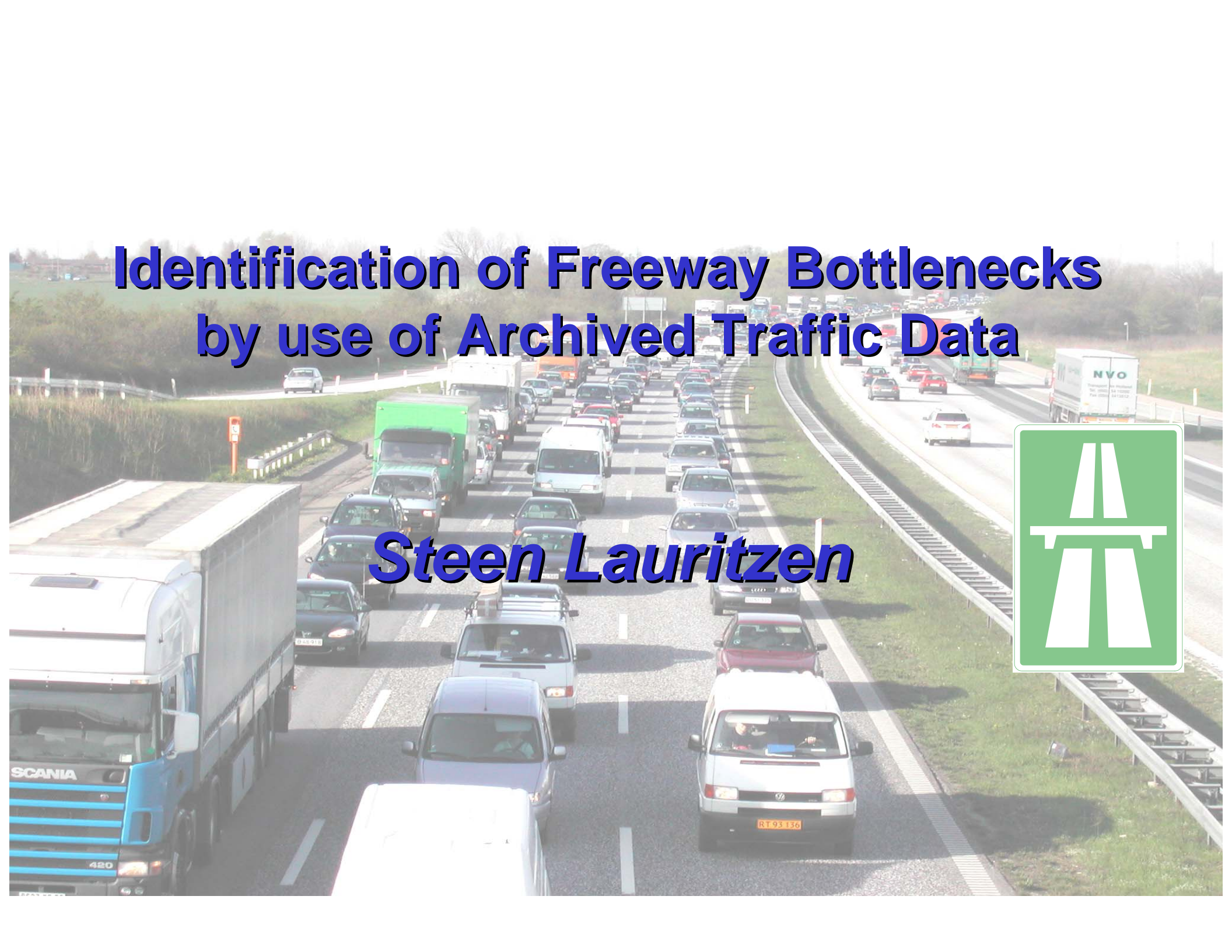


Identification of Freeway Bottlenecks by use of Archived Traffic Data

Steen Lauritzen



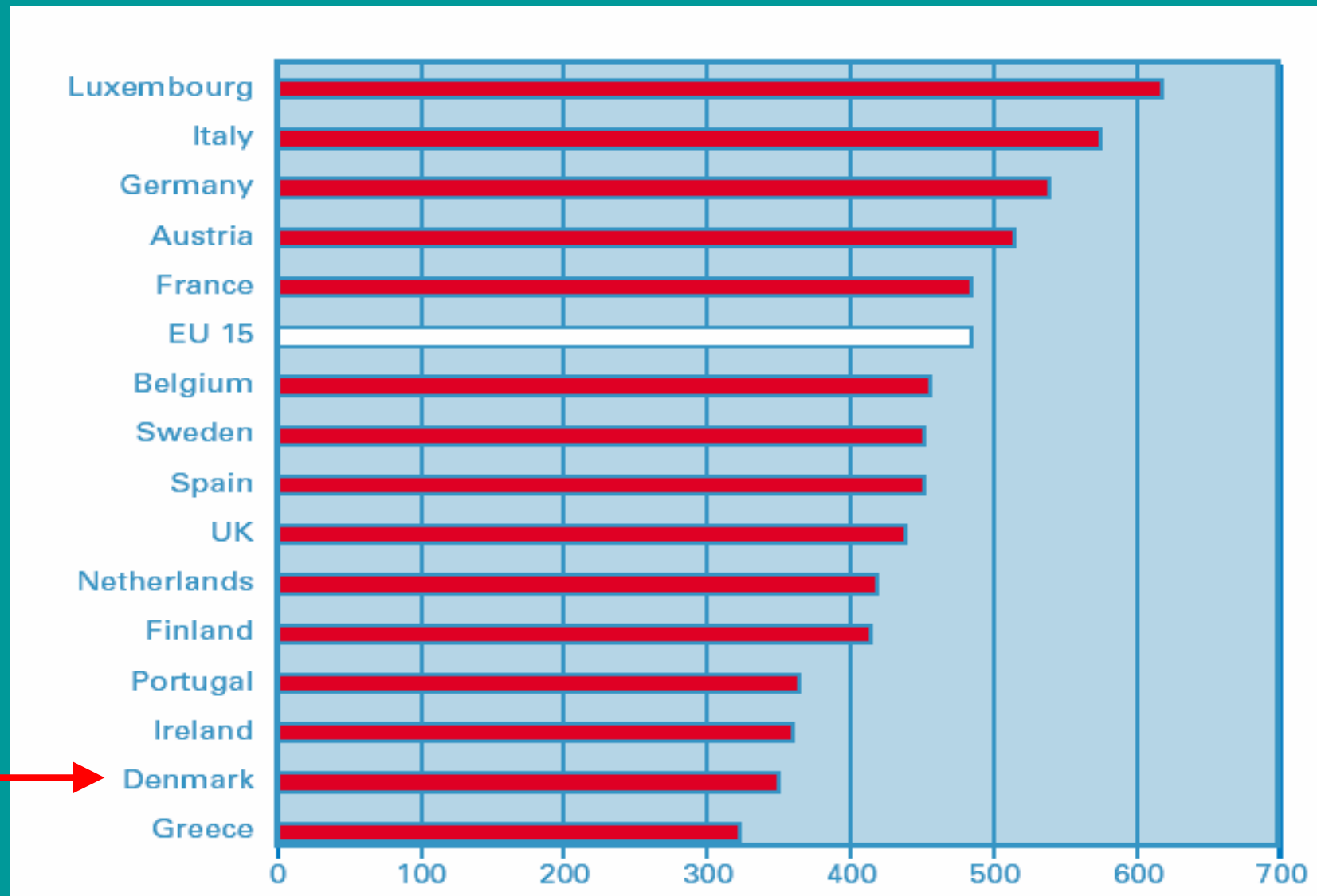
Outline of presentation

- Introduction
- TRIM-system (real-time traffic information)
- Data processing
- Travel time and delay calculations
- Internet applications

Introduction

- Population in the Copenhagen region: 1,7 mill.
- Increased freeway congestion level in recent 10 to 15 years
- Need for on-line traffic information
