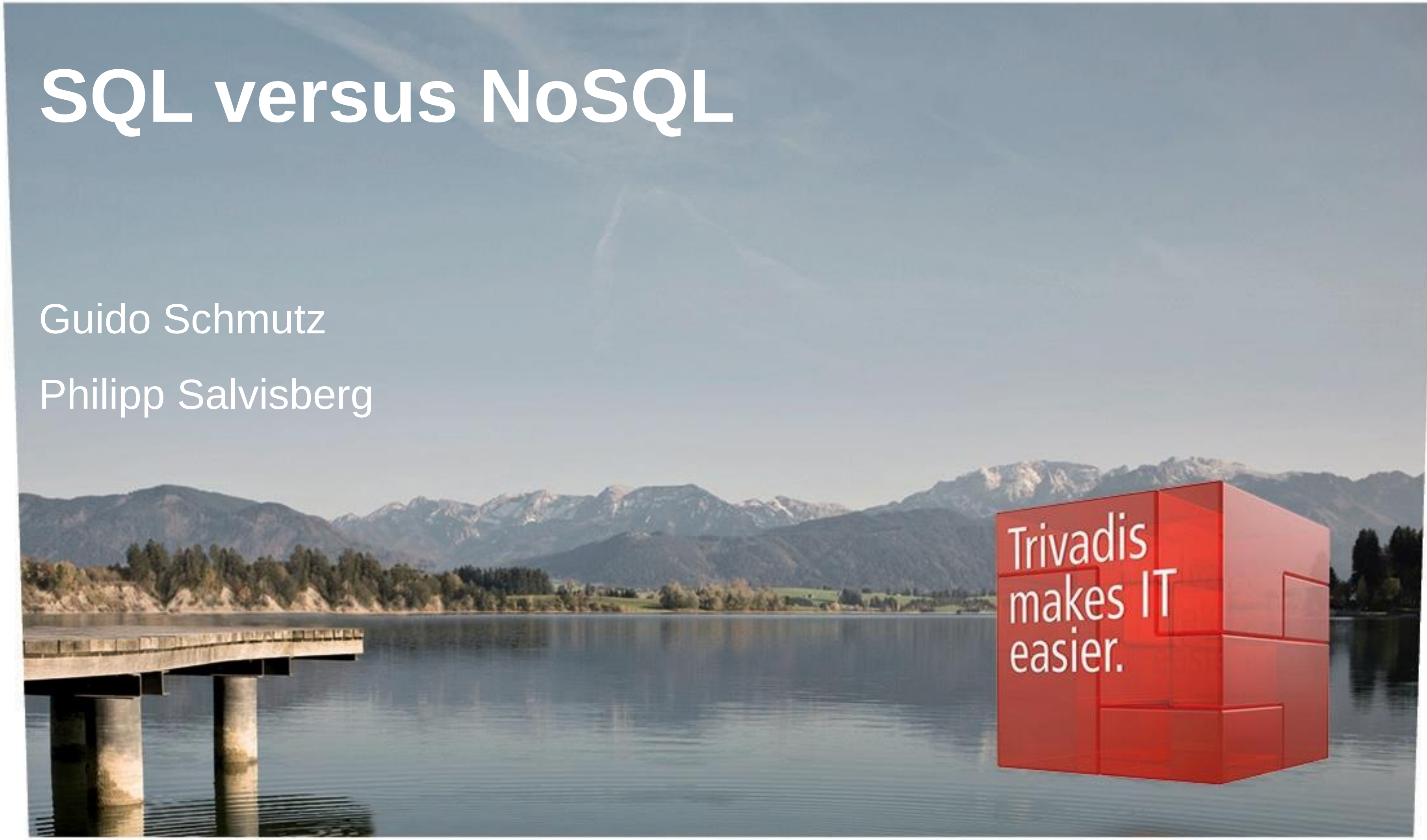
SQL versus NoSQL

Guido Schmutz

Philipp Salvisberg



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Guido Schmutz

- Working for Trivadis for more than 17 years
- Oracle ACE Director for Fusion Middleware and SOA
- Co-Author of different books
- Consultant, Trainer Software Architect for Java, Oracle, SOA and Big Data / Fast Data
- Member of Trivadis Architecture Board
- Technology Manager @ Trivadis

- More than 25 years of software development experience

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Philipp Salvisberg

- With Trivadis since April 2000
  - Senior Principal Consultant, Partner
  - Member of the Board of Directors
  - philipp.salvisberg@trivadis.com
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- Main focus on database centric development with Oracle database
  - Application Development
  - Business Intelligence
  - Application Performance Management
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Agenda

1. Motivation
2. Overview of SQL and NoSQL Data Stores
3. Use Cases – Let's Get Ready to Rumble
4. Core Messages

Understanding the Merits

RDBMSs do not scale as good as NoSQL systems like Google's BigTable.

Why NoSQL?
Can do everything with RDBMSs!
Having performance, scalability, transactions and SQL.

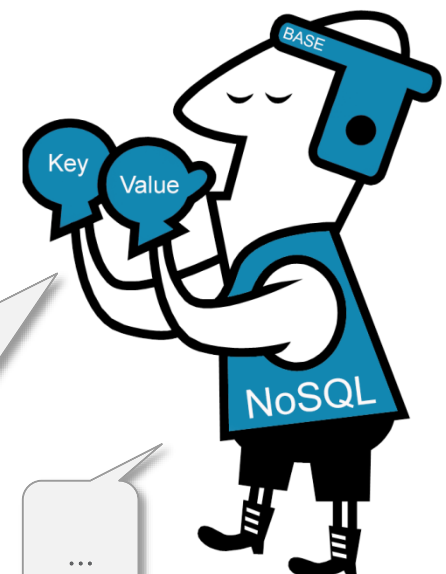
A key-value store is adequate for key lookups and easier to understand than a RDBMS.

RDBMSs provide a common interface with SQL, transactions, and relational schema.

…

Some applications require a flexible schema.
Adding new attributes at runtime in RDBMSs is typically not possible.

…



Source: Scalable SQL and NoSQL Data Stores, Rick Catell, 2010

Agenda

1. Motivation
2. Overview of SQL and NoSQL Data Stores
3. Use Cases – Let's Get Ready to Rumble
4. Conclusion

SQL Data Stores

- Relational Model
- Standardized, SQL:2011 is the 7th major revision since SQL-86
  - 9 parts, more than 4000 pages
  - But no single database implements all standards/features
- Rich set of features
  - Incl. SQL/PSM, SQL/MED, SQL/XML, SQL/RPR, Temporal Features
  - Incl. User-defined Types and Collection Types (since SQL:1999)
- ACID Transactions
  - **A**tomicity: all or nothing
  - **C**onsistency: from valid state to valid state considering constraints, triggers, …
  - **I**solation: result is not affected through concurrent execution
  - **D**urability: committed data stays available after crash, power loss or errors
- Good support by different languages, frameworks and tools
- Good understanding of basic concepts by IT professionals

NoSQL Definition

- Next Generation Databases mostly addressing some of the points:
  - being non-relational,
  - distributed,
  - open-source and
  - horizontally scalable.
- Often more characteristics apply such as:
  - schema-free,
  - easy replication support,
  - simple API,
  - eventually consistent / BASE (not ACID),
  - a huge amount of data
  - and more.

