Determination of a Representative Travel Speed for Road Facility Performance Evaluation Using Floating Car Data

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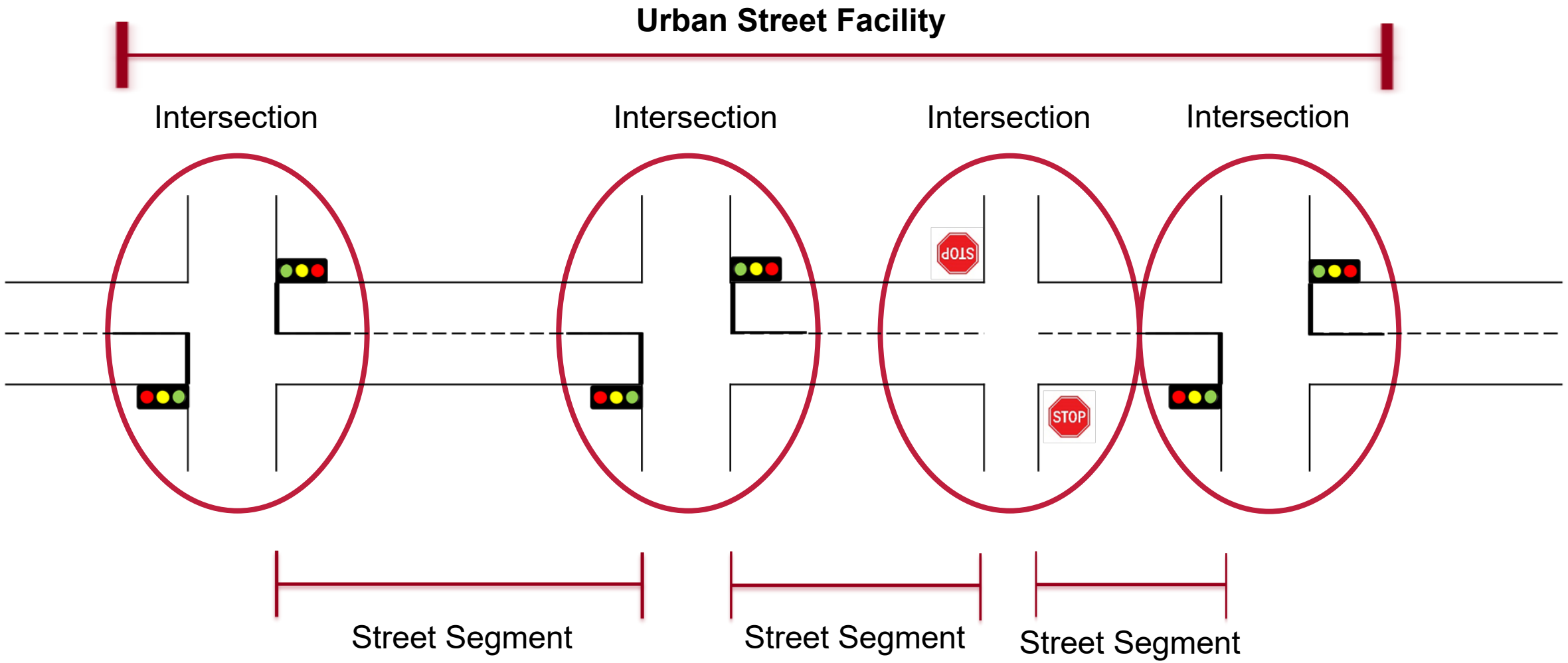
Level of Service Determination for Urban Street Facilities



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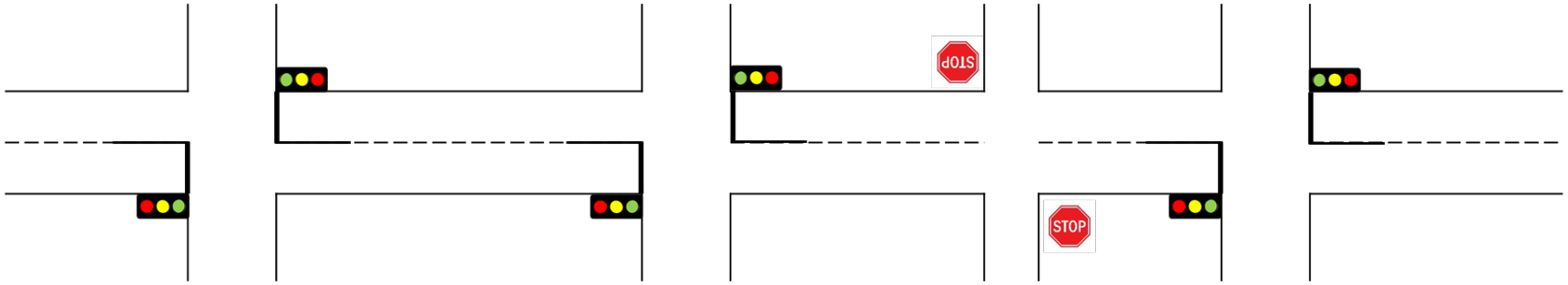


