Managing the AUDI Corrosion Center with PostgreSQL

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automatisieren – visualisieren

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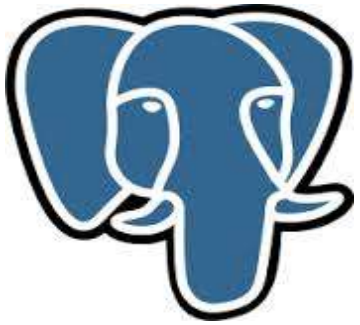
In Collaboration with Johnson Controls
Mannheim / Germany

Plea



Using

PostgreSQL

In Technical Software

For Industrial Automation

Agenda

- Definition of Job / Boundary Conditions
- Showing my way to develop
  - A Database centered
  - Technical application
  - For industrial Automation
  - With PostgreSQL
  - In the center
- Standard-IT ↔ Technical Software
  - *IT meets Physics*

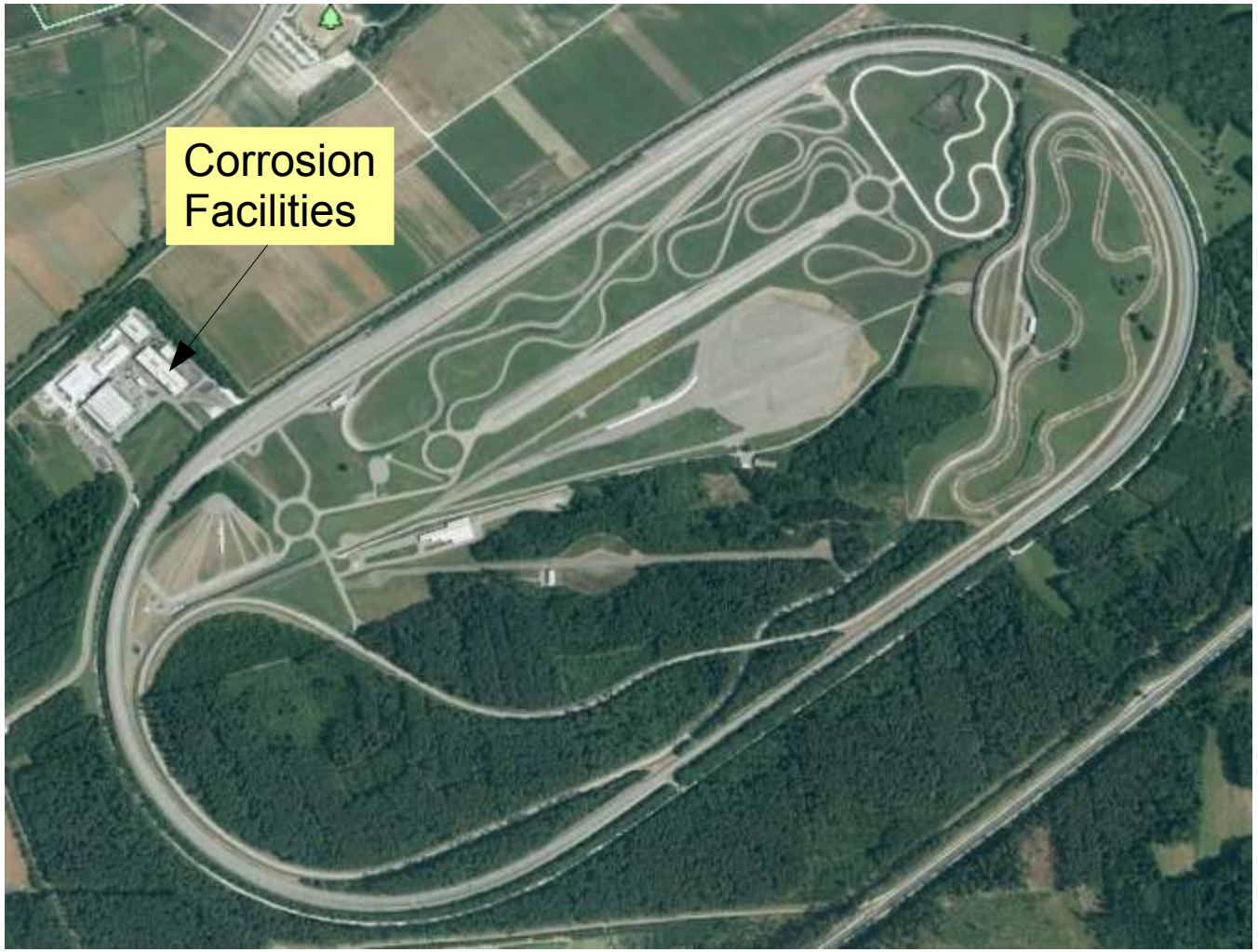

Why? → Corrosion Prevention!

AUDI → INKA Test Specification

Ingolstadt **C**orrosion and **A**geing Test

Youtube Video about INKA-test: 19 weeks of test = 12 years in cars life

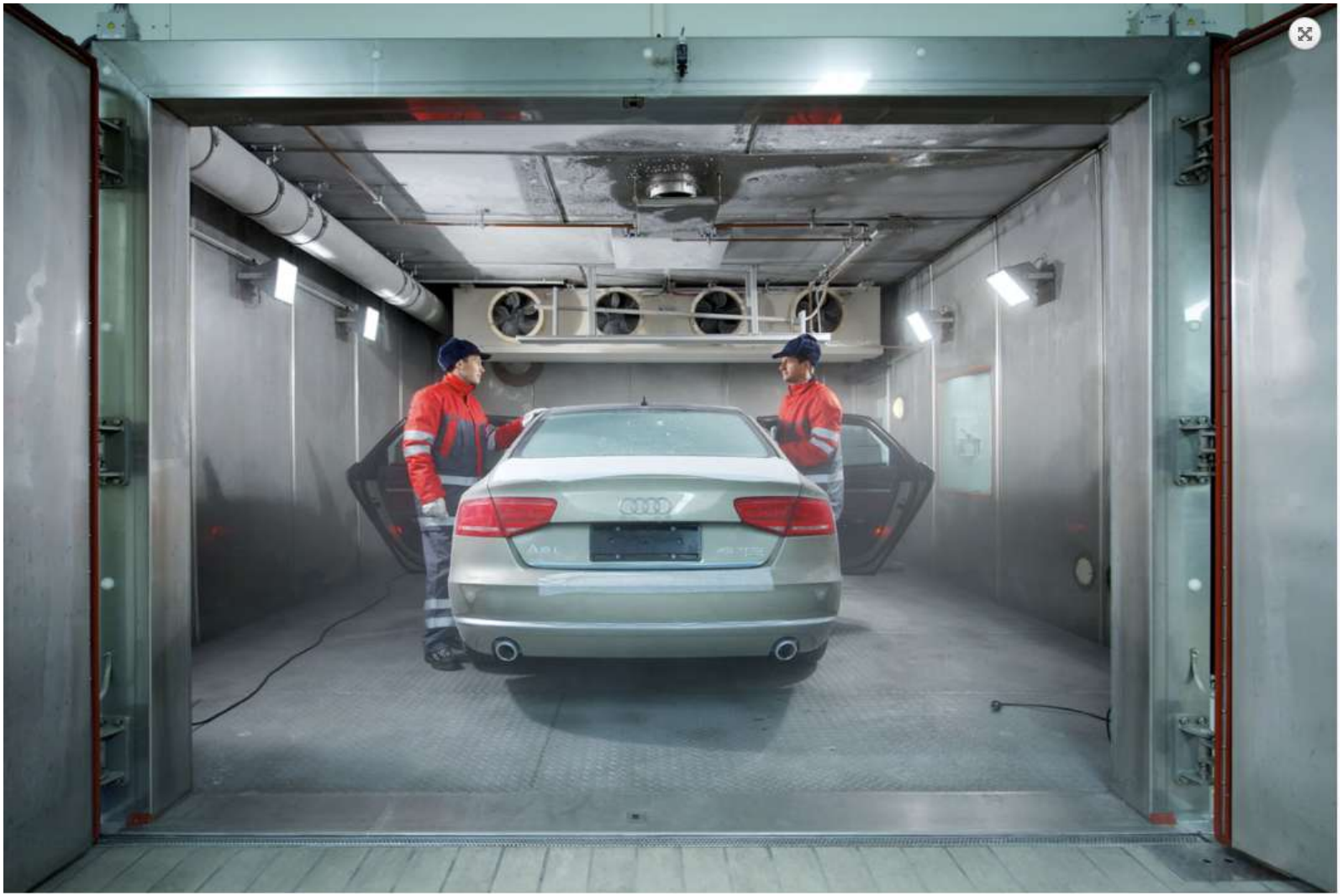
AUDI Test Center from Google Earth



Inside the Corrosion Center

Sun (Vis + UV)

