Postgres PROFESSIONAL

PostgreSQL Universal Database

Oleg Bartunov

Moscow University,
Postgres Professional

May 4, 2018 PGConf.Nepal

The first PostgreSQL talk in Nepal
May 4, 2009

wiki.fossnepal.org/index.php?title=FOSS_Ka_Kura

May 4th 2009	**Introduction to PostgreSQL and talk on Full-text search capabilities in PostgreSQL**	Oleg Bartunov (/ http://www.sai.msu.su/~magera/	M.Sc. Hall, Dept. of Electronics and Computer Engineering, IOE

Kerosene was used to power my notebook, Institute of Engineering, Tribhvan University

I gave a talk about full text search in postgresql after trek. We made special support of nepalese locale to make it works right. There was no light in the university, so we used generator to power notebok and projector. It was really funny to speak for people sitting in the darkness.

FTS 8.4

Devanagari script support (better Unicode support)

```
postgres=# set client_encoding to UTF8;
postgres=# select * from ts_parse('default','मदन पुरस्कार पुस्तकालय');
 tokid |  token
-------+---------
     2 | मदन
    12 |
     2 | पुरस्कार
    12 |
     2 | पुस्तकालय
(5 rows)
```

Thanks to Dibyendra Hyoju and Bal Krishna Bal
for testing and valuable discussion

When I started using Postgres

- No UTF-8, even no 8-bit
- No WAL
- No MVCC
- No replication
- No usable non-scalar data types
- No subselects, no window functions, no CTE
- It was Postgres95

Oleg Bartunov, major PostgreSQL contributor since Postgres95

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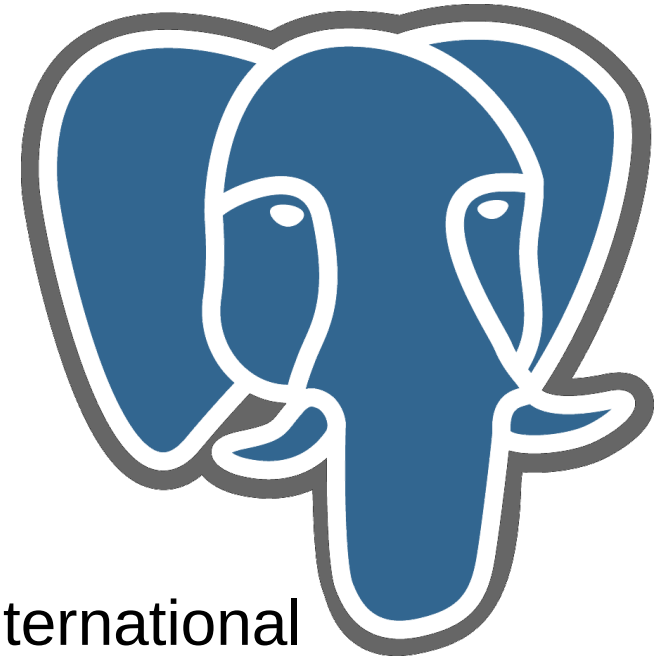
How to choose a right database ?

- People usually choose a database looking on
  - Functionality, Performance
  - Availability - License, price
  - Local expertise, Personal experience
  - Compatibility to existing environment
  - Support
  - Other
- People start to think about one important feature of database after the project needs
  - Need new functionality, Better performance
- Project is in production, no way to change database
  - Starting to use various ugly «solutions»
  - System works, but looks pretty strange

Your system with wrong database

What is PostgreSQL

PostgreSQL — The world“s most advanced open source object-relational database.



Extensible — data types, operators, functions, access methods (indexes).

ANSI SQL (1992, 1999, 2003, 2008, 2011), NoSQL (key-value, JSON, JSONB)

Developed and supported by independent international community (users, developers, companies)

Pronunciation: post-gress-Q-L, post-gres, pgsql

Web: http://www.postgresql.org, (BSD, MIT) - like

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PostgreSQL History >20 years

Michael Stonebreaker
Turing Award, 2015

started here

CODD 1969,1970
Relational model
1974-1975
IBM System R
1973
QUEL
UC Berkeley INGRES
INteractive Graphics REtrieval System
1978
1979
SQL
1981
SQL/DS
1983
DB2
$$$
SDL, RSI 1979
1983
ORACLE
$$$
1984
RDb/VMS
1994
2001
INFORMIX
$$$
1984
1984-1987
NonStop SQL
1995
ILLUSTRA
$$$
1992
1979-1982
Ingres Co
CA Ingres r3
1994
2004
$$$
1985-1988
Postgres
1989 V1
1993 V4.2
1993
MS SQL
$$$
1992
1987
Sybase ASE
$$$
1995
1994 V5
Postgres95
SQL
PGDG
1997-04-03
Agatha Christie
1996 V6
PostgreSQL
2005 V8
PostgreSQL
2016 9.6

2017 10

PostgreSQL Universal Database

- Any project could start with PostgreSQL
- PostgreSQL is a reliable and stable database with rich functionality and long history
- PostgreSQL has liberal BSD license, cross platform (~30)
- Developed by international community, no vendor lock

- PostgreSQL is **EXTENSIBLE**, this is the very important feature, which people miss ! It allow database to support
  - New workloads
  - New functionality
  - New environment
  - Often without restarting a server, no need core programmer.

Extendibility of PostgreSQL

"The main design goals of the new system are to:
2) provide user extendibility for data types, operators and access methods,"

Stonebraker M., Rowe L. A. The design of Postgres. – ACM, 1986. – T. 15. – №. 2. – C. 340-355.

"It is imperative that a user be able to construct new access methods to provide efficient access to instances of nontraditional base types"

Michael Stonebraker, Jeff Anton, Michael Hirohama.

Extendability in POSTGRES , IEEE Data Eng. Bull. 10 (2) pp.16-23, 1987

Extendibility of PostgreSQL

0. Ability to change executor and planner
1. Data types, operators, access methods, indexes without core developers, deploy online !
2. FDW, procedural languages

Need more:

1. API to pluggable storages
2. API to TM — XTM, eXtensible transaction manager
3. Type-specific compression

….more…

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Case 1: Web

- 1996: Start using Postgres on Web, no 8-bit support — introduced locale
- 1999: World“s top-5 portal. We start with PostgreSQL 6.5.?
- Requirement: on the hardware ~ my smartphone to support > 1 mln. users/day
- Quickly run out of resources
- Denormalize, use arrays -> slow -> discover GiST → improve GiST - intarray with indexes
- Need FTS, made tsearch using intarray and GiST indexes
- Need fast search on hierarchical data — ltree — GiST indexes
- Need flexible schema — hstore — GiST index
- Need faster FTS — GIN index for tsearch, hstore
- Need misprint search — pg_trgm — GiST/GIN indexes
- Compete to NoSQL - better/binary json - jsonb — GIN index
- Need faster FTS — RUM access methods

2017: STILL USING PostgreSQL !

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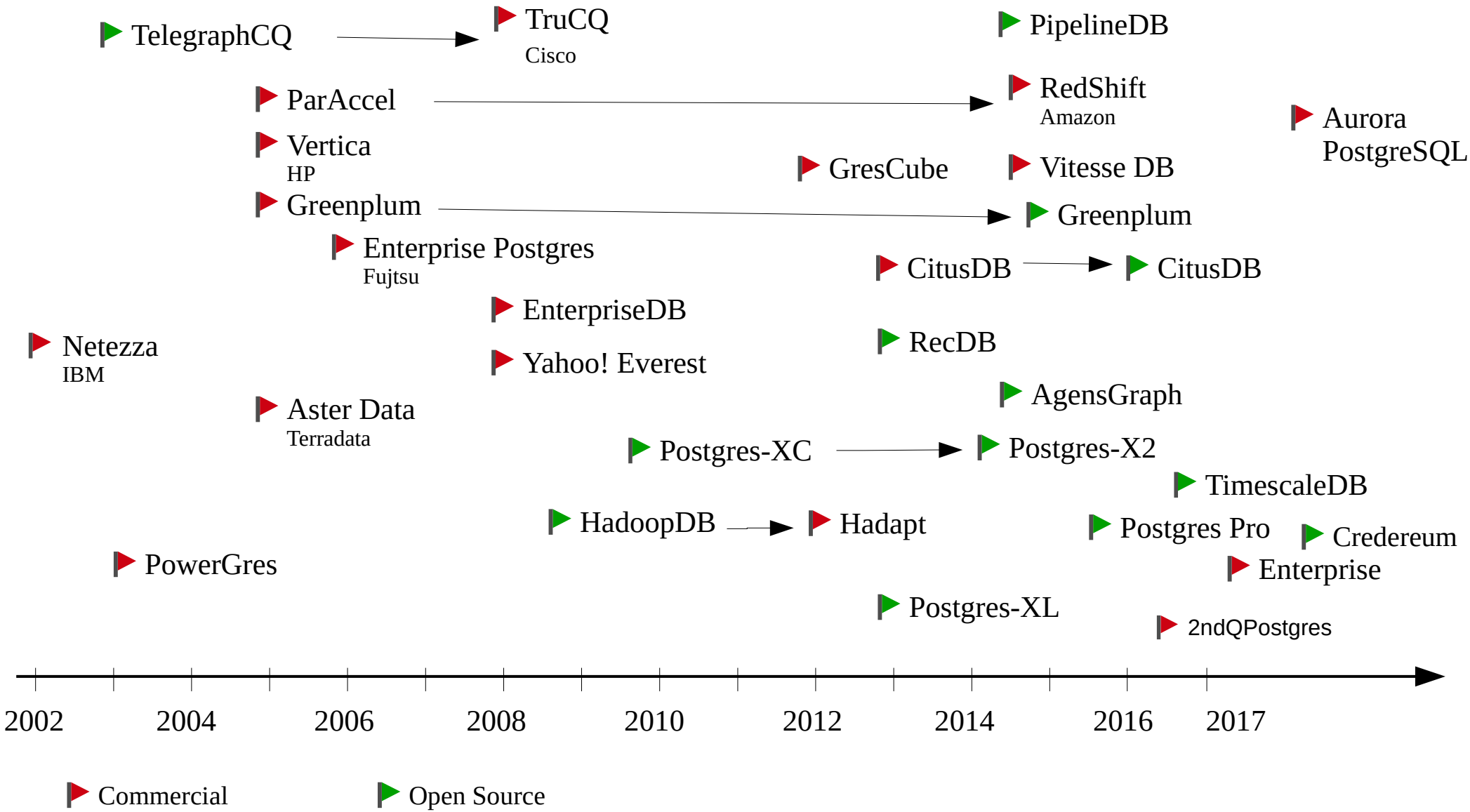
Extensibility makes PostgreSQL Universal Database !

