YOU'RE NOT PAID TO

A MINDLESS WORKER IS A HAPPY WORKER! SHUT UP AND DO YOUR JOB!

Following Google Or Don't Follow the Followers, Follow the Leaders Or The problem probably isn't the database, the problem is probably you

Third N

Qcon SF, November 2014

Mark Madsen www.ThirdNature.net @markmadsen

A Story of two companies

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Kids and Teens Arts, School Time, Teen Life	<u>News</u> <u>Media, Newspapers, Weather</u>	Recre	The Neil Postman Information Page :: Books, Online Articles, Audio @ Picture of Neil Postman Neil Postman (1931 — 2003) was an American critic and educator. Postman received his B.S. from the State University of New York at www.neilpostman.org/ - 27k - Cached - Similar pages -			
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Become an Editor Help build the largest human-edited directory of the web Copyright © 1998-2009 Netscape			Neil Postman Online			

What happened to directories? Scalability: human & data volume.



Who are you following?



Google Search

I'm Feeling Lucky



Tolker Pater - Engle Seath - Marr - Classifiele - News - Stock Quoter - Sportz Scores

- <u>Arty and Humanities</u> <u>Arthframes Elementics Literature</u>
- Business and Economy (Xest) Congresses Investing, Implement
- <u>Compaters and Internet (Nest)</u> Intenst WWW. Software, Multimedia
- News and Media (Xes) Constituents Magazines TV, Newspaper
- <u>Recreation and Sports (Med)</u> Sports Owners Travis Autors Outdoors
- Reference Libraries, Divisionates, Phone Numbers



And why are you following them?



History isn't taught in most university science curricula (probably because it's a rabbit hole)

A BRIEF HISTORY OF DATA STORAGE AND RETRIEVAL



Databases: the problem statements over time

"Information has become a form of garbage, not only incapable of answering the most fundamental human questions but barely useful in providing coherent direction to the solution of even mundane problems." – *Neil Postman, 1985*

"We have reason to fear that the multitude of books which grows every day in a prodigious fashion will make the following centuries fall into a state as barbarous as that of the centuries that followed the fall of the Roman Empire." – **Adrien Baillet, 1685**

"...so many books that we do not even have time to read the titles." – **Anton Francesco Doni, 1550**



The origin of information management problems



For ~5000 years we used counters of various types, eventually developing writing to cope with civilization's needs. Writing is more efficient than counters you can lose.

Sumerian bulla envelope with tokens. The beta period.

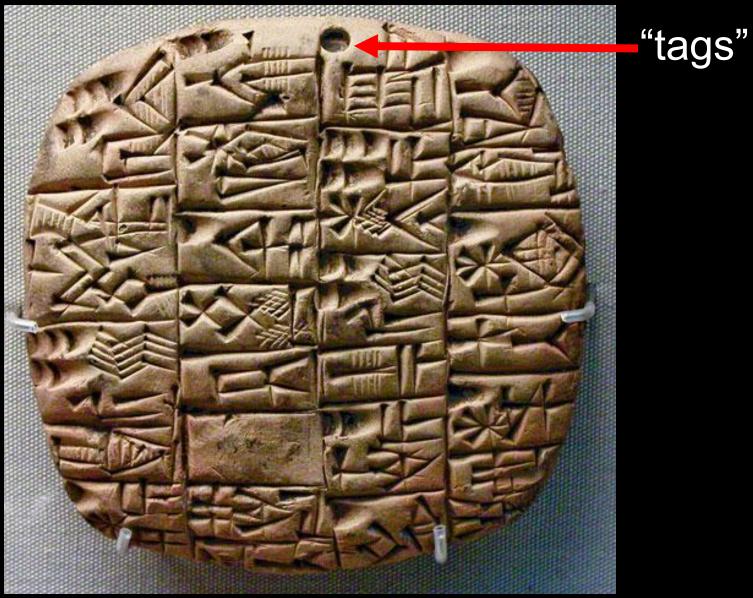


Information Technology v1.0: Clay Tech, ~3000 bce



The first information explosion

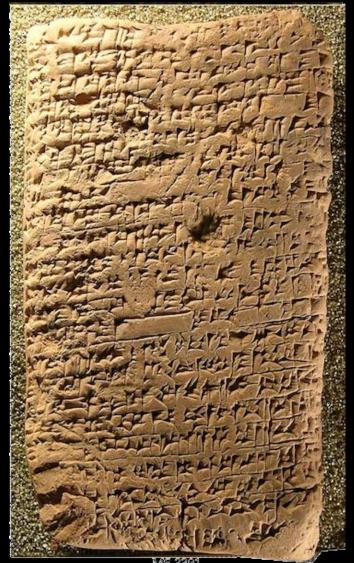
That explosion led to the first metadata



Small piles in baskets are easy to tag and search



Metadata v1.1: tablets about tablets



Library catalogue. Babylonis, 2000-1600 BC

When there are enough of these lying around you need to work on organization of the collection by categorizations, aka "taxonomy", "schema"

Like working out what tables are in a database, or what files are stored in HDFS.

Babylonian library catalog ~2000bce



Metadata v1.2: tablets about what's in tablets

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When literacy rates are higher and people need to communicate more effectively, you need to invent mechanisms to cope, like dictionaries.

Now we're worried about what's inside the documents, not where they are placed.

Synonym list, Ashurbanipal, ~900 bce



Clay Tech has some familiar limitations





Information Management v2.0 Paper Tech*



Lighter, denser, faster storage media





More information = need for new metadata techniques: content tagging, author catalogs

The first real library ~300BC

Discovery of one tradeoff between clay and paper...



Recorded information creates permanence and instability

You can't have discontinuous reading* until you have a random access technology.



*Indexing and encyclopedias are hard in linear scrolls. Hello ISAM

Paper Tech v2.1: increased storage density, smaller form factor, durability, high res RGB graphics

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Paper Tech v2.2

The change in printing over time accelerates.

Block printing replaced by movable metal type.

The job of production is faster and cheaper.

Commoditization changes the landscape over the next 200 years.

The *printed* becomes more important than the *printer*.



The Elizabethan Era

Production: printing presses

Data management tech:

- Perfect copies
- Topical catalogs
- Font standardization
- Taxonomy ascends

Information explosion:

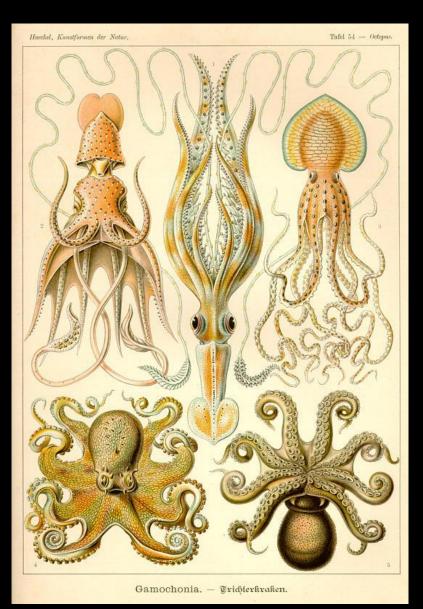
- 8M books in 1500
- 200M by 1600
- Commoditization
- Overload



Better *embedded* metadata: title page, colophon, ToC



The Georgian Era: The Explosion of Natural Philosophy





Ascidiae. - Seefcheiden.

