C \end{cases}$$

$$Tl > C$$

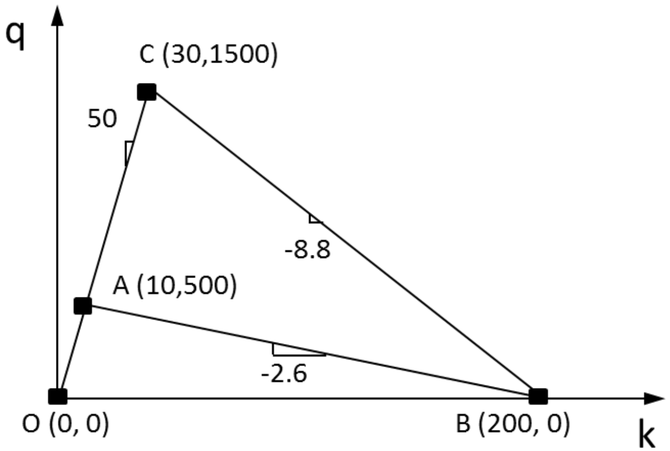
$$\begin{cases} Lu < \dfrac{v_f \cdot v_{BC}}{v_{BC} - v_f} \cdot C \cdot \alpha & if \quad \alpha \epsilon [0, \beta] \\ Lu < \dfrac{v_f \cdot v_{AB}}{v_{AB} - v_f} \cdot C & if \quad \alpha \epsilon [\beta, \beta + \delta] \end{cases}$$



Numerical Example

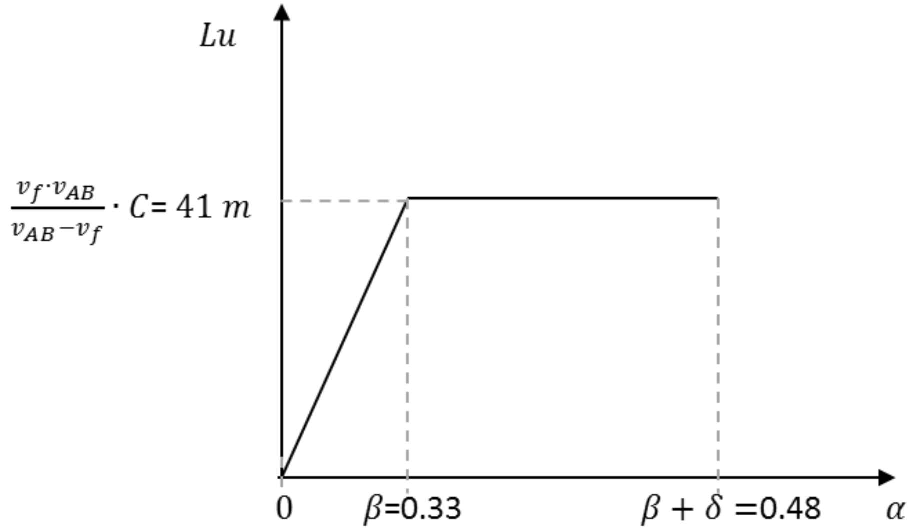
- The minimum Lu required to guarantee no capacity loss at the intersection

Traffic conditions:

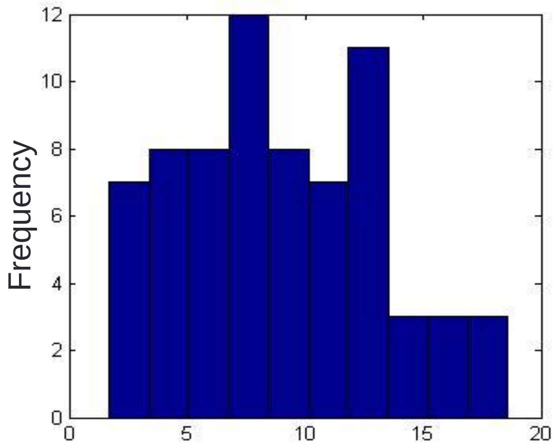


Signal control: $\mathrm{C} = 60\mathrm{s}$
Parking: $\mathrm{P} = 9\mathrm{s},\ \delta = 0.15$

