SBB CFF FFS

COST TU1004 TransITS

Transit simulation and available tools:

Passenger Simulation at Swiss Federal Railways

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Outline

1. SBB
2. Passenger modeling
   - 24H dynamic assignment
   - direct demand model
   - some practical aspects
3. Future perspectives and model development

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SBB in the numbers (2014)

- 3200 km network length (standard gauge)
  - most densely used rail network in the world
- 1.2 million passenger trips per day
- Punctuality
  - … more than schedule adherence of trains
  - 88% of passengers arrived with less than 3 minutes delay
- Renewable energy
  - > 90% of all electricity used in rail transport
- 33K employees
  - 14K passenger transport
  - 19K infrastructure, freight, real estate, corporate central units
- 100% ownership: federal government

Passenger demand modelling at SBB

- → Modeling team (corporate development), providing forecasts to :
  - SBB passenger division:
    - strategic planning (regional & long distance),
    - mid-term planning (a.k.a. product management)
  - other SBB units: infrastructure, real estate, finance, corp. comm.
  - federal and cantonal governments
- → "**SIMBA**" - our modeling system
  - in-house development over 15 years
  - demand forecasting: weekday & weekend,
    - Switzerland: direct demand approach
    - international long-distance demand: multi-modal approach
  - capacity-contraint 24-h dynamic assignment
  - production model
    - fleet, line blocking
    - cost-revenue forecast

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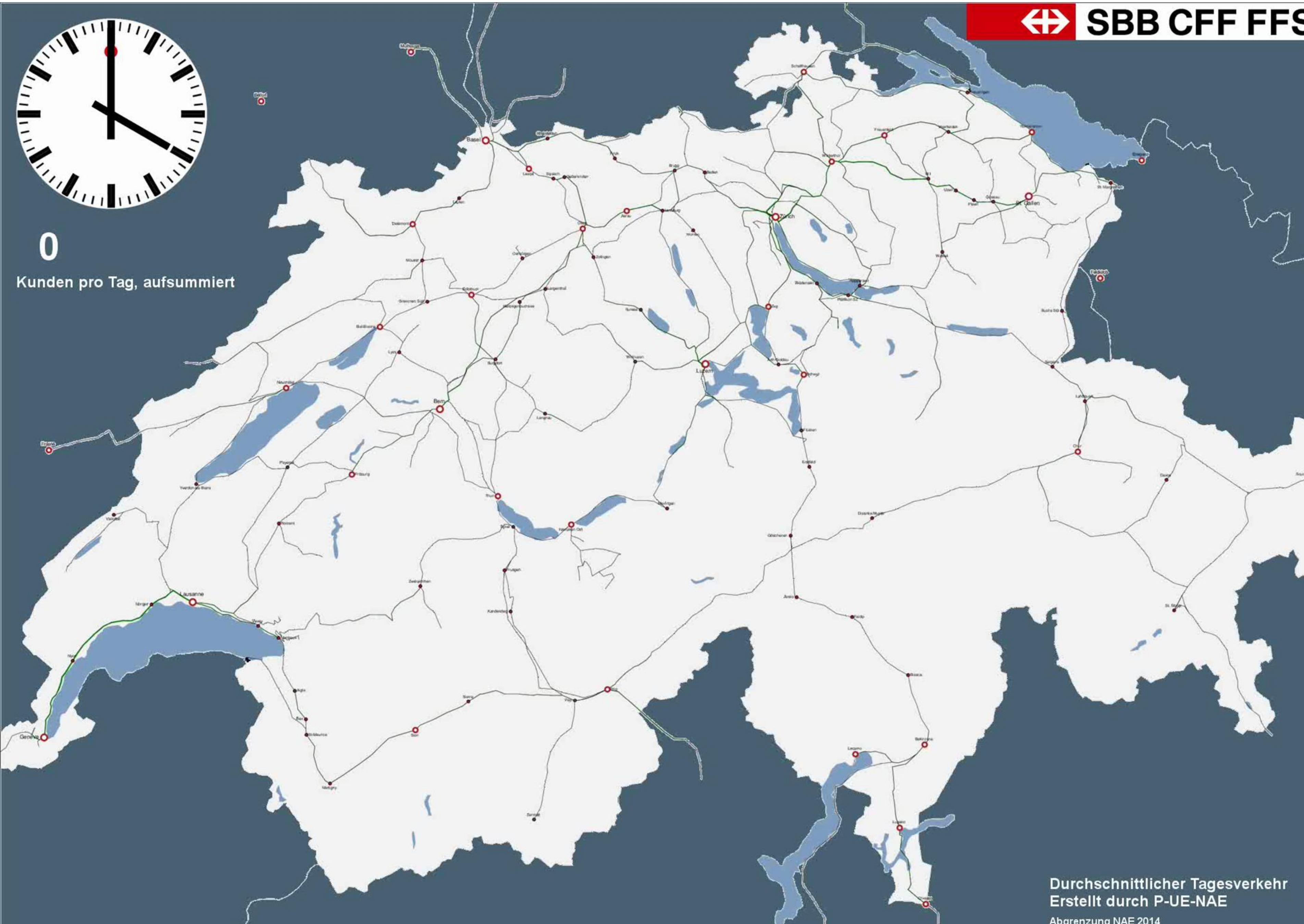
Dynamic capacity-contraint assignment


