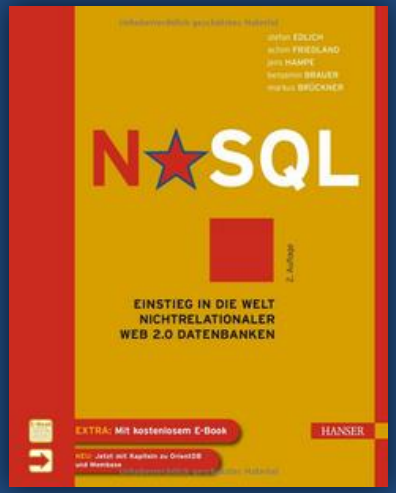
Stefan Edlich



BOOK

N★SQL

#1 WEBSITE

3y+ Consultant

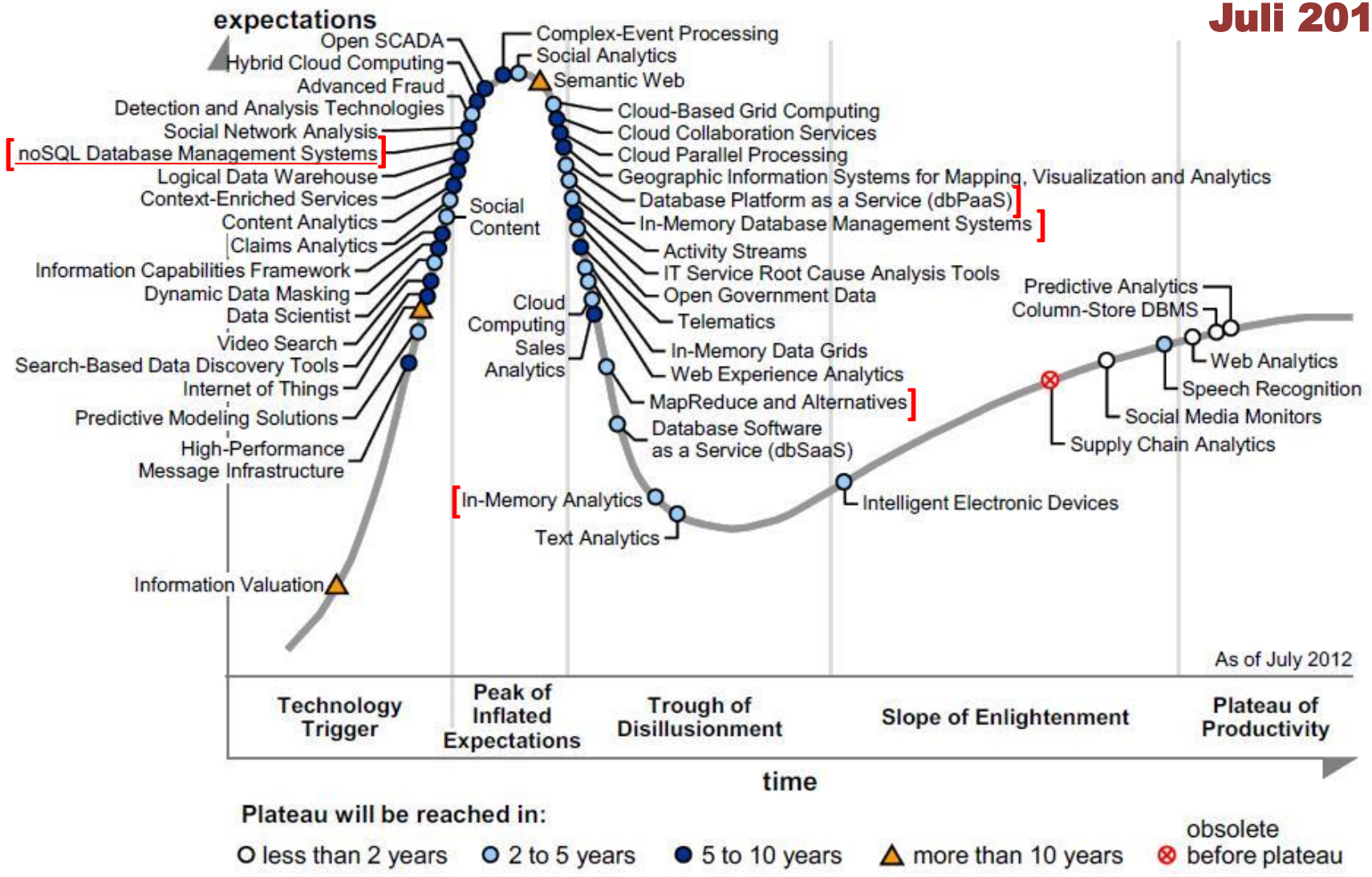
1. Where are we?

2. What‘s new?

3. Some predictions for the future?

Figure 1. Hype Cycle for Big Data, 2012

Juli 2012



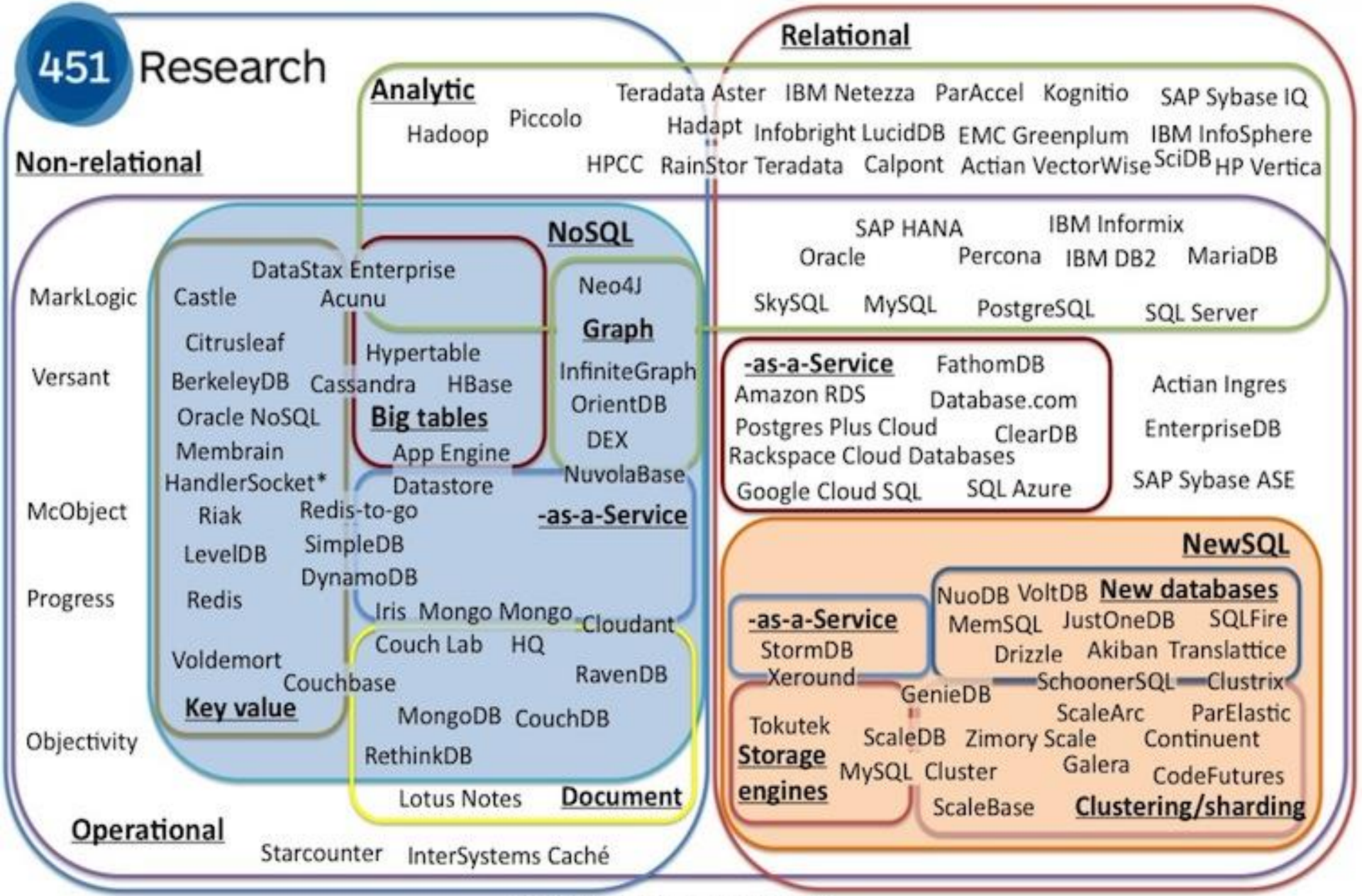
Source: Gartner (July 2012)

in 2009 „In the next years we will see a consolidation and many databases and DB companies will die!“

