

Managing the AUDI Corrosion Center with PostgreSQL

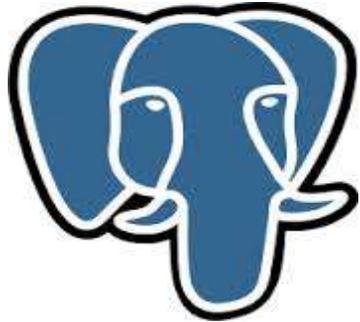


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In Collaboration with Johnson Controls
Mannheim / Germany

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 Corrosion and Ageing Test

Humidity
/ Rain



Sun (Vis + UV)



Frost



Salt



Stone Chips



Road Holes

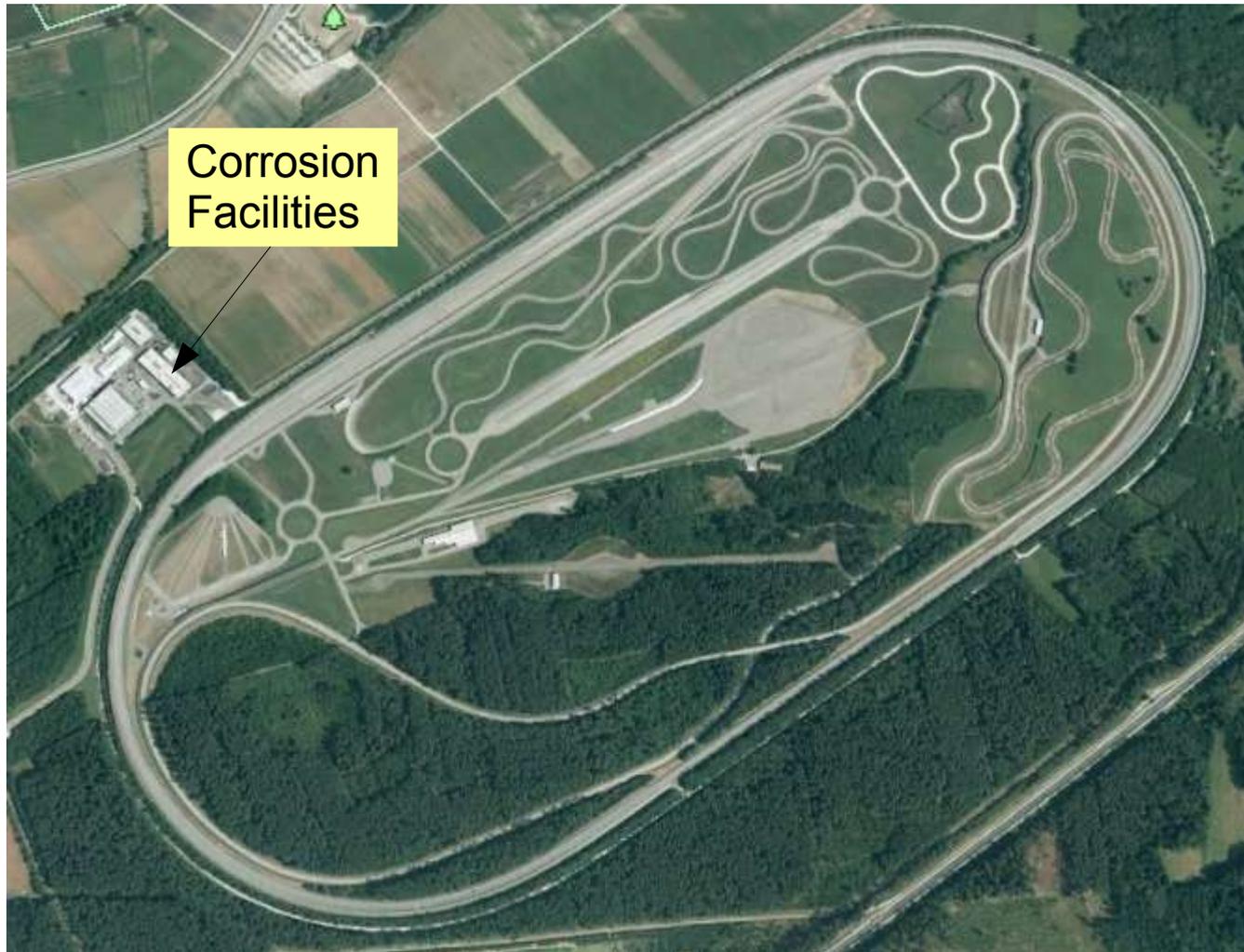
km



[Youtube Video about INKA-test: 19 weeks of test = 12 years in cars life](#)



AUDI Test Center from Google Earth



Inside the Corrosion Center



2014-04-04

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Sun (Vis + UV)