- TRIM-system established in 1997
- Archived data from 1998
- Analysis system established in 2000

Car ownership in Europe



TRIM-system overview I

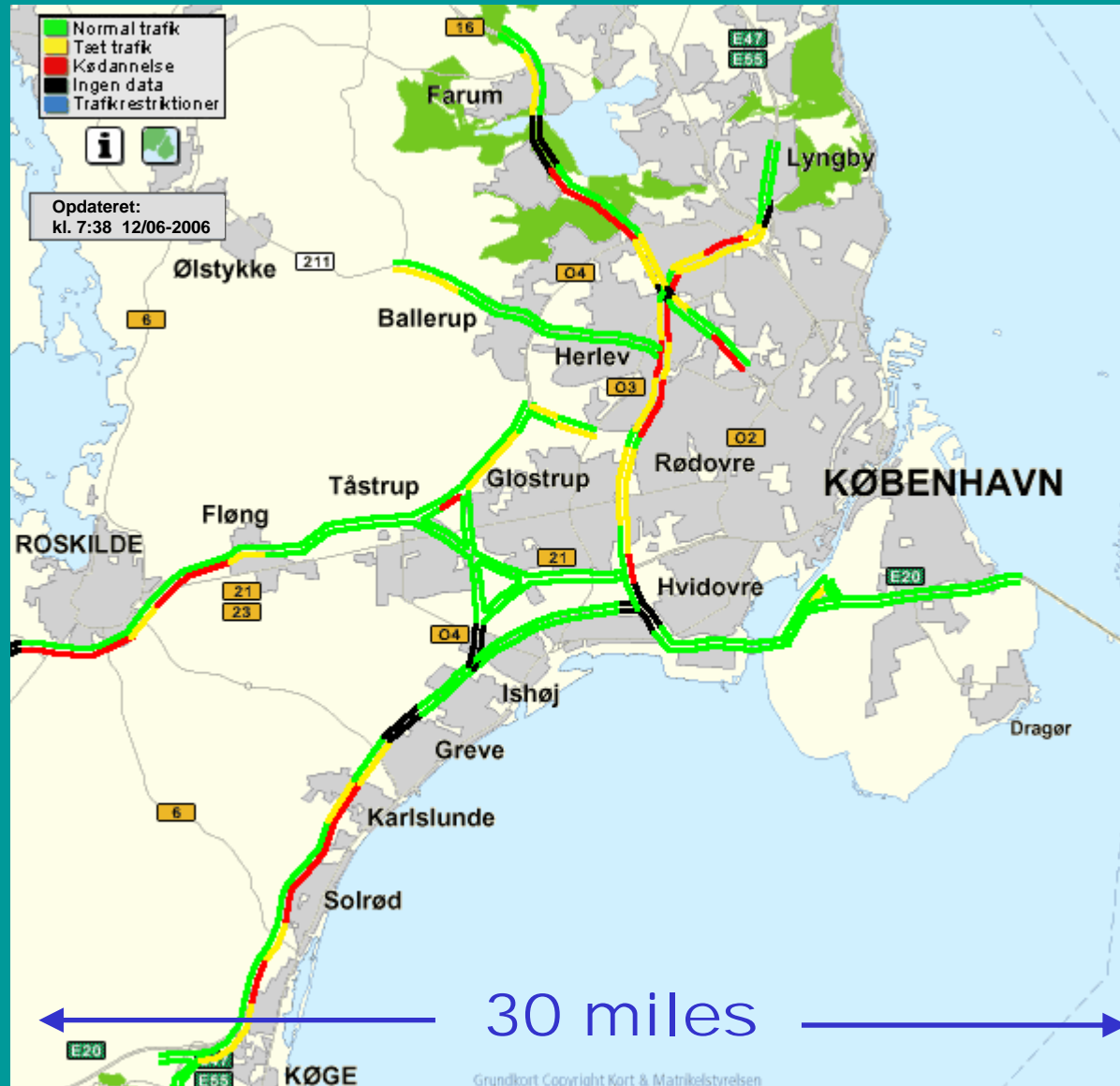
- 580 double inductive loops
- 91 detector stations
- Covering approx. 125 kms (80 miles) of freeway
 - all on/off-ramps equipped
 - Average spacing less than 1 mile
- Communication is based on radio and telephone lines
- Many loops replaced with radar detectors due to road work