BASE

- **B**asically **A**vailable: Availability is more important than consistency
- **S**oft State: Higher availability results in an eventual consistent state
- **E**ventually Consistent: If no new updates are made to a given data item, eventually all accesses to that item will return the last updated value

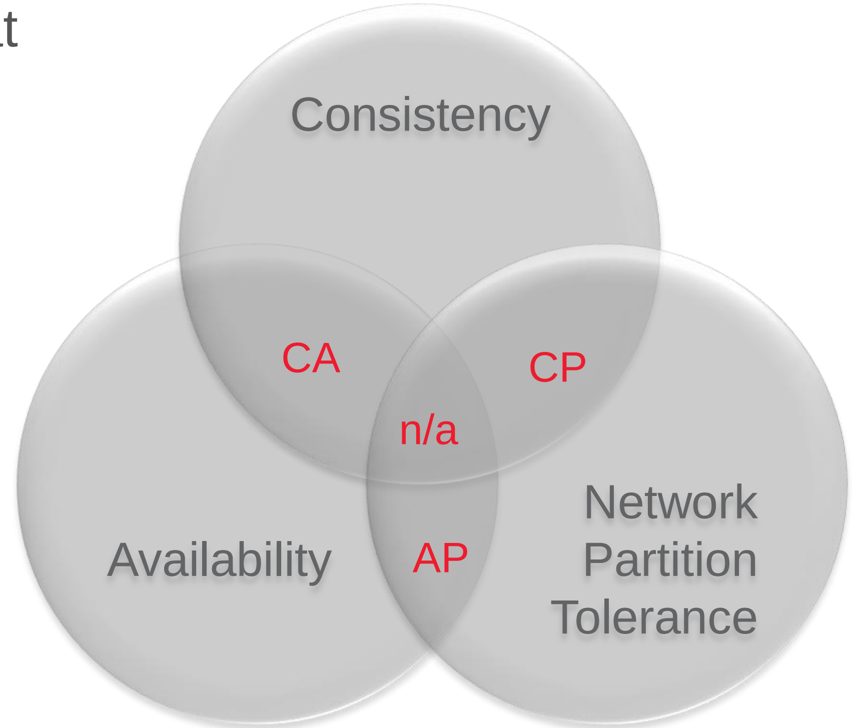
- The misleading term "nosql" (the community now translates it mostly with "not only sql") should be seen as an alias to something like the definition above

Source: http://nosql-database.org

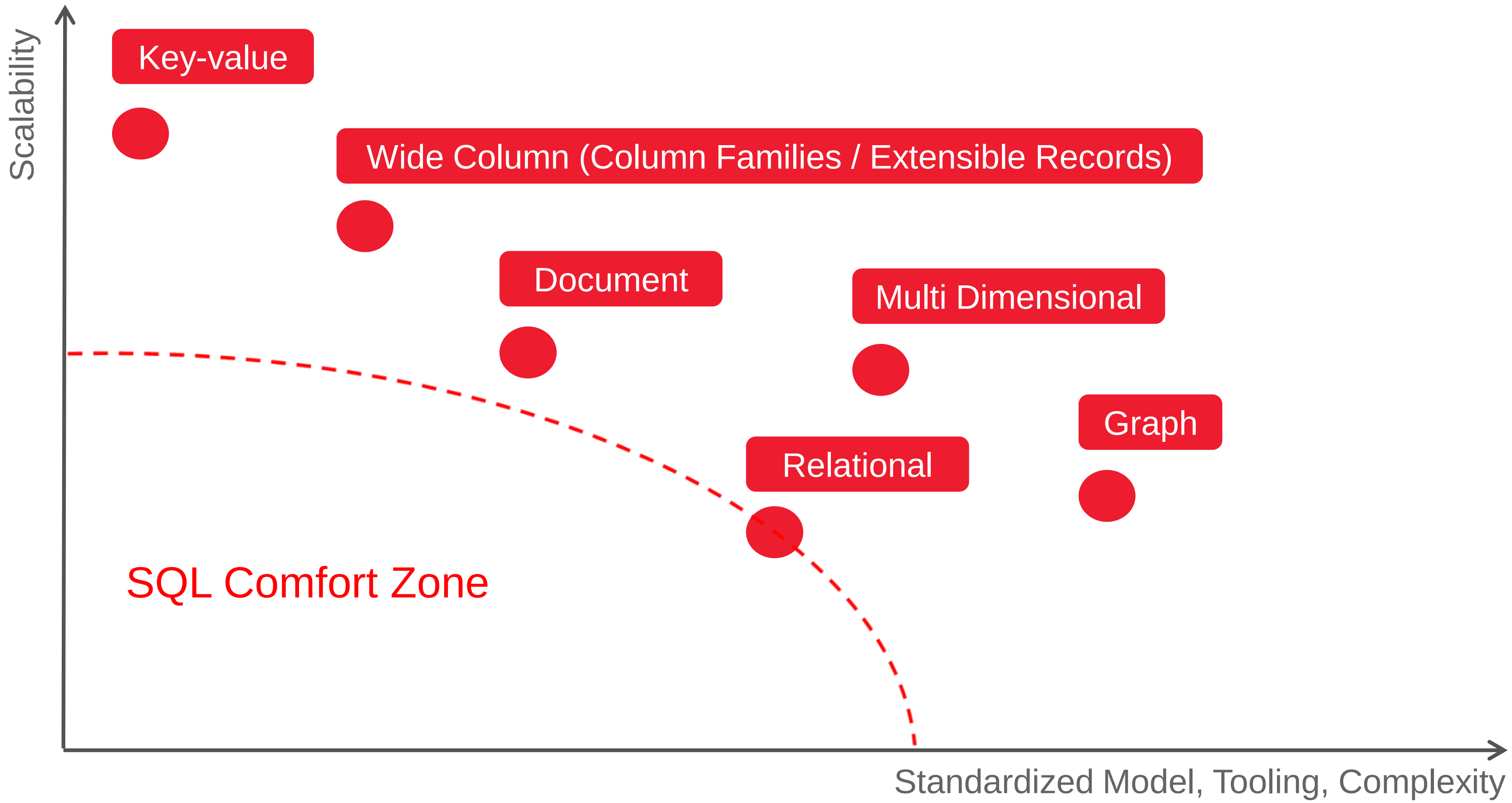
Brewer's CAP Theorem

Any networked shared-data system can have at most two of the three desirable properties:

- Consistency
  All of the nodes see the same data at the same time, regardless of where the data is stored
- Availability
  Node failures do not prevent survivors from continuing to operate
- Network Partition tolerance
  The system continues to operate despite arbitrary message loss



