PostgreSQL in the database landscape

by

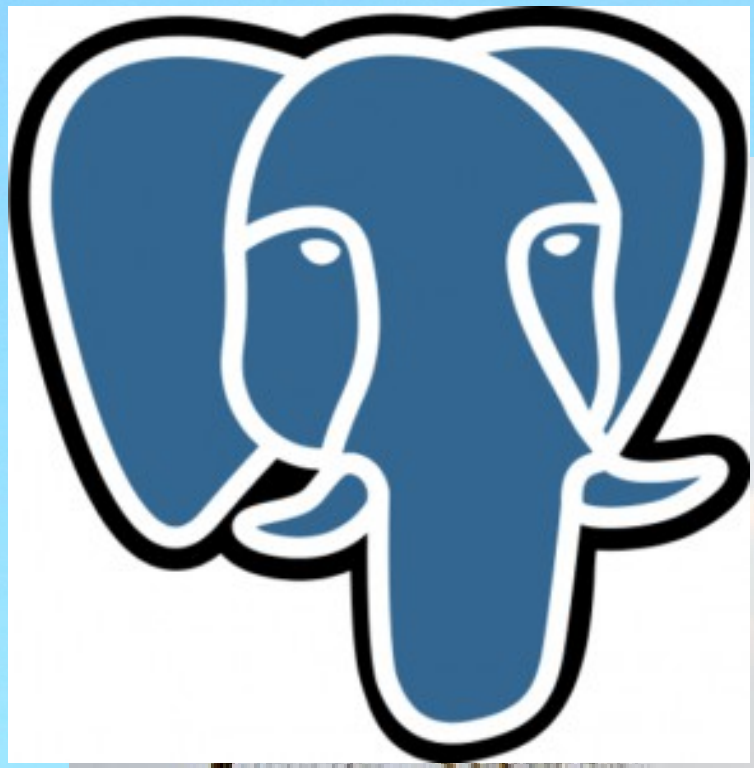
Simon Riggs
Harald Armin Massa

2ndQuadrant
Professional PostgreSQL

Computing Seminar at CERN, February 12 2013

organised by Benedikt Hegner, PH Department
Miguel Angel Marquina, Computing Seminars /IT Department

PostgreSQL



Who is this?
Why is he promoting PostgreSQL?
What is he trying to sell?

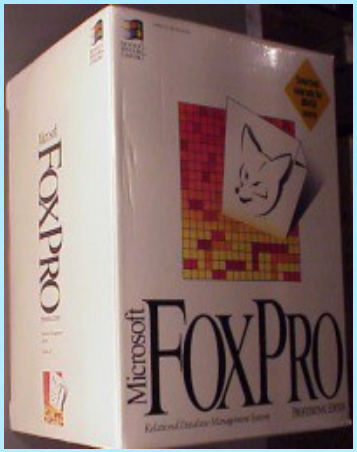
Harald Armin Massa
2ndQuadrant

1st database experience around 1984

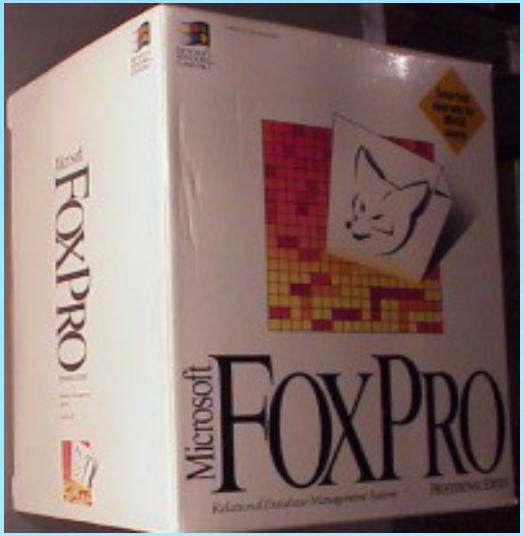
starting with NoSQL Databases on C64 / VC1541

IBM SNA
DOS/VSE
MVS/ESA

ABAP/4
COBOL
CICS



starting around 1997



PostgreSQL

why – 1

2002-12-11 *Bruce Momjian* **Reorder psql \? help into groupings, idea from Harald...** commit | commitdiff | tree

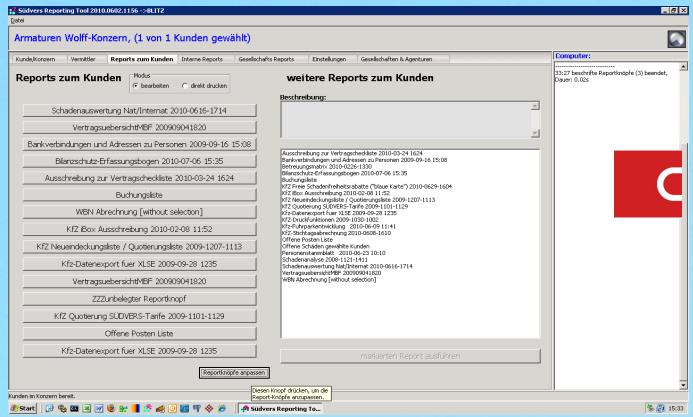
...help into groupings, idea from Harald Armin Massa.

