Traffic Engineering
Research Centre

An overview of some Norwegian research on SIDRA and intersection modelling

SIDRA User meeting

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Content

- Use of SIDRA in Norway
- Intersection modelling
- Critical time gap and follow-up headway
- Environment factor
- Saturation flow
- Driver behaviour

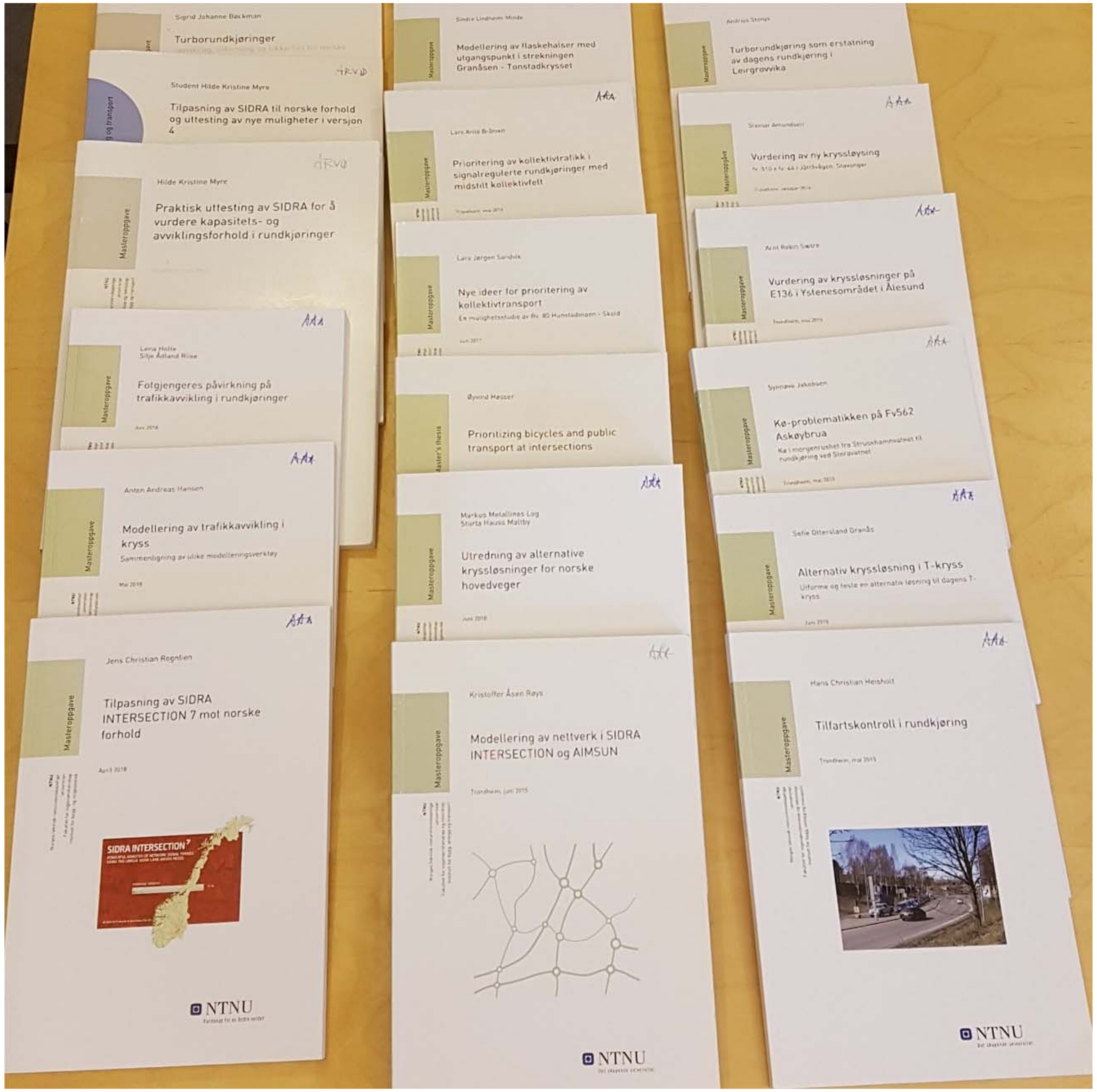
Use of SIDRA in Norway

- SIDRA is today the main tool for **analytical modelling** of Norwegian intersections
- SIDRA has been used in Norway since about 1985
- However, until about 1995 the Norwegian market mainly used TRL software with ARCADY, PICADY, OSCADY and CONTRAM
- After 2005 SIDRA has more or less been the only tool for analytical modelling of Norwegian intersections
- Nearly all traffic consultants are using SIDRA together with NPRA and NTNU
- Nearly all users have maintenance agreement and use the latest version

Use of SIDRA at NTNU

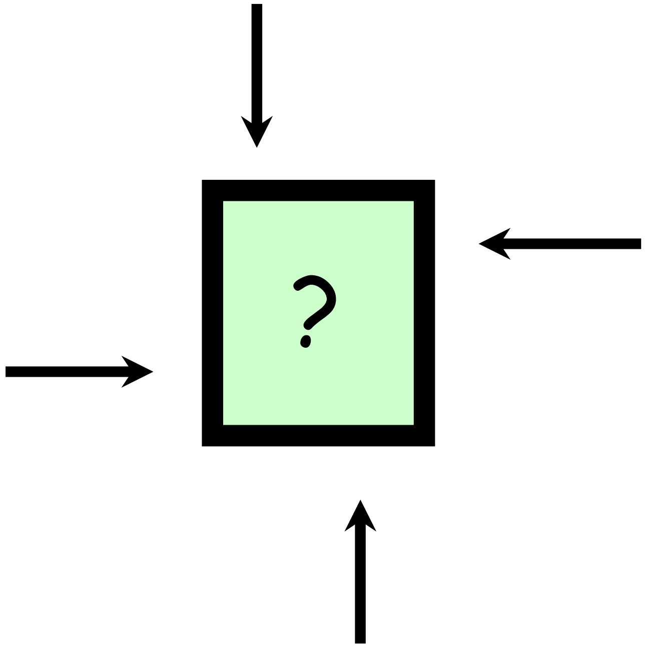
- At NTNU all traffic engineering students have been using SIDRA the latest 20 years
- The students are using SIDRA for a practical exercise, and they are learning the theoretical basis for traffic modelling
- We have had more than 20 master thesis which include SIDRA modelling
- A number of these have focused on theory and how to improve the use of SIDRA for Norwegian conditions
- I will present some of this work from NTNU during my presentations here at this SIDRA User meeting

Use of SIDRA at NTNU



What is important at an intersection?

