



ÉCOLE POLYTECHNIQUE  
FÉDÉRALE DE LAUSANNE

# Failure Handling with Actors

Principles of Reactive Programming

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# Failure Handling in Asynchronous Systems

Where shall failures go?

- ▶ reify as messages
- ▶ send to a known address

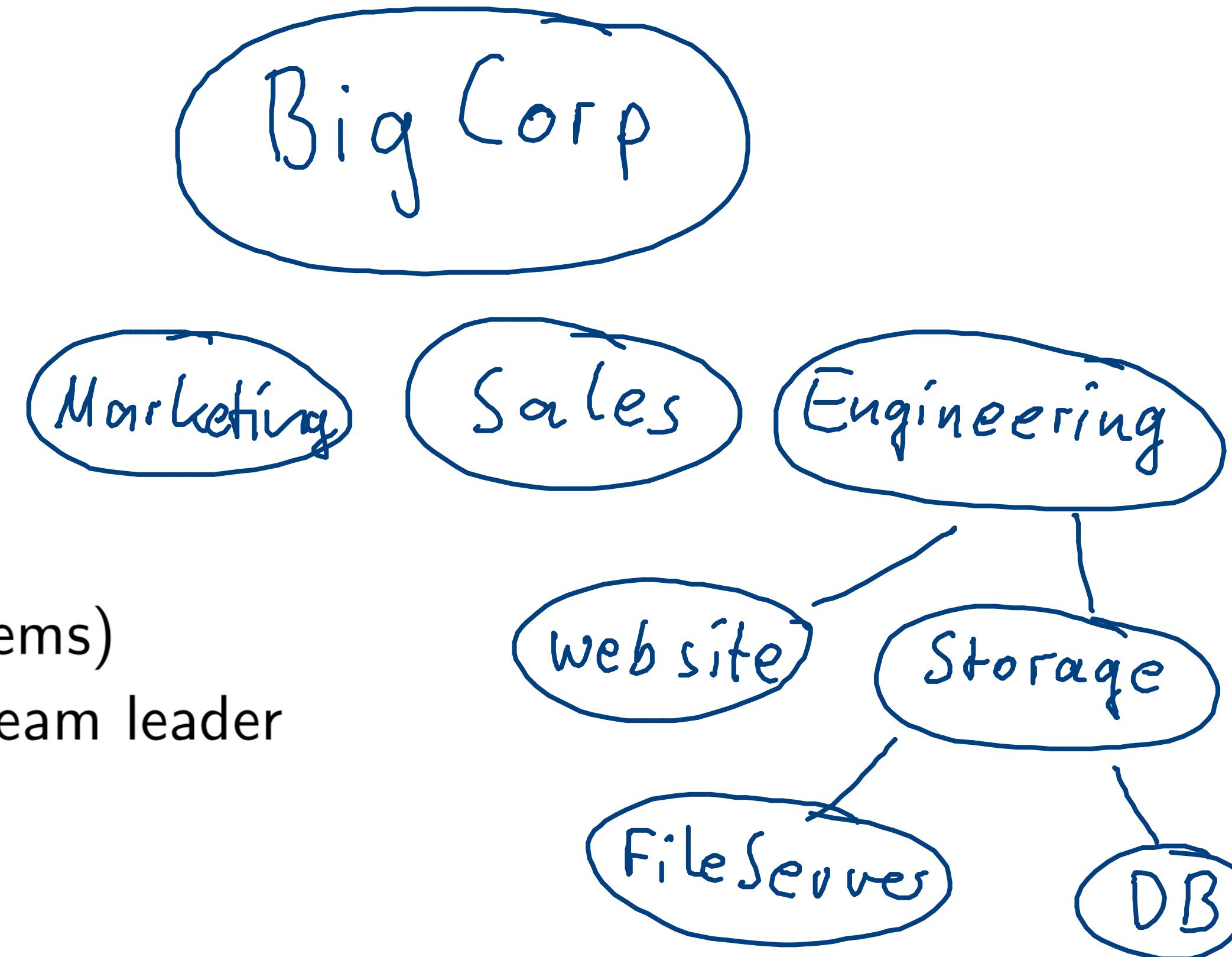
# Failure Handling in Asynchronous Systems

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The Actor Model is anthropomorphic:

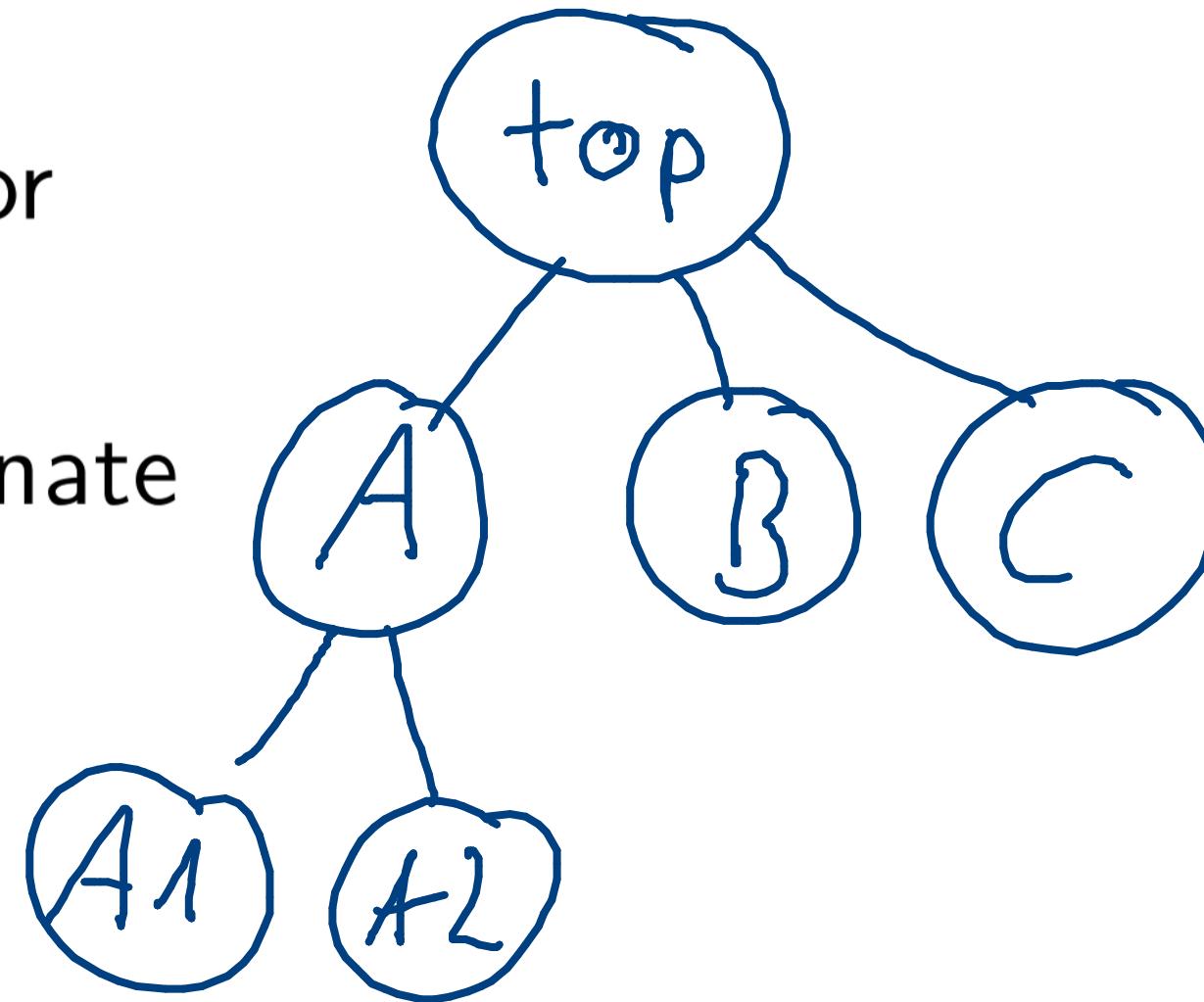
- ▶ Actors work together in teams (systems)
- ▶ individual failure is handled by the team leader



# Supervision

Resilience demands *containment* of and *automatic response* to failure.

- ▶ failed Actor is terminated or restarted
- ▶ decision must be taken by one other Actor
- ▶ supervised Actors form a tree structure
- ▶ the supervisor needs to create its subordinate



# Supervisor Strategy

In Akka the parent declares how its child Actors are supervised:

```
class Manager extends Actor {  
    override val supervisorStrategy = OneForOneStrategy() {  
        case _: DBException          => Restart // reconnect to DB  
        case _: ActorKilledException => Stop  
        case _: ServiceDownException => Escalate  
    }  
    ...  
    context.actorOf(Props[DBActor], "db")  
    context.actorOf(Props[ImportantServiceActor], "service")  
    ...  
}
```