Sharing knowledge in a larger community required common language, structure



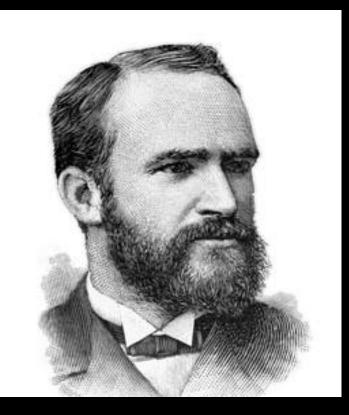
The Victorian Era

The powered printing information explosion:

- Card catalogs, crossreferencing, random access metadata
- Universal classification
- Extended information management debates
- Trading effort and flexibility for storage and retrieval
- Stereotyping



Melvil Dewey



Dewey Decimal System Top down orientation Static structure Descriptive rather than explanatory

Taxonomic classification



Charles Ammi Cutter



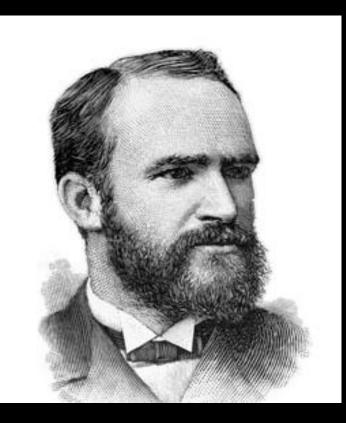
Cutter Expansive Classification System (~1882) Bottom up orientation More flexible structure Explanatory, descriptive

Faceted classification



SQL

NoSQL



VS





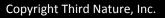
History is always the same

Every technology is a trade:

- Top down vs. bottom up
- Authority vs. anarchy
- Bureaucracy vs. autonomy
- Control vs. creativity
- Hierarchy vs. network
- Dynamic vs. static
- Power vs. ease
- Work up front vs. postponed

In every choice, something is lost and something is gained.

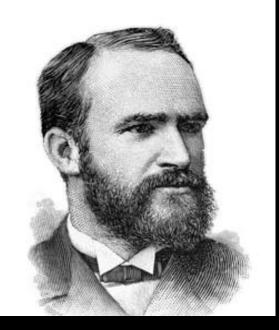






So why did Dewey beat Cutter?

<u>Pragmatism</u>



Good enough wins the day

It wasn't solving the problem you thought it was.



In every choice, something is lost when something is gained.



What has this to do with data and persistence?

"schema" is a broad term, a way of organizing and making something relatable and findable.

"Data" (or object) is to "Database" as "Books" are to "Library"



Summarizing

Thousands of years of thought have been put into principles of organization and use. The abstract patterns are the same, only the implementation changed.

- Clay: tablets about tablets, tablets about what's in tablets, 100X increase in data density over counting tech
- Scrolls: scrolls about scrolls, scrolls about what's in scrolls, prepended/appended navigation, >100X increase in density
- Books: books about books, books about what's in books, embedded internal navigation, >1000X increase in density
- Digitized data: similar, far denser, and different because it isn't locked into physical forms



Information management through human history always follows the same pattern

New technology development

creates

New methods to cope

creates

New information scale and availability

creates...



Big Data



"The most amazing achievement of the computer software industry is its continuing cancellation of the steady and staggering gains made by the computer hardware industry." -*Henry Peteroski*

DEALING WITH BIG: SOME SCALING HISTORY



Why doesn't your database scale?



Hipster bullshit

I can't get MySQL to scale *therefore* Relational databases don't scale *therefore* We must use NoSQL* for everything

*including Hadoop and related



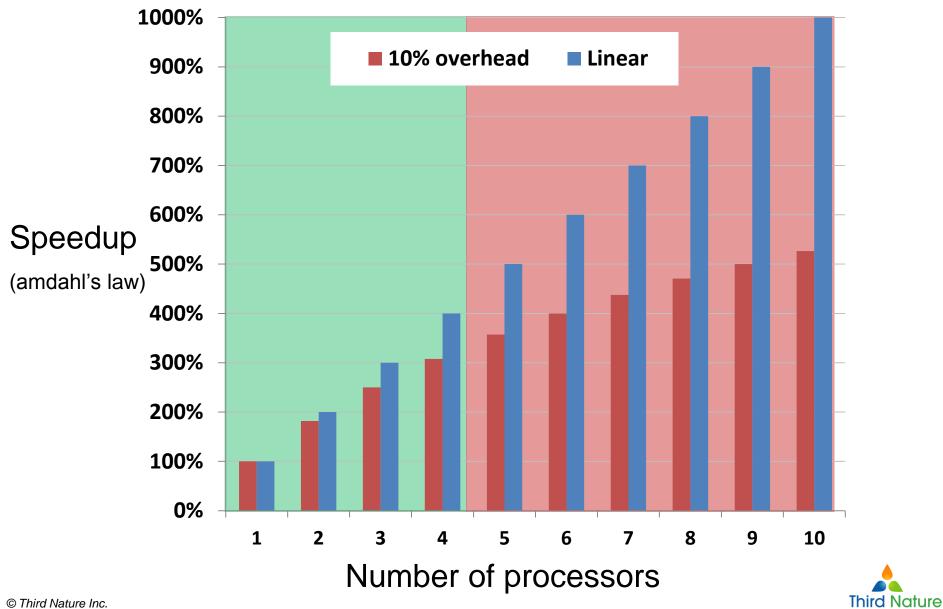


It is a poor carpenter who blames his tools*

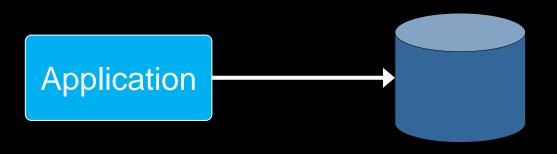
MEASURE

*but sometimes it *is* the tools

OMG just add nodez!



