# Safe Sessions for Erlang

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## Introduction

**Breaking News!**

**Erlang** systems are fault-tolerant!

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"Do not handle errors in your programs.
If a process is about to crash, let it crash and restart it immediately"

Made possible by a process supervision tree where:

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## Supervision tree

- **Workers**: Do all the hard work
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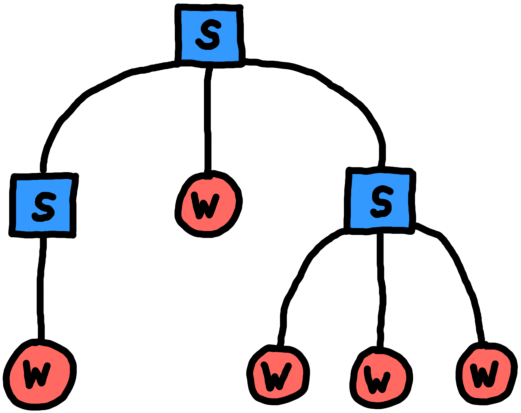

## Our proposal

Supervisors do not make any verification when restarting workers
$\rightarrow$ **inconsistent system state**

**Safe Sessions**

We propose **safe sessions**, an automatic recovery strategy for Erlang, as a complement to the *Let It Crash* philosophy

In safe sessions, concurrent actions are registered, so that the system can return to a safe state in case of error.

Based on the reversible semantics for **Erlang** from [LOPSTR'16].

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## The **Erlang** language

## Erlang's features

The **Erlang** language has:

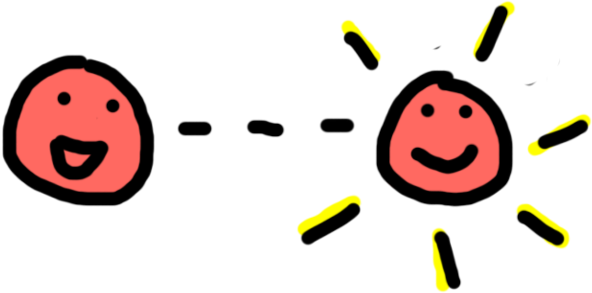
- functional and concurrent features
- concurrency based on the actor model