PostgreSQL: OLTP, MPP, OLAP, CLOUD, GIS, STREAM, TIMESERIES, GPU, BLOCKCHAIN

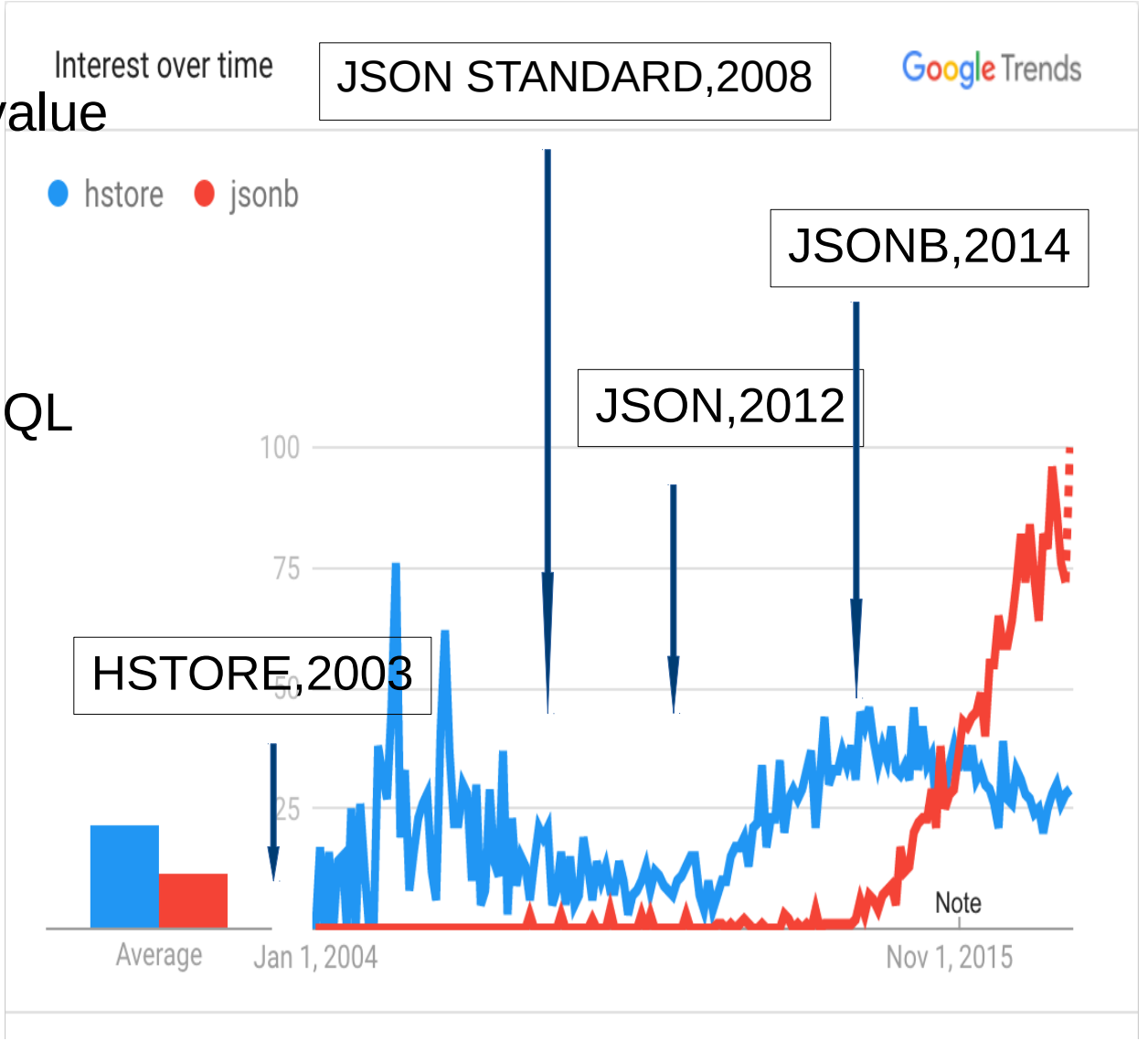


PostgreSQL Forks (we love forks!)

- PostgreSQL - OLTP, Web, Science
  extensions: GIS (PostGIS), time-series (TimeScaleDB), Stream data (PipelineDB), interactive analytics (Citus), vector ops, async mpp on GPU (PG-Strom)
- AgensGraph — Graph model, graph query language
- Postgres Pro Enterpise - Multimaster, block compression, 64-bit TX, partitioning, adaptive planning, scheduler, incremental backup
- Redshift — Cloud, column storage, compression, OLAP
- Greenplum - MPP, OLAP (complex reports)
- Postgres-XL — MPP OLAP (ACID)
- Vitesse DB — OLAP (JIT, column storage, threads)
- Aurora PostgreSQL — OLTP, S3 storage
- EDB Postgres Advanced Server - Oracle compatibility

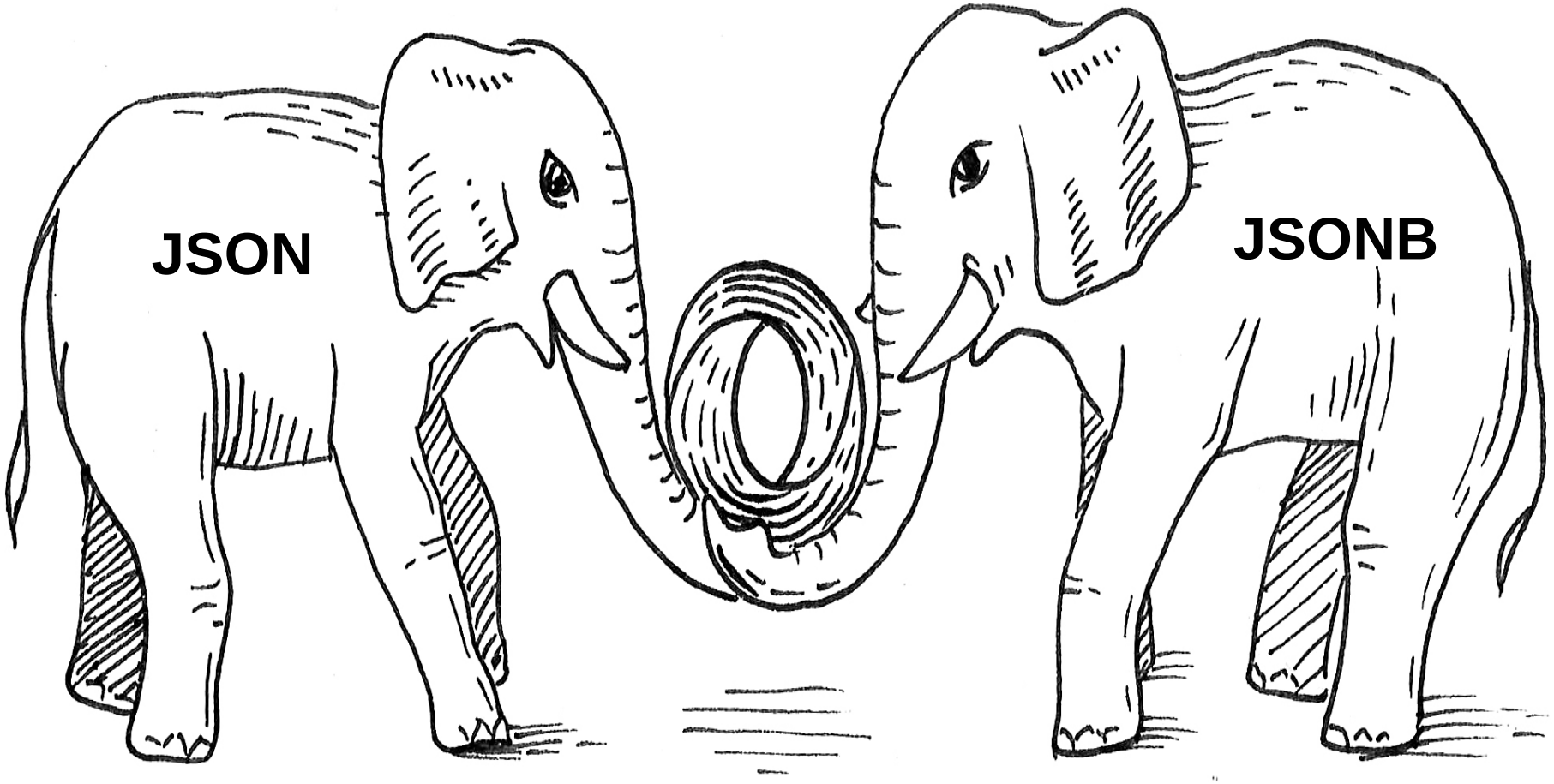
Case 2: NoSQL PostgreSQL is MATURE

- HSTORE — binary key-value storage, index support
- 2003 — initial release
- 2006 — part of PostgreSQL



Two JSON data types !!!

- Textual storage «as is»
- Binary storage, index support



- A lot of functionality !

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SQL/Foundation recognizes JSON after 8 years

4.46 JSON data handling in SQL. 174
4.46.1 Introduction. 174
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4.46.5 Overview of SQL/JSON path language. 178

5 Lexical elements. 181

5.1 <SQL terminal character>. 181
5.2 <token> and <separator>. 185

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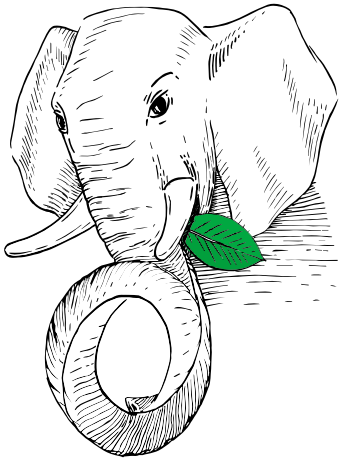
SQL/JSON in PostgreSQL

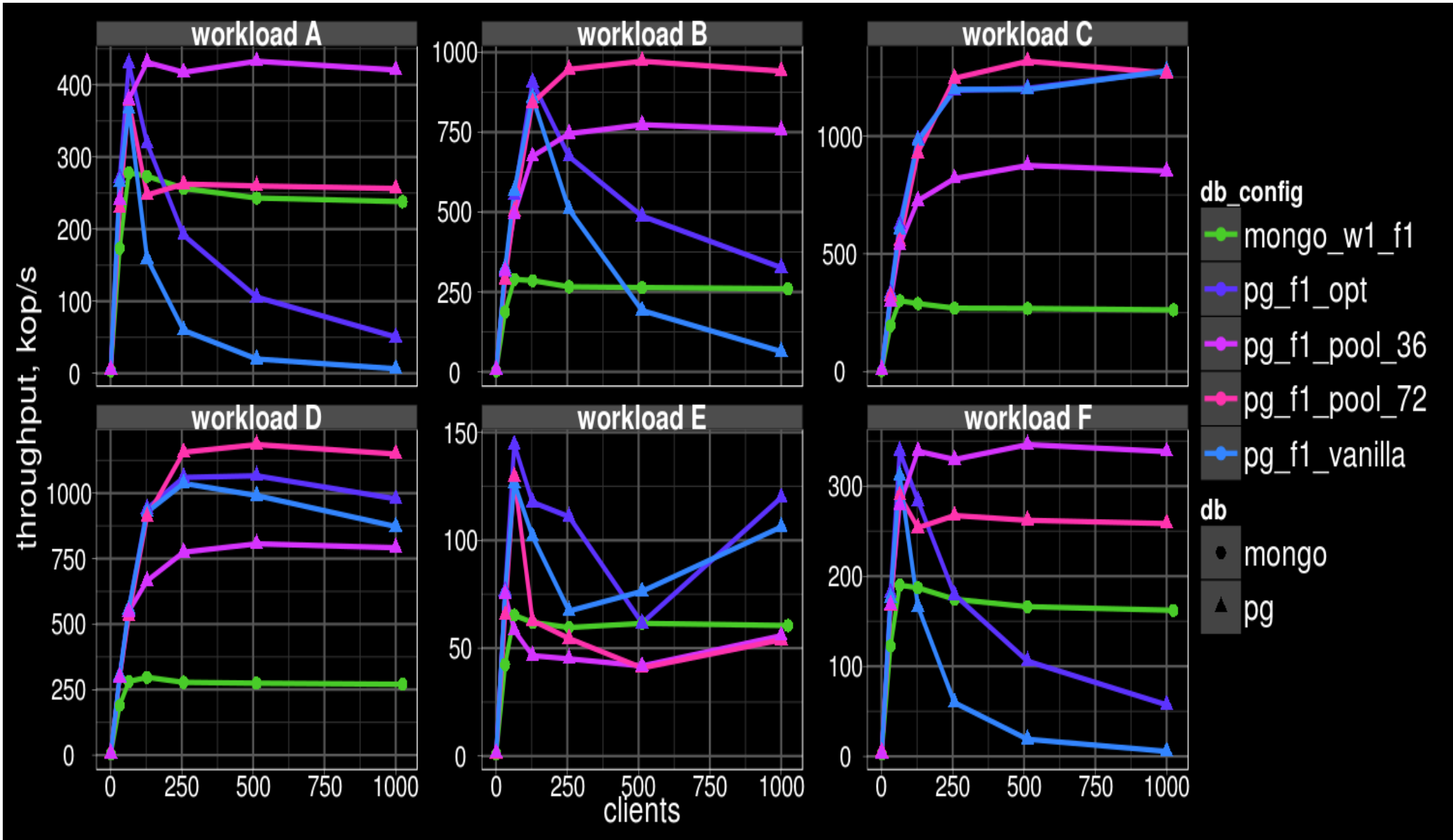
- PostgreSQL implementation (1 year of development)
  - Uses native data types JSON, JSONB
  - JSONPATH data type for SQL/JSON path language
  - Nine functions SQL/JSON functions for constructing:
    - JSON_OBJECT, JSON_ARRAY, JSON_OBJECTAGG, JSON_ARRAYAGG
  - and retrieving
    - JSON_VALUE, JSON_QUERY, JSON_TABLE, IS [NOT] JSON, JSON_EXISTS
  - Extensions: more methods, JSONB op JSONPATH

NoSQL Postgres is fast !