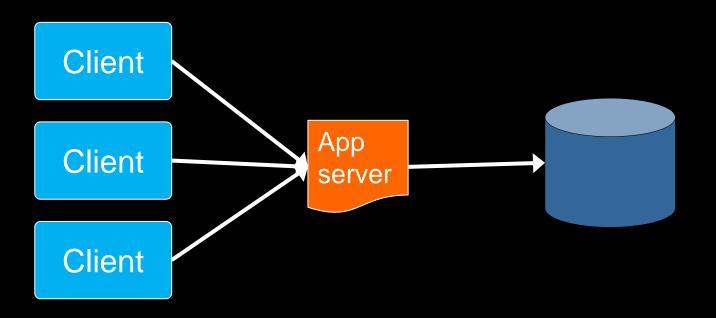
The early days: client/server as the starting point



We had transaction processing against the DB, all on the same machine. Then on two separate machines.



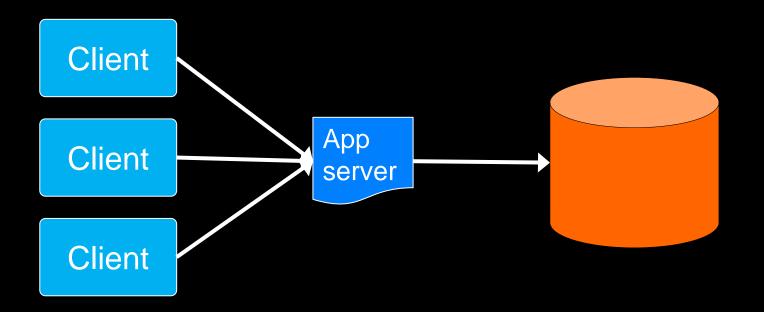
Scaling client/server



We added app servers and pooled connections.



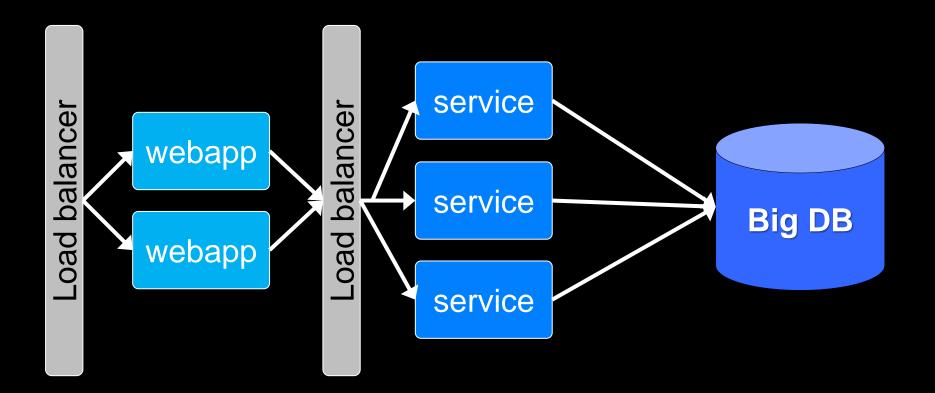
Scaling client/server



Then threw money at the problem in the form of hardware (made the database bigger).

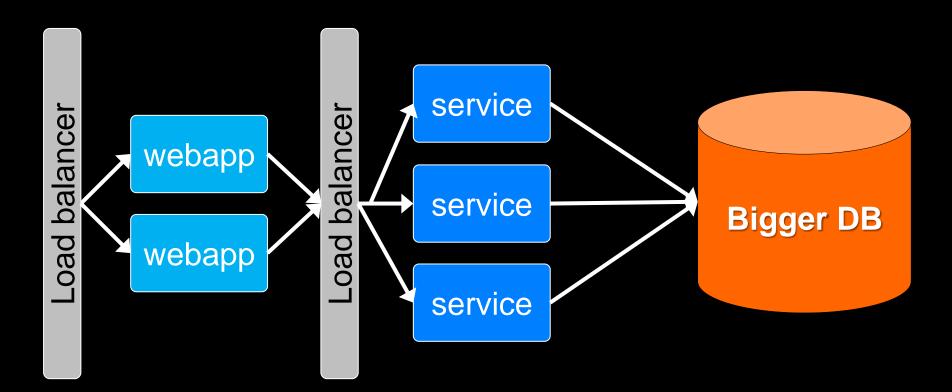


Web apps were a huge increase in concurrency

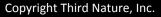


Architecture changed to reflect new stateless model. We had scalability and availability problems.

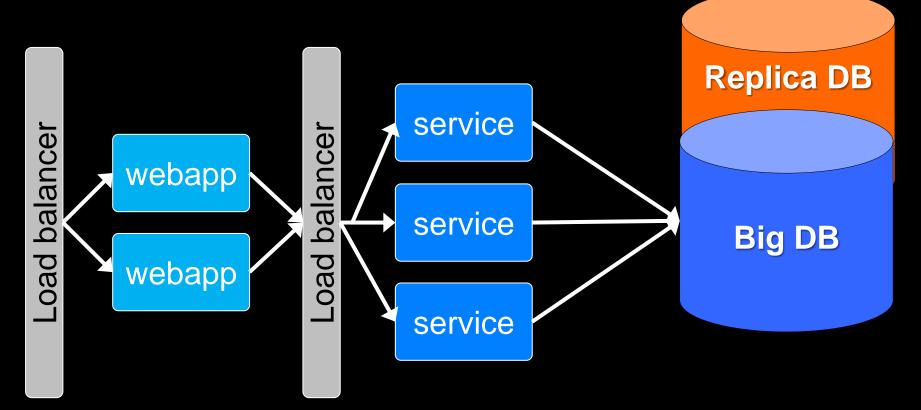




Keep adding hardware, make the DB bigger. Limits reached, performance, scalability and availability problems.