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Heat and Humidity



2014-04-04

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9



Salt, Rain and Wind



Frost and Hydro-Pulse



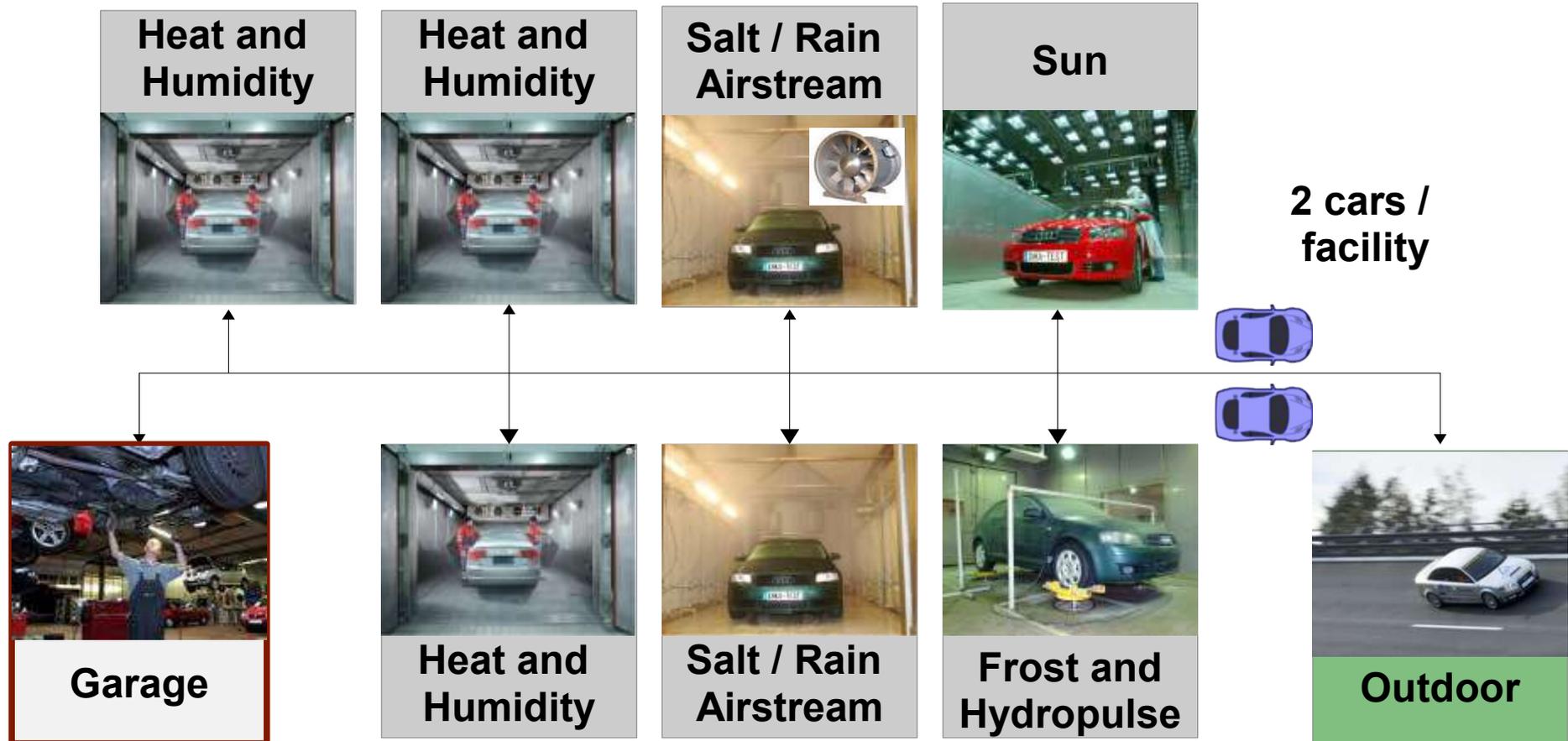
2014-04-04

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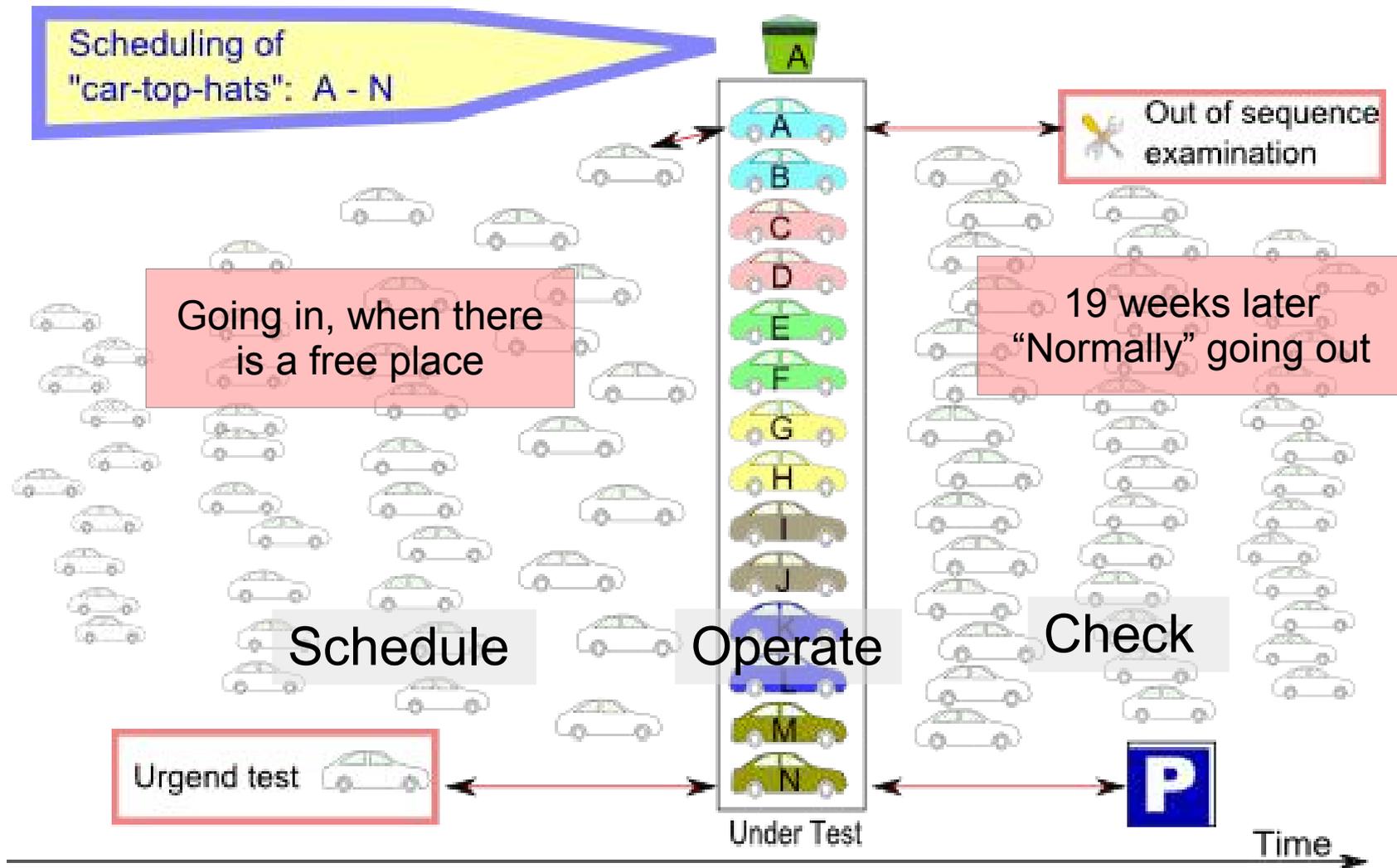
11



Constraint: Limited Test Facilities for Environmental Simulation



Cars under Test



Constraint: Working times

Mo – Fr
7:00 – 16:00



No Weekend

Keep It Simple!
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

? !

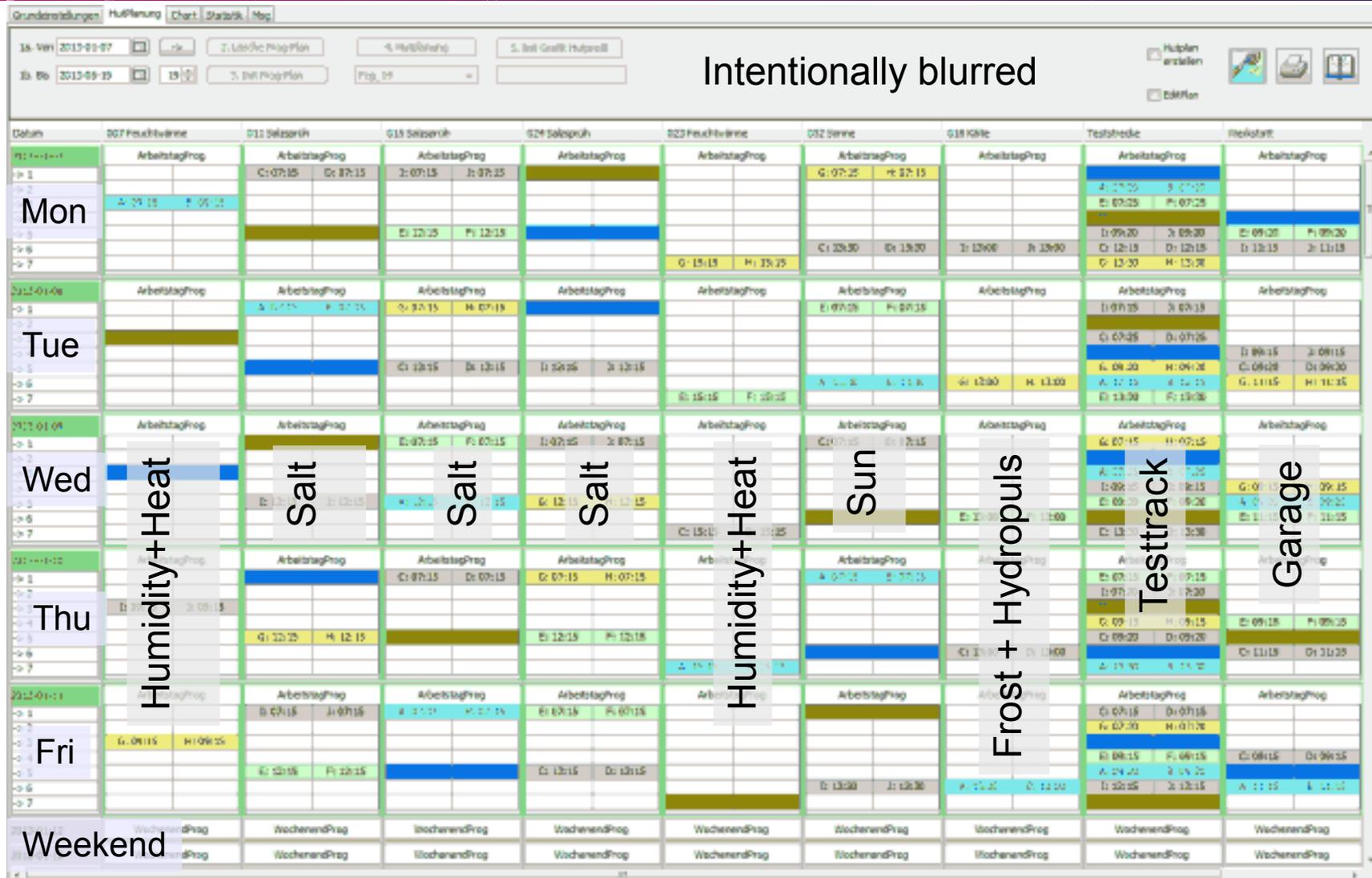


Scheduling

Setting up schedules for all hats



Goal of Development Calendar for daily Operation



Edit Profiles for Simulation

The screenshot shows the 'HutPlanung' software interface. The left sidebar displays a tree view of the project structure, with 'Hutplanung' expanded to show 'ProgrammListe' and 'Working Day'. The main window displays a table of simulation profiles. The table has columns for Ordinal, Zeit, Temp / °C, Feuchte/ %rF, Salz, Sonne, and Hydro. The table contains 16 rows of data, representing a 24-hour cycle.

