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Stored procedure wrapper for Java
&
PGObserver

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Outline

- **Introduction**
- Stored procedure wrapper
  - Problems before the wrapper
  - How it works
  - How to use it
  - More features including sharding
- PGObserver

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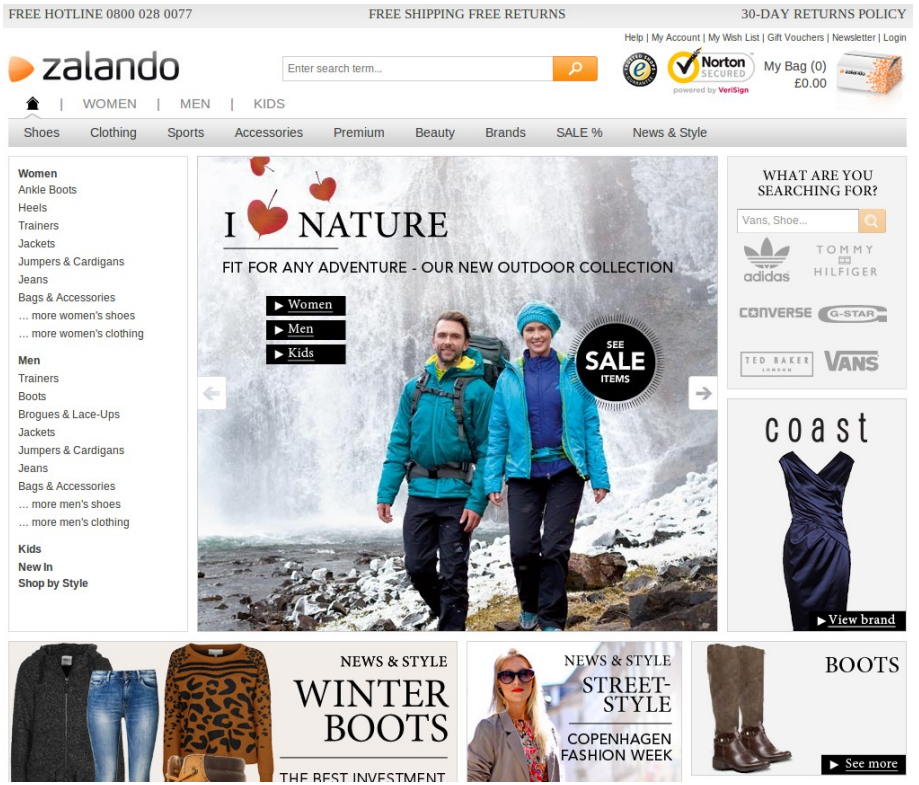

- 14 countries
- 471 Mio € revenue 1st half of 2012
- 3 warehouses
- Europe's largest online fashion retailer

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Zalando platform

- Modern open source software stack
- Mostly Java
- PostgreSQL database backend
- > 150 developers

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PostgreSQL setup

- ~ 20+ Servers PostgreSQL master servers
- ~ 4.000 GB of data
- Started with PostgreSQL 9.0 rc1
- Now running version 9.0 to 9.2
  - cascading replication very welcome
  - maintenance improvements great (drop concurrently)
  - Index only scan, pg_stat_statement improvements
- Machine setup
  - 8- to 48- cores, 16GB to 128GB
  - SAN, no SAN with (2x2x RAID 1, 4x RAID 10) preferred

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PostgreSQL availability

- BoneCP as Java connection pool
- All databases use streaming replication
  - Service IP for switching
- Failover is manual task
  - Monitored by Jave app, Web frontend
- Significant replication delays sometimes
  - Fullpage writes, Nested Transactions, Slave load

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Stored procedure experience

- Performance benefits
- Easy to change live behavior
- Makes moving to new software version easy
- Validation close to data
- Run a very simplistic transaction scope
- Cross language API layer
- More than 1000 stored procedures
  - More plpgsql than SQL than plpython

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Execution of stored procedures

- Using spring's BaseStoredProcudere
  - Initially a lot of work per stored procedure
  - One class per stored procedure
  - Write row mappers for domain object mapping
- Missing type mapper on Java side
  - Spring type mapper insufficient
    - Enums, array of types, nesting, and hstore missing
- JdbcTemplate or alternatives lack ease of use

