



FACULTY
OF INFORMATICS
Masaryk University

Use of Transactions within a Reactive Microservices Environment

Bc. Martin Štefanko

Microservices

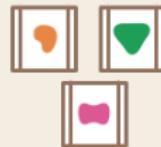
A monolithic application puts all its functionality into a single process...



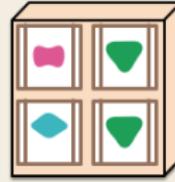
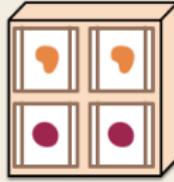
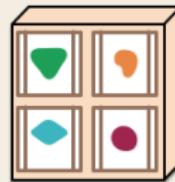
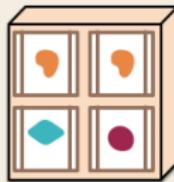
... and scales by replicating the monolith on multiple servers



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



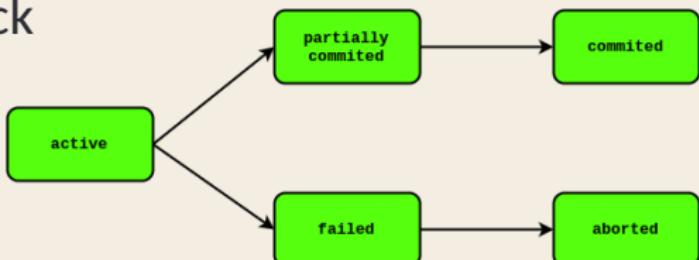
... and scales by distributing these services across servers, replicating as needed.



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 that shared resources are protected from multiple users" [1].

- sequence of operations
- commit or rollback



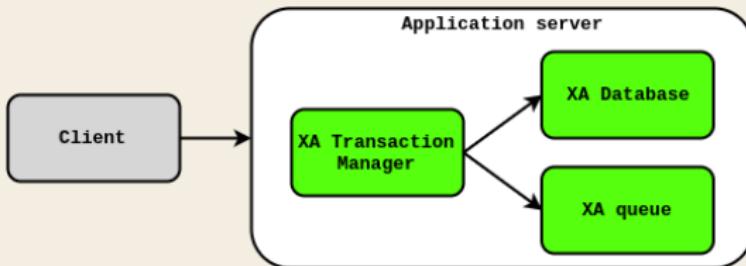
ACID transaction

- Atomicity
- Consistency
- Isolation
- Durability

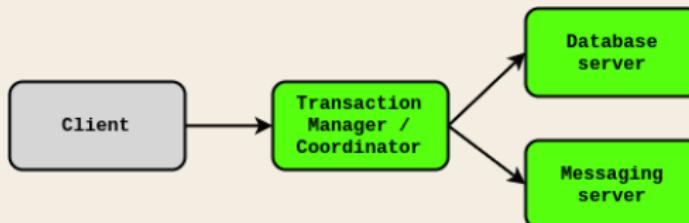


Distributed transactions

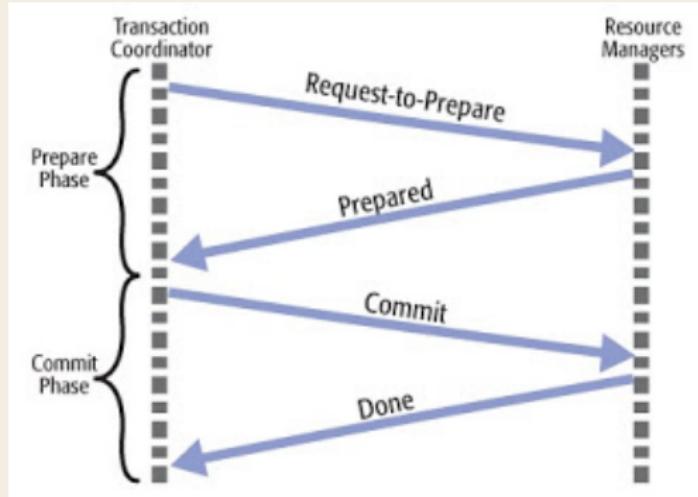
- XA



- Distributed system



Two phase commit protocol



- $O(n^2)$ 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, \dots, T_n (in a single step)
- Saga
 - success - T_1, T_2, \dots, T_n
 - failure - $T_1, T_2, \dots, T_k, C_k, C_{k-1}, \dots, C_1$