TRIM System overview II

- Data collection every minute
- Detailed data for each vehicle
(time, speed, length, covertime, gap)
- Speed for each segment updated every minute
- Presentation on the Internet
- Replay function (TRIM-player)

Internet presentation



www.vd.dk/trim

TRIM player – Internet application

TRIM afspiller

Vælg tidsrum

Dato: 06/06/2006

Starttid: 06:30

Sluttid: 09:30

Afspilnings hastighed: 3

Billedinterval: 1

Start ▶ Pause || Stop ■

Genvejsknapper

- Seneste time
- Seneste morgenmyldretid
- Seneste eftermiddagsmyldretid

7:26

Normal trafik
Tæt trafik
Kødannelse
Ingen data
Trafikrestriktioner

Grundkort Copyright Kort & Matrikelstyrelsen

www.vd.dk/trim/afspiller

ASTRID – offline analysis system

- Delay Monitoring System
- Based on historical data
- MS-ACCESS database
- For each segment and 5-minute interval:
 - Volume
 - Time mean speed
 - Harmonic mean speed

MS-ACCESS database

SegmentID	Local time	Vehicles	Speed1	Speed2
84101	17-05-2005 07:00	325	96,75	94,47
84101	17-05-2005 07:05	329	99,68	98,11
84101	17-05-2005 07:10	353	97,85	92,09
84101	17-05-2005 07:15	348	94,34	89,90
84101	17-05-2005 07:20	329	90,90	89,85
84101	17-05-2005 07:25	310	81,08	79,61
84101	17-05-2005 07:30	330	58,74	55,69
84101	17-05-2005 07:35	320	40,93	38,93
84101	17-05-2005 07:40	299	41,74	39,09

Vehicles: 5-minute volume

Speed1: Time mean speed (km/h)

Speed2: Space mean speed (km/h)

Conversion to segment speeds

- Time mean speed (average speed)
- Space mean speed, V_{seg}

$$\frac{1}{V_{seg}} = \frac{1}{n} \times \left[\frac{1}{V_1} + \frac{1}{V_2} + \frac{1}{V_3} + \dots + \frac{1}{V_n} \right]$$