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Goals of our wrapper

- Write as little code as possible on Java side
- One location for procedures of same topic
- One call path to any stored procedure
- “Natural” feeling for using stored procedures
  - Procedure call should look like Java method call
  - RPC like

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Brief example

```
CREATE OR REPLACE FUNCTION create_customer ( p_customer t_customer )
  RETURNS SETOF t_customer
AS
$$
  -- Procedure definition
$$
LANGUAGE 'plpgsql' SECURITY DEFINER;
```

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Brief example

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```
@SProcService
public interface CustomerExampleSProcService {

    @SProcCall
    Customer createCustomer(@SProcParam Customer customer);
}
```

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Brief example

```
@SProcService
public interface CustomerExampleSProcService {

    @SProcCall
    Customer createCustomer(@SProcParam Customer customer);
}
```

```
Customer c = new Customer();
c.setFirstName("Jan");
c.setName("Name");

Customer result = service.createCustomer(c);
```

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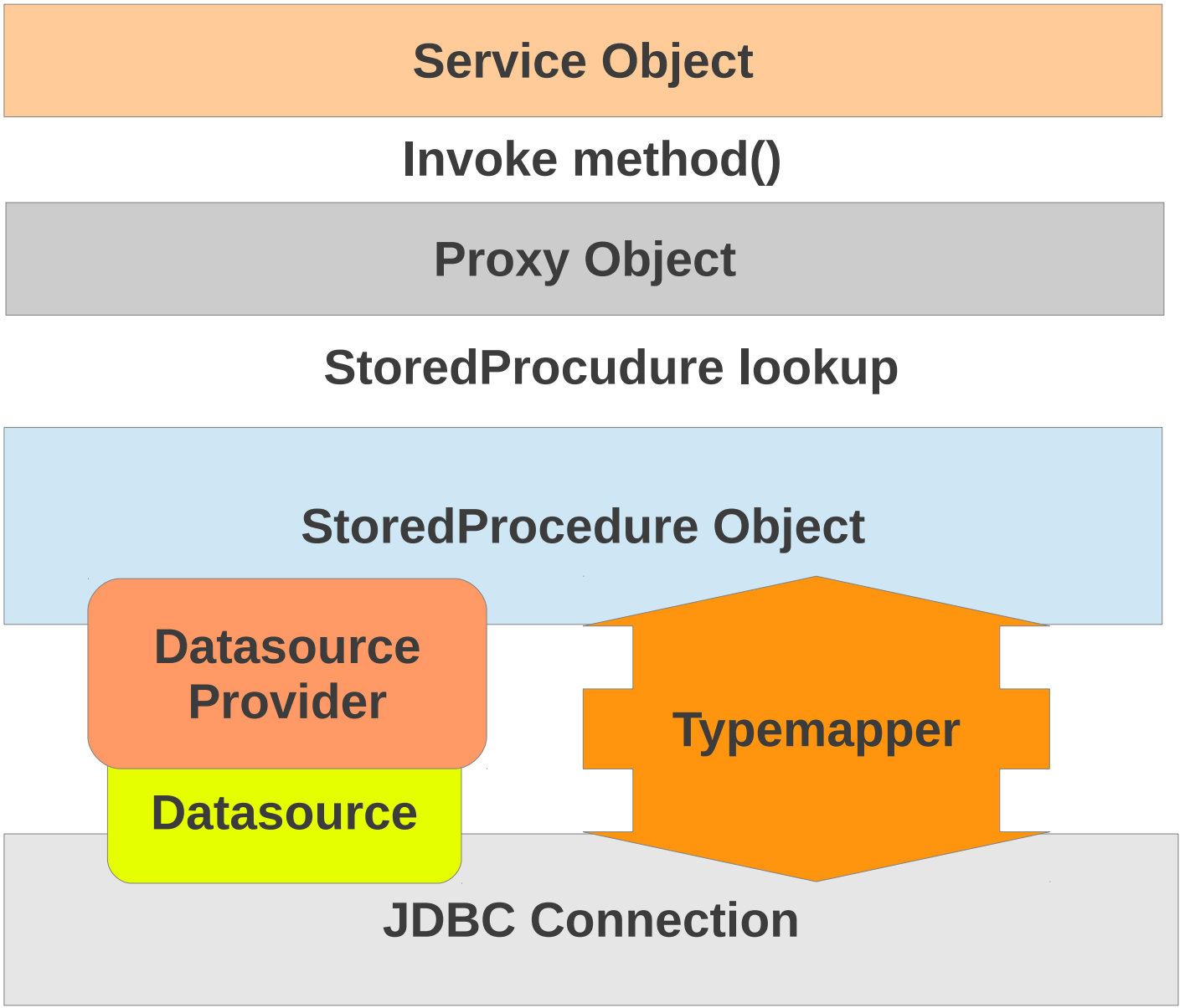
Under the hood



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Features

- New spring compatible type mapper
  - From simple types to nested domain objects
  - Supports PG enum to Java enum
- Accessing sharded data supported
  - Result “aggregation” across shards
  - Parallel query issuing
- Advisory locking via annotation
- Set custom timeout per stored procedure

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Type mapper

- Annotations for class and member variables
  - **@DatabaseType** and **@DatabaseField**
- CamelCase to camel_case conversion
- JPA 2.0 **@Column** annotation supported
- Addition type conversions include:
  - Nested PostgreSQL types to Java objects
  - hstore to Map<String,String>
  - PostgreSQL enum to Java enum (by name)
  - PostgreSQL array[] to List<?>()

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Using the wrapper

- Considere Java to PostgreSQL plpgsql
- First define the Java interface