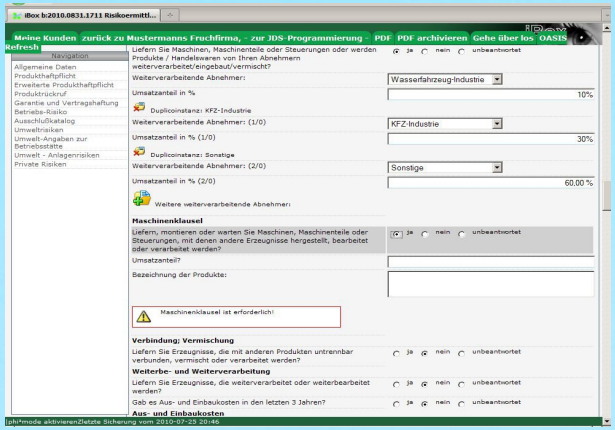
```
ws2ndq=> \?
General
  \copyright             show PostgreSQL usage and distribution terms
  \g [FILE] or ;         execute query (and send results to file or |pipe)
  \h [NAME]              help on syntax of SQL commands, * for all commands
  \q                     quit psql

Query Buffer
  \e [FILE]              edit the query buffer (or file) with external editor
  \ef [FUNCNAME]         edit function definition with external editor
  \p                     show the contents of the query buffer
  \r                     reset (clear) the query buffer
  \s [FILE]              display history or save it to file
  \w FILE                write query buffer to file

Input/Output
  \copy ...              perform SQL COPY with data stream to the client host
  \echo [STRING]         write string to standard output
  \i FILE                execute commands from file
  \o [FILE]              send all query results to file or |pipe
  \qecho [STRING]        write string to query output stream (see \o)

Informational
  (options: S = show system objects, + = additional detail)
  \d[S+]                 list tables, views, and sequences
  \d[S+]  NAME           describe table, view, sequence, or index
```