V_i is the speed of the i th vehicle in a 5-minute interval

Travel time and delay

- Travel time on a segment: $T = L / V_{\text{seg}}$

L = Length of segment

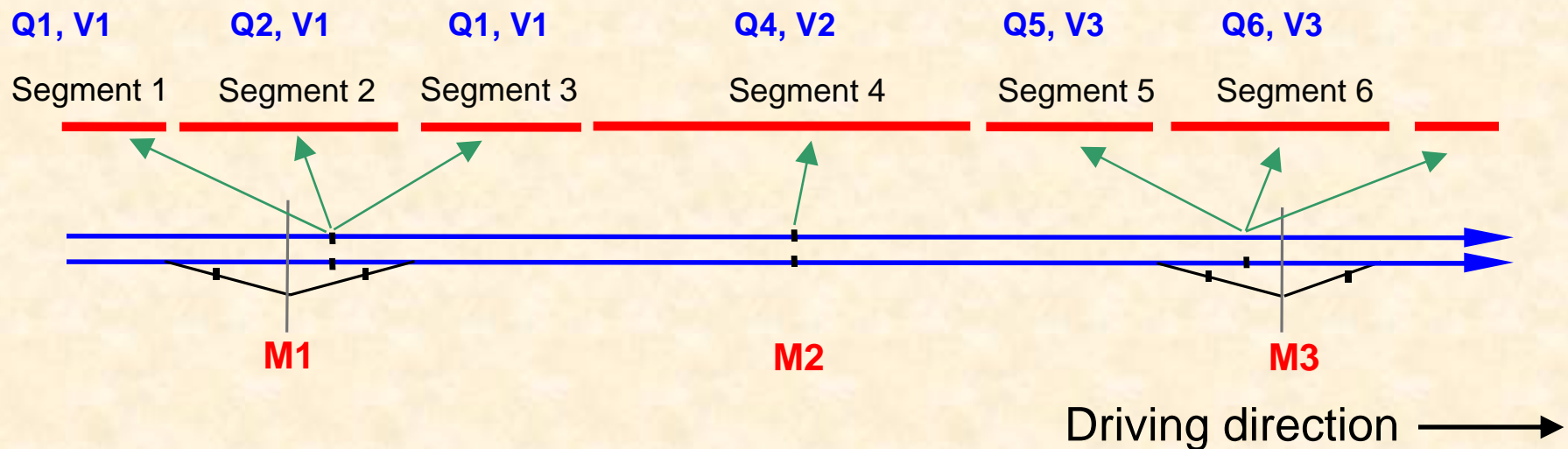
V_{seg} = Segment harmonic mean speed

- Delay on a segment: $D = T - T_{\text{free}}$

T_{free} = Free flow speed

Segment speeds





Q = vehicles per interval