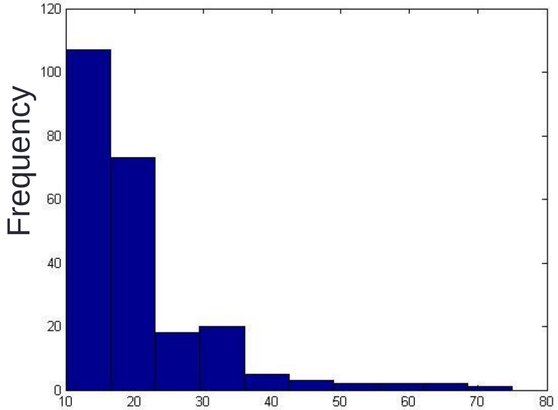
Results:



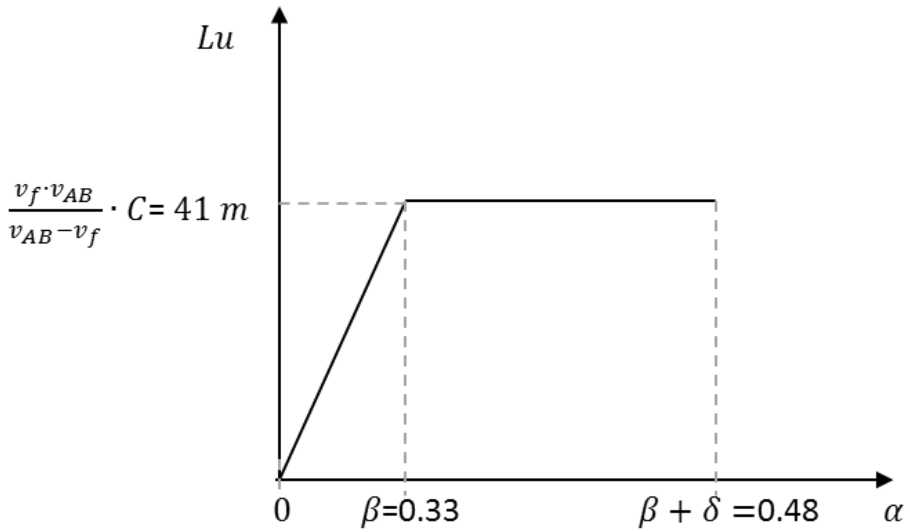
Numerical Example



Duration of maneuvers (in seconds)



Lu of urban zurich



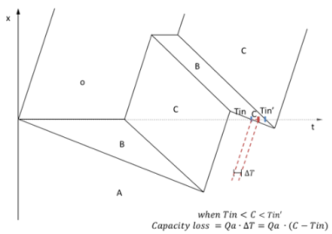
Compare the result and data from City Zurich:

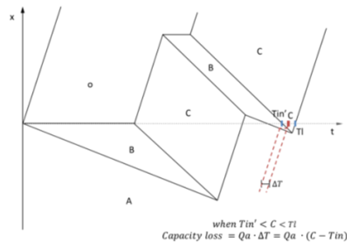
If the traffic assumption suits real situation in urban zurich, then one can tell that, the distance set in reality is quite short that there will be a capacity loss in most cases when parking maneuver happens there.