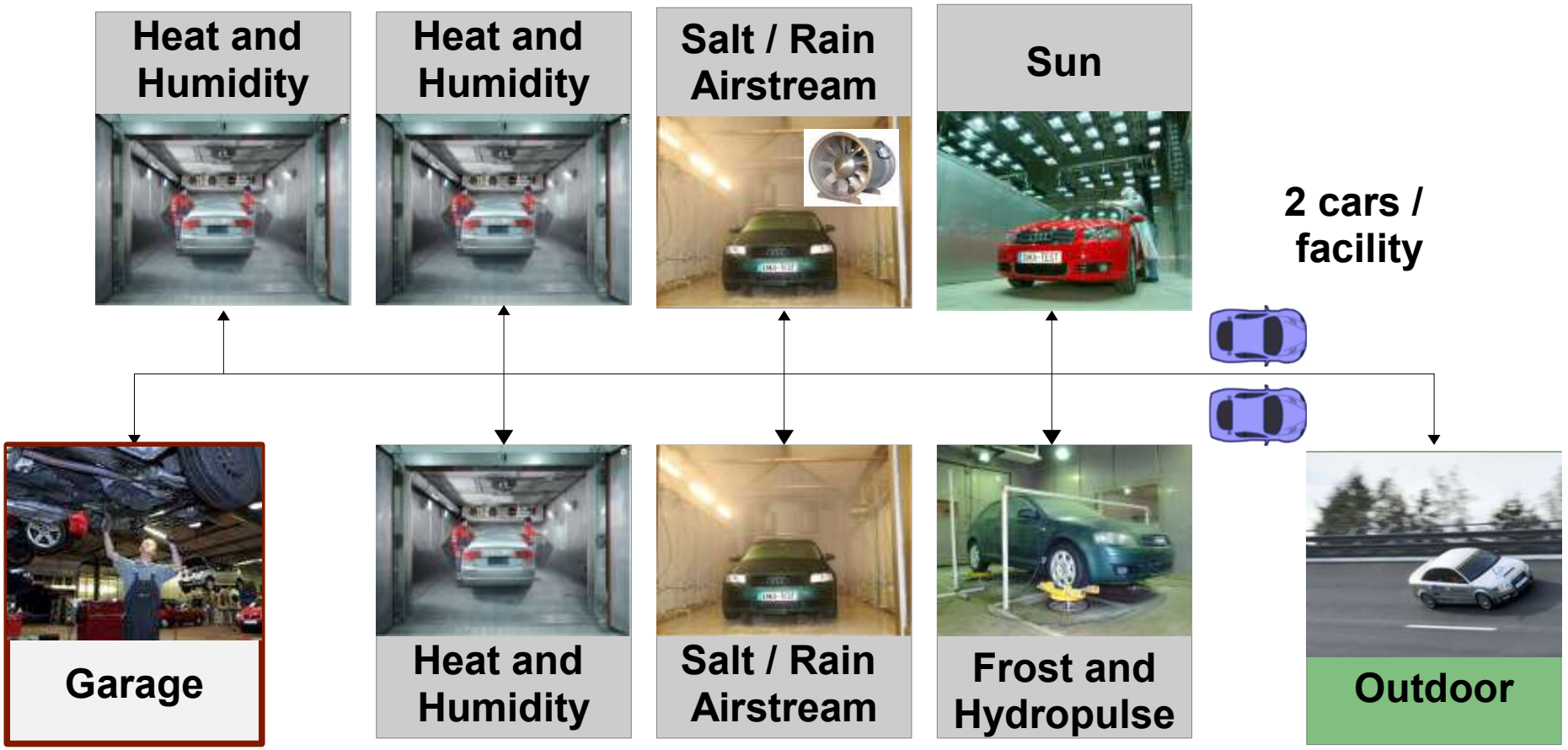
Heat and Humidity



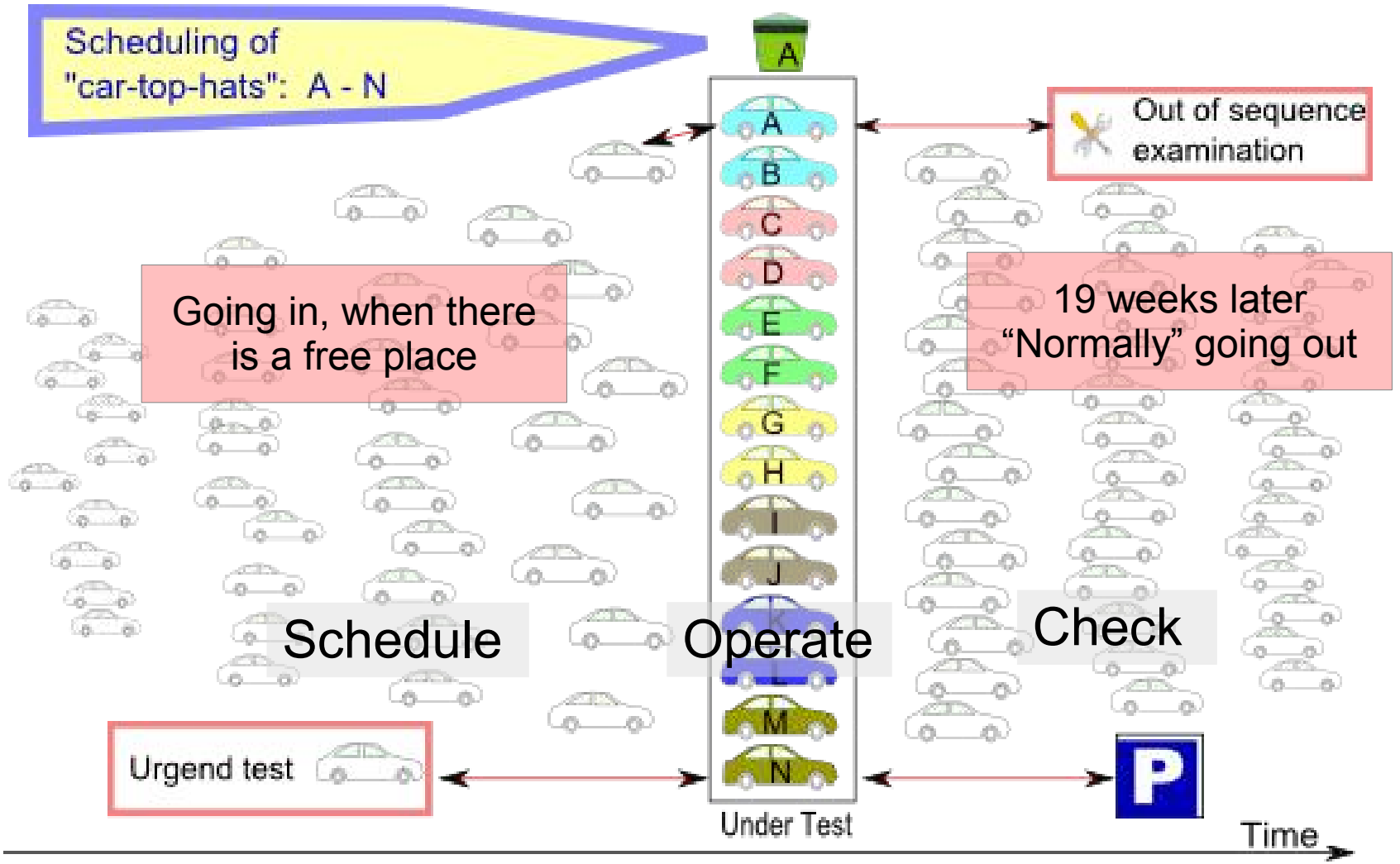
Salt, Rain and Wind

Frost and Hydro-Pulse

Constraint: Limited Test Facilities for Environmental Simulation



Cars under Test



Constraint: Working times

Mo – Fr
7:00 – 16:00

No Weekend

<u>Keep It Simple!</u>
Heuristic approach

- 24 h cyclic processes
  In test chambers
  ➔Working day
  ➔Weekend
- Fixed times
  ➔Car exchange
  ➔Outdoor test track

Definition of Job / Boundary Conditions

Software for ...

Schedule

How to do it

?

Operate

Do it

!

Check

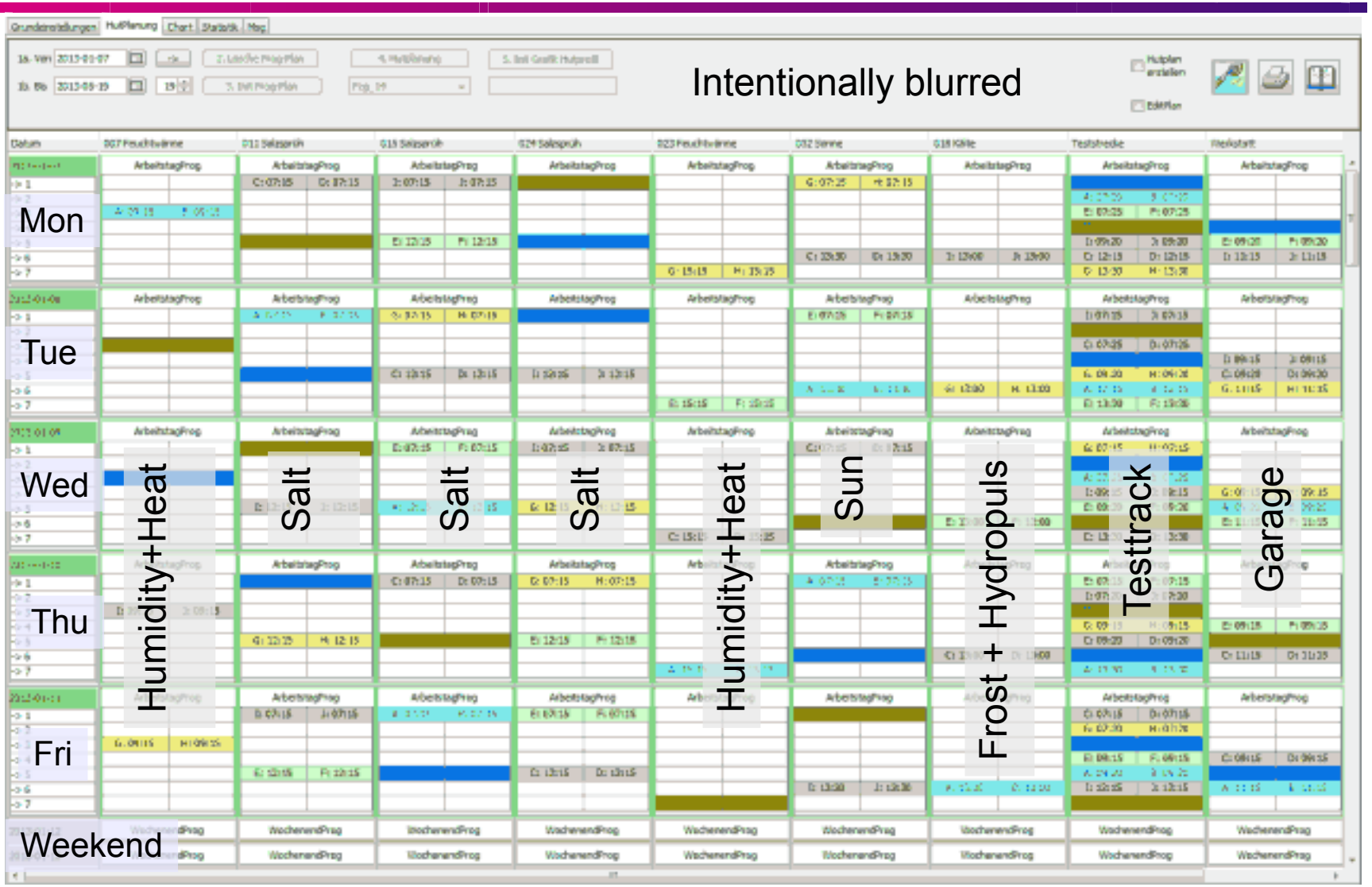
Well done

? !

Scheduling

Setting up schedules for all hats


Goal of Development
Calender for daily Operation



DB-Structure for Hat-Scheduling

Constrains

Schedule

Parameter

InkaStessTypeList		
StressId	int4	<pk>
Name	text	
WherePart	text	
Percentage	float8	

DayTypeList		
DayType	int4	<pk>
DayTypName	text	
Color	int4	

ProgramOfDayType		
BetrNr	int4	<pk,fk1>
DayType	int4	<pk,fk2>
ProgName	text	<fk1>

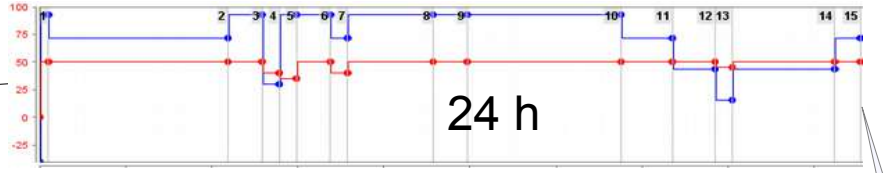
ProgramList		
BetrNr	int4	<pk,fk>
ProgName	text	<pk>
Color	int4	
ProgCode	xml	

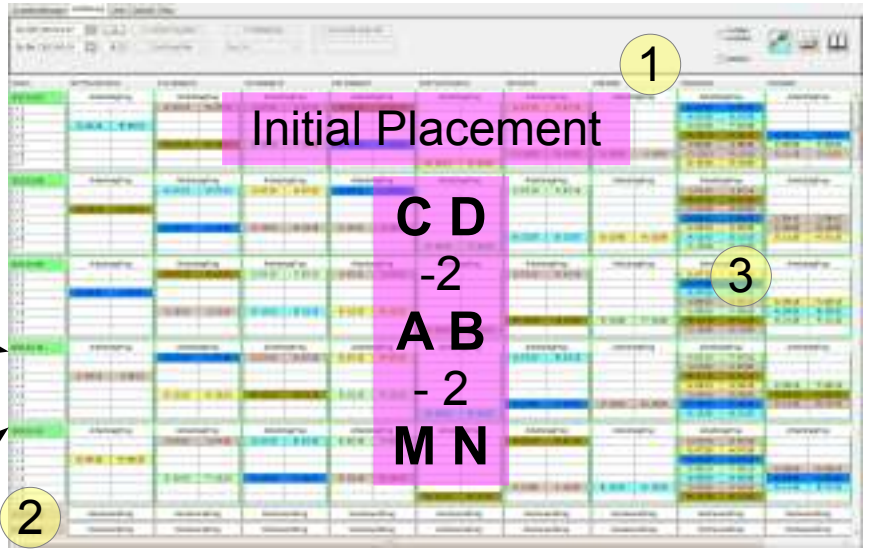
FacilityList		
BetrNr	int4	<pk>
Name	text	

Program_Calendar		
Day	date	<pk>
BetrNr	int4	<pk,fk>
ProgName	text	<fk>

HatList		
HatName	text	<pk>
Color	int4	
Ordinal	int4	

Hat_Calendar		
Day	date	<pk,fk1>
BetrNr	int4	<pk,fk1>
Position	int4	<pk>
Ordinal	int4	<pk>
TimeOfDay	time	
HatName	text	<fk2>