 V = speed

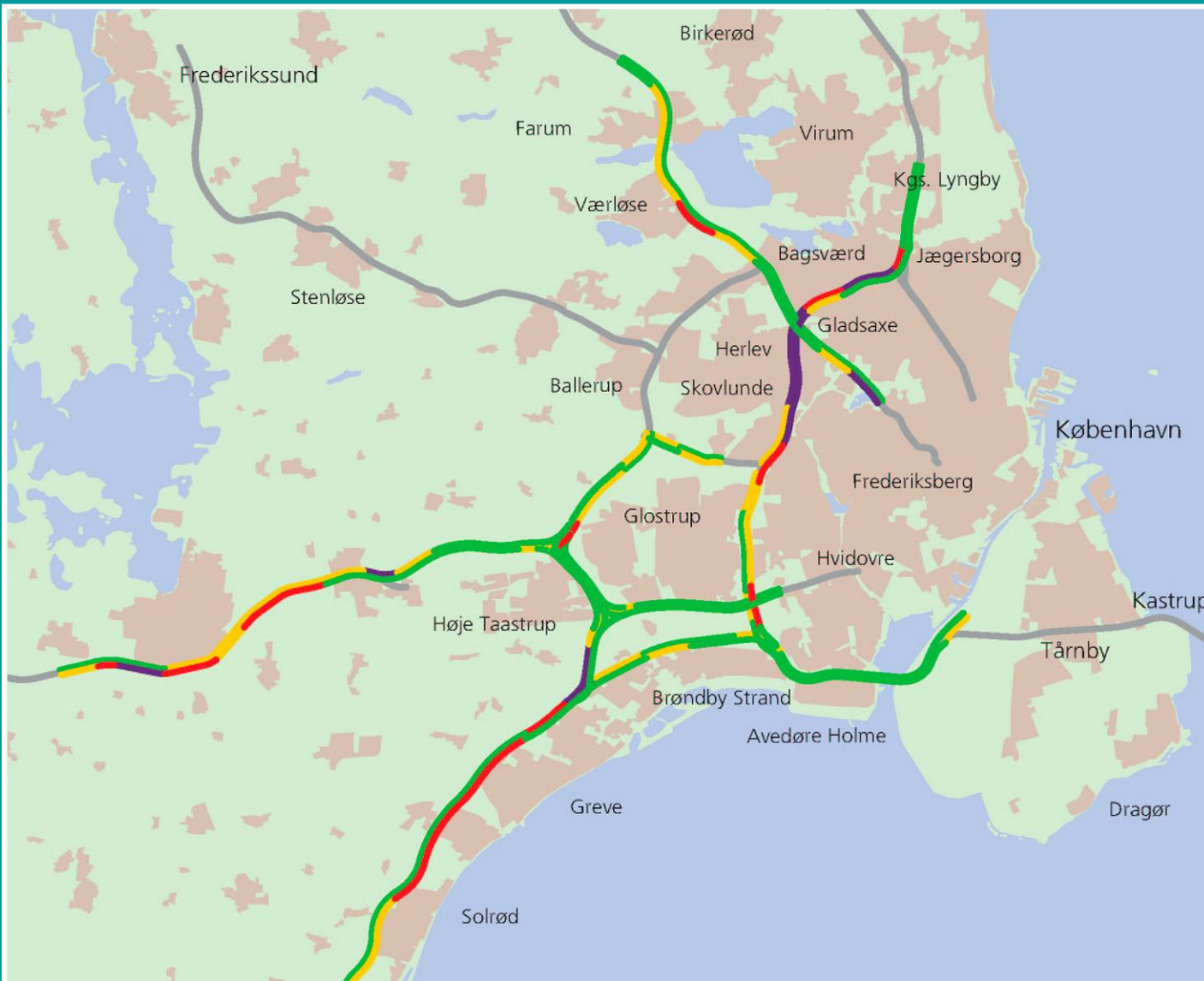


Speeds and volumes are allocated to segments without speed measurements

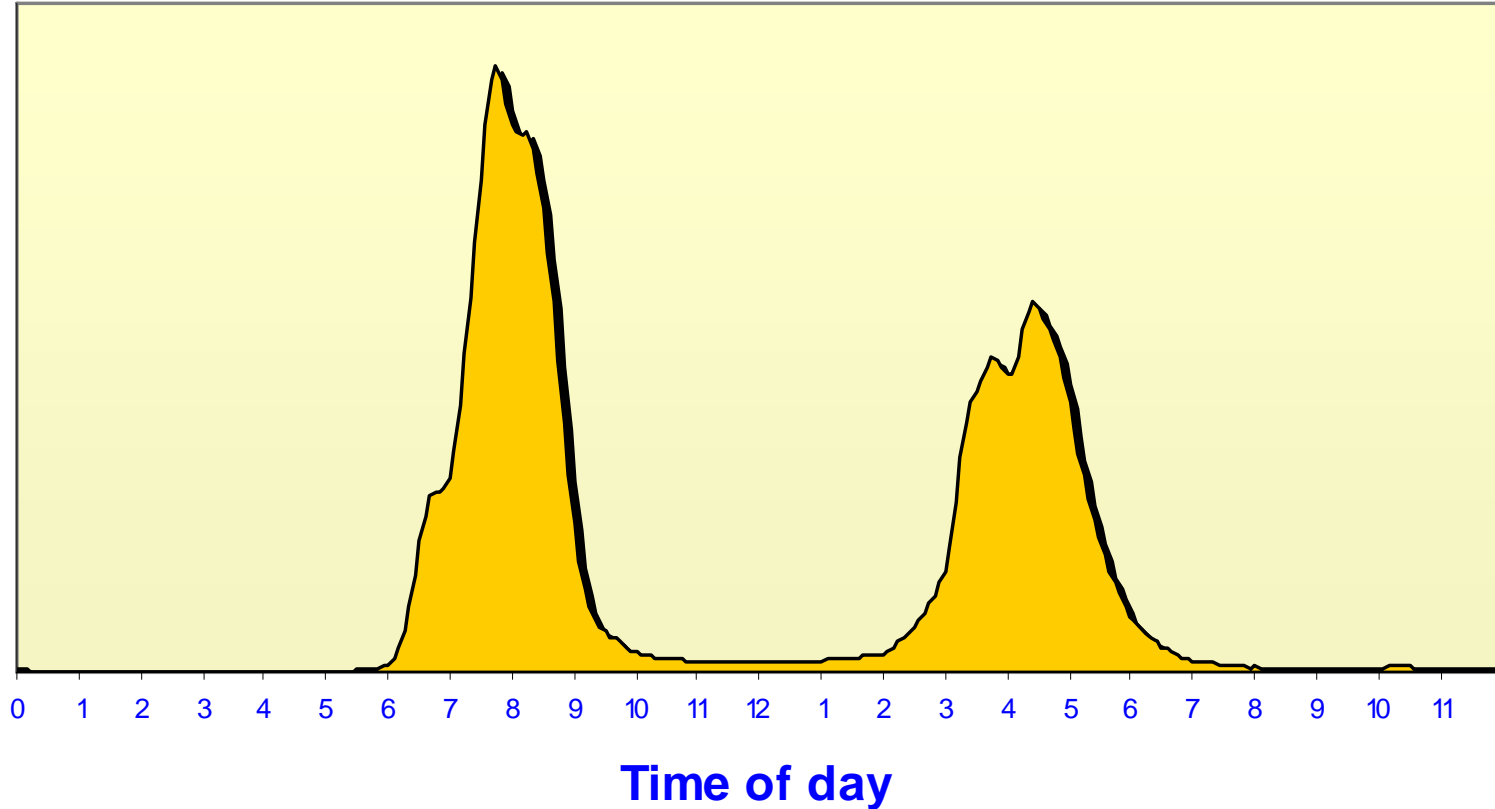
Freeway "Level of Service", 2003

**Minutes per day with
speed < 40 km/h (25 MPH)**

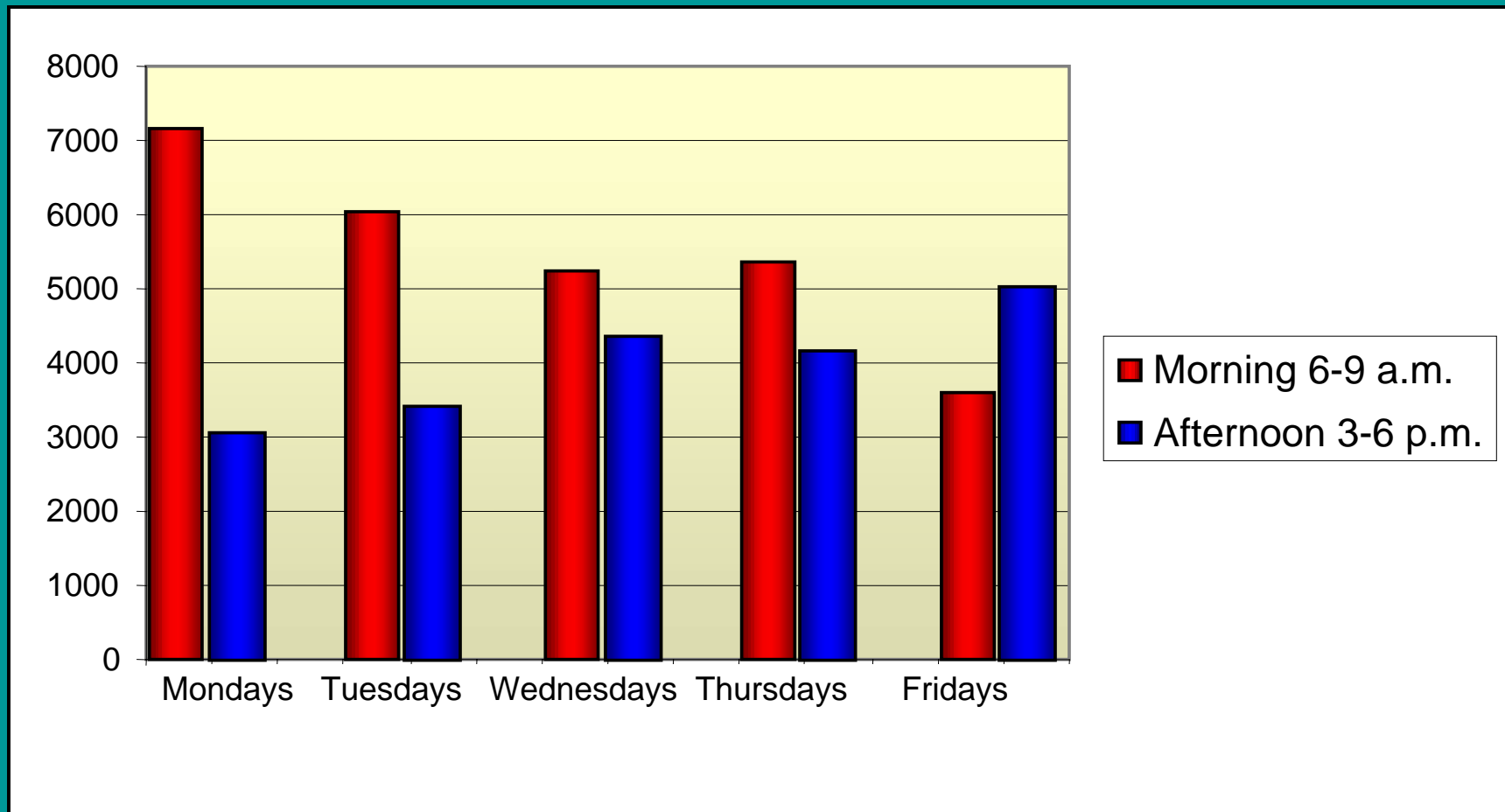
-  > 60 min.
-  30-60 min.
-  5-30 min.
-  0-5 min.