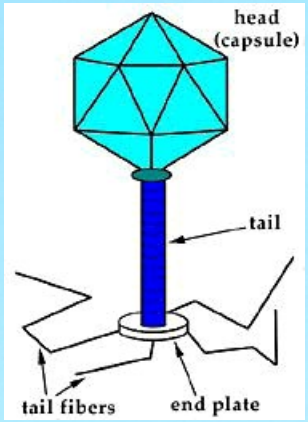
member of
Python Software Foundation

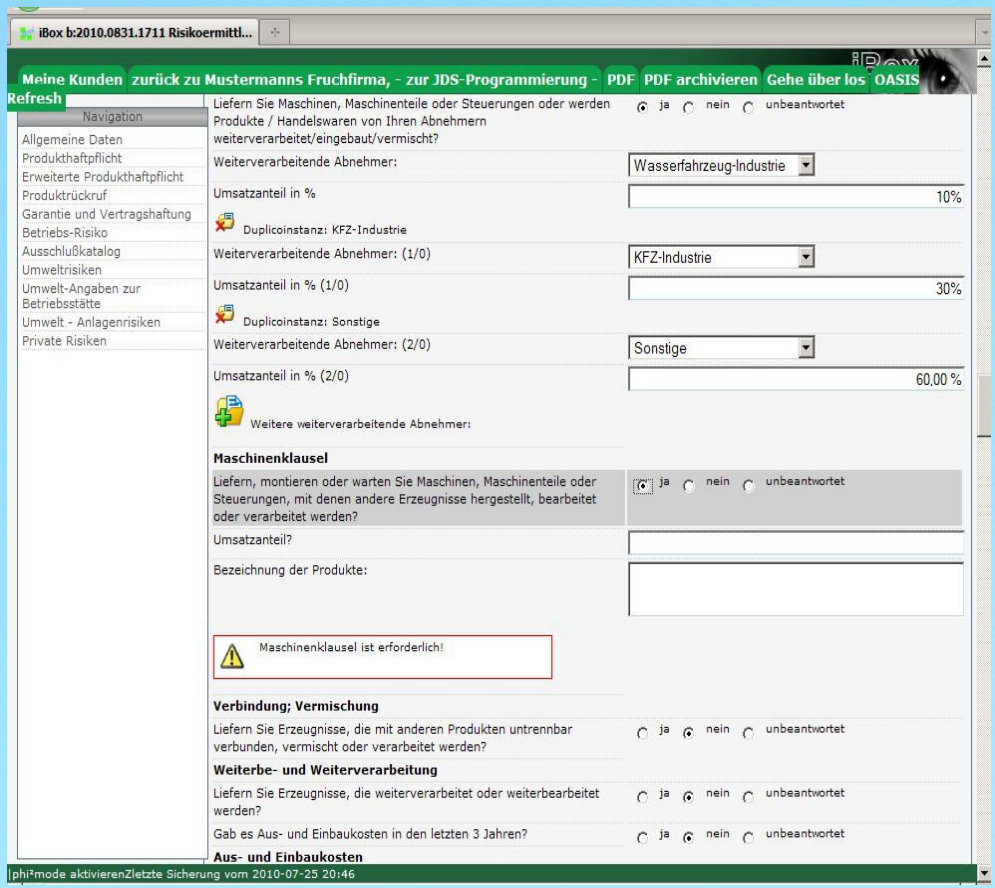
Square Kilometre Array South Africa

why - 2

PostgreSQL

Sternberg Astronomical Institute
Catalog Access Services





database PostgreSQL

first version of PostgreSQL on Windows

started development with PostgreSQL 7.4 binaries from an anonymous FTP server

pilot rollout with 8.0beta1

```
*** STOP: 0x0000000A (0xFFBDF004,0x00000010,0x00000000,0x800079D3)
IRQL_NOT_LESS_OR_EQUAL*** Address 800079d3 has base at 80007000 - SCSIPORT.SYS

CPUID:GenuineIntel 5.2.4 irql:1f DPC SYSVER 0xf0000565

Dll Base DateStmp - Name                 Dll Base DateStmp - Name
80100000 36224cda - ntoskrnl.exe         80010000 35e72341 - hal.dll
80001000 35ca19d8 - symc810.sys          80007000 35e5c313 - SCSIPORT.SYS
802fa000 353e319e - Disk.sys             8038c000 36269e3f - CLASS2.SYS
80390000 362383d3 - Ntfs.sys             f8ea8000 31ec6c8d - Floppy.SYS
f8eb8000 353e319c - Cdrom.SYS            f9214000 00000000 - Null.SYS
f9074000 35eb144b - KSecDD.SYS           f9215000 00000000 - Beep.SYS
f8ee8000 353e3184 - i8042prt.sys         f907c000 353e318a - mouclass.sys
f9084000 31ec6c94 - kbdclass.sys         f8f00000 35648e19 - VIDEOPRT.SYS
f8c10000 353e3155 - s3.SYS               f9094000 360ea154 - vga.sys
f8f30000 353e31df - Msfs.SYS             f8c30000 353e31d5 - Npfs.SYS
fe4bb000 362043ba - NDIS.SYS             f909c000 35fe17b4 - ndistapi.sys
a0000000 36248f4f - win32k.sys           fe482000 35d9fd5f - s3.dll
f8c70000 353e3626 - Cdfs.sys             fe437000 35dde3d6 - Fastfat.SYS
f9132000 35fe29fd - rasacd.sys           fe4a7000 31ec6e6c - TDI.SYS
fe3ea000 36243c12 - tcpip.sys            fe3cc000 36129a8d - netbt.sys
fe49f000 35e5c7f3 - rasarp.sys           f8cf0000 3548ba13 - asyncmac.sys
fe493000 31ec6e15 - el1nk3.sys           f8d00000 35fe1816 - ndiswan.sys
fe3bb000 3610249c - afd.sys              f8fbf000 353e35d4 - netbios.sys
fe47e000 31ec6c9b - Parport.SYS          fe476000 353e318f - Parallel.SYS
f913c000 31ec6c9d - ParVdm.SYS           f8d40000 35ef29c4 - Serial.SYS
fe352000 35f03aa8 - rdr.sys              fe2ef000 35b7f615 - srv.sys
fe2de000 353e362c - mup.sys

Address  dword dump   Build [1381]                                - Name
80149f8 800079d3 800079d3 805f58c8 8047b000 805f5a06 805f1400 - SCSIPORT.SYS
80149a0c 80149a3c 80140a3c 800079bf 805f58c8 8047b000 805f5a06 - ntoskrnl.exe
80149a10 800079bf 800079bf 805f58c8 8047b000 805f5a06 805f1400 - SCSIPORT.SYS
80149a5c 80149a84 80149a84 00000000 800079d3 00000008 00010296 - ntoskrnl.exe
80149a64 800079d3 800079d3 00000008 00010296 00000000 805f1530 - SCSIPORT.SYS
80149a80 80149ab8 80149ab8 80149ac0 800039b6 805f5a48 fe26dd3c - ntoskrnl.exe
80149a84 80149ac0 80149ac0 800039b6 805f5a48 fe26dd3c 805732c8 - ntoskrnl.exe
80149a88 800039b6 800039b6 805f5a48 fe26dd3c 805732c8 80149ab8 - symc810.sys
80149a98 80149ab8 80149ab8 805f5a48 fe26dd3c 805f14f0 fe26dd3c - ntoskrnl.exe
80149ac0 80149af8 80149af8 8000442b 805f5a48 805f14f0 fe26dd3c - ntoskrnl.exe
80149ac4 8000442b 8000442b 805f5a48 805f14c0 805f14c0 fe26dd3c - symc810.sys
80149afc 800023fd 800023fd fe26dd3c 805f5a48 fe26dd3c 805eed08 - symc810.sys
80149b14 800084eb 800084eb 805f5a48 fe26dd3c 80149b44 fe26dd4c - SCSIPORT.SYS

Beginning dump of physical memory
Restart and set the recovery options in the system control panel
or the /CRASHDEBUG system start option. If this message reappears,
contact your system administrator or technical support group.
```

