Scaling software with

Jonas Bonér

CTO

@jboner

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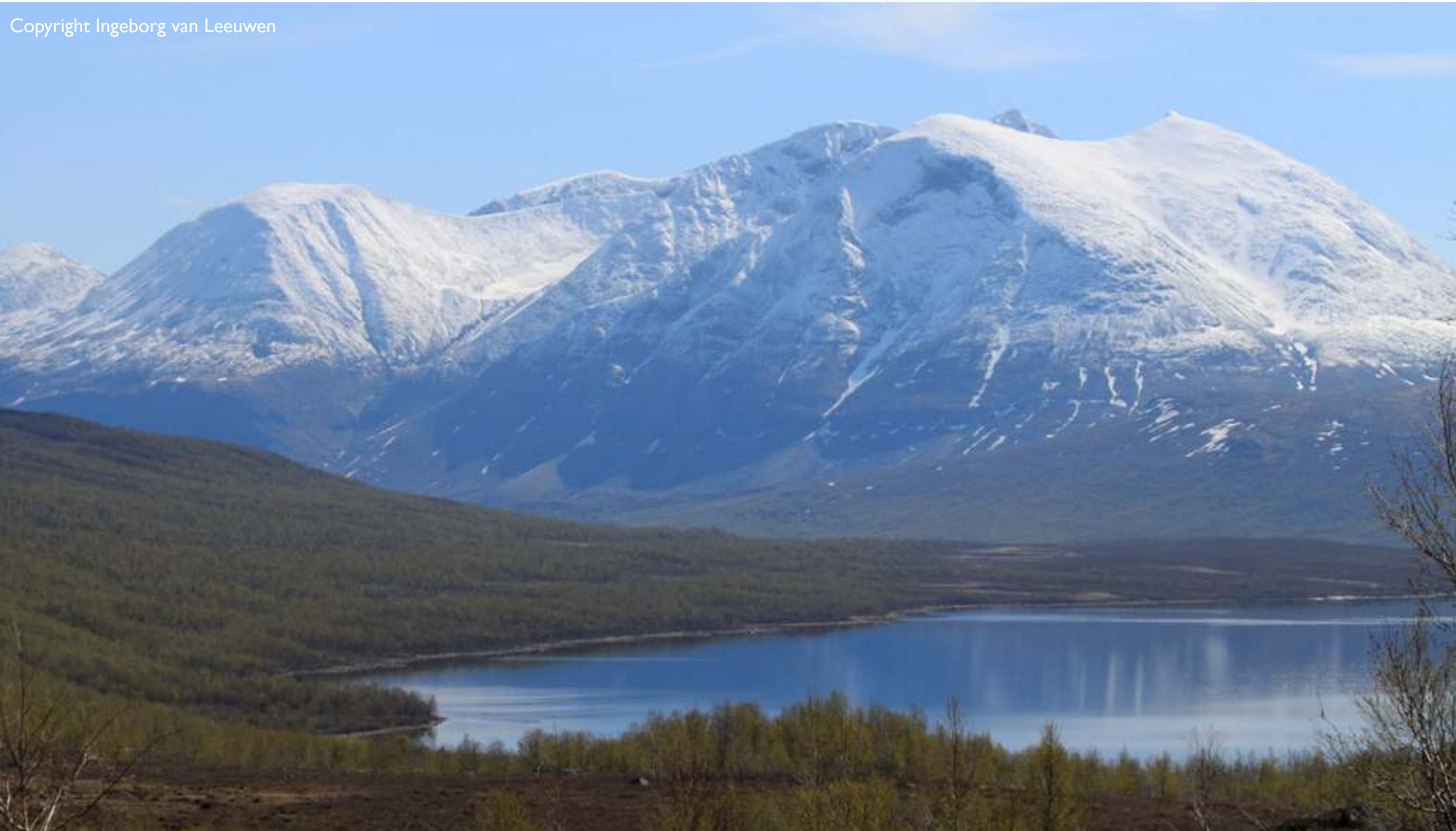
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banksimple
zeebox The best thing to happen to TV since TV

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Manage System Overload

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Automatic Replication & Distribution

for Fault-tolerance & Scalability

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Program at a Higher Level

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- Never think in terms of shared state, state visibility, threads, locks, concurrent collections, thread notifications etc.

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- Low level concurrency plumbing BECOMES SIMPLE WORKFLOW - you only think about how messages flow in the system
- You get high CPU utilization, low latency, high throughput and scalability - FOR FREE as part of the model
- Proven and superior model for detecting and recovering from errors

Distributable by Design

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- Actors are location transparent & distributable by design

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  - elastic & dynamic
  - fault-tolerant & self-healing
  - adaptive load-balancing, cluster rebalancing & actor migration
  - build extremely loosely coupled and dynamic systems that can change and adapt at runtime

How

can we achieve this?

Let's use Actors

What is an Actor?

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- Actors helps you create concurrent, scalable and fault-tolerant applications
- Like Java EE servlets and session beans, Actors is a model for organizing your code that keeps many "policy decisions" separate from the business logic
- Actors may be new to many in the Java community, but they are a tried-and-true concept (Hewitt 1973) used for many years in telecom systems with 9 nines uptime

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- an out-of-process service
- a Finite State Machine (FSM)

So, what is the

Actor Model?

Carl Hewitt's definition

http://bit.ly/hewitt-on-actors

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- The fundamental unit of computation that embodies:

http://bit.ly/hewitt-on-actors

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- 3 axioms - When an Actor receives a message it can:
  - Create new Actors
  - Send messages to Actors it knows
  - Designate how it should handle the next message it receives