Data Store Positioning



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Round 1

Smart Meter

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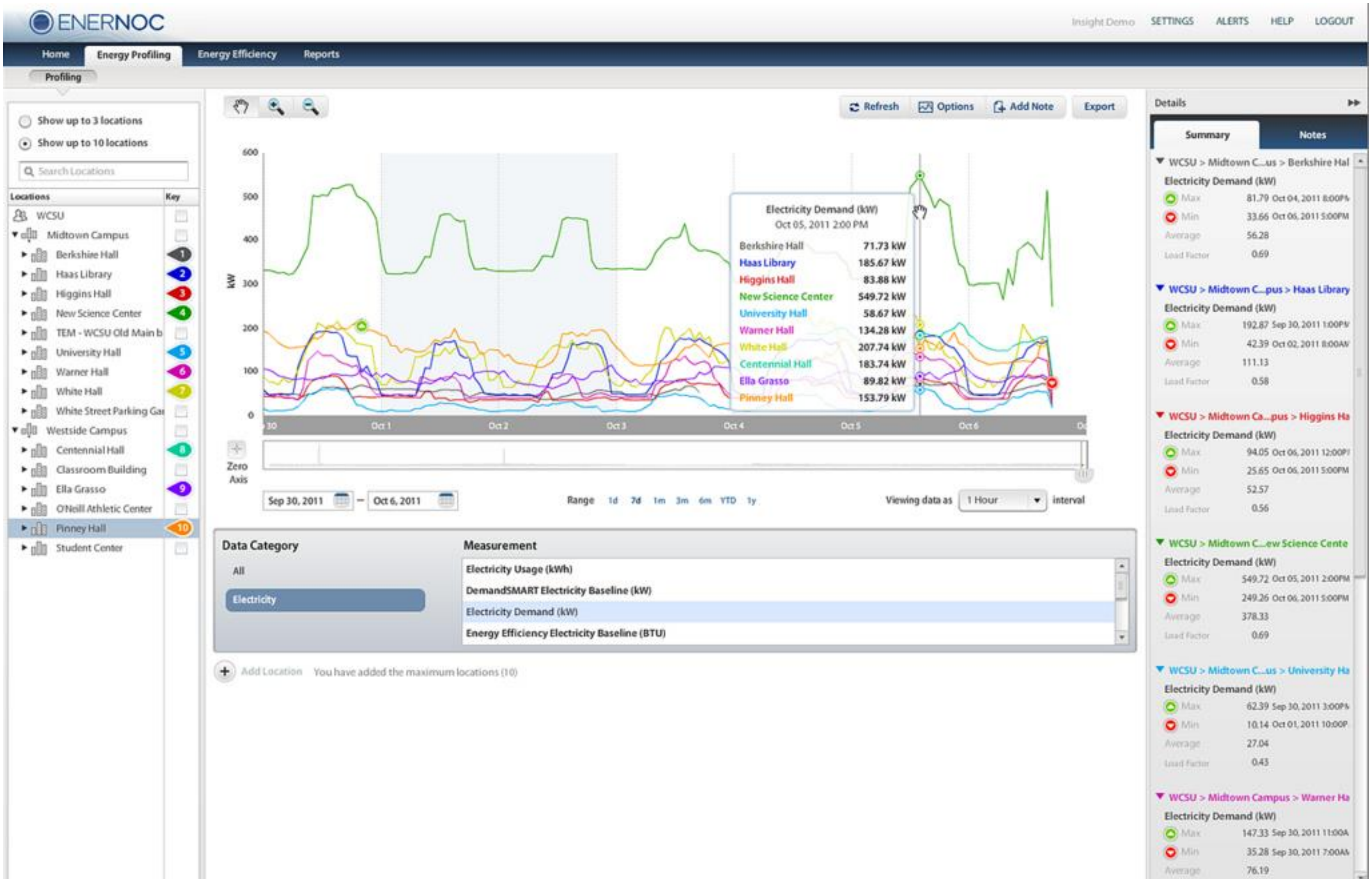
Smart Meter – Customer Dashboard



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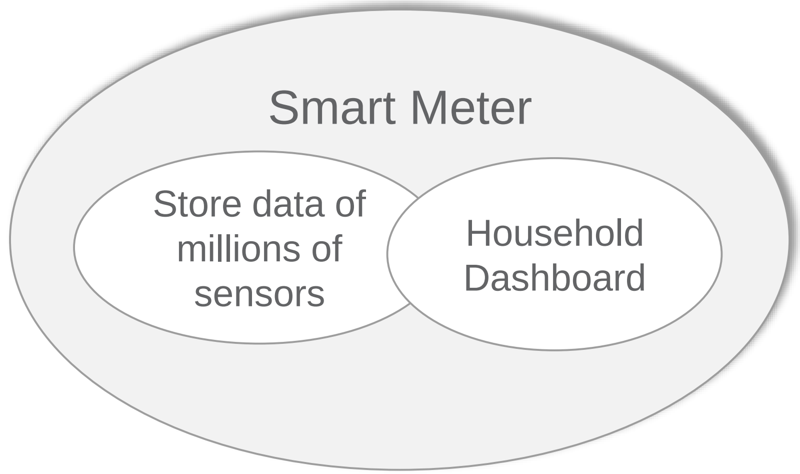
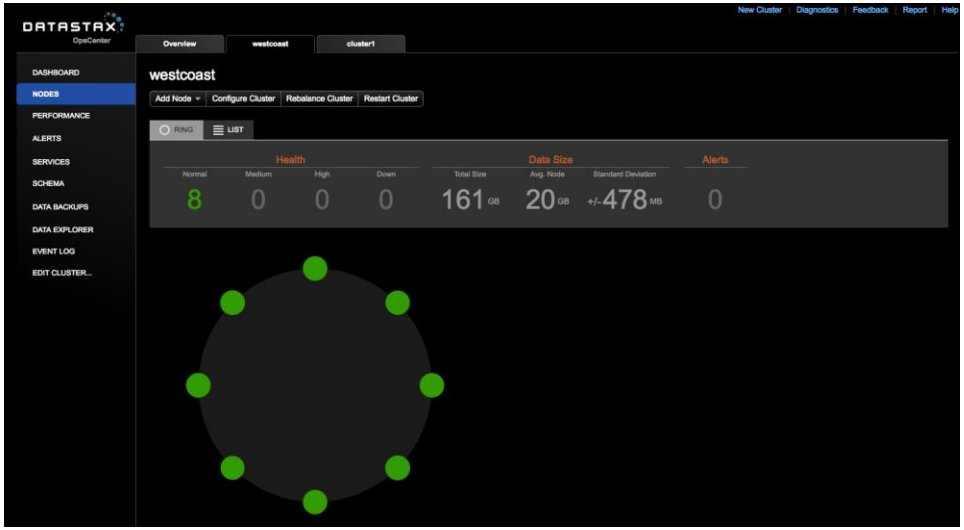
Smart Meter – Use Cases



- Store sensor and its sub-sensor values
  - 2 Mio sensors, up to 10 sub-sensors
  - Energy consumption per second per sensor (kWh)
  - Delivery interval between 1 second and 5 minutes
- Query usage per sensor and its sub-sensors to visualize a time series on a customer dashboard
  - Available in different granularities, values are aggregated in
    - Minute
    - Quarter of hour (15-minutes)
    - Hour
    - Day
  - Responsive UI

Cassandra NoSQL Datastore

- Wide-Column Store
- Developed at Facebook
- Professional grade support from DataStax
- Main Features
  - Real-Time
  - Highly Distributed
  - Support for Multiple Data Center
  - Highly Scalable
  - No Single Point of Failure
  - Fault Tolerant
  - Tunable Consistency
  - CQL – Cassandra Query Language



The Wide Column Store Way (Cassandra)