Ordinal	Zeit	Temp / °C	Feuchte/ %rF	Salz	Sonne	Hydro
1	00:15:00	50.0	95.0	0.0		
2	05:30:00	50.0	80.0	1.0		
3	06:30:00	50.0	95.0			
4	07:00:00	40.0	50.0			
5	07:30:00	35.0	100.0	1.0		
6	08:30:00	50.0	95.0			
7	09:00:00	40.0	80.0			
8	09:00:00	50.0	80.0			
9	11:30:00	50.0	95.0			
10	12:30:00	50.0	95.0			
11	17:00:00	50.0	95.0			
12	18:30:00	50.0	80.0			
13	19:45:00	50.0	60.0			
14	20:15:00	45.0	40.0			
15	23:15:00	50.0	60.0			
16	23:45:00	50.0	80.0			



Edit Changeovers for Simulation

The screenshot shows the 'HutPlanung' application window. The left pane displays a hierarchical tree structure with folders like 'Tagtypen', 'HutList', 'Testphasen', and 'Kammer'. Under 'Kammer', there is a folder '011 Salzsprüh' containing 'ProgrammListe', which in turn contains 'ArbeitsTagProg' and 'Changeover-Left'. The right pane shows a table with the following data:

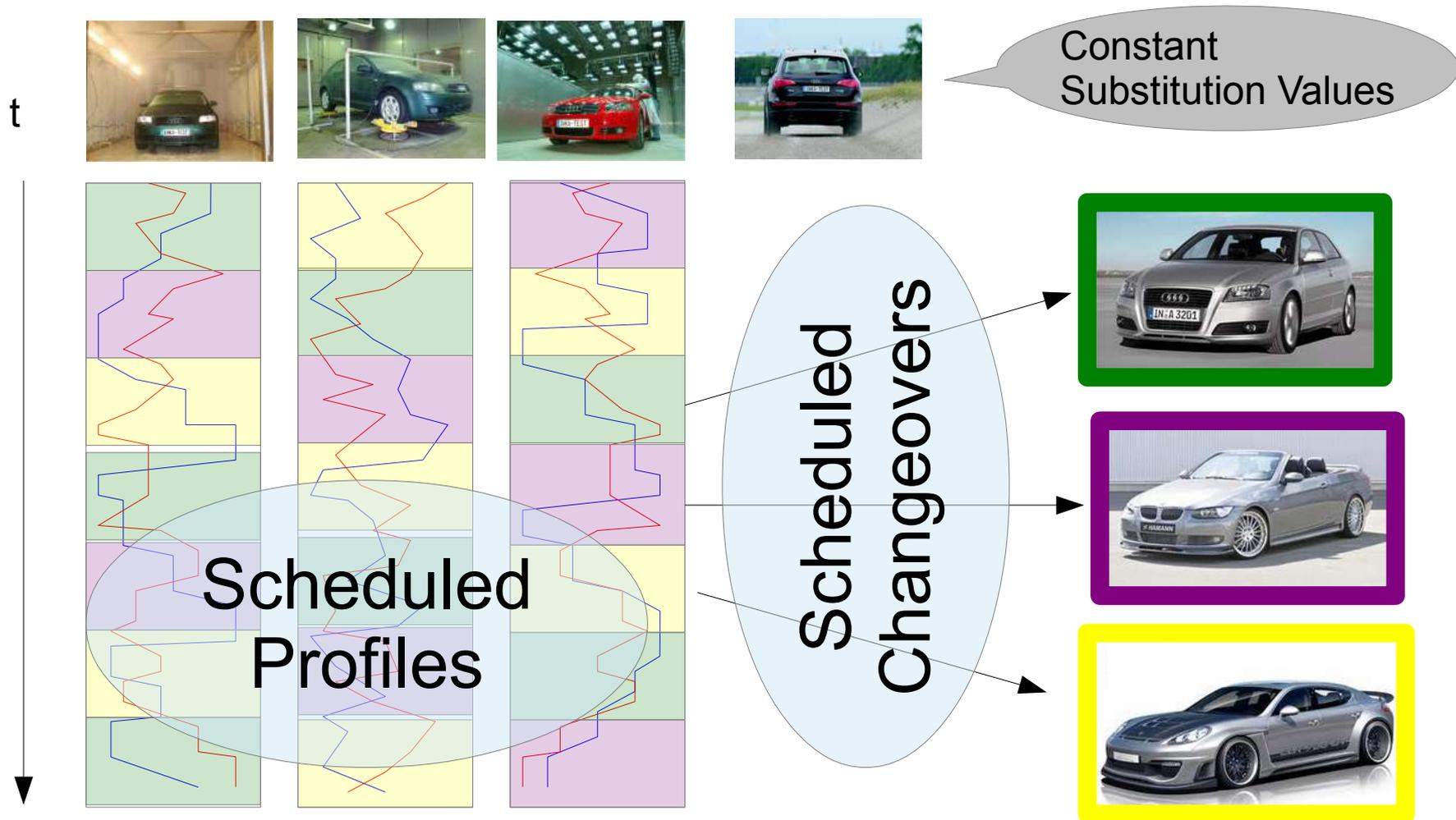
Pos.	Ordinal	Zeit	Time.
Links	1	07:15:00	
Links	5	12:15:00	

A text box is overlaid on the table with the following text:

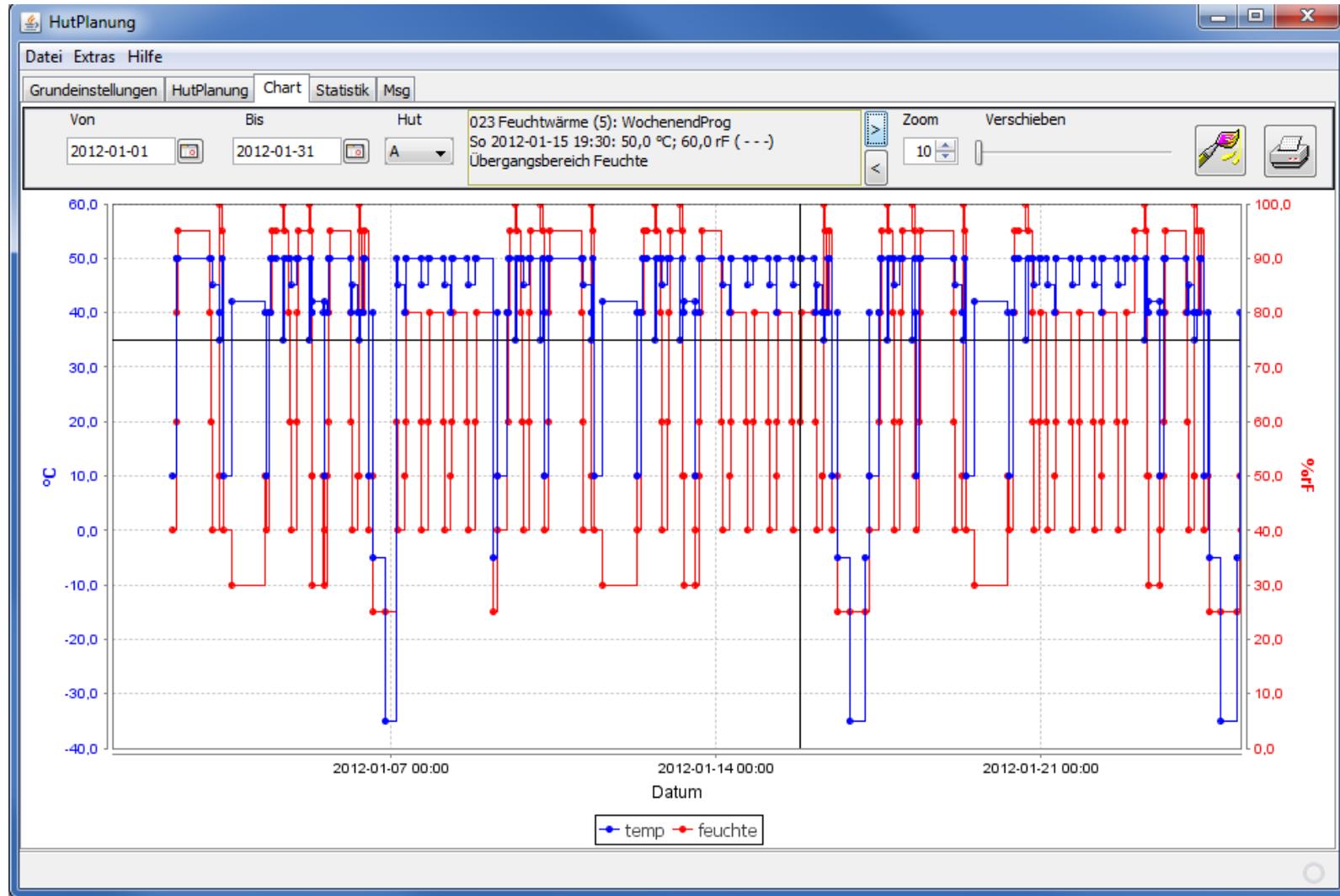
xml
Configurable
DB-Editor
(Java SE)