These features make it appropiate for distributed applications

Ericsson WhatsApp Messenger (Facebook chat) Ejabberd

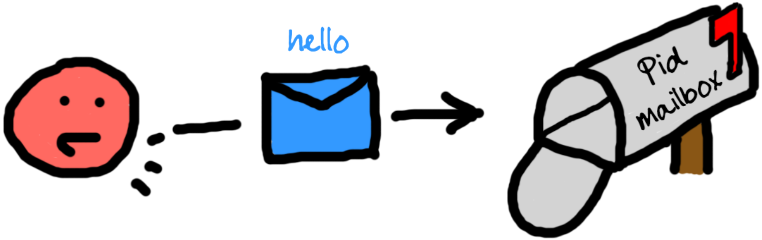
## Concurrent actions: Spawn

**Spawn:** Create a new process



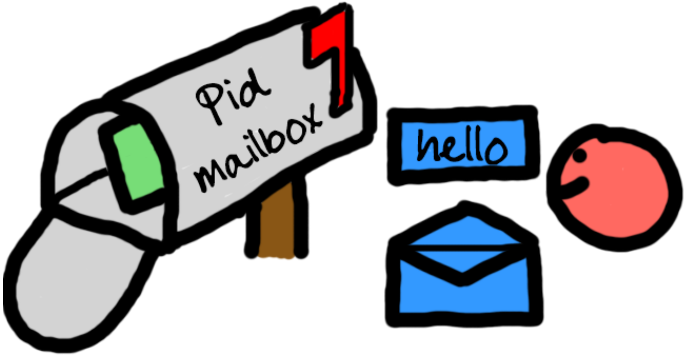
## Concurrent actions: Send

**Send:** Send a message to another process

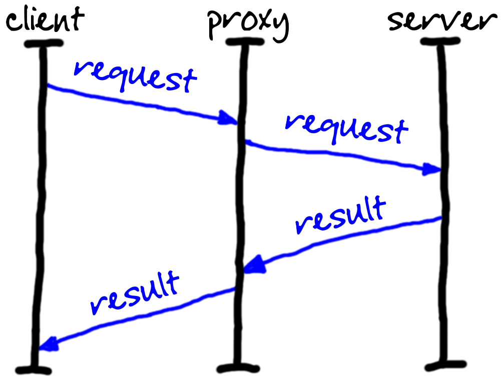


## Concurrent actions: Receive

**Receive:** Suspend execution until a message from the mailbox matches any of the receive clauses



## Example



Many things can **go wrong** !

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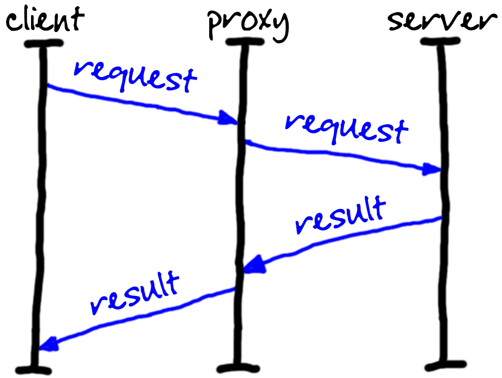

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## Safe Sessions

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We add a new construct to **Erlang**

$\boxed{\text{safetry} \quad \textit{expr} \quad \text{end}}$

If *expr* goes wrong, we **restore** the process

## Safe Sessions

safetry *expr* end

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**Causal Consistency**

An action may be undone only if every action caused by that action has not been executed yet or has been undone

**Restoring** the state is not enough to ensure causal consistency, we must also undo the effects of its

- spawn actions
- send actions

We solve this by "propagating the safety" to dependent processes.

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## Safe session (algorithm)

safetry *expr* end

When *p* enters the safetry block...

### Safe session

1. we take a snapshot of *p* before the evaluation of *expr*
2. if another process *q* is sent a message from *p*, or is spawned by *p*, we take a snapshot of *q* (safety propagation)
3. if the evaluation of *expr* fails
   - we restore the state from *p*
   - we restore the state of processes sent a message or spawned by *p* (safety propagation)
   - go to step 3
4. we discards all the snapshots

## Implementation

Safe sessions can be implemented using:

- Monitors:
  - Intercept incoming and outgoing messages
  - Send signals between themselves to propagate the safety
- Instrumentation:
  - Enable interaction of processes with their monitors

## Program Instrumentation

$$
\begin{array}{lcl}
[\![\text{safetry } \mathit{expr} \text{ end}]\!]_M & \to & M \;!\; \langle \text{start\_session} \rangle, \\
& & [\![\mathit{expr}]\!]_M, \\
& & M \;!\; \langle \text{end\_session} \rangle \\
[\![\text{spawn}(\ldots)]\!]_M & \to & M \;!\; \langle \text{spawn}(\ldots) \rangle, \\
& & \text{receive } \langle \text{spawn\_with}, P \rangle \to P \text{ end} \\
[\![\text{self}()]\!]_M & \to & M \\
[\![\mathit{Pid} \;!\; \mathit{expr}]\!]_M & \to & M \;!\; \langle \text{send}(\mathit{Pid}), [\![\mathit{expr}]\!]_M \rangle, \\
& & \text{receive } \langle \text{sent\_as}, E \rangle \to E \text{ end} \\
[\![\text{receive } \mathit{clauses} \text{ end}]\!]_M & \to & M \;!\; \langle \text{receive}, \mathit{clauses} \rangle, \\
& & \mathit{Arg} = \text{receive} \\
& & \quad \langle \text{rec\_msg}, \mathit{Msg} \rangle \to \mathit{Msg} \text{ end}, \\
& & \text{case } \mathit{Arg} \text{ of } [\![\mathit{clauses}]\!]_M \text{ end}
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$$

Concurrent actions are replaced by queries to the monitor.

