FACULTY
OF INFORMATICS
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Use of Transactions within a Reactive Microservices Environment

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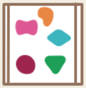
Assignment

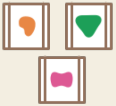
- Review the state of the art, in terms of problems of synchronous/blocking approaches for transaction management and other approaches/patterns available - taking into account the microservices context
- Propose a proof-of-concept implementation, using the Narayana transaction manager and prepare a service capable to manage transactions in the context of reactive microservices
- Prepare an example/quickstart showing the whole issues in more practical terms, proving that the transaction manager can work in an asynchronous environment

Microservices

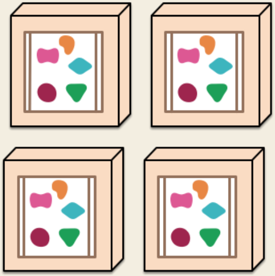
A monolithic application puts all its functionality into a single process...



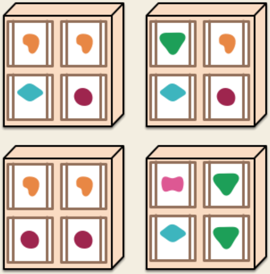
A microservices architecture puts each element of functionality into a separate service...



... and scales by replicating the monolith on multiple servers

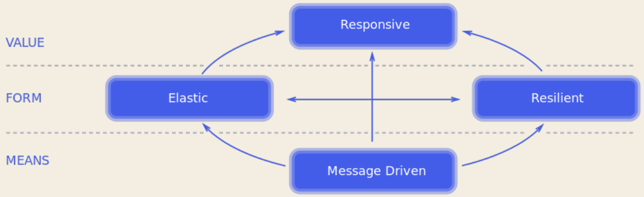


... and scales by distributing these services across servers, replicating as needed.



Reactive microservices

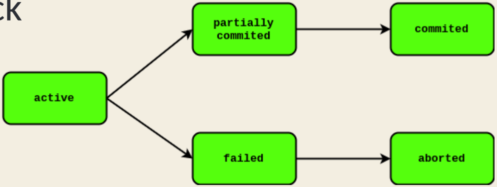
- reactive systems
- reactive programming
- reactive streams



Transactions

"A transaction is a unit of processing that provides all-or-nothing property to the work that is conducted within its scope, also ensuring thatshared resources are protected from multiple users" [1].

- sequence of operations
- commit or rollback

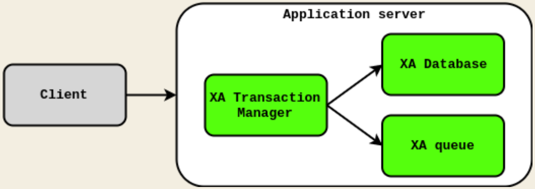


ACID transaction

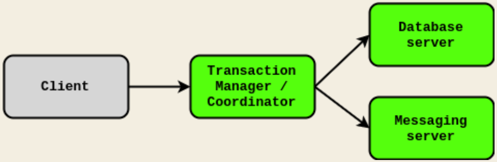
- Atomicity
- Consistency
- Isolation
- Durability

Distributed transactions

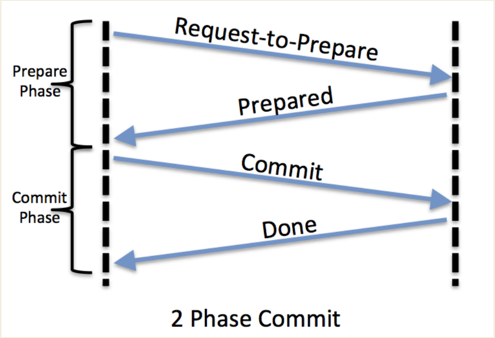
- XA



- Distributed system



Two phase commit protocol



2 Phase Commit

- $O(n^2)$ messages
- blocking
- coordinator - single point of failure

Saga pattern

Hector Garcia-Molina and Kenneth Salem, Princeton University, 1987

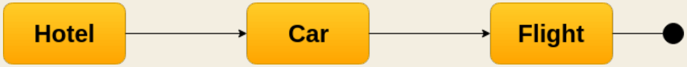
- long lived transactions
- compensations
- all-or-nothing property

Saga executions

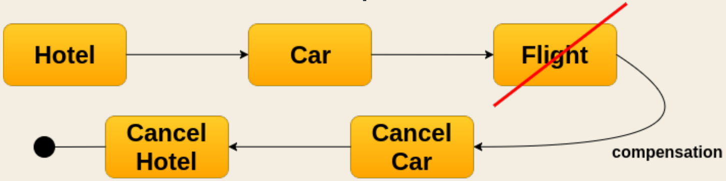
- 2PC - T_1, T_2, ..., T_n (in a single step)
- Saga
  - success - T_1, T_2, ..., T_n
  - failure - T_1, T_2, ..., T_k, C_k, C_{k-1}, ..., C_1