Criteria for Level of Service (LOS) calculation → **Through-Vehicle Travel Speed**

$$\textbf{Travel Speed} = \frac{\text{Facility Length}}{\text{Segment Running Time} + \text{Delay at Intersections}}$$

Estimated using information about:
- Traffic volume
- Segment geometry
- Posted speed-limit

Estimated using information about:
- Traffic volume
- Intersection geometry
- Control type (signalized, stop, yield)

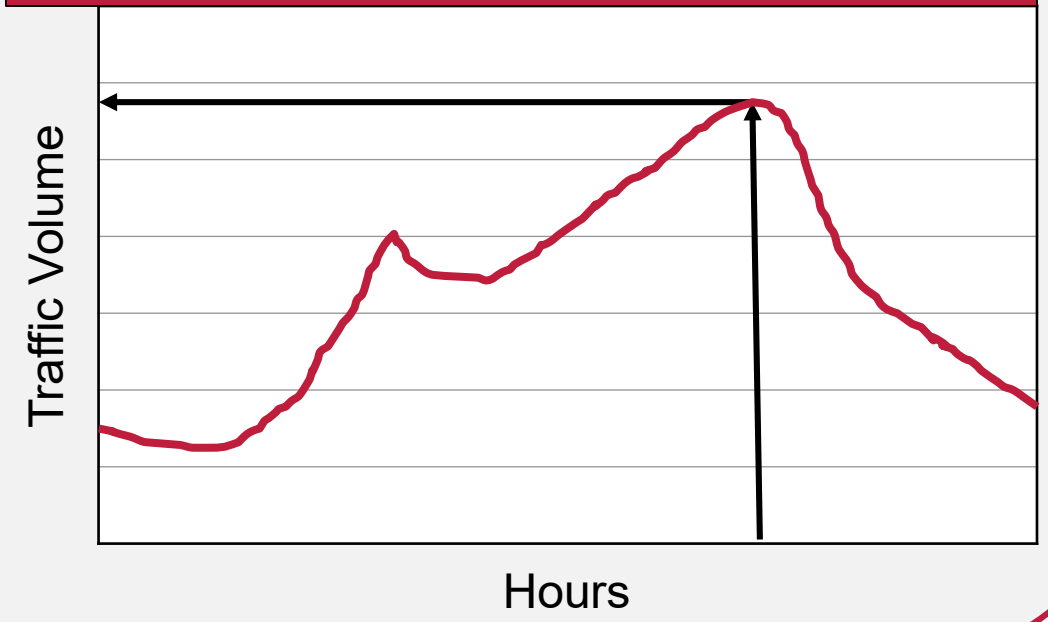
Level of Service Determination for Urban Street Facilities

Analysis Hour Traffic Volume

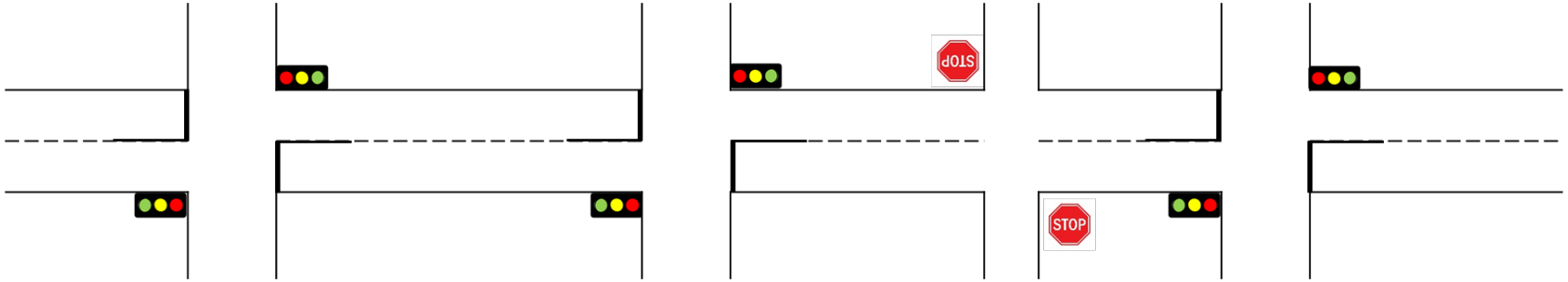
*"The selection of an appropriate hour for planning, design, and operational purposes is a compromise between **providing adequate operations** for every (or almost every) hour of the year and **providing economic efficiency**."* – Highway Capacity Manual 7th Edition