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4 core Actor operations

0. DEFINE
1. CREATE
2. SEND
3. BECOME
4. SUPERVISE

0. DEFINE

```
case class Greeting(who: String)

class GreetingActor extends Actor with ActorLogging {
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Define the message(s) the Actor should be able to respond to

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Define the Actor's behavior

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1. CREATE

- CREATE - creates a new instance of an Actor
- Extremely lightweight (2.7 Million per Gb RAM)
- Very strong encapsulation - encapsulates:
  - state
  - behavior
  - message queue
- State & behavior is indistinguishable from each other
- Only way to observe state is by sending an actor a message and see how it reacts

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Create an Actor system

Actor configuration

You get an ActorRef back

ate the Actor

Give it a name

Actors can form hierarchies

Guardian System Actor

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system.actorOf(Props[Foo], “Foo”)

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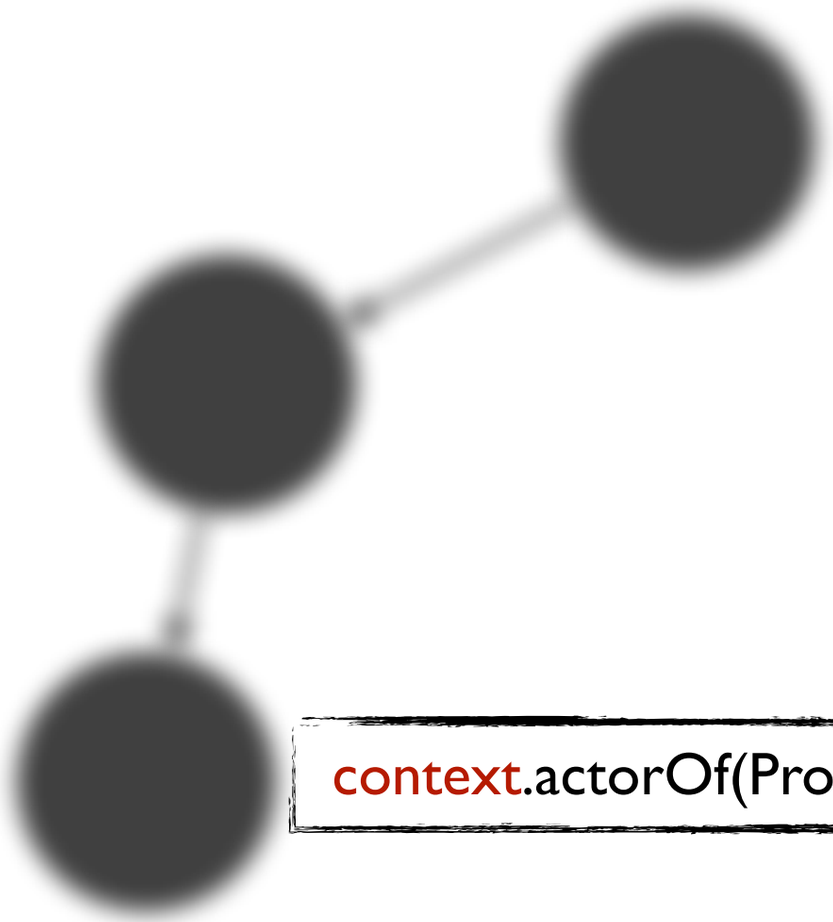
```
context.actorOf(Props[A], "A")
```

Actors can form hierarchies

Guardian System Actor



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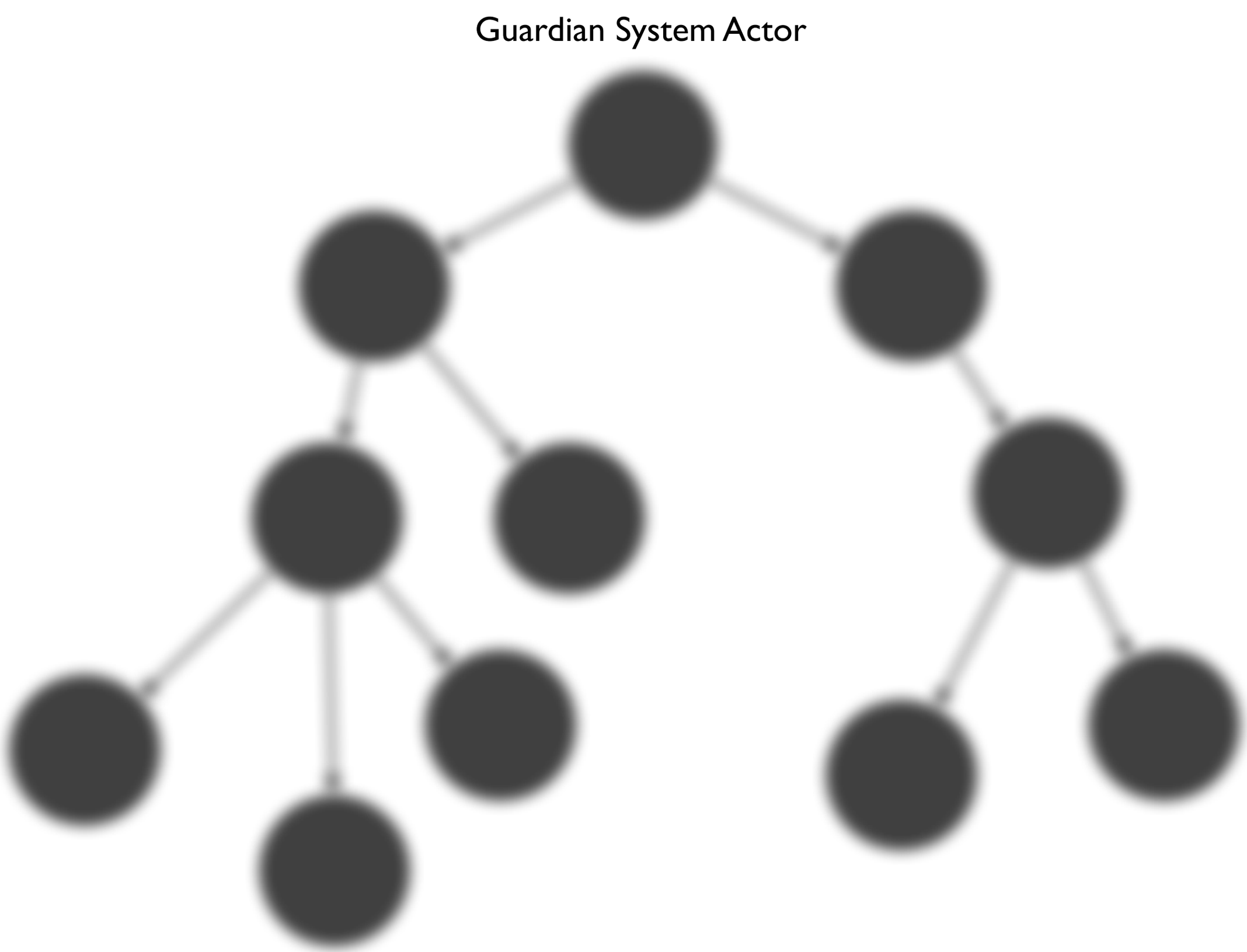

Name resolution - like a file-system

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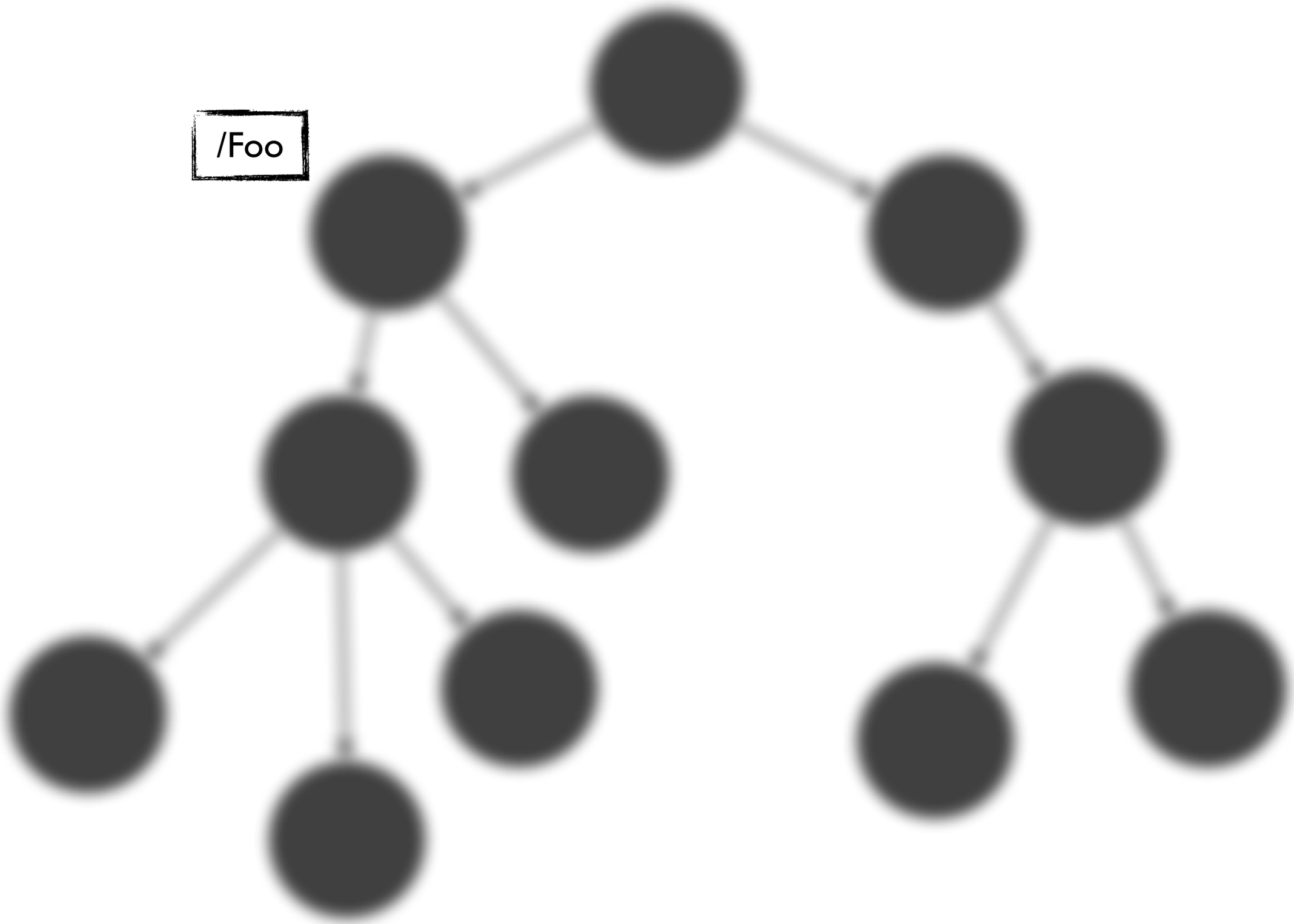

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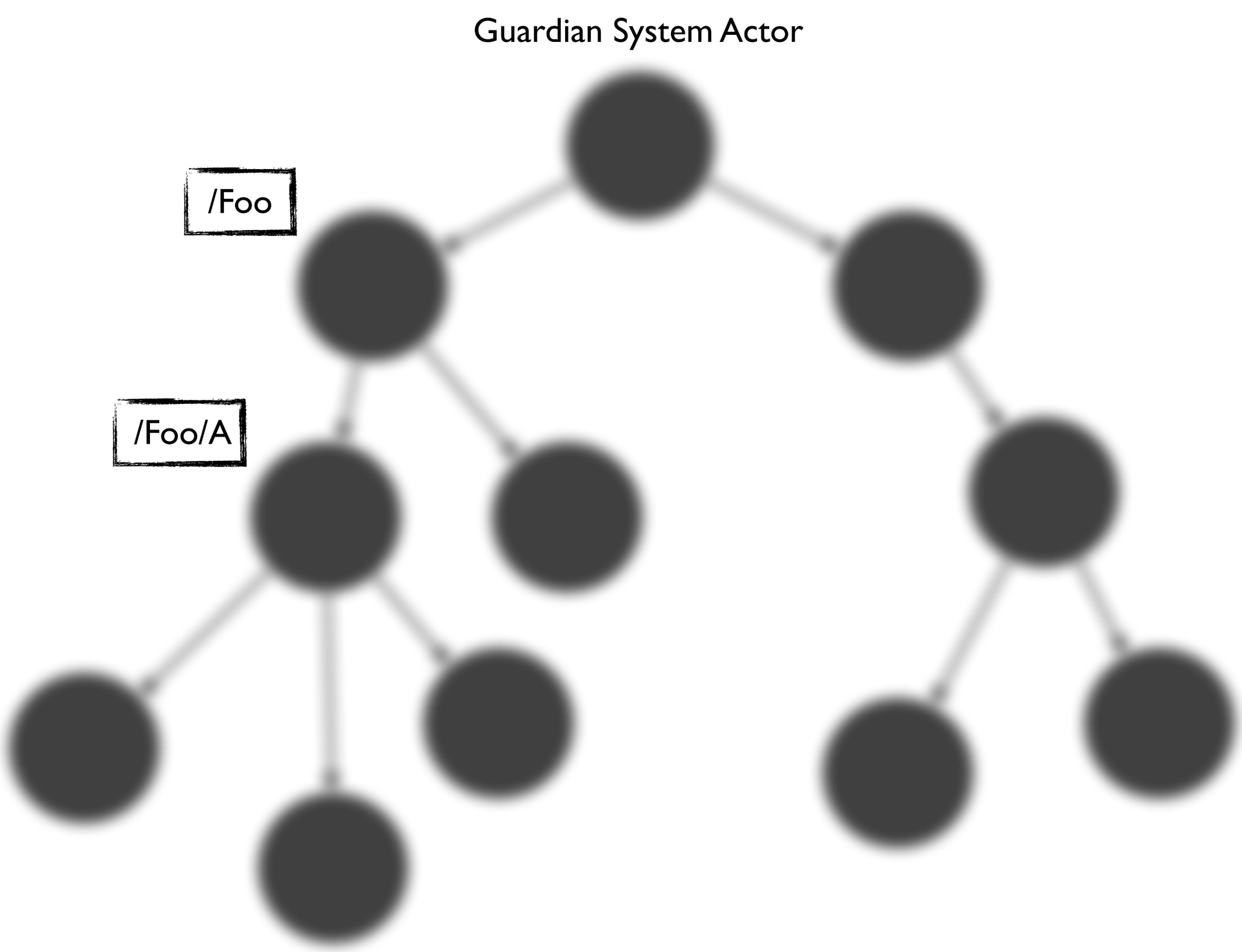

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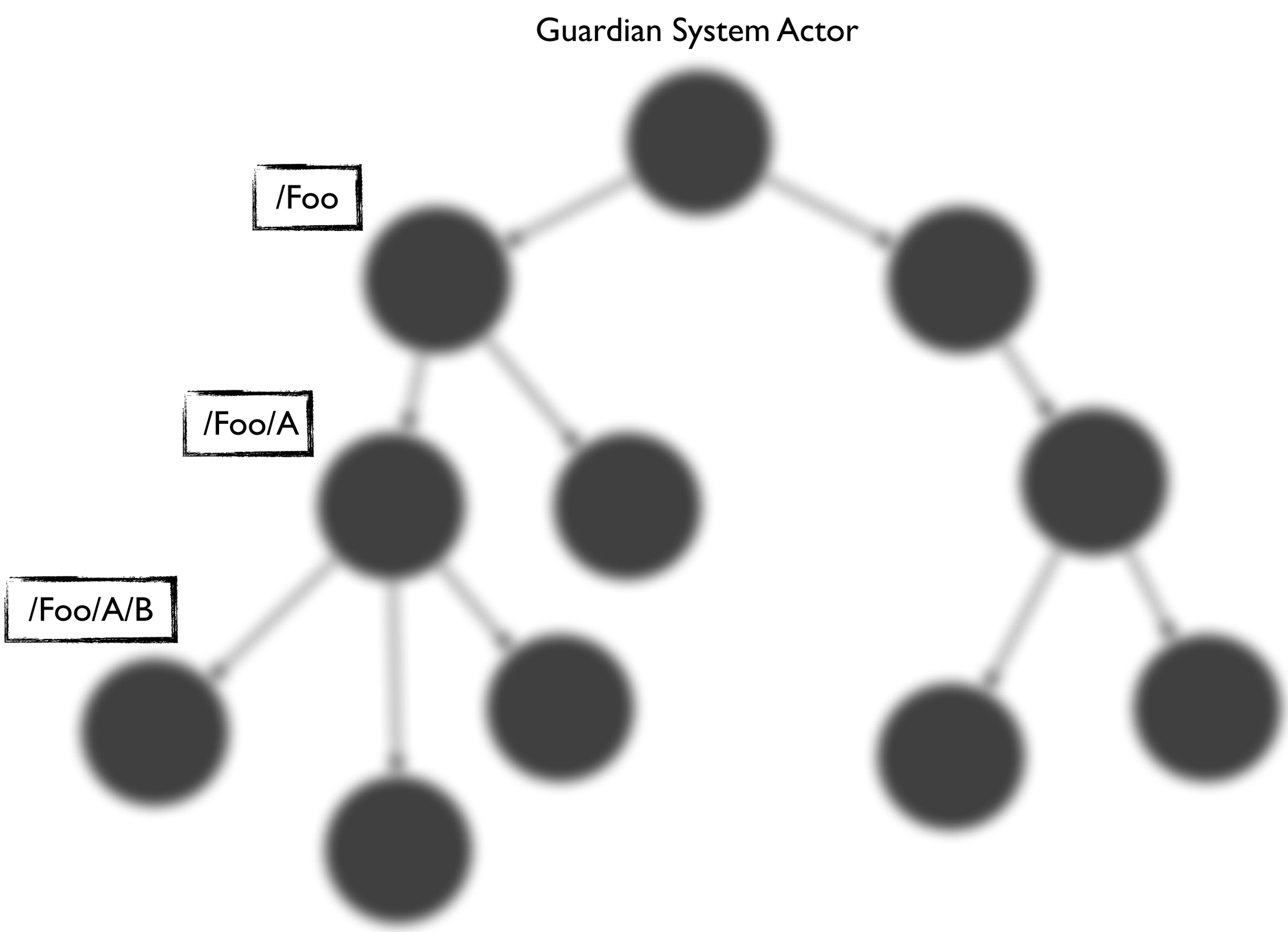

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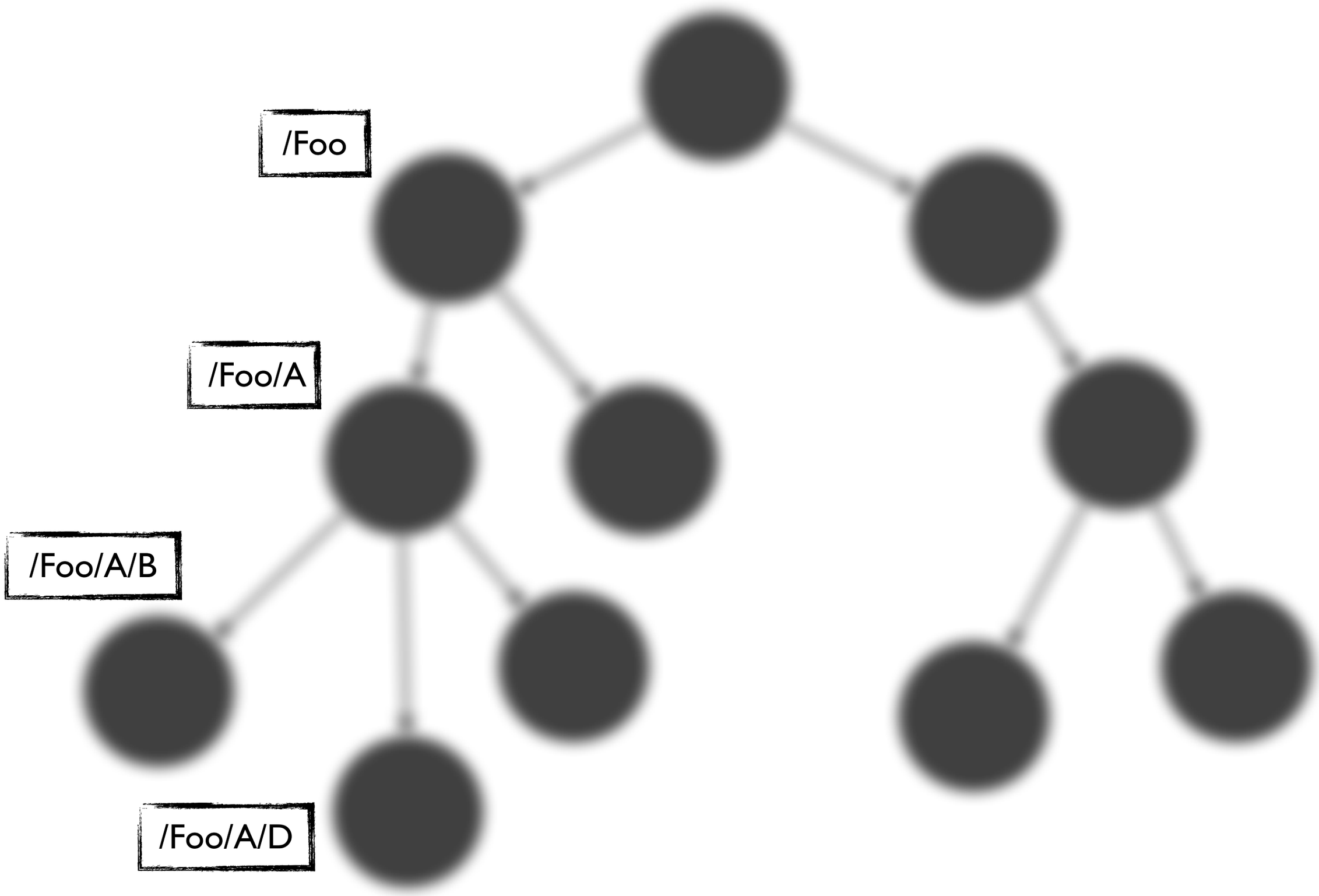

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- Everything happens Reactively
  - An Actor is passive until a message is sent to it, which triggers something within the Actor
  - Messages is the Kinetic Energy in an Actor system
  - Actors can have lots of buffered Potential Energy but can't do anything with it until it is triggered by a message

SEND message

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Full example

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Routers

Load Balancing

Routers