Example saga execution

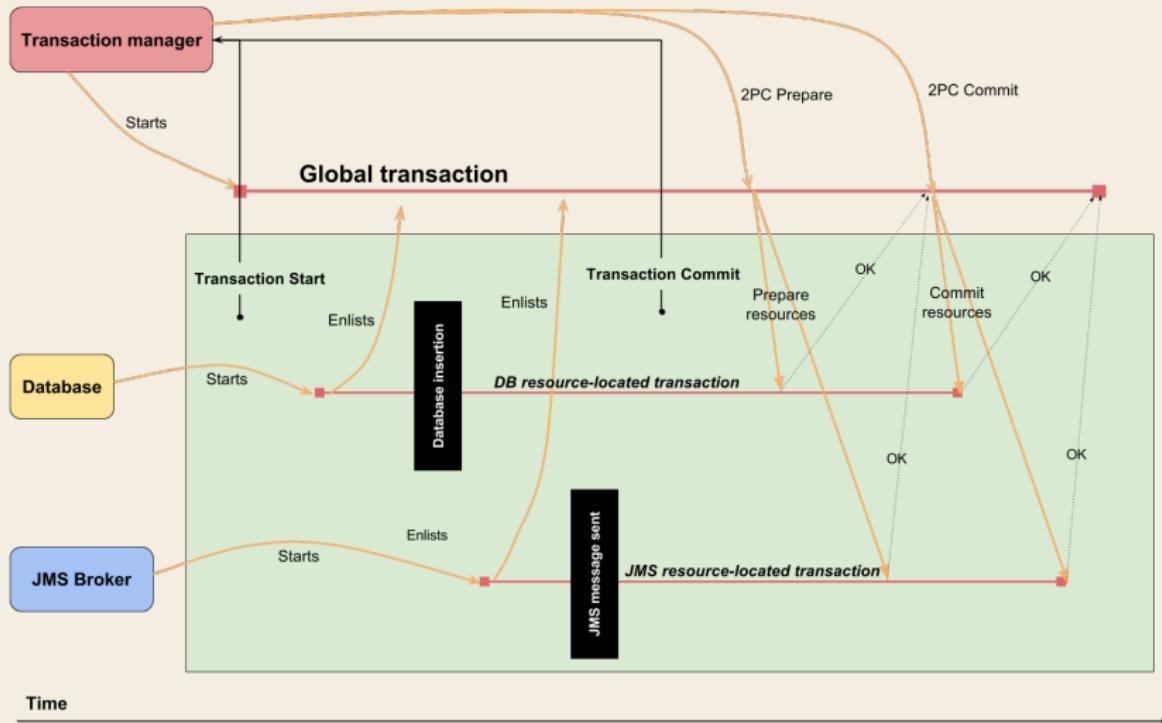
Success



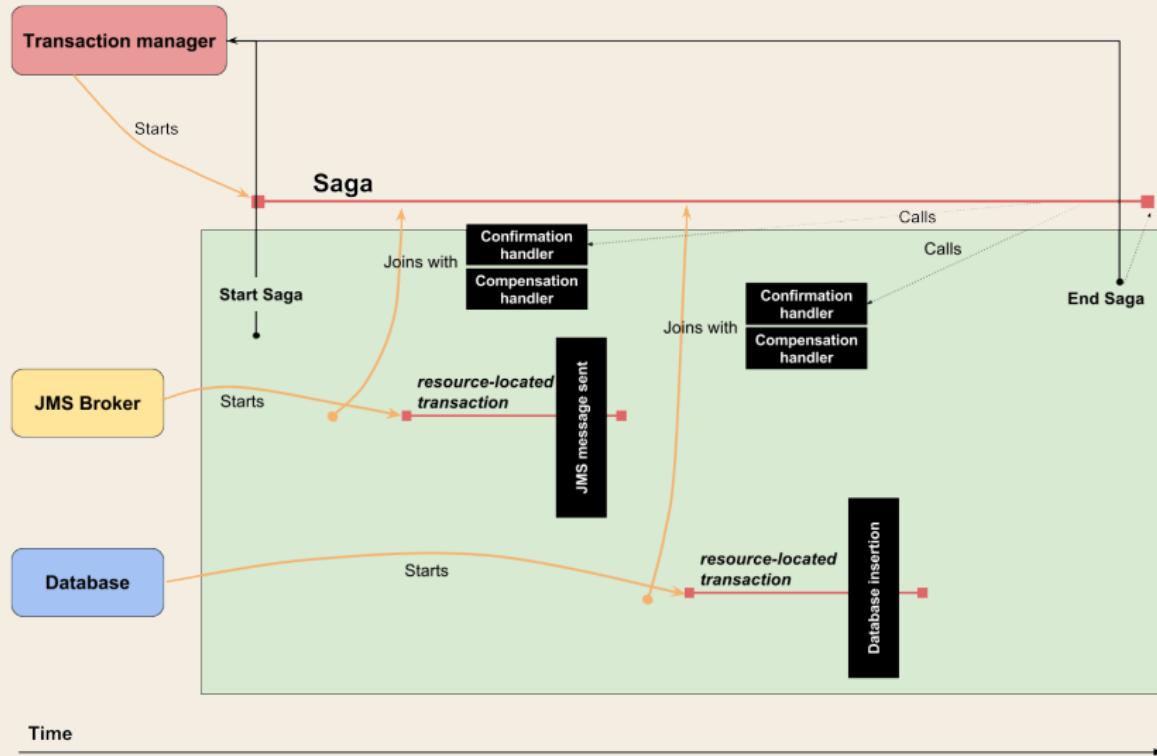
Failure / Compensation



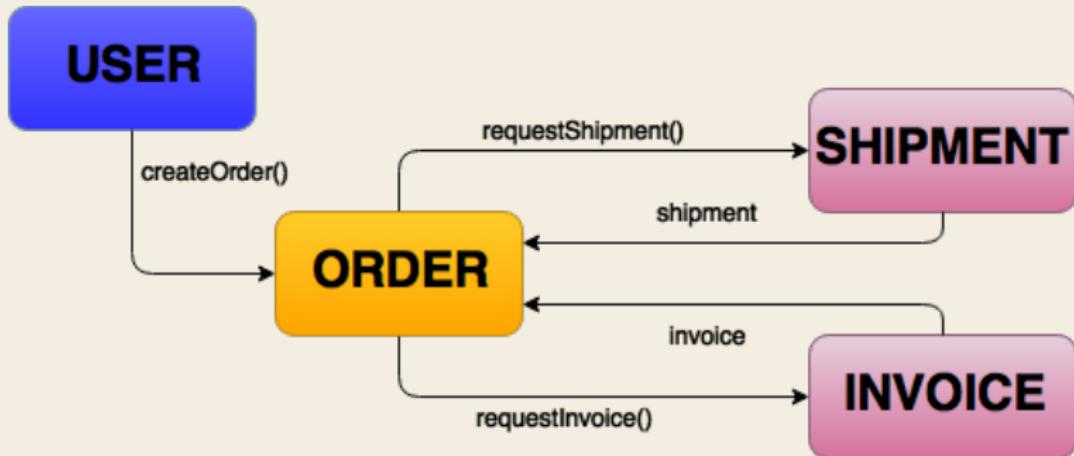
Two phase commit protocol



Saga pattern



Saga implementations comparison scenario



Saga implementations investigation

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

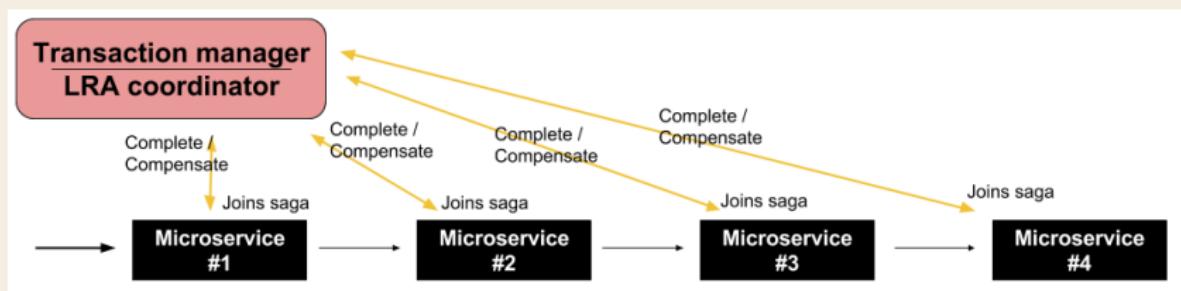
Saga implementations comparison

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



Transaction

Lewis Carroll

'Twas brillig, and the slithy toves
Did gyre and gimble in the wabe;
All mimsy were the borogoves,
And the mome raths outgrabe.

"Beware the Jabberwock, my son!
The jaws that bite, the claws that catch!
Beware the Jubjub bird, and shun
The frumious Bandersnatch!"



Lists and locales

Lorem ipsum dolor sit amet

- Nulla nec lacinia odio.
Curabitur urna tellus.
 - Fusce id sodales dolor. Sed id metus dui.
 - » Cupio virtus licet mi vel feugiat.