```
@SProcService
public interface CustomerExampleSProcService {

    @SProcCall
    public Customer loadCustomer(@SProcParam int id);

    @SProcCall
    public Customer createCustomer(@SProcParam Customer customer);

    @SProcCall
    public int addNewAddress(@SProcParam int customerId,
                             @SProcParam Address address);
}
```

Using the wrapper

- Create class implementing previous interface

```
@Repository
public class CustomerExampleSProcServiceImpl
    extends AbstractSProcService<CustomerExampleSProcService,
                                 SingleDataSourceProvider>
    implements CustomerExampleSProcService {


    @Autowired
    public CustomerExampleSProcServiceImpl(
            @Qualifier("testDataCustomerExampleProvider")
            final SingleDataSourceProvider p) {

        super(p, CustomerExampleSProcService.class);
    }

    @Override
    public Customer loadCustomer(int id) {
        return sproc.loadCustomer(id);
    }
```

Using the wrapper

- Define DTO classes if necessary
  - Input parameters
  - ResultSet mapping

```
@DatabaseType(name="t_customer")
public class Customer {

    @DatabaseField
    protected Integer id;

    @DatabaseField
    protected String name;
    @DatabaseField
    protected String firstName;
    @DatabaseField
    protected List<Address> addresses;

    @DatabaseField
    protected Address defaultAddress;
```

Using the wrapper

- Next create analogous PostgreSQL types

```
CREATE TYPE t_customer AS ( id int,
                            name text,
                            address t_address[] );
```

- Or use “OUT” columns

```
CREATE FUNCTION load_customer( INOUT id int,
                               OUT name text,
                               OUT address t_address[] )
  RETURNS SETOF record AS
```

- Implement stored procedures

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Putting it together

- Integration test

```
public class CustomerExampleIT {

    @Autowired
    private CustomerExampleSProcService service;




    @Test
    public void testCreate() {
        Customer c = new Customer();
        c.setFirstName("Jan");
        c.setName("Name");

        Customer result = service.createCustomer(c);

        assertEquals( true,  (int)result.getId() > 0 );
        assertEquals( null, result.getDefaultAddress());
    }
```

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Running SQL queries

- *@SProcCall(sql="[...]")* may run any query
  - Benefit from type mapper
  - Relatively easy to use
  - Although mixing SQL into Java source

```
@SProcCall(sql="UPDATE t SET name = ?"
                + " WHERE id = ? "
                + " RETURNING id")
int updateName(@SProcParam String newName,
               @SProcParam int userId);