Household	**Bucket**								
AFG10	MINUTE-2014/03/5	**sensor**	1	1	1	[illegible]	2	2	...
		at	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	…8	...
		kwh	7.05	7.10	8.11	...	6.95	7.04	...
AFG10	QHOUR-2014/03	**sensor**	1	1	1	[illegible]	2	2	...
		at	…5	…0	…5	[illegible]	…5	…0 …1:3	...
		kwh	105.78	104.73	102.29	...	102.78	101.61	...
AFG10	HOUR-2014/03	**sensor**	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...
		at	5T11	5T10	5T09	...	5T11	5…10	...
		kwh	423.00	410.33	395.99	...	598.32	522.12	...
AFG10	DAY-2014	**sensor**	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	...
		at	5T	3T	2T	...	5T	4…	...
		kwh	10100.2	9892.2	8987.4	...	879.8	912,3	...
GXK11	MINUTE-2014/03/5	**sensor**	1	1	1	...	2	2	...
		at	11:59	11:03	11:04	...	11:01	11:02	...
		kwh	100.10	90.88	95.00	...	92.50	88.50	...

24h * 60m * 11 sensor = 15’840 cols

30d * 24h * 4q * 11 sensor = 31’680 cols

30d * 24h * 11 sensor = 7’920 cols

365d * 11 sensor = 4’011 cols

Growth

The Cassandra Way

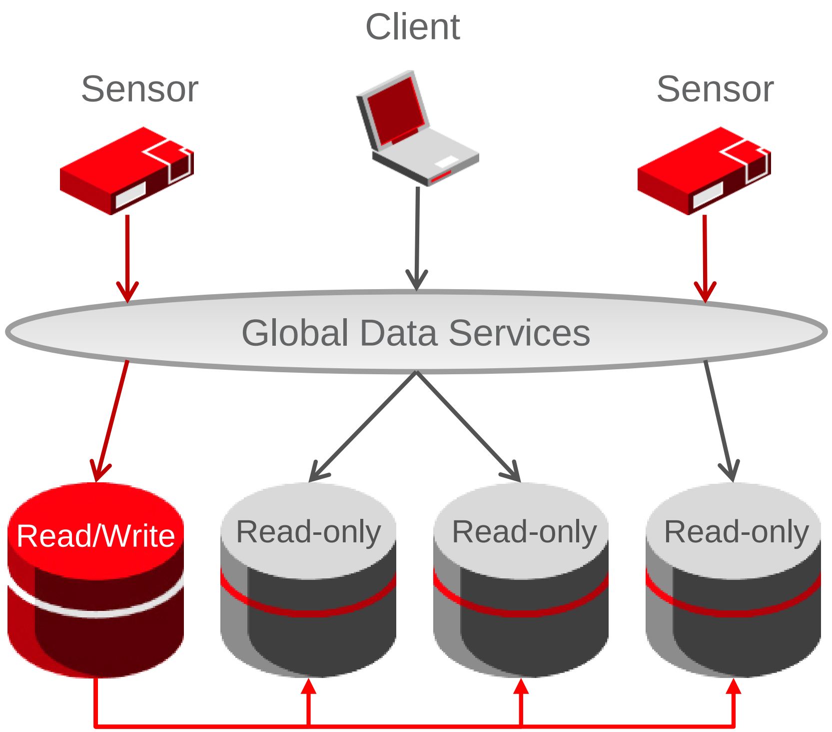
Household	Bucket								
AFG10	MINUTE-2014/03/5	sensor	1	1	1	...	2	2	...
		at	11:59	11:58	11:57	...	11:59	11:58	...
		kwh	7.05	7.10	8.11	...	6.95	7.04	...
AFG10	QHOUR-2014/03	sensor	1	1	1	...	2	2	...
		at	5T11:45	5T11:30	5T11:15	...	5T11:45	5T11:30	...
		kwh	105 78	104 73	103 38		103 78	101 61	

- 288 nodes on EC2
- Over 1 Mio writes/sec => 60Mio writes/min
- Rolling counters, always up to date

```
UPDATE meter_reading_timeunit
SET kwh_consumed = kwh_consumed + 10010
WHERE household_id = 2dc487f0-b271-11e3-a5e2-0800200c9a66
AND sensor_id = 1
AND bucket_id = 'MINUTE-2014/03/23/11'
AND at_timestamp = '2014-03-23T11:01:00';
```

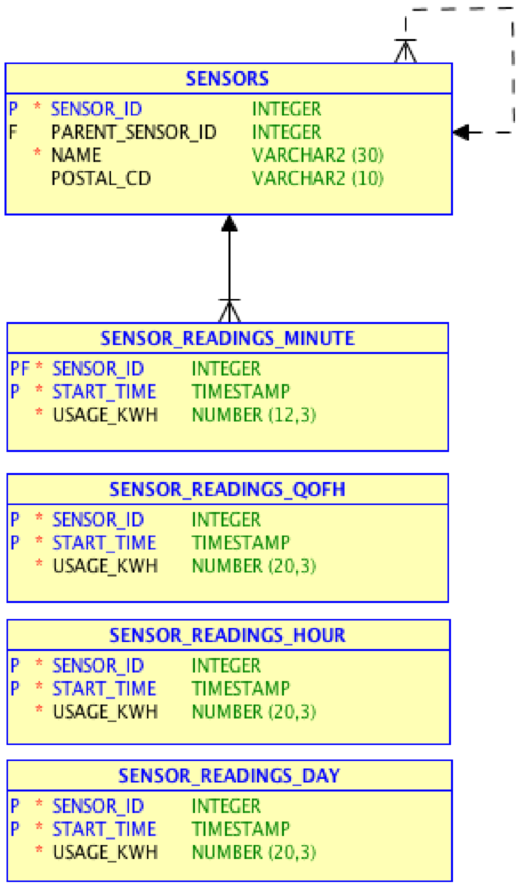
```
select household_id, bucket_id, at_timestamp, sensor_id, kwh_consumed
from meter_reading_timeunit
where household_id = 2dc487f0-b271-11e3-a5e2-0800200c9a66
and bucket_id = 'MINUTE-2014/03/23/11'
and sensor_id = 1
and at_timestamp > '2014-03-23T11:00:00'
order by sensor_id, at_timestamp DESC;
```

Relational Architecture



- Active Data Guard Configuration
- Global Data Services redirects requests based on
  - Server loads
  - Request type (read/write)
- Reader farm is geographically spread
- Failover/switchover to any node in the reader farm is possible
  - Read services are not affected
  - Write services are unavailable for a short period of time
- Scalability of the write services is the bottleneck of the system

Relational Data Model



- SENSOR_READINGS_...
  - Index-organized tables
  - Daily partitions
- JDBC Batch Merges
  - A transaction per sensor delivery
  - A single network roundtrip to merge 55 readings of a sensor delivery
  - Average between
    - 0.4 Mio tpm (delivery per 5 minutes)
    - 120 Mio tpm (delivery per second)
  - Top TPC-C Benchmark: 8.5 Mio tpm
- Batch job to aggregate readings every 15 minutes, avoiding intermediate results (updates)
  - Quarter of hour (5760 times a day)
  - Hour (24 times a day)
  - Day (once a day)

