Scaling software with

Jonas Bonér

CTO Typesafe

@jboner

Scaling
software with

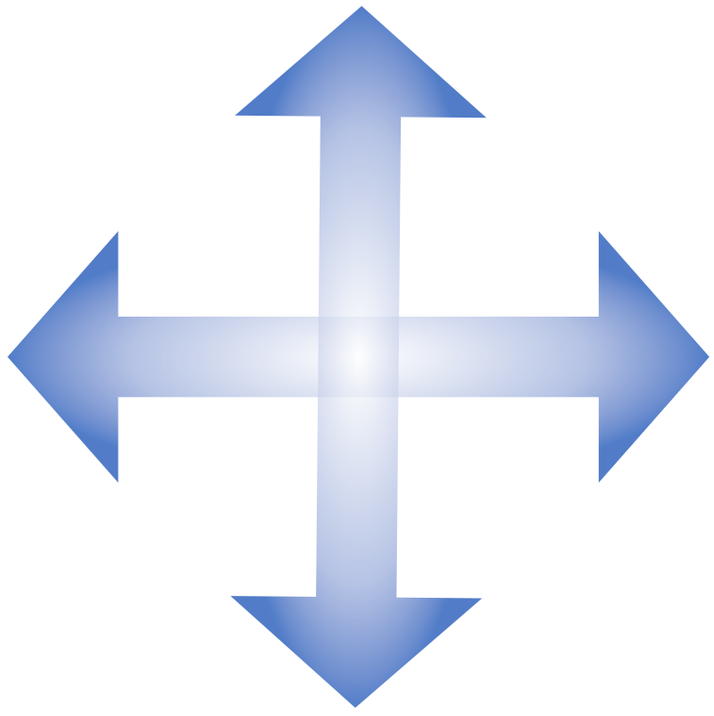
Leverage what you already know

All this is working with the Java investment; software, skills, tools and techniques, you have today:

- USE it from JAVA today
- ...with the option of using leveraging SCALA LATER (if the urge comes up)
- INTEGRATE with, and deploy into, your current infrastructure/environment

Selection of Akka Production Users

TDC
Telefónica
CSC
htc quietly brilliant
hp
BLIZZARD ENTERTAINMENT
UBS
SIEMENS
amazon.com
KLOUT
W3C
HSBC
CISCO
HUAWEI
JUNIPER NETWORKS
svt
Autodesk
CREDIT SUISSE
IGN
Atos
O2
vmware
dialog Smart Stream Platform
SEVEN Networks
xerox
UNIBET
DRW TRADING GROUP
OOYALA
novus
navirec
T8 Webware
CARTOMAPIC
Moshi Monsters
BBC
Maritime Poker
banksimple
zeebox The best thing to happen to TV since TV
Answers.com The world's leading Q&A site
azavea