why – 3

http://www.crowdrise.com

Professor Michael Stonebraker

POSTGRES – 1986

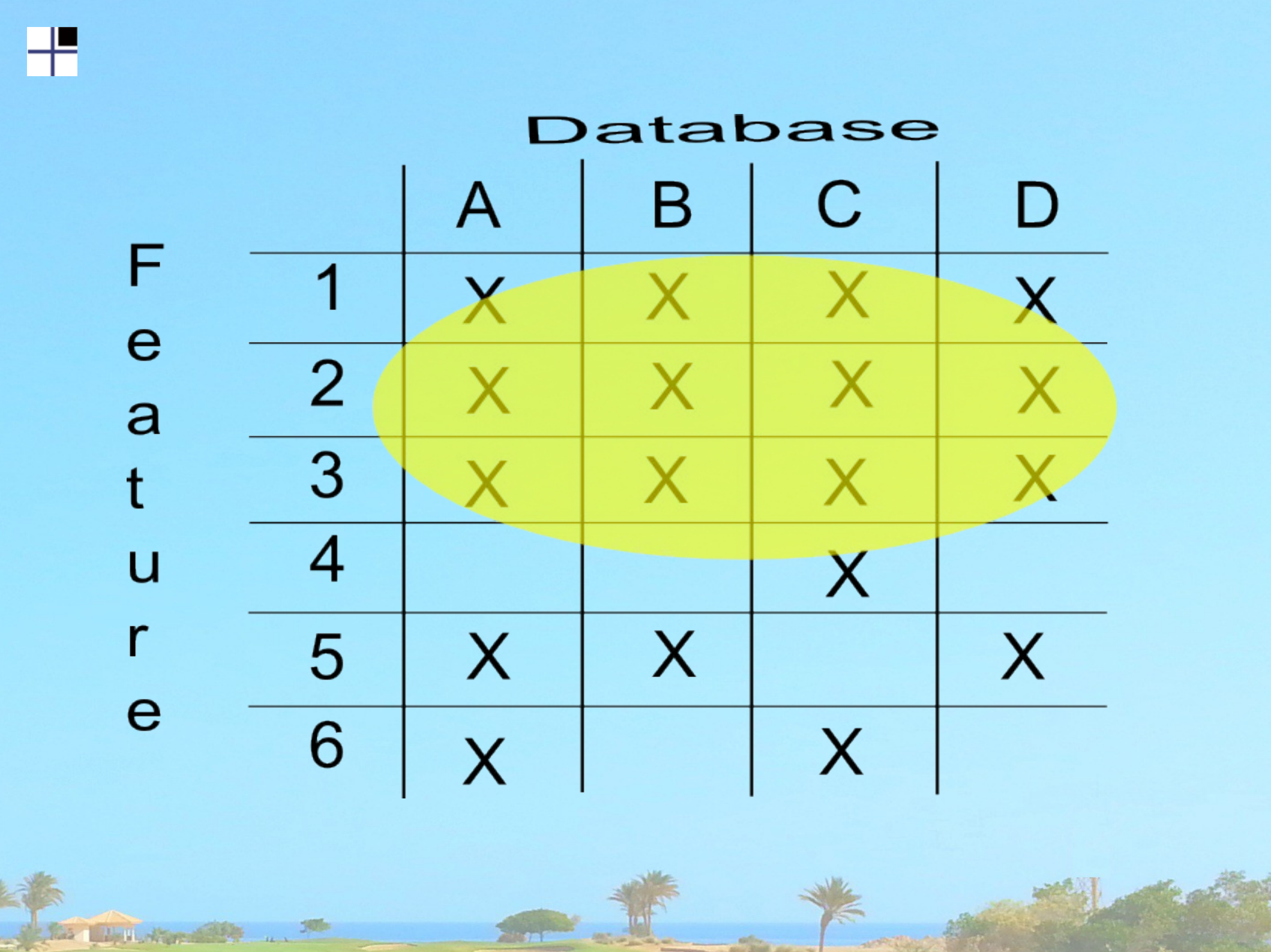
Successor to the INGRES relational database system

(quoting & rephrasing „The design of POSTGRES“, initial paper by M. Stonebraker):

- user extendibility for data types, operators and access methods
- facilities for active databases (i.e., alerters and triggers)
- simplify the DBMS code for crash recovery
- take advantage of [...]multiple tightly-coupled processors

theoretical limits as of now

Limit	Value
Maximum Database Size	unlimited
Maximum Table Size	32 TB
Maximum Row Size	1.6 TB
Maximum Field Size	1GB
Maximum Rows per Table	unlimited
Maximum Columns per table	250-1600 (depending on column types)
Maximum Indexes per Table	unlimtied


Database
A
B
C
D
Feature
1
2
3
4
5
6
X
X
X
X
X
X
X
X
X
X
X
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X
X
X
X
X

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PostgreSQL Database Management System
(formerly known as Postgres, then as Postgres95)

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some of the sponsors

concepts and consequences

- meritocracy for commit rights
  - those who proof that they are worthy are those who are in charge of the decisions
  - worthyness is proofen within the field, NOT by title in company