Example saga execution

Success



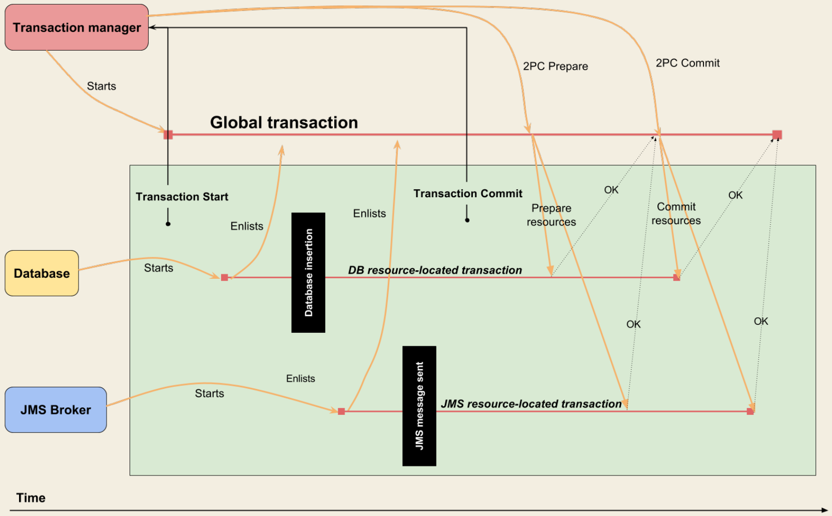
Failure / Compensation



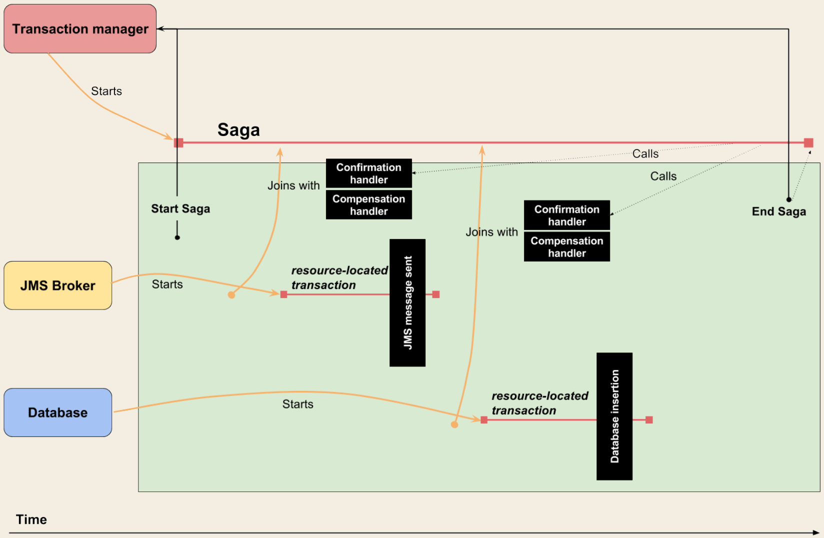
BASE transaction

- Basically Available
- Soft state
- Eventual consistency

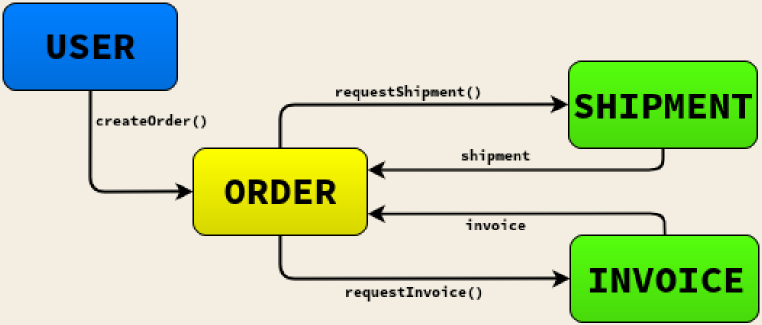
Two phase commit protocol



Saga pattern



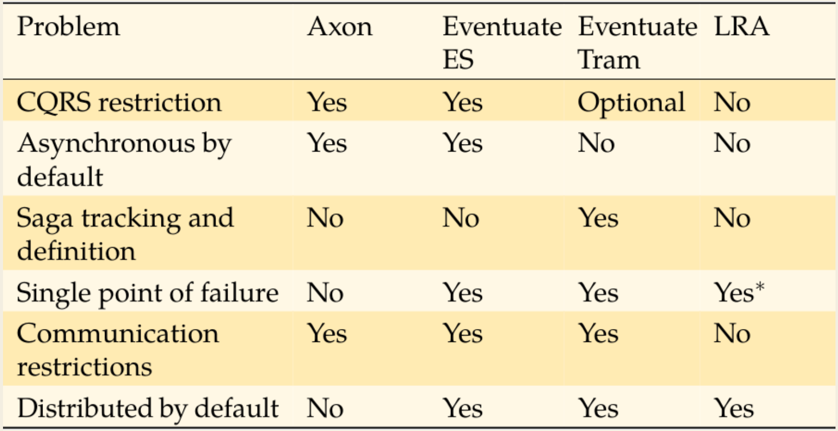
Saga implementations comparison scenario



Saga implementations investigation

- Axon framework
- Eventuate Event Sourcing (ES)
- Eventuate Tram
- Narayana Long Running Actions (LRA)

Saga implementations comparison

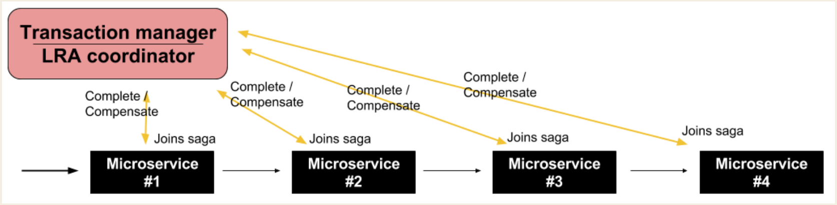


Problem	Axon	Eventuate ES	Eventuate Tram	LRA
CQRS restriction	Yes	Yes	Optional	No
Asynchronous by default	Yes	Yes	No	No
Saga tracking and definition	No	No	Yes	No
Single point of failure	No	Yes	Yes	Yes*
Communication restrictions	Yes	Yes	Yes	No
Distributed by default	No	Yes	Yes	Yes

Saga implementations performance testing

- Axon - 2 reported issues
- Eventuate ES - 1 reported issue
- Eventuate Tram - 1 feature request
- Narayana LRA

LRA executor motivation



LRA executor extension

- proof of concept / prototype
- asynchronous
- extensible and flexible design
- protocol / platform independent
  - further future extensions are expected
- two modules
  - LRA definitions
  - LRA executor

LRA Definitions

- `LRADefinition`
- `Action`
- fluent API

```
RESTLraBuilder.lra()
  .name("testLRA")
  .withAction(RESTAction
    .post(new URL("http://example.com/request"))
    .callbackUrl(new URL("http://example.com/callback"))
    .build())
  .data(42)
  .callback("http://local.org")
  .build();
```

```
{
  "name": "testLRA",
  "actions": [{
    "target": "http://example.com/request",
    "callbackUrl": "http://example.com/callback"
  }],
  "data": 42,