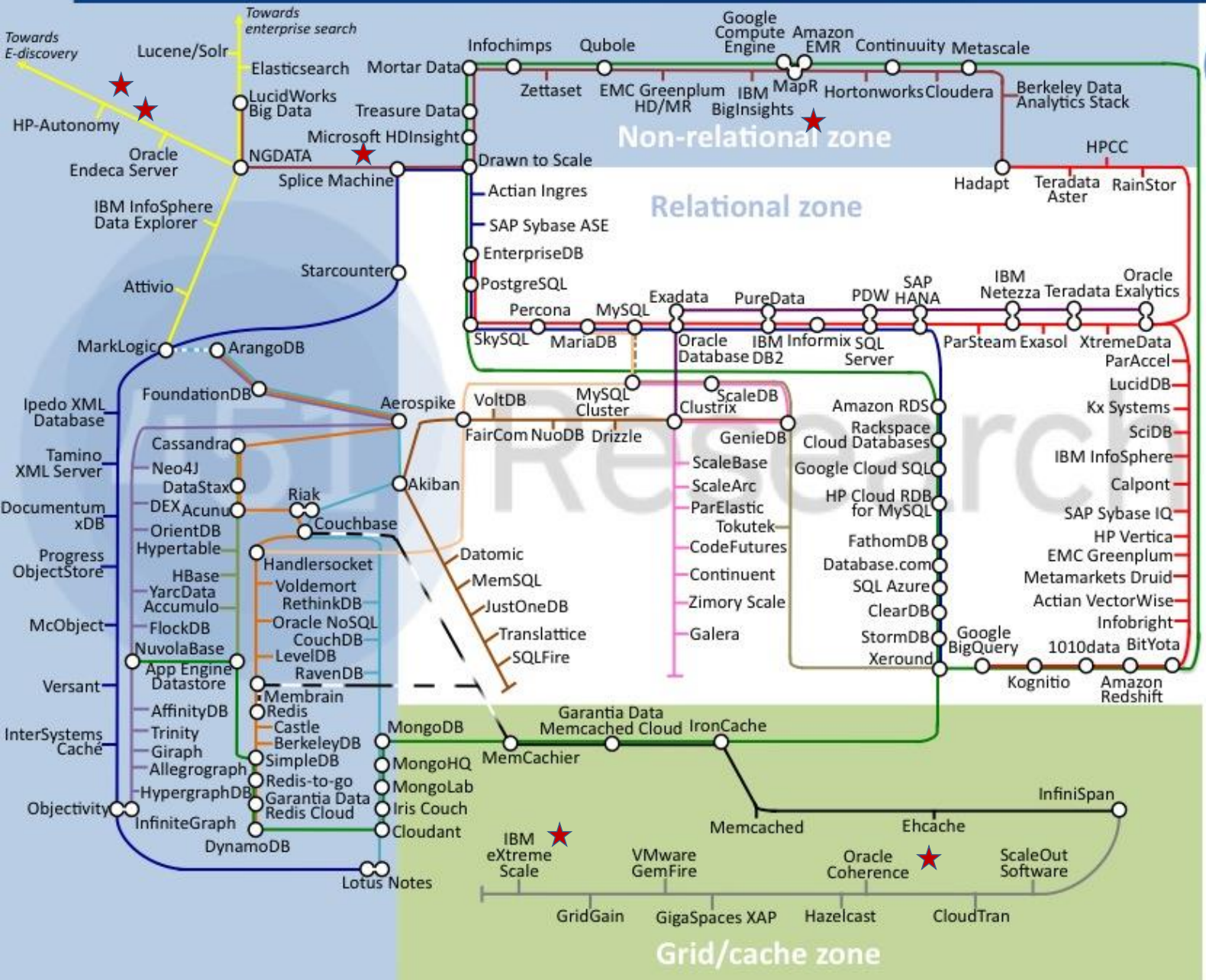
Rank	Last Month	DBMS	Database Model	Score	Changes
1.	1.	**Oracle**	**Relational DBMS**	**1560.59**	**+27.20**
2.	↑ 3.	**MySQL**	**Relational DBMS**	**1342.45**	**+47.24**
3.	↓ 2.	**Microsoft SQL Server**	**Relational DBMS**	**1278.15**	**-40.21**
4.	4.	**PostgreSQL**	**Relational DBMS**	**174.09**	**-3.07**
5.	5.	**Microsoft Access**	**Relational DBMS**	**161.40**	**-8.77**
6.	6.	**DB2**	**Relational DBMS**	**155.02**	**-4.31**
7.	7.	**MongoDB**	**Document store**	**129.75**	**+5.52**
8.	↑ 9.	**SQLite**	**Relational DBMS**	**88.94**	**+5.68**
9.	↓ 8.	**Sybase**	**Relational DBMS**	**80.16**	**-5.25**
10.	10.	**Solr**	**Search engine**	**46.15**	**+2.99**
11.		Teradata	Relational DBMS	44.93	
12.	11.	Cassandra	Wide column store	38.57	+2.21
13.	12.	Redis	Key-value store	35.58	+3.15
14.	13.	Memcached	Key-value store	24.80	-0.17
15.	14.	Informix	Relational DBMS	24.00	+0.10
16.	15.	HBase	Wide column store	21.84	+1.40
17.	16.	CouchDB	Document store	18.72	+0.42
18.	17.	Firebird	Relational DBMS	12.24	-1.54
19.		Netezza	Relational DBMS	11.14	
20.	18.	Sphinx	Search engine	9.55	+0.09
21.	19.	Neo4j	Graph DBMS	8.34	+0.90
22.	21.	Elasticsearch	Search engine	8.31	+1.56
23.	22.	Riak	Key-value store	7.20	+1.10
24.	20.	Vertica	Relational DBMS	6.98	-0.42
25.		Greenplum	Relational DBMS	6.29	
26.	26.	Couchbase	Document store	5.33	+1.16

db-engines.com

The evolving database landscape



Database Landscape Map – December 2012



451 Research

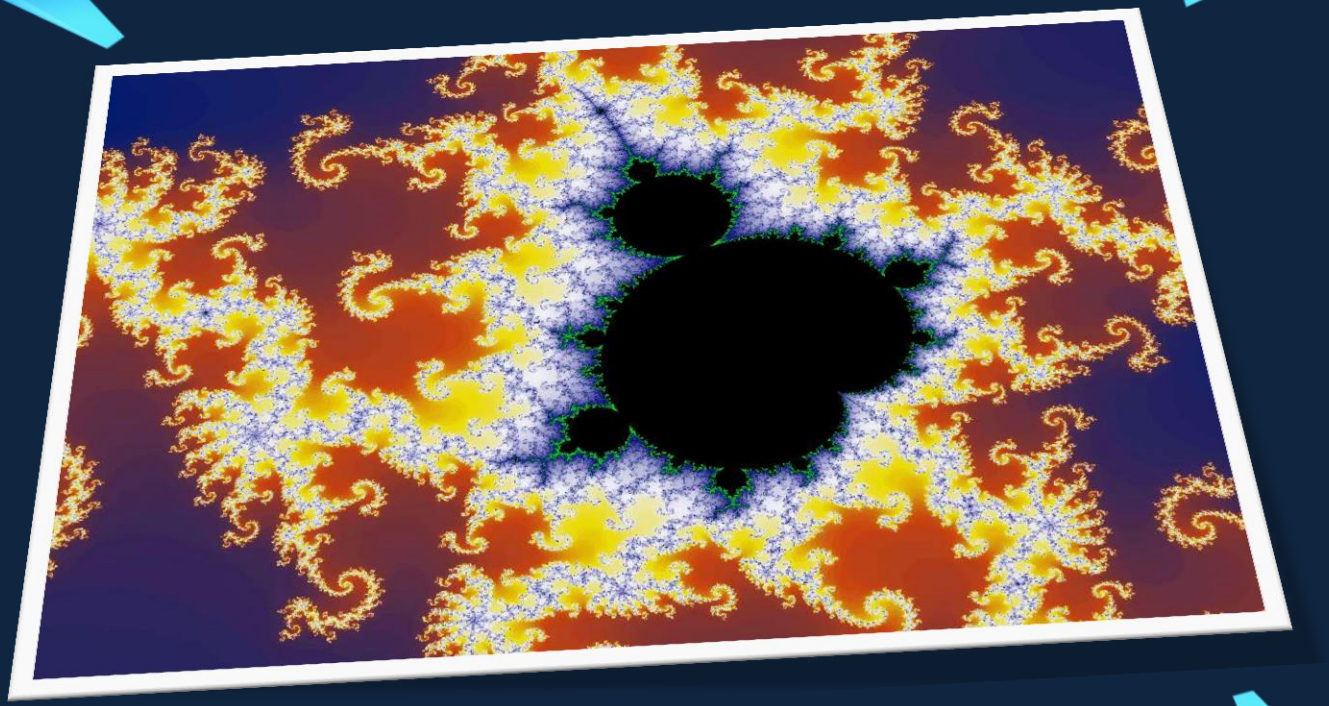
Key:

- Operational
- Analytic
- -as-a-Service
- NoSQL extension
- BigTables
- Graph
- Document
- Key value stores
- Key value direct access
- Hadoop
- NewSQL extension
- Storage engines
- Advanced clustering/sharding
- New SQL databases
- Data caching extension
- Data caching
- Data grid
- Index-based data management
- Appliances