Query Sensor Data – The SQL Way

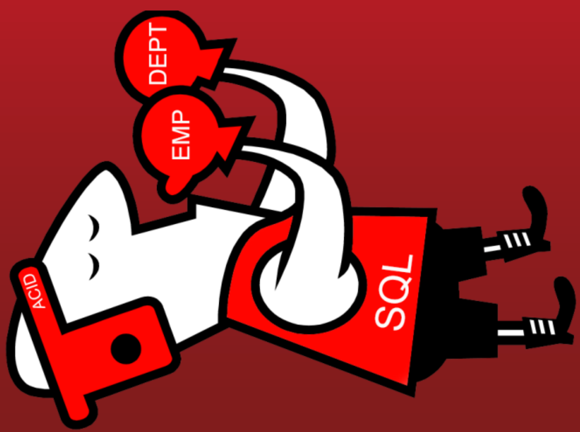
```
MERGE INTO sensor_readings_minute t
USING (SELECT sensor_id, TRUNC(start_time, 'MI') AS start_time,
              usage_kwh FROM TABLE(:p_sensor_data_list)) s
   ON (t.sensor_id = s.sensor_id AND t.start_time = s.start_time)
WHEN NOT MATCHED THEN
   INSERT (t.sensor_id, t.start_time, t.usage_kwh)
   VALUES (s.sensor_id, s.start_time, s.usage_kwh)
WHEN MATCHED THEN
   UPDATE SET t.usage_kwh = t.usage_kwh + s.usage_kwh;
```

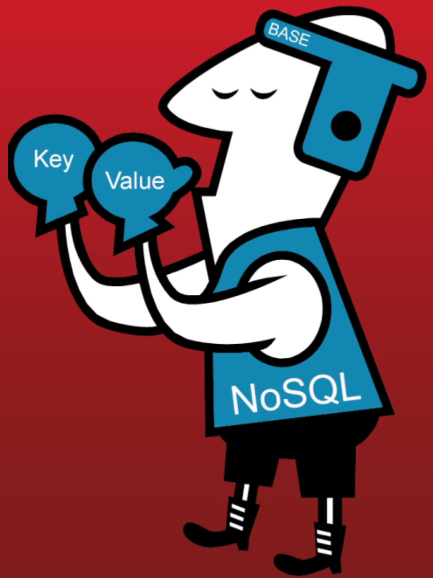
Use aggregate tables to change granularity (quarter of hours, hours, days)

```
SELECT sensor_id, start_time, usage_kwh
  FROM sensor_readings_minute
 WHERE sensor_id = :p_sensor_id
   AND start_time BETWEEN :p_from AND :p_to
 ORDER BY sensor_id, start_time;
```