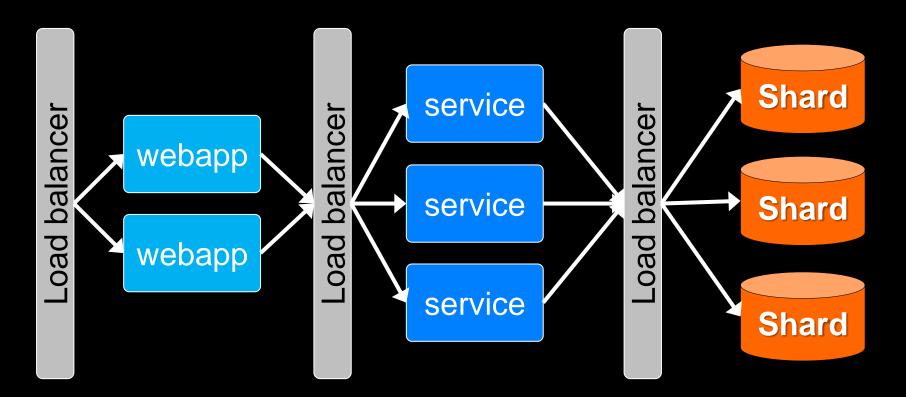






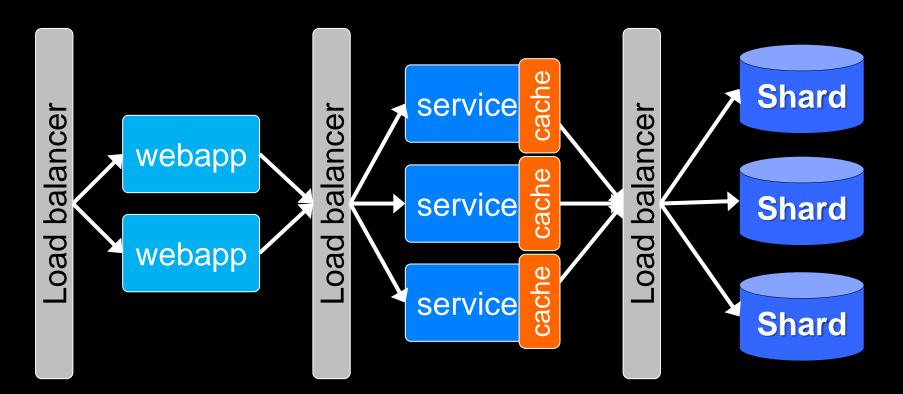
Read-only replicas will save the day! Still have scalability and availability problems. And now operational overhead and problems.

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Scaling and perf better, overhead and operational complexity high and worsening. Sharding seems a fine thing. But it's one letter from...

Third Nature



Let's cache data at the service tier! Performance better, overhead and operational complexity higher still.

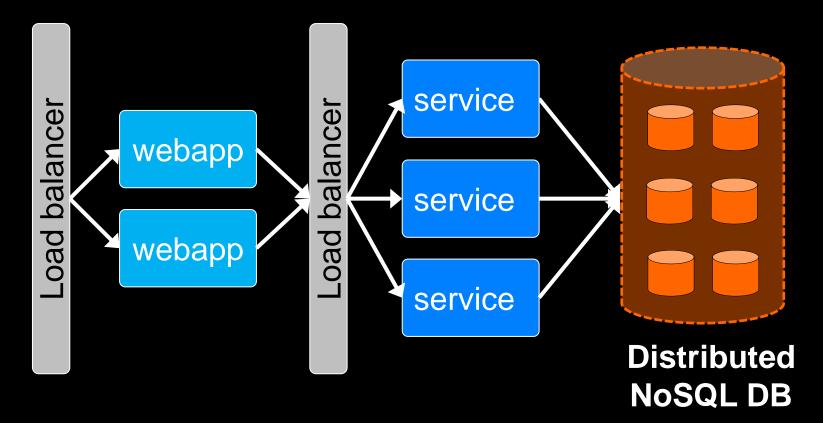


What are the problems now?

- 1. More hardware, more things to break
- 2. More management and administration
- 3. More software complexity
- 4. Increasing distance for data to travel = latency
- 5. Data administration difficult to impossible



Problem solved?



Distributed database (handles cache, load balance, data distribution). Similar performance, simpler scaling, reduced operational problems, simpler application architecture. Finished!

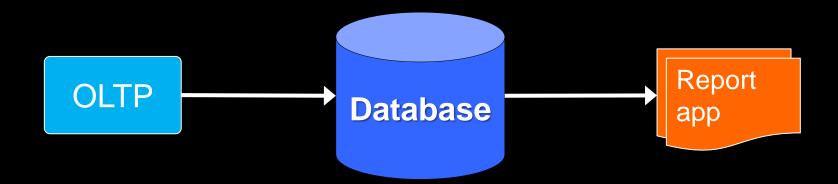
Not finished: remember the cycle of history...

The biggest hole in the prior section on scaling is that we scaled OLTP, what about OLAP (query)?

Queries <> transactions.



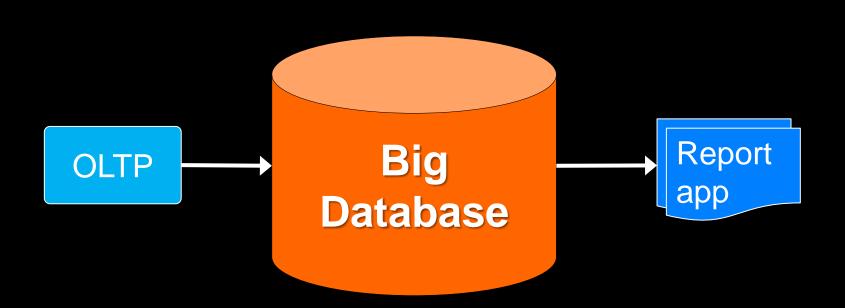
Solving query problems



Aggregate or low selectivity queries were a problem early on, when people wanted to *use* the data. Every report or query is a program.



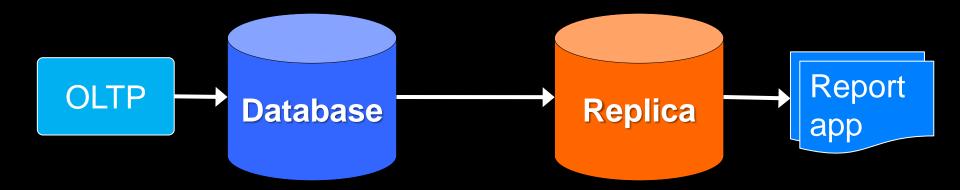
Increasing data volume



Make it faster by throwing money at hardware (sound familiar?)



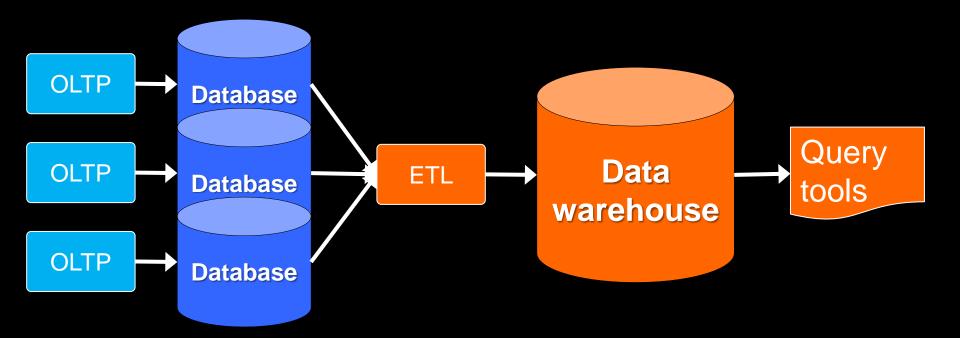
Increasing data volume



Replicas: split the workload and tune the systems based on their workload.