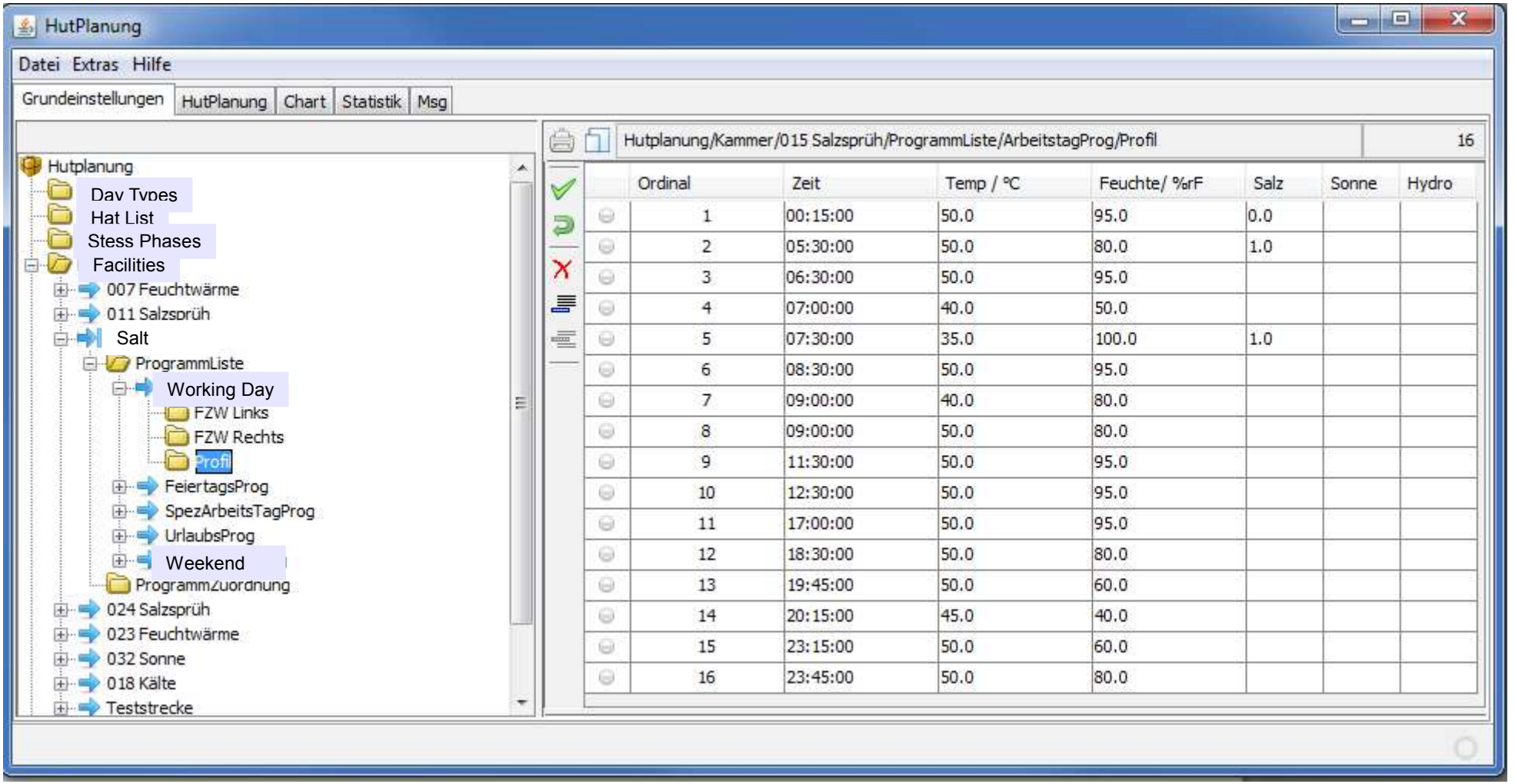




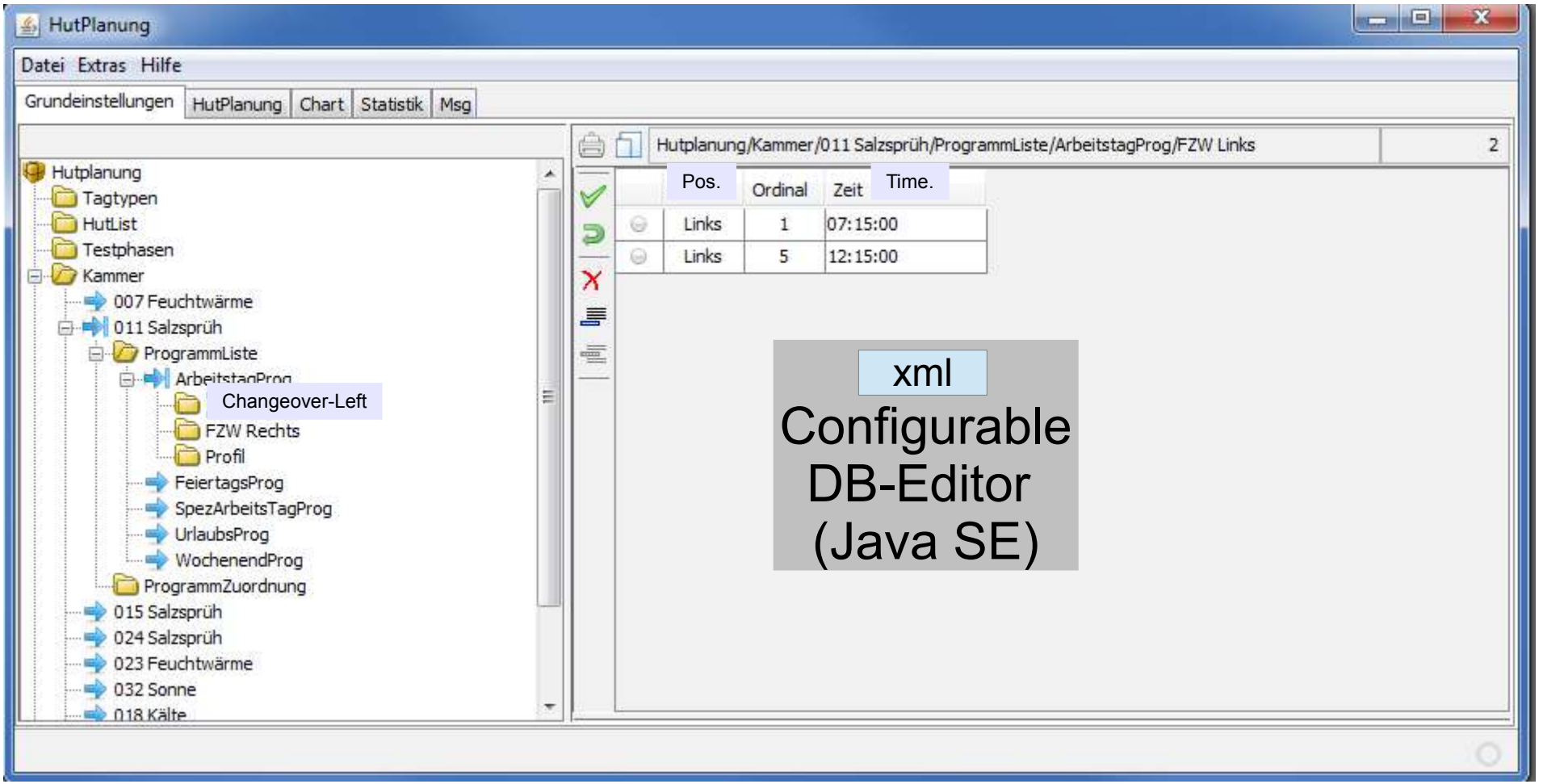
Car_ChangeOver		
BetrNr	int4	<pk,fk>
ProgName	text	<pk,fk>
Position	int4	<pk>
Ordinal	int4	<pk>
TimeOfDay	time	

Program_Simul_Profil		
BetrNr	int4	<pk,fk>
ProgName	text	<pk,fk>
Ordinal	int4	<pk>
TimeOfDay	time	
Temperature	float8	
Hunidity	float8	
Salt_On	float8	
Sun_On	float8	
HydroPuls_On	float8	