Smart Meter

0 – 1

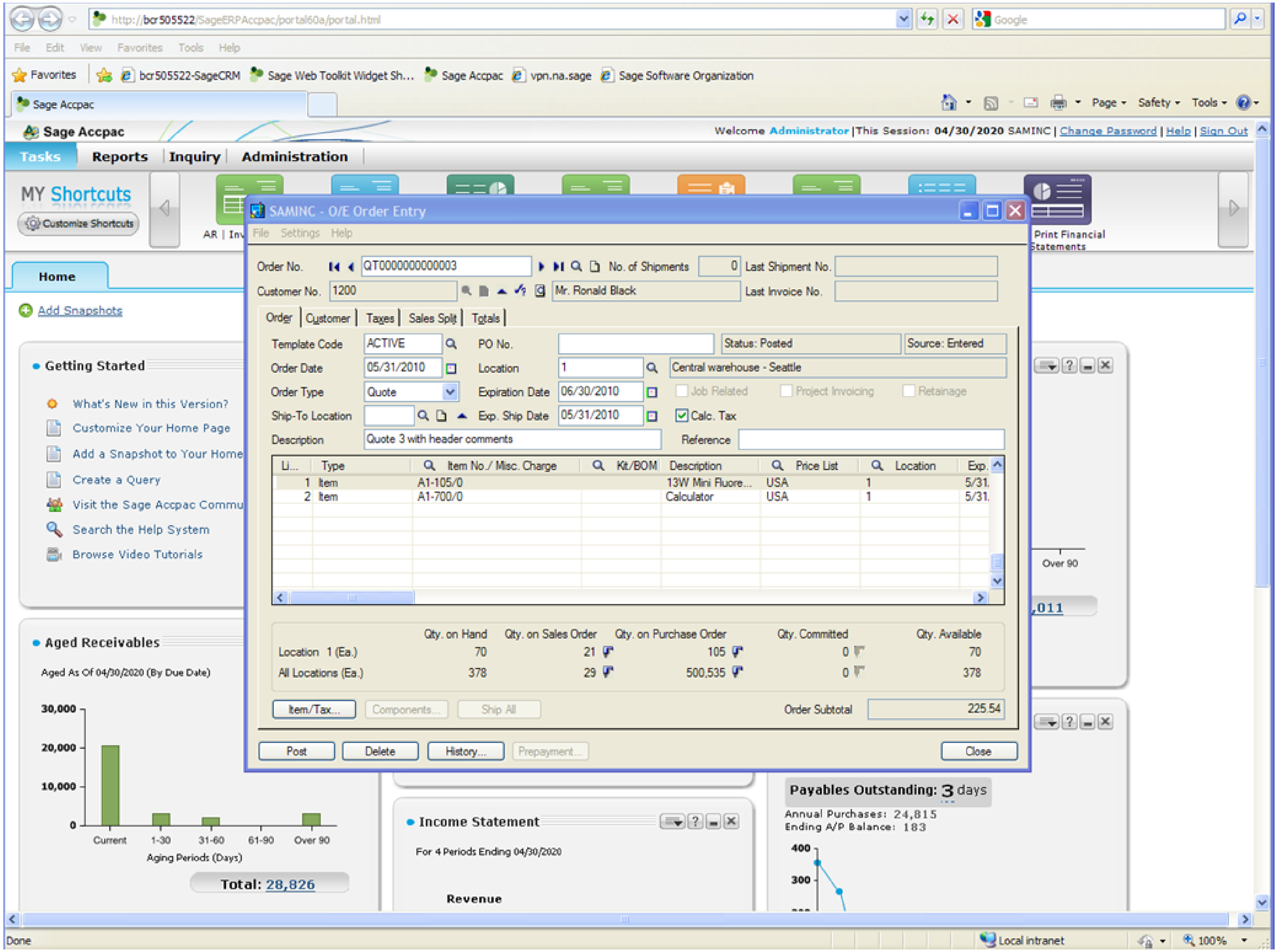




Round 2

Order Entry

Order Entry – Example



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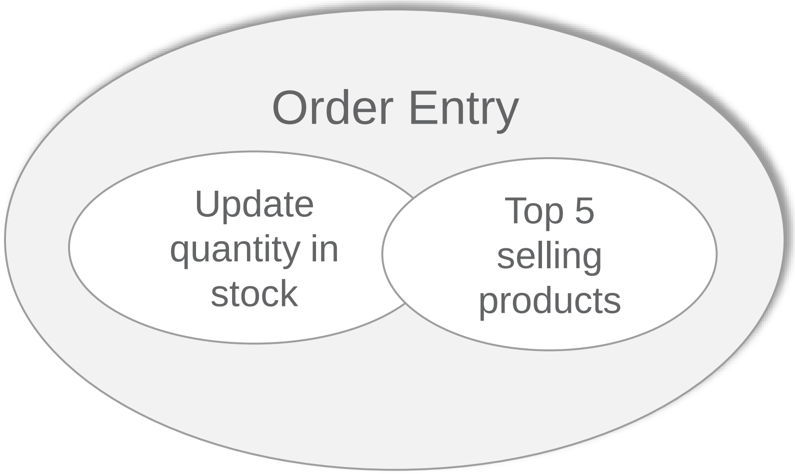
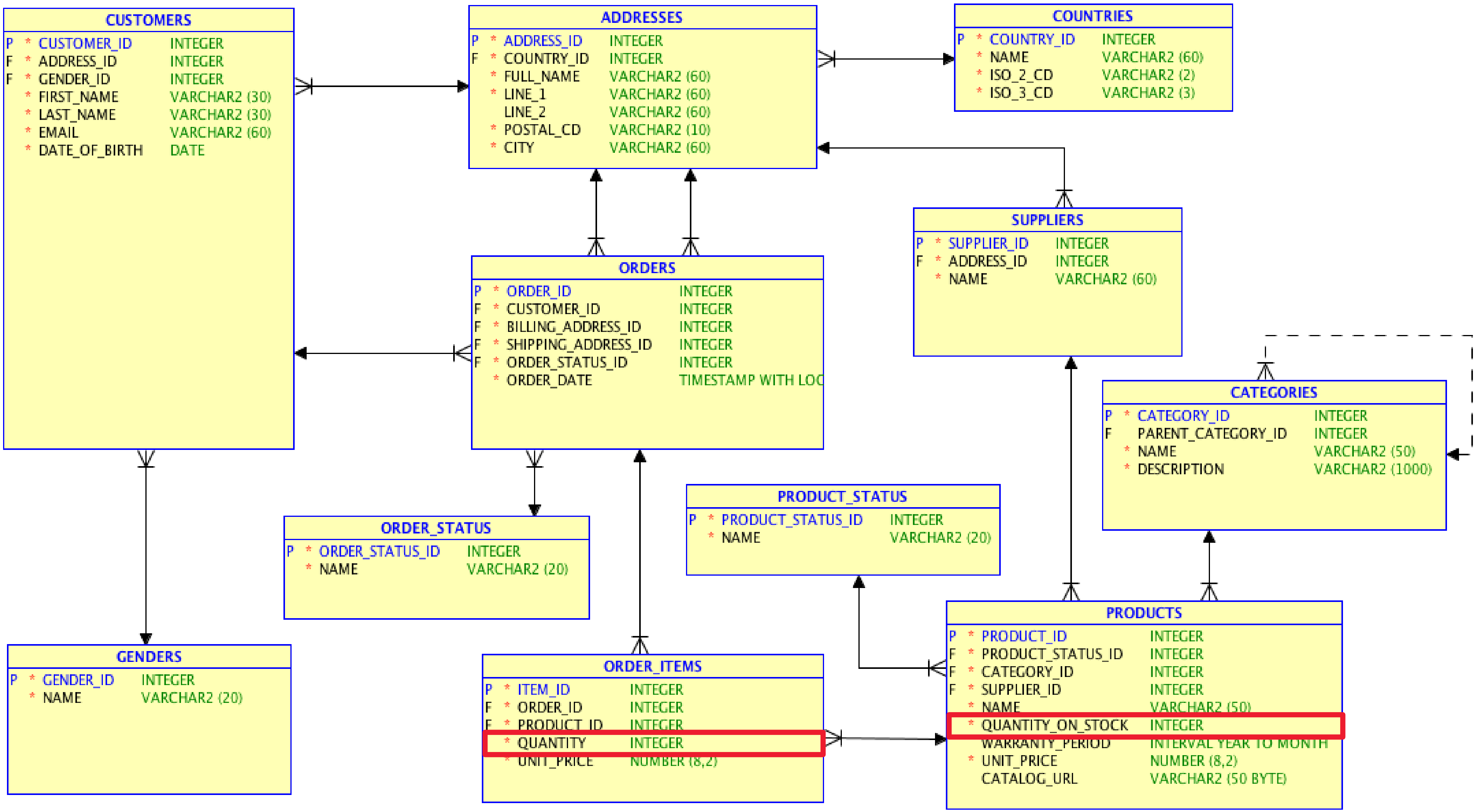
Order Entry – Use Cases



- Update the quantity in stock of all ordered products
  - When order status changes from "incomplete" to "complete"
  - When order status changes from "complete" to "cancelled"
  - Ensure that the quantity in stock is always correct (no lost updates or similar)
- Create a report for the 5 top-selling products for a year

Relational Model



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Change Quantity in Stock – The SQL Way

Single Transaction

```
UPDATE ORDERS
   SET order_status = :p_value_for_complete
 WHERE order_id = :p_order_id;

MERGE INTO PRODUCTS t
USING (SELECT product_id,
              SUM(quantity) AS quantity
         FROM order_items
        WHERE order_id = :p_order_id
        GROUP BY product_id) s
   ON (t.product_id = s.product_id)
 WHEN MATCHED THEN
    UPDATE SET t.quantity_on_stock =
               t.quantity_on_stock - s.quantity;

COMMIT;
```

5 Top-Selling Products – The SQL Way

```
SELECT p.name AS product_name,
       SUM(i.quantity * i.unit_price) AS sales_volume
  FROM order_items i
 INNER JOIN orders o
    ON o.order_id = i.order_id
 INNER JOIN products p
    ON p.product_id = i.product_id
 WHERE o.order_date > DATE '2013-01-01'
       AND o.order_date <= DATE '2014-01-01'
       AND o.order_status = :p_value_for_complete
 GROUP BY p. name
 ORDER BY 2 DESC
 FETCH FIRST 5 ROWS WITH TIES;
```