SBB CFF FFS
0
Kunden pro Tag, aufsummiert
Basel
Zürich
St. Gallen
Bern
Luzern
Lausanne
Geneva
Durchschnittlicher Tagesverkehr
Erstellt durch P-UE-NAE
Abgrenzung NAE 2014

Dynamic assignment model

Tool: Visum by PTV

→ «timetable based assignment»

Development at SBB (Lieberherr et al.)

→ Optimisation of route choice parameters

→ Integration of capacity-constraints

→ Time-of-day distribution of demand

Use cases:

→ Project level planning

- required seat/standee capacity per train segment
- absolute numbers wanted!

→ System level planning

- Long term rolling stock requirements

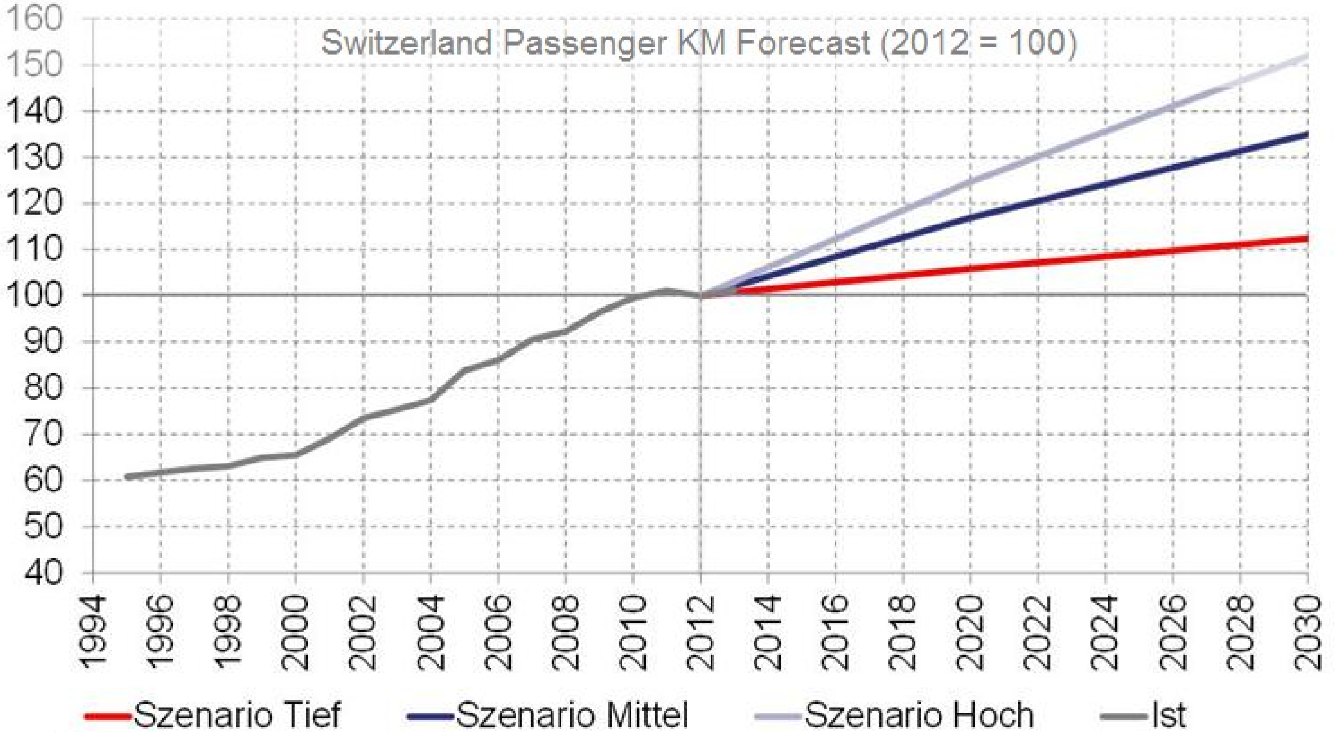
	Dep	05:19	05:34	05:49	06:04	06:19	06:34	06:49	07:04	07:19	07:34	07:49	08:04	08:19	08:34	08:49	09:04	09:19
1 CO	2 TA	3	2	3	4	8	14	23	34	56	68	77	77	61	59	29	30	14
2 TA	3 MI	5	4	5	9	14	23	34	49	74	89	98	96	77	69	37	35	19
3 MI	4 PT	7	5	8	13	21	33	49	67	98	110	119	110	91	76	45	37	23
4 PT	5 VS	20	18	26	42	66	98	142	182	232	240	246	208	176	137	99	80	63