// allows you then to do:
int r = service.updateName('Jan',1001);
```

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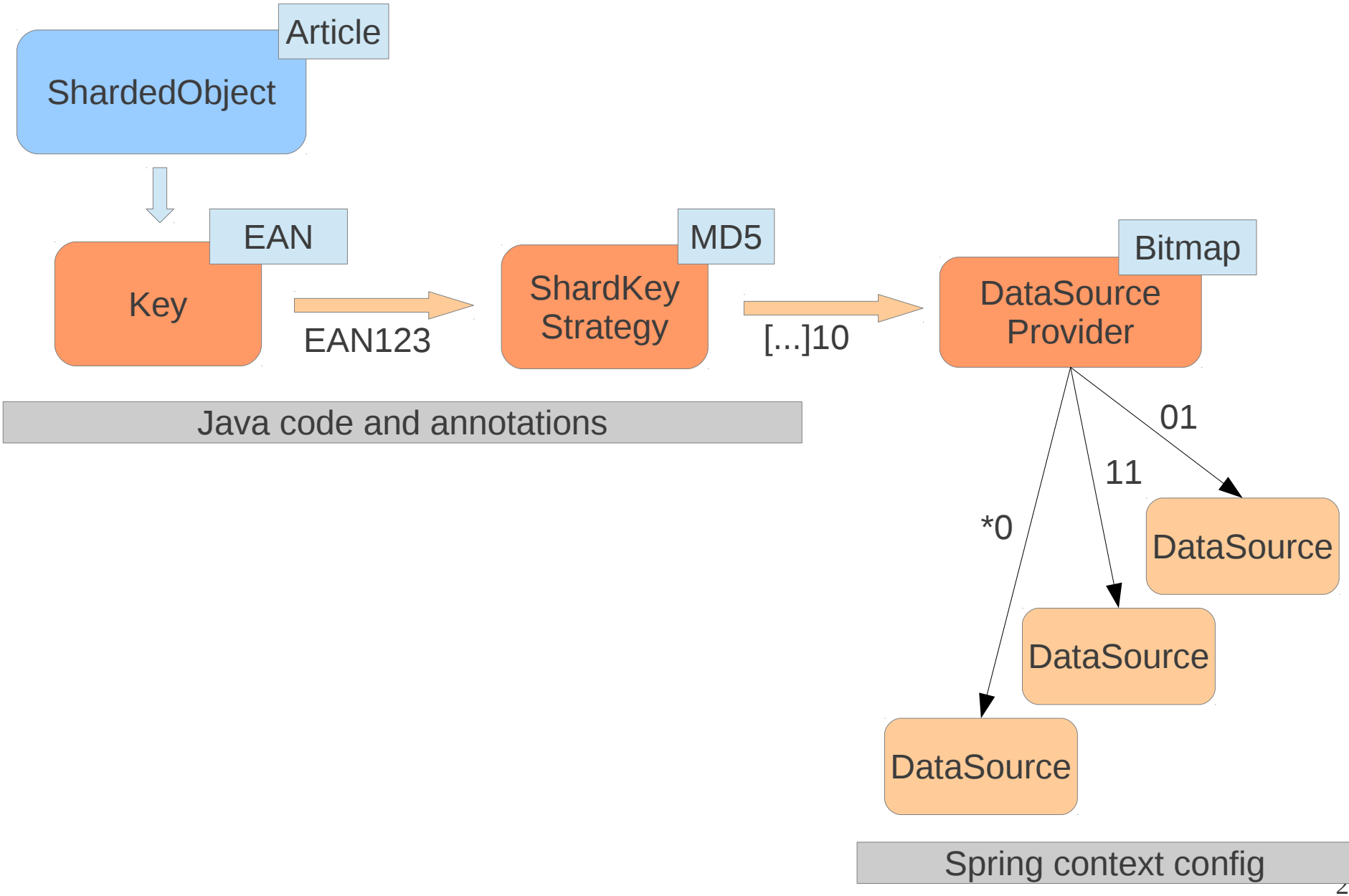
Sharding support

- Parameter annotation **@ShardKey**
- **@ShardKey** and **@SProcParam** may overlap

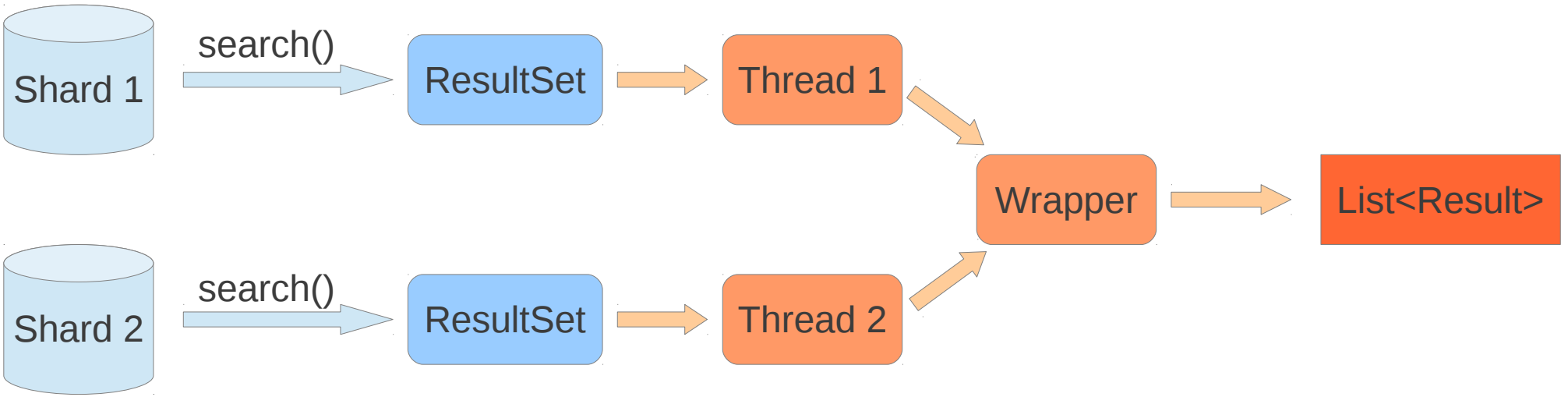
```
@SProcCall
Customer getCustomer(@ShardKey int shardId,
                     @SProcParam String cnumber)