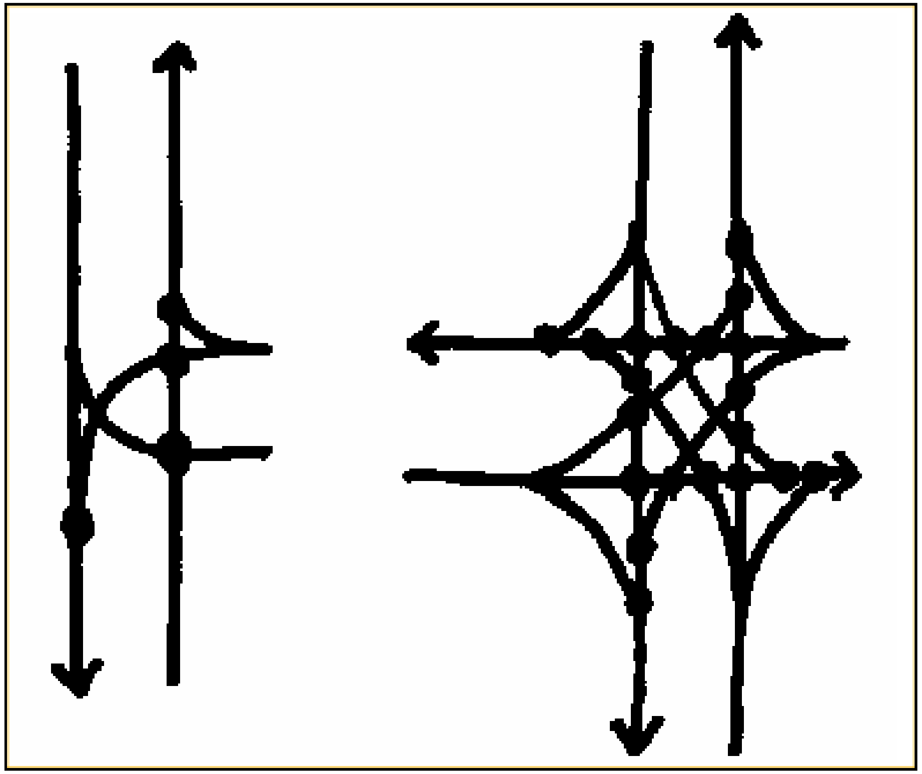
- An intersection is where three or more roads come together
- There will be conflicts between different movements at an intersection
- We have to define a set of rules to separate and solve these conflicts (with regard to time or space)
- There are many possible solutions to this problem with conflicting movements
- **How to solve conflicts?**



Intersections: A matter of priority

- Solving conflicts and defining traffic rules at intersections is a matter of priority
- We have to give a certain priority (rank) to different movements
- Priority decides quality of traffic flow and distribution of capacity and delay (high priority -> no/short delay, low priority -> larger delay)
- Movements with high priority will reduce priority (and increase delay) for other movements
- The movements with low priority will usually decide the overall capacity and level of service at the intersection
- The main problem at an intersection is often **LEFT TURN**

Conflicts at T- and X- intersections



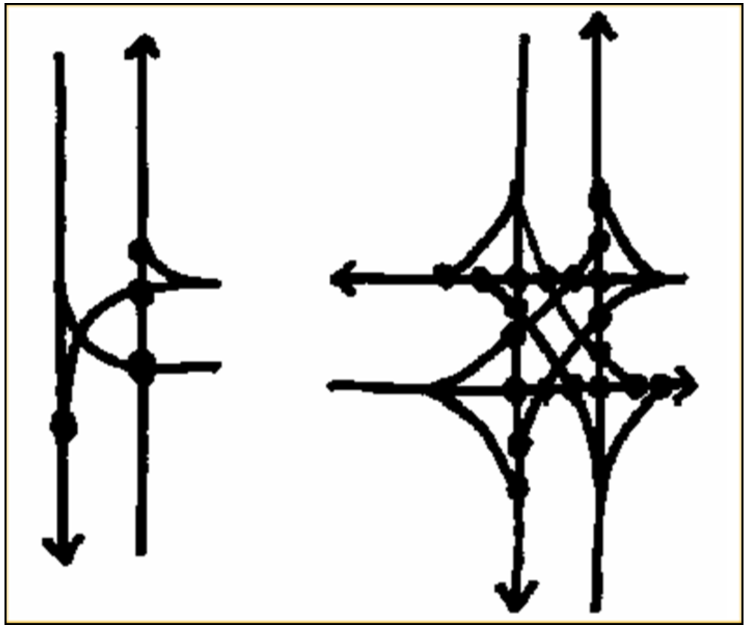
- The number of conflicts should be reduced
- Some conflicts are more serious than others – these conflicts should be avoided
- The main problem is ”crossing” conflicts at high speeds
- The conflict area should be made as defined and restricted as possible
- The drivers should easily understand how to solve conflicts
- Show video from Addis Ababa…

Crossing and merging conflicts

- Most merging conflicts could perhaps most efficient be soved by zipper merge and weaving

- Crossing conflicts are often more difficult to solve; we need to define priority rules

- We have to consider
  - capacity
  - quality of traffic flow
  - emissions, fuel consumption etc
  - traffic safety
  - and much more...



The most important factors for (crossing) conflicts

- Priority intersections (including roundabouts)
  - Critical time gap
  - Follow-up headway

- Signalized intersections
  - Saturation flow rate

- These are also the most important factors for **calibration** of a model like SIDRA

Priority intersections with give-way

Base values for critical time gap and follow-up headway

Movement	SIDRA	HCM	Norway
Right turn from Minor road	5.0 (3.0)	6.9 (3.3)	5.0 (3.0)
Straight from Minor road	6.5 (3.5)	6.5 (4.0)	6.0 (3.5)
Left turn from Minor road	7.0 (4.0)	7.5 (3.5)	6.5 (4.0)
Major road Left turn	4.5 (2.5)	4.1 (2.2)	4.5 (2.5)

- These are base values – the corrections are important !
- Please have a **critical look** at the TWSC model in SIDRA !
- Always check if the actual values seem to be realistic