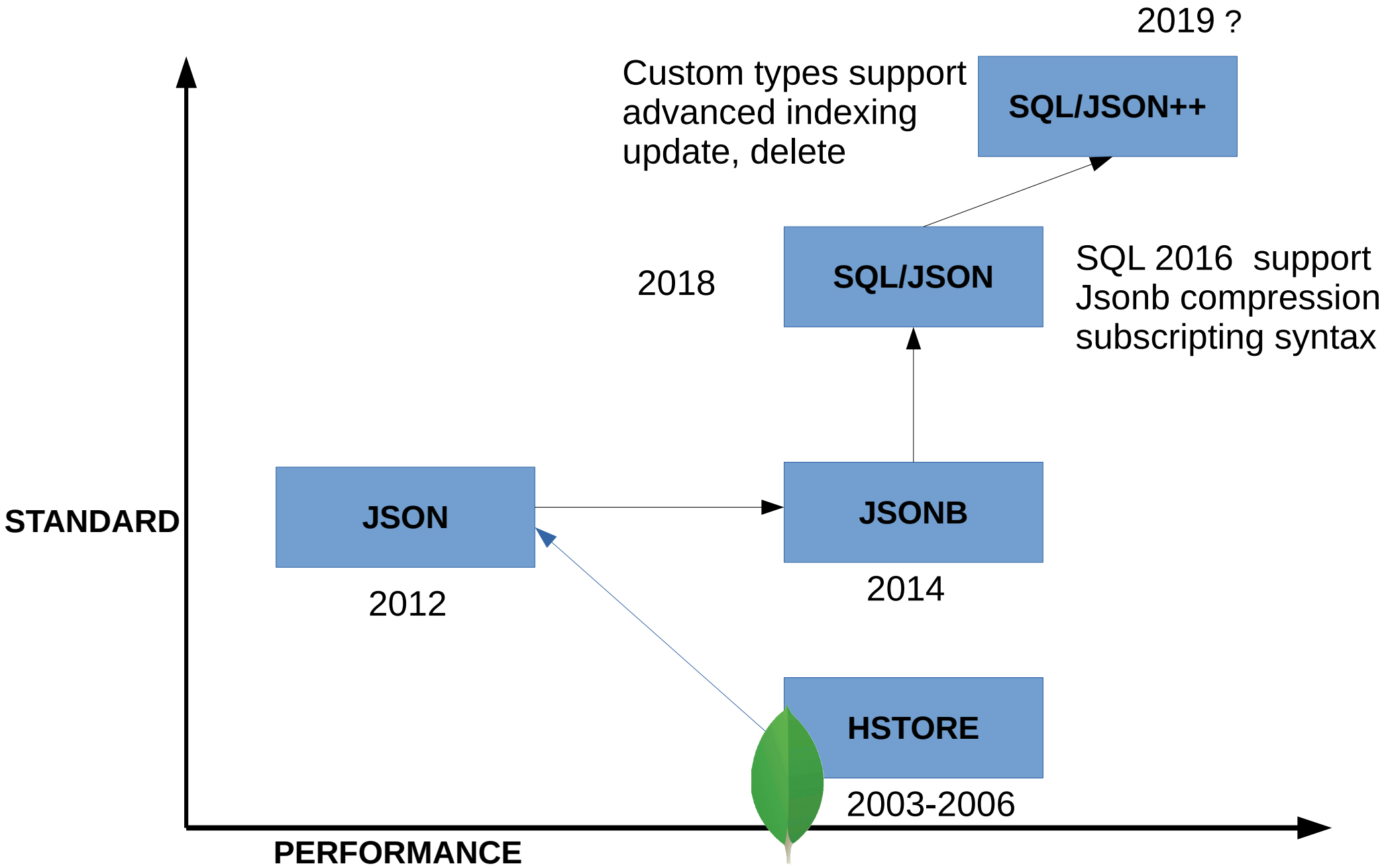


- Yahoo! Cloud Serving Benchmark (YSCSB) - de-facto benchmark for NoSQL databases
- We run YCSB for PostgreSQL 10, MongoDB 3.4.5
  - 1 server with 72 cores, 3 TB RAM, 2 TB SSD for clients
  - 1 server with 72 cores, 3 TB RAM, 2 TB SSD for database
  - 10Gbps switch
- In most practical cases PostgreSQL is faster MongoDB
- PostgreSQL performance degrades in high-contention writes (zipfian distribution of queries, high number backends >100)
- Avoid high-contention with built-in pool of connections (PG 12)

Built-in pool of connections helps !!!



History NoSQL Postgres



SQL/JSON availability

- Currently under review for PG 11
- Github Postgres Professional repository
  https://github.com/postgrespro/sqljson
- WEB-interface to play with SQL/JSON
  http://sqlfiddle.postgrespro.ru/#!21/0/1819
- Technical Report (SQL/JSON) - available for free
  http://standards.iso.org/ittf/PubliclyAvailableStandards/c067367_ISO_IEC_TR_19075-6_2017.zip

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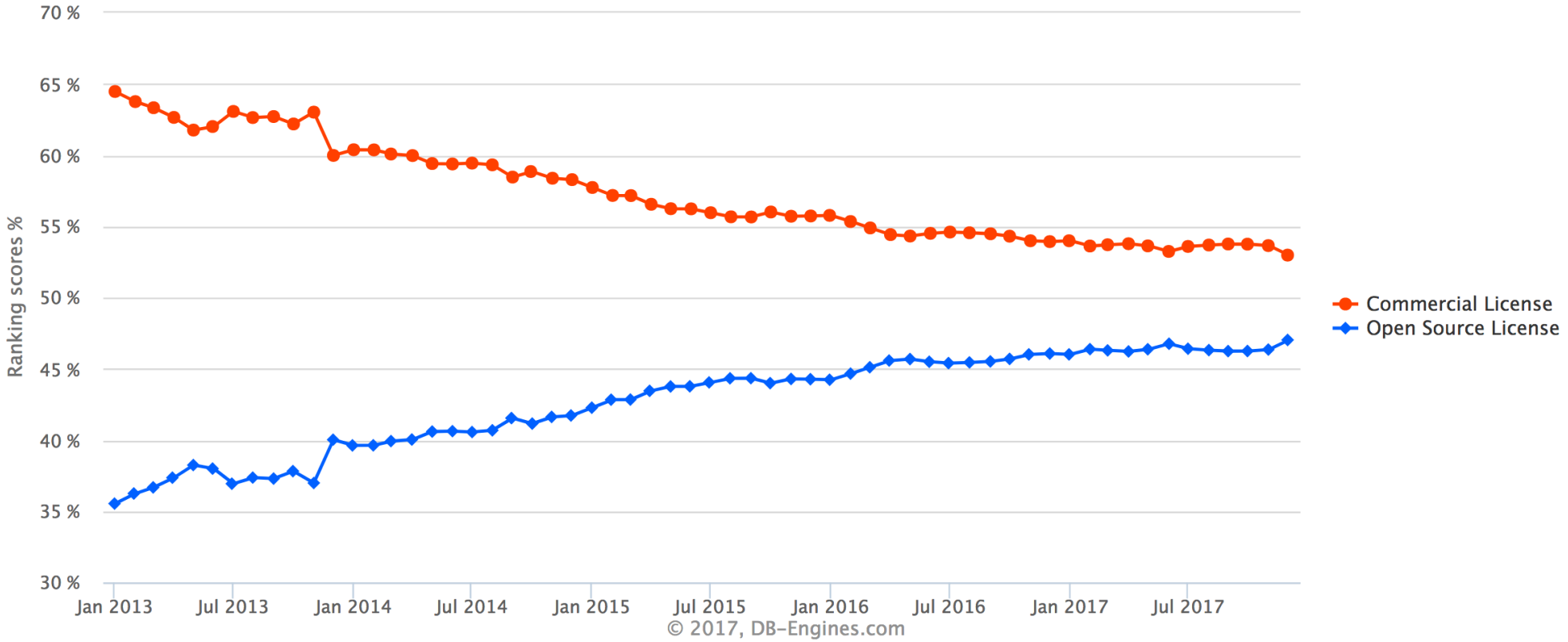
PostgreSQL users

+BIG RUSSIAN Enterprise !

Open source vs commercial DBMS

Popularity trend



DBMS of the Year (2017): PostgreSQL

Previous winners of the DB-Engines DBMS of the Year Award:

PostgreSQL	2017
Microsoft SQL Server	2016
Oracle	2015
MongoDB	2014
MongoDB	2013

341 systems in ranking, January 2018

Rank			DBMS	Database Model	Score		
Jan 2018	Dec 2017	Jan 2017			Jan 2018	Dec 2017	Jan 2017
1.	1.	1.	Oracle	Relational DBMS	1341.94	+0.40	-74.78
2.	2.	2.	MySQL	Relational DBMS	1299.71	-18.36	-66.58
3.	3.	3.	Microsoft SQL Server	Relational DBMS	1148.07	-24.42	-72.89
4.	4.	↑ 5.	PostgreSQL	Relational DBMS	386.18	+0.75	+55.81
5.	5.	↓ 4.	MongoDB	Document store	330.95	+0.18	-0.96
6.	6.	6.	DB2	Relational DBMS	190.28	+0.70	+7.78
7.	7.	↑ 8.	Microsoft Access	Relational DBMS	126.70	+0.82	-0.75
8.	↑ 9.	↓ 7.	Cassandra	Wide column store	123.88	+0.67	-12.57
9.	↓ 8.	9.	Redis	Key-value store	123.14	-0.10	+4.44
10.	10.	↑ 11.	Elasticsearch	Search engine	122.55	+2.77	+16.38

https://db-engines.com/en/ranking

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https://db-engines.com/en/ranking

- **Number of mentions of the system on websites**, measured as number of results in search engines queries. At the moment, we use Google, Bing and Yandex for this measurement. In order to count only relevant results, we are searching for <system name> together with the term database, e.g. "Oracle" and "database".
- **General interest in the system.** For this measurement, we use the frequency of searches in Google Trends.
- **Frequency of technical discussions about the system.** We use the number of related questions and the number of interested users on the well-known IT-related Q&A sites Stack Overflow and DBA Stack Exchange.
- **Number of job offers, in which the system is mentioned.** We use the number of offers on the leading job search engines Indeed and Simply Hired.
- **Number of profiles in professional networks, in which the system is mentioned.** We use the internationally most popular professional networks LinkedIn and Upwork.
- **Relevance in social networks.** We count the number of Twitter tweets, in which the system is mentioned.

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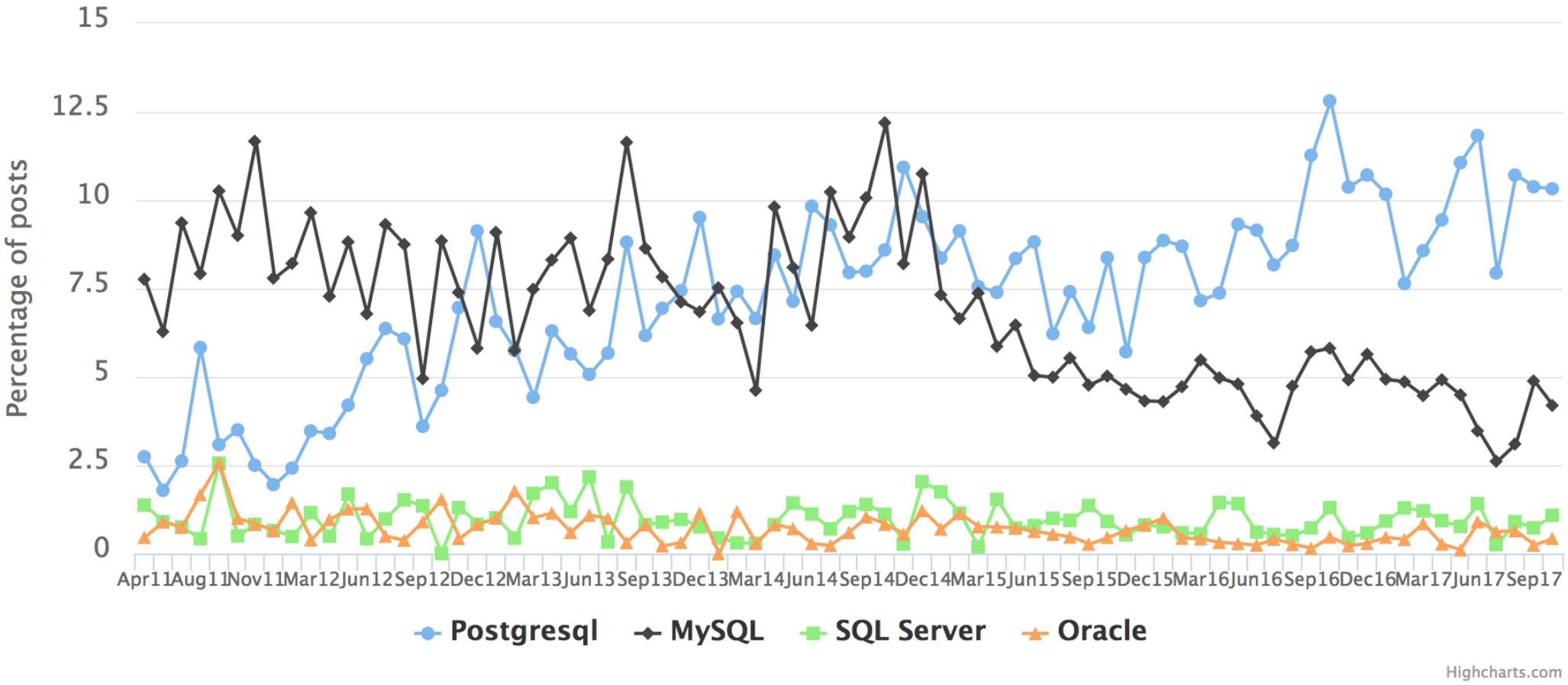
Hacker News Hiring Trends