Question 3

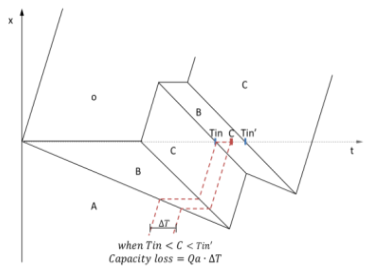
- **What is the corresponding capacity loss according to Lu?**

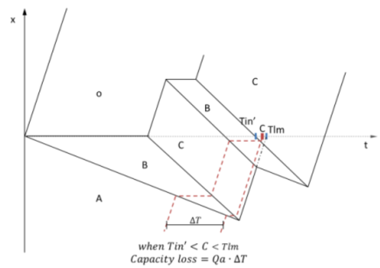
A. $When\ Xm < 0, Xl2 > 0, Tin < C < Tl$

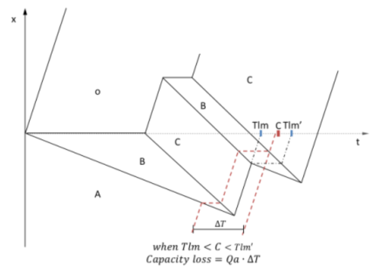


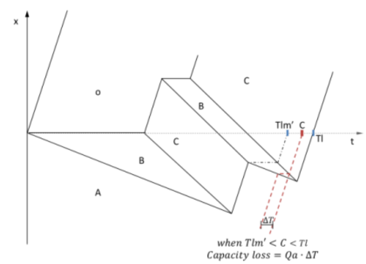


B1. $When\ Xm < 0, Xl2 < 0, Tin < C < Tl,\ \ Tin' < Tlm$

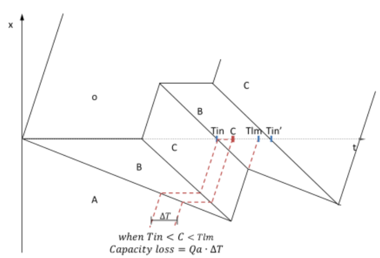


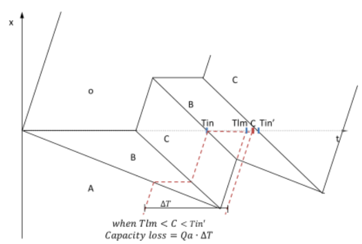


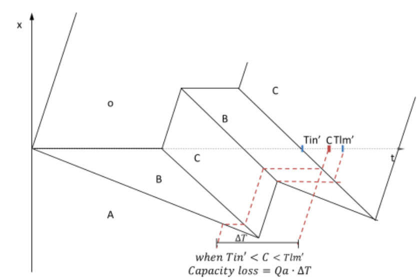


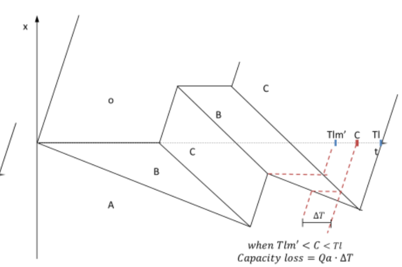


$B2. When\ Xm < 0, Xl2 < 0, Tin < C < Tl,\ \ Tlm < Tin'$









Conclusions

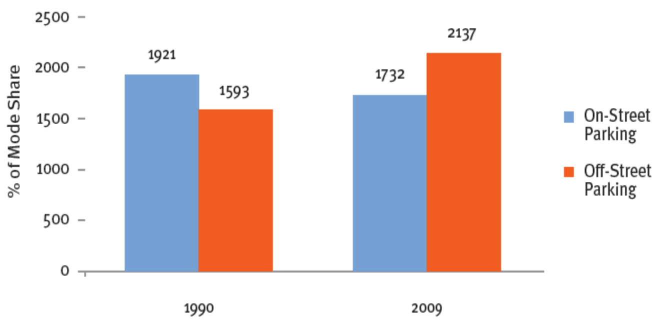
- Till now, we have obtained the minimum distance of Lu to guarantee no capacity loss of the upstream intersection (based on traffic and signal, etc. conditions). One is able to make suggestions to the on-street parking design project.
- Further work will focus on the value of capacity loss, based on Lu, and the simulation of parking maneuver and its impact on traffic in a local network (instead of a single link).