```
val router =
 system.actorOf(
   Props[SomeActor].withRouter(
    RoundRobinRouter(nrOfInstances = 5)))
```

Router + Resizer

```
val resizer =
  DefaultResizer(lowerBound = 2, upperBound = 15)

val router =
  system.actorOf(
    Props[ExampleActor1].withRouter(
      RoundRobinRouter(resizer = Some(resizer))))
```

...or from config

```
akka.actor.deployment {
  /path/to/actor {
    router = round-robin
    nr-of-instances = 5
  }
}
```

...or from config

```
akka.actor.deployment {
  /path/to/actor {
    router = round-robin
    resizer {
      lower-bound = 12
      upper-bound = 15
    }
  }
}
```

3. BECOME

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- In a type system analogy it is as if the object changed type - changed interface, protocol & implementation
- Will now react differently to the messages it receives
- Behaviors are stacked & can be pushed and popped

Why would I want to do that?

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- Other: Use your imagination!

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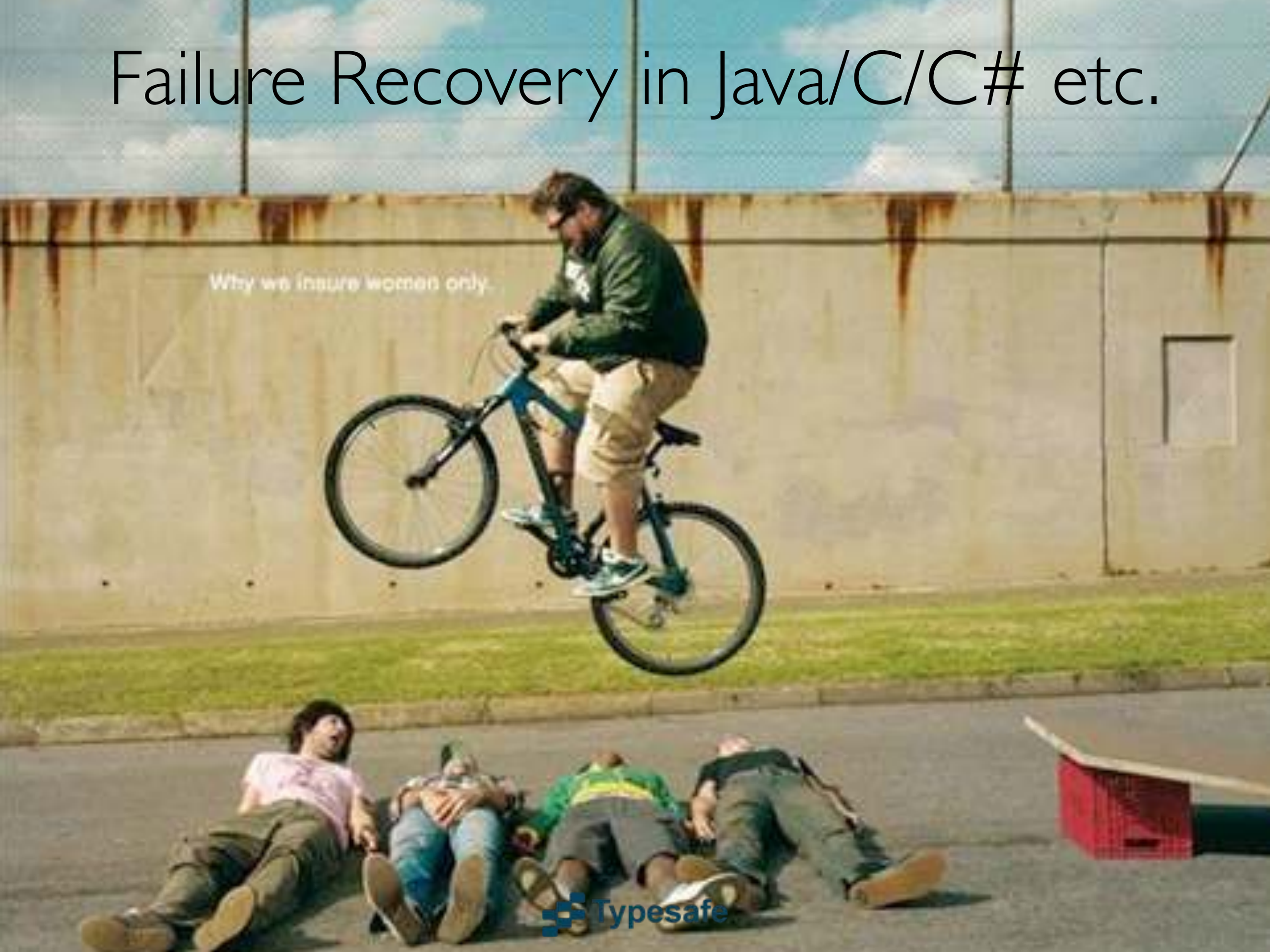
- Other: Use your imagination!
- Very useful once you get the used to it

become