n^{th} highest hourly traffic volume in a year

most frequently occurring peak hour traffic volume



Level of Service Determination for Urban Street Facilities



Criteria for Level of Service (LOS) calculation → **Through-vehicle Travel Speed**

$$\textbf{Travel Speed} = \frac{\text{Facility Length}}{\text{Segment Running Time} + \text{Delay at Intersections}}$$

1. **Is it possible to obtain a representative travel speed for the analysis hour directly using Floating Car Data?**

2. **Which value best represents the analysis hour traffic state?**

Representative Travel Speed from FCD

Approaches to represent traffic state in the analysis hour using FCD:

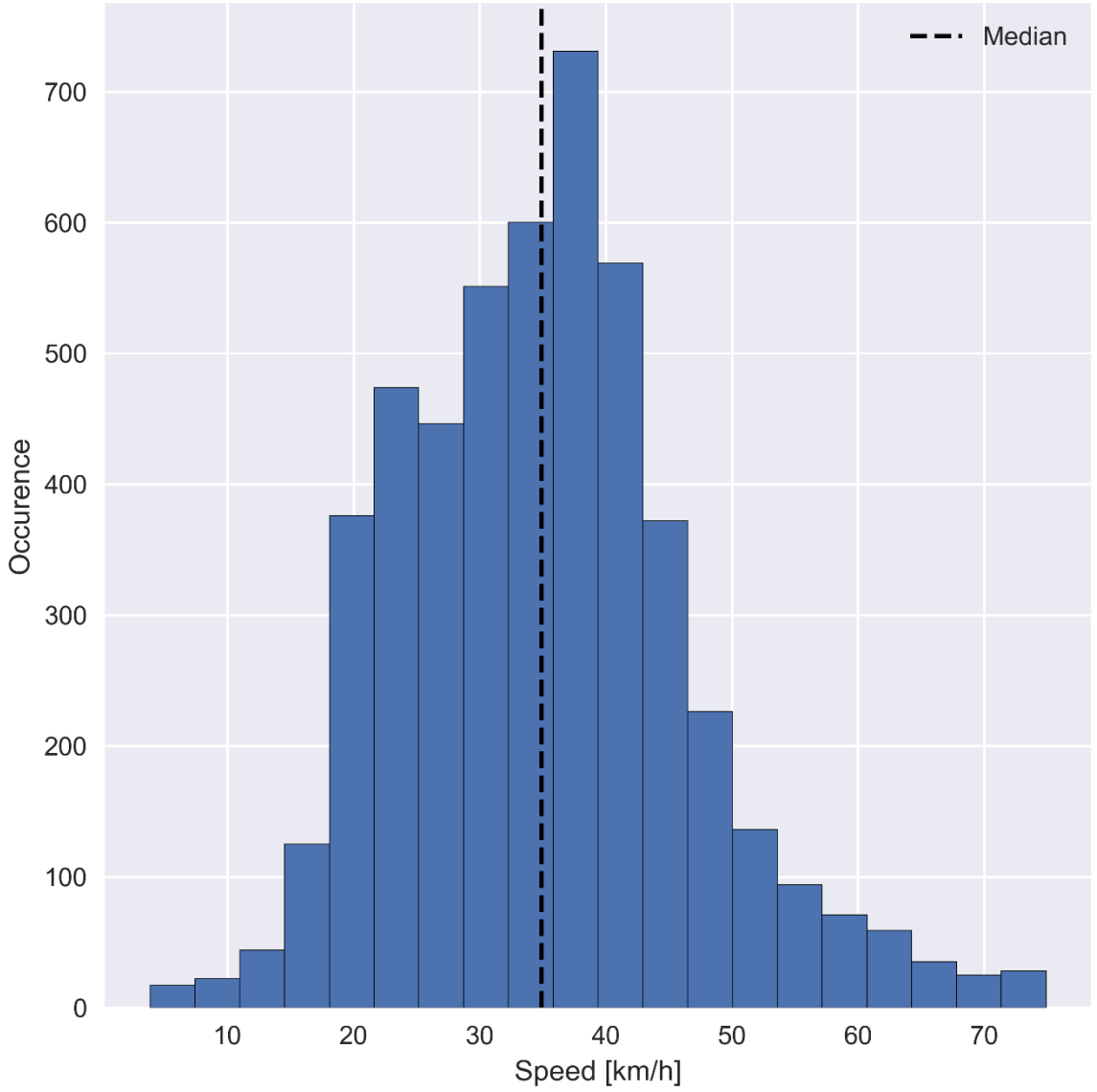
Median Individual Travel Speed

50th Hourly Travel Speed in a Year

Average Peak-Hour Travel Speed