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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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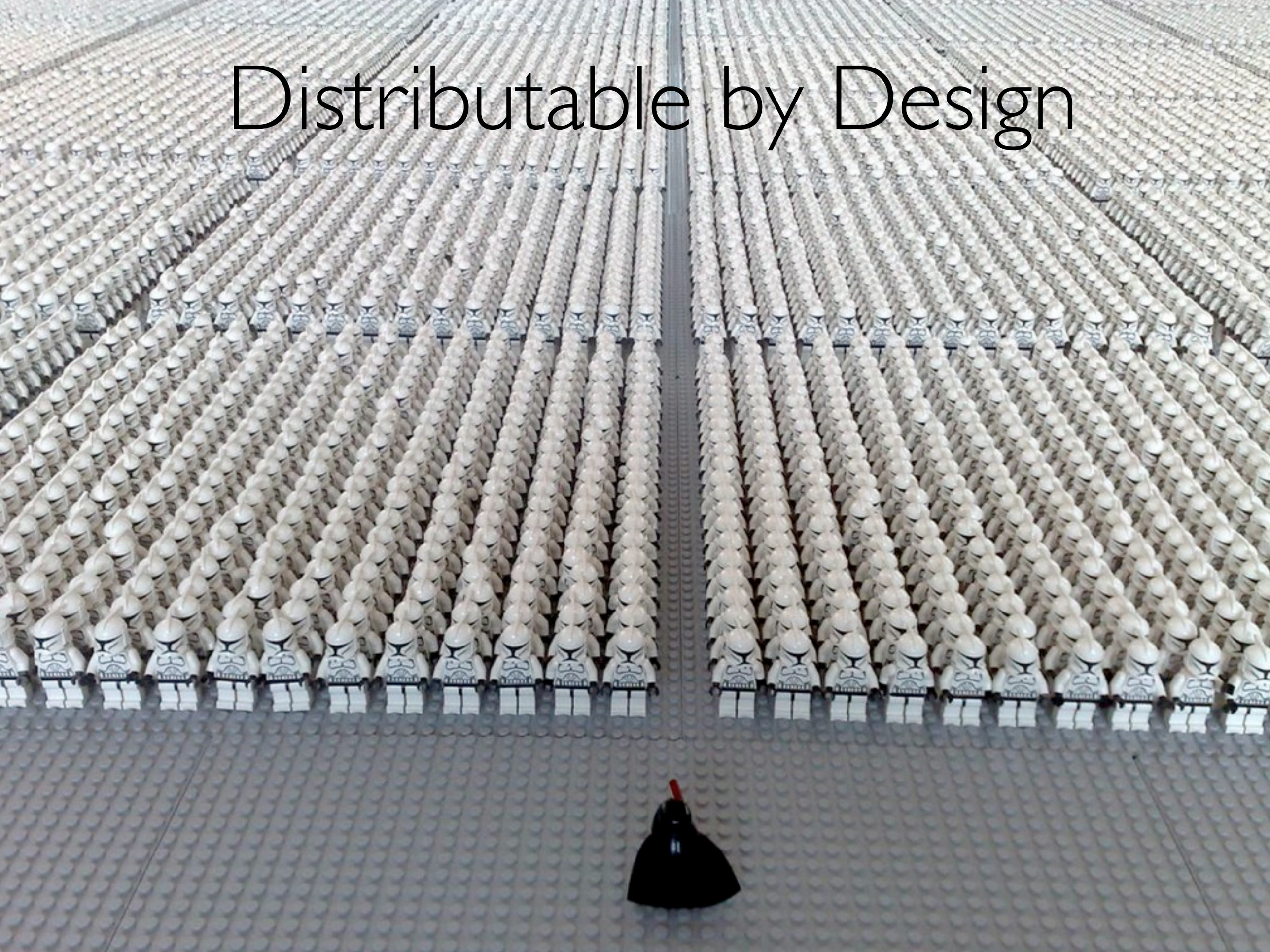
- Proven and superior model for detecting and recovering from errors

Distributable by Design



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?

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Let's use Actors

What is an Actor?

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- Akka's unit of code organization is called an Actor
- 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

What can I use Actors for?

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In different scenarios, an Actor may be an alternative to:

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- a singleton or service
- a router, load-balancer or pool
- a Java EE Session Bean or Message-Driven Bean
- 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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  - 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

```
public class Greeting implements Serializable {
   public final String who;
   public Greeting(String who) { this.who = who; }
}

public class GreetingActor extends UntypedActor {
    LoggingAdapter log = Logging.getLogger(getContext().system(), this);

    public void onReceive(Object message) throws Exception {
      if (message instanceof Greeting)
         log.info("Hello " + ((Greeting) message).who);
      }
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}
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Define the message(s) the Actor should be able to respond to

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```

Define the Actor class

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

CREATE Actor

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Actor configuration

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Actor configuration

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Create an Actor system

Actor configuration

You get an ActorRef back

Create the Actor

Give it a name

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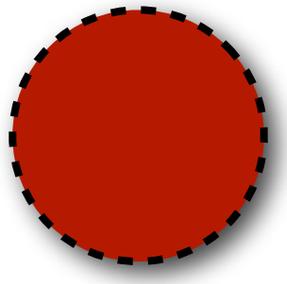
Actors can form hierarchies

Guardian System Actor



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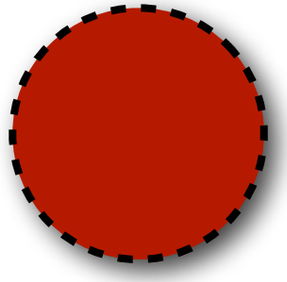
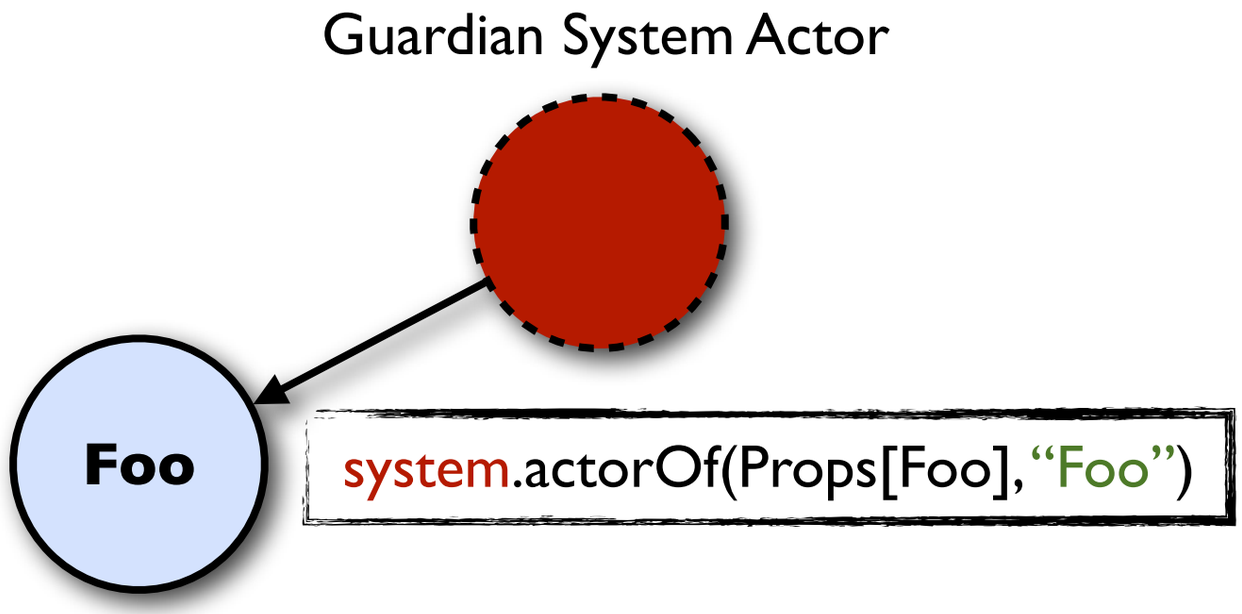


system.actorOf(Props[Foo], “Foo”)

Actors can form hierarchies



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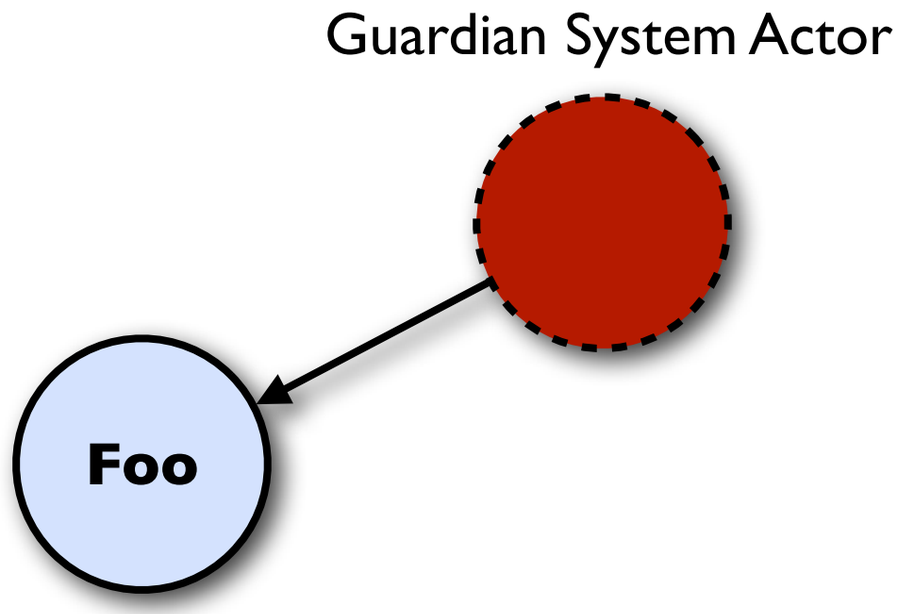