TWSC correction model

	Critical Gap Adjustment, t_c (sec)				Follow-up Headway Adjustment, t_f (sec)			
Major Road Number of Lanes:	2-lane (or 1-lane)	3-lane	5-lane	6-lane or more	2-lane (or 1-lane)	3-lane	5-lane	6-lane or more
SIDRA Standard model								
Minor Road Left Turn	-0.5	-0.5	0.0	0.0	-0.5	-0.5	0.0	0.0
Minor Road Through	-1.5	-0.5	0.5	1.0	-0.5	-0.3	0.5	1.0
Minor Road Right Turn	-1.5	-0.5	0.5	1.0	-0.5	-0.3	0.5	1.0
Major Road Turn (Right or Left)	-0.5			1.0	-0.5			1.0

	Critical Gap Adjustment, t_c (sec)		Follow-up Headway Adjustment, t_f (sec)	
	SIDRA Standard	SIDRA HCM	SIDRA Standard	SIDRA HCM
Give-Way / Yield Sign Control	-0.5	-0.5	-0.3	-0.3
One-Way Major Road (for Minor Road Through and Minor Road Critical Turn) (1)	-0.5	-0.5	-0.3	-0.3
T Intersection (for Minor Road Critical Turn only) (1)	-0.7	-0.7	-0.4	0.0
Entry Road Grade (for each per cent grade) (2)	0.1	0.1	0.0	0.0
U Turn (Major Road)	1.5	1.5	0.9	0.9
User Adjustment	0.0	0.0	0.0	0.0

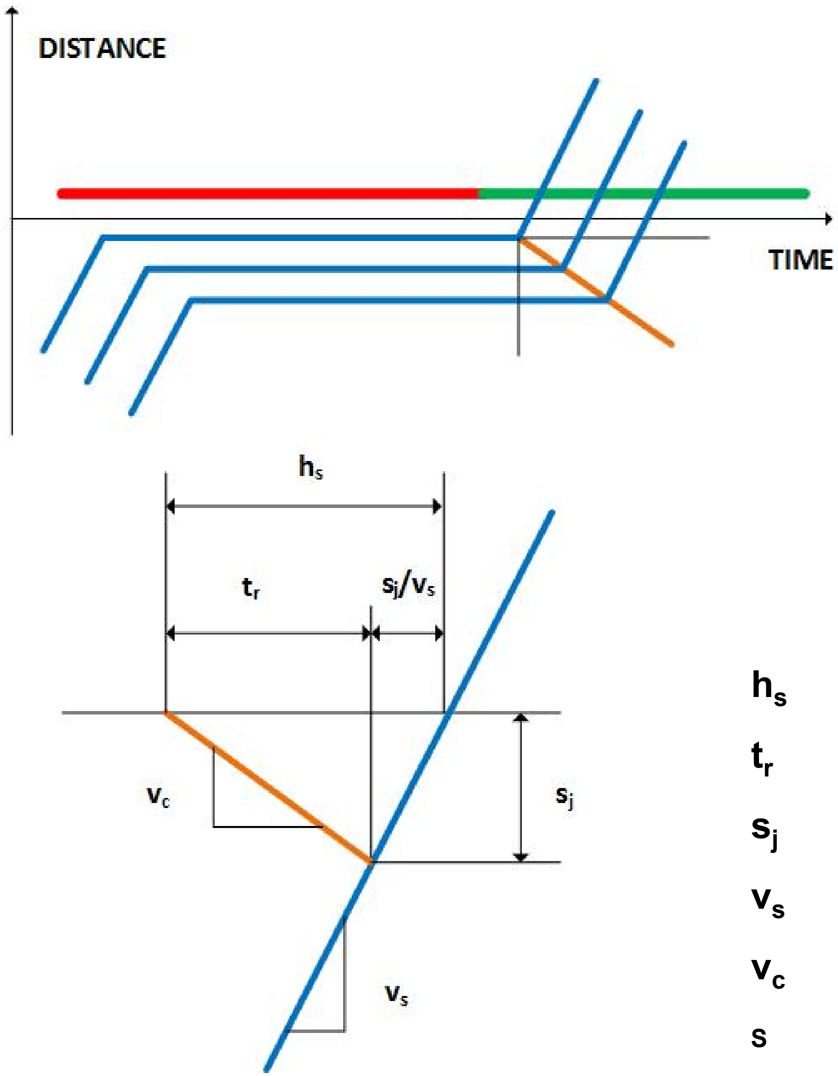
Environment factor at roundabouts

- The environment factor is used for roundabout calibration
- The default value is 1.0
- Several Norwegian studies suggest values between 1.05 (single lane roundabout) and 1.15 (multilane roundabout)

Saturation flow

- There are methods for <u>calculating</u> saturation flow
- There are also methods for <u>observing</u> saturation flow
- But we are often using <u>default values</u> based on experience and local conditions:
  - Straight forward 1700 - 1900 veh/h
  - Right turn 1600 - 1800 veh/h
  - Left turn 1500 - 1700 veh/h
- Rule of thumb:
  - 2 seconds between front of each vehicle on green signal
  - which gives a saturation flow of <u>1800 veh/h</u>