Schedule Stitching Profiles of Stress per Car



Simulation: Sticked Chart of Scheduled Treatments



Simulation: Statistical Analysis

Crosstab of Scheduled Treatments

HutPlanung

Datei Extras Hilfe

Grundeinstellungen HutPlanung Chart Statistik Msg

Von 2012-01-02 Bis 2012-01-31

696,0 Stunden = 29,00 Tage

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

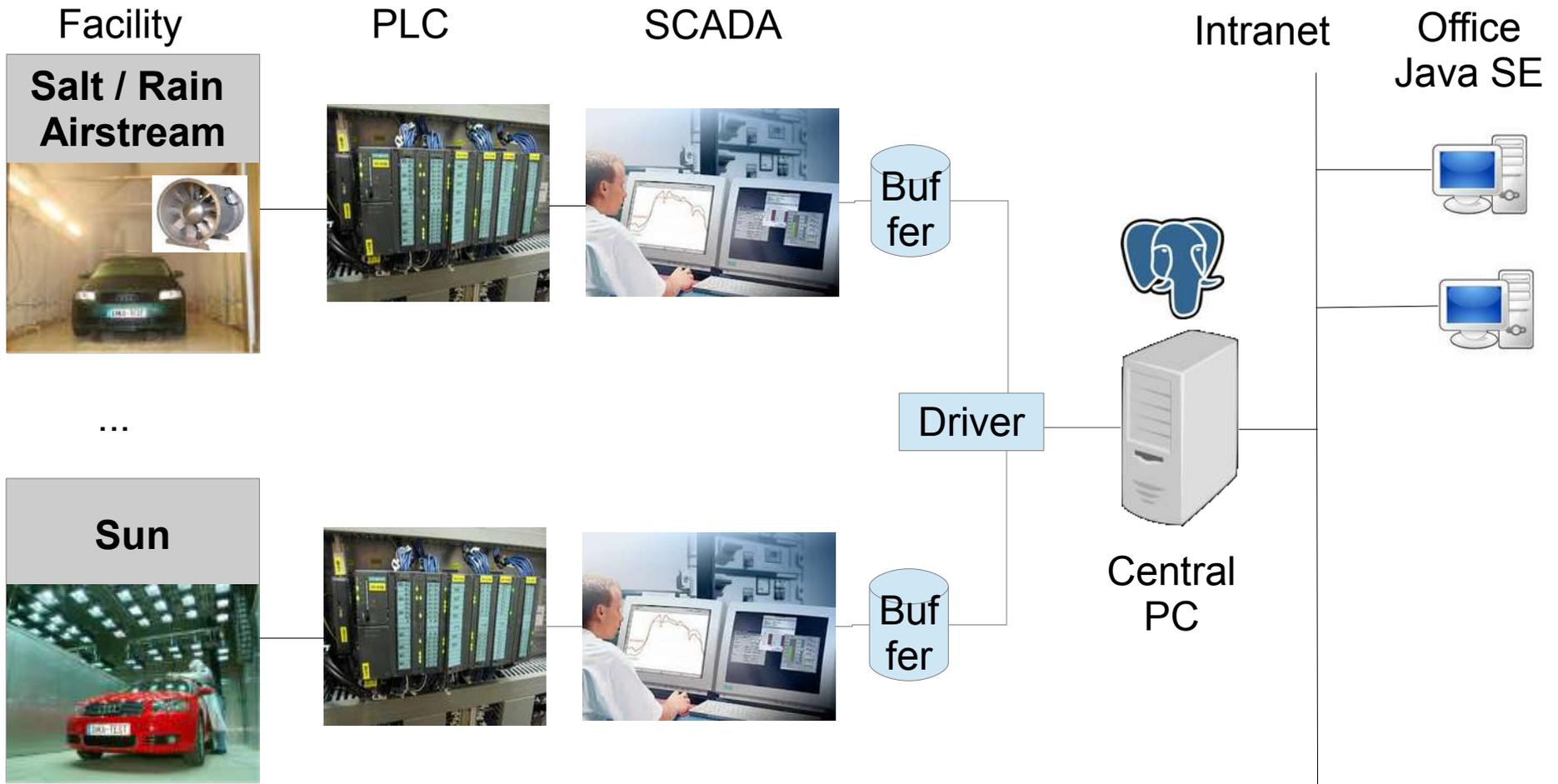


How to do it ?



Measurements

Flow of Data



SCADA System for each Chamber Supervisory Control and Data Acquisition



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



Programmer Driving Profiles in Real World

The screenshot shows the 'Program Editor' interface for a facility control system. The main window displays a graph of 'Temp [°C] (L1)' and 'Feuchte [%rF] (L2)' over time. The graph shows a profile with six segments. A text box is overlaid on the graph with the text: "Macro-Generator and Macro-Executer to control a facility".

The job list on the left shows the following jobs:

- 0: Warte Zeitpunkt_0 (Sonntag 00:00:00)
- 1: SetAndCheck_1 (Konditionierung)
- 2: Block_2 (BlockCycles 1)
- 3: Schleife_7 (Anzahl Schleifen 10)
- 4: Schleife_8 (Anzahl Schleifen 7)
- 5: Nächstes Programm

The data table below the graph shows the following data:

Se...	Dauer	Temp	Feuchte	Spur 1	Spur 2	Schalter 1	Schalter 2	Licht 1	Licht 2
1	0h01m00s 0:01:00	58,0	50,0	<input type="checkbox"/> B1.Aus	<input checked="" type="checkbox"/> B2.Ein	I1.2 (2)	I2.3 (3)	19,0	12,0
2	0h02m00s 0:01:00	60,0	50,0						
3	0h03m00s 0:01:00	32,0	30,0						
4	0h04m00s 0:01:00	32,0	30,0						
5	0h05m00s 0:01:00	-0,0	15,0						
6	0h06m00s 0:01:00	-0,0	15,0						

The 'ProgramList' table shows the following data:

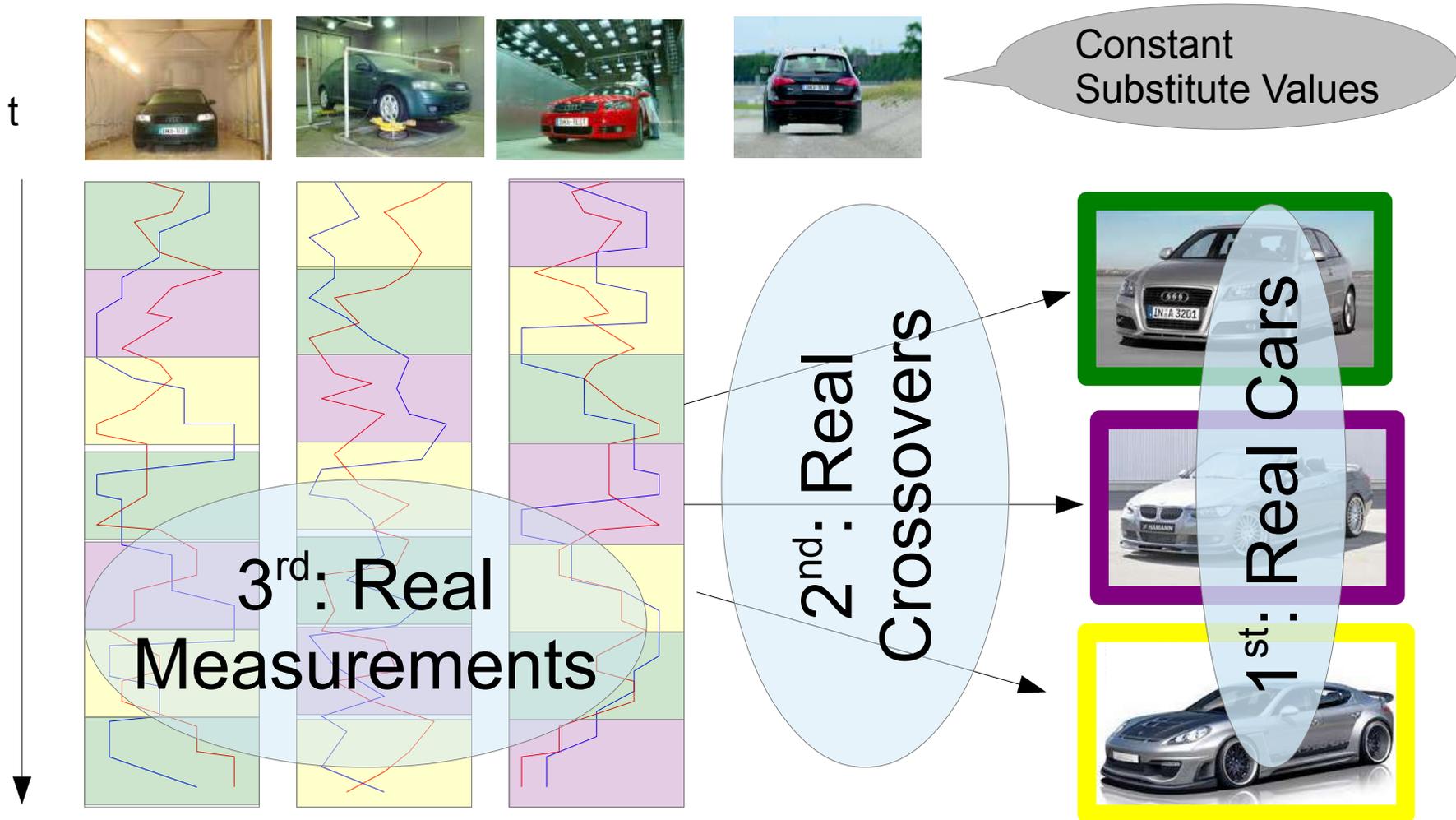
BetrNr	int4	<pk.fk>
ProgName	text	<pk>
Color	int4	
ProgCode	xml	

Do it !