```
context become {
  // new body
  case NewMessage =>
    ...
}
```

Failure Recovery

Failure Recovery in Java/C/C# etc.



Failure Recovery in Java/C/C# etc.

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We can do better than this!!!

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Just

LET IT CRASH

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- This means that if an Actor crashes, a notification will be sent to his supervisor, who can react upon the failure

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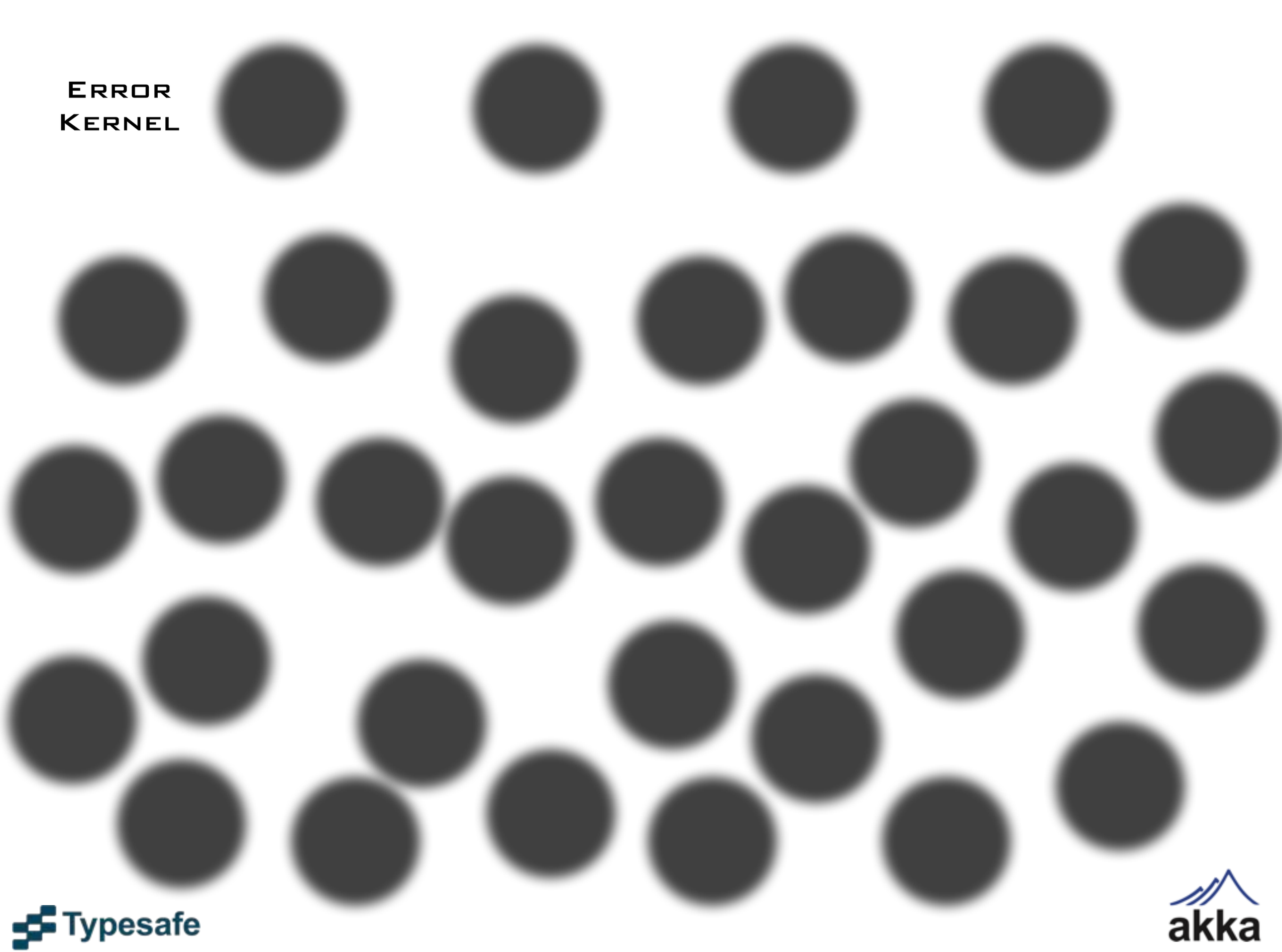
- SUPERVISE - manage another Actor's failures
- Error handling in actors is handle by letting Actors monitor (supervise) each other for failure
- This means that if an Actor crashes, a notification will be sent to his supervisor, who can react upon the failure