Saturation headway and saturation flow rate – model 1

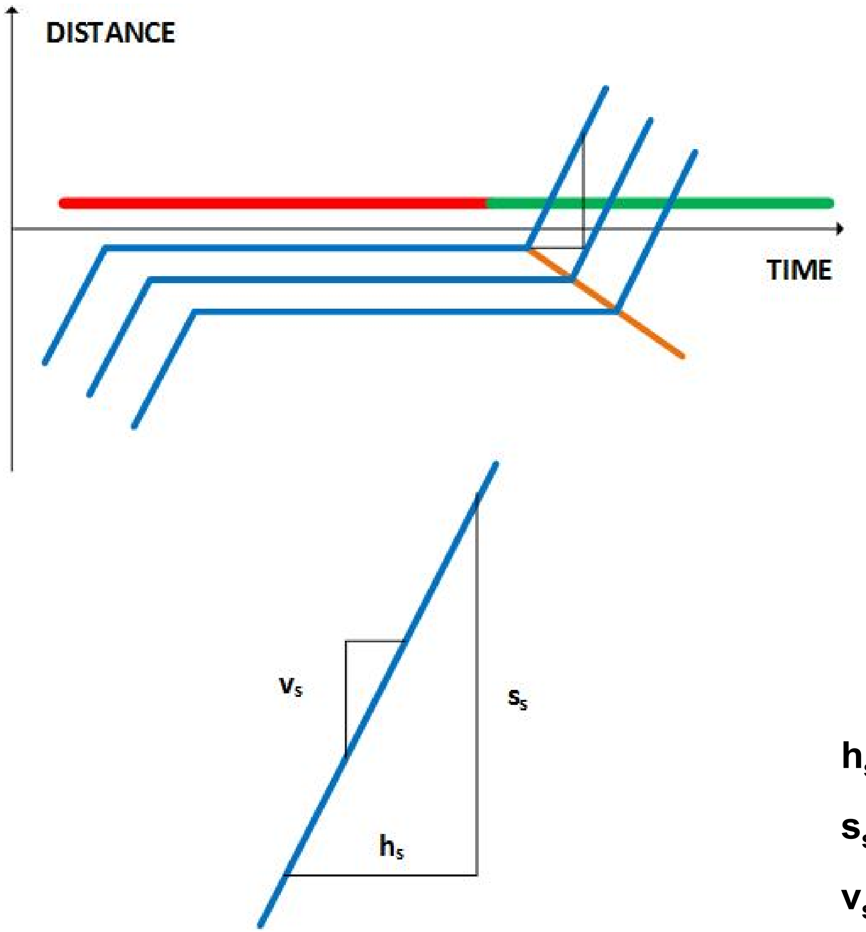


$$h_s = tr + \frac{s_j}{v_s}$$

$$S = \frac{1}{h_s}$$

	Parameter	Typical value
h_s	Saturation headway	1.8 - 2.0 sec
t_r	Queue dep. reaction time	1.0 - 1.5 sec
s_j	Jam spacing	7 - 10 m
v_s	Saturation speed	40 - 60 km/h
v_c	Queue clearance wave speed	20 - 30 km/h
s	Saturation flow rate	1800 - 2000 veh/h