Well Done ? !

Stitch Measurements per Car



Administration of cars Hat Assignments

Stammdaten

File Help

HutBelegung Msg

Stammdaten/Hutbelegung Historie fk fk 257

Ser	Serial	Fahr	Type	Auft	Order	Hut	Von	From	Bis	To
061A	023 365		Daimler C-Klasse	EG-35 Nr.	116	C	2001-10-26 07:30		2002-04-25 07:15	
8HZK	000 137		AUDI B6 Cabrio	EG-35 Nr.	115	A	2001-11-09 07:30		2002-04-02 07:30	
4E2N	000 039		Audi D3 Prototyp	EG-35 Nr.	117	B	2001-12-21 07:30		2002-06-04 07:30	
8E62A	218 150		AUDI B6 Avant	GQ-43 Nr.	001	D	2002-02-28 07:30		2002-07-11 07:15	
AAT51040FT	56341		BMW 316 Ti 1,6l	EG-35 Nr.	118	E	2002-04-12 07:30		2002-09-12 07:30	
8PZ2A000042			AUDI A3 Prototyp	EG-35 Nr.	119	F	2002-05-08 11:51		2002-09-25 07:30	
4E3N000177							2002-05-08 11:53		2002-12-20 09:00	
ID1016Nr	20237						2002-05-15 14:00		2002-11-04 07:15	
4B02N	126200						2002-05-23 14:00		2002-10-04 08:45	
VW3BZ3P054451							2002-07-08 07:15		2002-11-29 08:45	
8H73K006718							2002-07-29 07:15		2002-12-16 07:15	
LfdID	1061200259						2002-08-01 01:50		2002-12-18 08:44	
Lfd ID	1101/2002/093		Dächer Seat Ibiza 3St	I/EG-35Lfd.ID: 1101/ ...		C	2002-11-06 07:15		2003-03-17 07:15	
8Z64000112			A2 Hybridbauweise	Eg-35 Nr.	121	E	2002-11-06 14:15		2003-03-19 15:15	
8P3A000172			Audi A3 PVS	EG-35 Nr.	122	F	2002-11-21 13:00		2003-04-24 08:50	

Hat_Assignment

Id	bigserial	<pk>
CarSerial	text	
HatName	text	
From	timestamp with time zone	
To	timestamp with time zone	

Administration of cars

Changeovers → Treatments

The screenshot shows the 'FzgAuswertung' application window. The main interface includes a menu bar (File, Auswertung, Einstellungen, Meldungen) and a search/filter section with fields for 'Nur aktuelle FZG', 'Fz-Typ' (Audi AU 213 Serie A1 SB), 'Hut' (A), 'SerienNr.' (8X0CB247575), 'Von' (2012-06-01 15:15), 'Bis' (NULL), 'Auftrag' (I/GQ-31_071), and 'Kunde' (NULL). Below this is a 'Behandlungen' section with tabs for 'Statistik', 'Histogramme', and 'Diagramme'. A table of treatments is displayed with columns: Kammer, Chamber, FZW, Treatment, Position, Startzeit, From, Endezeit, To, and Status. A yellow tooltip titled 'Treatments' is overlaid on the table, showing the following database schema:

Field	Type	Constraint
BetrNr	int4	<pk>
Name	text	<pk>
StartTime	timestamp with time zone	
EndTime	timestamp with time zone	
Status	int4	
Memo	text	

The table below shows the data for the treatments:

Kammer	Chamber	FZW	Treatment	Position	Startzeit	From	Endezeit	To	Status
019	Salzsprüh	8X0CB247575.1		Links	2012-06-01 15:15		2012-06-04 07:15		Fertig
	Teststrecke	8X0CB247575.2		-/-	2012-06-04 07:15		2012-06-04 15:15		Fertig
007	Feuchtwärme	8X0CB247575.3		Links	2012-06-04 15:15		2012-06-05 07:15		Fertig
	Teststrecke	8X0CB247575.4		-/-	2012-06-05 07:15		2012-06-05 13:30		Fertig
032	Sonne	8X0CB247575.5					2012-06-06 07:15		Fertig
	Teststrecke	8X0CB247575.6					2012-06-06 09:15		Fertig
015	Salzsprüh	8X0CB247575.7					2012-06-11 07:15		Fertig
	Teststrecke	8X0CB247575.8					2012-06-11 09:15		Fertig
	Werkstatt	8X0CB247575.9					2012-06-11 12:15		Fertig
011	Salzsprüh	8X0CB247575.10					2012-06-12 07:15		Fertig
	Teststrecke	8X0CB247575.11					2012-06-12 09:15		Fertig
007	Feuchtwärme	8X0CB247575.12		Links	2012-06-12 09:15		2012-06-13 07:15		Fertig

The status bar at the bottom indicates: [2014-03-31 18:50:15 INFO] Fzg-Profil: Fertig