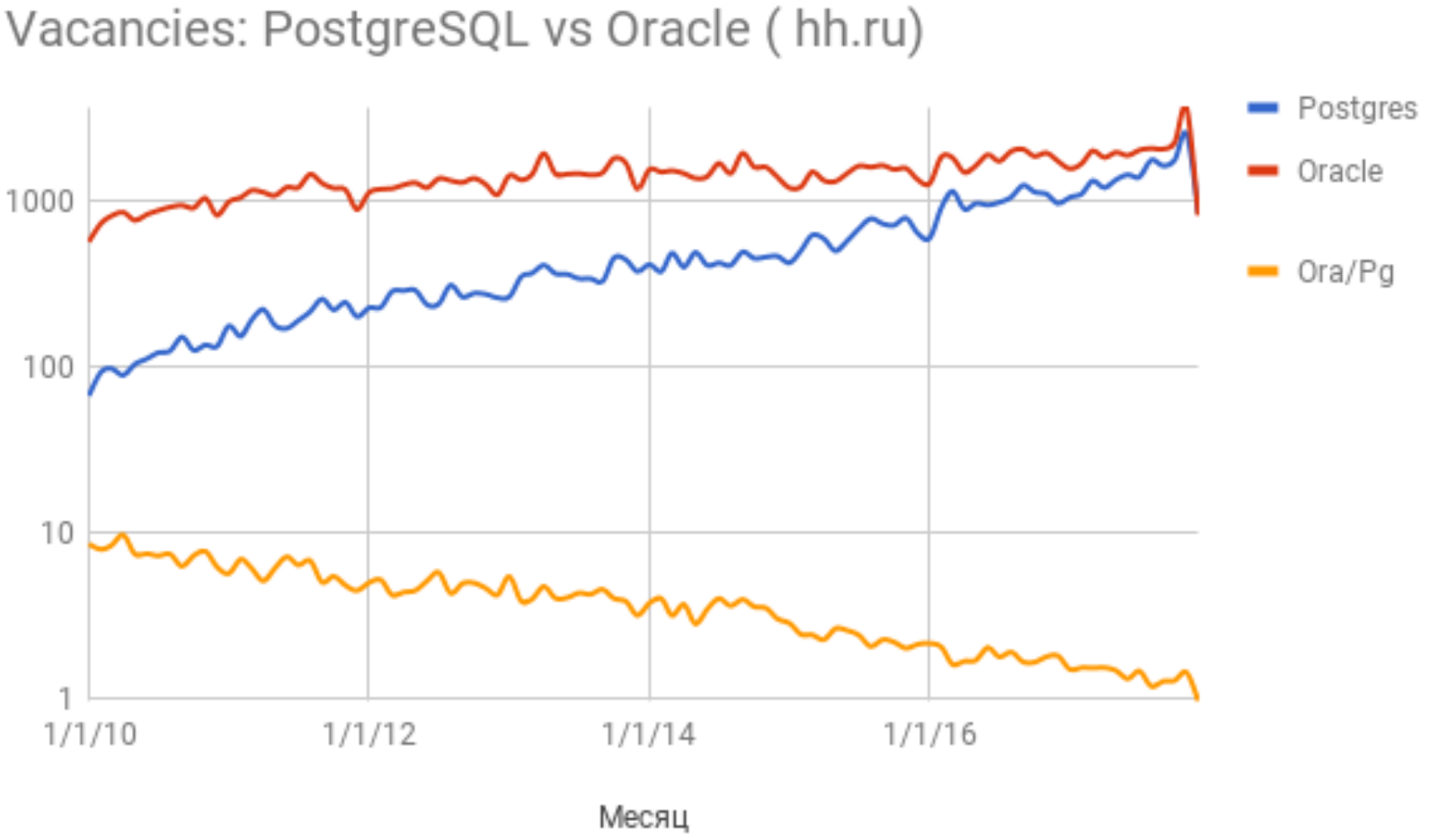
October 2017 Hacker News Hiring Trends

Show: Top 5 or compare Postgresql MySQL SQL Server Oracle Compare



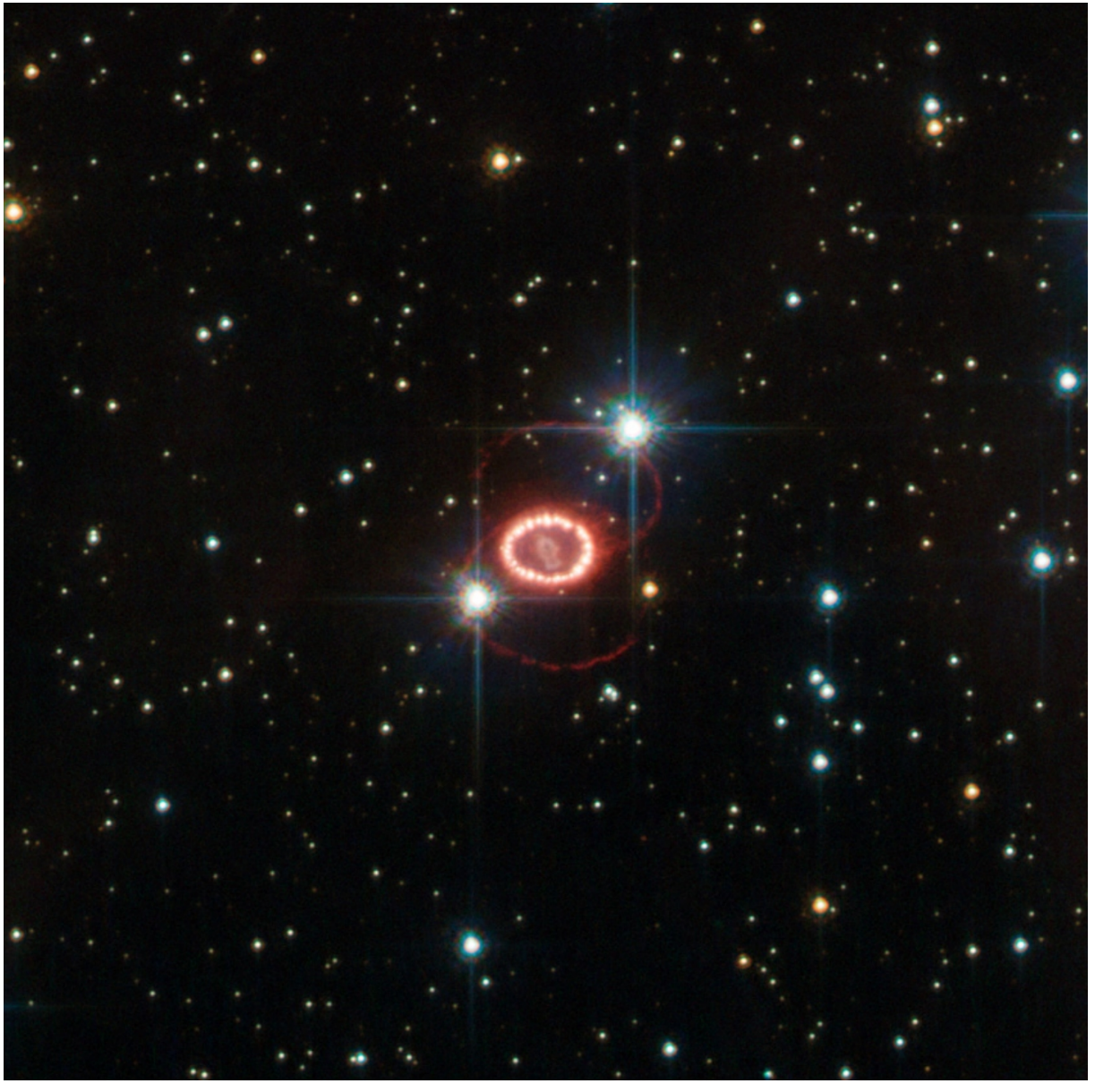
PostgreSQL in Russia is #1

PostgreSQL reach Oracle in Russia

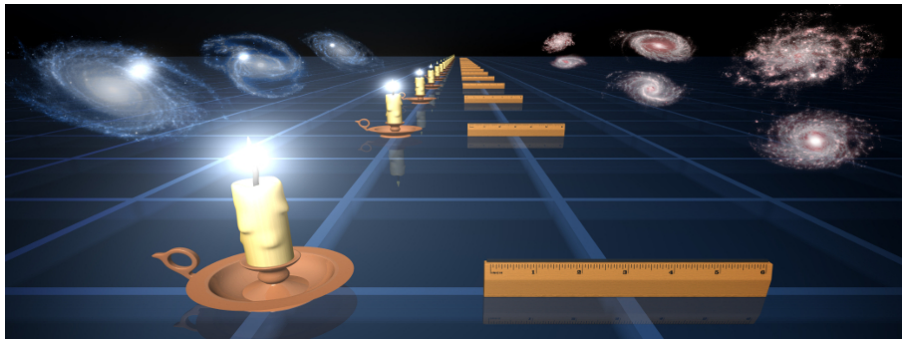


Case 3: PostgreSQL and Supernovae

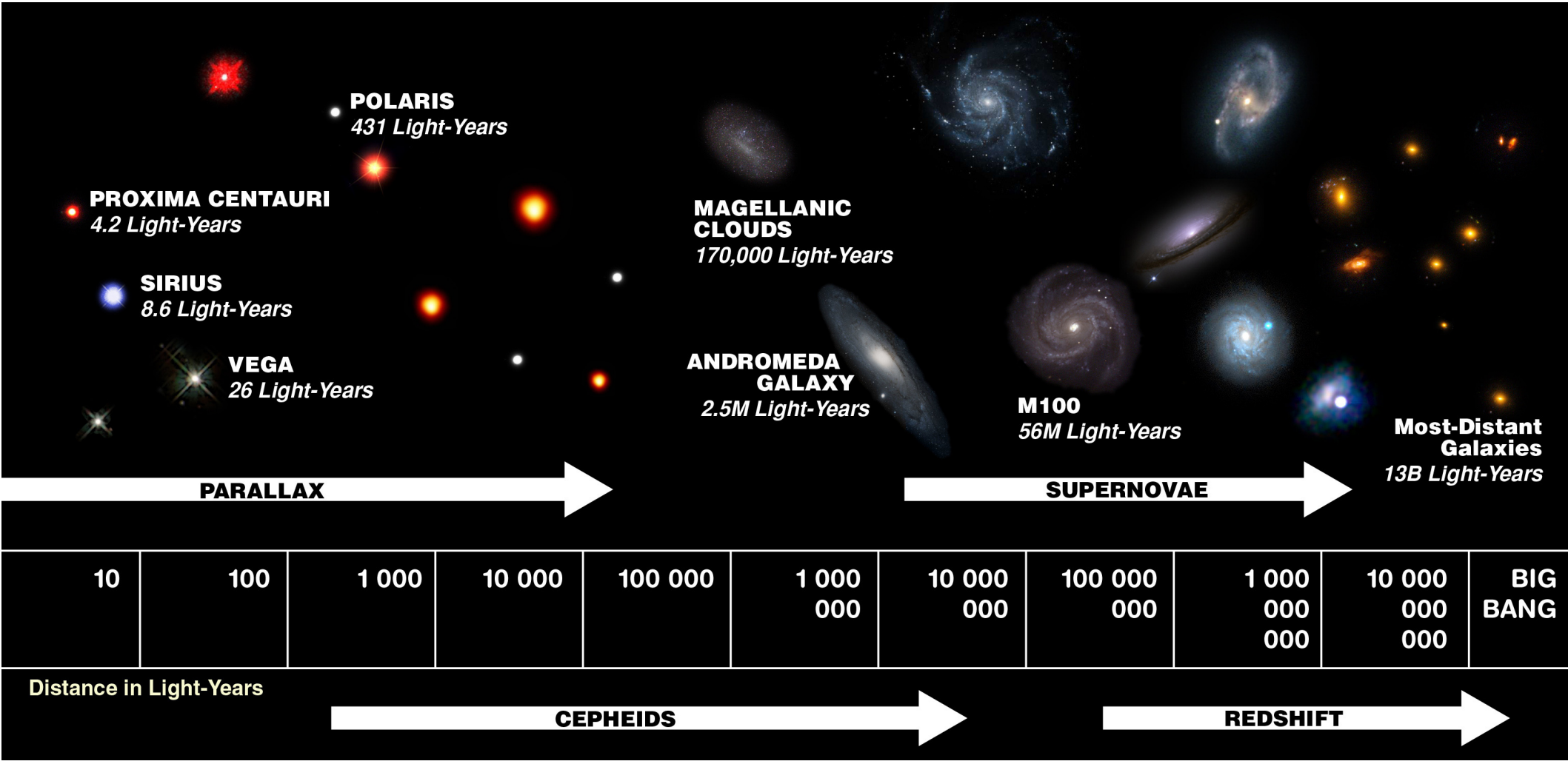
SN 1987a, Type II, +2.9, Tarantula Nebulae in LMC,
168 000 ly, progenitor: Sanduleak -69° 202,