- This provides clean separation of processing and error handling


Fault-tolerant
onion-layered
Error Kernel

Error Kernel



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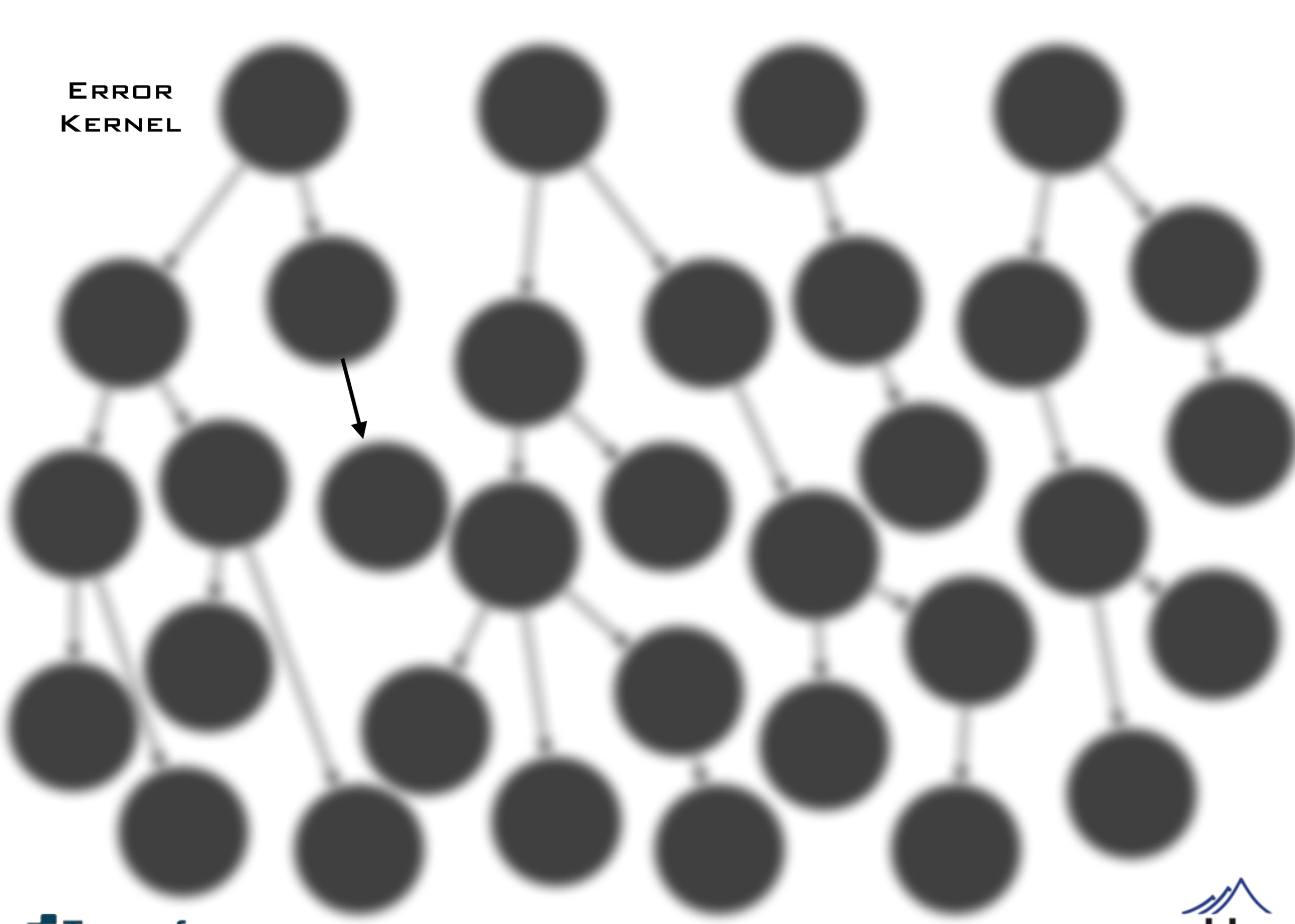

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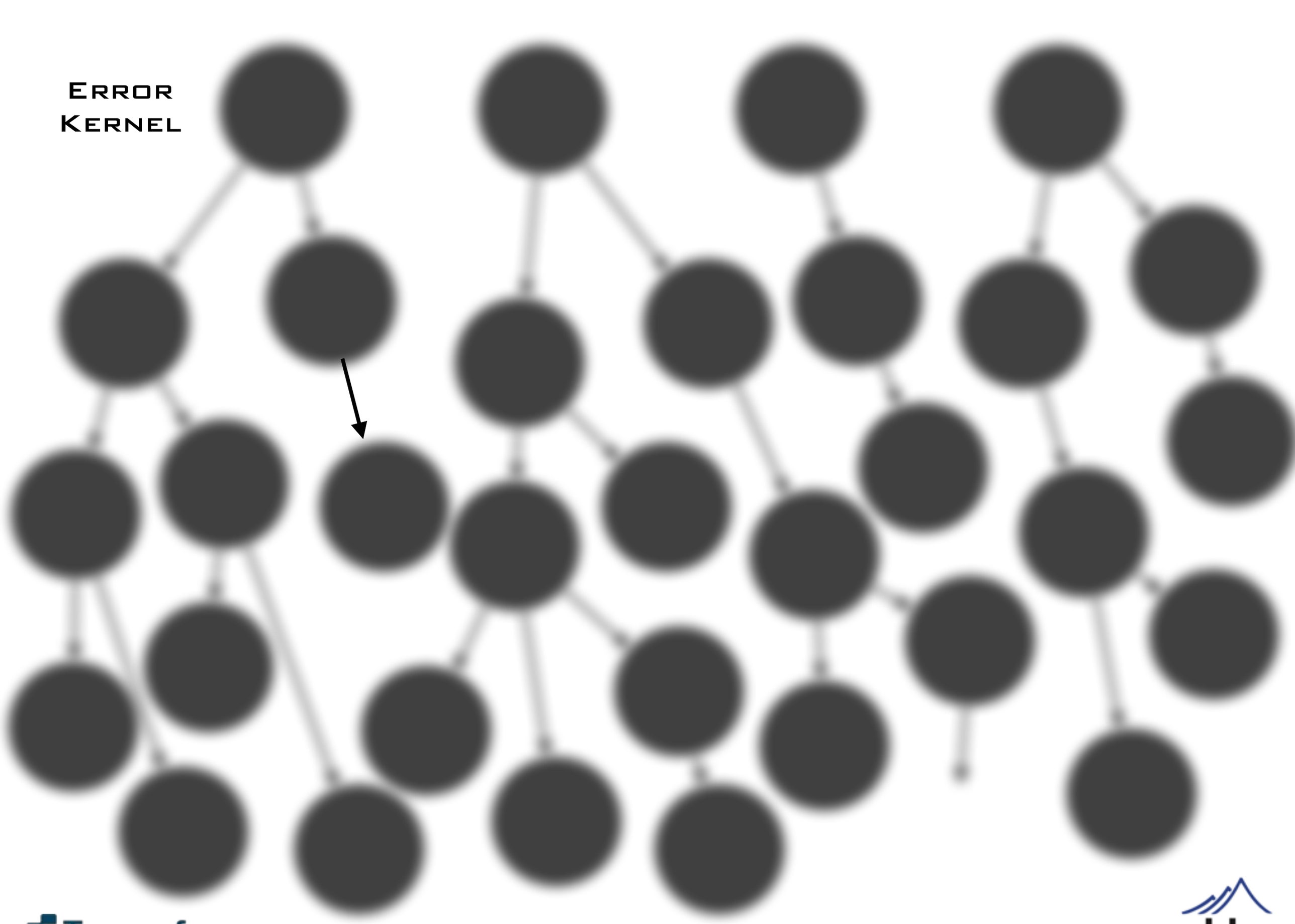

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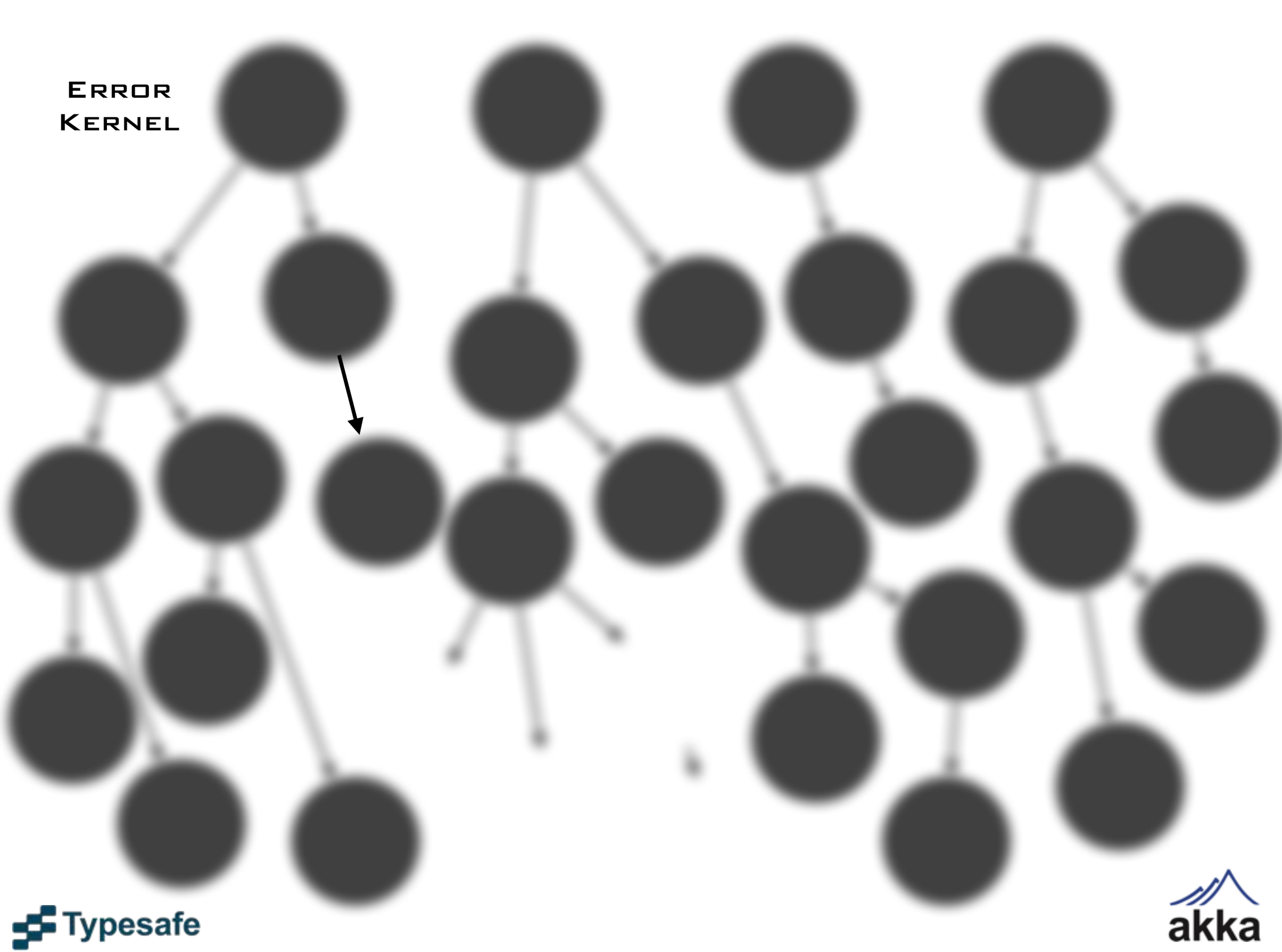

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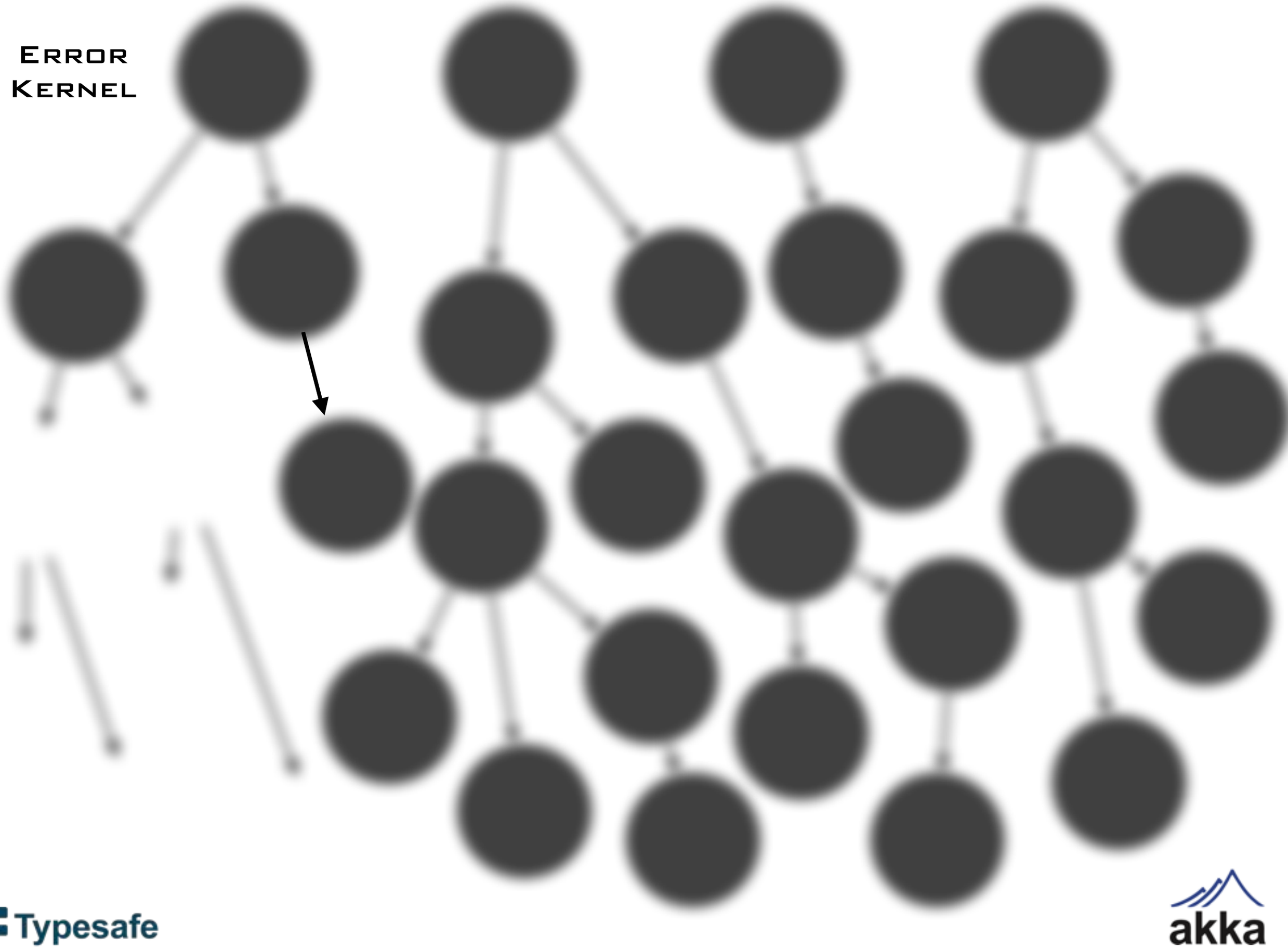

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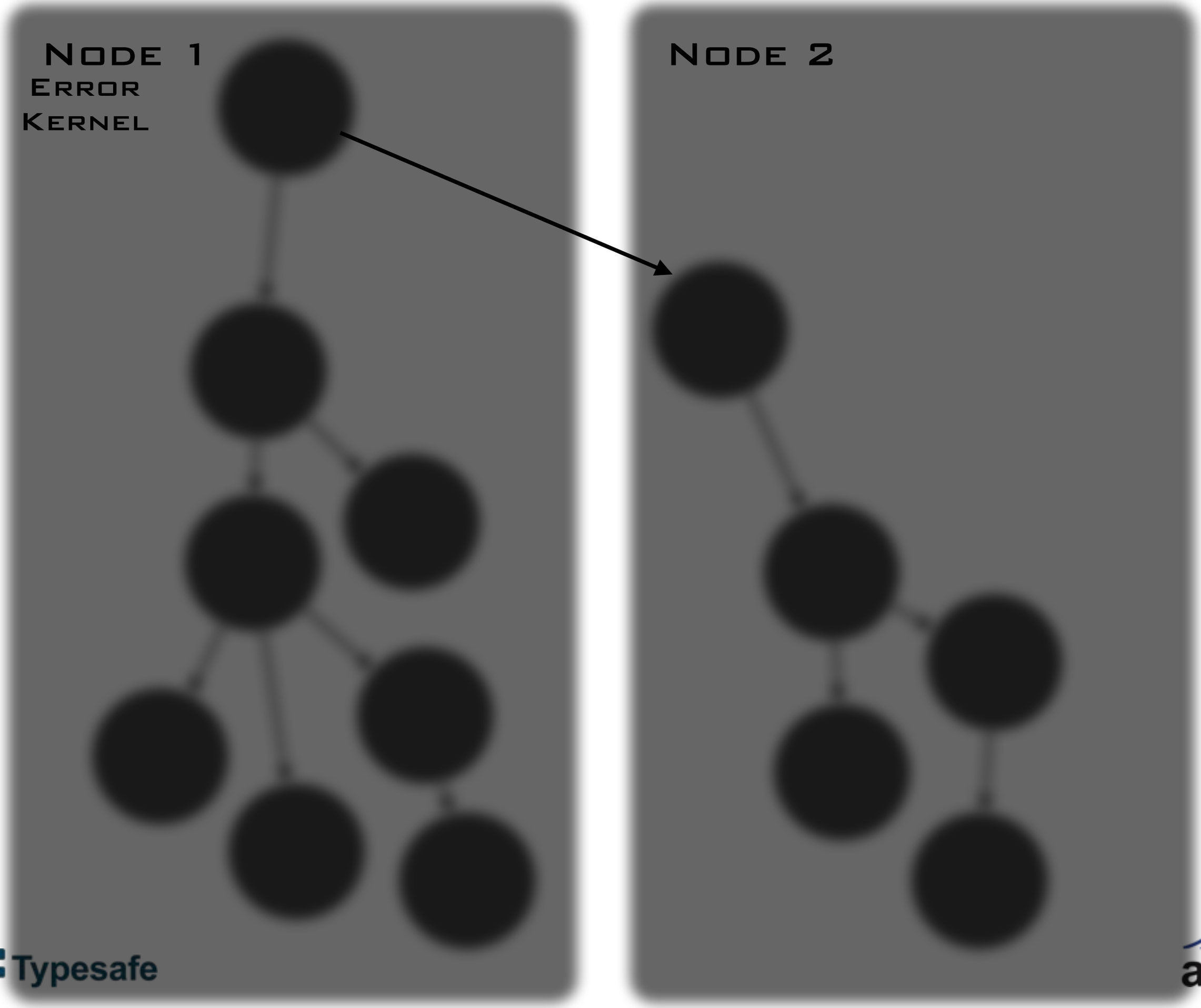
Node 1
Error
Kernel
Node 2
Typesafe
akka

SUPERVISE Actor

Every single actor has a
default supervisor strategy.
Which is usually sufficient.
But it can be overridden.

SUPERVISE Actor

Every single actor has a
default supervisor strategy.
Which is usually sufficient.
But it can be overridden.