www.451research.com

@maslett

Expanding Universe…



In 5-N years…
DBs like the smartphone market

„excessive feature exchange“

Microsoft
PostgresQL Oracle
IBM SAP

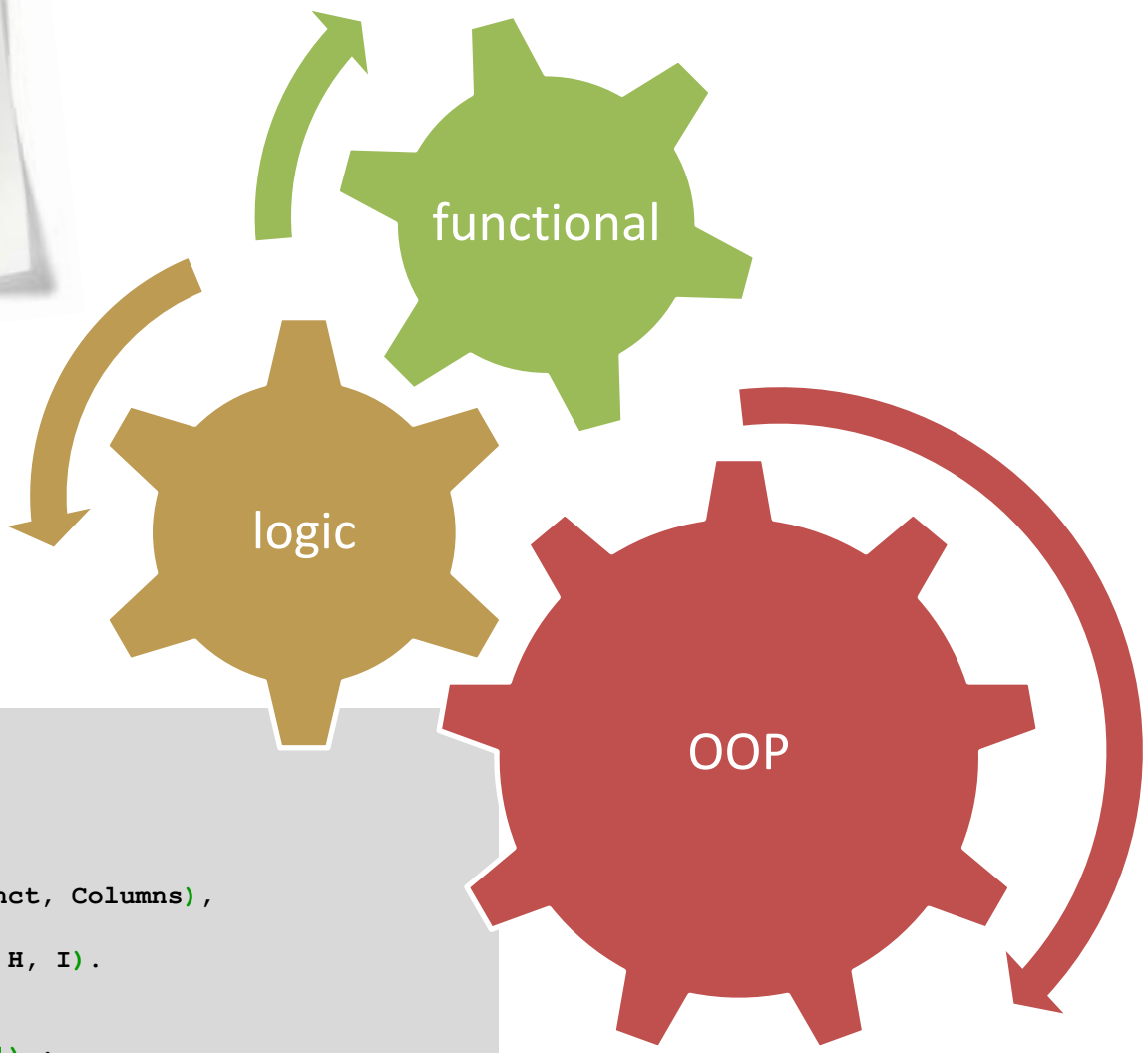
JSON
Hadoop Scalability
relaxed-Schema
NewSQL

Schema-support love-SQL
Management-Support
tunable-Consistency
OLAP-Mining-Analytics

MongoDB Cassandra
Riak
Aerospike
Graph-DBs

analogy Programming Languages

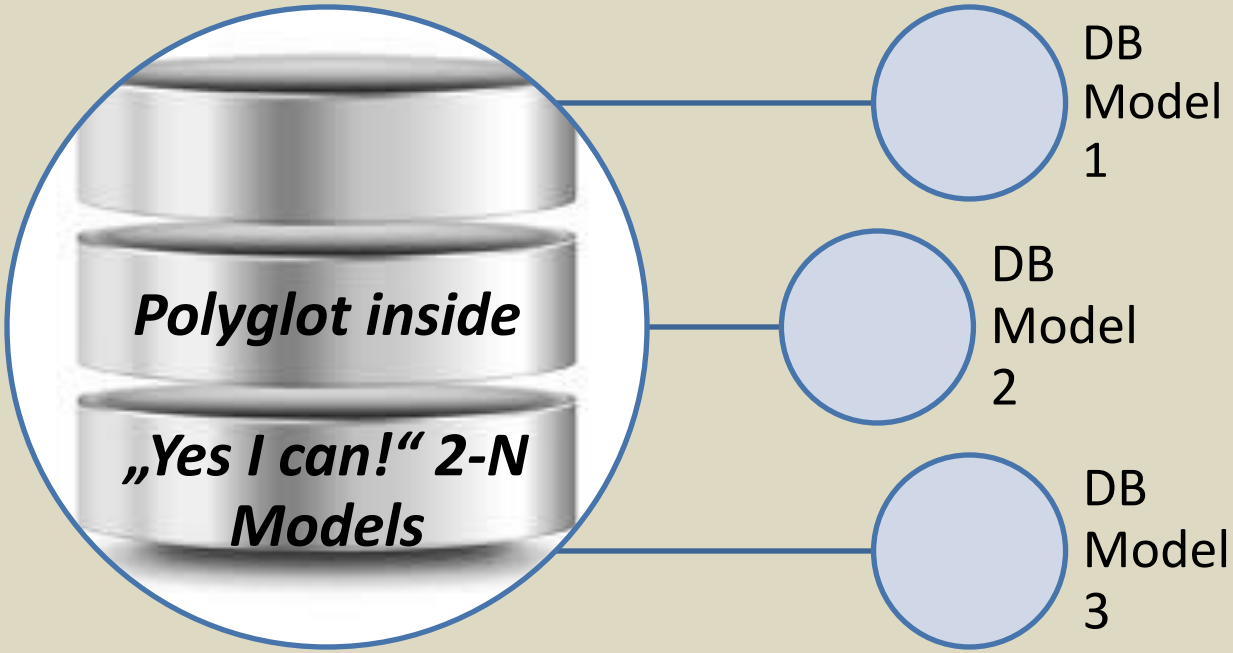
multicore
no state

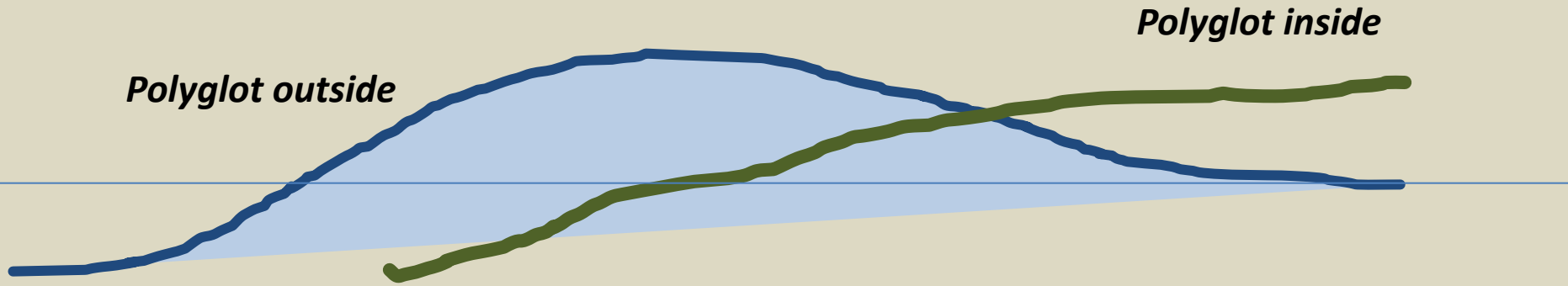


3			2	4			6	
	4						5	3
1	8	9	6	3	5	4		
				8		2		
		7	4	9	6	8		1
8	9	3	1	5		6		4
		1	9	2		5		
2			3			7	4	
9	6		5			3		2

```
:- use_module(library(clpfd)).
sudoku(Rows) :-
length(Rows, 9), maplist(length_(9), Rows),
append(Rows, Vs), Vs ins 1..9,
maplist(all_distinct, Rows),
transpose(Rows, Columns), maplist(all_distinct, Columns),
Rows = [A,B,C,D,E,F,G,H,I],
blocks(A, B, C), blocks(D, E, F), blocks(G, H, I).
length_(L, Ls) :- length(Ls, L).
blocks([], [], []).
blocks([A,B,C|Bs1], [D,E,F|Bs2], [G,H,I|Bs3]) :-
all_distinct([A,B,C,D,E,F,G,H,I]),
blocks(Bs1, Bs2, Bs3).
```