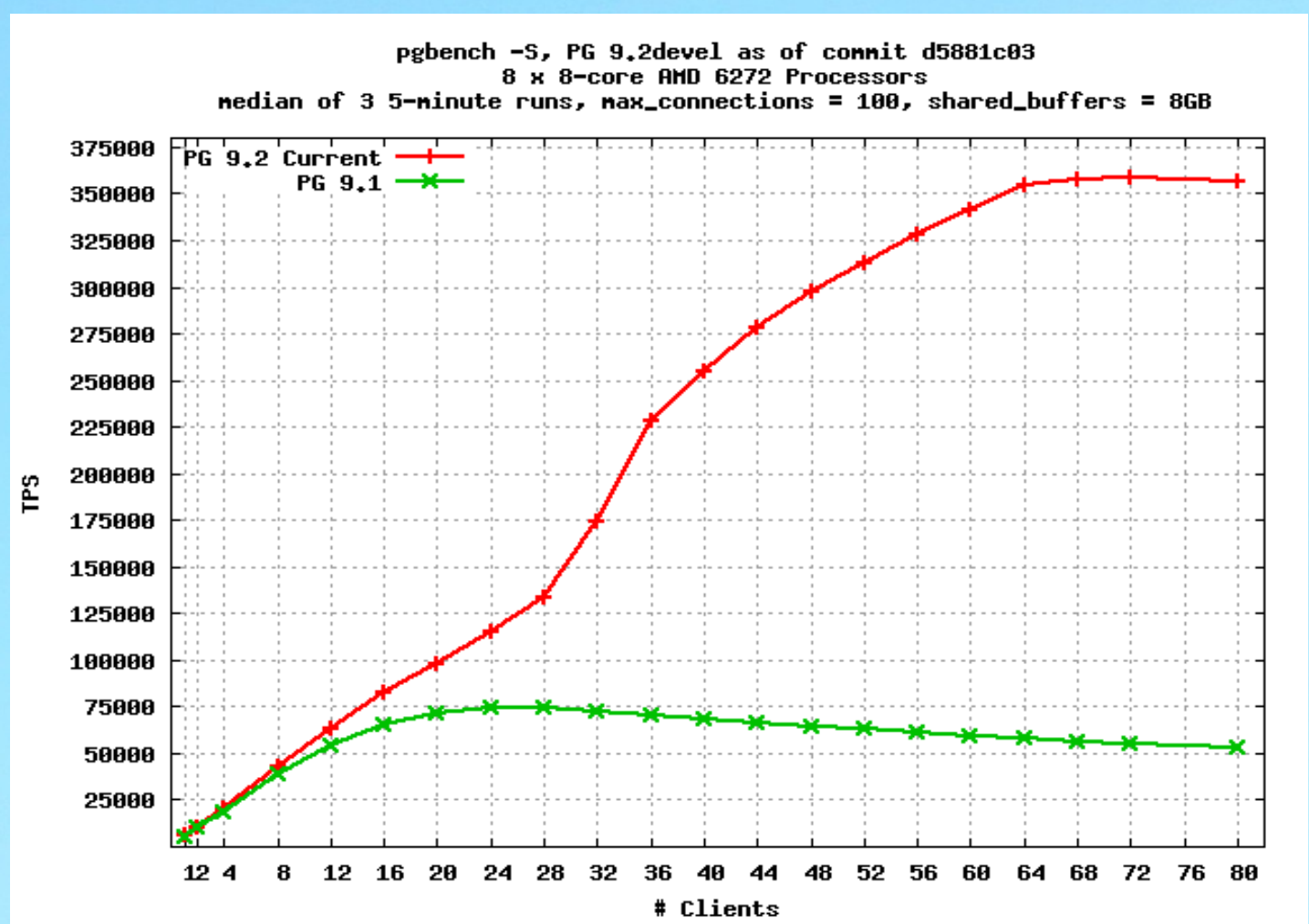
concepts and consequences

- avoid reimplementing functions implemented by the operating system
  - use OS-drivers for disk access
  - use OS disk cache
  - physical backup via filecopy
    - no „certified for PostgreSQL“ needed

concepts and consequences

- designed for multiple processors from the start
  - price of interprocess communication
  - new process costly on older operating systems
  - cost needs to be payed even with one processor
  - NOW with multicore everywhere....

concepts and consequences



concepts and consequences

- open engeneering
  - open discussions
  - publicly archived & docmented discussions
  - public flame wars

„user driven development“

exhibit 1: the psql utility

- interactive shell
- tab completion
- line editing / history
- available since the beginning

development by database users

exhibit 2: datatype text

- up to 1 Gigabyte per field
- better performance then char, varchar
- one solution for every length
- no need for „are 80 chars wide enough for x“