5 VS	6 CR	31	28	42	62	97	142	206	258	327	327	341	281	252	180	147	107	91
6 CR	7 GD	32	29	44	65	102	151	218	274	347	347	358	295	264	189	154	113	95
7 GD	8 TU	37	33	51	78	123	184	262	327	400	397	401	326	290	206	170	125	108
8 TU	9 CH	41	36	55	85	134	201	285	356	428	423	420	339	299	212	176	130	115
9 CH	10 GS	44	38	59	90	144	214	303	378	452	446	442	355	312	222	184	137	120
10 GS	11 GE	50	39	62	92	153	215	301	351	424	395	400	313	292	201	169	119	107
11 GE	12 LA	38	38	53	65	136	173	254	237	313	345	259	221	171	156	100	75	69
12 LA	13 CA	38	35	47	48	111	131	213	175	263	266	215	163	146	123	88	62	64
13 CA	14 CH	32	33	43	40	98	113	182	140	223	222	178	128	120	100	71	48	51
14 CH	15 GE	31	31	43	26	91	90	158	83	183	163	134	76	98	74	54	30	39
15 GE	16 CH	44	28	59	25	125	94	199	65	226	120	157	48	120	53	61	16	43
16 CH	17 AN	45	27	61	20	125	89	197	51	221	107	149	35	117	46	57	12	41
	Arr	06:10	06:25	06:40	06:55	07:10	07:25	07:40	07:55	08:10	08:25	08:40	08:55	09:10	09:25	09:40	09:55	10:10