Saturation headway and saturation flow rate – model 2

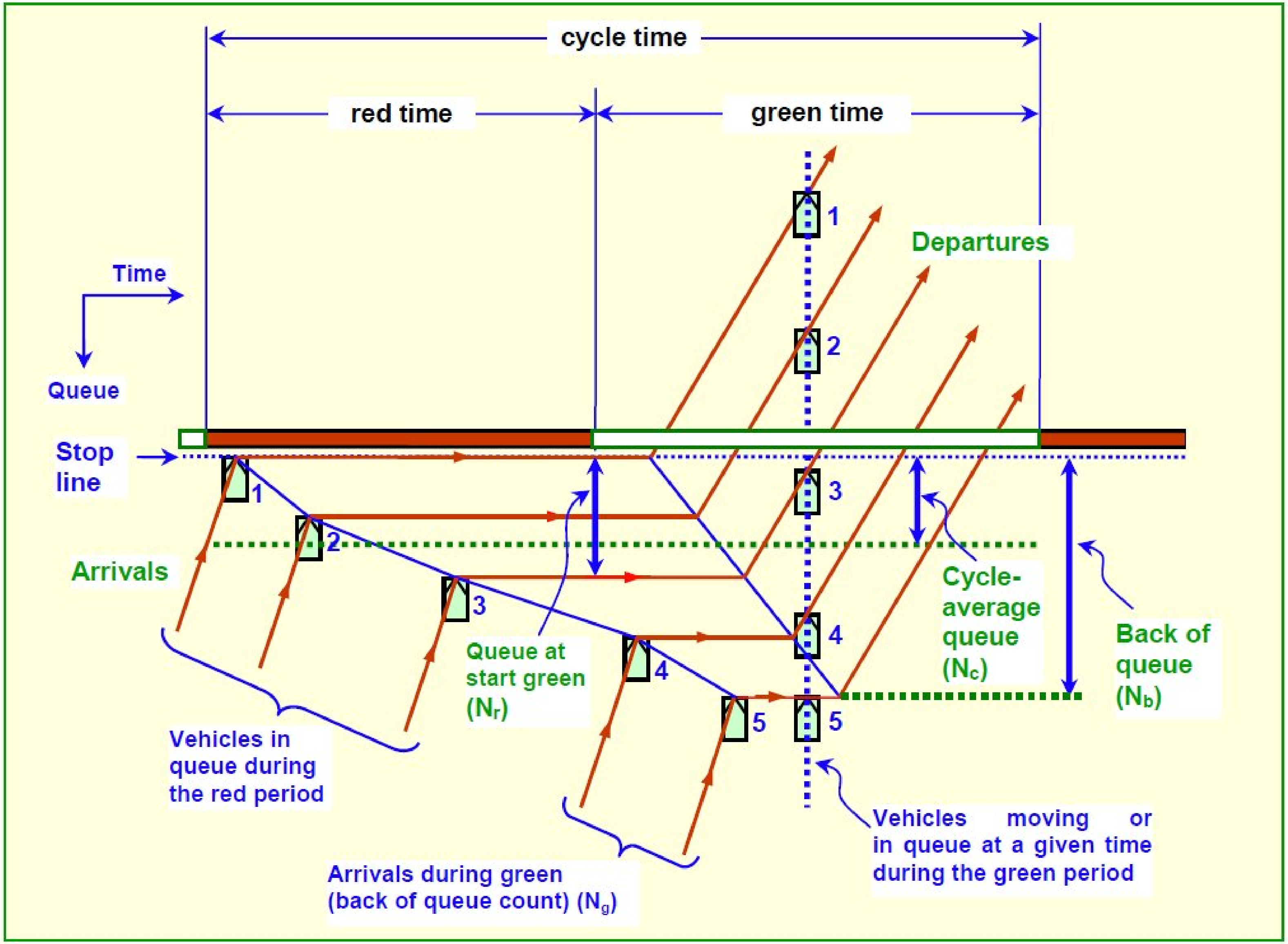


$$h_s = \frac{s_s}{v_s}$$

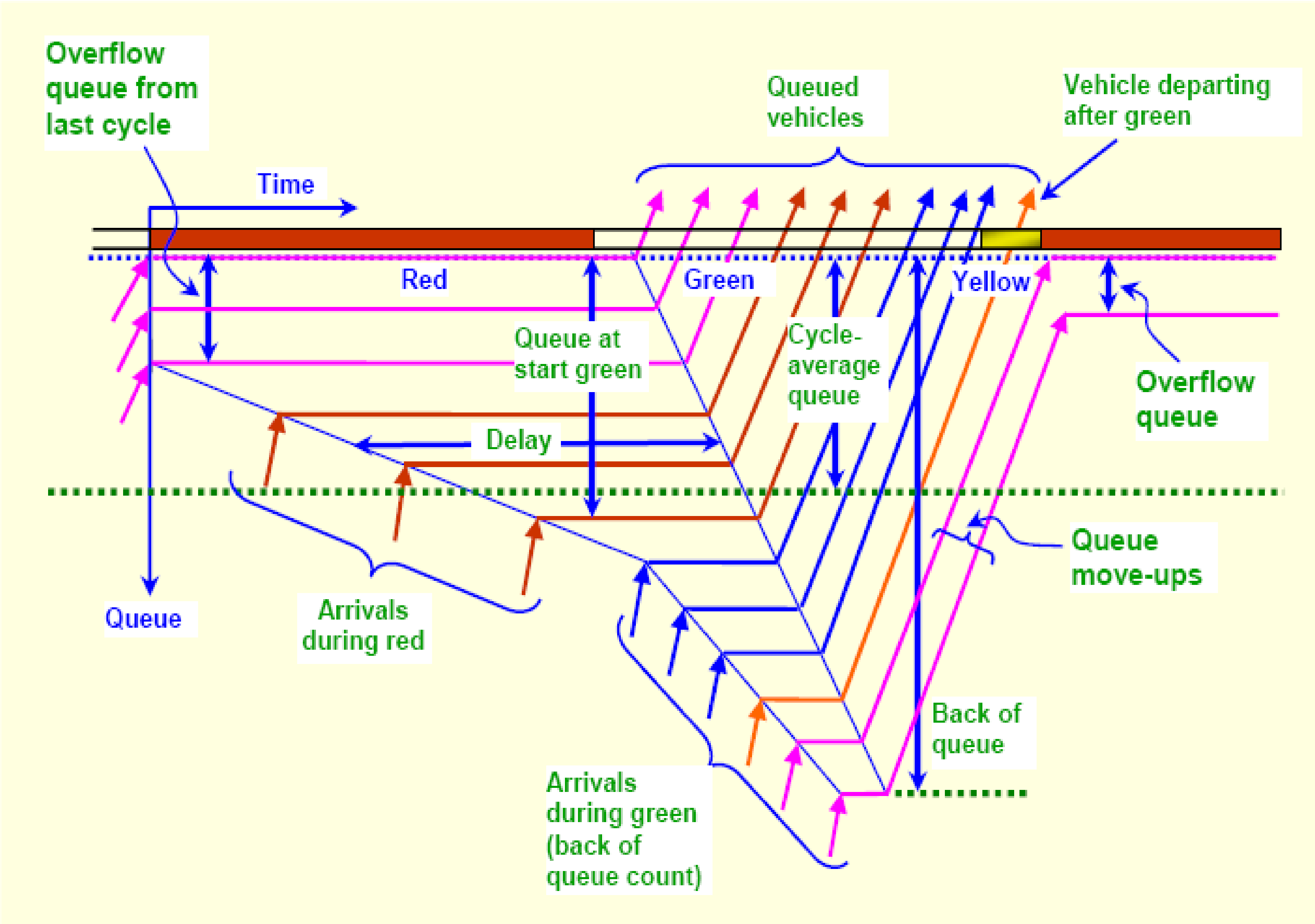
$$S = \frac{1}{h_s}$$

	Parameter	Typical value
h_s	Saturation headway	1.8 - 2.0 sec
s_s	Saturation spacing	20 - 30 m
v_s	Saturation speed	40 - 60 km/h
s	Saturation flow rate	1800 - 2000 veh/h

Cycle average queue and average back of queue



Traffic flows and queues at a traffic signal (oversaturation)