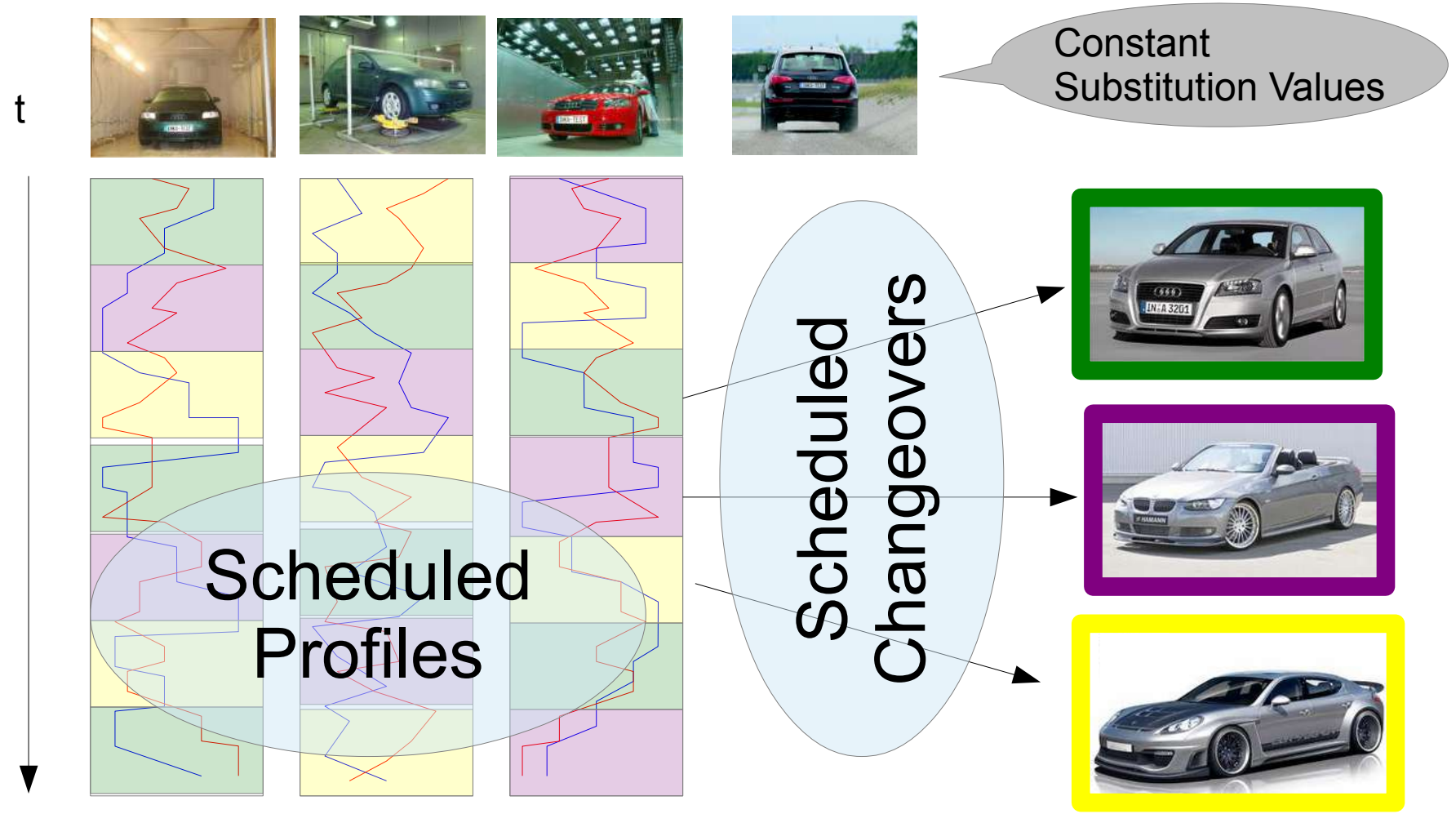
Edit Profiles for Simulation



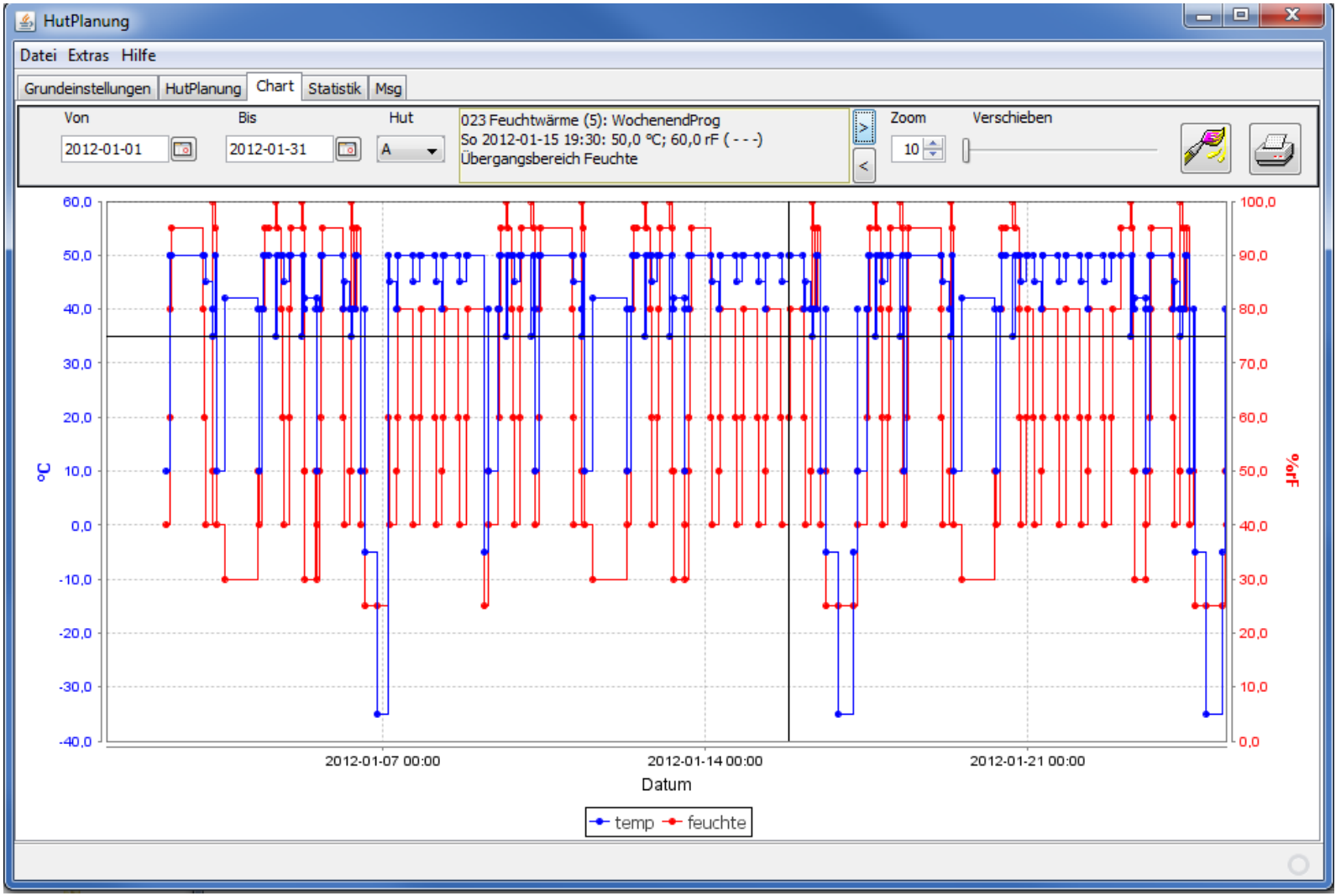
Edit Changeovers for Simulation



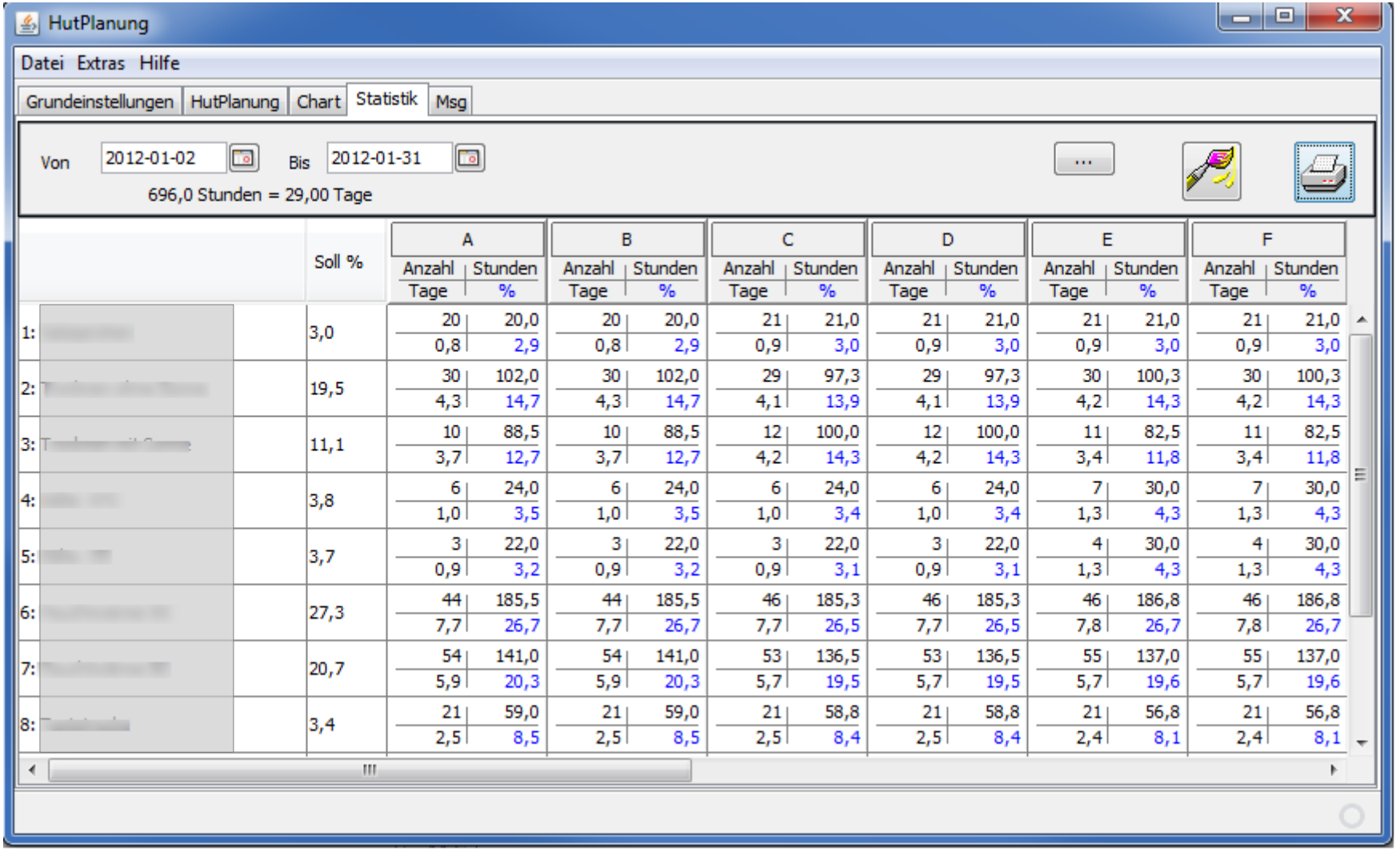
Schedule
Stitching Profiles of Stress per Car



Simulation: Stiched Chart of Scheduled Treatments



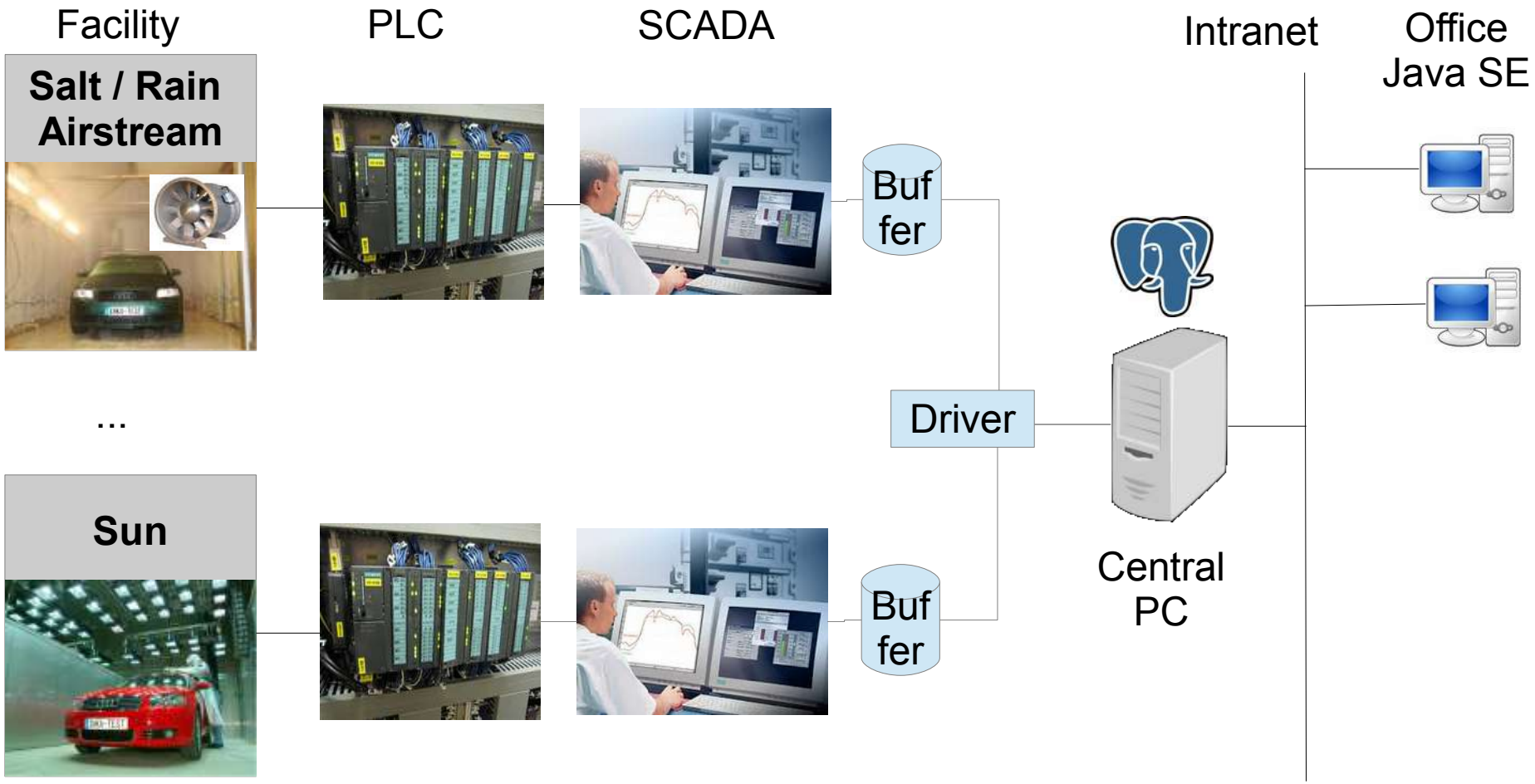
Simulation: Statistical Analysis Crosstab of Scheduled Treatments



	Soll %	A		B		C		D		E		F	
		Anzahl Tage	Stunden %	Anzahl Tage	Stunden %	Anzahl Tage	Stunden %	Anzahl Tage	Stunden %	Anzahl Tage	Stunden %	Anzahl Tage	Stunden %
1:	3,0	20	20,0	20	20,0	21	21,0	21	21,0	21	21,0	21	21,0
		0,8	2,9	0,8	2,9	0,9	3,0	0,9	3,0	0,9	3,0	0,9	3,0
2:	19,5	30	102,0	30	102,0	29	97,3	29	97,3	30	100,3	30	100,3
		4,3	14,7	4,3	14,7	4,1	13,9	4,1	13,9	4,2	14,3	4,2	14,3
3:	11,1	10	88,5	10	88,5	12	100,0	12	100,0	11	82,5	11	82,5
		3,7	12,7	3,7	12,7	4,2	14,3	4,2	14,3	3,4	11,8	3,4	11,8
4:	3,8	6	24,0	6	24,0	6	24,0	6	24,0	7	30,0	7	30,0
		1,0	3,5	1,0	3,5	1,0	3,4	1,0	3,4	1,3	4,3	1,3	4,3
5:	3,7	3	22,0	3	22,0	3	22,0	3	22,0	4	30,0	4	30,0
		0,9	3,2	0,9	3,2	0,9	3,1	0,9	3,1	1,3	4,3	1,3	4,3
6:	27,3	44	185,5	44	185,5	46	185,3	46	185,3	46	186,8	46	186,8
		7,7	26,7	7,7	26,7	7,7	26,5	7,7	26,5	7,8	26,7	7,8	26,7
7:	20,7	54	141,0	54	141,0	53	136,5	53	136,5	55	137,0	55	137,0
		5,9	20,3	5,9	20,3	5,7	19,5	5,7	19,5	5,7	19,6	5,7	19,6
8:	3,4	21	59,0	21	59,0	21	58,8	21	58,8	21	56,8	21	56,8
		2,5	8,5	2,5	8,5	2,5	8,4	2,5	8,4	2,4	8,1	2,4	8,1

How to do it ?