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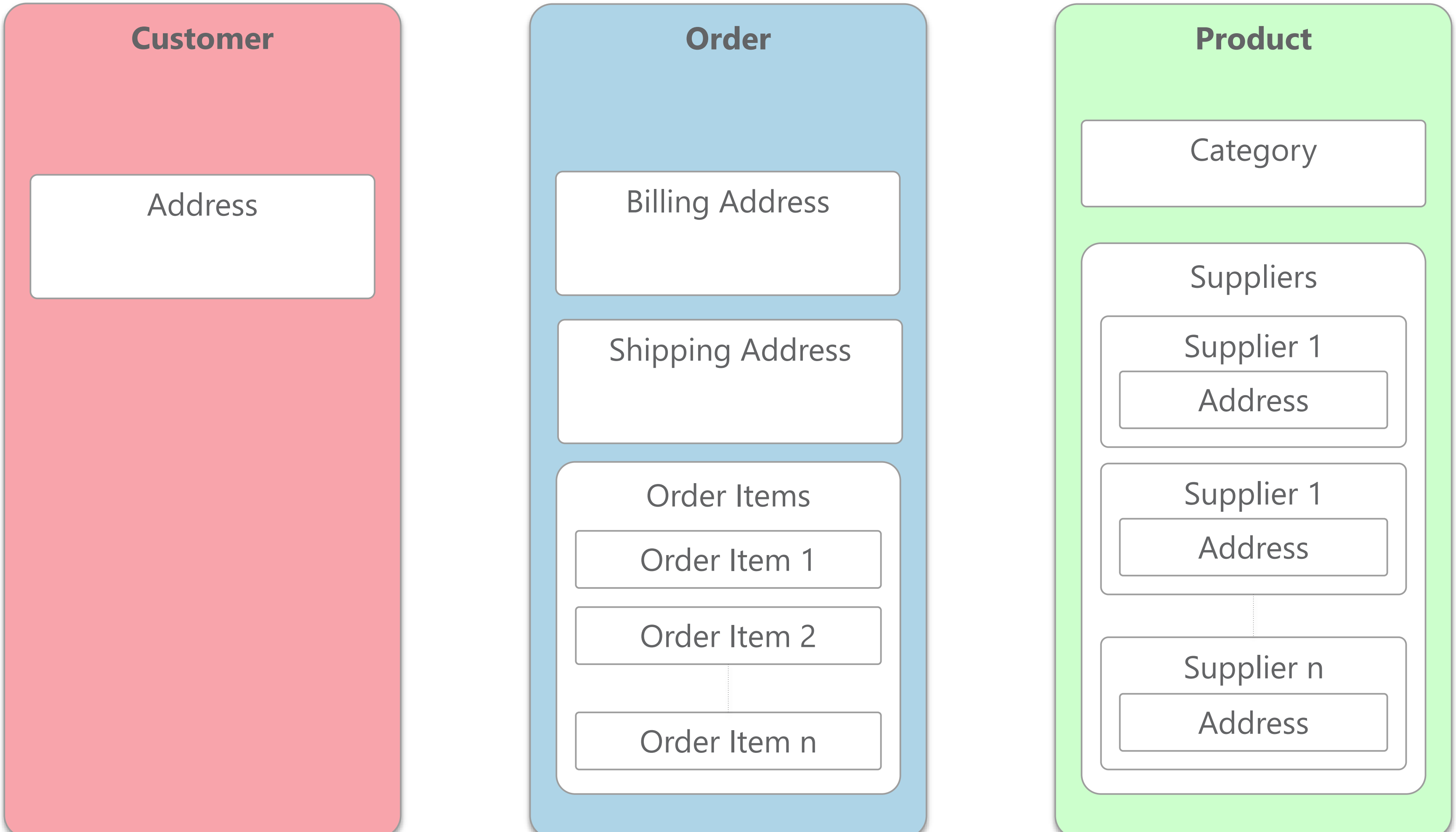
MongoDB Document Data Model (Aggregate Pattern)



Update Quantity in Stock – The MongoDB Way

Transaction 1

```
db.orders.update( { orderId: 1},
                  { $set : { orderStatus: "COMPLETE" } },
                  { multi: false } );
```

Read Operation

```
db.orders.find ( { orderId: 1} );
```

Transaction 2 .. n

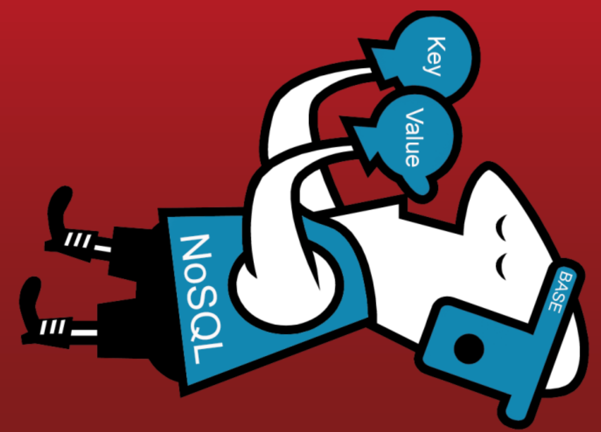
```
ForEach orderItems.item {
      db.products.update( { productId : 101 },
                          { $inc : { quantity: -10 } },
                          { multi: false }
                        );
}
```

5 Top-Selling Products – The MongoDB Way

```
db.orders.aggregate([
    { $match : {
             orderStatus: "COMPLETE",
             orderDate: { $gt: ISODate("2014-01-01"),
                          $lt: ISODate("2014-04-01") }
                        } },
    { $unwind : "$orderItems" },
    { $project : { _id: 0,
             productId: "$orderItems.productId",
             total : { $multiply : ["$orderItems.quantity",
                                     "$orderItems.unitPrice”] }
    } },
    { $group : { _id: "$productId",
                 total : { $sum : "$total"} } },
    { $sort : { total: -1 }},
    { $limit : 5 }
])
```

Order Entry

1 – 1



Round 3

Spotify

Spotify – Example

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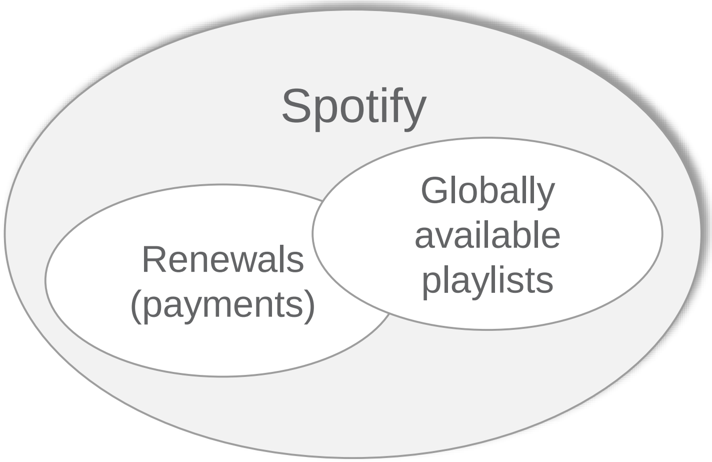
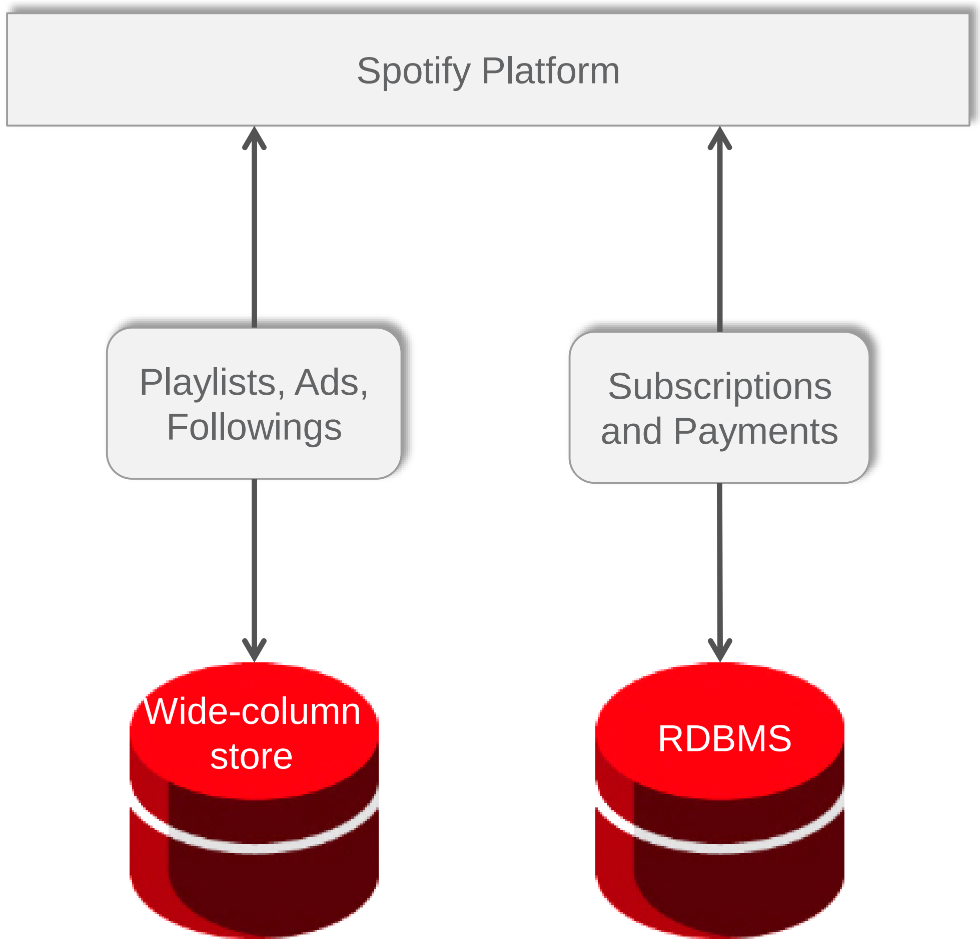
Spotify – Use Cases