Median Individual Travel Speed

- Utilize value from the distribution of travel speeds along the road facility
- For short-term analysis of traffic state, average travel speed is often used (Axer & Friedrich, 2014; He et al., 2016)
- For long-term evaluations, **median travel speeds** give a stronger indication on the midpoint of the distribution



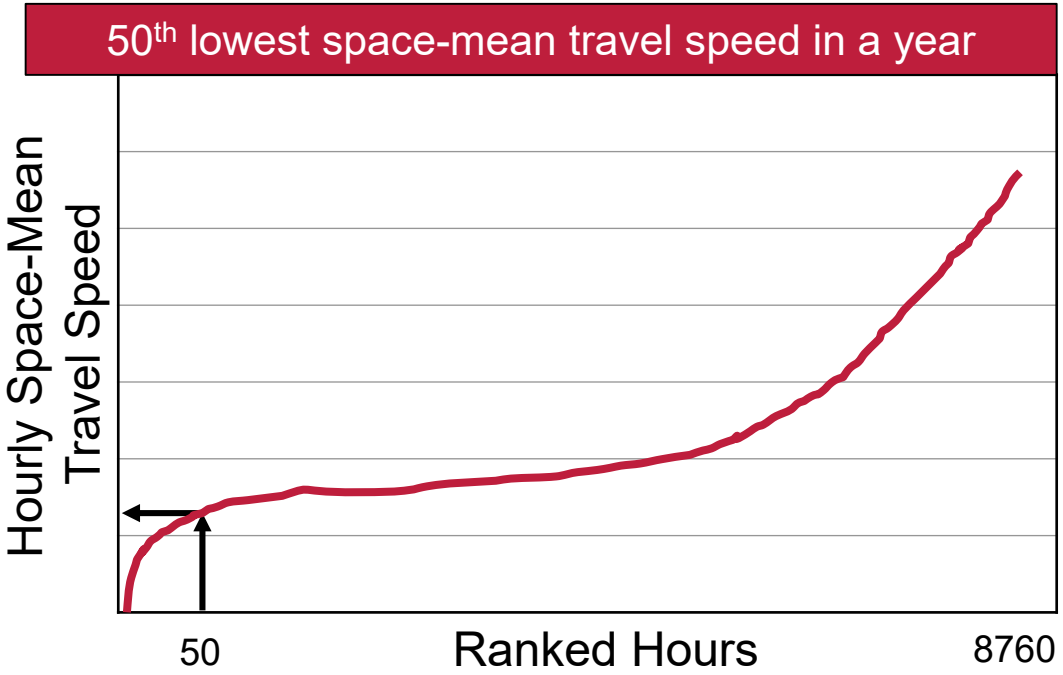
50th Hourly Travel Speed

- Adapts the established methodology for determining the analysis hour traffic volume from hourly traffic volumes

- Space-mean speed of all vehicles n traveling through the respective road facility at every hour of the year is calculated

$$v_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} t_i}$$

- **50th lowest space-mean travel speed** within the year is then chosen as the representative value