```
class Supervisor extends Actor {
  override val supervisorStrategy =
                    (maxNrOfRetries = 10, withinTimeRange = 1 minute) {
      case _: ArithmeticException  => Resume
      case _: NullPointerException => Restart
      case _: Exception            => Escalate
  }
```

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SUPERVISE Actor

```
class Supervisor extends Actor {
  override val supervisorStrategy =
                    (maxNrOfRetries = 10, withinTimeRange = 1 minute) {
      case _: ArithmeticException  => Resume
      case _: NullPointerException => Restart
      case _: Exception            => Escalate
  }

  val worker = context.actorOf(Props[Worker])

  def receive = {
    case n: Int => worker forward n
  }
}
```

Manage failure

```
class Worker extends Actor {
  ...

  override def preRestart(
    reason: Throwable, message: Option[Any]) {
    ... // clean up before restart
  }

  override def postRestart(reason: Throwable) {
    ... // init after restart
  }
}
```

Remoting

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Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote =
      }
    }
  }
}
```

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akka {
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      }
    }
  }
}
```

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akka

Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://
      }
    }
  }
}
```

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akka

Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem
      }
    }
  }
}
```

Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1
      }
    }
  }
}
```

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akka

Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1:2552
      }
    }
  }
}
```

Remote deployment

Just feed the ActorSystem with this configuration

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1:2552
      }
    }
  }
}
```

Zero code changes

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Remote Lookup

```
val greeter = system.actorFor(
    "akka://MySystem@machine1:2552/user/greeter")
```

Can you see the problem?