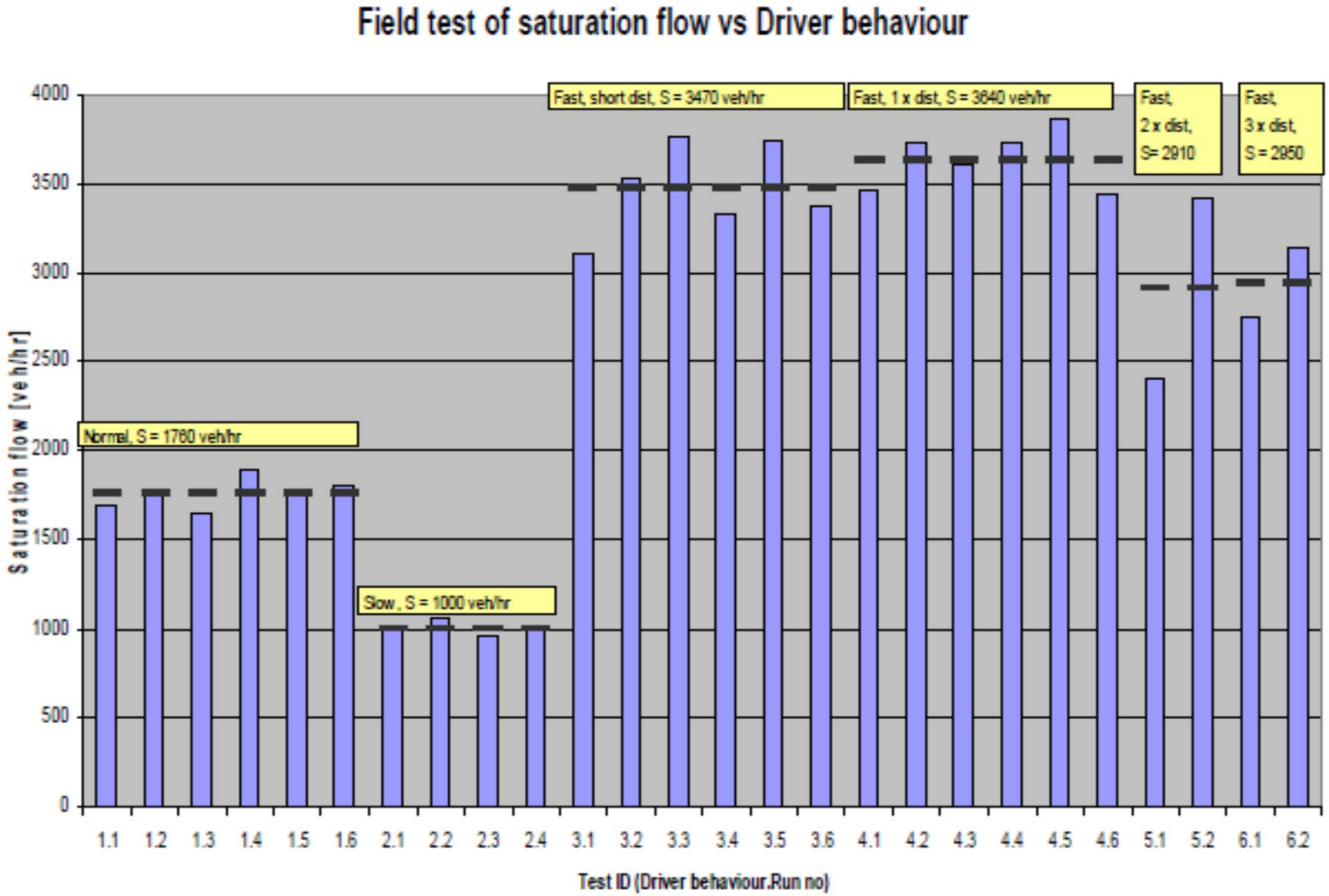
Example from Trondheim

Experiments – field trials at a closed track

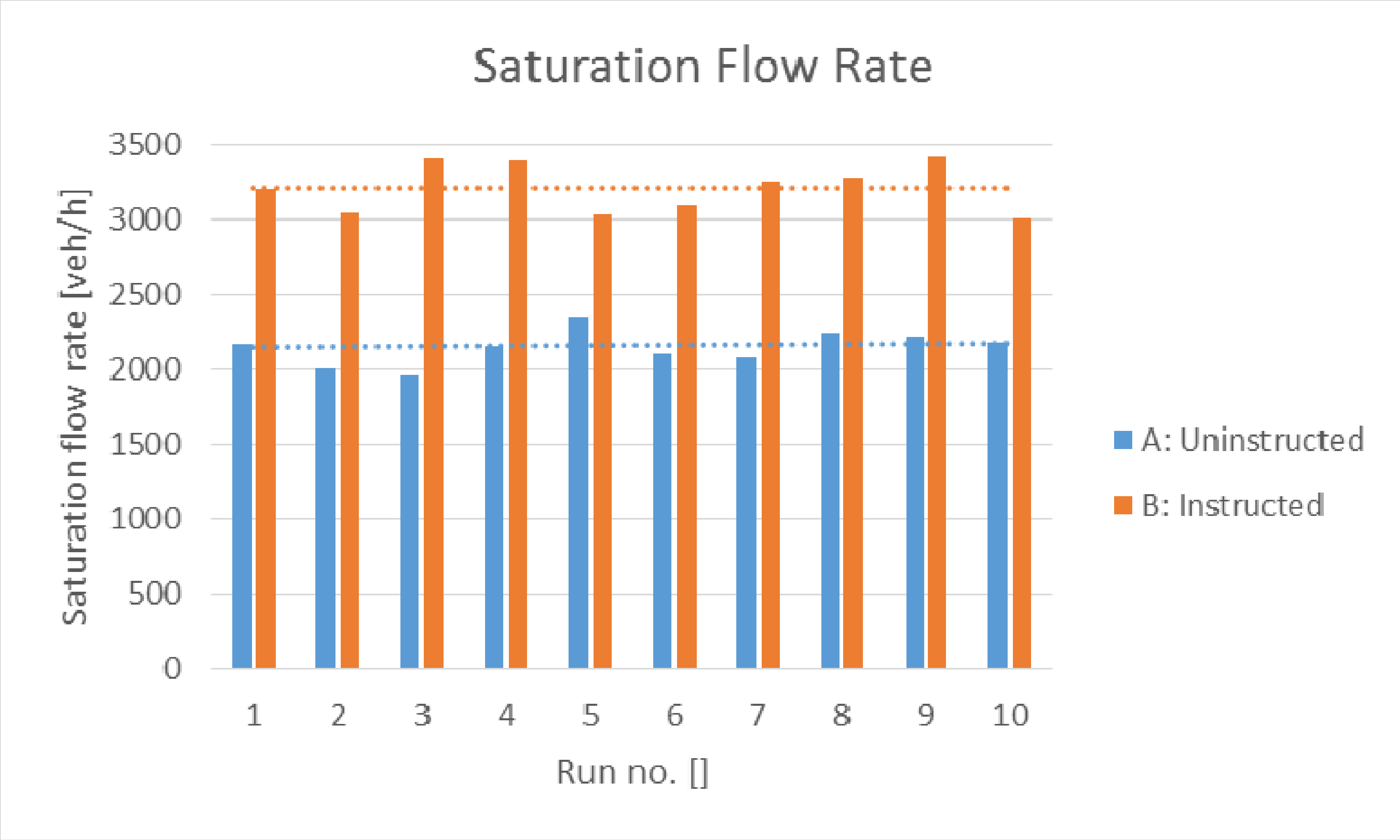
2016 Hell Motor Arena
- 22 cars
- 20 runs
- 2 different scenarios

1999 Tiller
- 10 cars
- 26 runs
- 6 scenarios

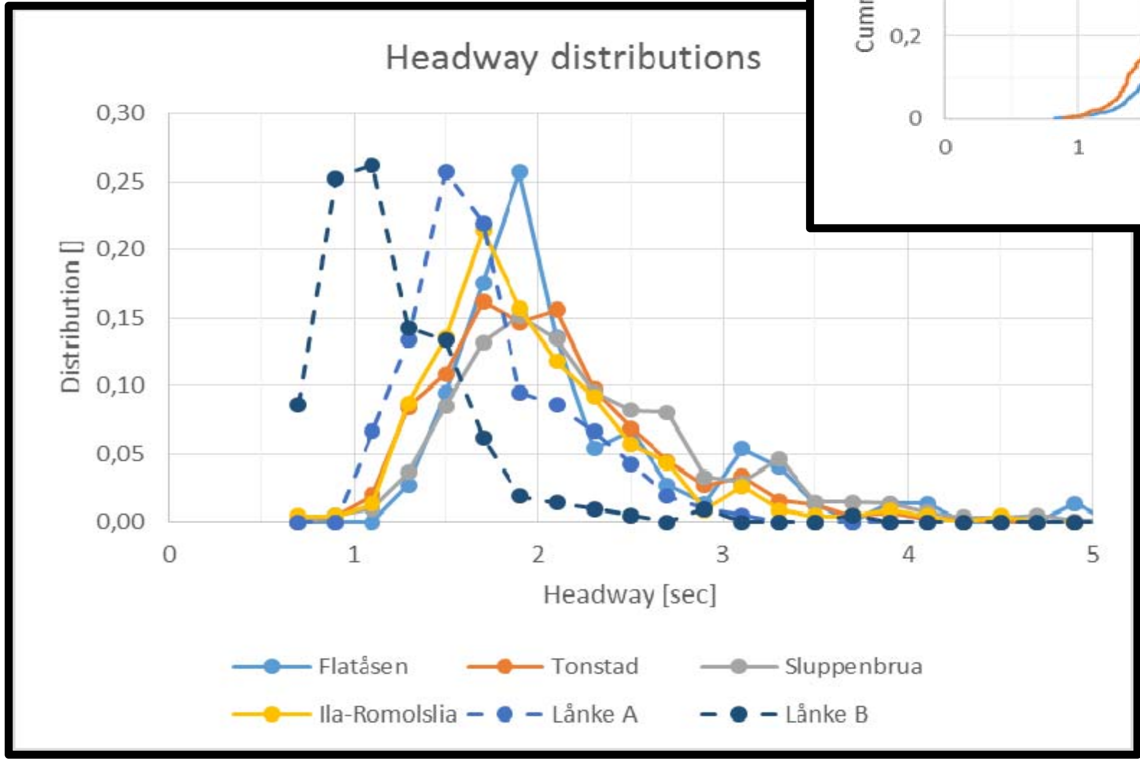
Results 1999 – Finding the limit for efficency