development by database users

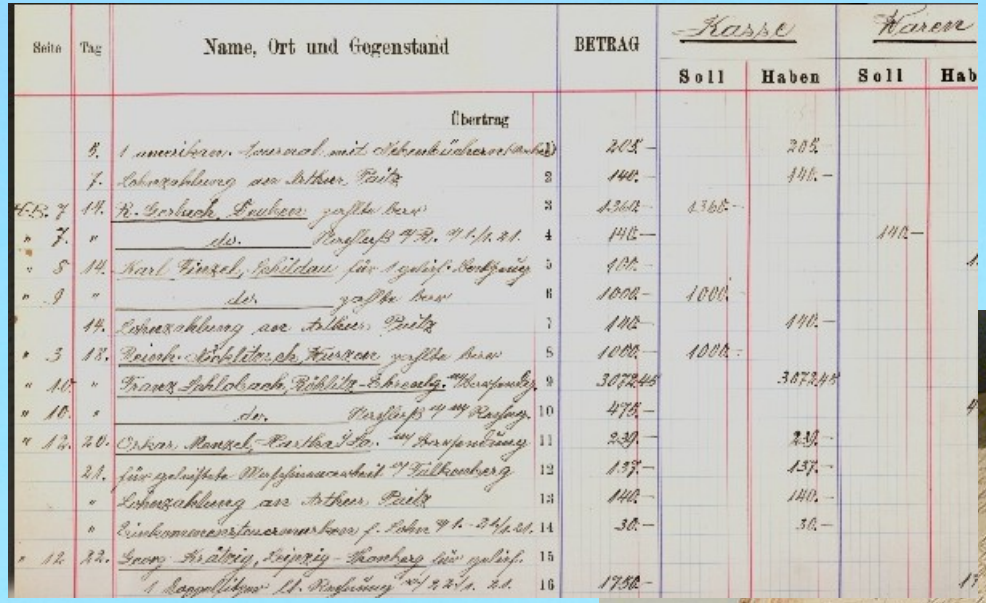
exhibit 3: COPY FROM / TO <csv table>

- included in psql command line tool & server
- no extra utility for import/export

exhibit 4: pg_dump / pg_restore

backup running system into 1 file

reusing concepts and code



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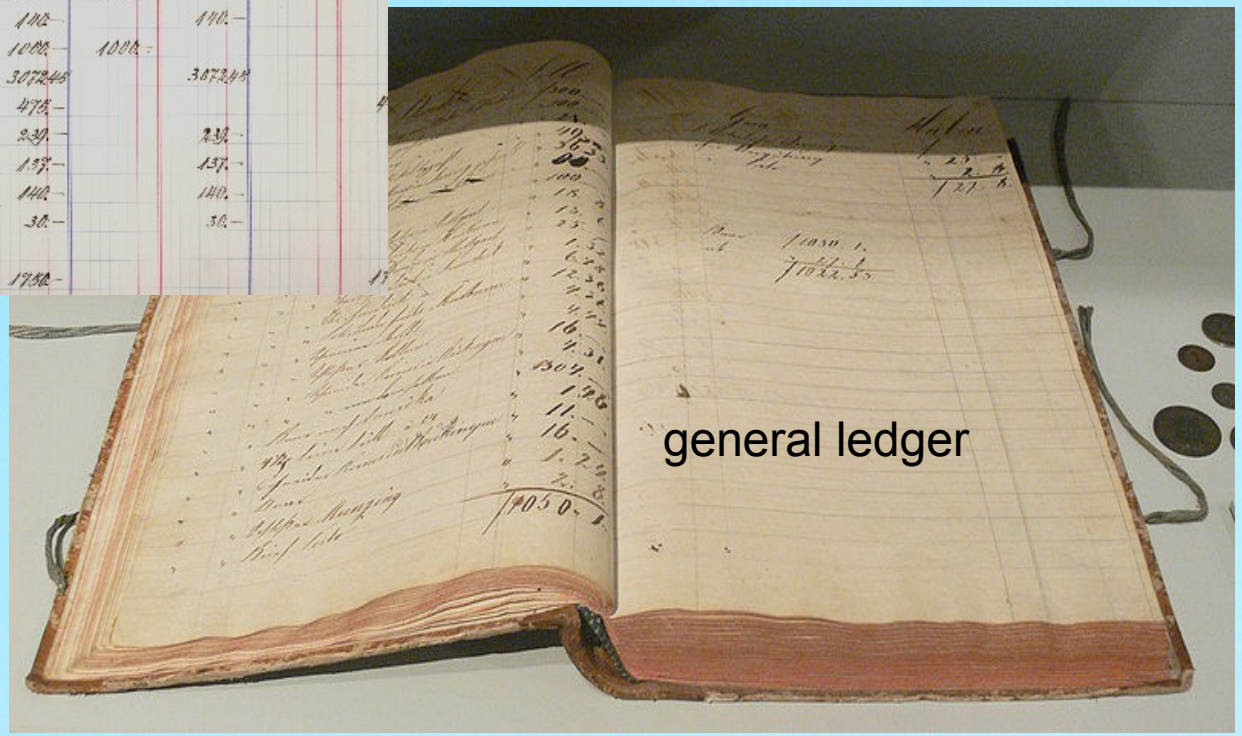
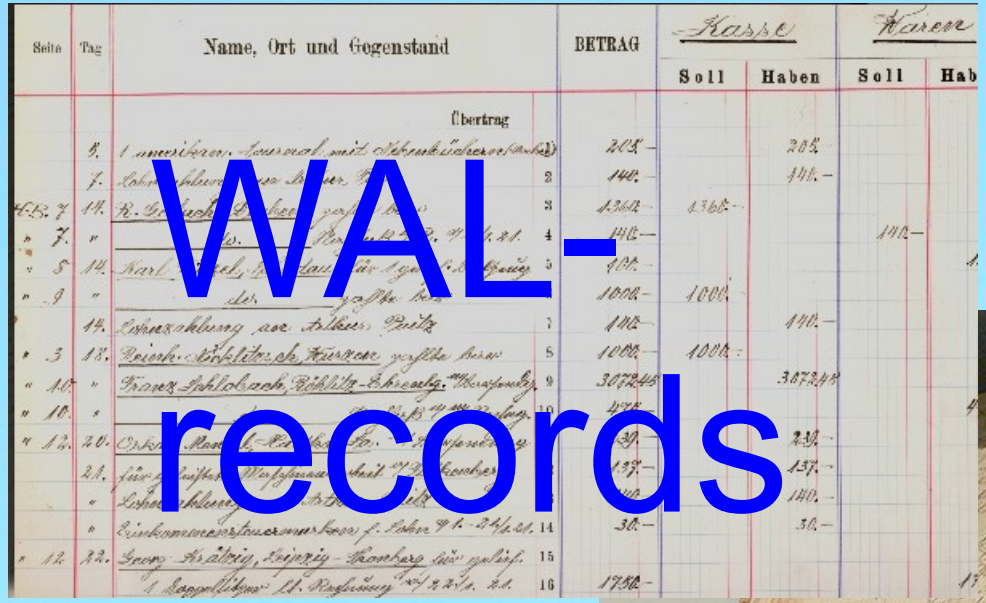
		Übertrag						
	5.	1 amerikan. Journal mit Nebenbüchern (Anhang)	1	205.–		205.–		
	7.	Lohnzahlung an Arthur Paitz	2	140.–		140.–		
H.B. 7	14.	R. Gerbach, Deuben zahlte bar	3	1360.–	1360.–			
" 7.	"	do. Verschluß v. R. v. 1/1. 21.	4	140.–			140.–	
" 8	14.	Karl Finzel, Schildau für 1 gelief. Denkzeug	5	100.–				
" 9	"	do. zahlte bar	6	1000.–	1000.–			
	14.	Lohnzahlung an Arthur Paitz	7	140.–		140.–		
" 3	18.	Reinh. Röhlitzsch, Hurzen zahlte bar	8	1000.–	1000.–			
" 10.	"	Franz Schlobach, Röhlitz-Ehrenbg. m/ Verschluß	9	3072.45		3072.45		
" 10.	"	do. Verschluß v. m/ Rechng.	10	475.–				
" 12.	20.	Oskar Menzel, Hartha i/Sa. m/ Verschluß	11	239.–		239.–		
	21.	für geleistete Maschinenarbeit v/ Falkenberg	12	137.–		137.–		
	"	Lohnzahlung an Arthur Paitz	13	140.–		140.–		
	"	Einkommensteuermarken f. Lohn v. 1.–24/1. 21.	14	30.–		30.–		
" 12	22.	Georg Krätzig, Leipzig-Thonberg für gelief. 1 doppelsitzer Lt. Rechnung v. 22/1. 21.	15 16	1750.–				