Measurements

Lots of edges and data to stitch

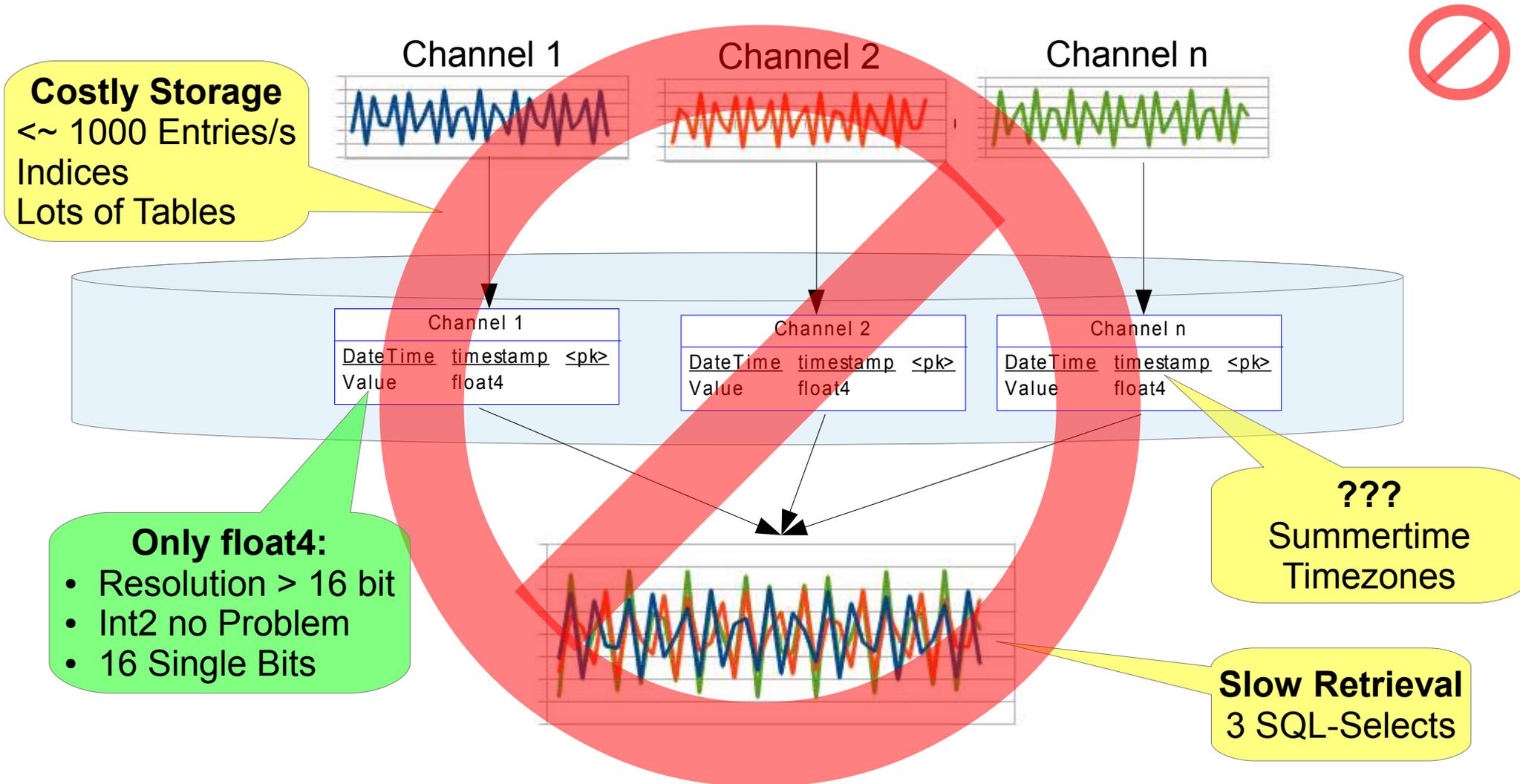
14 cars under test

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

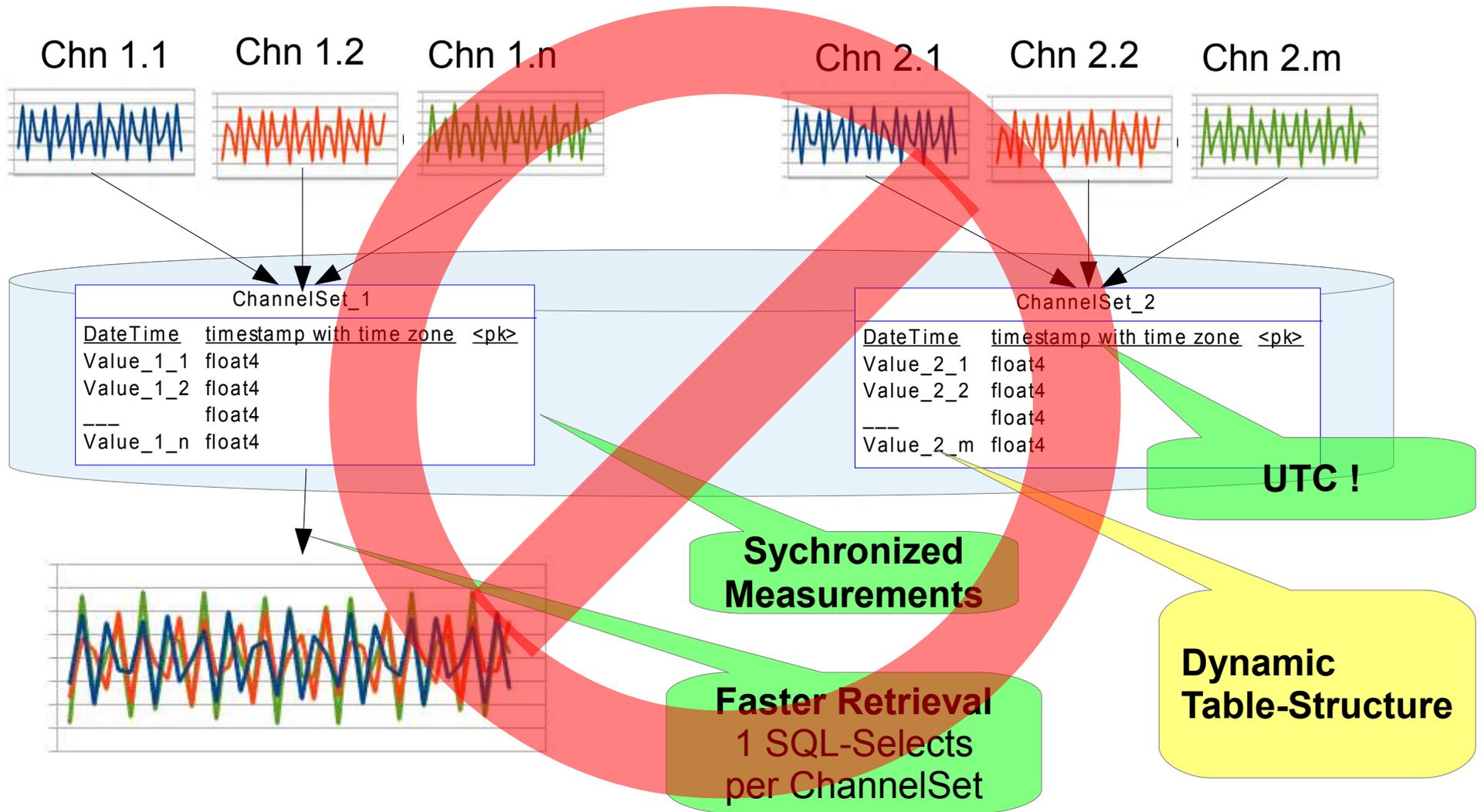
→ **Fast Access to measurements !**



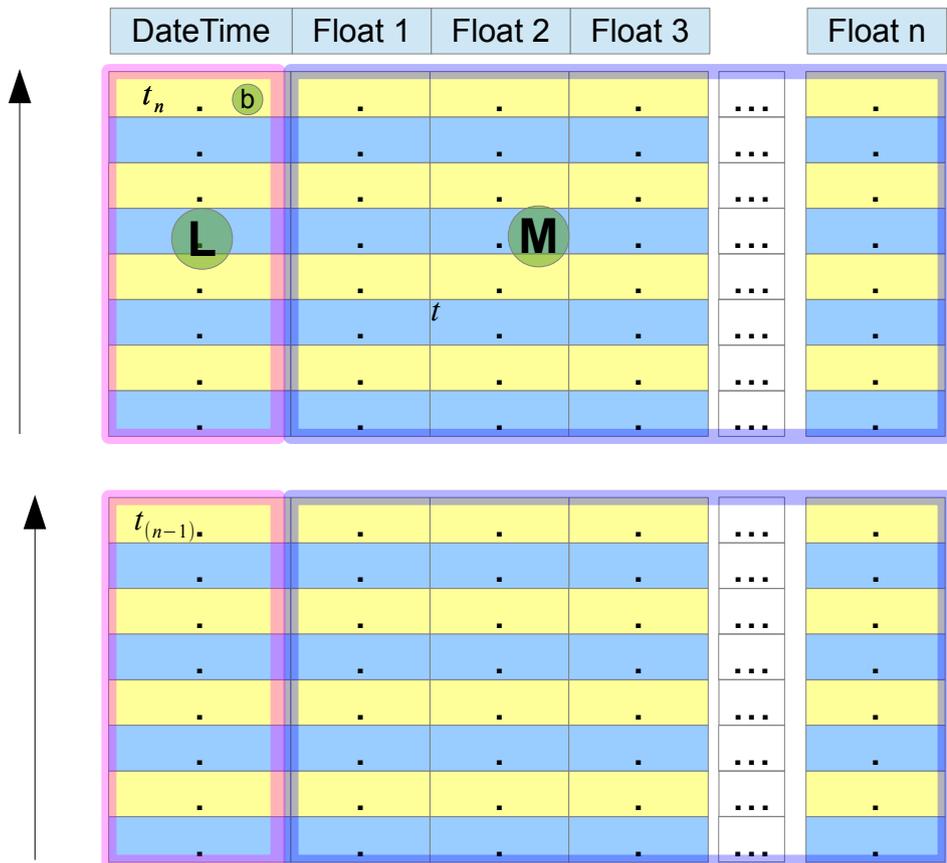
Storing Measurements (Simplest Way)



Storing Measurements (Channel-Sets)