The Scale of the Universe



- Supernovae(Ia) - «standard candles»
- Used to measure the distance to the host galaxy



What is the fate of the Universe ?

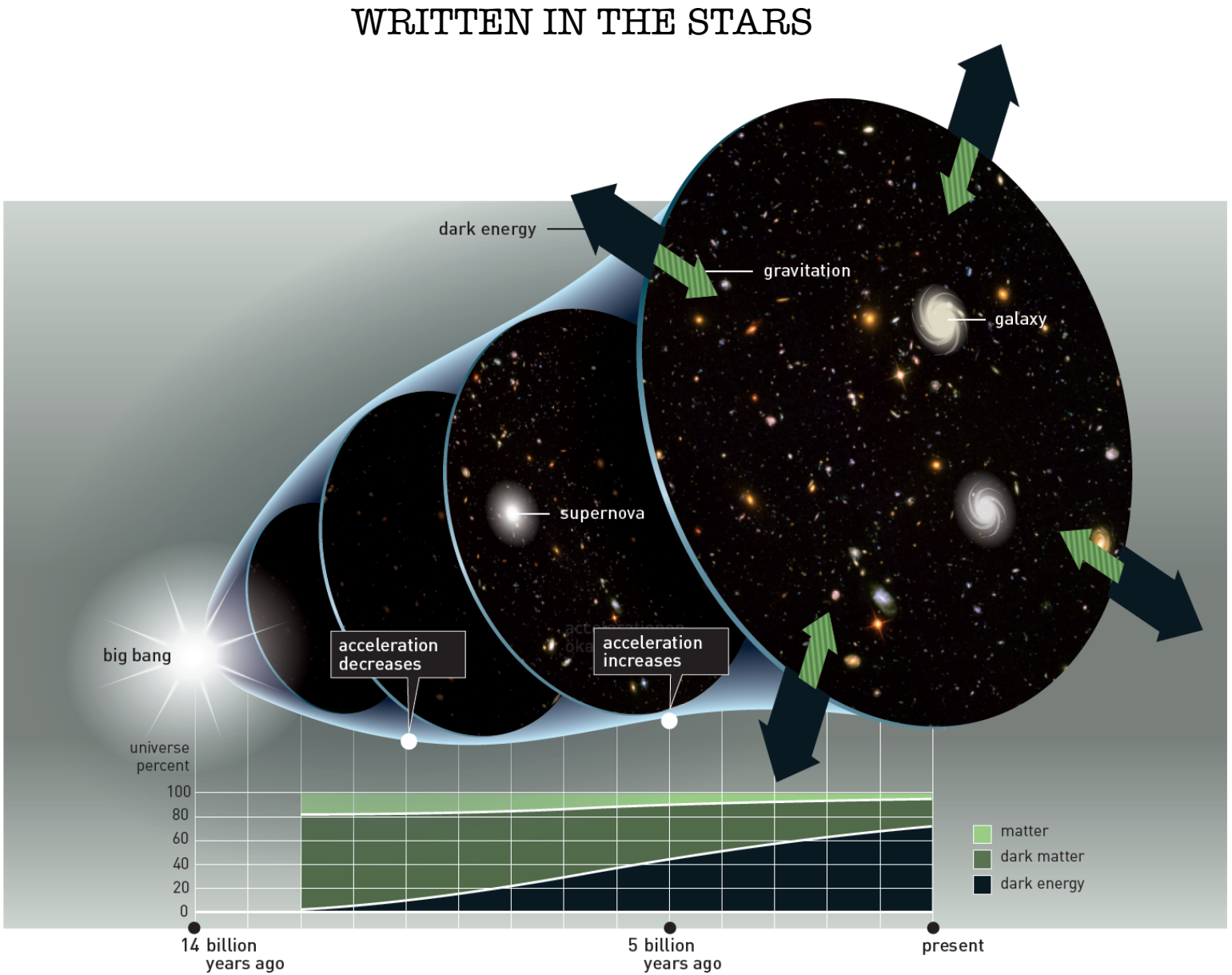


Figure 1. The world is growing. The expansion of the Universe began with the Big Bang 14 billion years ago, but slowed down during the first several billion years. Eventually it started to accelerate. The acceleration is believed to be driven by dark energy, which in the beginning constituted only a small part of the Universe. But as matter got diluted by the expansion, the dark energy became more dominant.

Change photo

Oleg Bartunov

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Lomonosov Moscow State University
astrophysics, databases, astroinformatics
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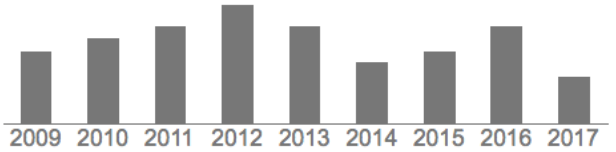

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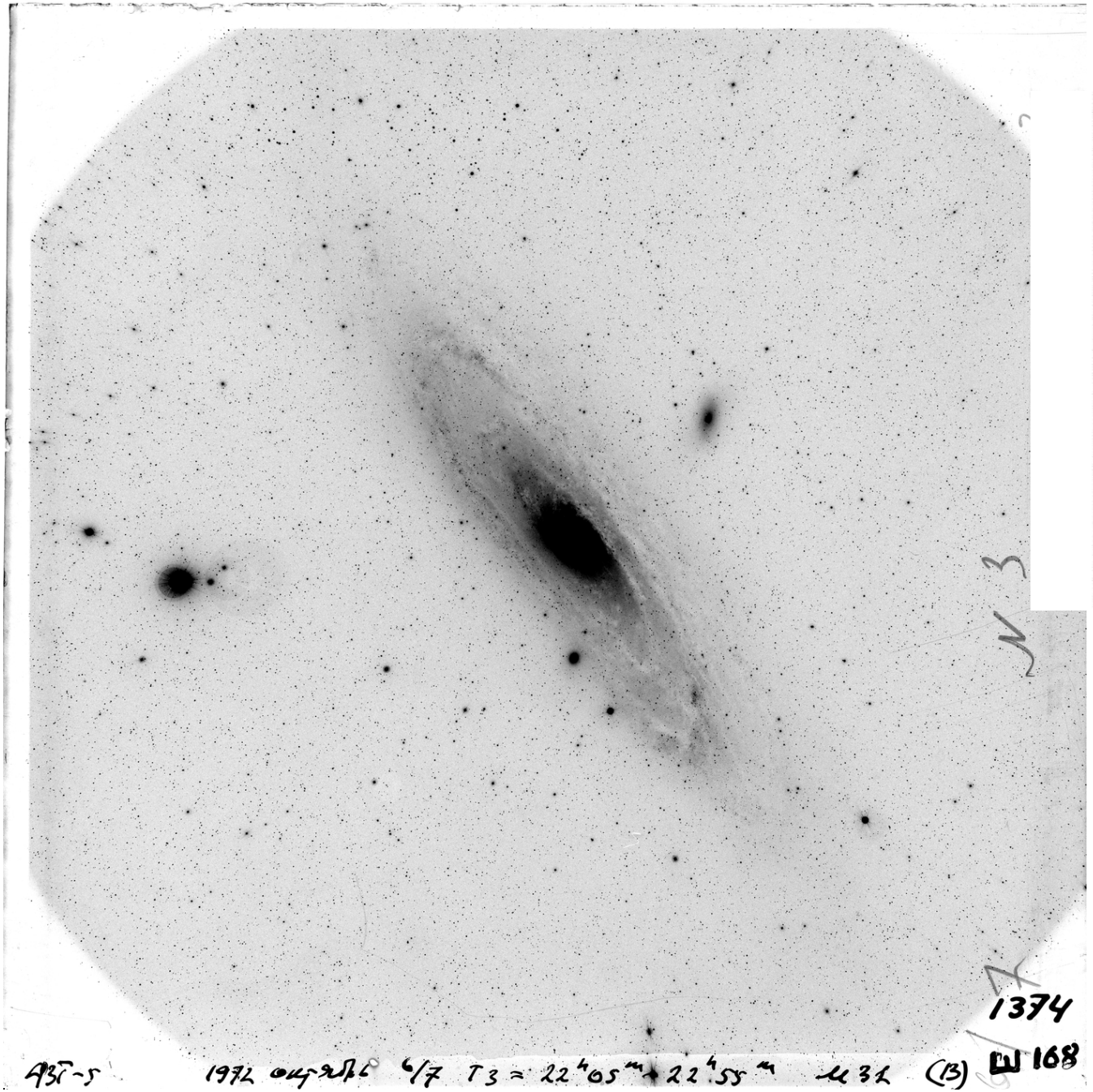
Sergei B. Popov

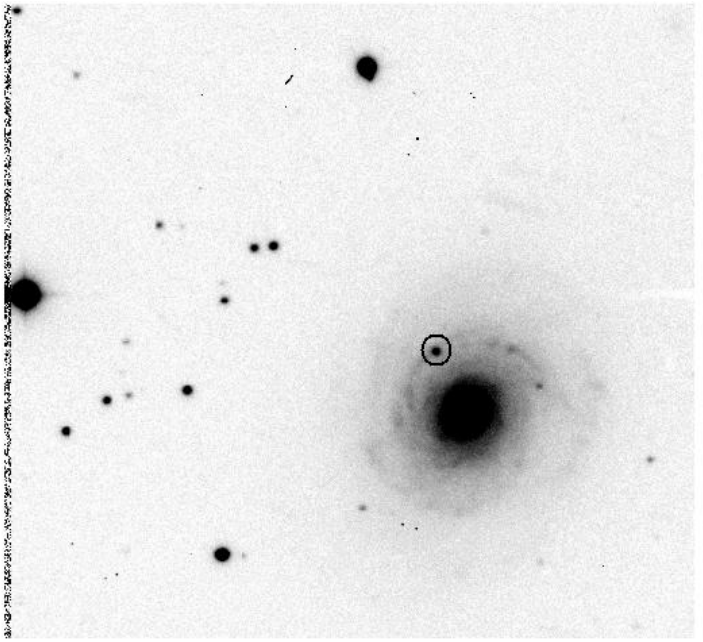
Co-authors Edit...