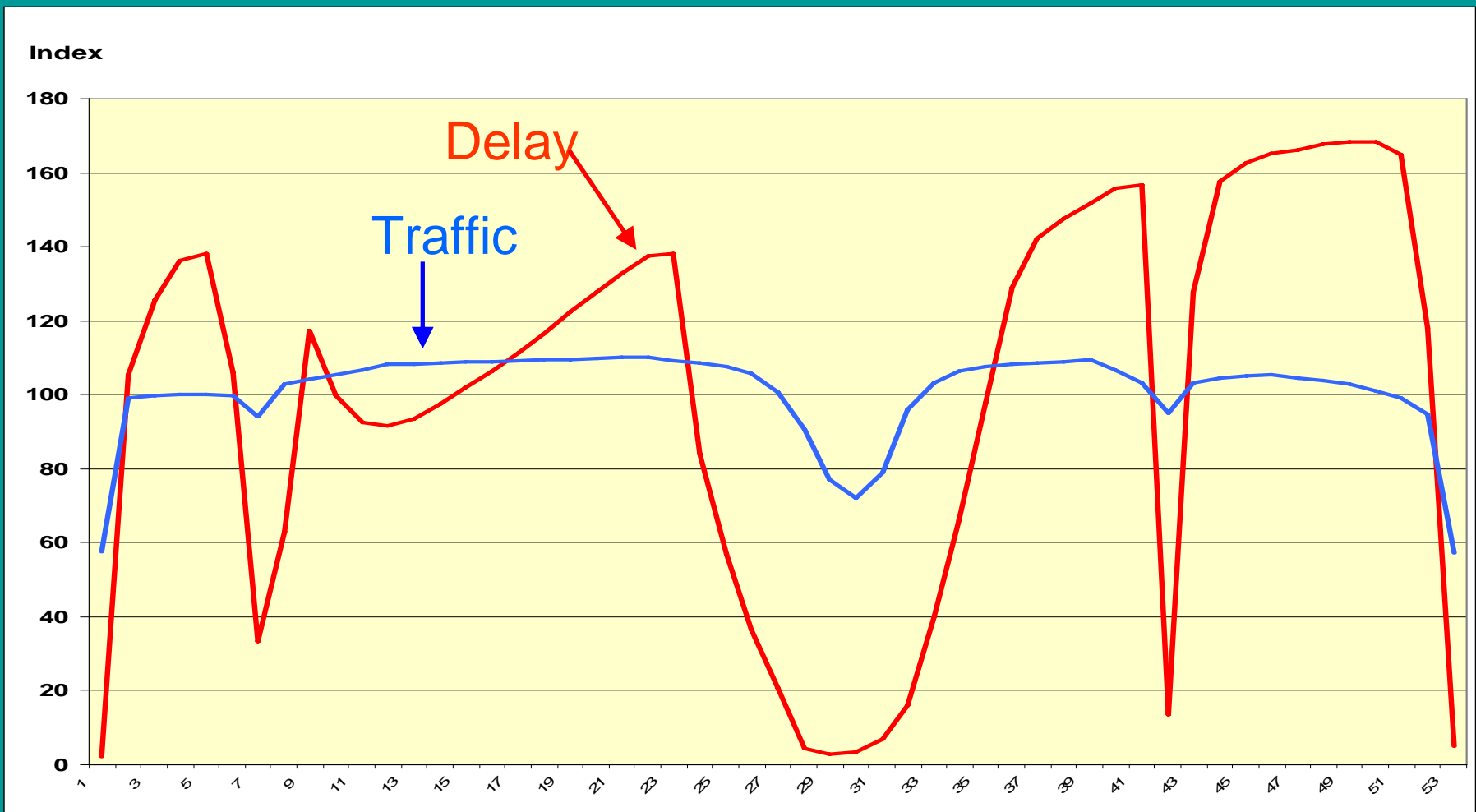
Dayly variation of total delay (2004)



Weekly variation of total delay (hours)



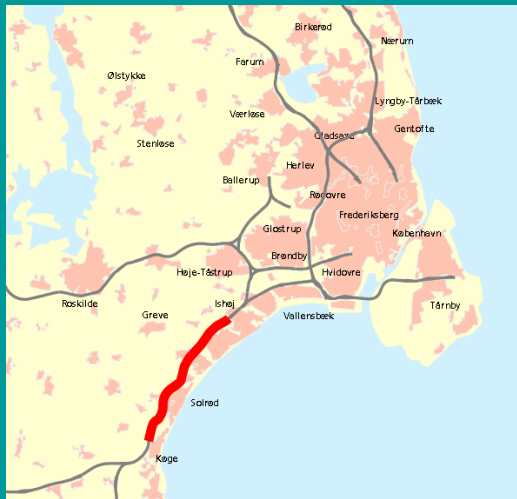
Relationship between traffic volume and total delay through a year