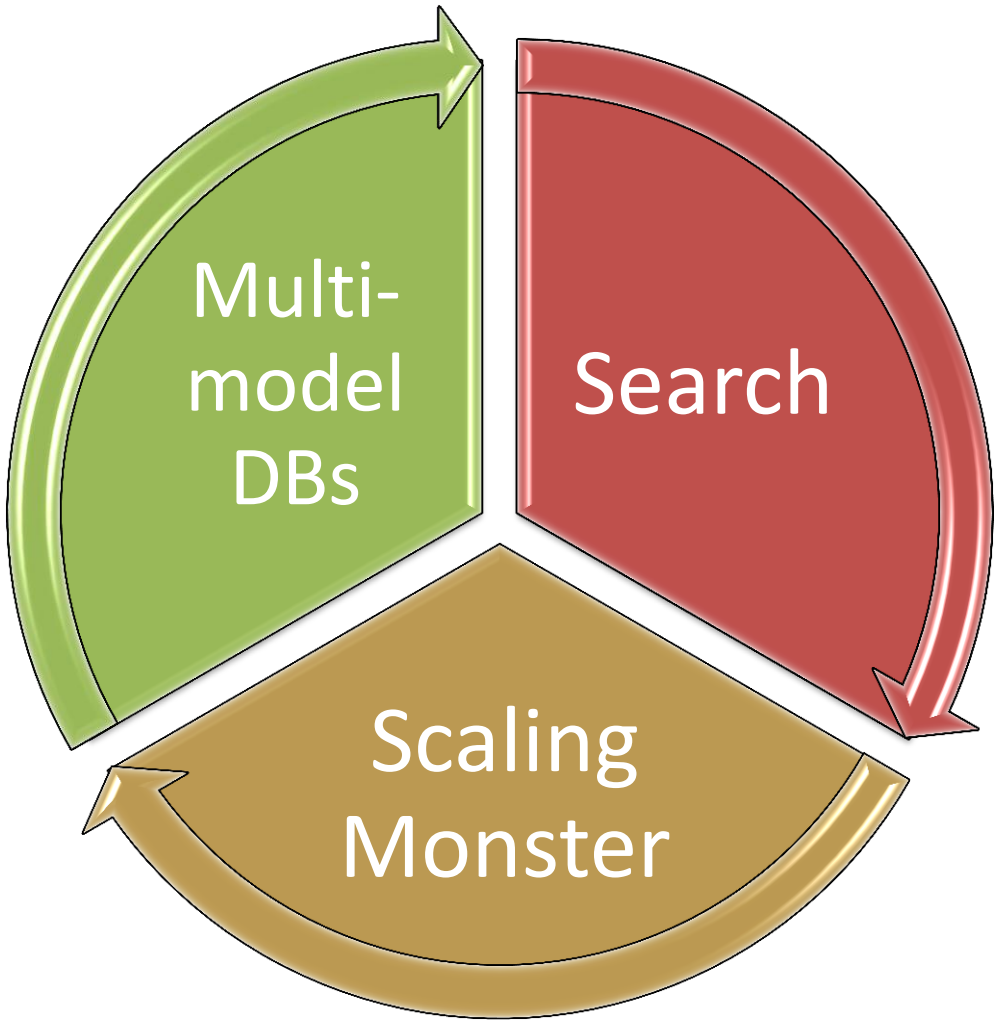
Polyglot outside +pics please



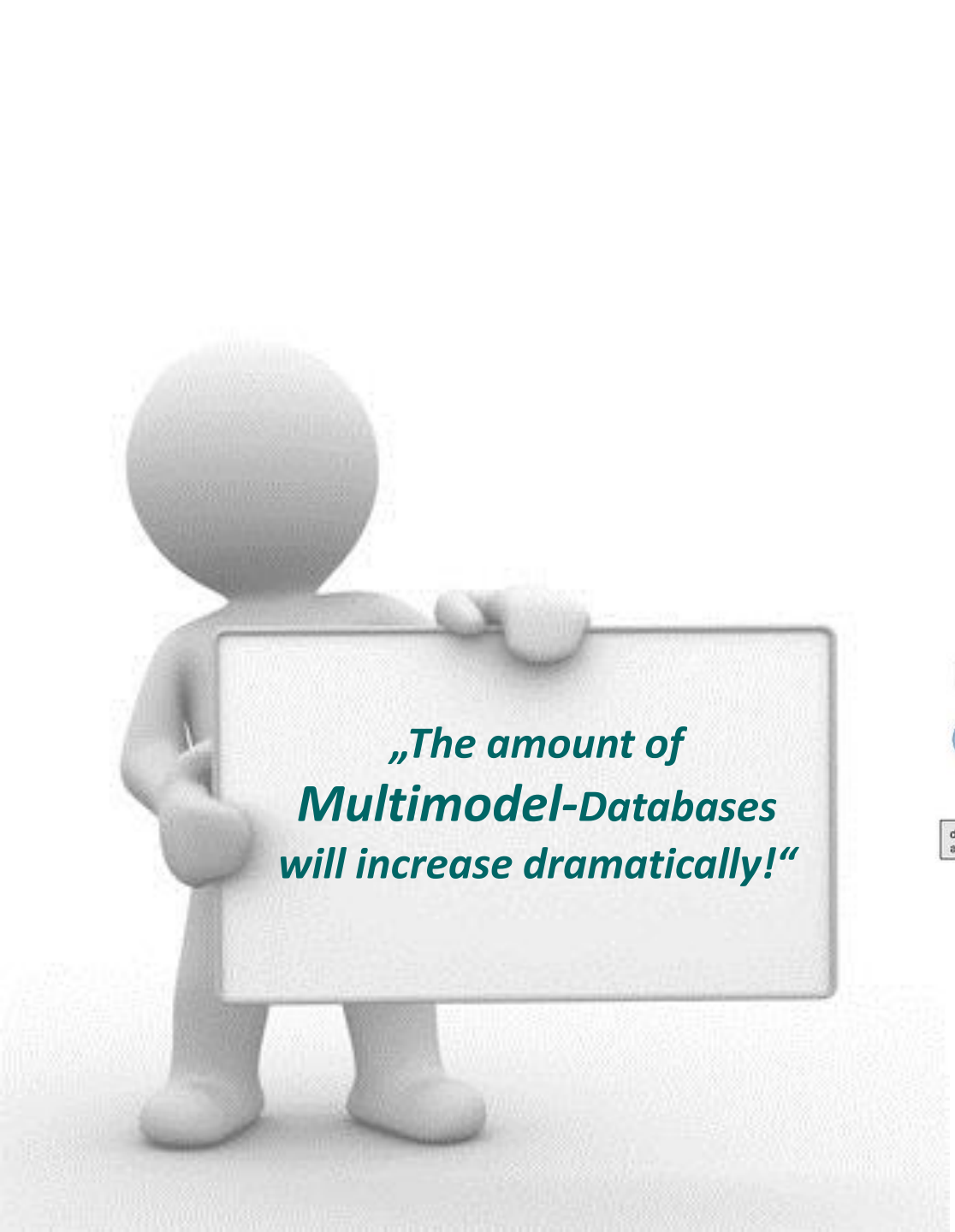


Part II

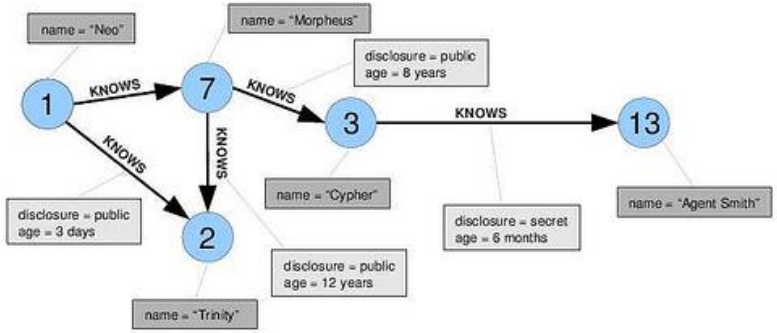
new Ideas & Newcomers

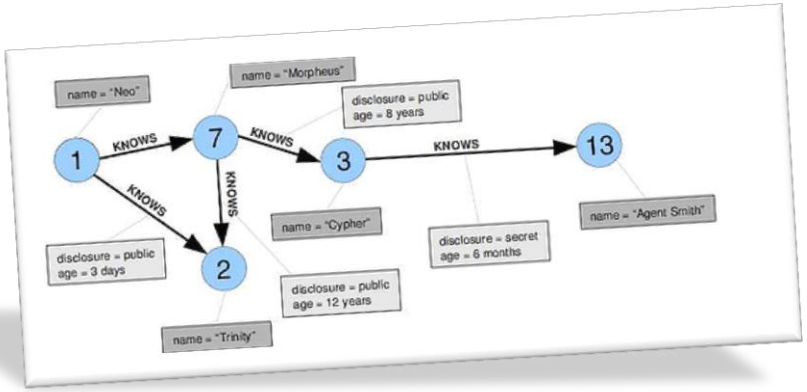


Design Pattern: „Append only = write once => SSD ready“


„The amount of
Multimodel-Databases
will increase dramatically!“


json

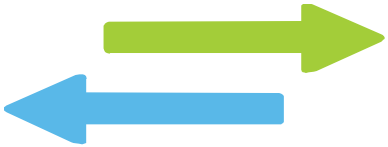

name = "Neo"
name = "Morpheus"
disclosure = public
age = 8 years
KNOWS
KNOWS
KNOWS
KNOWS
KNOWS
1
7
3
13
2
name = "Cypher"
disclosure = public
age = 3 days
disclosure = secret
age = 6 months
name = "Agent Smith"
disclosure = public
age = 12 years
name = "Trinity"



Microsoft Trinity?
IBM RDF Store?!
Object-Databases?

2nd Iteration

V 9.3
+ new Parser

JSON  tables, KV

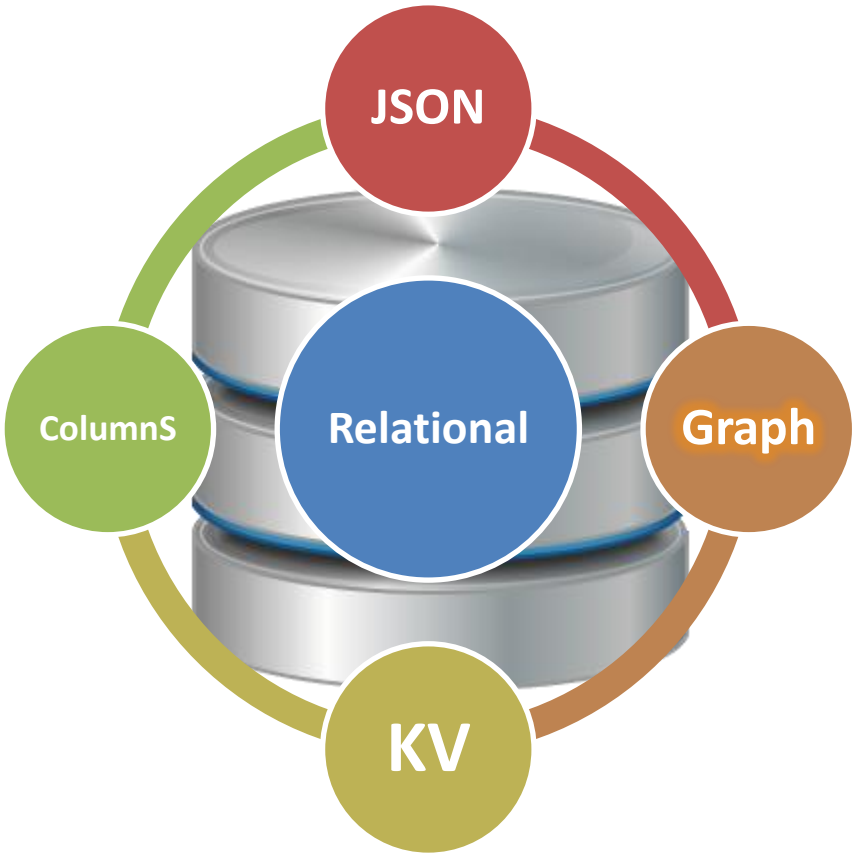
```
json_agg(anyrecord) -> json          => json array
to_json(any) -> json
hstore_to_json(hstore) -> json (also used as a cast)
hstore_to_json_loose(hstore) -> json
```

```
postgres=# SELECT json_agg(aa) FROM aa;
Access JSON Objects: -> and ->>
condense fields with: #> and #>>
```

```
postgres=# CREATE TABLE aa (id int, txt hstore);
CREATE TABLE
postgres=# INSERT INTO aa VALUES (1, 'f1=>t, f2=>2, f3=>"Hi", f4=>NULL');
INSERT 0 1
postgres=# SELECT id, txt::json, hstore_to_json(txt) FROM aa;
id | txt | hstore_to_json
----+-----------------------------------------------+-----------------------
-------------------------
1 | {"f1": "t", "f2": "2", "f3": "Hi", "f4": null} | {"f1": "t", "f2": "2",
"f3": "Hi", "f4": null}
(1 row)
```

http://www.postgresql.org/docs/devel/static/functions-json.html

Multimodel-Databases



Example: Handler Socket first 2010, now 2013 Oracle / MySQL

Premise: Atoms

inducible to MultimodelDBs

Labs do work on:

DB Personalities!