@SProcCall
Article getArticle(@ShardKey @SProcParam ean)
```

- *ShardedObject* interface for custom classes
- Added datasource providers for translation

Different datasource providers

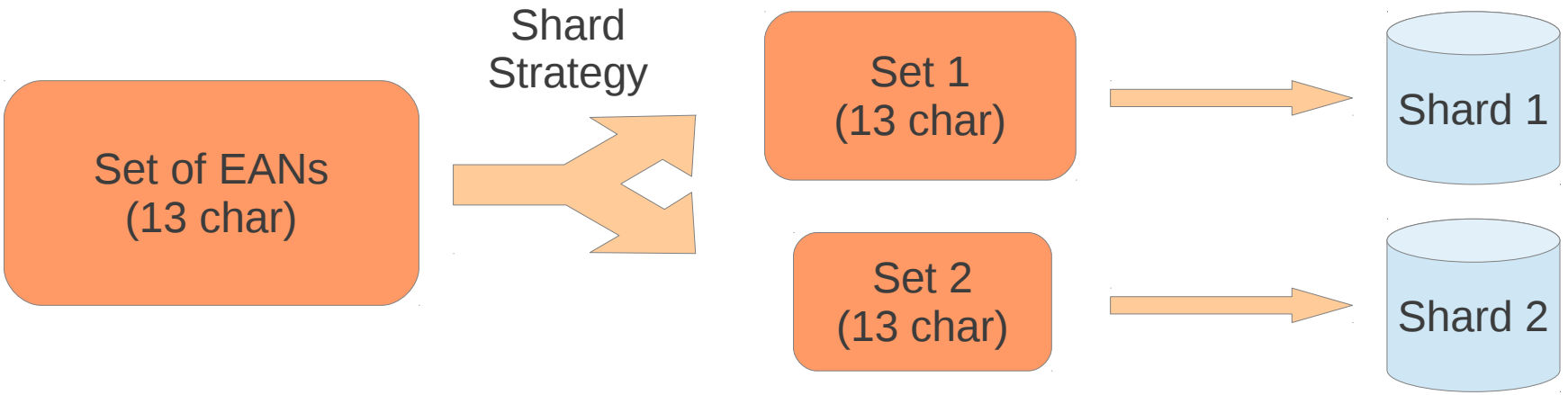


Search and “Merge” result set



- Use **searchShards** where you do not know the shard
  - will run on all shards return on first find
- Use **runOnAllShards** execute on all shards
  - Search *name like 'Na%'* and return one collection

Auto partitioning



- Java method called with one large collection
  - Wrapper will split collection according to key
  - Execute SQL for split collection on each shard
- Default behavior if **@ShardKey** is a collection

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Java bean validation

- Annotation based validation (JSR 303)