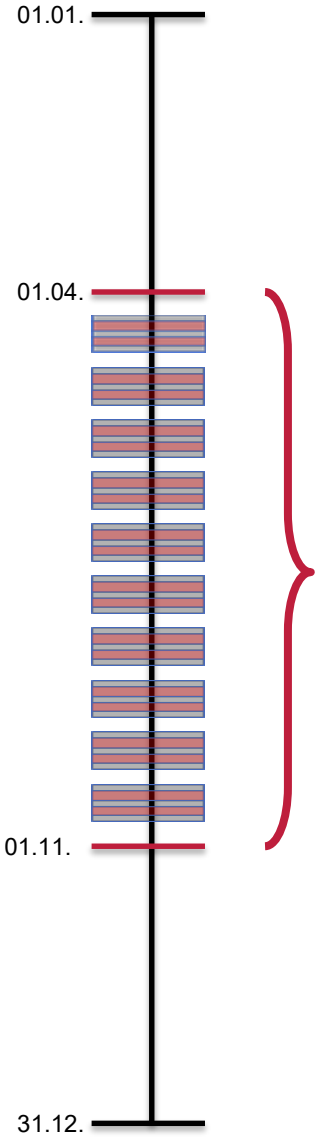


Average Peak Hour Travel Speed

- Identification of an average peak hour on typical working days
- Aggregation of the trajectories within these hours and calculation of the space-mean speed for each 15-minute interval
- Determination of the **four consecutive 15-minute intervals with the lowest average travel speed** as the representative value

= Typical working days (Tue, Wed & Thu)

= Peak hour periods (06:00 – 10:00 & 15:00-19:00)



intervall	trajectories	space-mean speed
2024-04-08 08:00:00	18	39.980645
2024-04-08 08:15:00	34	38.601768
2024-04-08 08:30:00	40	34.075079
2024-04-08 08:45:00	80	35.013951
2024-04-08 09:00:00	52	36.328780
2024-04-08 09:15:00	34	38.698734
2024-04-08 09:30:00	33	36.015622
2024-04-08 09:45:00	30	33.701413
2024-04-08 10:00:00	25	35.359008
2024-04-08 10:15:00	20	31.455835
2024-04-08 10:30:00	24	38.782164
2024-04-08 10:45:00	26	32.988607
2024-04-08 11:00:00	16	30.626655
2024-04-08 11:15:00	26	34.231688
2024-04-08 11:30:00	33	33.047132
2024-04-08 11:45:00	20	34.060203
2024-04-08 12:00:00	27	36.169165
2024-04-08 12:15:00	24	33.618626
2024-04-08 12:30:00	25	34.976197
2024-04-08 12:45:00	23	34.869402
2024-04-08 13:00:00	29	33.896963
2024-04-08 13:15:00	32	37.140232
2024-04-08 13:30:00	15	40.848088
2024-04-08 13:45:00	25	34.471558

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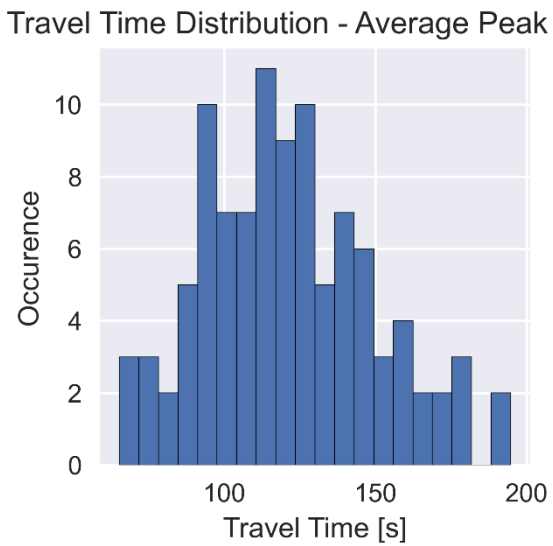

Space-Mean Speed
Avg. Working Day
10:45 – 11:45

32.9 km/h

Case Study

“Elberfelder Straße – Wansbeckstraße”

Remscheid, North-Rhine Westphalia

Length	973 m
Speed Limit	50 km/h
Intersections	4 (all signalized)