DANKE

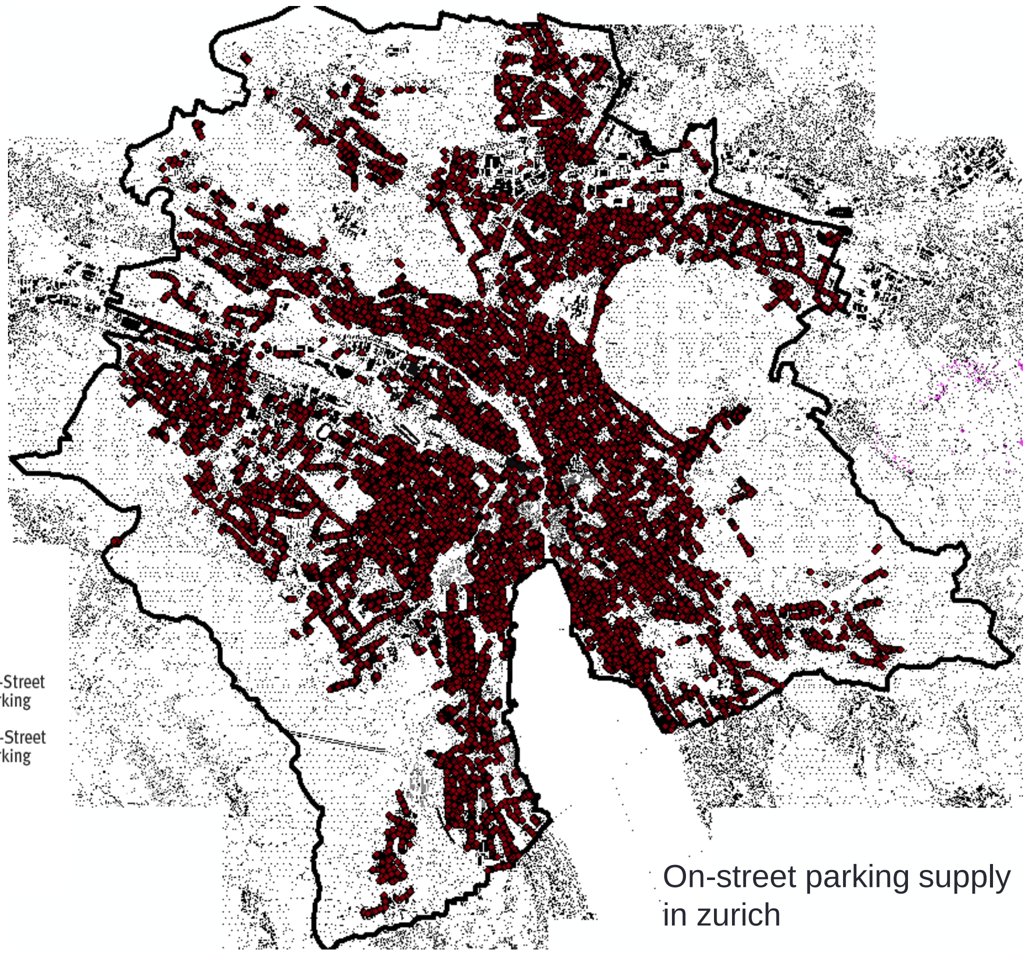
On-street parking in Zurich

Introduction Model Conclusions

- There are nearly 270,000 total parking spaces in the city, 220,000 are located on private land, approximately 50,000 on public land and about 15,000 private spaces are publicly accessible.
- During 1990-2009, the on street parking (only kreis 1) have been decreased by200 stalls.