- Playlist, Showing Ads, Following Artists … are all uses cases which have to be highly available, and accessible worldwide
  - Needs to be distributed to be fast
  - Service should be available even if a partition happen (due to network failure/machine failure)
- First time subscription and subscription renewal must be absolutely consistent
  - Customer should only pay once!

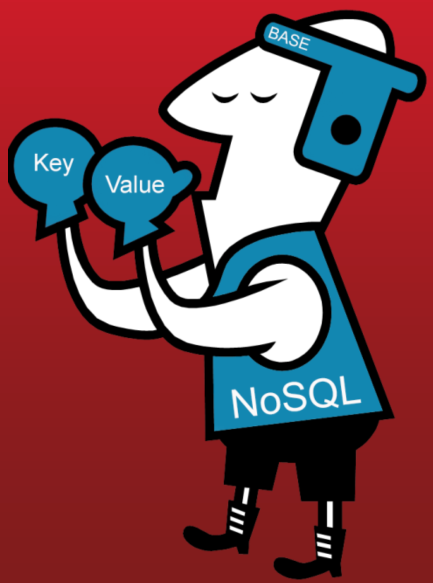
Polyglot Persistence – SQL And NoSQL



Spotify

2 – 2

Draw!



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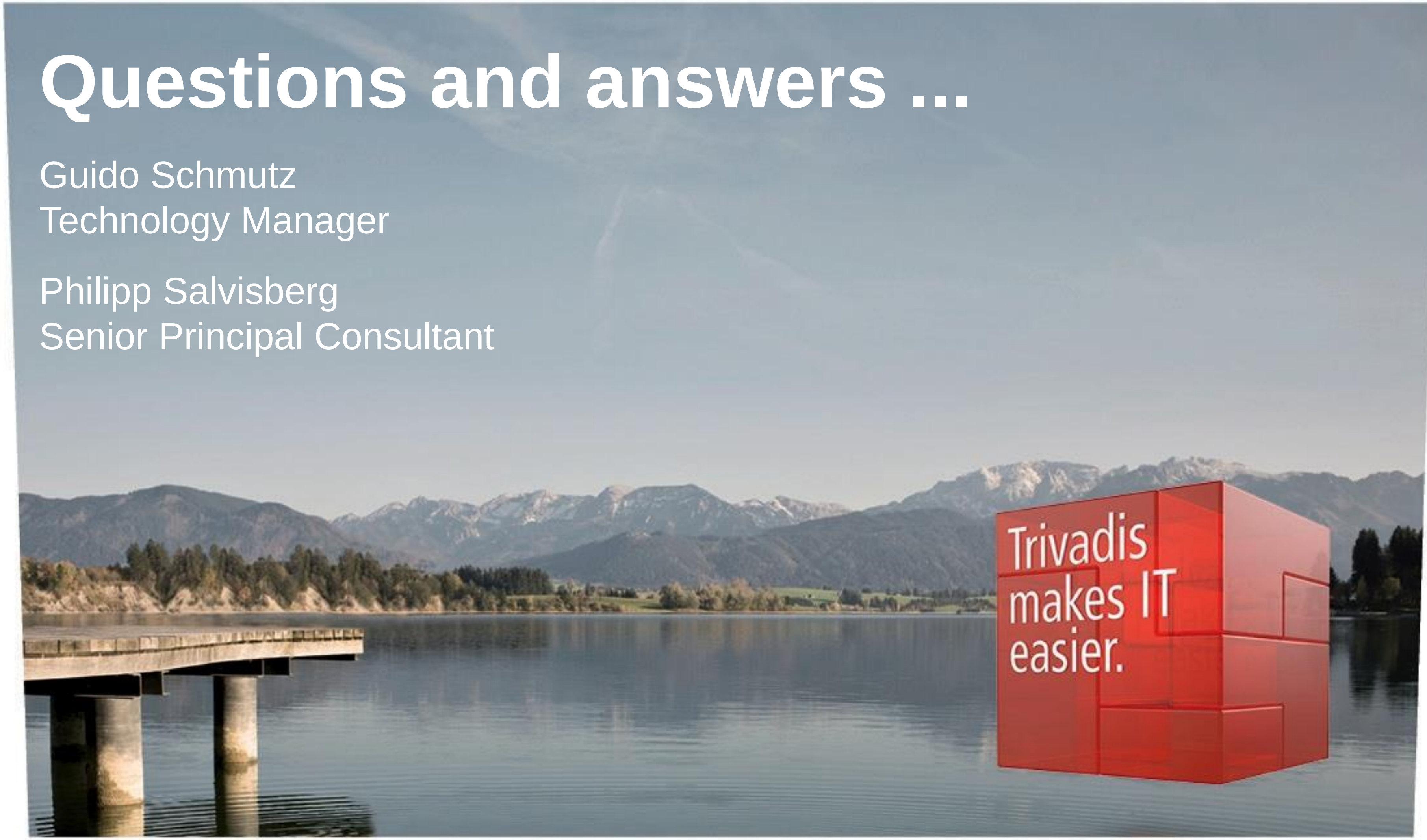
Core Messages

- We will see a major consolation in the NoSQL area
- SQL is and stays important
- Polyglot persistence will be part of every solution design in the near future
- Enterprise capabilities are required
  - Tooling (monitoring, backup & recovery, data security, …)
  - Organization, skills
  - Opportunity for cloud based solutions

Questions and answers ...

Guido Schmutz
Technology Manager

Philipp Salvisberg
Senior Principal Consultant



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Further information ...

- http://martinfowler.com/books/nosql.html
- http://www.manning.com/mccreary/
- http://highlyscalable.wordpress.com
- http://nosql-database.org
- http://db-engines.com/