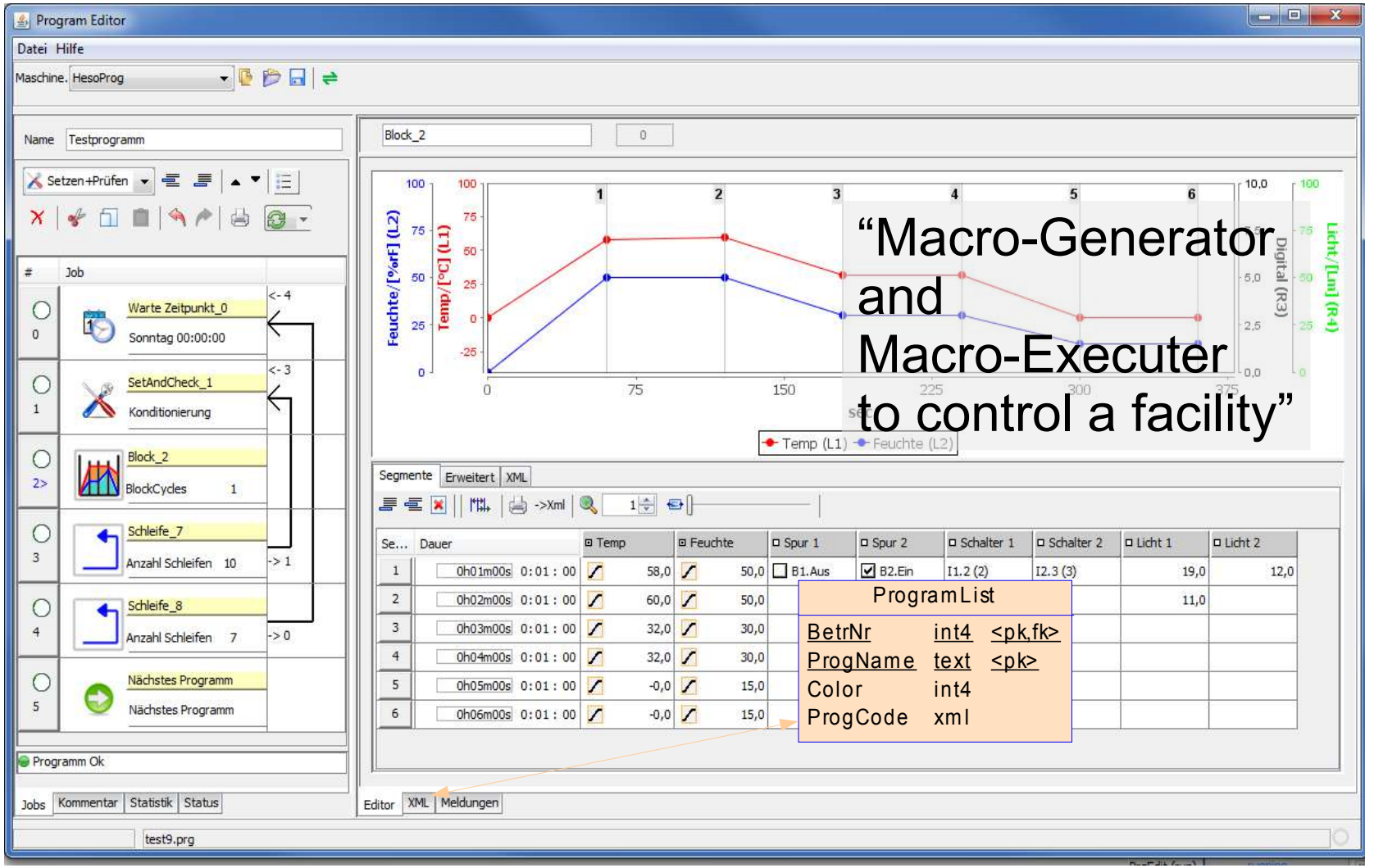
Measurements
Flow of Data



SCADA System for each Chamber
Supervisory Control and Data Aquisition

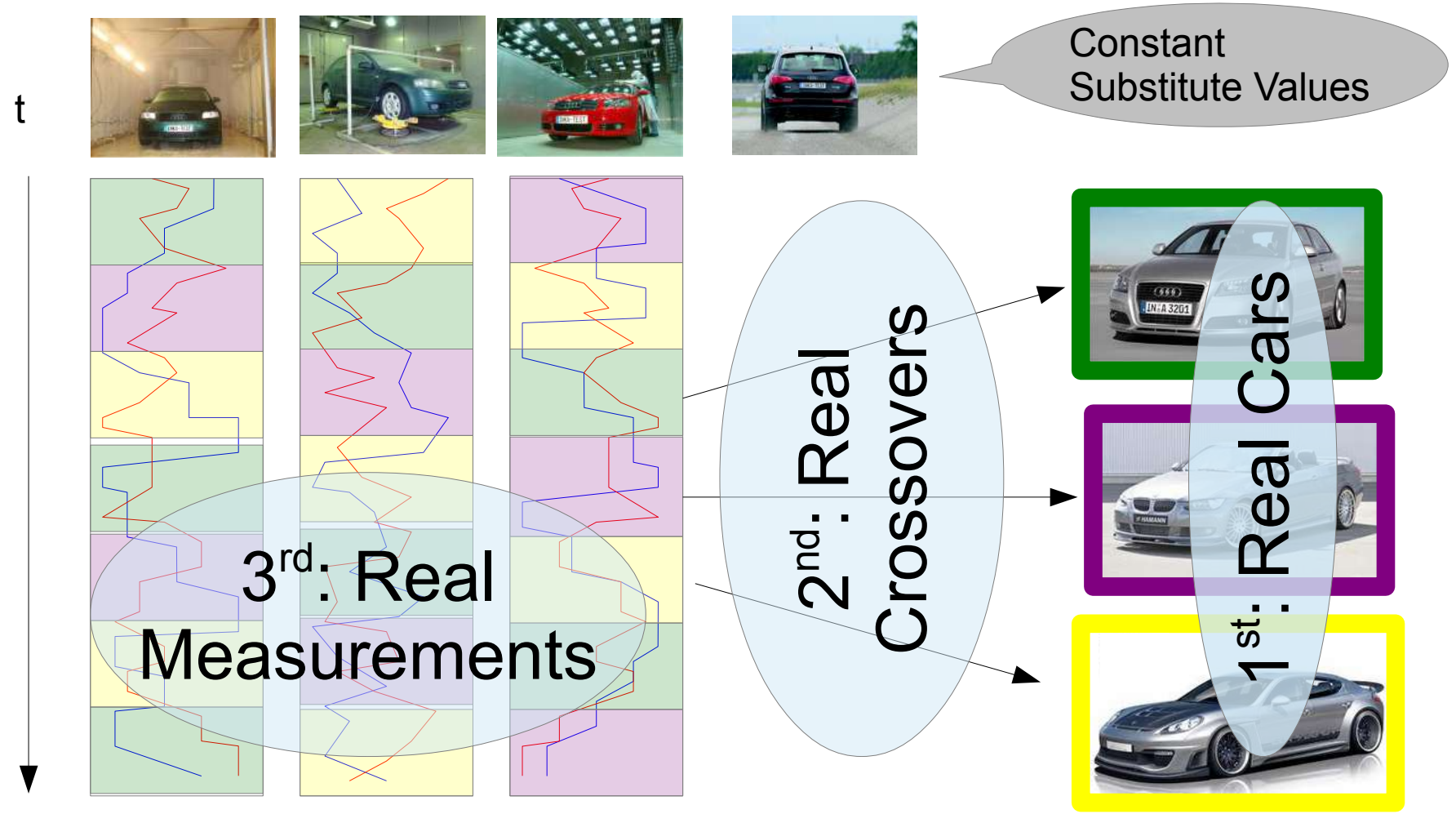
Each facility / chamber
is equipped with a
SCADA System
for control and monitoring
the plant

Programmer
Driving Profiles in Real World

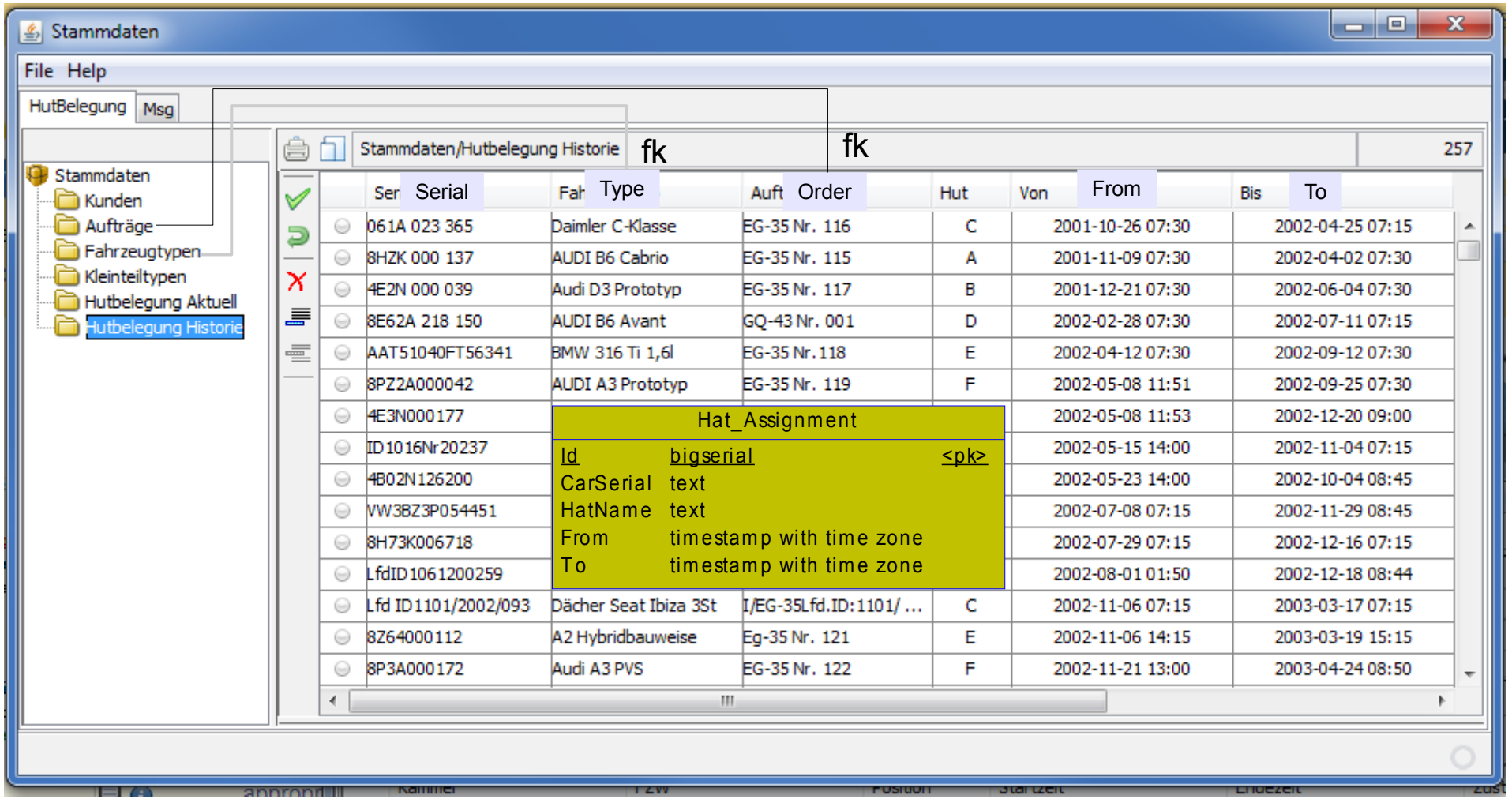


Do it !