Increasing data volume breaks the old model

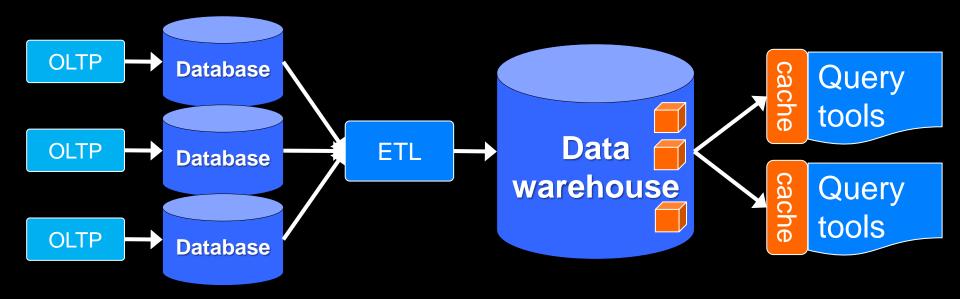


Devise a new architecture.

Reschematize the database, eliminate cyclic joins, selective denormalization, *query generators*. But it takes bulk processing to reschematize the data.

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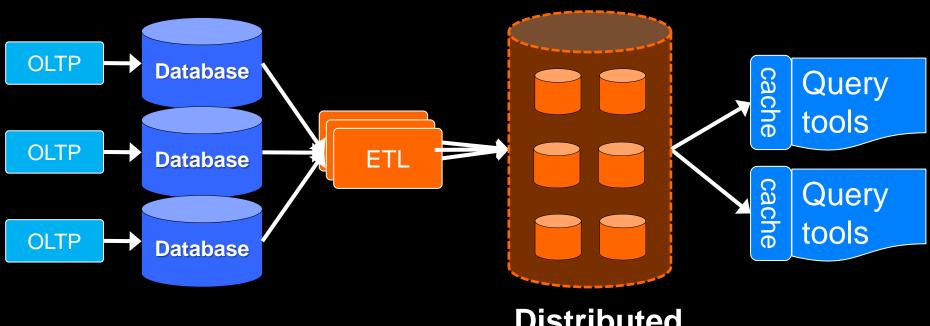
Increasing data volume



Improve response time with caching in the query tools, and by using MOLAP tools that map into cache or memory.

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Increasing data volume



Distributed SQL Database

Parallel processing for ETL. Distributed <u>query</u> databases for fine grained high volume parallelism.



The architecture looks familiar

Two workloads, two not dissimilar architectures:

- Load-balanced front ends
- Distributed caching layers
- Scalable distributed parallel databases

But the nature of the OLTP and OLAP workloads is very different. Forcing them into one platform is almost impossible for data architecture reasons and particularly at scale*



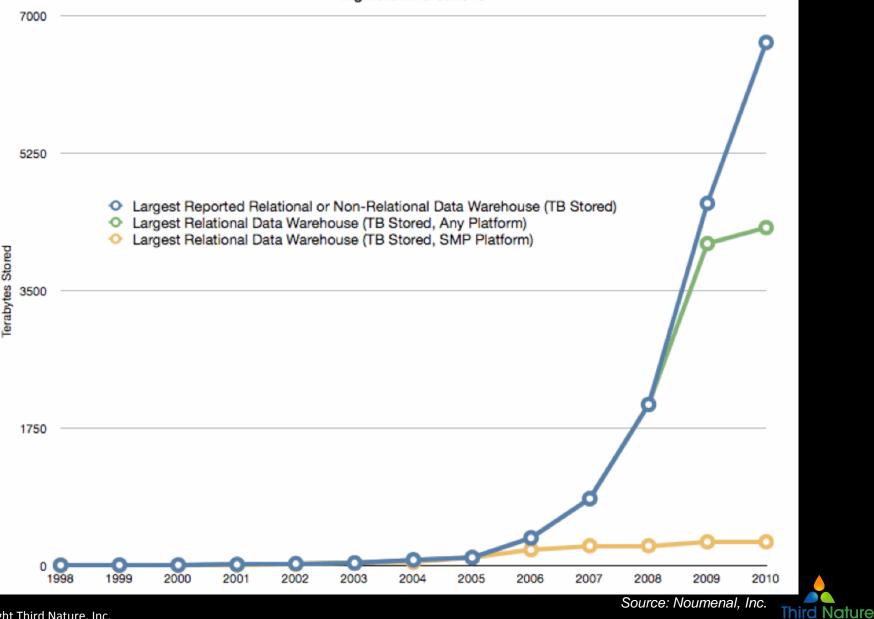
(It's all being done in the name of)

BIGNESS AND SCALABILITY



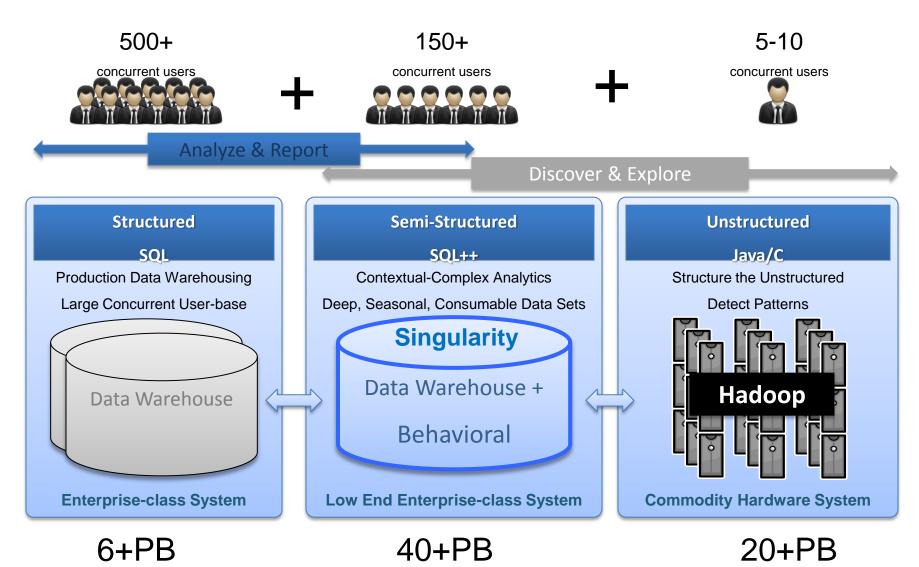
Technology Capability and Data Volume: Solved?