```
@DatabaseField
@NotNull
public String a;

@DatabaseField
@Min(4)
@Max(6)
@NotNull
public Integer b;
```

- Relying on hibernate validator
- Automatically checked inside wrapper
  - Less boiler plate code
  - **@SProcService(validate = true)**

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Value transformers

- Global registry for type conversions
  - e.g. for use with JodaTime class
  - Enables transparent handling of legacy types
- Usefull for *::text* to Java class conversion
  - Type safe domain classes
  - *::text* => class EAN

Per stored procedure timeout

- Trouble with global statement timeout
  - Long running queries and supposedly fast ones
- Added **@SProcCall(timeout=x)**
  - X is timeout in ms
  - Allows overwrite for long running jobs
  - Ensures limited run time for “fast” functions
    - Search functions with too few constraints

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Concurrency with advisory locks

- Single database serves many Java instances
  - Synchronization may be required
- Wrapper features one enum for different locks
  - **@SProcCall(advisoryLockType=LOCK1)**
  - Easy locking
  - One enum warns developers of existing locks

Transaction support

- Spring's @Transactional should work
  - More or less datasource dependent
  - Sharded environment more complicated
- For multi shard operations wrapper provides
  - Context is one procedure equals one transaction
  - Immediate commit on each shard
  - Commit only if all executions were successful
  - Use two phase commit
- Enabled on SProcService or SProcCall level

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PGObserver

- Build to monitor PostgreSQL performance
  - Stored procedures as execution unit
  - Track table statistics to assist identifying causes
- Infrastructure
  - One Java data gatherer
  - Web frontend in using Python
  - Metric data is stored in PostgreSQL
  - Per service configuration of all gather intervals

PGObserver database view

Database size **all tables**

Top 10 Sprocs last 1 hour by total run time

Name	Calls	Total Time	Avg. Time
[illegible]	311	11m 58.561s	2.310s
[illegible]	9141	9m 36.958s	0.063s
[illegible]	3552	7m 8.279s	0.121s
[illegible]	3552	7m 7.633s	0.120s
[illegible]	1258	4m 31.393s	0.216s
[illegible]	285	4m 27.331s	0.938s
[illegible]	7104	4m 21.282s	0.037s
[illegible]	20677	4m 14.160s	0.012s
[illegible]	18940	3m 59.183s	0.013s
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[illegible]	56845	13.663s	0.000s