## Supervisor Strategy (cont'd)

Failure is sent and processed like a message:

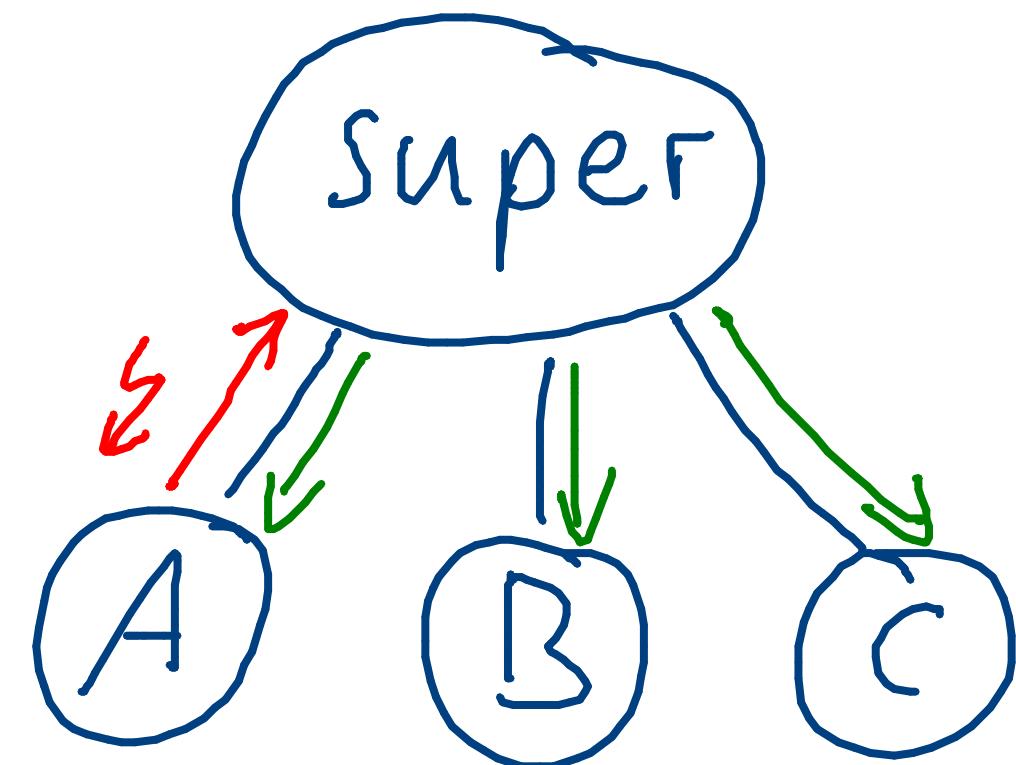
```
class Manager extends Actor {  
    var restarts = Map.empty[ActorRef, Int].withDefaultValue(0)  
    override val supervisorStrategy = OneForOneStrategy() {  
        case _: DBException =>  
            restarts(sender) match {  
                case toomany if toomany > 10 =>  
                    restarts -= sender; Stop  
                case n =>  
                    restarts = restarts.updated(sender, n + 1); Restart  
            }  
    }  
}
```

## Supervisor Strategy (cont'd)

If decision applies to all children: AllForOneStrategy

Simple rate trigger included:

- ▶ allow a finite number of restarts
- ▶ allow a finite number of restarts in a time window
- ▶ if restriction violated then Stop instead of Restart



# Actor Identity

Recovery by restart requires stable identifier to refer to the service:

- ▶ in Akka the ActorRef stays valid after a restart
- ▶ in Erlang a name is registered for the current PID