K/V rebirth?!

```
1  db = openDatabase(id);
2  db.selectPersonality(GRAPHDB);
3  // db.selectModel(JSONDB)
4  db.insert(graph-node1);
5  db.insert(graph-node2);
6  db.query(cypherQuery);
7  ...
```

- ✓ Atoms => Datomic!
- ✓ Clojure Principles, 2-3 persons, 2 years work
- ✓ Immutable Data MVCC, replay, compare DBs, history juggling (query „as of“ or „time-windows“)
- ✓ Nathan Marz: „Single Source of Truth…“

- ✓ACID LAYER
- ✓unlimited read scalability
  e.g. with DynamoDB
- ✓Full-Text Search

✓Smart Caching => Data Gravity

- ✓ minimal Schema / Metadata
- ✓ has cardinality,
- ✓ references are „bi“ by default,

  => graph ‚alike‘ queries

Stu Halloway „The impedance mismatch is our fault“

```
(unifier '[(?a * ?x | 2) + (?b * ?x) + ?c]
         '[?z + (4 * 5) + 3])

;=> [(?a * 5 | 2) + (4 * 5) + 3]
```

✓Datalog + Queries!

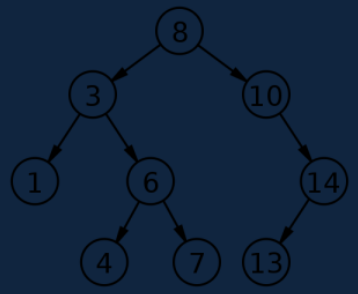
- ✗ Rectangulation of Data
- ✗ Place Oriented Programming

- ✓ unification (MGU) + logic capabilities
- ✓ Code as Data

```
(datomic/q '[:find   ?name ?url
             :where (lang-anchor ?name ?url)]
           [[-100 :language/name "Visi"]
            [-200 :language/name "Ioke"]
            [-3   :language/name "Frink"]
            [-4   :language/name "Roy"]
            [-100 :language/url  #url "http://visi.io"]
            [-200 :language/url  #url "http://ioke.org"]]
           the-rules)
```

```
(def people [["ben" 35]
             ["jerry" 41]])

(??- (<- [?name ?age]
         (people ?name ?age)
         (< ?age 40)))

;=> ((["ben" 35]))
```

- ✓ lessons from Cascalog
- ✓ logic querying
- ✓ recursive rules / queries
- ✓ implicit joins



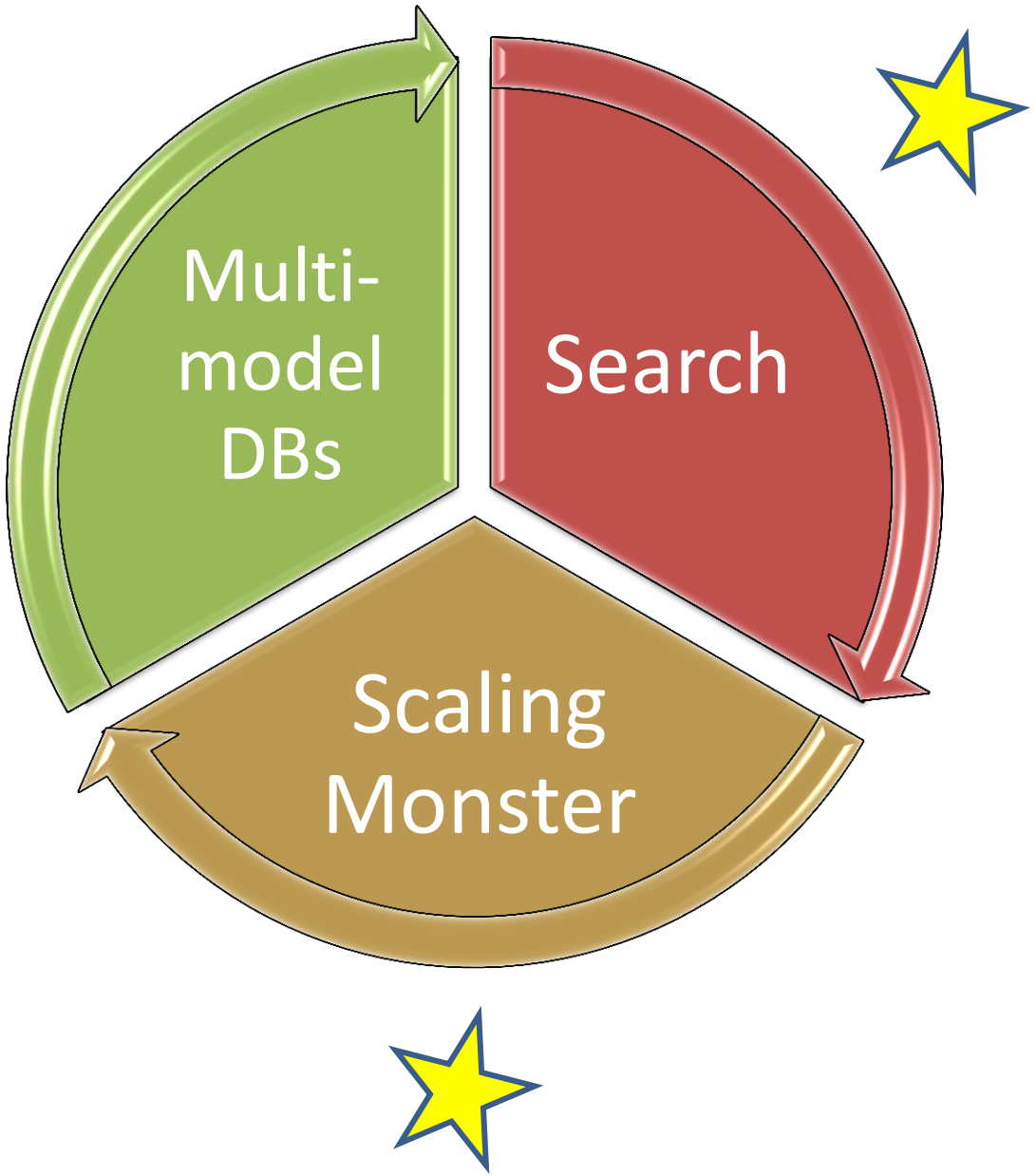
✓abstractions + composability!

```clojure
(defn constrain
  "Apply constraints to a query"
  [query constraints]
  (update-in query [:where] (partial apply concat) constraints))
```

```clojure
{:find [?v], :in [$ %], :where [(vote-join ?v ?y ?p ?s)]}
```

```clojure
(constrain base-query [(year "2000")])
```

```clojure
{:find [?v], :in [$ %], :where ((vote-join ?v ?y ?p ?s) [?v :year "2000"])}
```


Multi-
model
DBs
Search
Scaling
Monster

Lucene 4.1

MVCC->SSD Pattern

ElasticSearch Inc. 10+24 M$

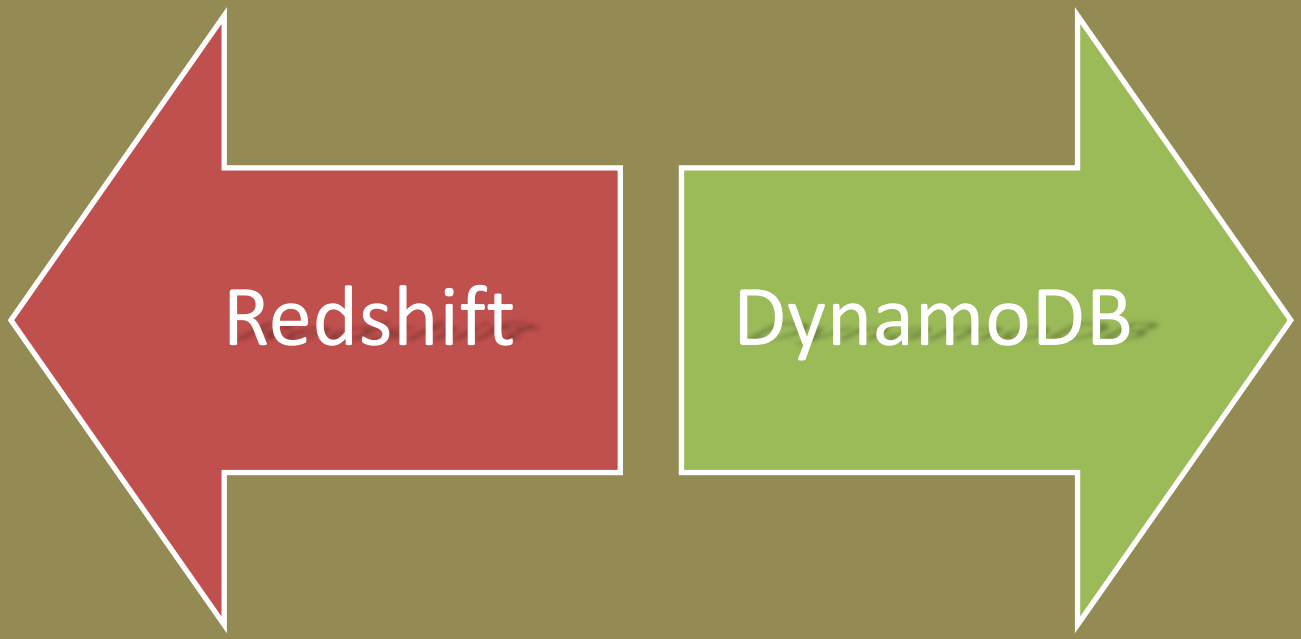
Elasticsearch as primary storage?
Jodok Batlogg
Effner I

elasticsearch.