	Dep	05:20	05:35	05:50	06:05	06:20	06:35	06:50	07:05	07:20	07:35	07:50	08:05	08:20	08:35	08:50	09:05	09:20
1 AN	2 CH	6	6	21	15	58	65	157	78	243	215	426	78	398	167	264	25	126
2 CH	3 GE	10	9	24	18	62	71	160	89	248	221	417	88	385	164	255	30	123
3 GE	4 CH	18	19	24	27	59	78	136	93	207	199	324	85	294	145	190	44	99
4 CH	5 CA	27	25	28	33	68	90	142	113	207	198	287	95	250	131	159	53	89
5 CA	6 LA	38	32	35	44	84	110	165	139	230	218	298	109	253	134	161	63	93
6 LA	7 GE	38	38	38	56	90	130	166	156	221	225	282	123	242	138	154	70	87
7 GE	8 GS	17	16	25	40	59	88	115	138	155	160	171	138	139	99	90	58	55
8 GS	9 CH	17	16	24	40	56	86	104	135	139	151	139	134	109	92	70	56	49
9 CH	10 TU	16	15	23	37	54	82	98	127	127	136	121	116	93	80	61	52	45
10 TU	11 GD	15	15	22	36	51	79	93	121	119	128	113	107	86	74	56	49	42
11 GD	12 CR	14	14	21	36	50	78	87	114	105	109	88	81	62	54	42	39	33
12 CR	13 VS	13	14	20	34	46	74	82	107	98	103	83	75	57	52	40	38	32
13 VS	14 PT	10	14	13	33	32	66	57	86	64	71	48	50	34	36	25	29	22
14 PT	15 MI	7	18	11	36	23	59	34	65	33	49	23	33	16	23	12	18	10
15 MI	16 TA	5	20	9	37	19	58	28	63	26	45	18	29	12	21	9	15	7
16 TA	17 CO	4	25	9	47	20	68	28	71	24	51	15	33	10	24	8	19	6
	Arr	06:11	06:26	06:41	06:56	07:11	07:26	07:41	07:56	08:11	08:26	08:41	08:56	09:11	09:26	09:41	09:56	10:11

Demand forecasting – direct demand model

Demand forecasting

- CH: 20 years of continuous growth of passenger demand
- Forecasting practice:
  - Long-term scenarios: updated every 3 years
  - Project level forecasts (rail service studies): all the time



Direct demand model (a.k.a. elasticity model)

- Theoretical form: $T = \prod (X_i)^{\varepsilon_i}$
- In practice, incremental form: $T(s) = T(0) \cdot \prod_i \left(\frac{X_i(s)}{X_i(0)}\right)^{\varepsilon_i}$
- Linearised form (for regression modeling): $\mathrm{LN}\left(\frac{T(s)}{T(0)}\right) = \sum \left[\varepsilon_i \cdot \mathrm{LN}\left(\frac{X_i(s)}{X_i(0)}\right)\right] + const$
- *where:*
  - *s* = future state / service variation
  - *0* = existing state / base year
  - *T* = passenger trips (per OD-pair and demand segment)
    T(0) = empirical trip table if *0* = existing state
  - X = explaining variables
    - endogenous (rail LOS, rail price), exogenous (GDP, Pop, Auto-LOS)
  - ε = elasticity parameters (constant or variable)