Massimo Turatto
Mario Hamuy
Sergey Koposov
Stefano Benetti
Sergey Karpov
Igor Chilingarian

Title	Add	More	1–20	Cited by	Year
The rate of supernovae from the combined sample of five searches E Cappellaro, M Turatto, DY Tsvetkov, OS Bartunov, C Pollas, R Evans, ... arXiv preprint astro-ph/9611191				406	1996
Radiation hydrodynamics of SN 1987A. I. Global analysis of the light curve for the first 4 months S Blinnikov, P Lundqvist, O Bartunov, K Nomoto, K Iwamoto The Astrophysical Journal 532 (2), 1132				179	2000
A comparative modeling of supernova 1993J SI Blinnikov, R Eastman, OS Bartunov, VA Popolitov, SE Woosley The Astrophysical Journal 496 (1), 454				159	1998
The rate of supernovae. II. The selection effects and the frequencies per unit blue luminosity E Cappellaro, M Turatto, DY Tsvetkov, OS Bartunov, IN Makarova arXiv preprint astro-ph/9302017				118	1993
Non-equilibrium radiative transfer in supernova theory-models of linear Type-II supernovae SI Blinnikov, OS Bartunov Astronomy and Astrophysics 273, 106				102	1993
Distribution of supernovae relative to spiral arms and H II regions OS Bartunov, DY Tsvetkov, IV Filimonova Publications of the Astronomical Society of the Pacific 106 (706), 1276				100	1994

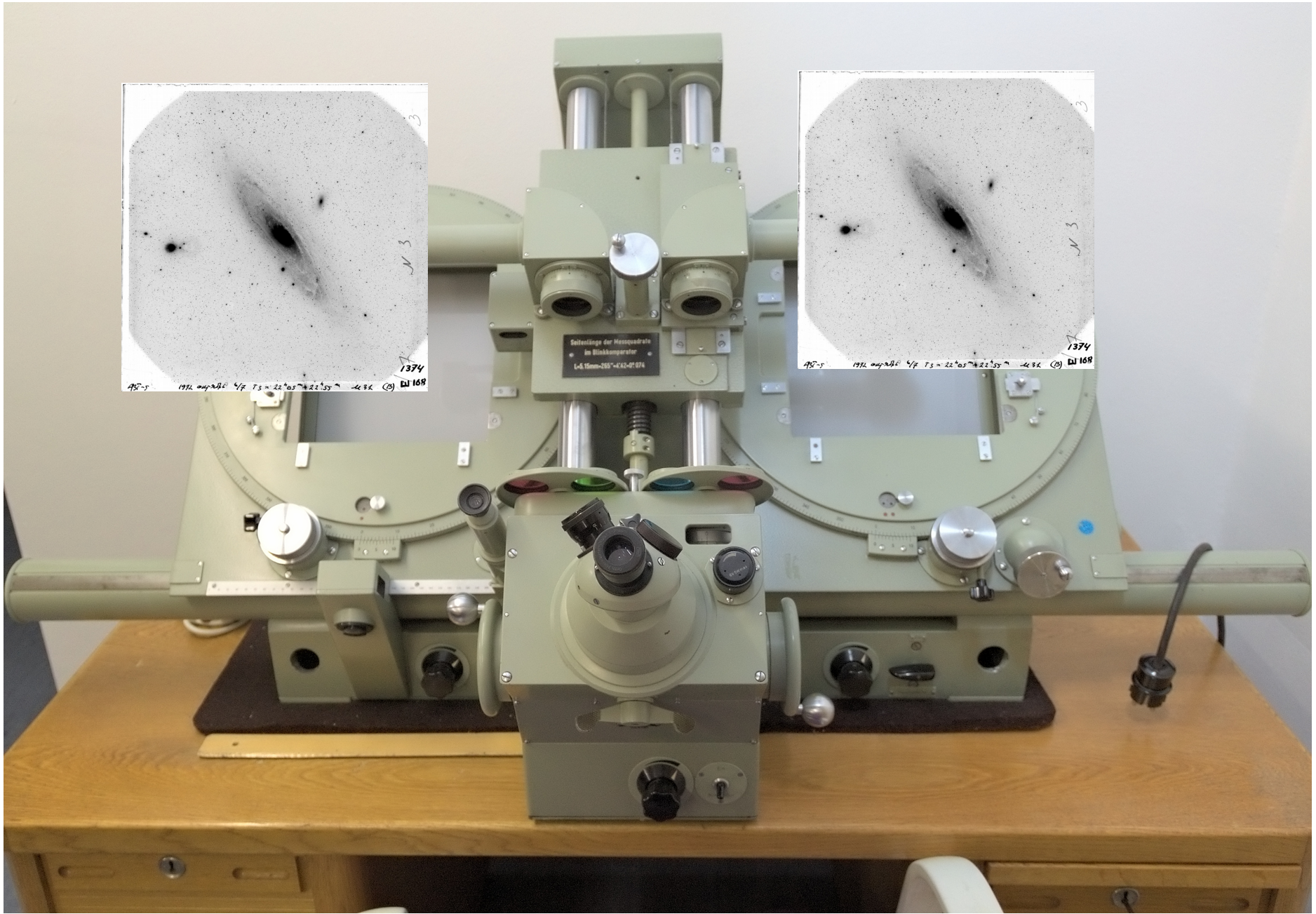
M31 (Andromeda), AZT-5 telescope



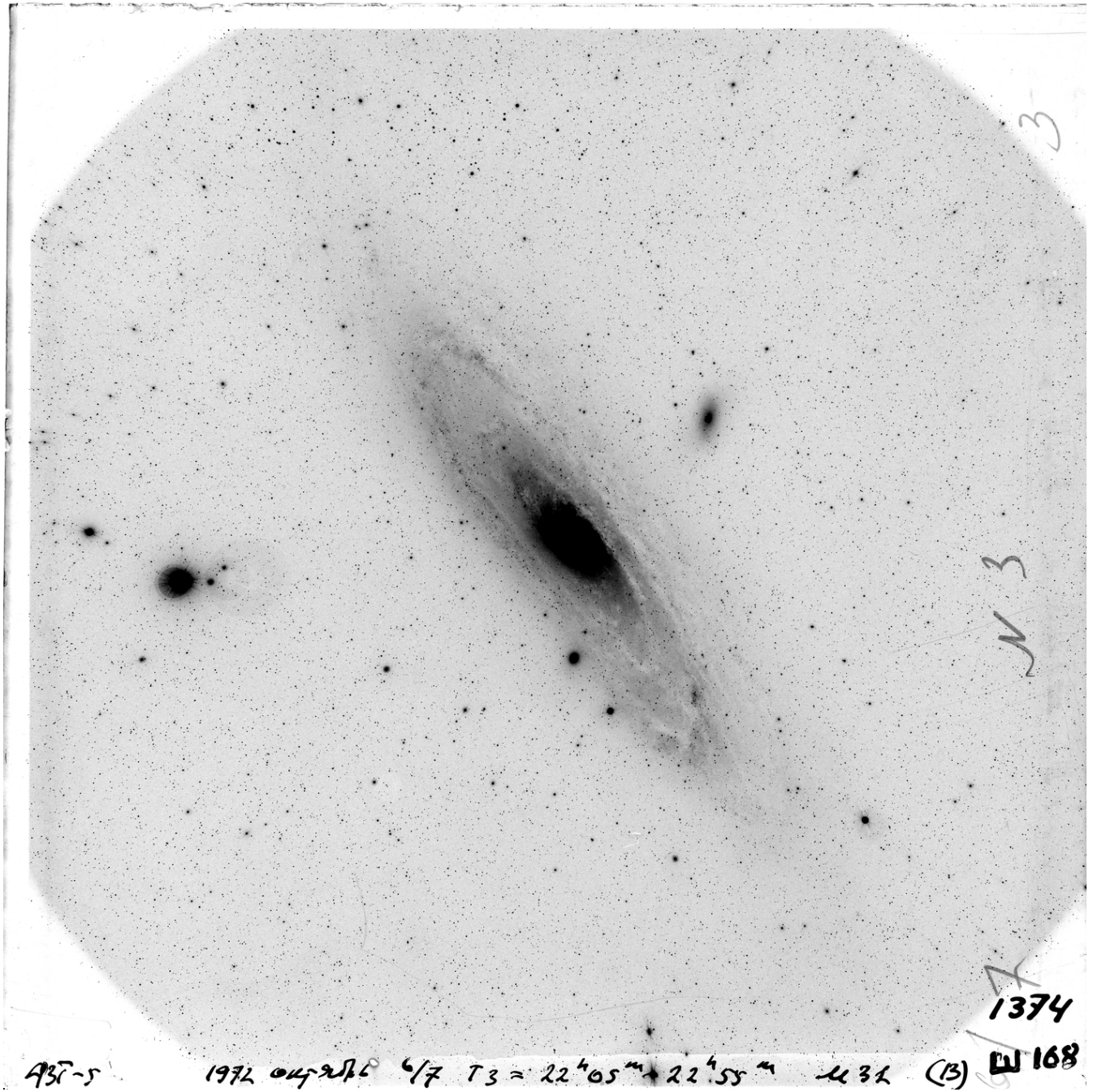


SN 2008fv in NGC 3147, Draco
Dmitry Tsvetkov, SAI MSU

Blink Comparator (manual discovery)
Many hours of hard work !



M31 (Andromeda), AZT-5 telescope




```
x-00001|1.1458447|-89.9186147
x-00002|1.3300139|-89.9332336
x-00003|3.2556022|-89.9641031
x-00004|3.6464625|-89.9060142
x-00005|6.3110253|-89.9523947
x-00006|6.6275517|-89.9279197
x-00007|7.8266025|-89.9129272
x-00008|9.0694378|-89.9714031
x-00009|9.6627953|-89.9244314
x-00010|10.0494292|-89.9705058
x-00011|10.4863922|-89.9699058
x-00012|11.0953692|-89.9016031
x-00013|11.3240233|-89.9344336
x-00014|11.7906064|-89.9070308
x-00015|12.0416581|-89.9300586
x-00016|12.0522308|-89.9002281
x-00017|12.2808536|-89.9107669
x-00018|13.0316142|-89.9214558
x-00019|13.8727033|-89.9577031
x-00020|14.6546639|-89.9191919
x-00021|18.3035981|-89.9447475
x-00022|18.5185631|-89.9446836
x-00023|19.8675597|-89.9836308
x-00024|20.9699533|-89.9226864
x-00025|21.6777744|-89.9256808
x-00026|23.3660669|-89.9036558
x-00027|24.2841308|-89.9516475
x-00028|24.3273161|-89.9202392
x-00029|24.5540458|-89.9246003
x-00030|24.5655172|-89.9122336
x-00031|26.3487519|-89.9460336
x-00032|26.5268008|-89.9311503
x-00033|26.6070808|-89.9271808
x-00034|27.4104919|-89.9768558
x-00035|27.8290442|-89.9304622
x-00036|28.5552036|-89.9199117
x-00037|29.4407347|-89.9762836
x-00038|30.5729608|-89.9377753
x-00039|30.7101131|-89.9105642
x-00040|33.2918250|-89.9106614
x-00041|33.4843678|-89.9442058
```

Spatial Join (Machine Discovery, < 1s)

Observations: 10^5

```
x-00001|1.1458447|-89.9186147
x-00002|1.3300139|-89.9332336
x-00003|3.2556022|-89.9641031
x-00004|3.6464625|-89.9060142
x-00005|6.3110253|-89.9523947
x-00006|6.6275517|-89.9279197
x-00007|7.8266025|-89.9129272
x-00008|9.0694378|-89.9714031
x-00009|9.6627953|-89.9244314
x-00010|10.0494292|-89.9705058
x-00011|10.4863922|-89.9699058
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x-00029|24.5540458|-89.9246003
x-00030|24.5655172|-89.9122336
x-00031|26.3487519|-89.9460336
x-00032|26.5268008|-89.9311503
x-00033|26.6070808|-89.9271808
x-00034|27.4104919|-89.9768558
x-00035|27.8290442|-89.9304622
x-00036|28.5552036|-89.9199117
x-00037|29.4407347|-89.9762836
x-00038|30.5729608|-89.9377753
```