- Elastic > 100 nodes proven
- Indexing + (Ad Hoc) Search
- Nested JSON DOCs
- Near Real Time
- Distributed Search
- more as Keyword Search
- an Analytics Engine

- no transactions
- not quite a DB ?!
- secondary source!

SOUNDCLOUD


Redshift
DynamoDB

- years of experience from Dynamo, SimpleDB and S3
- 1,6 PByte scalable and reliable
- uses SSD
- fully managed & no maintanance window!
- mutiple syncronous availability zone replication = durability
- provisioned throughput configurable per table
- no fixed schema, any number of attributes & multi value attributes
- consistency and performance tradeoffs tunable
- conditional writes & atomic counters
- index: simple hash or composite hash + key/range
- define a table => make a rw capacity reservation
- backup & restore tables or EMP results into S3 with EMP
- cloud watch & alarms
- 40 million of requests per month free

(Jan 2012)

Datomic, Lucene 4 / ElasticSearch, DynamoDB, …

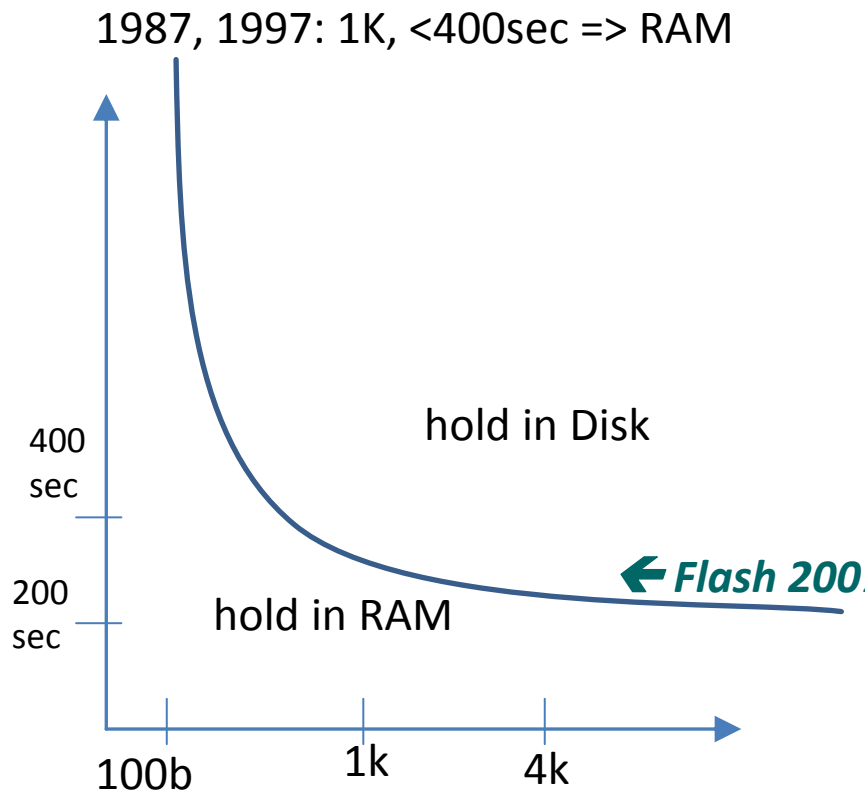
Pattern: write once + append only

RAM – SSD – Disk

Jim Gray, … & Götz Gräfe

„The 5 Minute Rule for Disc Access and the 5 Byte Rule for Trading Memory for CPU Time“ 1987, 1997, 2007

BreakEvenInSeconds = (PagesPerMBofRAM / AccessesPerSecondPerDisk) x (PricePerDiskDrive / PricePerMBofRAM)



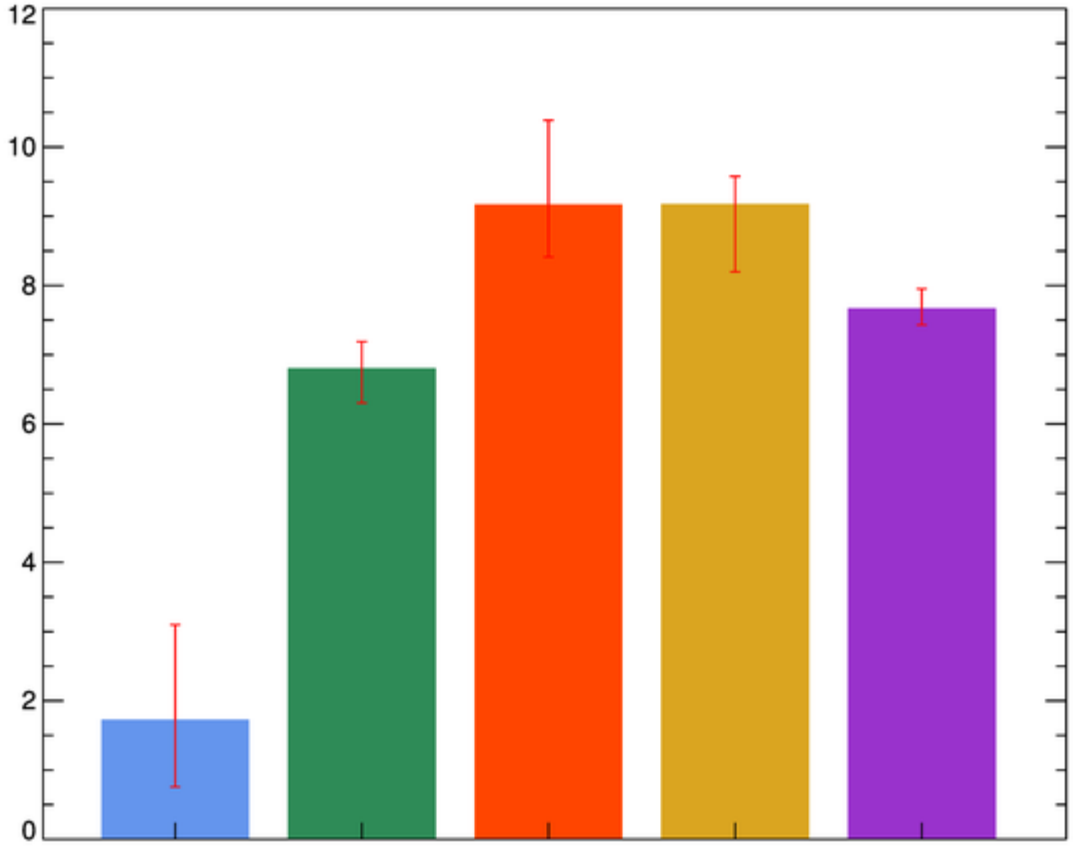
- *Hybrid Disks?!*
- *Slow vs. Fast Write SSDs?!*
- *Rule valid only for big blocks*
- *5248 sec für 4k blocks*

  - *5M: big blocks: Ram -> Flash*
  - *5M: small blocks: RAM -> Disk*

✓ *100.000 erase-write cycles: no problem*
✓ *important: energy efficiency*
✓ *append-only paßt zu, wear-leveling‘*