Rail demand forecasting – practical aspects

Trip table development - existing demand

→ Update every year

→ 1/2 man year effort for the modelling team

→ Calibration of the OD table = independent of model route choice

→ Integration of multiple data sources

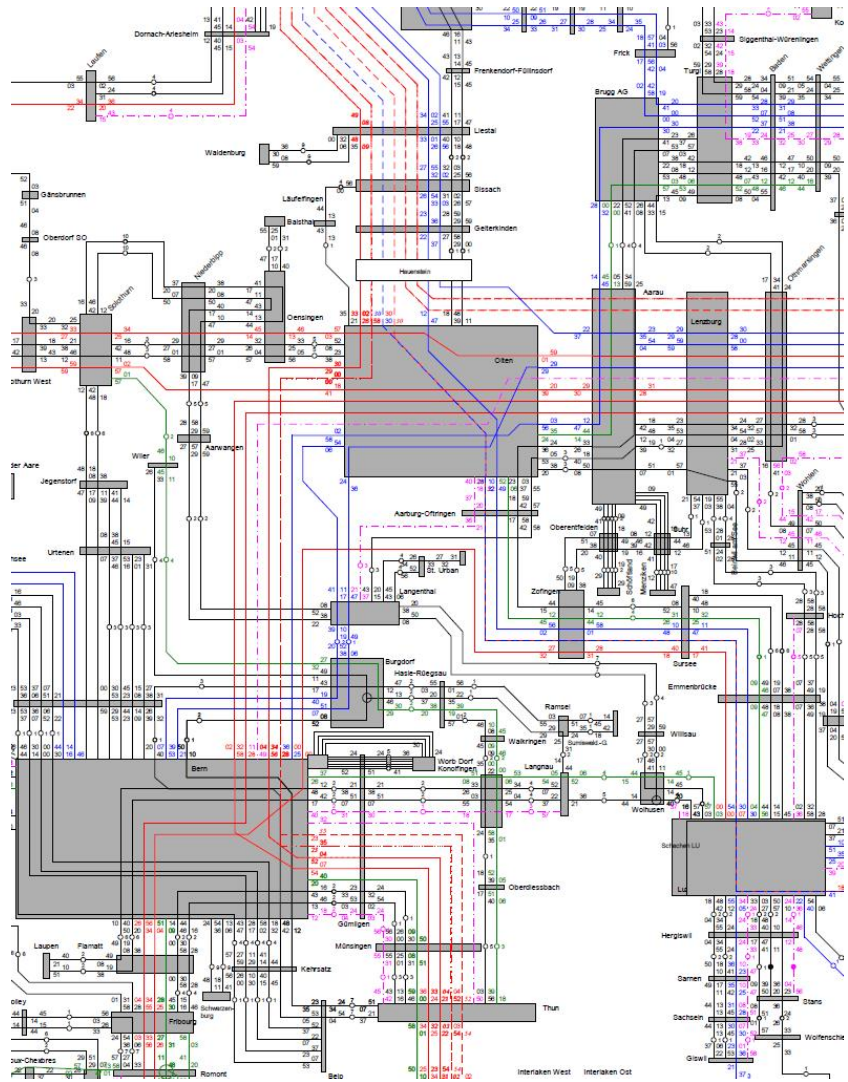
- OD survey records (7 million per year)
- Expansion with passenger counts
  - count coverage: 100% of network segments, 100% time of day
  - regional network: 30% of the fleet equipped with APC
  - long distance network: manual counts
- Trip diary survey

→ Result: trip tables from-station to-station

- segmentation: ticket type, trip purpose, $1^{st}/2^{nd}$ class
- Distribution of departure time: weekday/weekend, 24H

Future timetables

- ➔ Requirement: the same level of optimisation and precision must be applied in the base year and in future scenarios
- ➔ SBB service planning culture:
  - – schedule = highly regular
  - – Schematic graphical timetable
- ➔ SBB practice:
  - ▪ Strategic planners: deliver electronic TT to modellers
  - ▪ Modellers: adjust and complete the TT and perform QA/QC



Calibration & validation, using ex-post analysis

→ «could the model predict today's situation?»

→ input: complete model data sets for two years

- consistent methodology for empirical trip table, load counts
- consistent sources for all explaining variables

→ study: estimation of elasticity par. and explanation of 2004-2012 growth

- 20'000 OD pairs with sufficient sample size for par. estimation
- 200'000 OD pairs for aggregated validation

Future perspectives and model development

SBB model development

Anticipate what questions we will be asked in the future …

Recently finished development – being integrated in the work flow:
- → LOS computation consistent with dynamic assignment model
- → Variable (i.e. non-constant) elasticity parameters

Ongoing model development:
- → Border-crossing regional travel demand: filling the data gap
- → Long-term forecast: non-measurable exogenous factors (e.g. «what will be the effect of the self-driving car»)
- → Multi-modal, behavioural demand model for CH
- → Use of “big data” from telecommunications
- → Model use for operations planning

Thank you!

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References

- Lieberherr, J., Pritscher, E., (2012): Capacity-restraint railway transport assignment at SBB-Passenger. Conference paper, STRC 2012, Ascona.
- Kaeslin, L., Lieberherr, J., Scherr, W. (2014): Demand Data for Dynamic Passenger Assignment within the Swiss National Rail Model. Conference paper, STRC 2014, Ascona.
- ATOC (Association of Train Operating Companies) (2013): Passenger Demand Forecasting Handbook PDFH. London.
- Bützberger, Patrick (2013): Analyse der erklärenden Faktoren für das Wachstum der Bahnnachfrage im Personenverkehr – Verfahren der multiplen Regression zur Verfeinerung der Prognosemethodik im SBB-Modell Simba. Masterarbeit, Universität Bern.