Big Data Bifurcations



Data Platforms

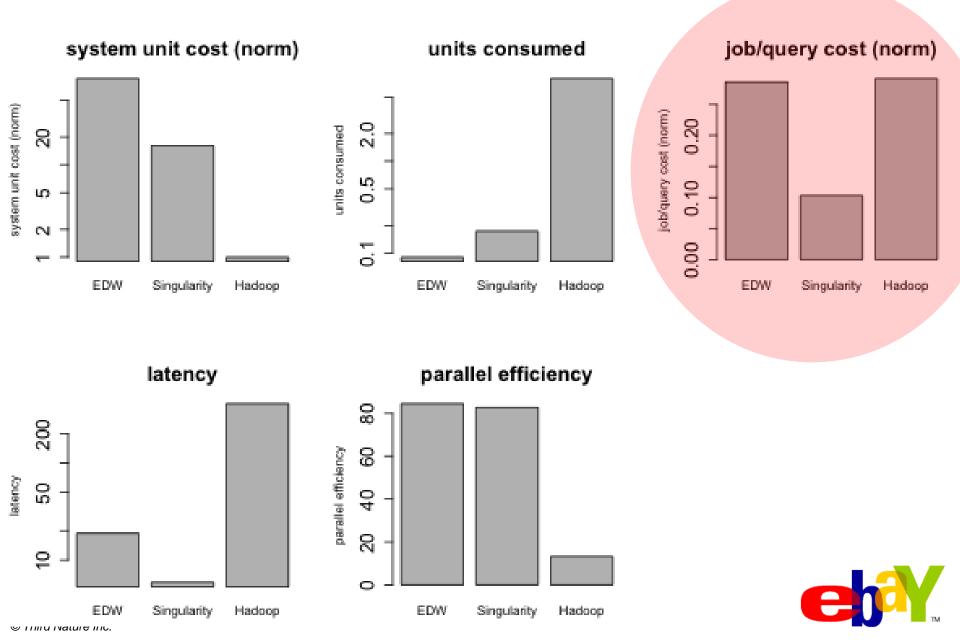




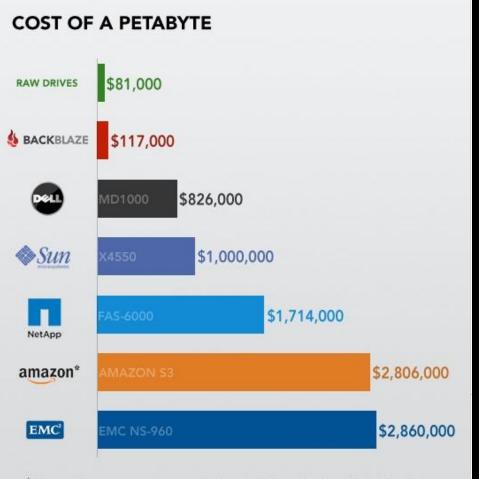
© Third Nature Inc.

Thanks to eBay for these case slides.

Platform Metrics for Table Scan and Sum, Hadoop vs Teradata



Pricing and performance: Hadoop is a storage and processing play, *not* a database play*



* Amazon S3 Storage over three years (minus electricity, co-location and administration).

Source: Venturebeat

With big data systems, the cost of storing data is an order of magnitude lower than with databases today (but not the cost or ability to query it back out).

Processing data at scale is at least an order of magnitude cheaper too.



BIGNESS AND DATA COMPUTATIONAL WORKLOADS



Not finished: remember the cycle of history...

The biggest hole in the prior sections is that we scaled OLTP and OLAP but what about analytics?

Queries <> transactions <> <u>computations</u>

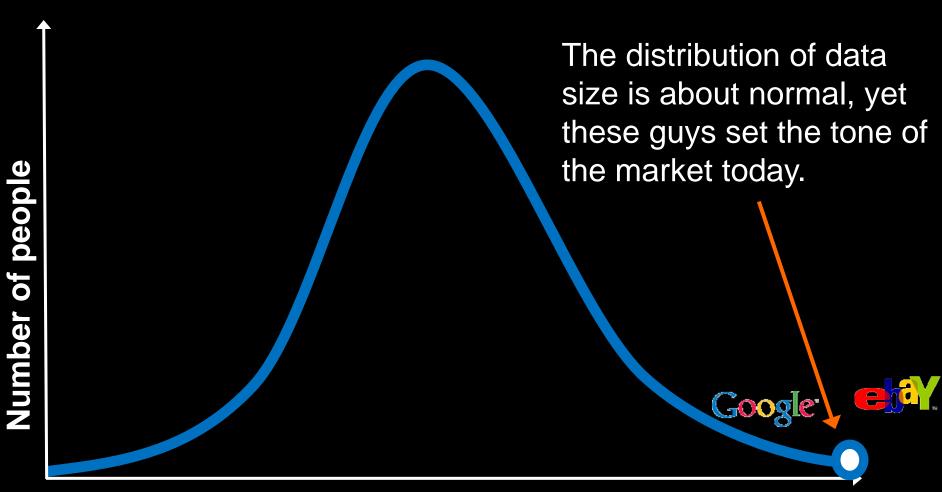


Analytics embiggens the data volume problem



Many of the processing problems are O(n²) or worse, so moderate data can be a problem for most platforms

Bigness: most people do not need special technology



Bigness of data





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A Simple Division of the Analytic Problem Space

Lots	Big analytics, little data	Big analytics, big data			
	Specialized computing, modeling problems: supercomputing, GPUs	Complex math over large data volumes requires non- relational shared nothing architectures			
	Little analytics, little data	Little analytics, big data			
Little	The entry point R, SAS, SMP databases, even OLAP cubes can work	The BI/DW space, for the most part, done in databases mostly			
	Little Data v	Lots			



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Computation

The <u>three way</u> workload break

- 1. Operational: OLTP systems
- 2. Analytic: OLAP systems
- 3. Scientific: Computational systems

Unit of focus:

- 1. Transaction
- 2. Query
- 3. Computation

Different problems require different platforms



	OLTP	BI	Analytics
Norkloads			
Access	Read-Write	Read-only	Read-mostly
Predictability	Fixed path	Unpredictable	All data
Selectivity	High	Low	Low
Retrieval	Low	Low	High
Latency	Milliseconds	<seconds< th=""><th>msecs to days</th></seconds<>	msecs to days
Concurrency	Huge	Moderate	1 to huge
Model	3NF, nested object	Dim, denorm	BWT
Task size	Small	Large	Small to huge

Why would digital data be any different than clay or scrolls or books?

DATA PERSISTENCE AND STORES



"Big data is unprecedented."

- Anyone involved with big data in even the most barely perceptible way



1960s	Relational CODASYL System R SQL/DS INGRES (C Mimer Oracle	(SEQUEL)	OODBMS, O Versant Objectivity Gemstone Informix* Oracle*	<u>ORDBMS</u> 2000s	<u>News</u> SciD Nuo[Jethr Meta	B DB
MultiValue, PICK IMS IDS ADABAS	1970s <u>Hierarchical</u>	<u>RDBMS, S</u> DB2 Teradata Informix Sybase Postgres	1990s SQL standard	MPP Que Netezza Paraccel Vertica MongoDB CouchBas Riak Cassandra	Se	



NoSQL?

There's a difference between having no past and actively rejecting it.



A history of databases in No-tation

1970s: NoSQL = We have no SQL 1980s: NoSQL = Know SQL2000s: NoSQL = No SQL!2005s: NoSQL = Not only SQL 2013: NoSQL = No, SQL!