Storage: Packaging

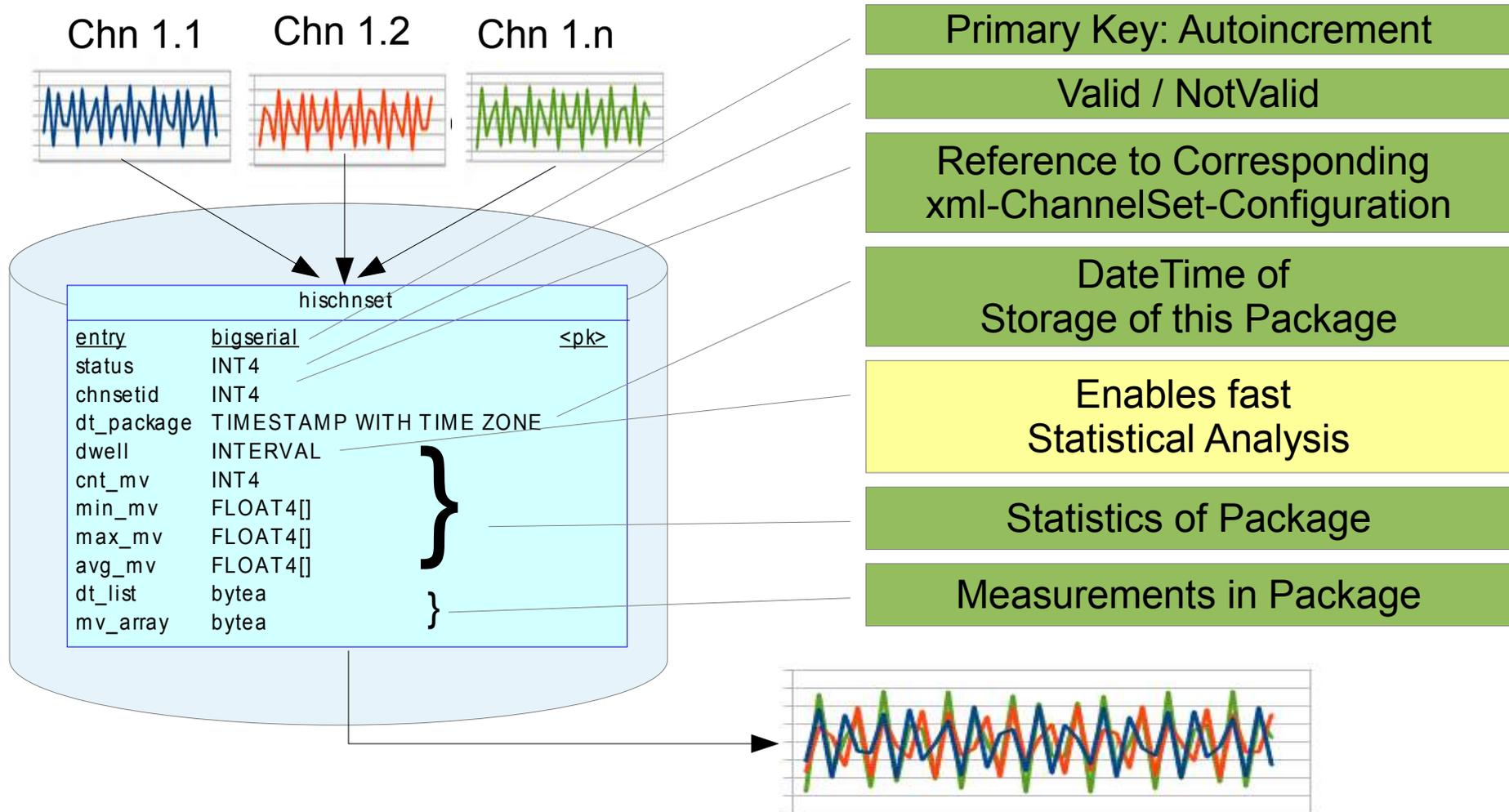


- b** • DateTime of Package
- c** • $dwell = t_n - t_{(n-1)}$
- d** • Count Of Measurements in Package
- e** • $[\min(\text{Float } 1), \min(\text{Float } 2), \dots, \min(\text{Float } n)]$
- f** • $[\max(\text{Float } 1), \max(\text{Float } 2), \dots, \max(\text{Float } n)]$
- g** • $[\text{avg}(\text{Float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

hischnset		
<u>entry</u>	<u>bigserial</u>	<u><pk></u>
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

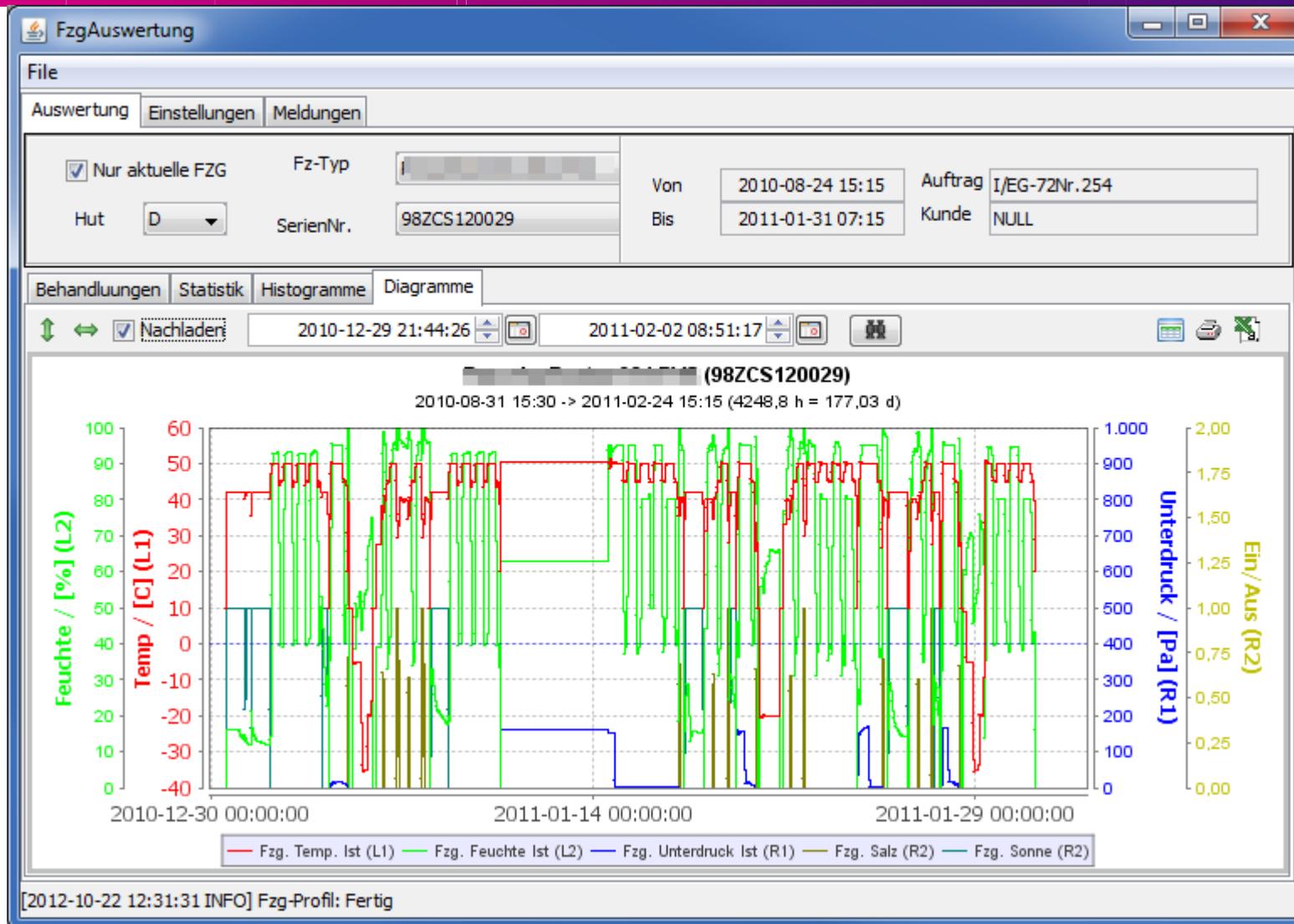


Stitching the Measurements

- 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

File
Auswertung | Einstellungen | Meldungen

Nur aktuelle FZG Fz-Typ: []
Hut: D SerienNr.: 98ZCS120029 Von: 2010-08-24 15:15 Auftrag: I/EG-72Nr.254
Bis: 2011-01-31 07:15 Kunde: NULL

