Vehicle Scheduling: Models and Algorithms

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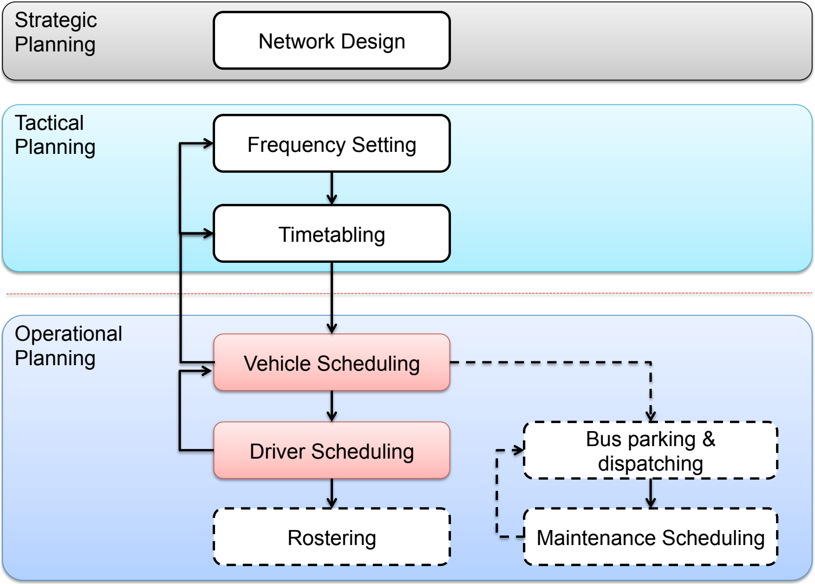
Overview of Planning Activities (Desaulniers&Hickman2007)



Strategic Planning: Network Design (Urban)

Strategic Planning: Network Design (Regional)

Tactical Planning: Frequency Setting and Timetabling

41 **42**

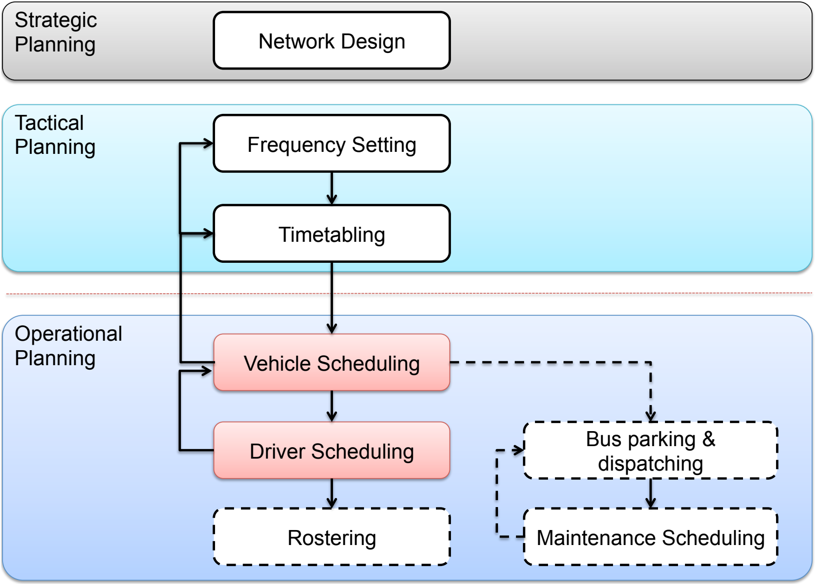
Odense Banegård - Syddansk Universitet (SDU)

Hverdag

OBS:
Ikke gyldig mellem 13. maj - 23. august.
Se sommerkøreplanen på side 70-71.

Rutenr.	OBC Plads B	Hans Mules Gade	Nyborgvej / Frederiksgade	Palnatokesvej	Nansensgade	Ejbygade	L. A. Rings Vej	Rosengårdc. / Gul indg.	Bilka	Rosengårdc. / Ørbækvej	Niels Bohrs Allé	Campusvej	SDU
42	**05.25**	05.26	05.28	05.29	05.30	05.31	05.33			05.34	05.36	05.37	**05.40**
41	**06.23**	06.24	06.26	06.27	06.28	06.29	06.31	06.33	06.35			06.37	**06.40**
41	**07.20**	07.21	07.23	07.24	07.25	07.26	07.29	07.31	07.34			07.36	**07.40**
42	**07.28**	07.30	07.32	07.33	07.34	07.35	07.39			07.41	07.44	07.46	**07.50**
42	**07.36**	07.38	07.40	07.41	07.42	07.44	07.46			07.48	07.51	07.53	**07.56**
42	**07.44**	07.46	07.48	07.49	07.50	07.51	07.55			07.57	08.00	08.02	**08.06**
42	**07.52**	07.54	07.56	07.56	07.57	07.58	08.01			08.03	08.06	08.07	**08.12**
151P	**08.00**	08.02	08.04	08.04	08.05	08.06	08.09			08.11	08.14	08.15	**08.20**
41	**08.10**	08.12	08.14	08.15	08.16	08.18	08.21	08.23	08.27			08.29	**08.33**
41	**08.25**	08.27	08.29	08.30	08.31	08.32	08.35	08.37	08.41			08.43	**08.47**
41	**08.35**	08.37	08.39	08.40	08.41	08.42	08.45	08.47	08.51			08.53	**08.57**
41	**08.45**	08.47	08.49	08.50	08.51	08.52	08.55	08.57	09.01			09.03	**09.07**
41	**08.55**	08.57	08.59	09.00	09.01	09.02	09.05	09.07	09.11			09.13	**09.17**
41	**09.05**	09.07	09.09	09.10	09.11	09.12	09.15	09.17	09.21			09.23	**09.27**
41	**09.15**	09.17	09.19	09.20	09.21	09.22	09.25	09.27	09.31			09.33	**09.37**