(R)DB(MS)



The secret of pre-relational DB: schema

<u>Loose coupling</u> – the physical model of data structures and physical placement are no longer a program's responsibility; data portability ensues.

<u>Reusability</u> – More than one program can access the same data, and no more custom coding for each application or OS

<u>Scalability</u> – Constraints of schema and typing reduce resource usage, have finer granularity for concurrent access, multiple online users.



It's nice, but it'll never replace playing outside in the fresh air and getting plenty of exercise.

listoricLOL

TANSTAAFL

When replacing the old with the new (or ignoring the new over the old) you always make tradeoffs, and usually you won't see them for a long time.

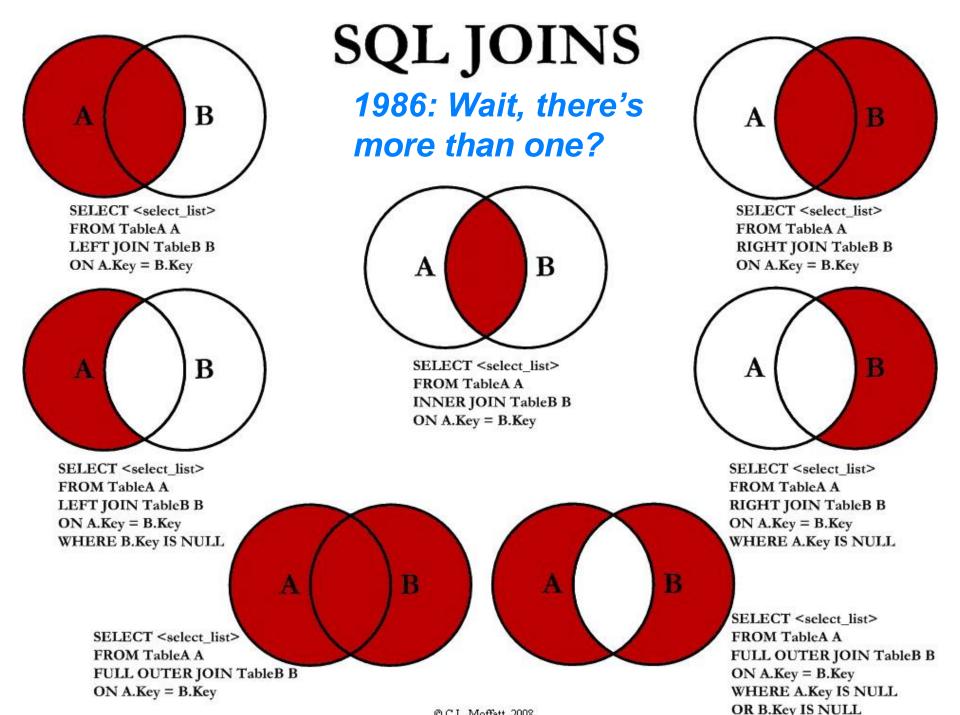
Technologies are not perfect replacements for one another. Often not better, only different.



Schema on write vs schema on read

Match the shape to the hole or Match the hole to the shape

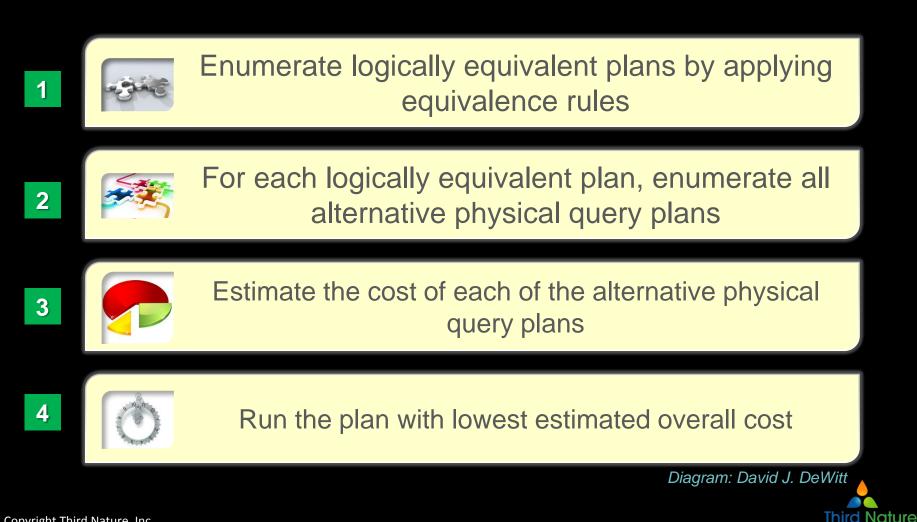
Predicate schemas for write flexibility (agility) and speed



© C.L. Moffatt, 2008

What the optimizer does

It turns a SQL query into an optimal* execution plan for a parallel pipelined dataflow engine



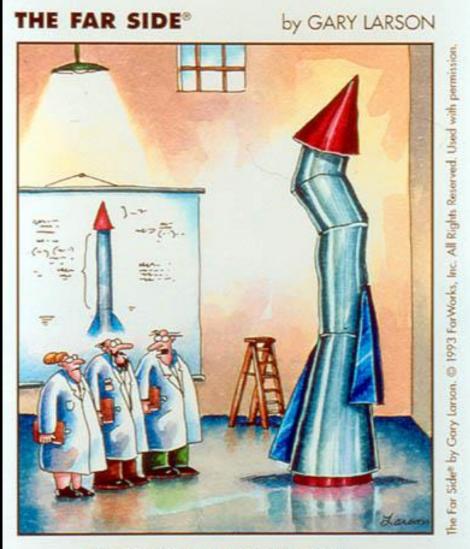
A simple 3 table join

SELECT C.name, O.num
FROM Orders O, Lines L, Customers C
WHERE C.City = "Copenhagen" AND L.status = "X"
AND O.num = L.num AND C.cid = O.cid

Number of logical plans based on equivalence rules: 9 Ways to join (hash, merge, nested): 3 For each plan, there are multiple physical plans: 36 That makes a total of 324 physical plans, the efficiency of which changes based on cardinality.