ca. 1340, Genua



general ledger

reusing concepts and code



WAL-records

table files

reusing concepts and code

WAL-record

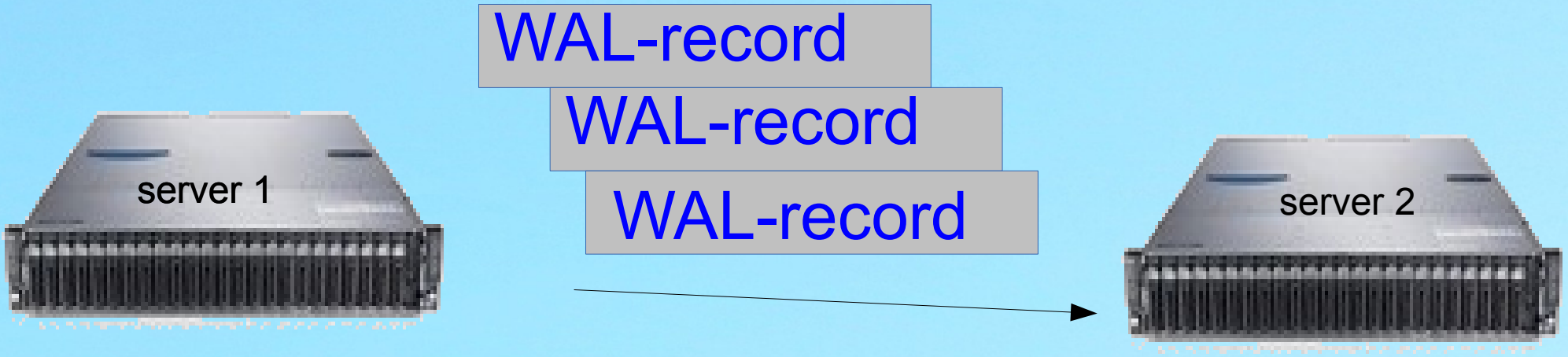
WAL-record

WAL-record

online physical backup

Point In Time Recovery

reusing concepts and code



(streaming) replication

LIBO.RU

server-side-programming: Procedural Languages

- a wealth of languages is available
  - PL/Python
  - PL/Java
  - PL/Perl
  - PL/Tcl
  - PL/R
  - PL/Mono
  - PL/V8
  - PL/scheme

```
CREATE OR REPLACE FUNCTION pyoav(jsondata
text, feldname text)
  RETURNS text AS
$BODY$
  import json
  jsonparsed=json.loads(jsondata)

  return jsonparsed.get(feldname,'<nicht vorhanden>')
$BODY$
  LANGUAGE plpythonu VOLATILE
  COST 100;
```

server-side-programming: Procedural Languages

- creating new proceduar languages may be even too easy:

```
CREATE FUNCTION LOL_MAIN_TEST(TEXT)
RETURNS BOOLEAN
LANGUAGE PLLOLCODE
AS $$
HAI
    VISIBLE INFO LOL1
    FOUND YR WIN
KTHXBYE
$$;

SELECT LOL_MAIN_TEST('IM IN YR DATABUKKIT');

INFO:  IM IN YR DATABUKKIT
 lol_main_test
 ---------------
  t
  (1 row)
```

server-side-programming

- create new functionality running within the server
- calling into PostgreSQL via Server Programming Interface
- advantage open source
  - detailed documentation
  - debugging into servercode