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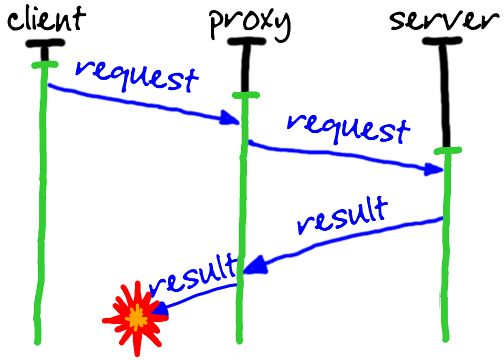
## Example with safe sessions



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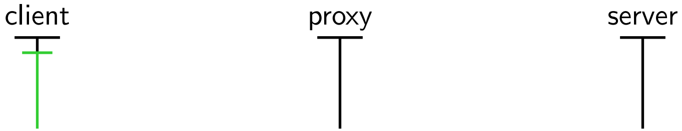
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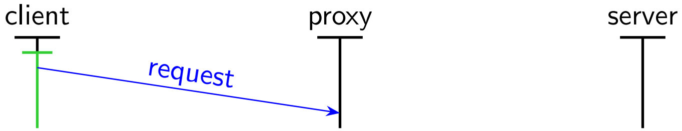
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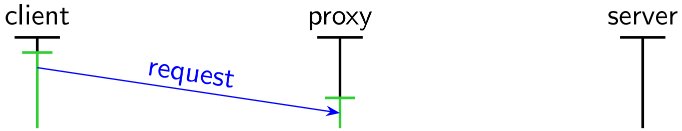
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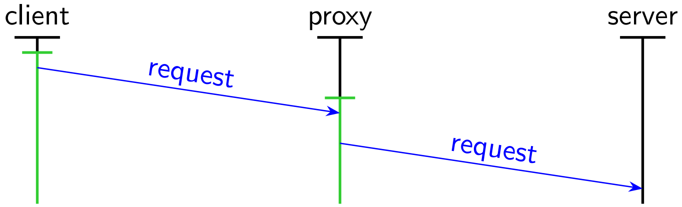
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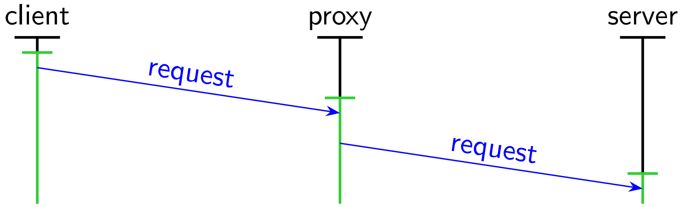
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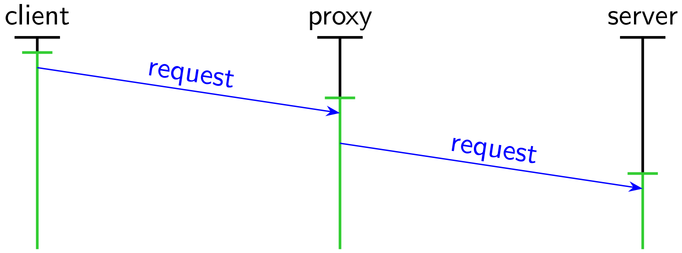