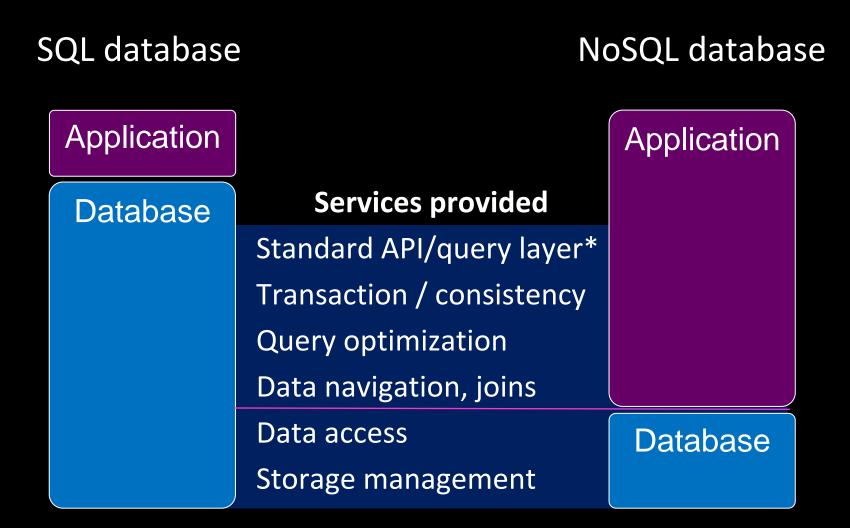
Tradeoffs? In NoSQL Land, Optimizer is You!



"It's time we face reality, my friends... We're not exactly rocket scientists." "Query optimization is not rocket science. When you flunk out of query optimization, we make you go build rockets."



Tradeoffs: In NoSQL the DBMS is in your code



Anything not done by the DB becomes a developer's task.



Coppoppright ght Thiad Nature, Inc.

Simplifying ACID vs BASE

MT.GO

SIGN UP NOW

Eventually consistent is a nice Way of saying "not correct" Trade with confidence on the world's largest Bitcoin exchange!

Mt.Gox is the world's most established Bitcoin exchange. You can guickly and securely trade bitcoins with other people around the world with your local currency!

"transaction malleability" is a nice way of saying "broken"

Remember: it's a poor carpenter who blames his tools.

Maybe...

We need one that speaks pig latin.

These aren't the databases we're looking for.

Google on eventual consistency:

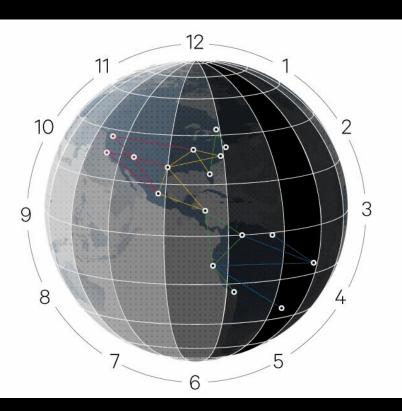
Designing applications to cope with concurrency anomalies in their data is very error-prone, timeconsuming, and ultimately not worth the performance gains.

developers spend a significant fraction of their time building extremely complex and error-prone mechanisms to cope with eventual consistency and handle data that may be out of date. We think this is an unacceptable burden to place on developers and that consistency problems should be solved at the database level. Full transactional consistency is one

"F1: A Distributed SQL Database That Scales", Proceedings of the VLDB Endowment, Vol. 6, No. 11, 2013



Google F1: Another Evolution



Distributed SQL database ACID compliance, 2PC and rowlevel locking (!) Transparent data distribution Synchronous replication across data centers Table interleaving (hierarchies) Queryable protobufs MapReduce access to underlying data Average user-facing latency of ~200ms with small deviation

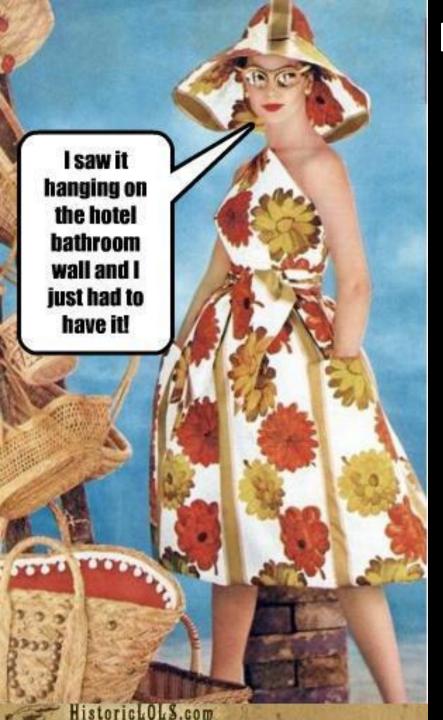
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The holy grail of databases under current market hype

We're talking mostly about computation over data when we talk about "big data" and analytics.

The goal is combining data storage, retrieval and analysis into one system, a potential mismatch for both relational and nosql.





Hadoop & NoSQL Adoption

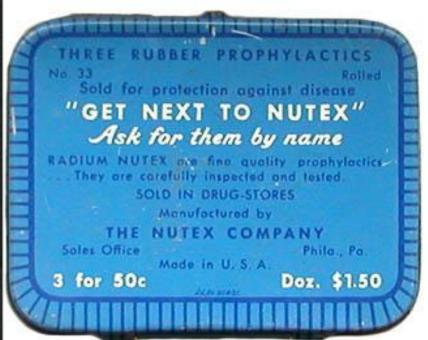
Some people can't resist getting the next new thing because it's new.

Many organizations are like this, promoting a solution and hunting for the problem that matches it.

Better to ask "What is the problem for which this technology is the answer?"



Unintended consequences





CRÈME POUDRE THO = RADIA EMBELLISSANTES PARCE QUE CURATIVES

a base de thorium et de radium selon la formule du CNEAN DOCTEUR ALFRED CURIE

SHOCALEL GRADULE CUR DEMANDE A THO BADIA 20 BUI DES CARDONET, ME

Disruption vs Destabilization

Disruption is a bad framing for most software.

New technology exists in a software ecosystem with many dependencies.

Better to frame new technology as destabilizing. This does not imply direct replacement.



The big data revolution, more of an evolution



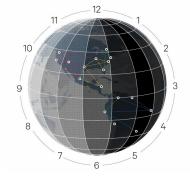
Be pragmatic, not dogmatic

Who are you following?



Google Search

I'm Feeling Lucky





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And why are you following them?



Conclusion

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IF YOU PROCRASTINATE LONG ENOUGH MOST PROBLEMS SOLVE THEMSELVES

Summary

- 1. All design decisions are tradeoffs. Be aware of what you trade away for the thing you get.
- Pay attention to workloads and try to isolate them when you can. Mixed workloads are very hard.
- 3. Relational algebra is still useful. The key is distributed parallel database implementations.
- Declarative models enable optimizers.
 Optimizers save you work.



References (things worth reading on the way home)

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About the Presenter

Mark Madsen is president of Third Nature, a technology research and consulting firm focused on analytics, business intelligence and data management. Mark is an award-winning author, architect and CTO whose work has been featured in numerous industry publications. Over the past ten years Mark received awards for his work from the American Productivity & Quality Center, TDWI, and the Smithsonian Institute. He is an international speaker, a contributor to Forbes Online and on the O'Reilly Strata program committee. For more information or to contact Mark, follow @markmadsen on Twitter or visit http://ThirdNature.net





About Third Nature



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