$\bowtie\theta$

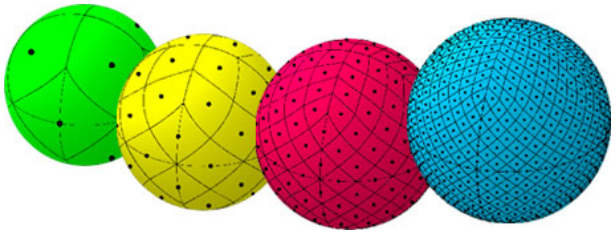
Catalog(s): 10^9

```
t-0000001|1.1458447|-89.9186147|0.015|0.028
t-0000002|1.3300139|-89.9332336|0.050|0.110
t-0000003|3.2556022|-89.9641031|0.050|0.050
t-0000004|3.6464625|-89.9060142|0.204|0.224
t-0000005|6.3110253|-89.9523947|0.114|0.050
t-0000006|6.6275517|-89.9279197|0.098|0.150
t-0000007|7.8266025|-89.9129272|0.025|0.021
t-0000008|9.0694378|-89.9714031|0.200|0.200
t-0000009|9.6627953|-89.9244314|0.000|0.000
t-0000010|10.0494292|-89.9705058|0.050|0.228
t-0000011|10.4863922|-89.9699058|0.200|0.200
t-0000012|11.0953692|-89.9016031|0.050|0.259
t-0000013|11.3240233|-89.9344336|0.050|0.050
t-0000014|11.7906064|-89.9070308|0.159|0.131
t-0000015|12.0416581|-89.9300586|0.216|0.050
t-0000016|12.0522308|-89.9002281|0.050|0.050
t-0000017|12.2808536|-89.9107669|0.050|0.050
t-0000018|13.0316142|-89.9214558|0.152|0.120
t-0000019|13.8727033|-89.9577031|0.050|0.121
t-0000020|14.6546639|-89.9191919|0.050|0.069
t-0000021|18.3035981|-89.9447475|0.139|0.440
t-0000022|18.5185631|-89.9446836|0.057|0.268
t-0000023|19.8675597|-89.9836308|0.050|0.120
t-0000024|20.9699533|-89.9226864|0.050|0.050
t-0000025|21.6777744|-89.9256808|0.055|0.105
t-0000026|23.3660669|-89.9036558|0.050|0.135
t-0000027|24.2841308|-89.9516475|0.213|0.050
t-0000028|24.3273161|-89.9202392|0.550|0.999
t-0000029|24.5540458|-89.9246003|0.160|0.086
t-0000030|24.5655172|-89.9122336|0.205|0.050
t-0000031|26.3487519|-89.9460336|0.050|0.095
t-0000032|26.5268008|-89.9311503|0.335|0.245
t-0000033|26.6070808|-89.9271808|0.050|0.075
t-0000034|27.4104919|-89.9768558|0.094|0.090
t-0000035|27.8290442|-89.9304622|0.017|0.019
t-0000036|28.5552036|-89.9199117|0.050|0.115
t-0000037|29.4407347|-89.9762836|0.635|0.265
t-0000038|30.5729608|-89.9377753|0.314|0.170
```

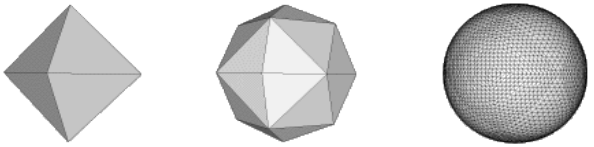
Astronomy meets database

Indexing the SKY with PostgreSQL

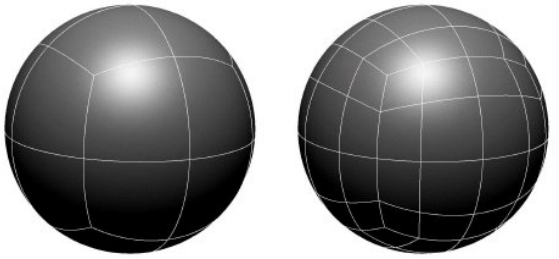
HEALPIX



HTM

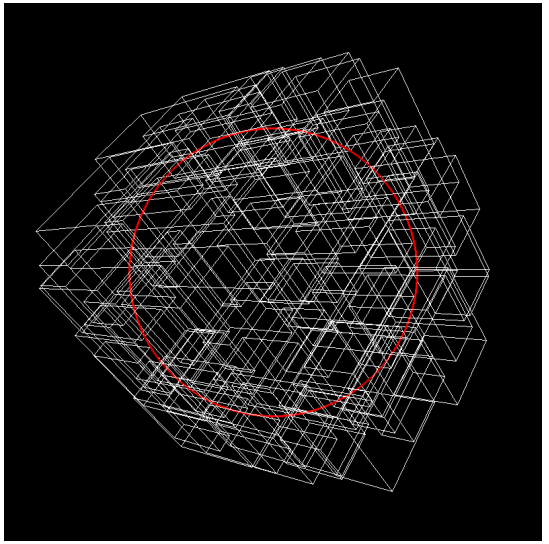


Q3C (PG)



The sphere segmentation in Q3C

PGSphere (PG)



WSDB Whole Sky DataBase

Database of astronomic catalogues in Cambridge University

~5 dbs,~ 40 users, up to ~ 10^7 queries per day, size 40Tb

pg 9.4 + q3c + hstore

Example of research:Koposov, S. E., Belokurov, V., Torrealba, G., & Evans, N. W. (2015). Beasts of the Southern Wild: Discovery of nine Ultra Faint satellites in the vicinity of the Magellanic Clouds. The Astrophysical Journal, 805(2), 130.

Gaia Alerts Database

Real time Detection of alerts in the Gaia

~10 dbs, 10 users, up to ~ 10^6 queries per day, size 30Tb

pg 9.3 + synchronous replication + q3c

Example of research:Campbell, H. C., Marsh, T. R., Fraser, M., Hodgkin, S. T., de Miguel, E., Gänsicke, B. T., ... & Koposov, S. E. (2015). Total eclipse of the heart: the AM CVn Gaia14aae/ASSASN-14cn. Monthly Notices of the Royal Astronomical Society, 452(1), 1060-1067.

MASTER database

Robotic network telescopes by SAI MSU

8 observatories (5 in Russia, 3 outside)

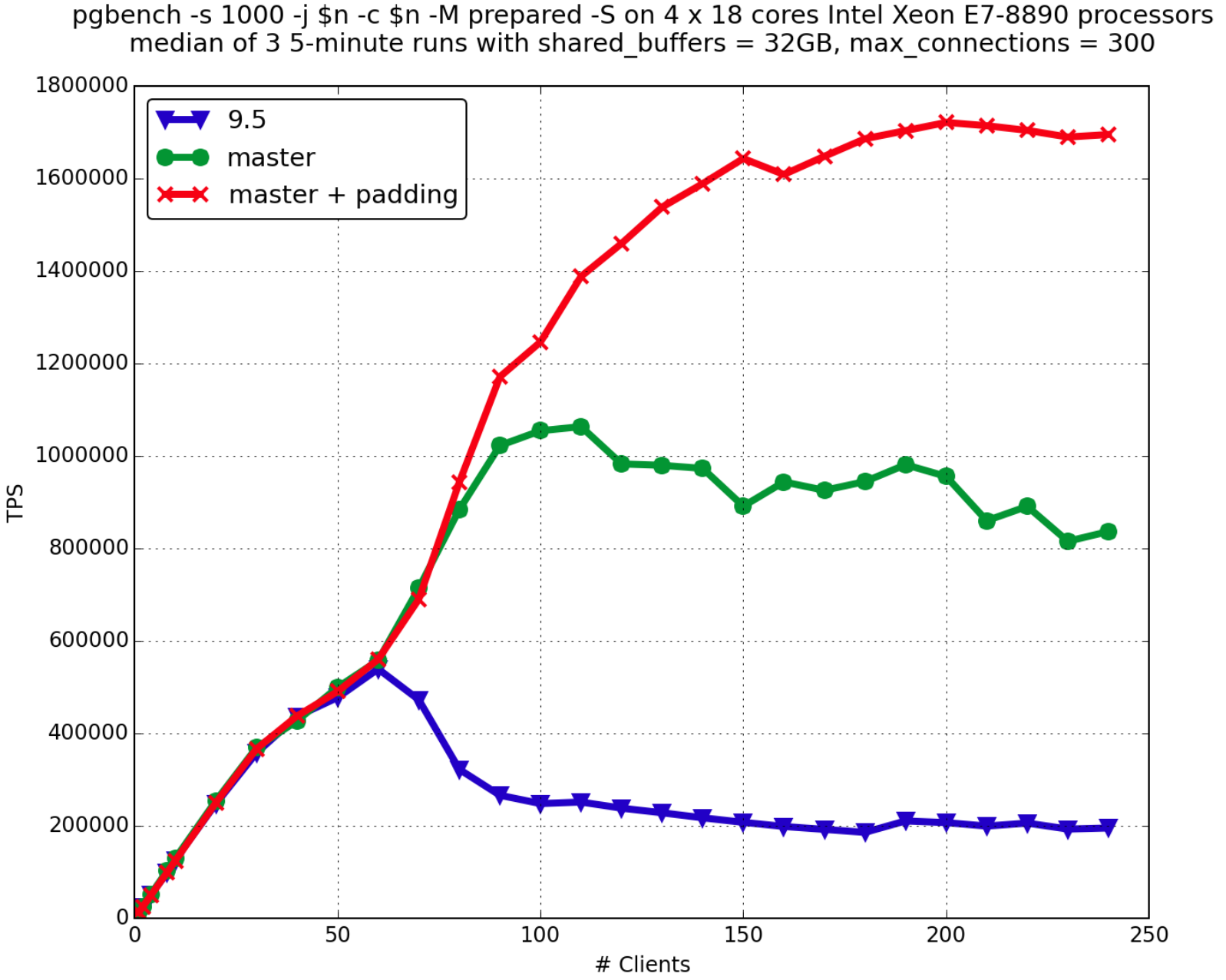
total size ~100TB

pg 9.0-9.4 + pgsphere + replication

See:

- Lipunov, Vladimir, et al. "Master robotic net." Advances in Astronomy 2010 (2010).
- Kornilov, Victor G., et al. "Robotic optical telescopes global network MASTER II. Equipment, structure, algorithms." Experimental Astronomy 33.1 (2012): 173-196.

PostgreSQL scalability on 4x18 x86



~~When I started using Postgres~~ (Today)

Excellent scalablity on 4-socket X86 machines

Support a wide range of workloads

- High security data, relational, NoSQL, OLAP

Postgres-centric companies

- 2ndQuadrant, EDB, Postgres Professional (roadmaps)

Postgres groups

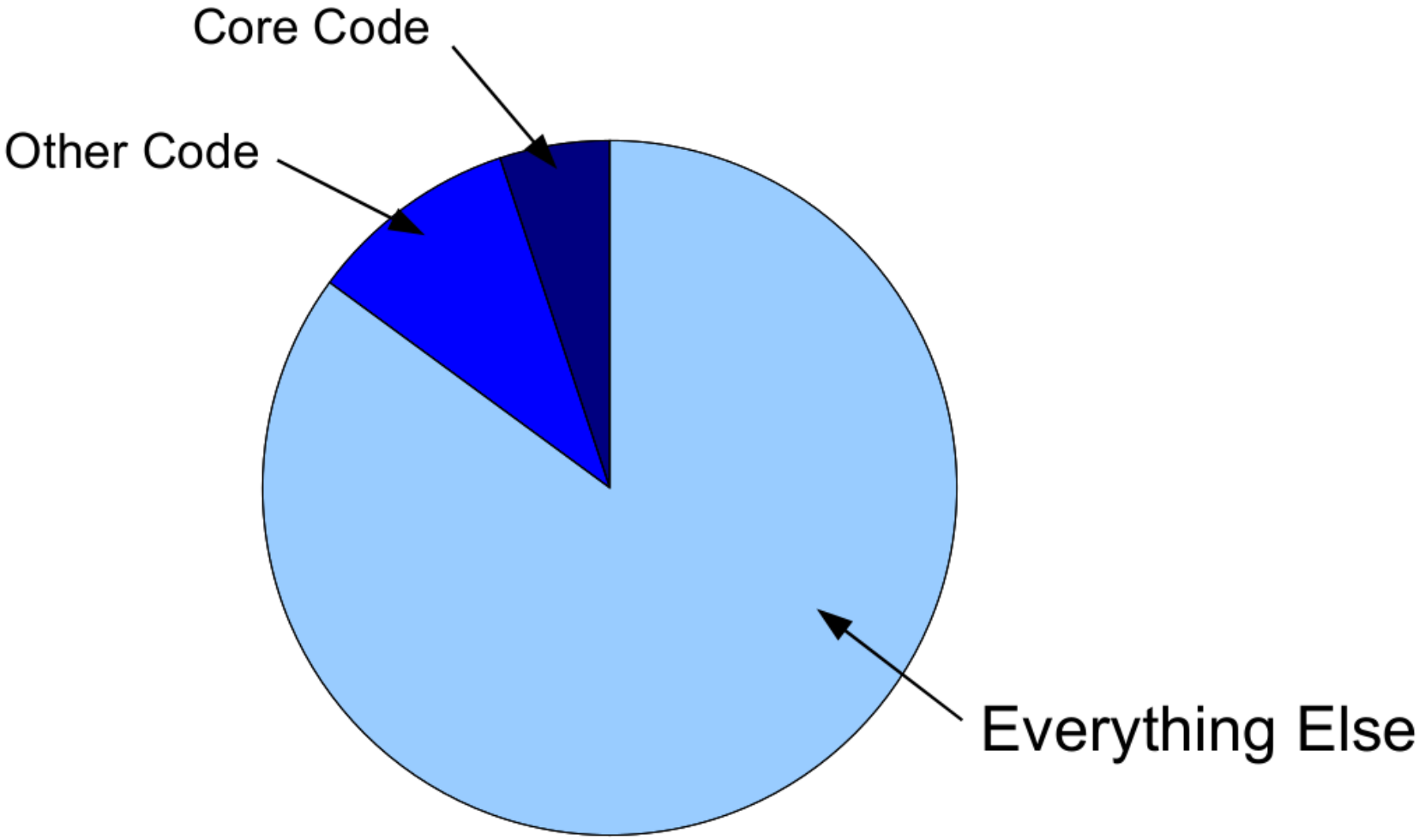
- NTT, Fujitsu, Amazon, Alibaba, Tencent,…