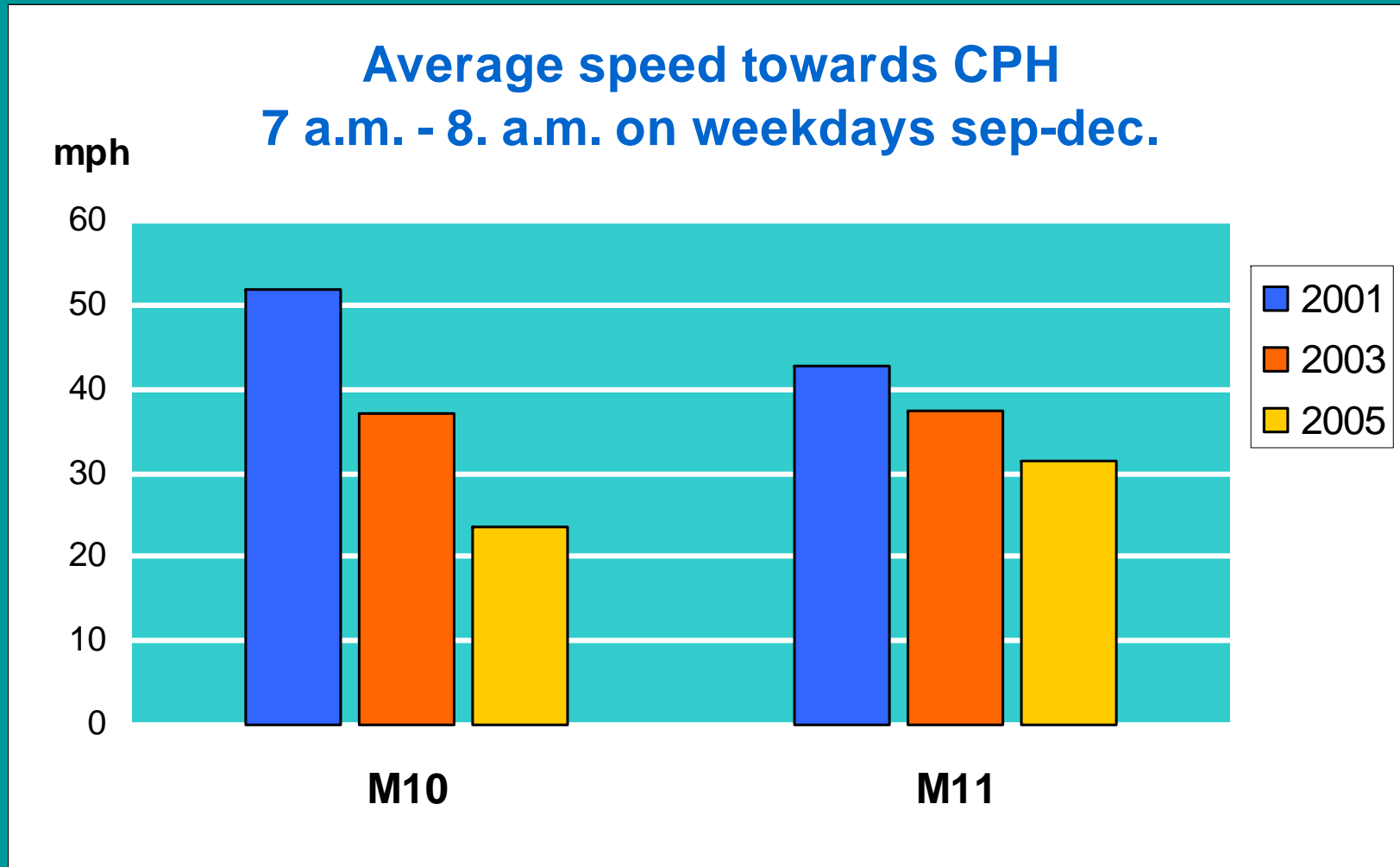
Delay per vehicle day by day (2004)

Minutes
per vehicle

M10 Northbound 7 a.m. - 8 a.m.