- 1. Donec porta, risus porttitor egestas scelerisque video.
 - 1.1 Nunc non ante fringilla, manus potentis cario.
 - 1.1.1 Pellentesque servus morbi tristique.

Nechť již hříšné saxofony d'áblů rozzvučí sín úděsnými tóny waltzu, tanga a quickstepu! Nezvyčajné krdle šťastných figliarskych ďatľov učia pri kótovanom ústí Váhu mlkveho koňa Waldemara obžierať väčšie kusy exkluzívnej kôry. The quick, brown fox jumps over a lazy dog. DJs flock by when MTV ax quiz prog. "Now fax quiz Jack!"

Text blocks

In plain, example, and alert flavour

This text is highlighted.

A plain block

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Definitions, theorems, and proofs

All integers divide zero

Definition

$$\forall a, b \in \mathbb{Z} : a \mid b \iff \exists c \in \mathbb{Z} : a \cdot c = b$$

Theorem

$$\forall a \in \mathbb{Z} : a \mid 0$$

Proof

$$\forall a \in \mathbb{Z} : a \cdot 0 = 0$$

□

Numerals and Mathematics

Formulae, equations, and expressions

$$1234567890 \quad 1234567890 \quad \hat{x}, \check{x}, \tilde{a}, \bar{a}, \dot{y}, \ddot{y} \quad \iint f(x, y, z) dx dy dz$$

$$\frac{1}{1 + \frac{1}{2 + \frac{1}{3+x}}} + \frac{1}{1 + \frac{1}{2 + \frac{1}{3+x}}} \quad F : \begin{vmatrix} F''_{xx} & F''_{xy} & F'_x \\ F''_{yx} & F''_{yy} & F'_y \\ F'_x & F'_y & 0 \end{vmatrix} = 0$$

$$\iint_{x \in \mathbb{R}^2} \langle x, y \rangle dx \quad \overline{a\alpha^2 + b\beta + d\delta} \quad]0, 1[+ \lceil x \rceil - \langle x, y \rangle$$

$$e^x \approx 1 + x + x^2/2! + \dots + x^3/3! + x^4/4!$$
$$\binom{n+1}{k} = \binom{n}{k} + \binom{n}{k-1}$$

Figures

Tables, graphs, and images

Faculty	With \TeX	Total	%
Faculty of Informatics	1 716	2 904	59.09
Faculty of Science	786	5 275	14.90
Faculty of Economics and Administration	64	4 591	1.39
Faculty of Arts	69	10 000	0.69
Faculty of Medicine	8	2 014	0.40
Faculty of Law	15	4 824	0.31
Faculty of Education	19	8 219	0.23
Faculty of Social Studies	12	5 599	0.21
Faculty of Sports Studies	3	2 062	0.15