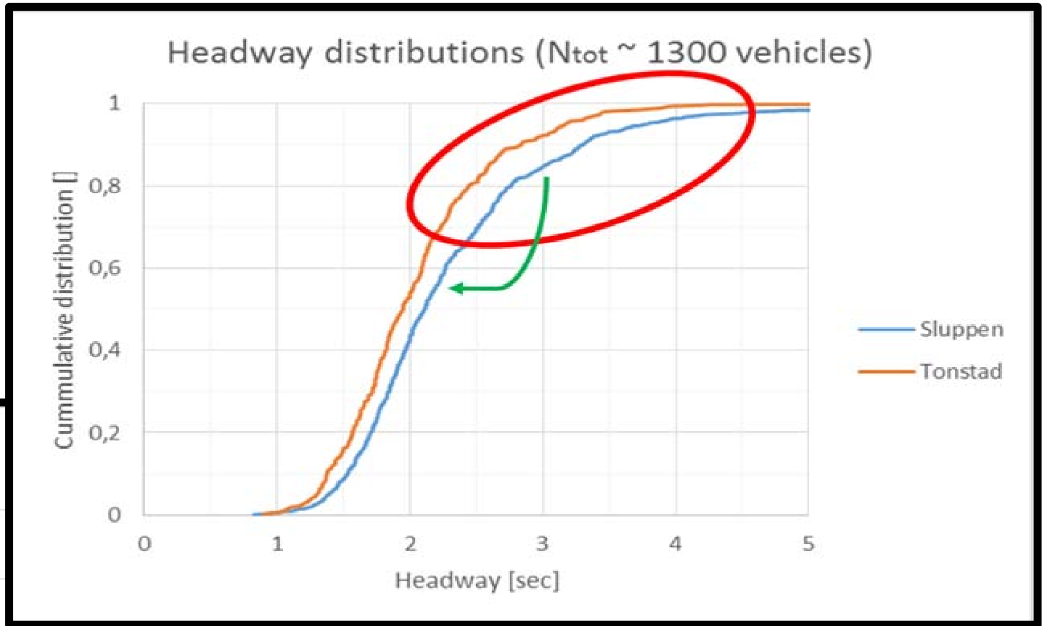


Results 2016 – Saturation flow rate



Observed headway distributions

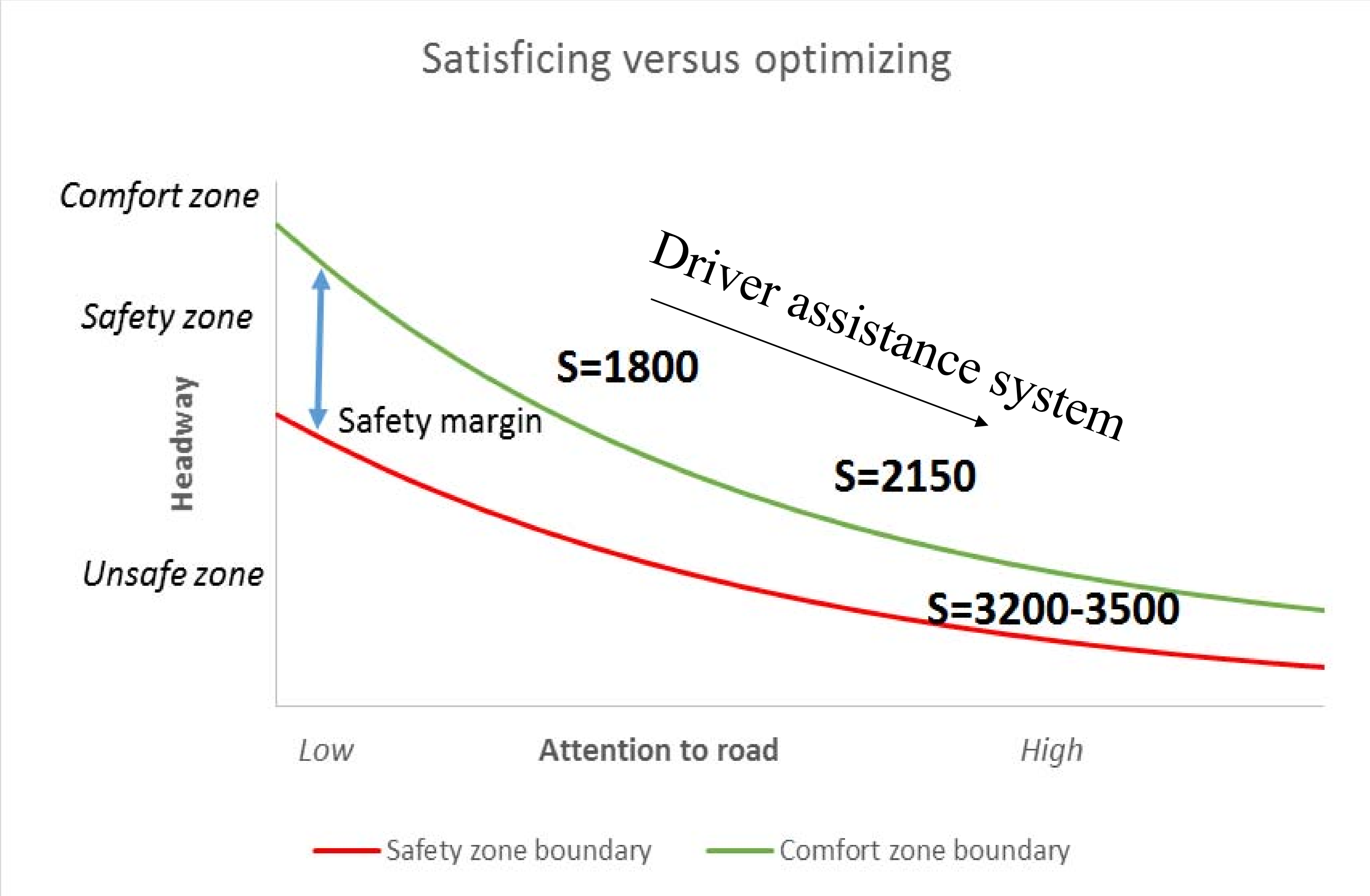




Diver behaviour

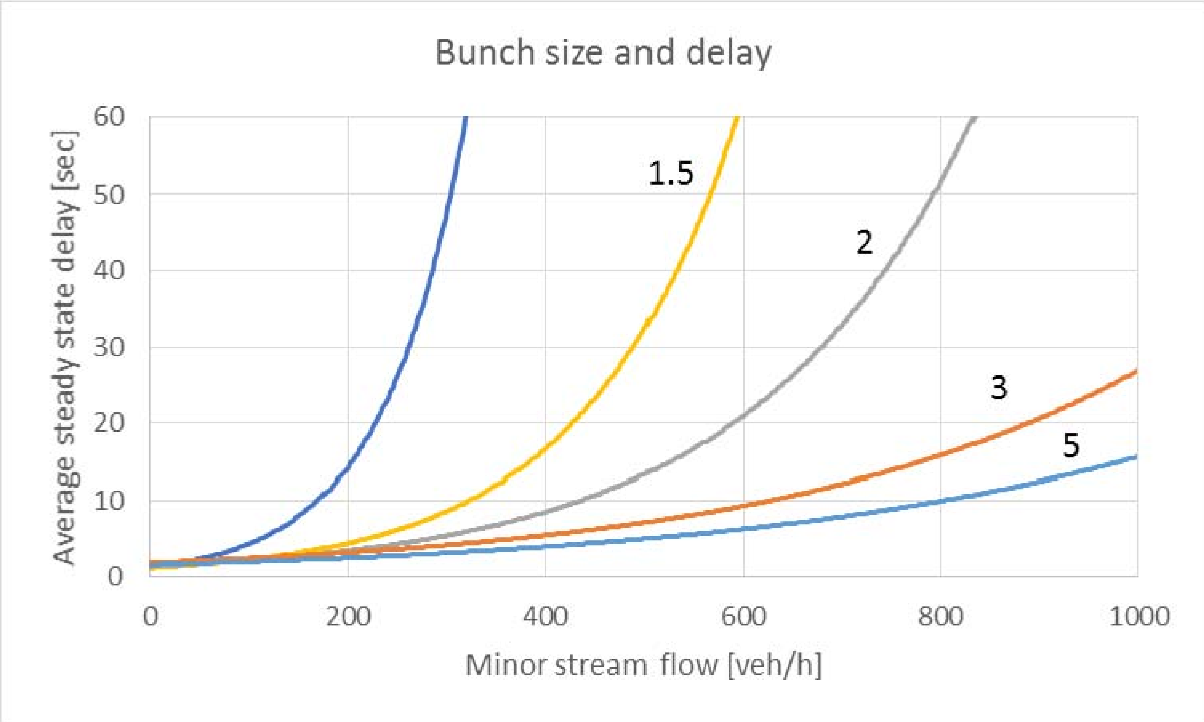
- Driver beaviour plays an important role in traffic modelling
- It is possible to change and adjust driver behaviour (individually and as a group)
- Your driver behaviour will affect other vehicles behind you
- Challenge and paradox:
  Your contribution to efficient traffic flow and driver behaviour will usually mainly help others – why should you contribute?

Driver behaviour and efficiency