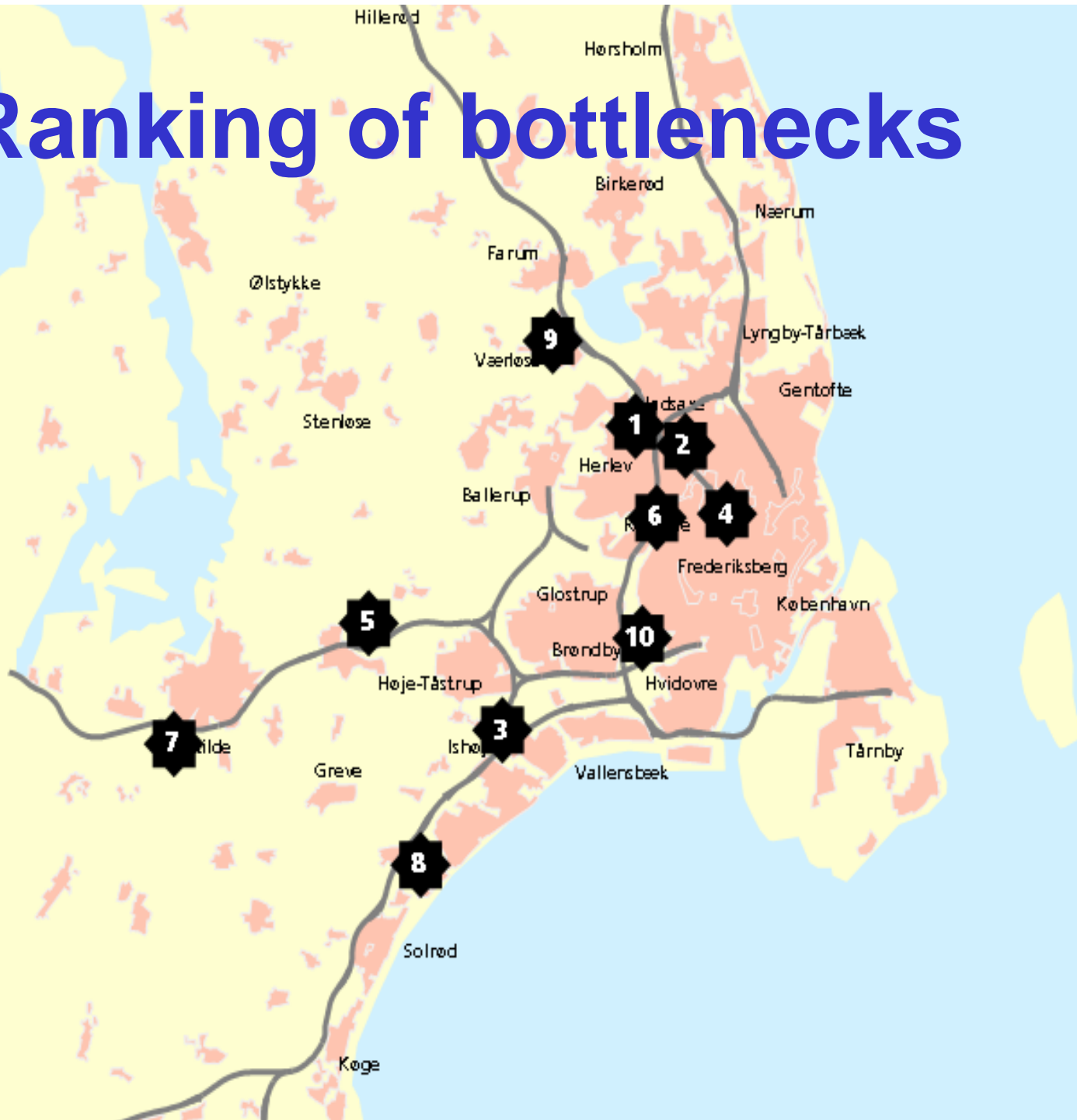
Development on two freeways



Queues during a.m. peak

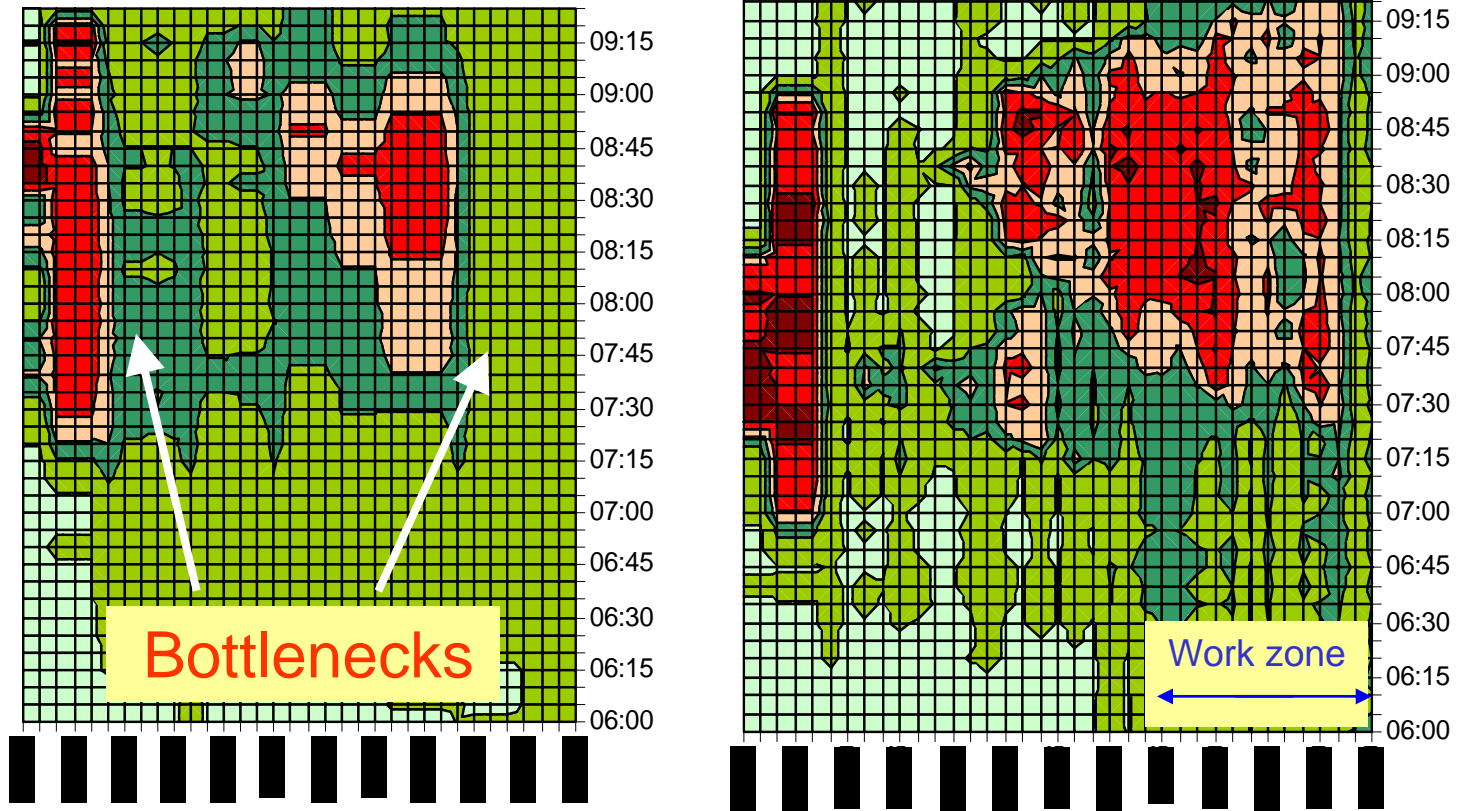


Ranking of bottlenecks









Bottleneck identification, M3 NB

Driving direction 



Speed Intervals km/h:

-  100 - 120
-  80 - 100
-  60 - 80
-  40 - 60
-  20 - 40
-  0 - 20

May/June 2004
Before road work

May 27, 2005
During road work, phase 1

Questions ?