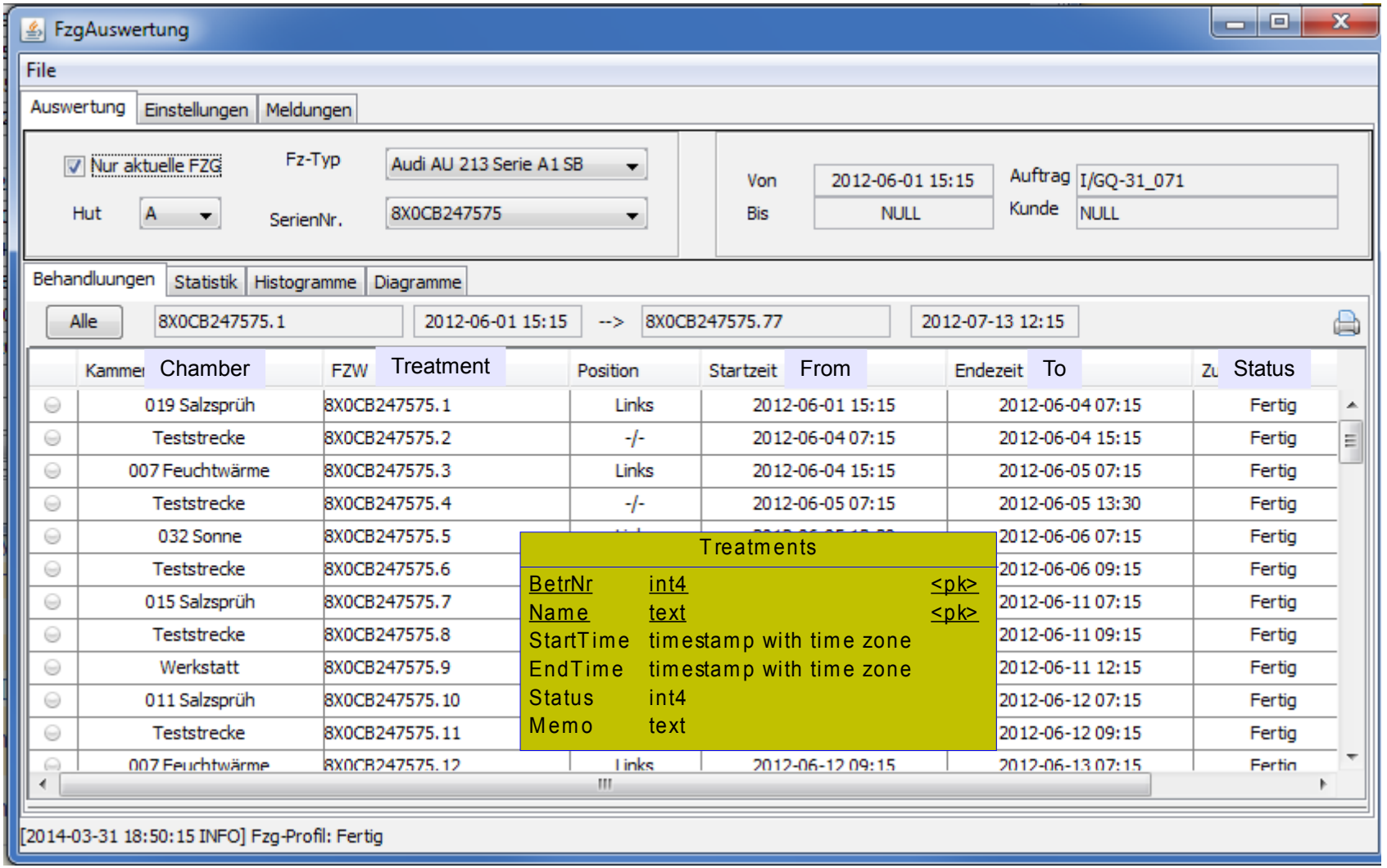
Well Done ? !
Stitch Measurements per Car



Administration of cars
Hat Assignments



Administration of cars
Changeovers → Treatments



Measurements

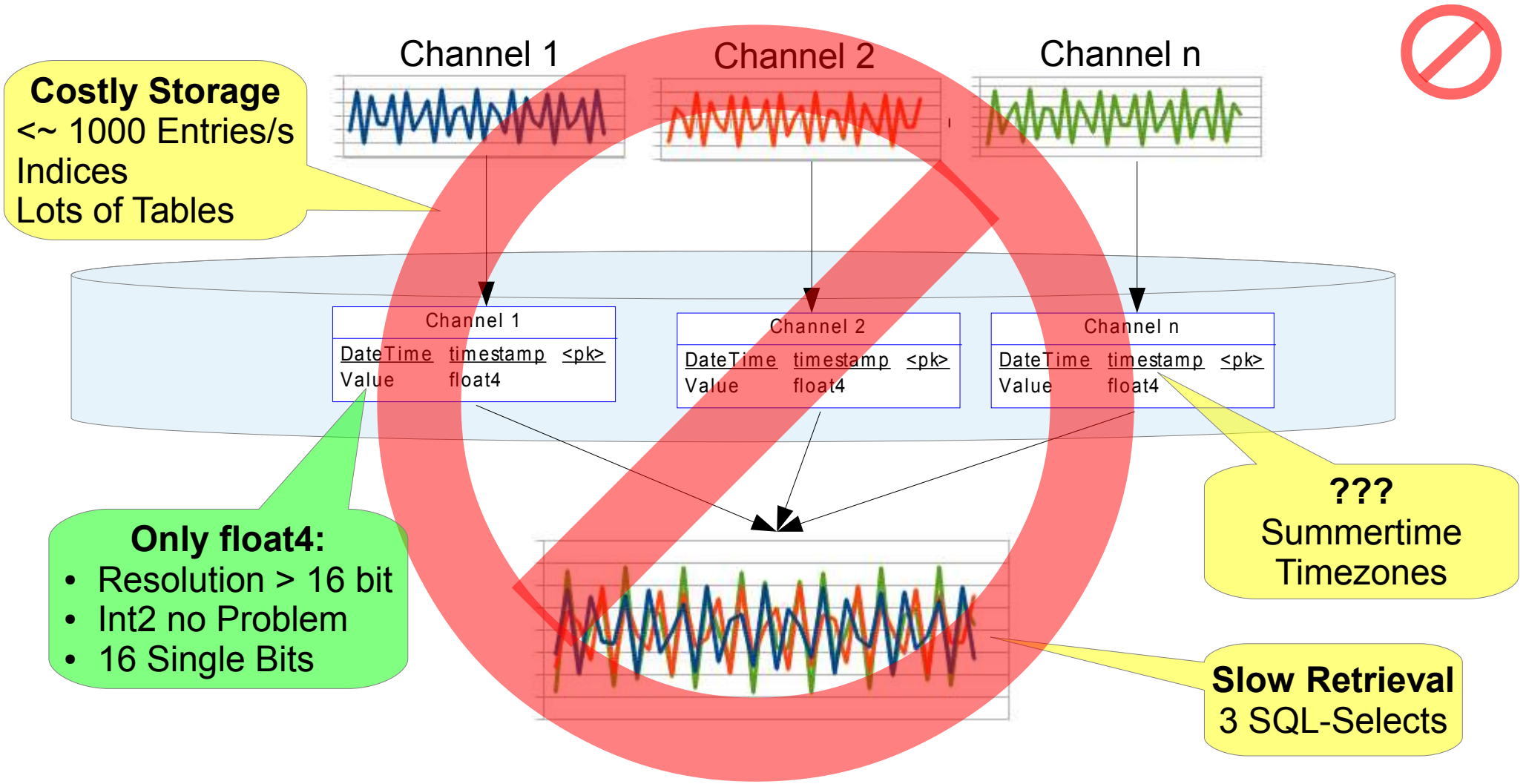
Lots of edges and data to stitch

14 cars under test

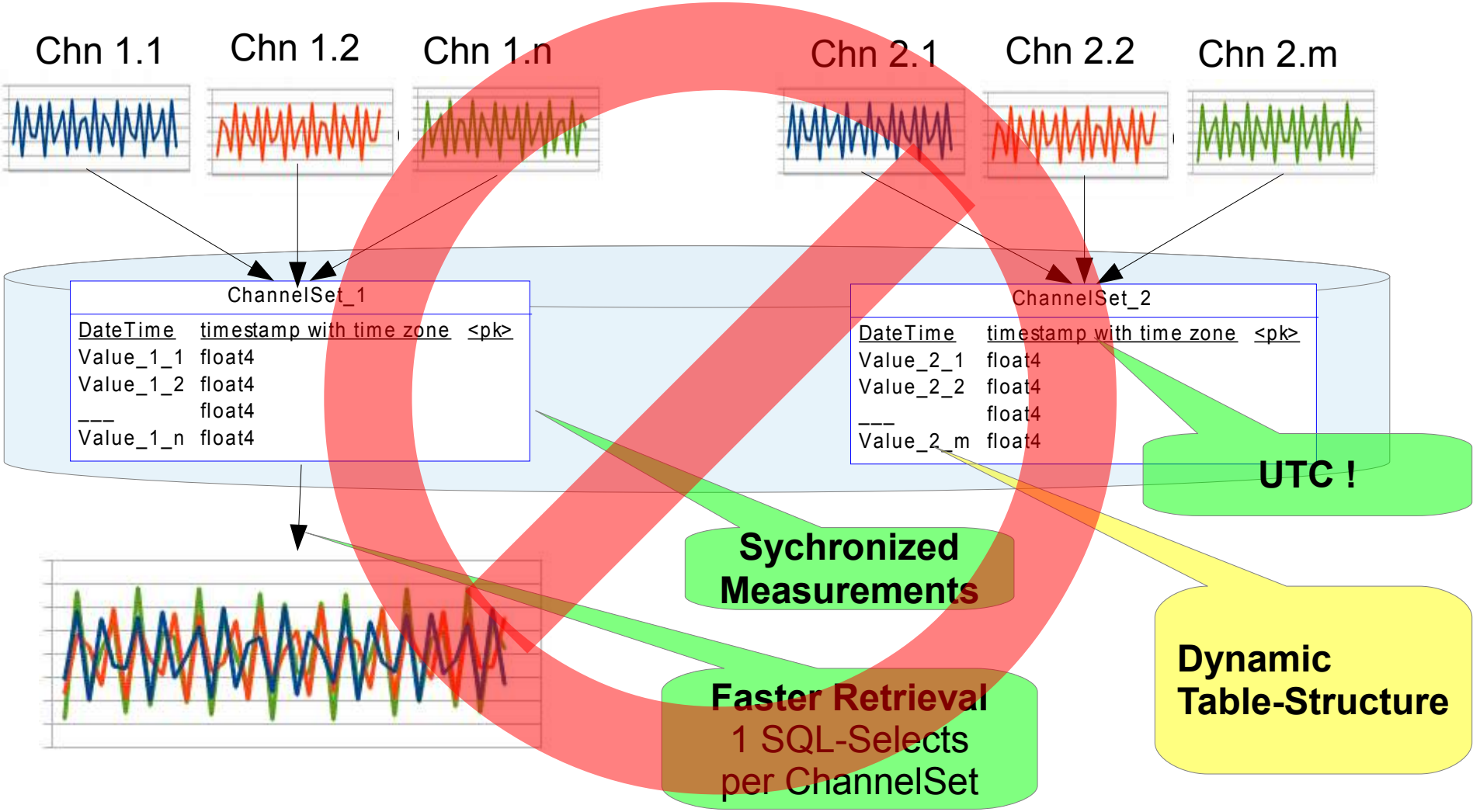
- ~ 40 cars per year
- 300 changeovers / car
- > 10 measurements per facility
- Each aprox. Every 5 sec
-

→ Fast Access to measurements !