Table: The distribution of theses written using \TeX during 2010–15 at MU

Figures

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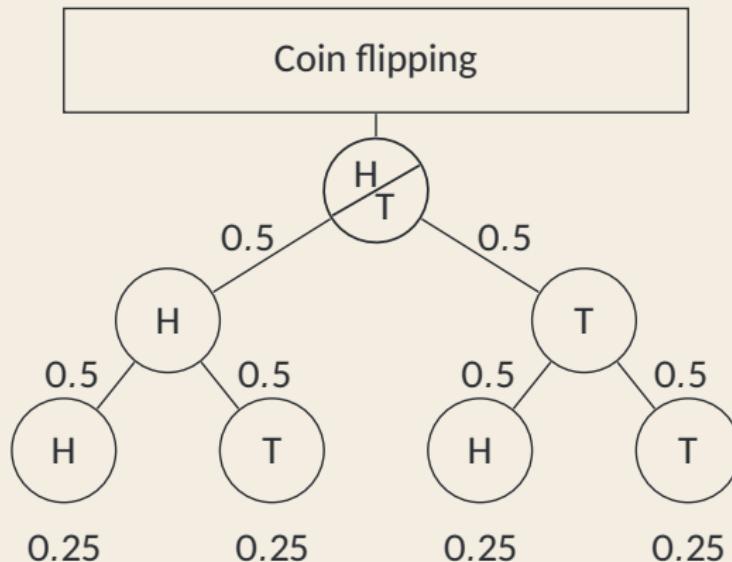


Figure: Tree of probabilities – Flipping a coin¹

¹A derivative of a diagram from texexample.net by cis, CC BY 2.5 licensed

Code listings

An example source code in C

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#include <stdio.h>
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#include <sys/wait.h>

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int main(int argc, char **argv)
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Citations

\TeX , \LaTeX , and Beamer

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Bibliography

- [1] M. Little, J. Maron, and G. Pavlik. *Java transaction processing*. Prentice Hall, 2004.
- [2] Leslie Lamport. *L^AT_EX: A Document Preparation System*. Addison-Wesley, 1986.
- [3] M. Goossens, F. Mittelbach, and A. Samarin. *The L^AT_EX Companion*. Addison-Wesley, 1994.
- [4] Till Tantau. *User's Guide to the Beamer Class Version 3.01*. Available at <http://latex-beamer.sourceforge.net>.

Images

- [1] <https://www.martinfowler.com/articles/microservices.html>
- [2] <http://www.24pressrelease.com/assets/news/Propylene%20Glycol%20Solvent%2017614.jpg>.

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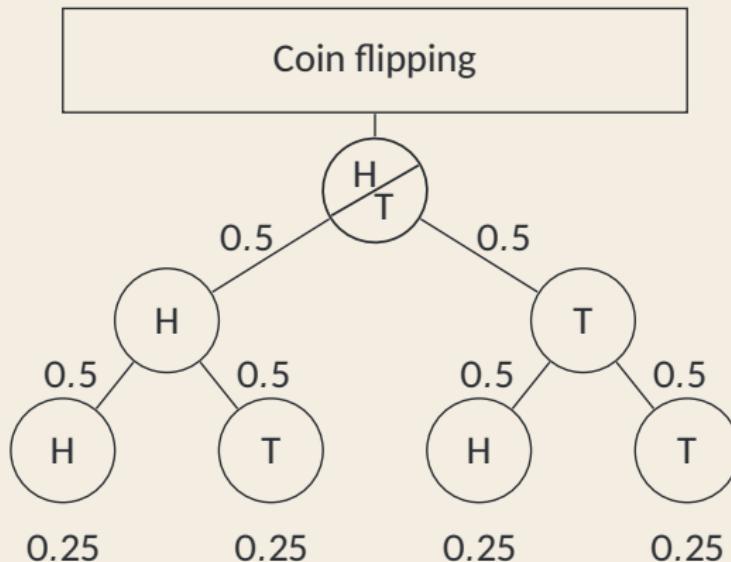


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