  "parentLRA": null,
  "clientId": "",
  "timelimit": 0,
  "callbackUrl": "http://local.org",
  "nestedLRAs": []
}
```

LRA executor

- `LRAExecutor`
- synchronous and asynchronous executions
- `AbstractLRAExecutor` – default implementation
  - actions are invoked in the declared order
- LRA manipulation methods
  - startLRA, completeLRA, compensateLRA
- integrated and tested (quickstart) with Narayana 5.8.1.Final

Future work

- integration in the Narayana codebase
- communication methods
- definition representations
- processing strategies

Questions

Bibliography

[1] M. Little, J. Maron, and G. Pavlik. *Java transaction processing*. Prentice Hall, 2004.

[2] Leslie Lamport. *LaTeX: A Document Preparation System*. Addison-Wesley, 1986.

[3] M. Goossens, F. Mittelbach, and A. Samarin. *The LaTeX Companion*. Addison-Wesley, 1994.

[4] Till Tantau. *User's Guide to the Beamer Class Version 3.01.* Available at `http://latex-beamer.sourceforge.net`.

[5] https://www.martinfowler.com/articles/microservices.html

[6] http://www.24pressrelease.com/assets/news/Propylene%20Glycol%20Solvent%2017614.jpg.

[7] https://encrypt.co.in/2-phase-commit-protocol/

Opponent’s review

- transaction heuristic outcomes
  - heuristic commit, rollback, mixed
  - non-atomic outcome
  - requires semantic knowledge
- LRA service performance test
  - REST requests queuing
- recovery capabilities of the executor
  - main concern - failure after the marking of the participant invocation
  - idempotent requests (may be too restrictive)
  - timeouts

Supervisor’s review

- performance testing
- LRA specification relations
  - still in the draft form
  - focusing only on the coordination capabilities
  - currently only providing the REST reference implementation