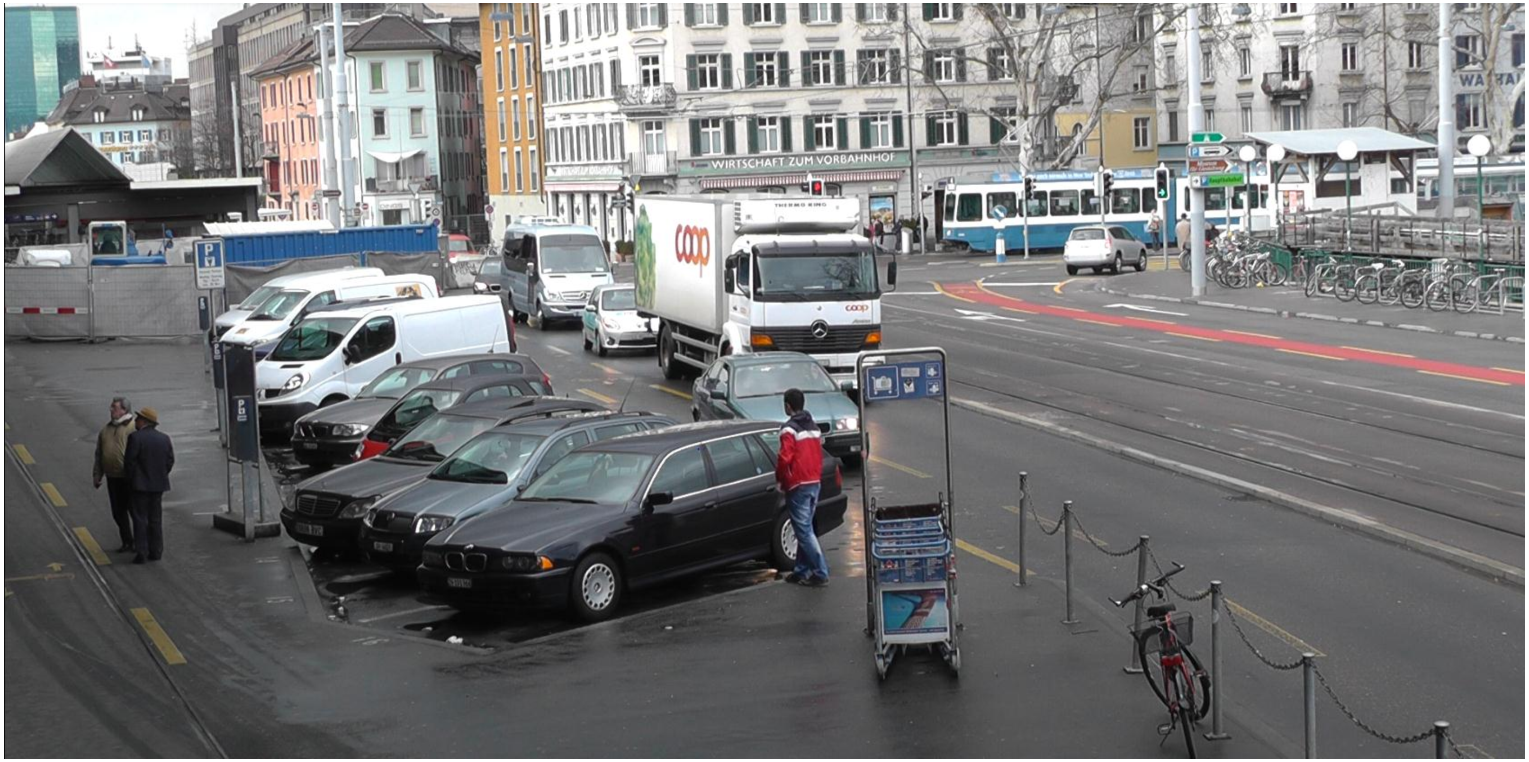
Parking supply in kreis 1 (1990 & 2009)



On-street parking supply in zurich

Source: http://www.stadt-zuerich.ch/parkierung

- Example in zurich



Unparking car block traffic