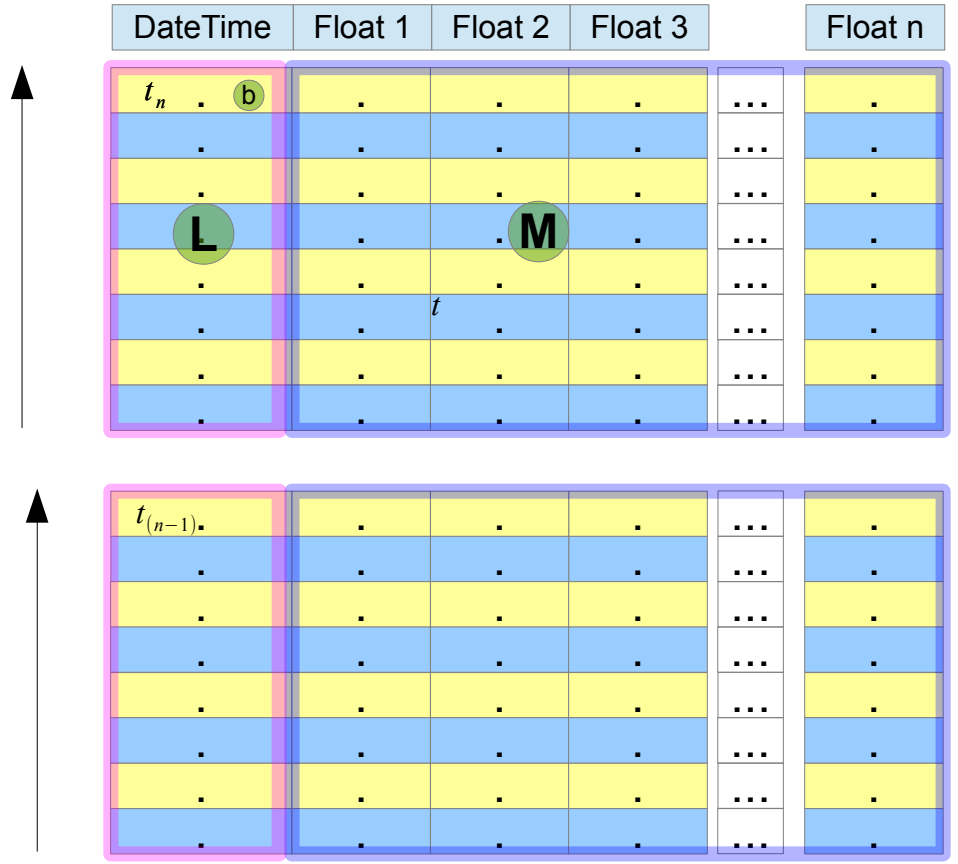
Storing Measurements (Simplest Way)



Storing Measurements (Channel-Sets)



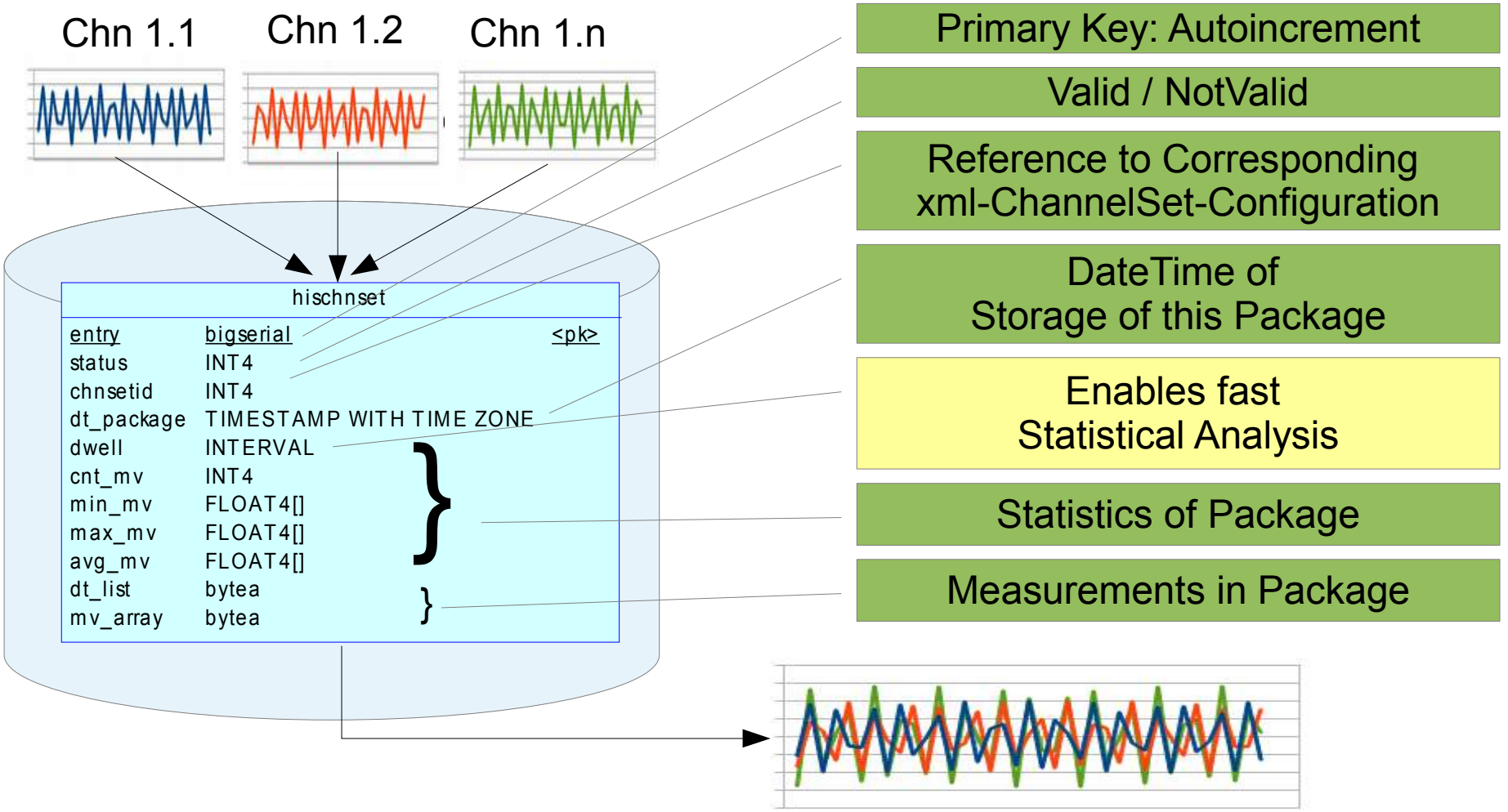
Storage: Packaging



- b • DateTime of Package
- c • $dwell = t_n - t_{(n-1)}$
- d • Count Of Measurements in Package
- e • [**min**(*Float 1*), **min**(*Float 2*), …, **min**(*Float n*)]
- f • [**max**(*Float 1*), **max**(*Float 2*), …, **max**(*Float n*)]
- g • [**avg**(*Float 1*), **avg**(*Float 2*), …, **avg**(*Float n*)]
- h • [**cur**(*Float 1*) **cur**(*Float 2*), …, **cur**(*Float n*)]
- L • List of DateTimes in Package
- M • Matrix of Measurements in Package

	hischnset		
	entry	bigserial	<pk>
	status	INT4	
a	chnsetid	INT4	
b	dt_package	TIMESTAMP WITH TIME ZONE	
c	dwell	INTERVAL	
d	cnt_mv	INT4	
e	min_mv	FLOAT4[]	
f	max_mv	FLOAT4[]	
g	avg_mv	FLOAT4[]	
h	cur_mv	FLOAT4[]	
L	dt_list	bytea	
M	mv_array	bytea	

Storing Measurements Cascaded Storage



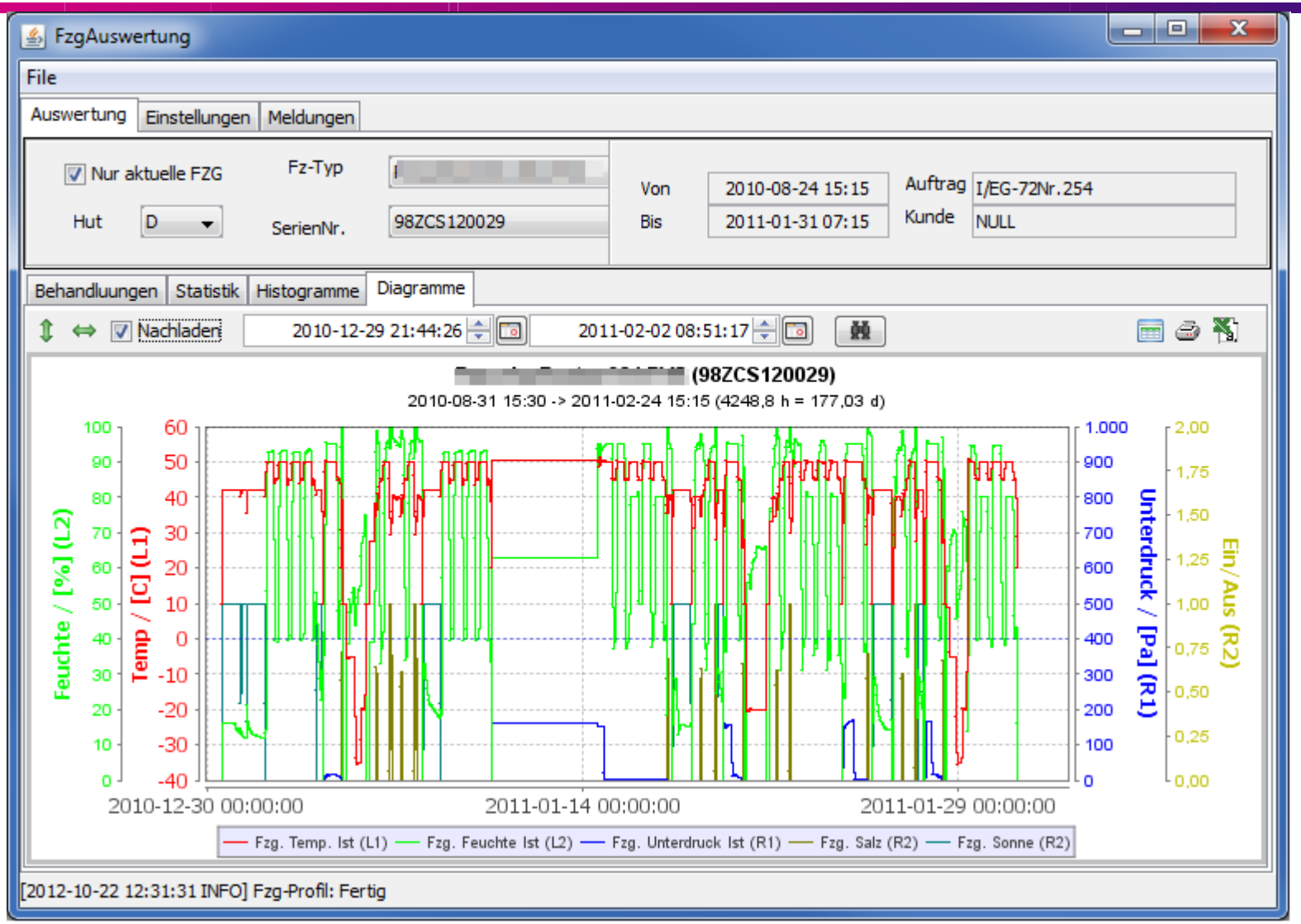
Stitching the Measurements

- All Chambers have the same channelset
- If channel is not available, value is set to null