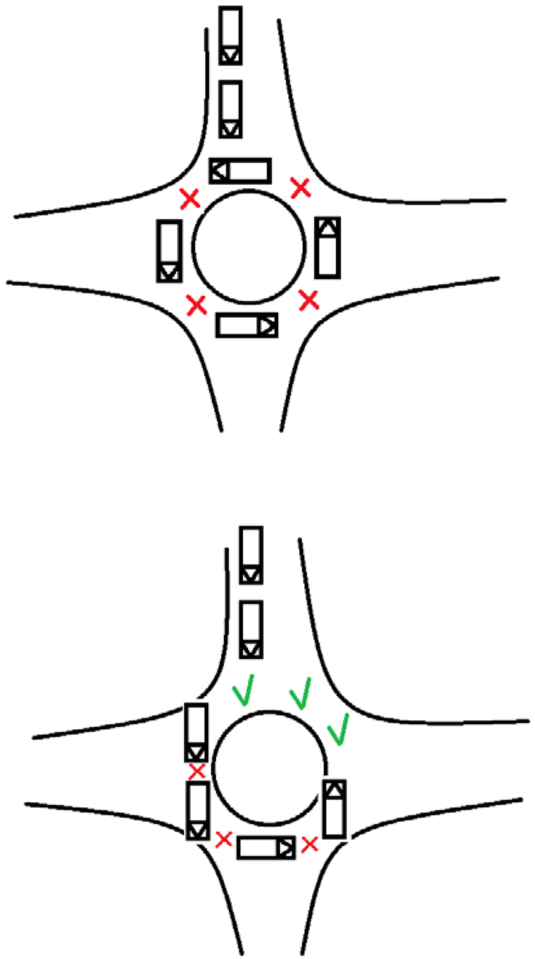


Driver cooperation at roundabouts

Affecting gaps offered to yielding drivers



Adapted from figure 8.14
Revised Monograph on traffic flow theory
Chapter 8: Troutbeck and Brilon (2001)



Results - Roundabout

	A	B
Critical headway [sec]	3,75	3,67
Critical gap [sec]	2,95	2,87
Follow-up headway [sec]	2,19	2,02

Delay per lap	**Experiment 1 A**	**Experiment 2 A**	**B < A?**
Average [sec]	72	49	Yes
Confidence interval	67-77	45-53	

Experiment	Circulating flow [veh/h]	Capacity for entering flow [veh/h]	Total
A	726	597	1323
B	840	668	1508
A/B	1,16	1,12	1,14