Overview of Planning Activities (Desaulniers&Hickman2007)



Leuthardt Survey

(Leuthardt 1998, Kostenstrukturen von Stadt-, Überland- und Reisebussen, DER NAHVERKEHR 6/98, pp. 19-23.)

bus costs (DM)	*urban*	*%*	*regional*	*%*
crew	349,600	73.5	195,000	67.5
depreciation	35,400	7.4	30,000	10.4
calc. interest	15,300	3.2	12,900	4.5
materials	14,000	2.9	10,000	3.5
fuel	22,200	4.7	18,000	6.2
repairs	5,000	1.0	5,000	1.7
other	34,000	7.1	18,000	7.2
total	475,500	100.0	288,900	100.0

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Smart models start small

Posted on SEPTEMBER 9, 2013 *Written by* MARC-ANDRE LEAVE A COMMENT

There is only one good way to build large-size or complex optimization models: to start by a small model and adding elements gradually until you get the model you wanted in the first place. I have seen so many people (including myself) try to build large-size, complex models from scratch, only to spend countless frustrating hours trying to debug all kinds of problems. It just doesn't work.

A better approach is to start with the simplest version of the model. On or two

Vehicle Scheduling

Given a timetable as a set $V = \{v_1, \ldots, v_n\}$ of **trips**, where for each trip v_i we have:

t_i : departure time

a_i : arrival time

o_i : origin (departure terminal)

d_i : destination (arrival terminal)

v_i	t_i	a_i	o_i	d_i
v_1	7:10	7:30	T_a	T_b
v_2	7:20	7:40	T_c	T_d
v_3	7:40	8:05	T_b	T_a
v_4	8:00	8:30	T_d	T_c
v_5	8:35	9:05	T_c	T_d

Given the **deadheading trips** (i.e. trips without passengers) of duration h_{ij} between every pair of terminals

h_{ij}	T_a	T_b	T_c	T_d
T_a	0	15	20	20
T_b	15	0	25	10
T_c	20	25	0	15
T_d	20	10	15	0

Definition (Compatible Trips)

A pair of trips (v_i, v_j) is compatible if and only if $a_i + h_{ij} \leq t_j$

Vehicle Scheduling

Definition (Vehicle Duty)

A subset $C = \{v_{i_1}, \ldots, v_{i_k}\}$ of V is a **vehicle duty (or block)** if $(v_{i_j}, v_{i_{(j+1)}})$ is a compatible pair of trips, for $j = 1, \ldots, k-1$

Definition (Vehicle Schedule)

A collection $C_1, \ldots, C_r$ of *vehicle duties* such that each trip v in V belongs to exactly one C_j with $j \in \{1, \ldots, r\}$ is said to be a **Vehicle Schedule**

Vehicle Scheduling: Example

v_i	t_i	a_i	o_i	d_i
v_1	7:10	7:30	T_a	T_b
v_2	7:20	7:40	T_c	T_d
v_3	7:40	8:05	T_b	T_a
v_4	8:00	8:30	T_d	T_c
v_5	8:35	9:05	T_c	T_d

h_{ij}	T_a	T_b	T_c	T_d
T_a	0	15	20	20
T_b	15	0	25	10
T_c	20	25	0	15
T_d	20	10	15	0

Example: These 5 trips can be scheduled with 2 vehicle duties:

- $C_1 = \{v_1, v_3\}$
- $C_2 = \{v_2, v_4, v_5\}$

Further features of the problem

- Limited number of vehicles
- Minimize fleet size (number of vehicles)
- Minimize operational costs (given by pull-out and pull-in from depots and deadheading trips)
- Multiple depots
- Different types of vehicles with different operational costs located at a single depot