```
context.actorOf(Props[A], "A")
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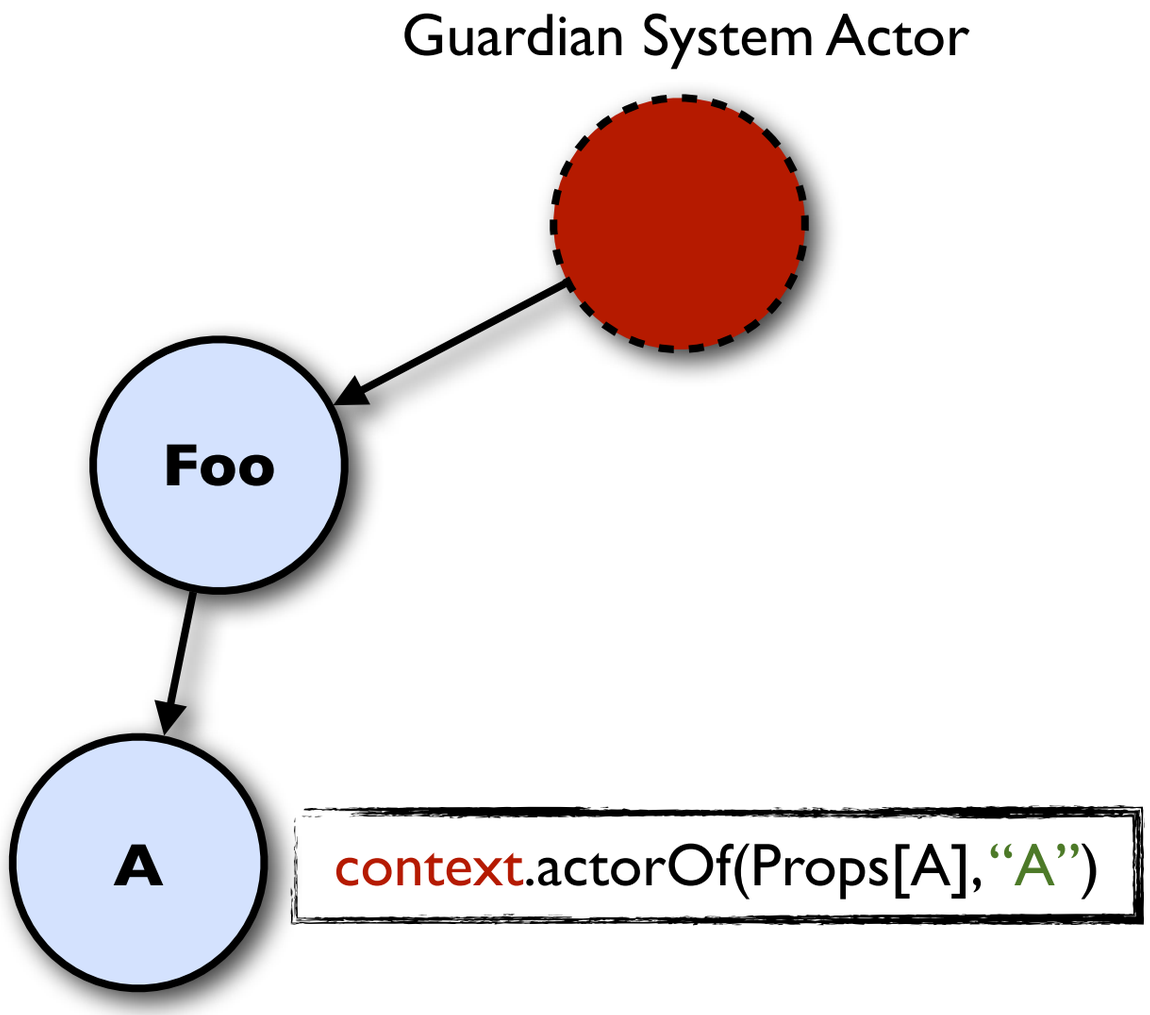