Fixed Addresses

```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1:2552
      }
    }
  }
}
```

```
val greeter = system.actorFor(
    "akka://MySystem@machine1:2552/user/greeter")
```

Akka Cluster

Features

- Gossip-based Cluster Membership
- Leader determination
- Accrual Failure Detector
- Cluster DeathWatch
- Cluster-Aware Routers

Enable clustering

```
akka {
  actor {
    provider = "akka.cluster.ClusterActorRefProvider"
    ...
  }

  extensions = ["akka.cluster.Cluster"]

  cluster {
    seed-nodes = [
      "akka://ClusterSystem@127.0.0.1:2551",
      "akka://ClusterSystem@127.0.0.1:2552"
    ]

    auto-down = on
  }
}
```

Configure a clustered router

```
akka.actor.deployment {
  /statsService/workerRouter {
    router = consistent-hashing
    nr-of-instances = 100

    cluster {
      enabled = on
      max-nr-of-instances-per-node = 3
      allow-local-routees = on
    }
  }
}
```

Typesafe **Console**

free for developers later in the fall

Typesafe | Documentation | Demo | demo@typesafe.com LOGOUT

Search (or 'help')

NODES | DISPATCHERS | ACTORS | TAGS

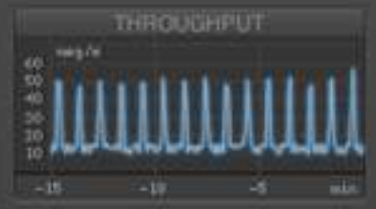
NODES

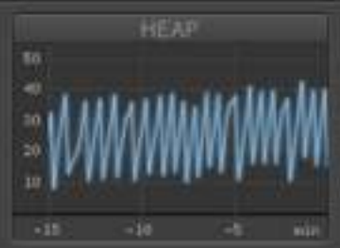
Nodes in your system

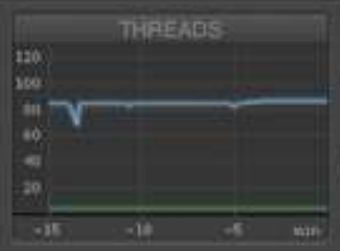
node1

7 actors | 2 dispatchers

MAX MAILBOX	MEAN MAILBOX
68	12.51
PEAK RATES	**REMOTE ERR**
35.41 · 26.11	0





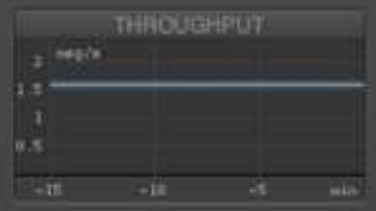


MACHINE		NETWORK	
Max Heap:	8105 MB	Rx Rate:	321 KB/s
Used Heap:	1232 MB	Tx Rate:	395 KB/s
Memory Usage:	76.70 %	TCP Established:	91
Running Actors:	6	TCP Resets:	0
Processors:	4	Rx Errors:	0
Up Time:	13832 mins	Tx Errors:	0

node2

2 actors | 1 dispatcher

MAX MAILBOX	MEAN MAILBOX
1	0
PEAK RATES	**REMOTE ERR**
- · -	0



SYSTEM

Overview

THROUGHPUT

Total msg rate:	46.97 msg/s
Peak msg rate:	78.74 msg/s
Mean msg rate:	10.51 msg/s

OVERVIEW

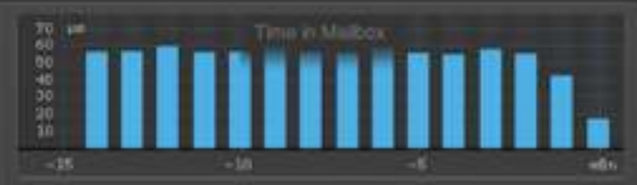
Query period:
from 2012-03-26 08:48
to 2012-03-26 09:03

Peak receive rate:	45.08 msg/s
Peak tell rate:	33.19 msg/s

ERRORS	
Errors:	30
Warnings:	15
Deadlocks:	20
Dead letters:	0

MAILBOX

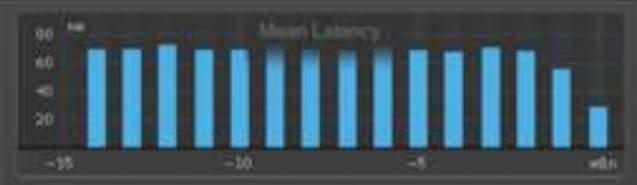
Max mailbox size:	101
Max time in mailbox:	1559 ms
Mean time in mailbox:	57 ms



REMOTE

Send rate:	0.645 msg/s
Receive rate:	0.747 msg/s
Peak receive rate:	- msg/s

Nodes:	2
Dispatchers:	2
Actors:	9
Tags:	4



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d:*

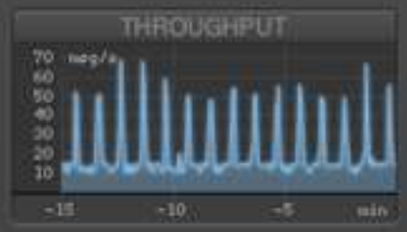
NODES | DISPATCHERS | ACTORS | TAGS

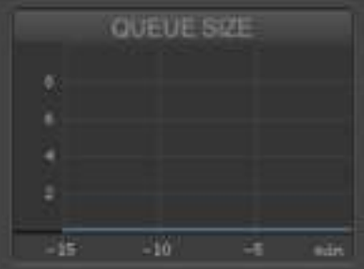
DISPATCHERS
Dispatchers for your query

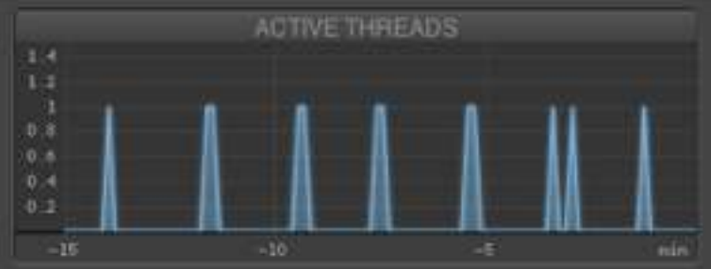
akka.actor.default-dispatcher

NODE: node1

TYPE: Dispatcher-FJ







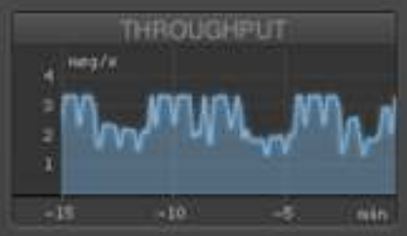
ACTOR COUNTS	
Processed messages:	8128
Restarts:	1
Errors:	1
Warnings:	0
Tell messages:	5923
Ask messages:	0

ACTOR RATES	
Total message rate:	12.50 msg/s
Peak rate:	58.02 msg/s
Receive rate:	7.265 msg/s
Tell rate:	5.160 msg/s
Remote receive rate:	0.322 msg/s
Remote send rate:	0.322 msg/s

another-dispatcher

NODE: node1

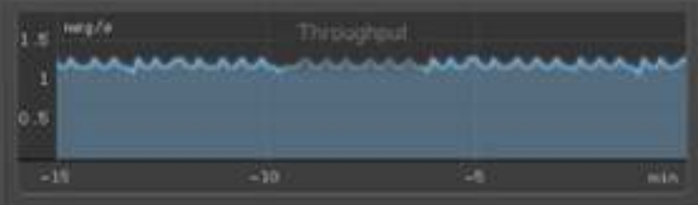
TYPE: Dispatcher-TP

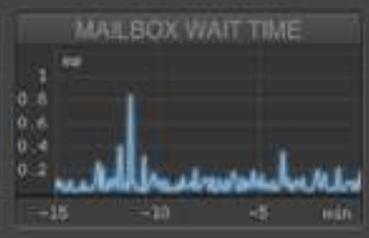


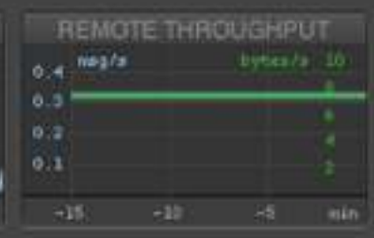
ACTOR
Actor for your query

akka://Demo/user/RemoteActorA

Errors:	0
Mean time in mailbox:	88 µs
Max time in mailbox:	833 µs
Max time node:	node1







MESSAGE COUNTS	
Processed messages:	627
Restarts:	0
Errors:	0
Warnings:	0
Tell messages:	298
Ask messages:	0

MESSAGE RATES	
Total message rate:	1.282 msg/s
Peak rate:	1.285 msg/s
Receive rate:	0.854 msg/s
Tell rate:	0.322 msg/s
Remote receive rate:	0.322 msg/s
Remote send rate:	0.322 msg/s