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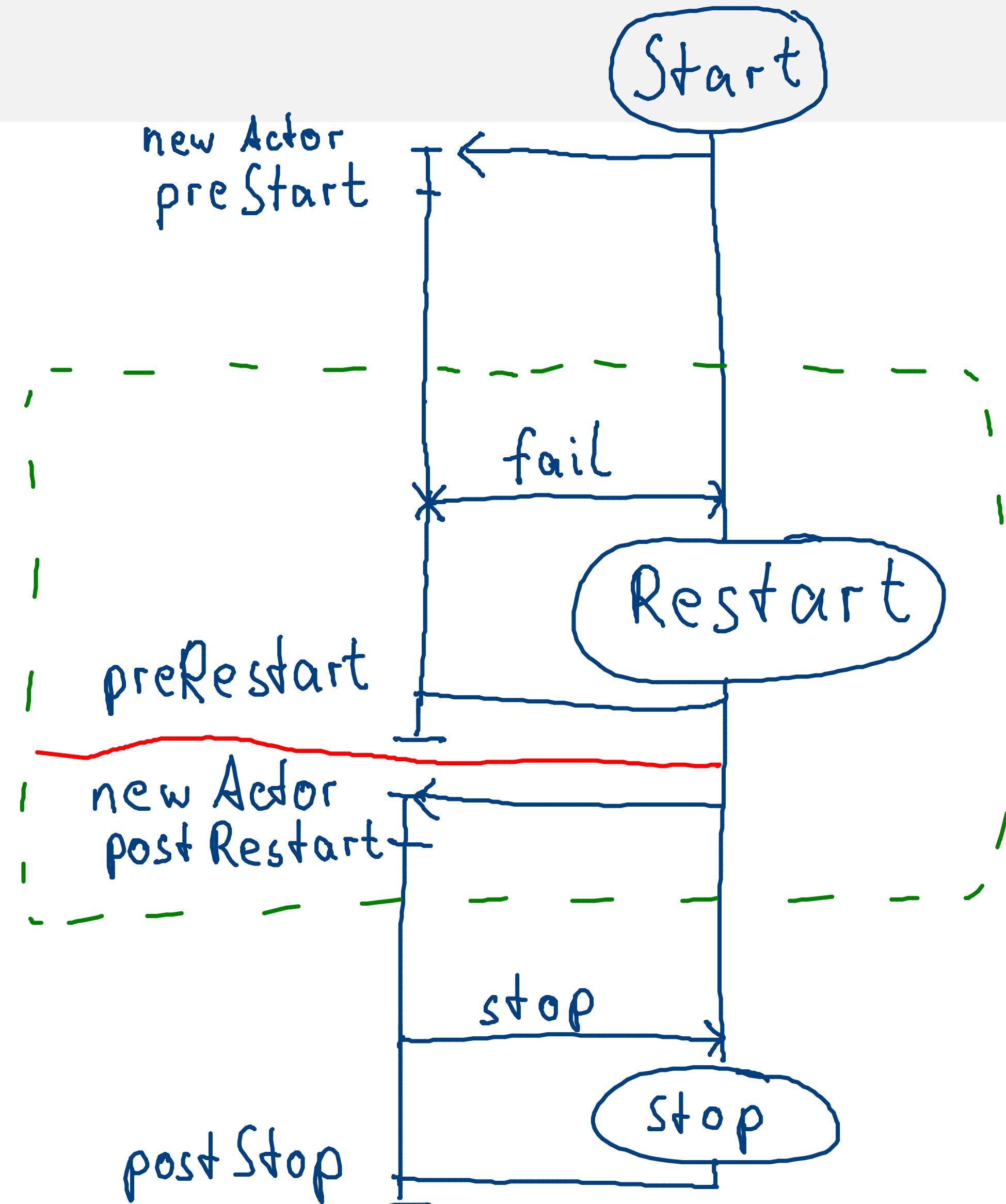
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What does restart mean?

- ▶ expected error conditions are handled explicitly
- ▶ unexpected error indicate invalidated actor state
- ▶ restart will install initial behavior / state

# Actor Lifecycle

- ▶ start
- ▶ (restart)\*
- ▶ stop



# Actor Lifecycle Hooks

```
trait Actor {  
    def preStart(): Unit = {}  
    def preRestart(reason: Throwable, message: Option[Any]): Unit = {  
        context.children foreach (context.stop(_))  
        postStop()  
    }  
    def postRestart(reason: Throwable): Unit = {  
        preStart()  
    }  
    def postStop(): Unit = {}  
    ...  
}
```

# The Default Lifecycle

```
class DBActor extends Actor {  
    val db = DB.openConnection(...)  
    ...  
    override def postStop(): Unit = {  
        db.close()  
    }  
}
```

In this model the actor is fully reinitialized during restart.

# Lifecycle Spanning Restarts

```
class Listener(source: ActorRef) extends Actor {  
    override def preStart() { source ! RegisterListener(self) }  
    override def preRestart(reason: Throwable, message: Option[Any]) {}  
    override def postRestart(reason: Throwable) {}  
    override def postStop() { source ! UnregisterListener(self) }  
}
```

Actor-local state cannot be kept across restarts, only external state can be managed like this.

Child actors not stopped during restart will be restarted recursively.

# Summary

Actors work together in hierarchical systems.

Failures are handled by sending them upwards to the supervisor.

Actors are started, possibly restarted and finally stopped.