- *Access Time andAccess Patterns ☹*

Flash 2007: 1000$ for 32GB

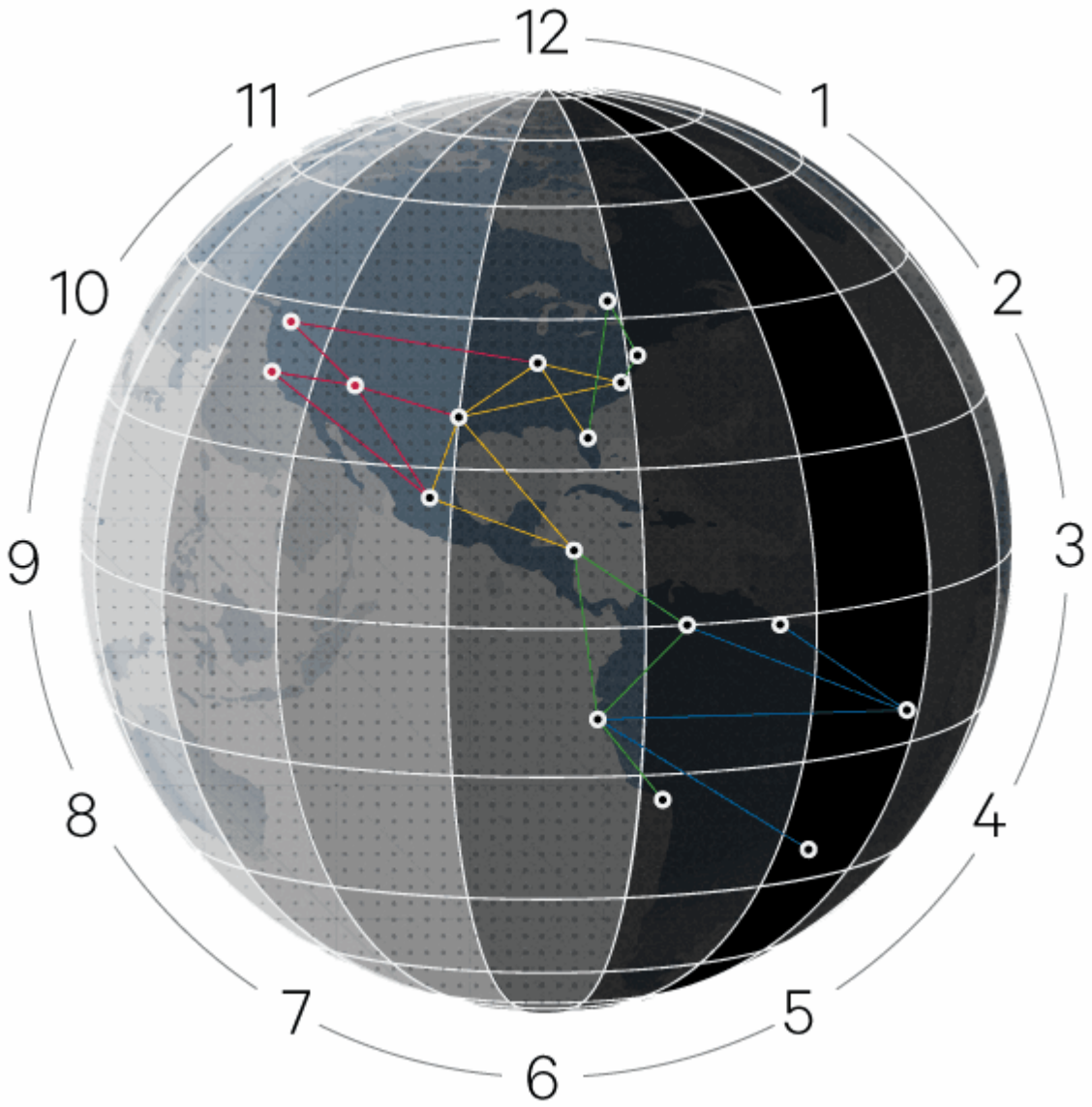


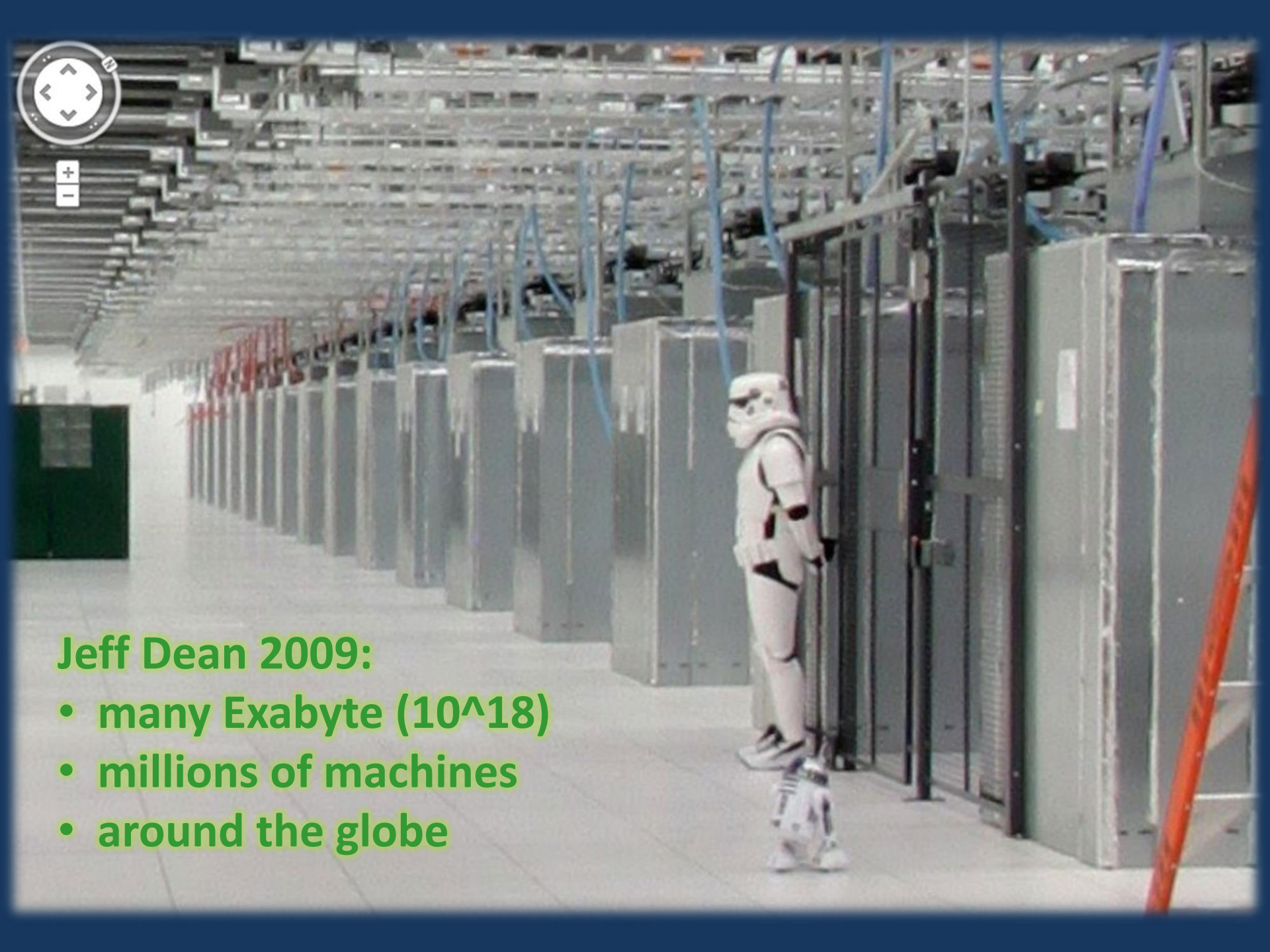
RAM ⇨ SSD ⇨ Disk

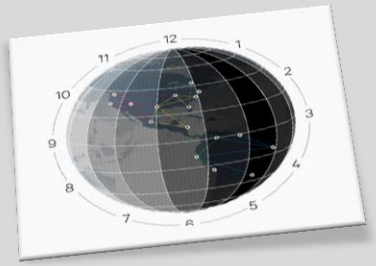
Register ⇨ L1 ⇨ L2 ⇨ RAM ⇨ SCM: PCM? ⇨ SSD ⇨ Disk ⇨ Tape ⇨ /dev/null

Google

Spanner



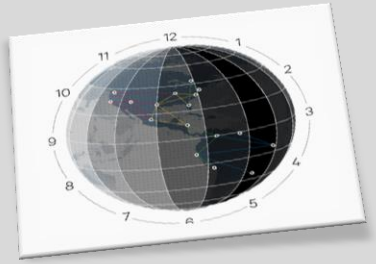

Jeff Dean 2009:
• many Exabyte (10^18)
• millions of machines
• around the globe



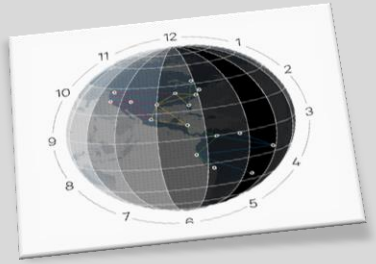
```
CREATE TABLE Users {
  uid INT64 NOT NULL,
  email STRING
} PRIMARY KEY (uid), DIRECTORY;

CREATE TABLE ALBUMS {
  uid INT64 NOT NULL, aid INT64 NOT NULL,
  name STRING
} PRIMARY KEY (uid, aid),
  INTERLEAVE IN PARENT Users ON DELETE CASCADE;
```

- protobuf encoded columns
- extended SQL syntax

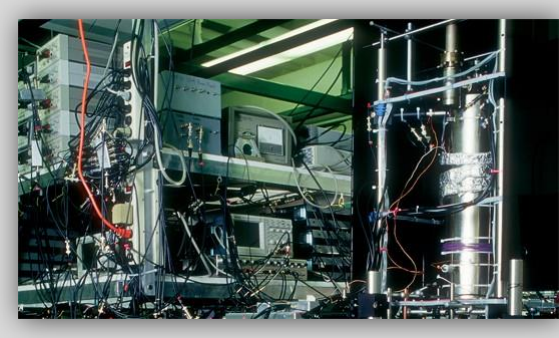
- logically denormalized, physically one Objekt



„Time synchronisation on this level
is not possible!“

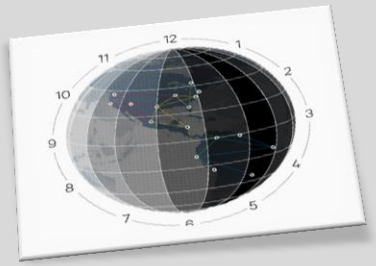


True-Time API: 1-7ms



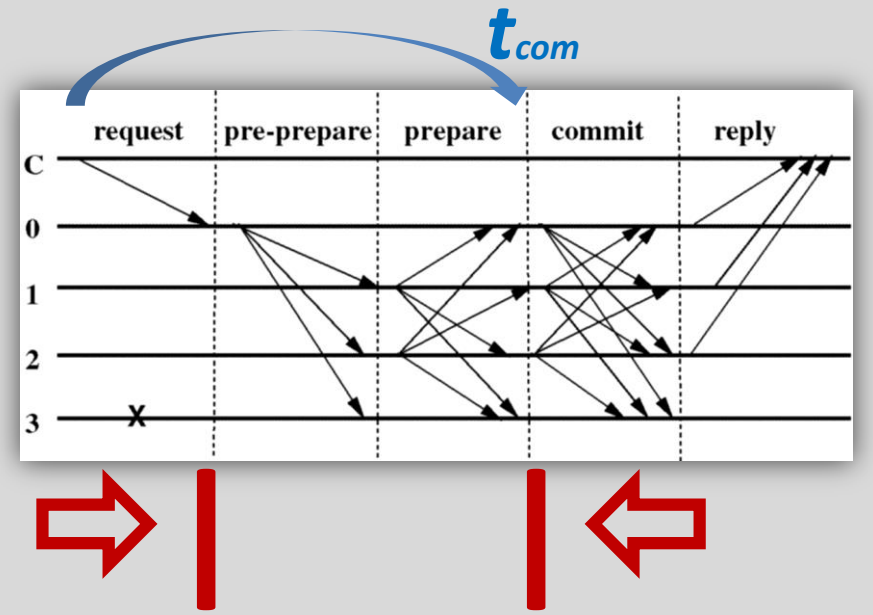
GPS-Antennas & Atomic-Clocks

„An atomic clock is not that expensive!”