Extending: new data types

- PostgreSQL operation catalog-driven
- including information about data types
- new data types = new catalog entries
- including operations on them

Extending: data type examples

- hstore
  - stores key => value pairs
  - foo => bar, baz => whatever
- range types
  - part of PostgreSQL 9.2
  - range of some element type
  - full index support for range-overlapping queries
- json (new in 9.2)

Extending: data type examples

- PostBIS - Bioinformatics Booster for PostgreSQL
  - DNA_SEQUENCE
  - RNA_SEQUENCE
  - AA_SEQUENCE
  - ALIGNED_DNA_SEQUENCE
  - ALIGNED_RNA_SEQUENCE
  - ALIGNED_AA_SEQUENCE

Extending: entirely new index types

quoting PostgreSQL documentation, Chapter 52:

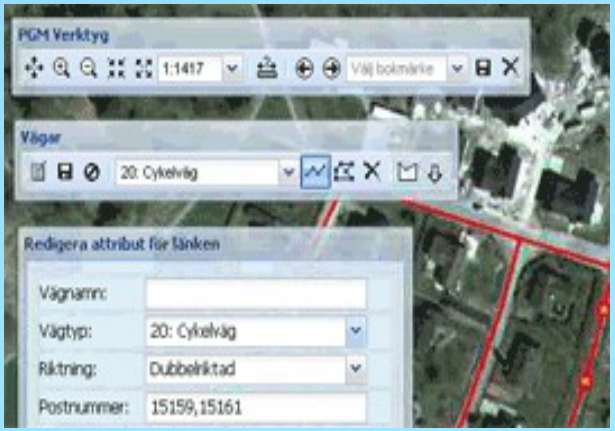
„Index Access Method Interface Definition“

…The core system knows nothing about indexes beyond what is specified here, so it is possible to develop entirely new index types by writing add-on code...

Advanced Index Types

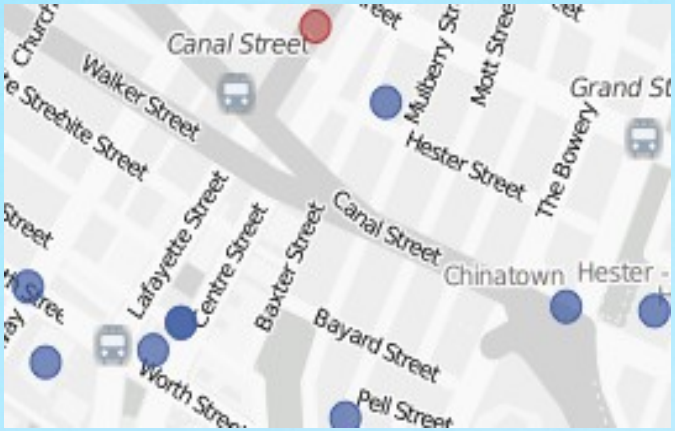
- GIST
  - Generalized Search Tree
  - may be lossy
  - used for example to speed up full text search
  - used for k-nearest-neighbour indexing (return sorted rows if „distance“ has a meaning for the data type)
- GIN
  - Generalized INverted Index
  - used to speed up full text search

PostGIS


PGM Verktyg
1:1417
Vägar
20: Cykelväg
Redigera attribut för länken
Vägnamn:
Vägtyp:
20: Cykelväg
Riktning:
Dubbelriktad
Postnummer:
15159,15161

WEST SWAN
EDIT
BP MIDVALE PETROL / AUTOGAS STATION
last updated by landgate on 1/1/2006
Sourced from Landgate Streetsmart Directory
Comments | History | Link to this note
CAVERSH
MIDLAND
WOODBRIDGE
CAVERSHAM
WOODBRIDGE
MIDVALE

Address Details
101 FREDERICK ST
SF MAIN 94117
Addresses
More
Base/Unit
Unit #
base
unit 1
unit 2
unit 3
unit 4


Canal Street
Walker Street
Mulberry Street
Mott Street
Grand St
Hester Street
The Bowery
Lafayette Street
Centre Street
Baxter Street
Canal Street
Chinatown
Hester
Bayard Street
Pell Street

extending the extensibility

version.myparticleclass
myparticleclass.so
myparticleclass.sql
myparticleclass.plpgsql
myparticleclass.howtoinstall

extending the extensibility

CREATE EXTENSION <extension>;

PostgreSQL 9.1

Dimitri Fontaine,
2ndQuadrant France

Elephants at Amboseli national park against Mount Kilimanjaro
Date:11 August 2012
Author: Amoghavarsha amoghavarsha.com

your questions.

Harald Armin Massa
2ndQuadrant