live demo

http://console-demo.typesafe.com

...we have much **much** more

...we have much **much** more

EventBus

TestKit

FSM

Pub/Sub

Durable Mailboxes

IO

Camel

Microkernel

SLF4J

TypedActor

ZeroMQ

Transactors

Dataflow

Agents

Extensions

get it and learn more

http://akka.io

http://letitcrash.com

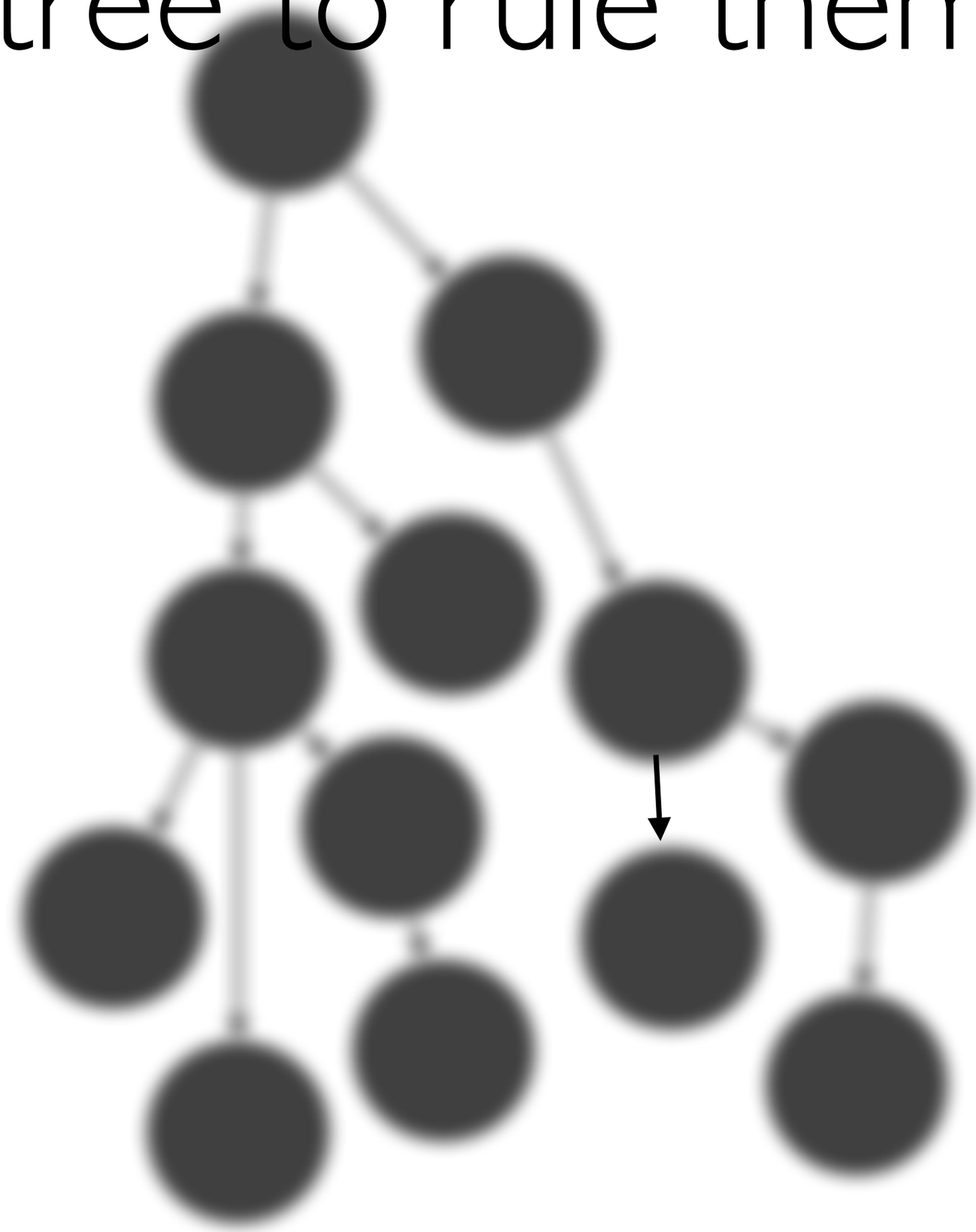
http://typesafe.com

EØF

Akka Cluster

Upcoming features

One tree to rule them all



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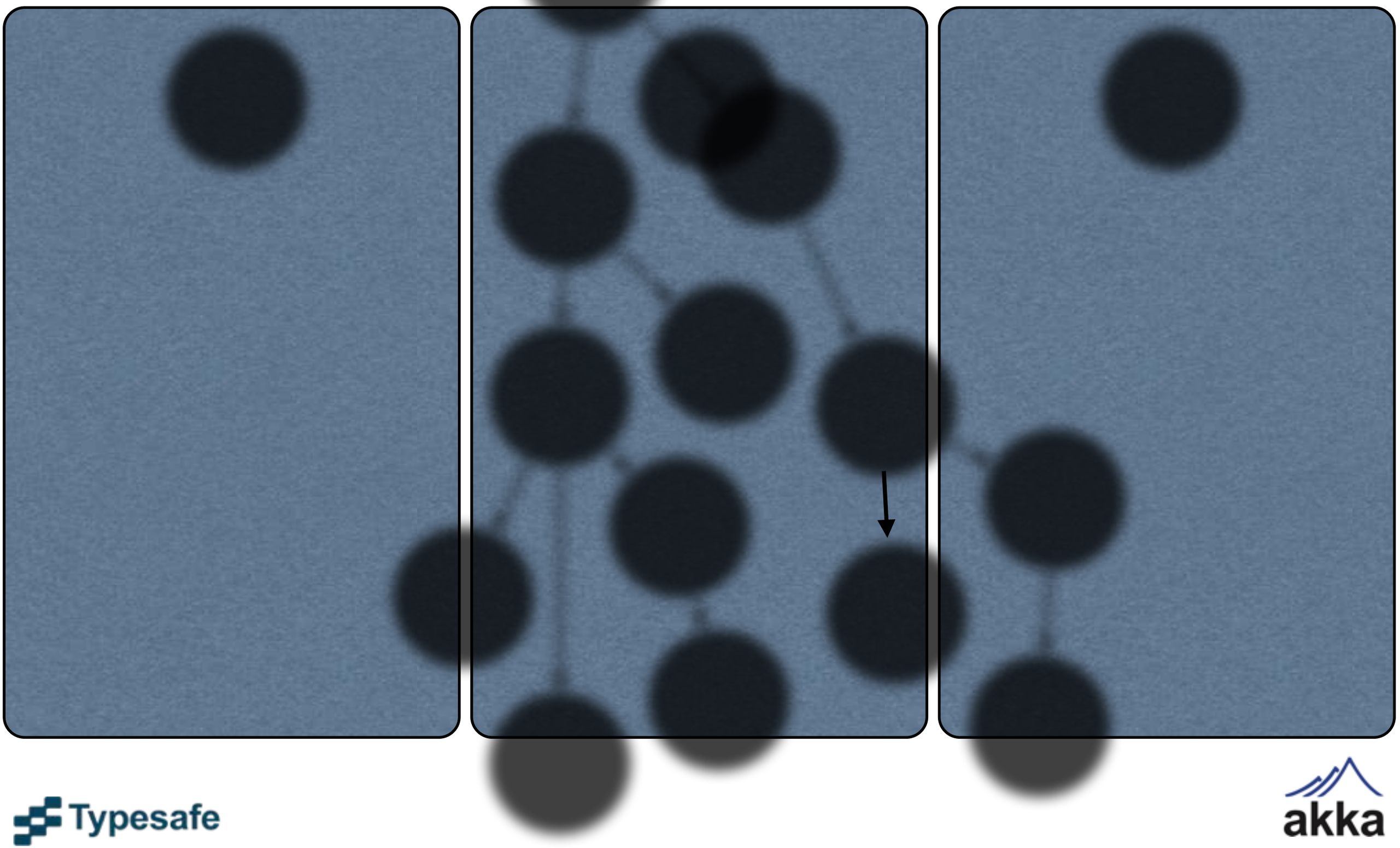
One tree to rule them all



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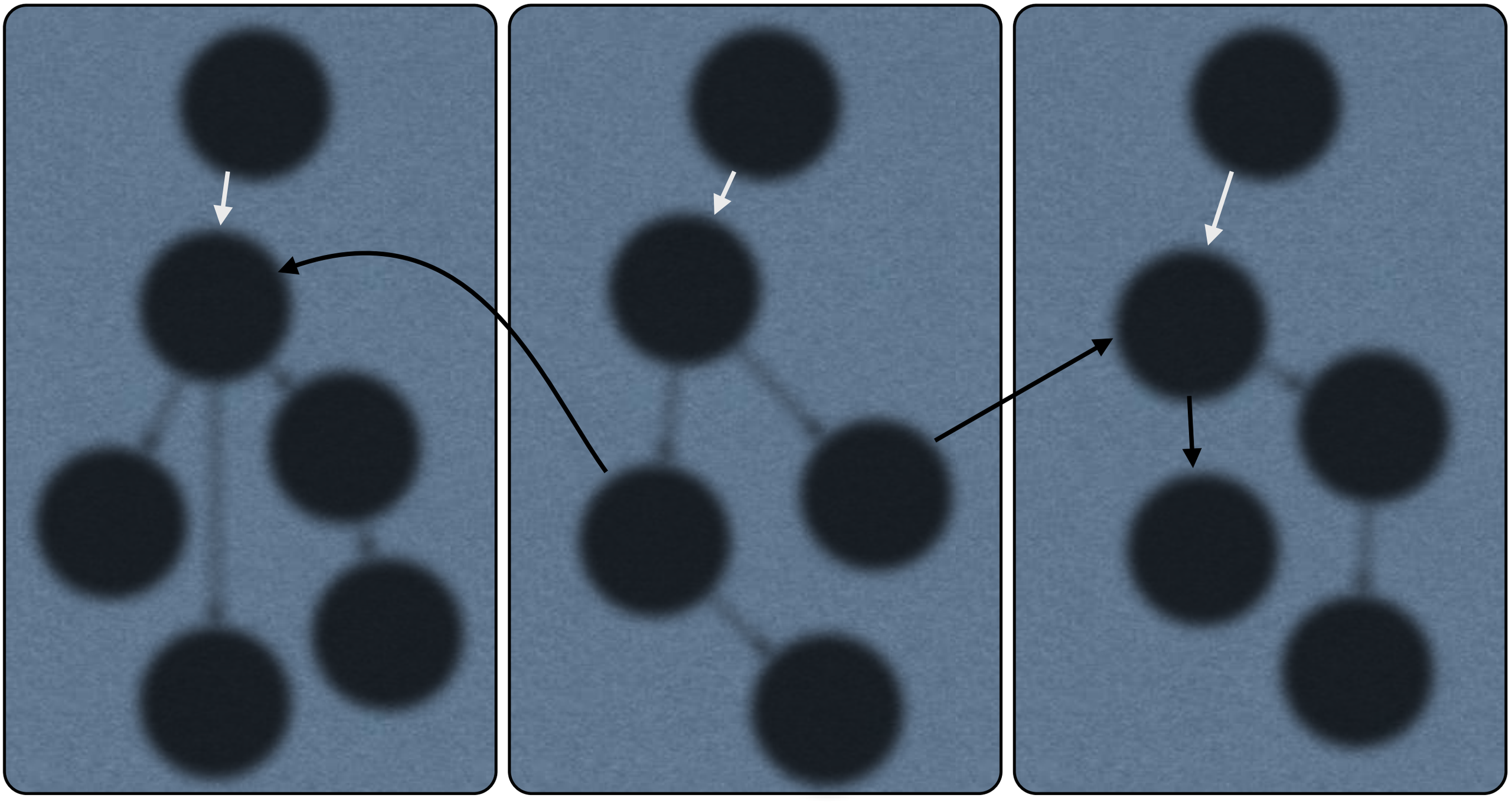
One tree to rule them all



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The Magic Sauce

- User code only sees `cluster://...` names
- ActorRef becomes repointable
  - local (current ActorCell)
  - remote (new RemoteActorCell)
- Can now move actors around transparently
  - Actor encapsulation makes it possible

What does this enable?

- Actor migration
- Actor replication
- Automatic cluster partitioning
  - later also based on runtime metrics
- Node fail-over
  - first for stateless actors
  - later for stateful actors using event sourcing

⇛ *Fault Tolerance & Distribution*