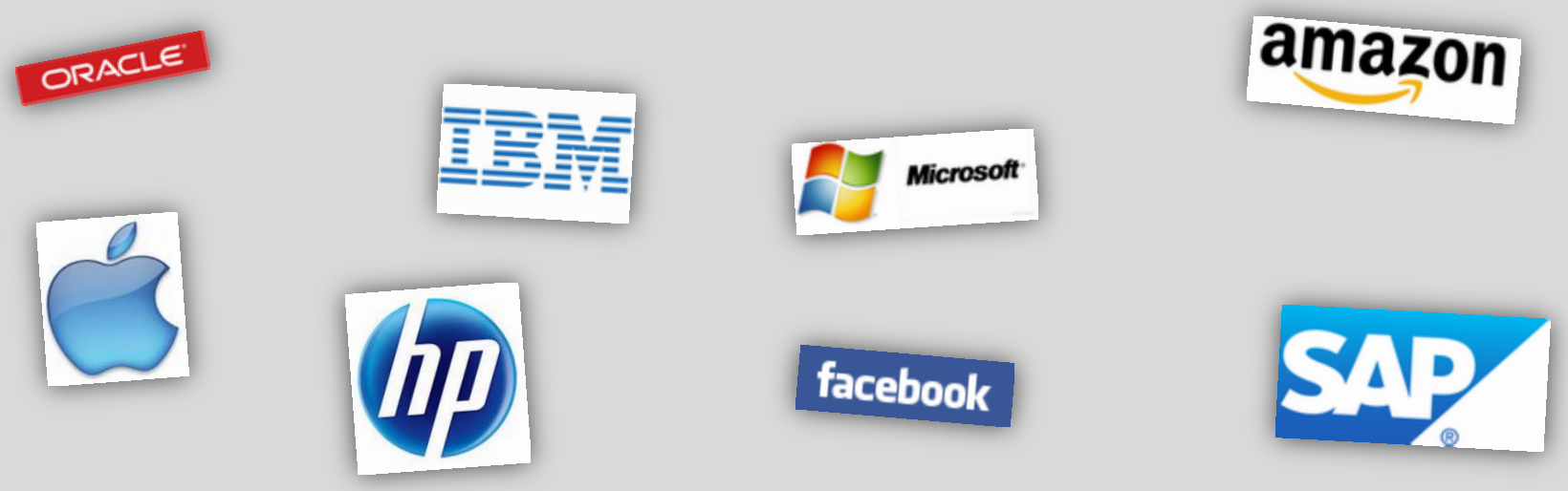


Paxos wait minimal for RW-Transactions✓

⇨| 2ε |⇦

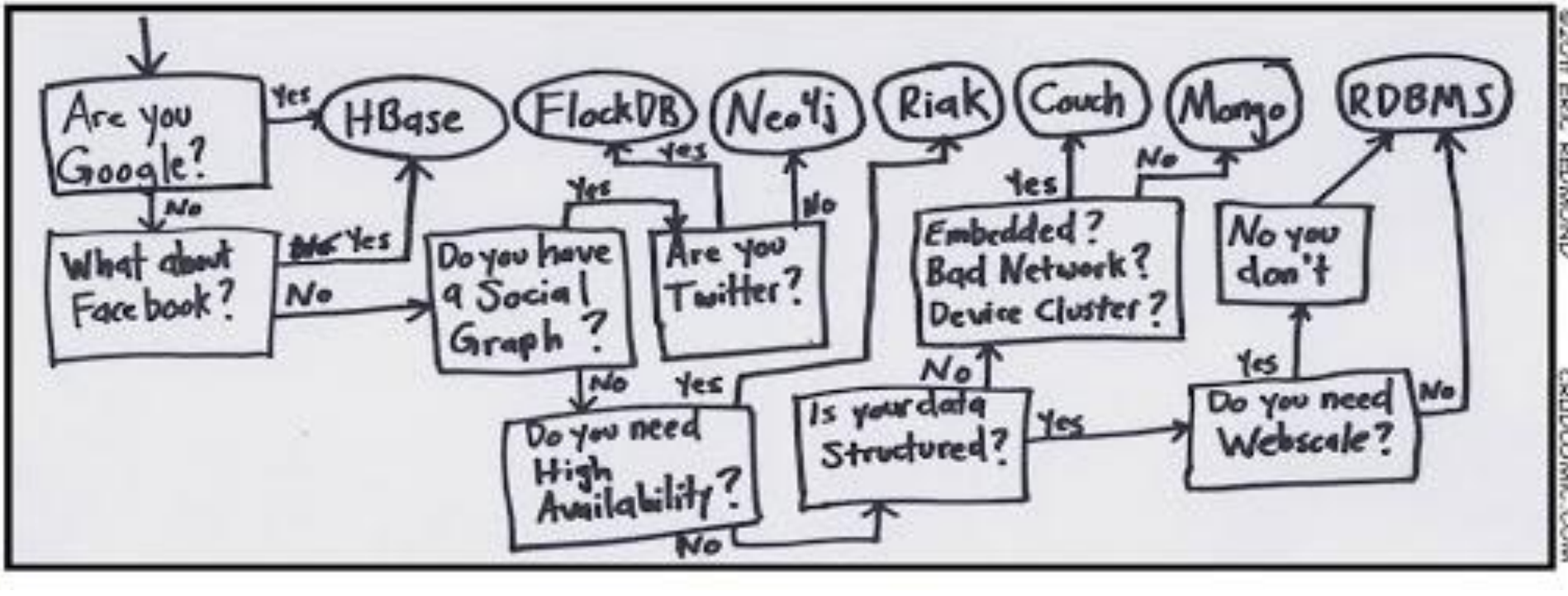


a dozen truly global databases till 2018



Part III

How to ...
...tie up the loose ends?!


Are you Google?
Yes
HBase
No
What about Facebook?
Yes
No
Do you have a Social Graph?
Yes
No
FlockDB
Yes
Neo4j
Are you Twitter?
Yes
No
Riak
Do you need High Availability?
Yes
No
Is your data Structured?
No
Yes
Couch
Embedded? Bad Network? Device Cluster?
Yes
No
Mongo
No you don't
Yes
RDBMS
Do you need Webscale?
Yes
No
©2011 ERIC REDMOND
CRUDCOMIC.COM

Cluster 1: Know & Segment your data

Analyze & Categorize it:

- Domain-Data
- Log-Data
- Event-Data
- Message-Data
- critical Data
- Business-Data
- Meta-Data
- temp Data
- Session-Data
- Geo Data
- etc.

Data- / Storage Model:

- relational
- column-o
- doc-alike
- graphs
- objects
- multivalue
- objects=ORM
- JSON
- BLOBS
- etc. (beyond bit-bucket)

Data / Type constraints:

- Data-Navigation?
- Data Amount?
- Data Komplexity (Deep XML?)
- Schema flexibility?
- Schema support needed?

Persistence design: (Reference: (C) highscalability link to be inserted)

- Durability? On power failure?
- Memtable/SSTable; Apend-only B-tree; B-tree; On-disk linked lists; In-memory replicated; In-memory snapshots; In-memory only; Hash; Pluggable.

Cluster 2: Consistency Model

Global consistency model:

- ACID / BASE / WATER?
- Ability to (fine) tune the consistency model

CAP tradeoff:

- CP, AP, CA or tunable?

Cluster 3: Performance Dimensions

- Latency / Request behaviour / distribution [High = 10, Low = 0]
- Throughput [High = 10, Low = 0]
- High Concurrency?

Cluster 4: Query Requirements

- Typical queries look like?
- SQL needed? LINQ needed?
- BI / Analytic-Tools needed? (M/R sufficient?)
- Ad-Hoc Queries needed?
- Map/Reduce needed? Background data analytics?
- Secondary Indices
- Range queries
- Weird aggregations
- ColumnDB needed for Analytics?
- Views

Cluster 5: Architecture and Patterns

Architecture looks like:

+ Prototype

- local, parallel, distributed / grid, service, cloud, mobile, p2p, …
- Hosted? Cloud? Local? Datacenter?

Data Access Patterns

- read / write distribution?
- random / sequential access?
- Access Design Patterns

Cluster 6: Non functional Requirements

- Replication needed? = Rubustness
- Automatic load balancing, partitioning, and repartitioning?
- Auto-Scaling
- Text search integration? Lucene / Solr?
- Refactoring Frequency?
- 24/7 System? Live add and remove?
- Developer Qualification
- DB simplicity? (installation, configuration, development, deployment, upgrade)
- Company restrictions?
- DB diversity (allowed?)
- Security? (authentication, authorization, validation?)
- Licence Model?
- Vendor trustworthiness?
- Community support?
- Documentation?
- Company and DB dev in the future?

Costs:

- DB-Support? (responsiveness, SLA)
- Costs in general, Scaling Costs
- Sysadmin costs
- Operational Costs: (noOps)
- Safety / Backup & Restore
- Crash Resistance, Disaster Management
- Monitoring

> 75% relational fit!

http://nosql-database.org

Architekturvision - z.B.

Speed

- High Latency updates
- Incremental algorithms

Serving

- Updates vom Batch Layer
- Random Access

Batch

- Quelle / „Source of Truth“
- Views

Paradigm Shift

x10 more expensive!

early adopters win

Executive Summary - wohin geht die Reise:

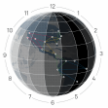
komplexer „DB-Smartphone-Mash“

Immutability → MVCC → SSD

5 min rule

radikal new ideas all over (Datomic)

Multimodel & Global Databases



new Architectures & Checklists

contact ***edlich@gmail.com*** ***Thanks!***

http://edlich.de