Postgres Development from

- Community driven → Business driven

Postgres is used in mission-critical enterprise systems

There are many ways to help Postgres



There are many ways to help Postgres

Core development
Development, review, testing, reporting bugs

Ecosystem
Extensions, drivers, ORM, monitoring tools… Postgres support in applications Distributions, packages

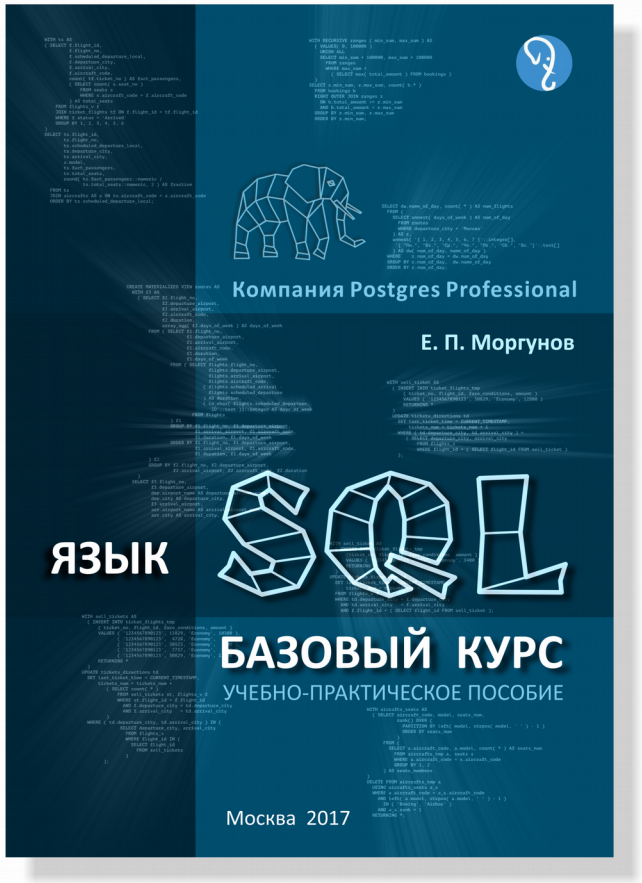
Documentation
Improvement, translations, writing books, papers, ...blogging!

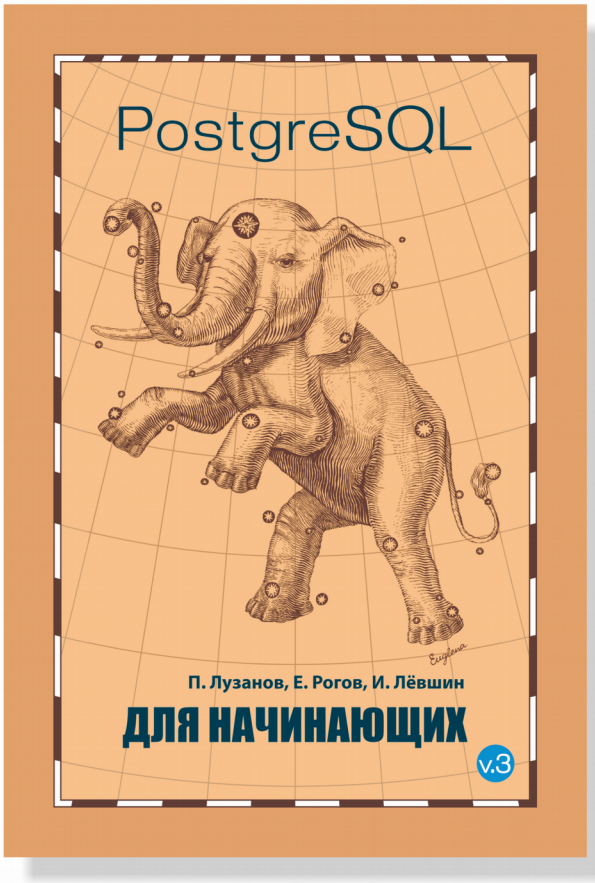
Meetings, Education
Creating of local communities, Conference, meetups, seminars, hackatons, educational and training courses

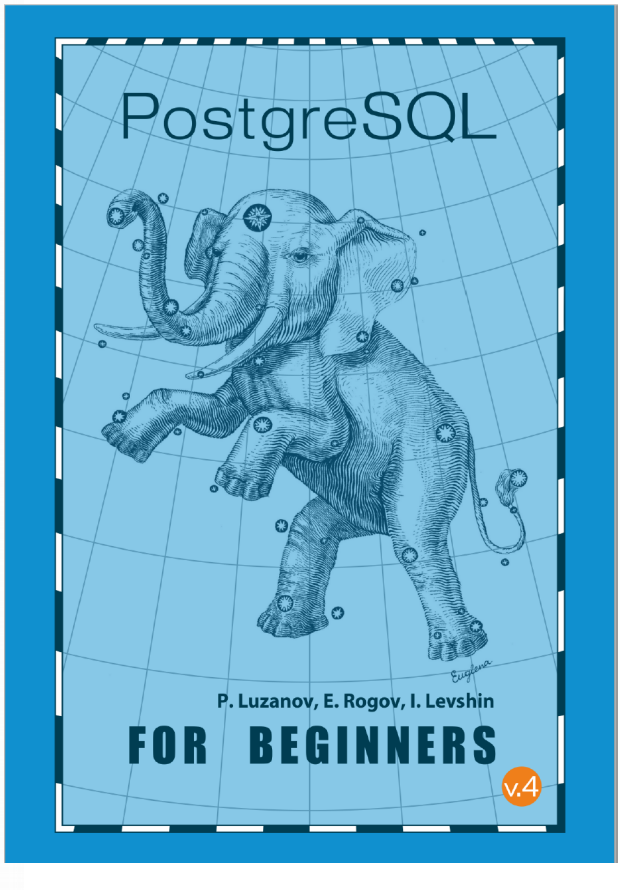
Use PostgreSQL!
Use Postgres in your company !

Sponsorship
Help development, sponsor community events.

Books about PostgreSQL
BSD License, translate them !





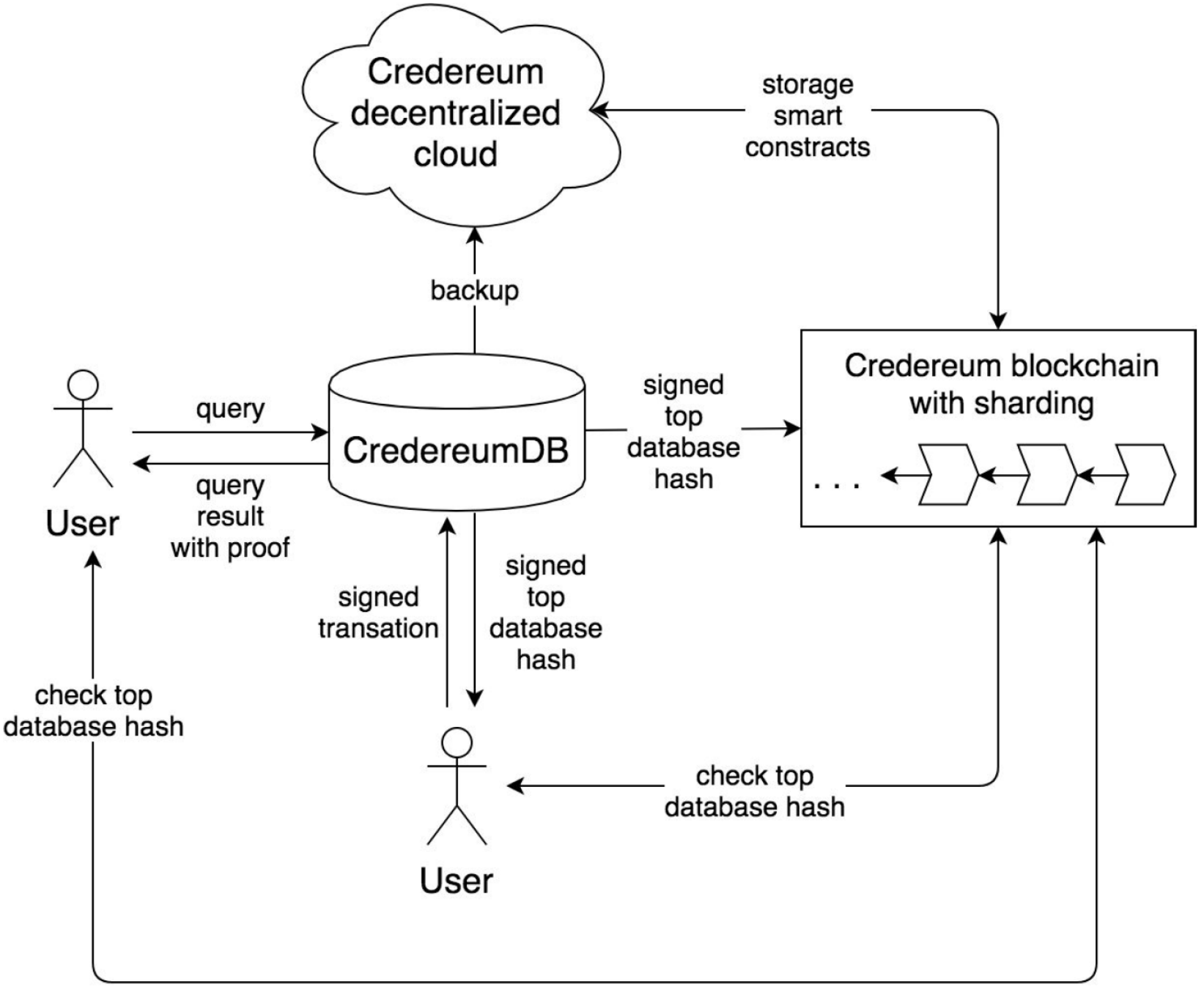


Case 4: Trusted PostgreSQL

How to know
your database
is not compromised ?

Credereum uses digital signature to sign transactions and Blockchain to store signatures to solve this problem.

Credereum platform



PostgreSQL Future

Several Postgres groups are working on

Postgres Distributed

Postgres Parallel

Postgres Asynchronous

Postgres Extendable+

Postgres NoSQL

Postgres Scalable

Postgres Trusted

References

1. https://www.postgresql.org/ - community site
2. https://wiki.postgresql.org/ - wiki
   - https://wiki.postgresql.org/wiki/FAQ - PostgreSQL FAQ
3. https://www.postgresql.org/list/ - mailing lists archive
   - https://postgrespro.com/list/ - search mailing lists
4. https://planet.postgresql.org/ - Planet PostgreSQL (blogs)
5. https://www.postgresql.org/about/events/ - Events
   PGConf.eu, PGConf.ru, PGConf.asia, PGCon.org, PGConf.org — major conferences
6. https://postgrespro.ru/education - Postgres Professional education materials
7. https://pgxn.org/ - PostgreSQL Extension Network
8. https://postgres-slack.herokuapp.com/ - Slack channel
9. https://stackoverflow.com/questions/tagged/postgresql - StackOverflow
10. https://www.facebook.com/groups/postgres/ - FB (en)
11. https://www.facebook.com/groups/postgresql - FB (ru)
12. https://telegram.me/pgsql - Telegram (ru)
13. https://postgis.net/ - PostGIS
14. http://postgresql.org.il/ - PostgreSQL Israel
    http://pgday.org.il/ - PGDay Israel (March 19, 2018)

ध्यानपूर्वक सुनिदिनुभएकोमा धेरै धन्यवाद।