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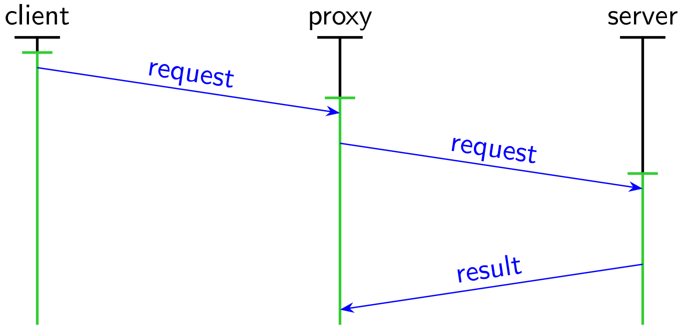
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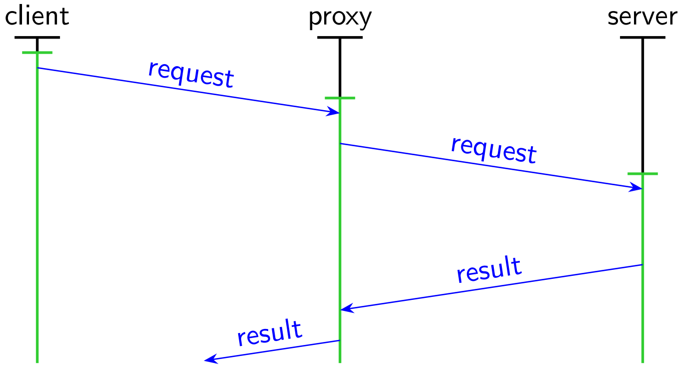
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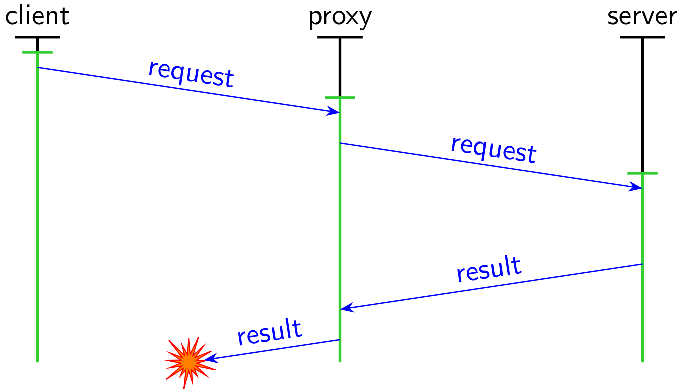
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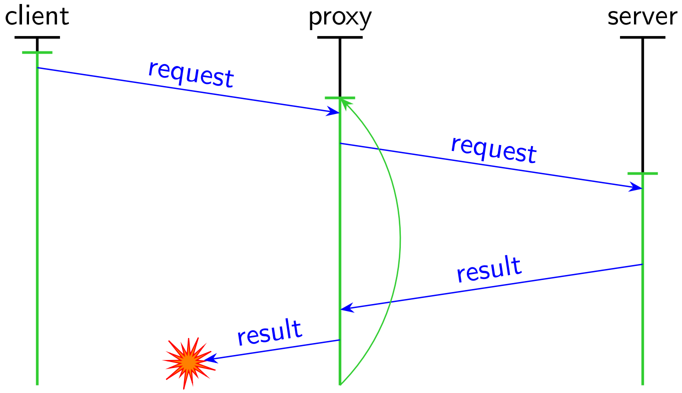
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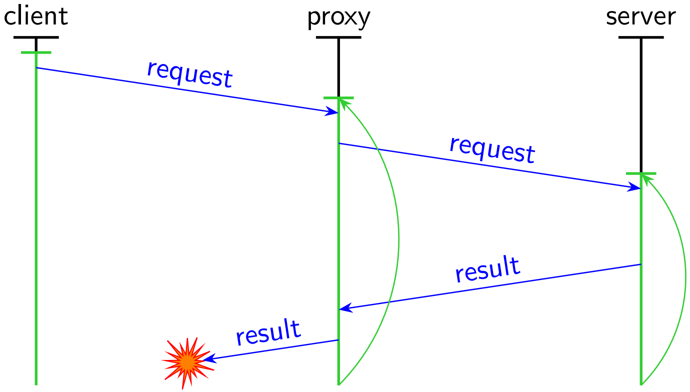
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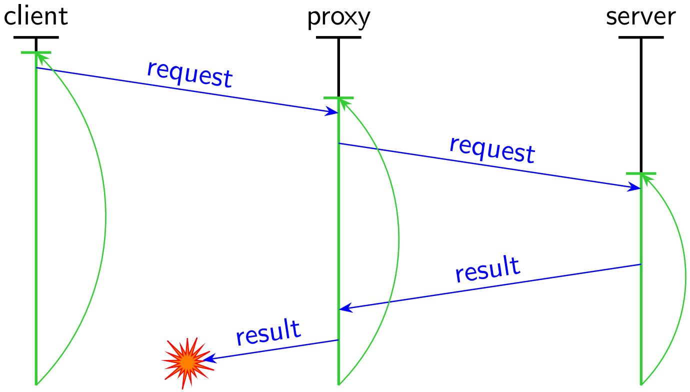
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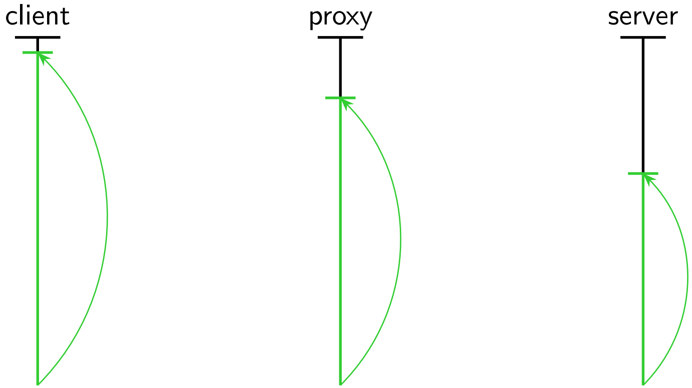