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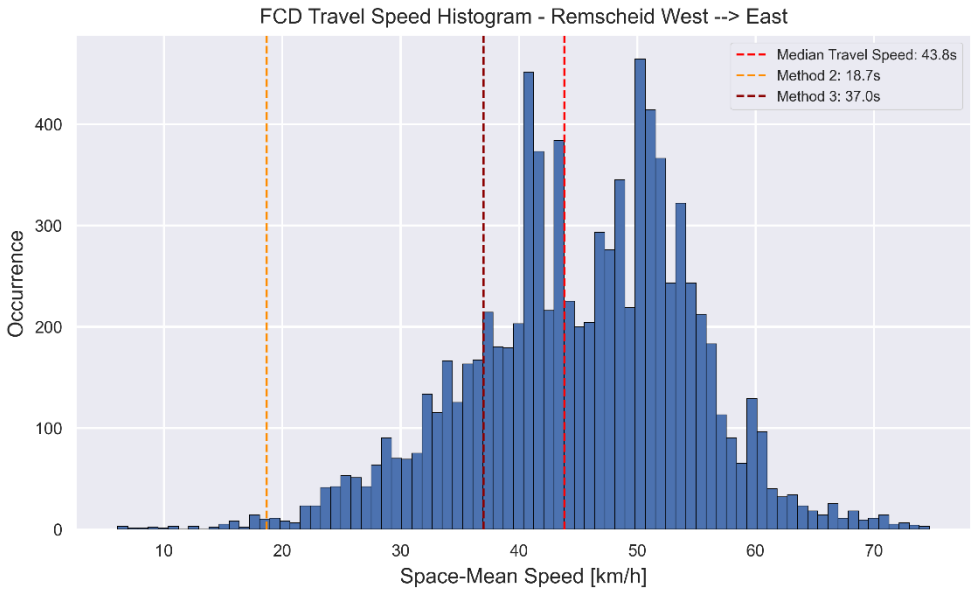
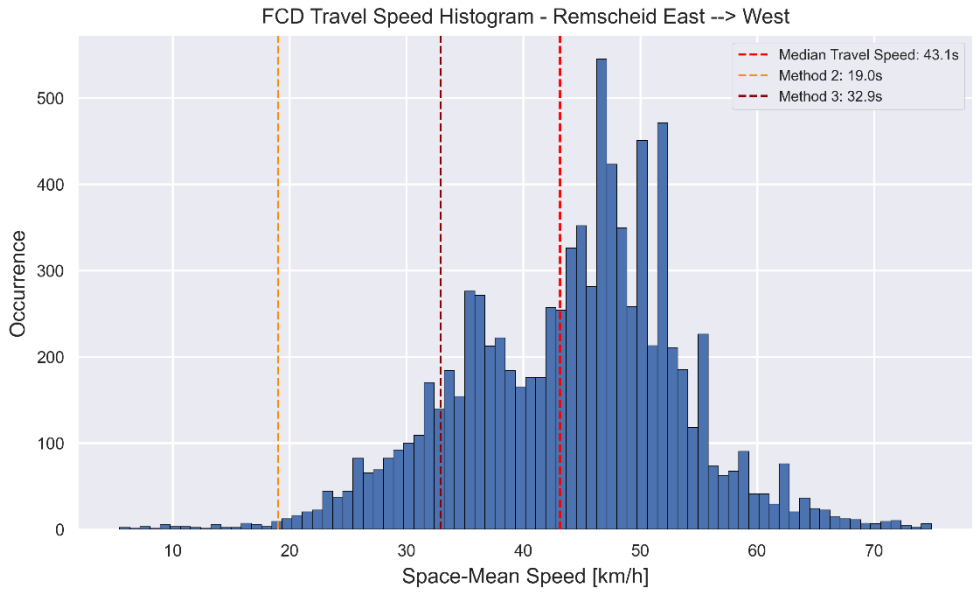
Case Study

	Travel Speed [km/h] Direction West → East	**Travel Speed** [km/h] Direction East → West
Reference Travel Speed - Simulation	**33,7**	**35,0**
1. Median Individual Travel Speed	43,8	43,1
2. 50th Hourly Travel Speed	18,7	19,0
3. Average Peak Hour Travel Speed	37,0	32,9





Case Study

Level of Service Analysis – German HCM (HBS):

Direction	Travel Speed [km/h]	
	FCD	HBS
West → East	37.0	25.3
Difference	4.7 km/h | 31.6 %	
East → West	32.9	19.5
Difference	13.4 km/h | 40.7 %	

Direction	Level of Service (LOS)	
	FCD	HBS
West → East	B	D
East → West	B	E

Results:

- Travel speeds from FCD generally higher than according to analytical HBS procedure
- Leads to significantly better LOS evaluation

- Possible explanation:
  - Existing coordination of intersection signalling (not included in HBS procedure)

Key Takeaways

1. FCD offers an easy and universally applicable way to determine average travel speeds → possible simplification of operational and design analysis

2. The analysis hour travel speed is best represented by using FCD from an average peak hour an typical working days

3. There exist significant differences between regulatory analytical procedures and direct data analysis due to limitations in the regulatory procedures → Consolidation?

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