[illegible]	40588	41.182s	0.001s
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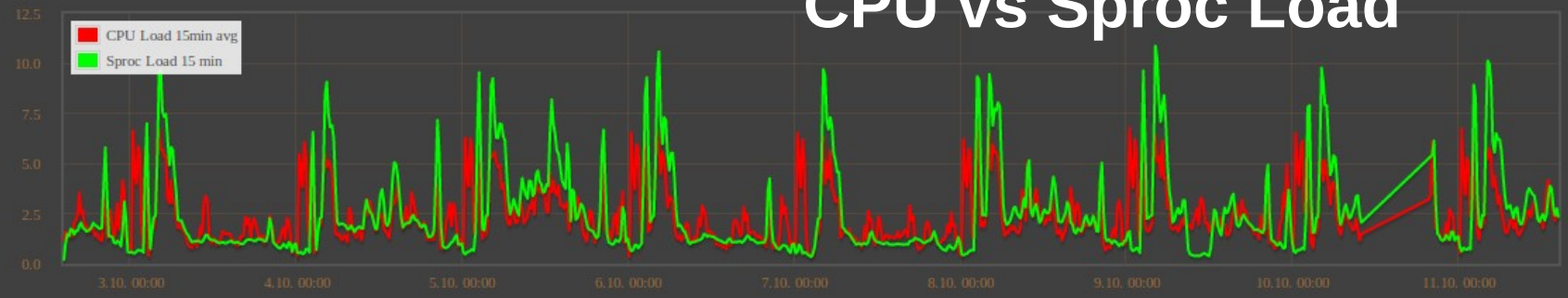
[illegible]	10882	28.645s	0.003s
[illegible]	10558	1m 15.699s	0.007s

PGObserver database view

CPU vs Sproc Load



IO related stats

Database size all tables

Top 10 by runtime

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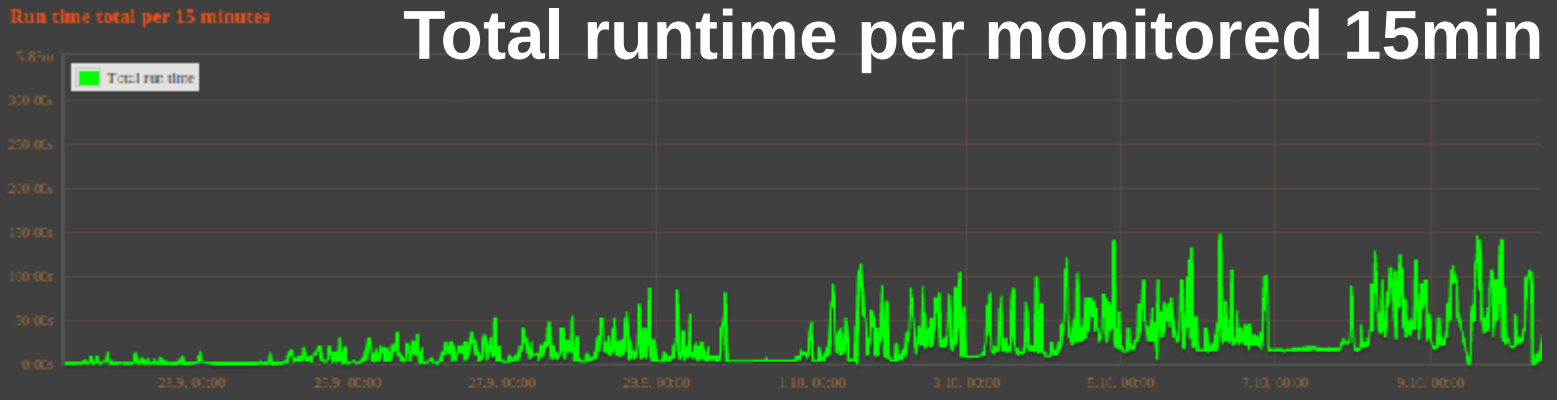
Sequential scan in live env.

Total runtime per monitored 15min



Avg. run time per call

Avg. self time per call

Table I/O data excerpt

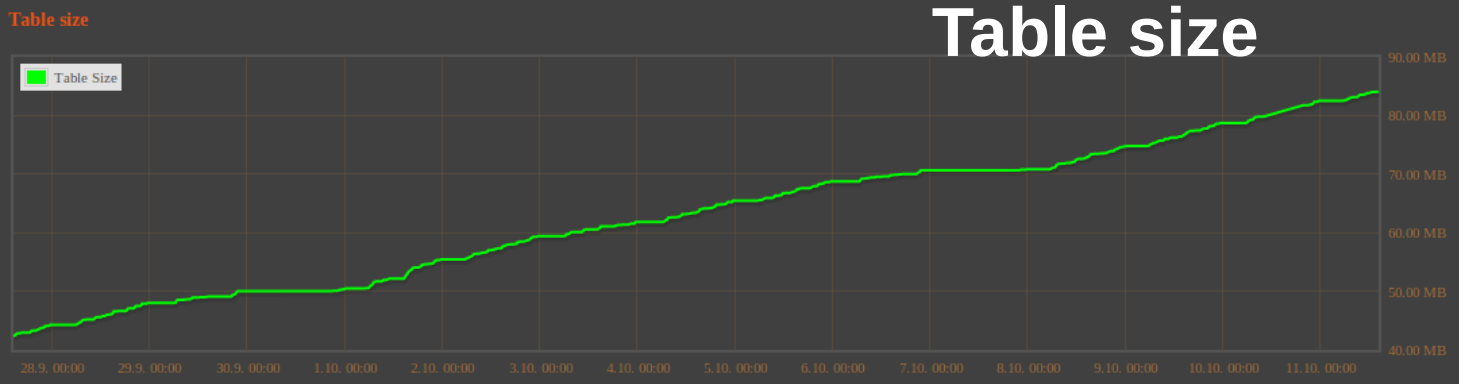
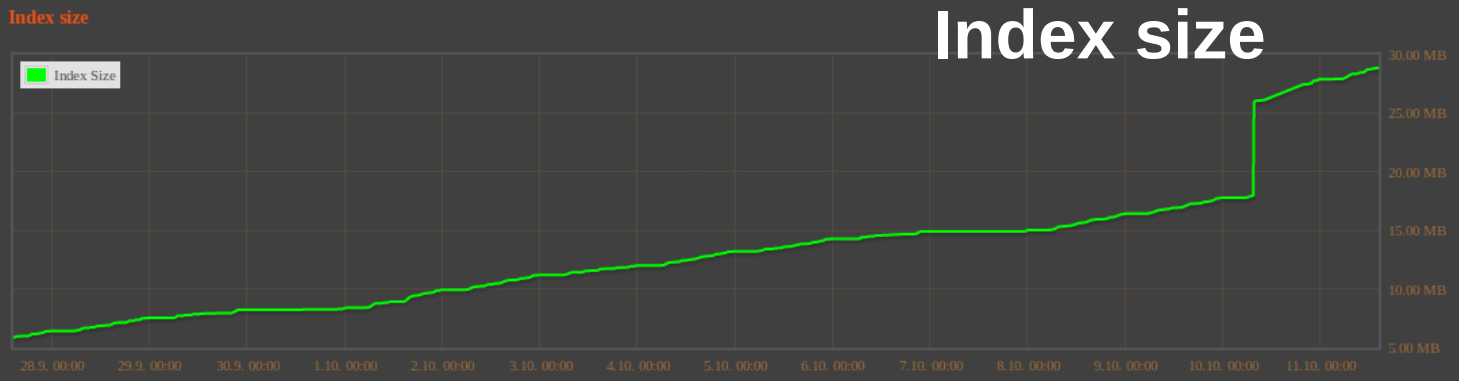
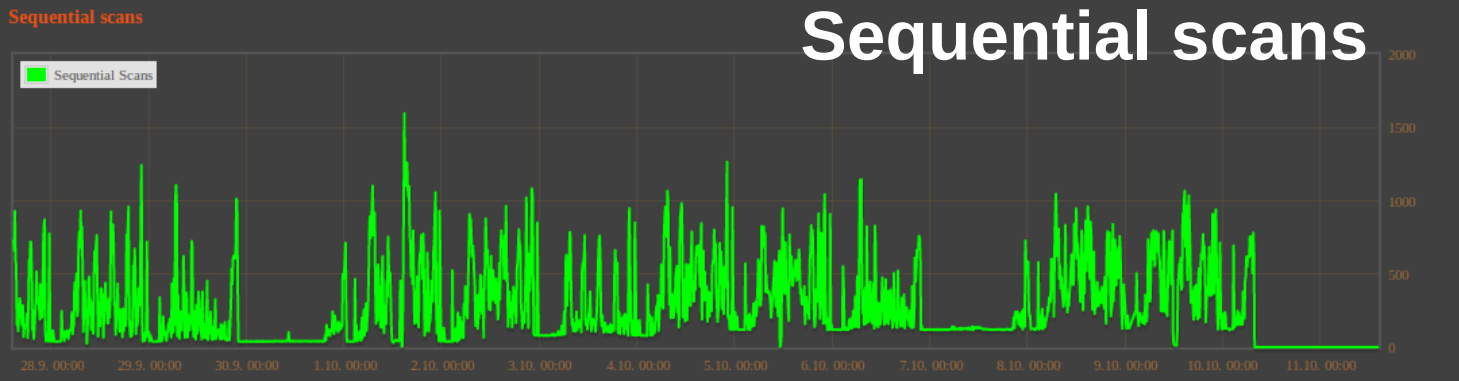


Table size



Index size



Sequential scans

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Summary

- Stored procedures can improve performance
- Type mapper great library to reduce map code
- Wrapper makes procedure usage a lot easier
- Stored procedure and general PostgreSQL performance monitoring is very important
- Wrapper and PGObserver available soon!

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- http://www.github.com/zalando
- http://tech.zalando.org

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Thank you for listening