  → Data can be all appended into a temp-table

- Stitching is done by a stored procedure

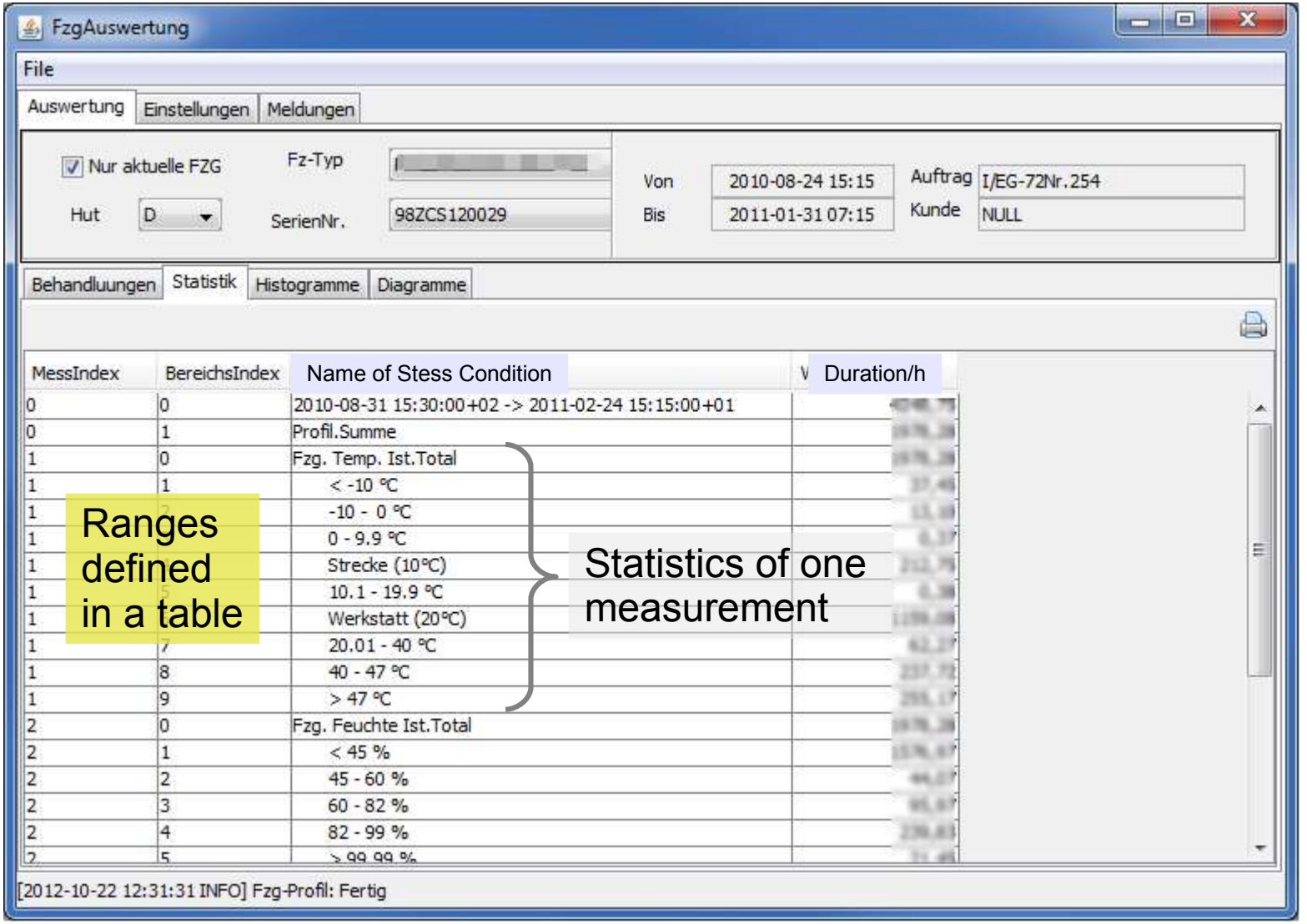

Stitched Chart of a Car



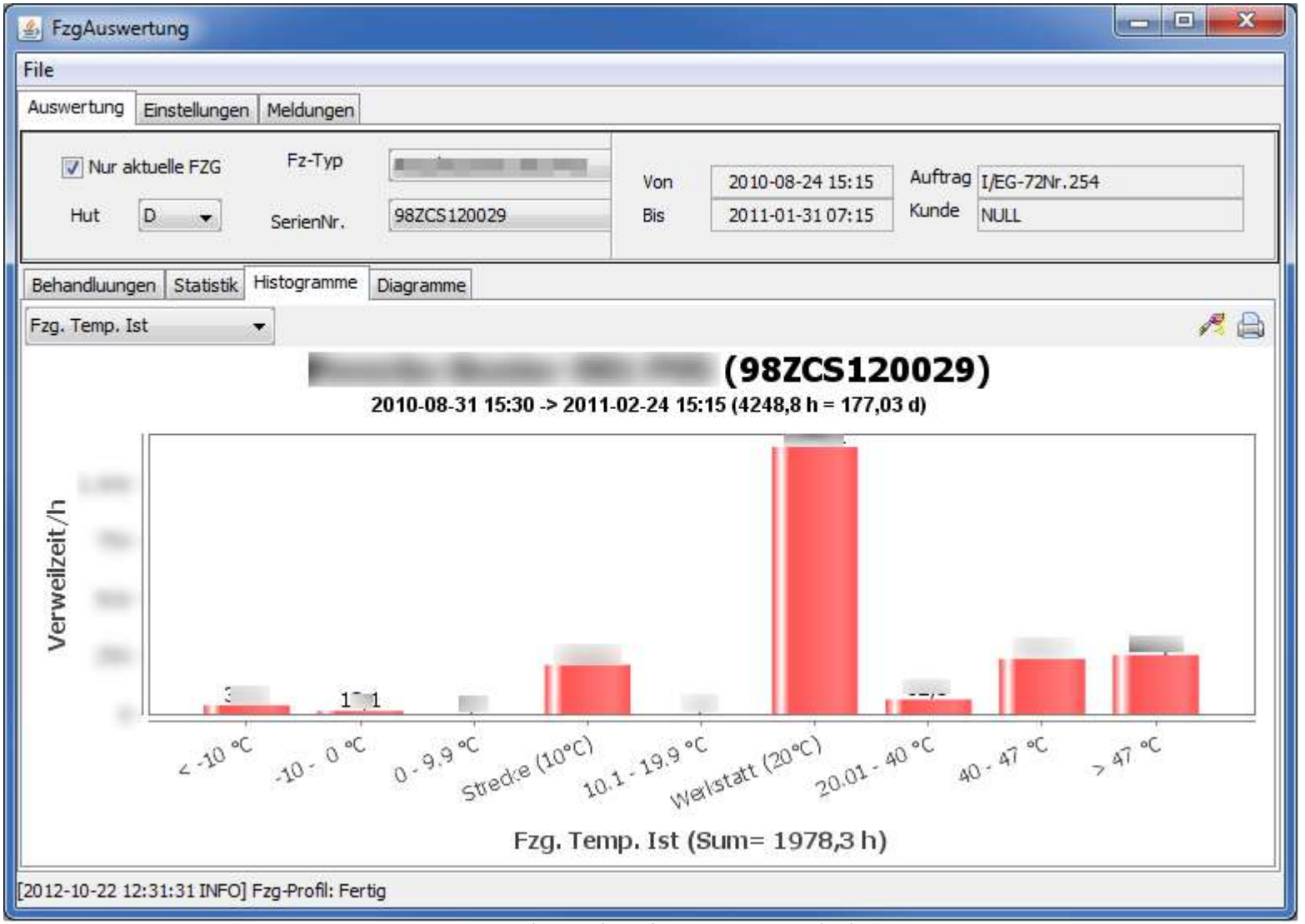
Statistical Analysis

- **dwell** Column is essential for fast statistical analysis
- Stress conditions are defined by a where-clause of comparisons of meas-values
- Time within a certain stress condition
  - Select sum(dwell) where avg_mv[3] between 45 and 50 and ...


Car under Test: Statistics

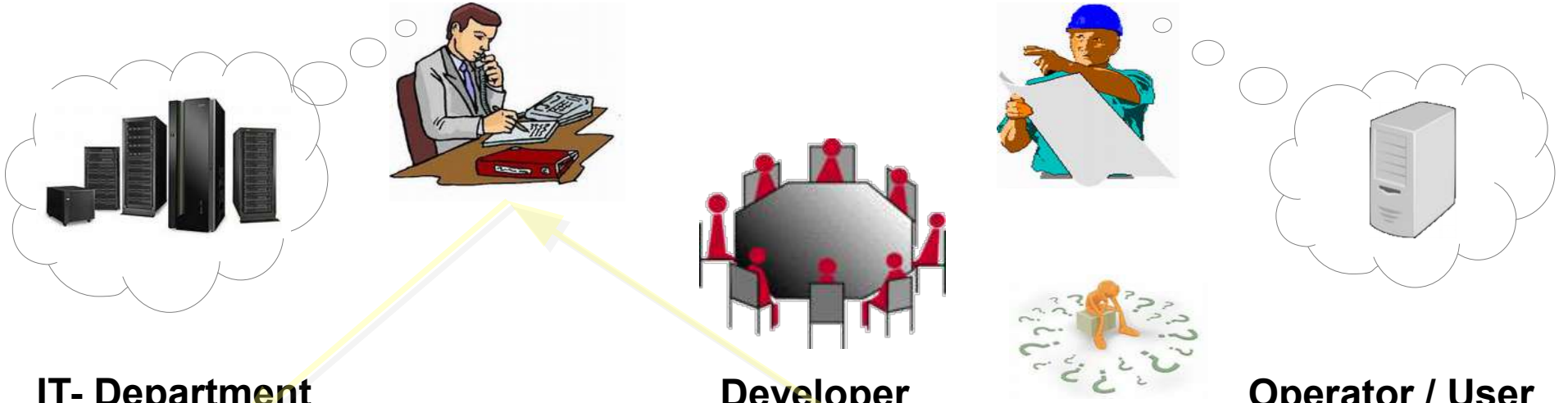


Car under Test: Statistics



Well Done ? !

Story: Kick-Off Meeting
Standard-IT ↔ Technical Software



IT- Department

- Detailed regulations
- Internet / Website
- High Traffic
- Thousands of users
- Dedicated Server HW
- Administration
- Security

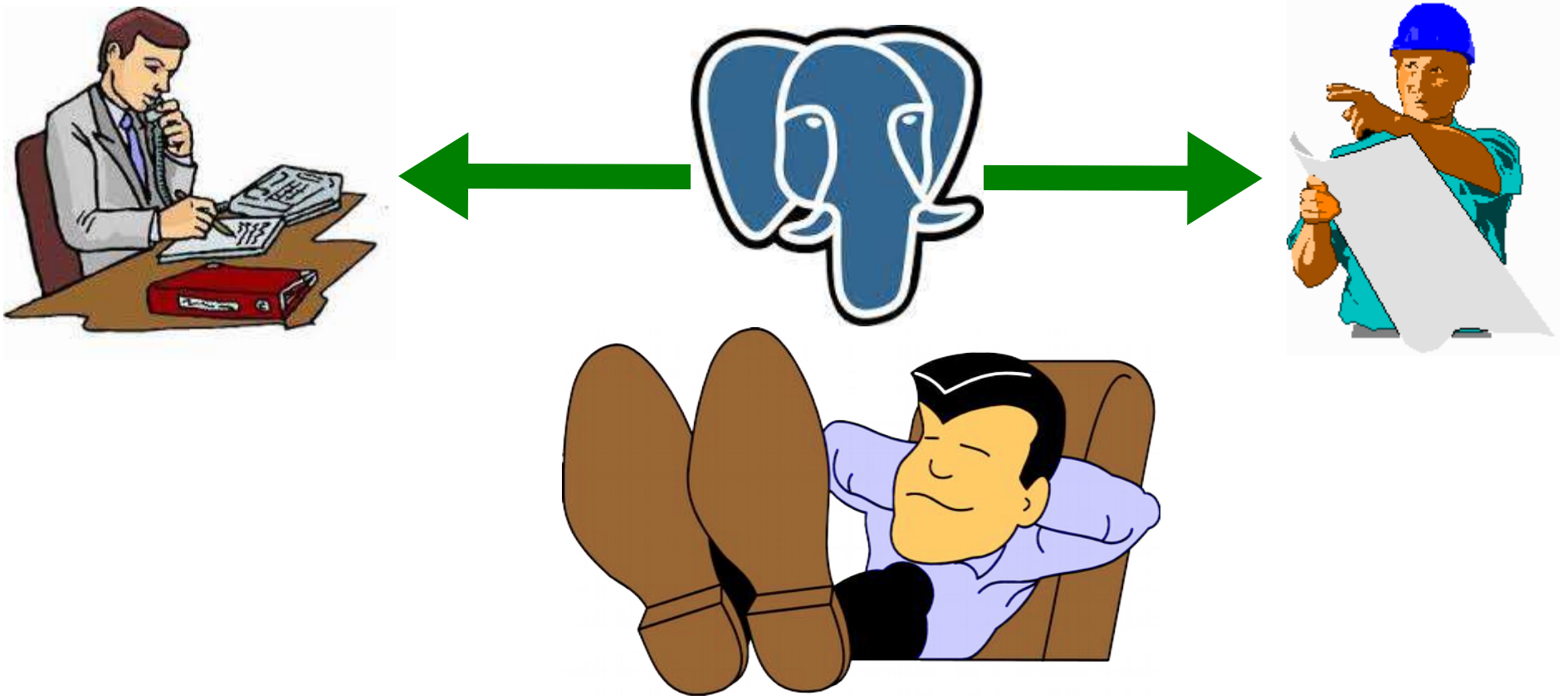
Developer

- Client-Server Architecture
- Database
- Operation via network
- Java SE
- No installation on office PC

Operator / User

- Limited budget
- 5-10 users
- Network-Application
- Effective
- User-optimized
- Non-bureaucratic
- Operated by user

Sharing Technologies and Experiences



Large Benefit