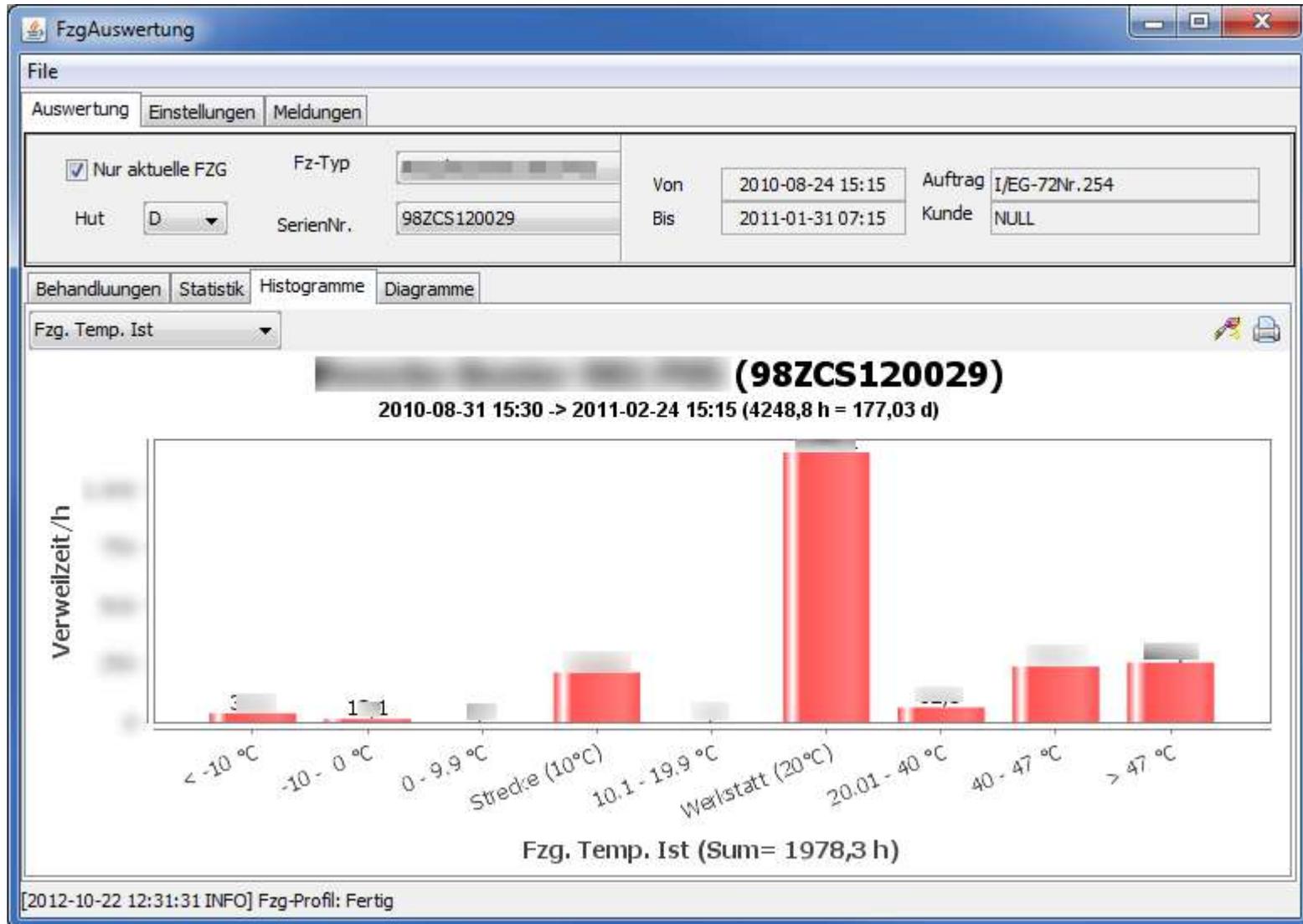
Behandlungen | Statistik | Histogramme | Diagramme

MessIndex	BereichsIndex	Name of Stress Condition	Duration/h
0	0	2010-08-31 15:30:00+02 -> 2011-02-24 15:15:00+01	
0	1	Profil.Summe	
1	0	Fzg. Temp. Ist.Total	
1	1	< -10 °C	
1	1	-10 - 0 °C	
1	1	0 - 9.9 °C	
1	1	Strecke (10°C)	
1	1	10.1 - 19.9 °C	
1	1	Werkstatt (20°C)	
1	7	20.01 - 40 °C	
1	8	40 - 47 °C	
1	9	> 47 °C	
2	0	Fzg. Feuchte Ist.Total	
2	1	< 45 %	
2	2	45 - 60 %	
2	3	60 - 82 %	
2	4	82 - 99 %	
2	5	> 99.99 %	

[2012-10-22 12:31:31 INFO] Fzg-Profil: Fertig



Car under Test: Statistics

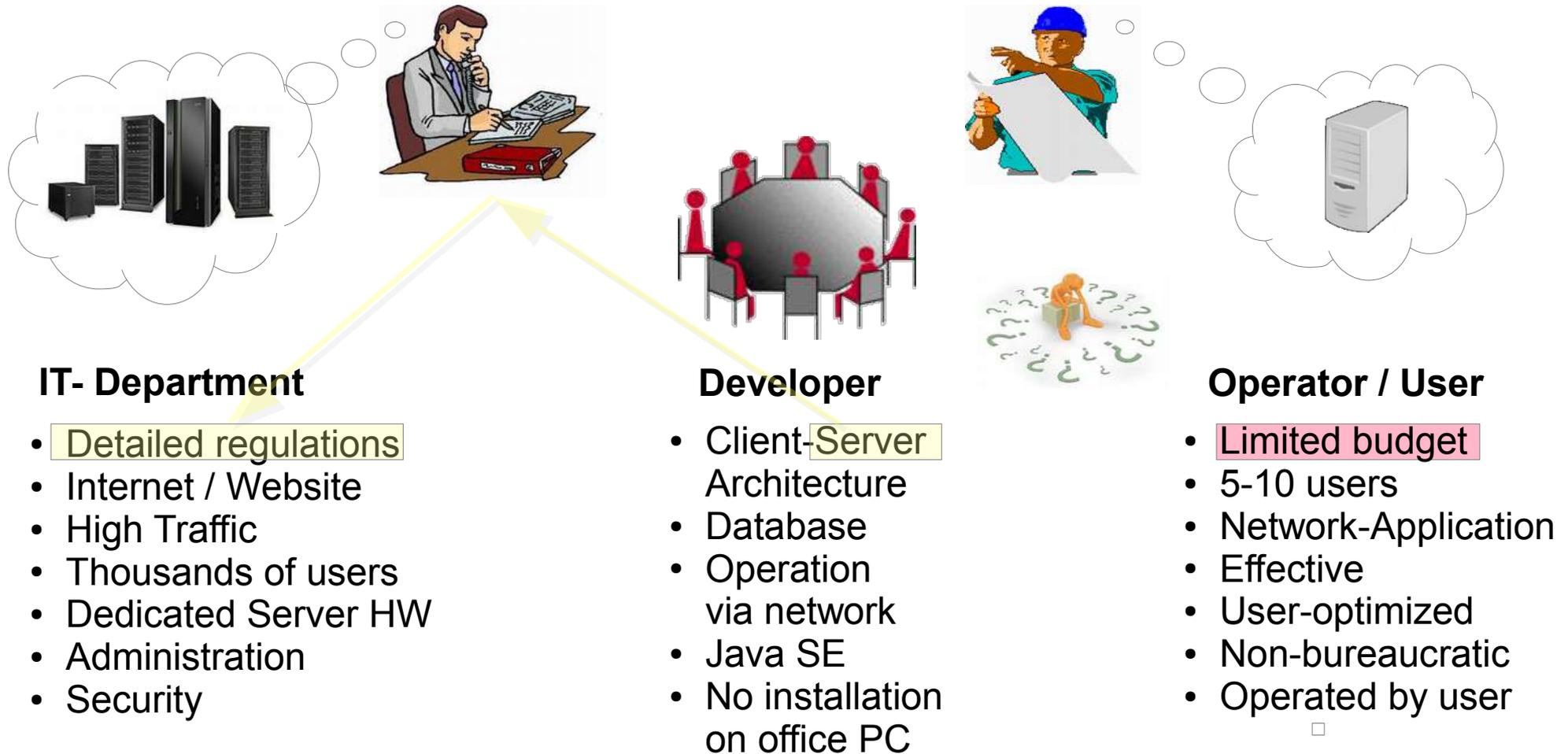


Well Done ? !

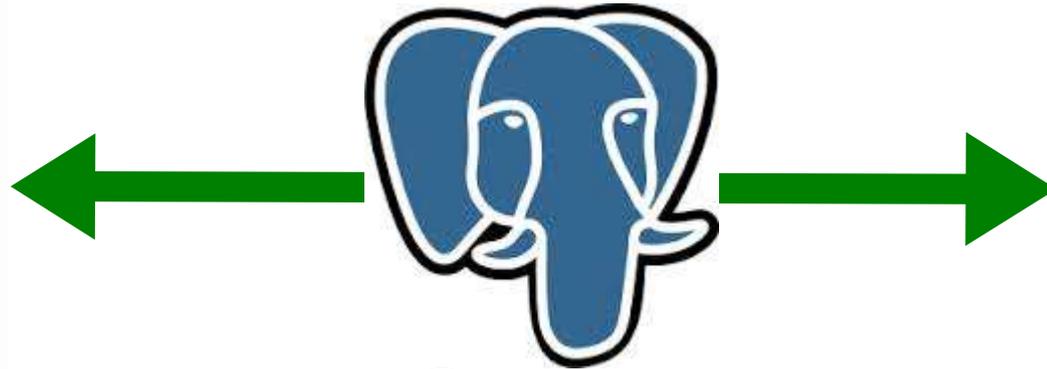


Story: Kick-Off Meeting

Standard-IT ↔ Technical Software



Sharing Technologies and Experiences



Large Benefit