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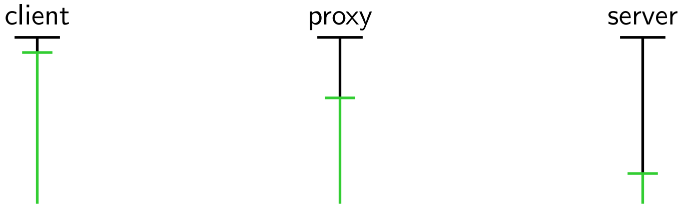
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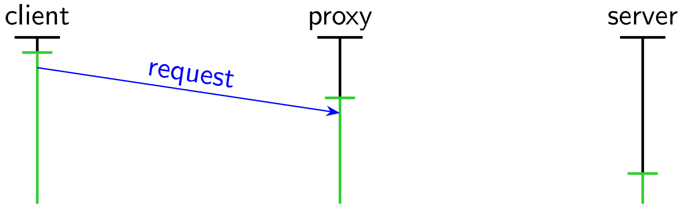
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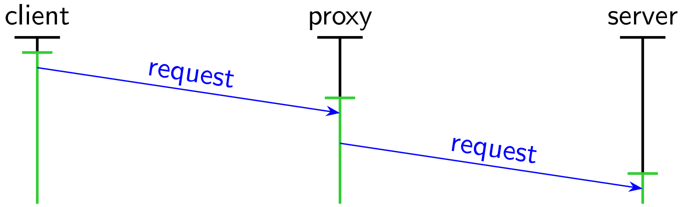
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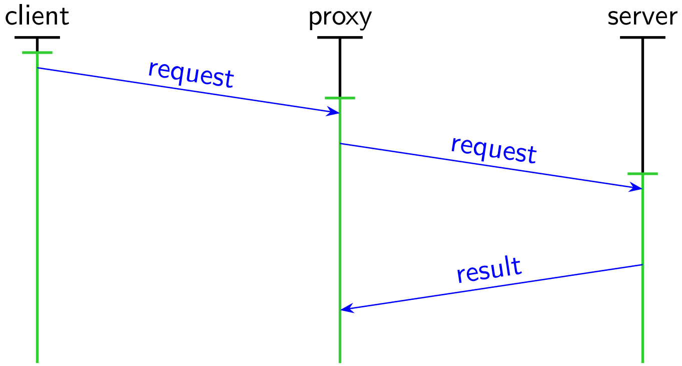
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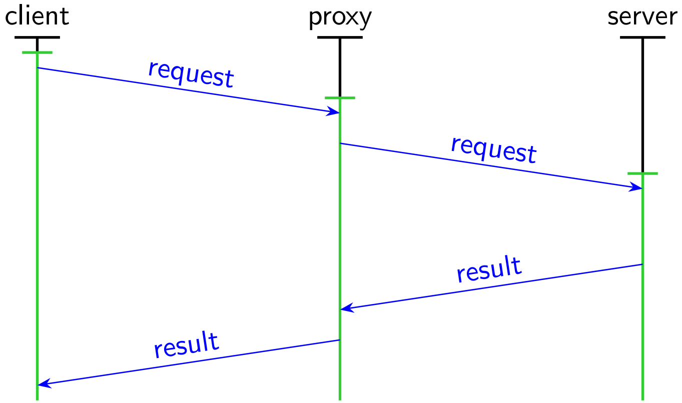
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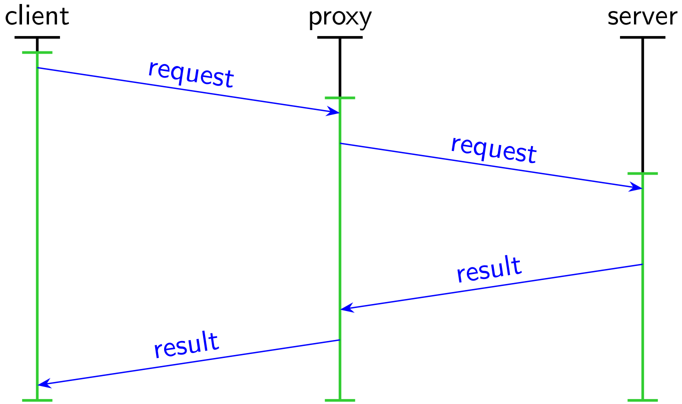
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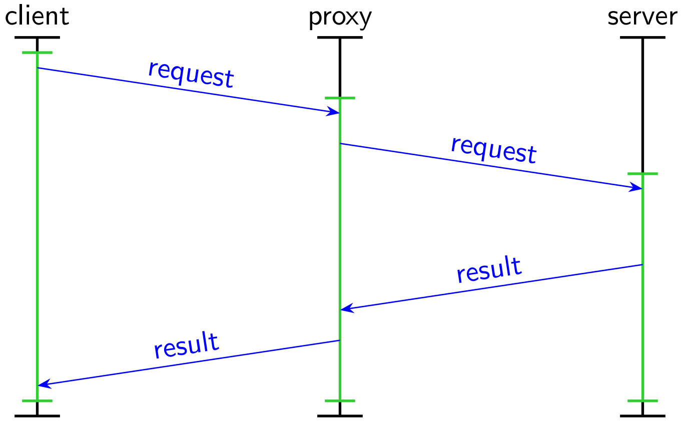
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## Conclusions

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Some related work:

- **Field and Varela [POPL'05]:**
  - checkpoint-based approach with some similarities
  - they aim at defining a new language, rather than extending one
- **Neykova and Yoshida [CC'17]**
  - interprocedural recovery strategy based on session types
  - not so fine-grained, we could define an intraprocedural strategy

In the future, we will:

- refine our design of safe sessions
- develop an implementation
- compare our implementation against other approaches

Thanks for your attention!