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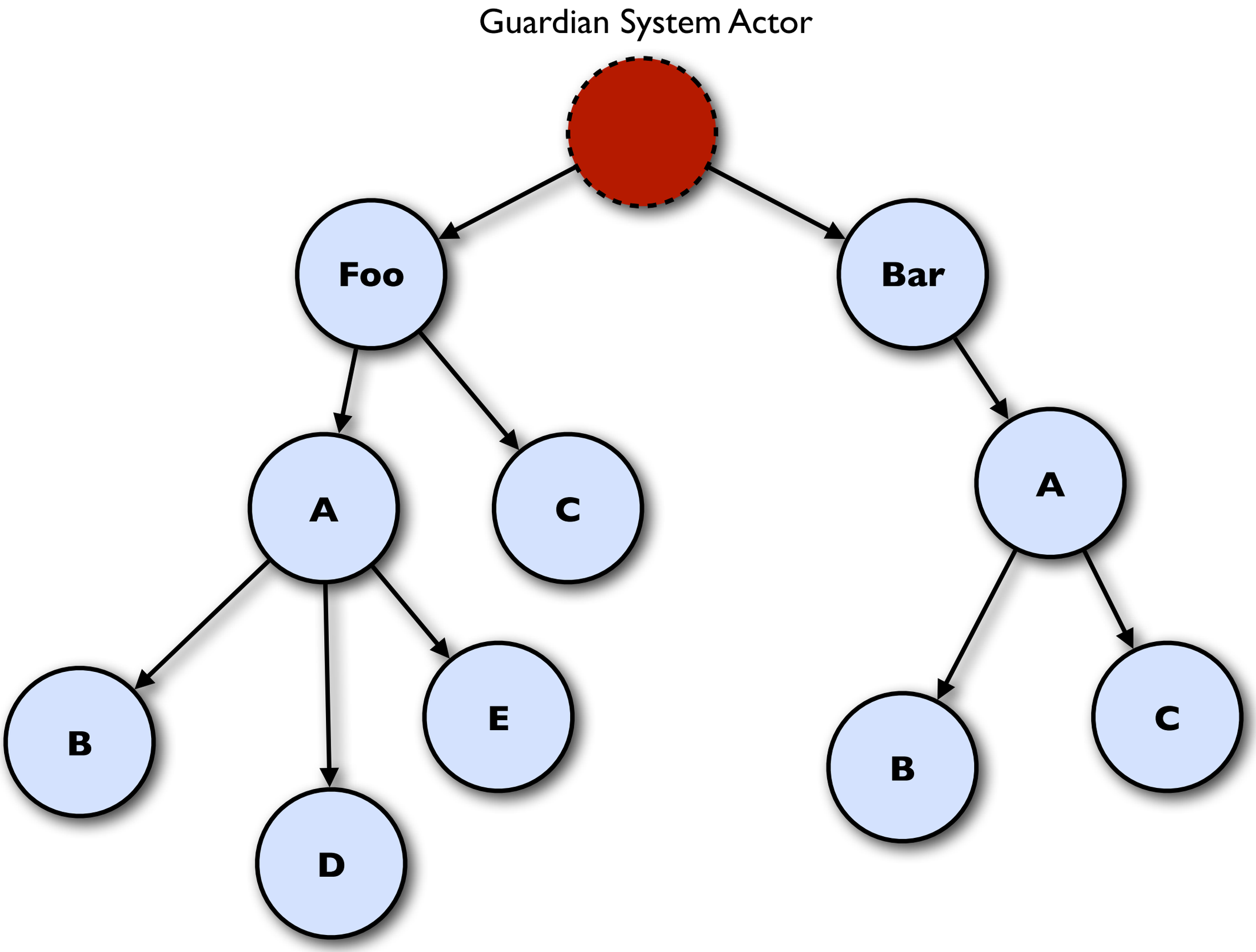
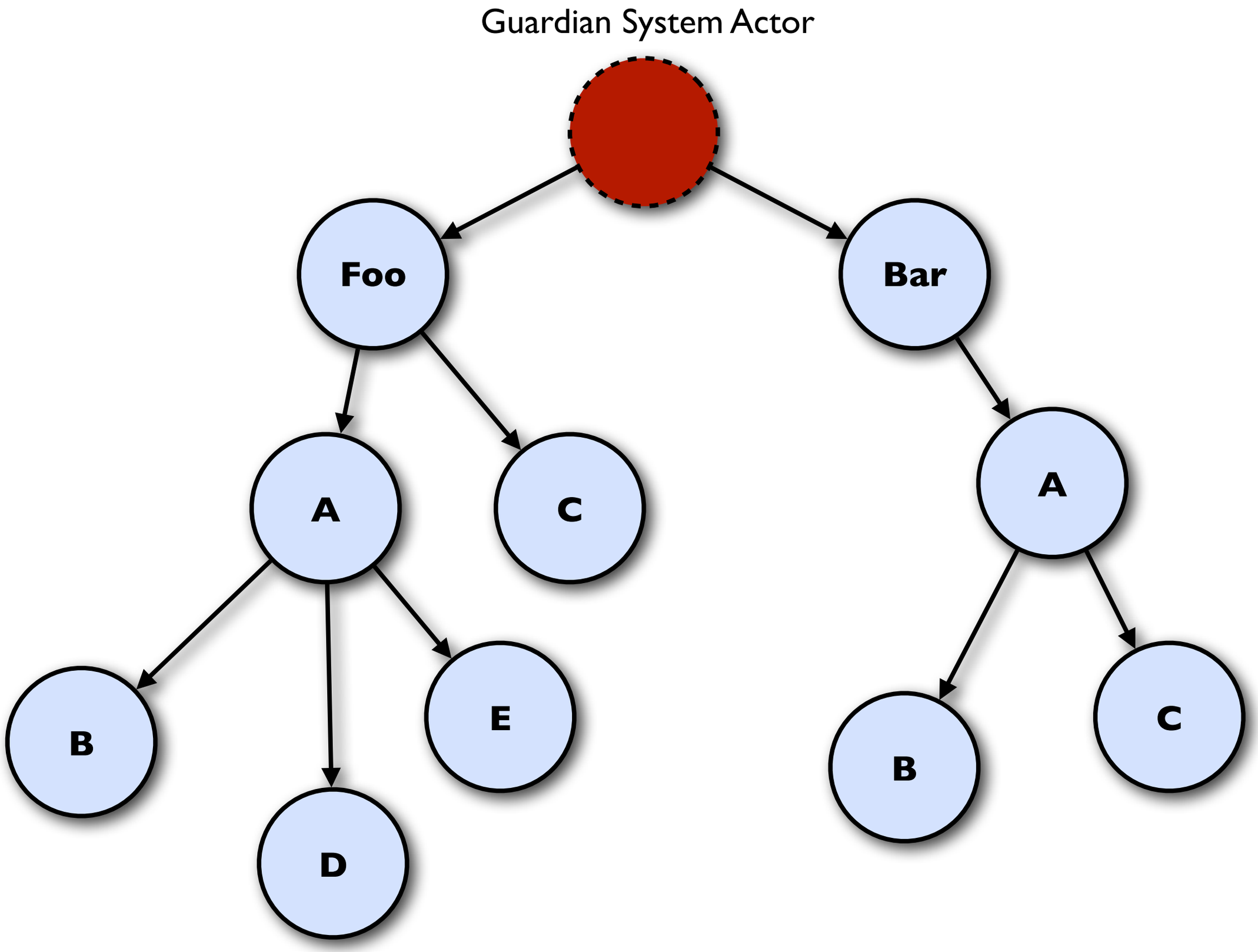


Name resolution - like a file-system



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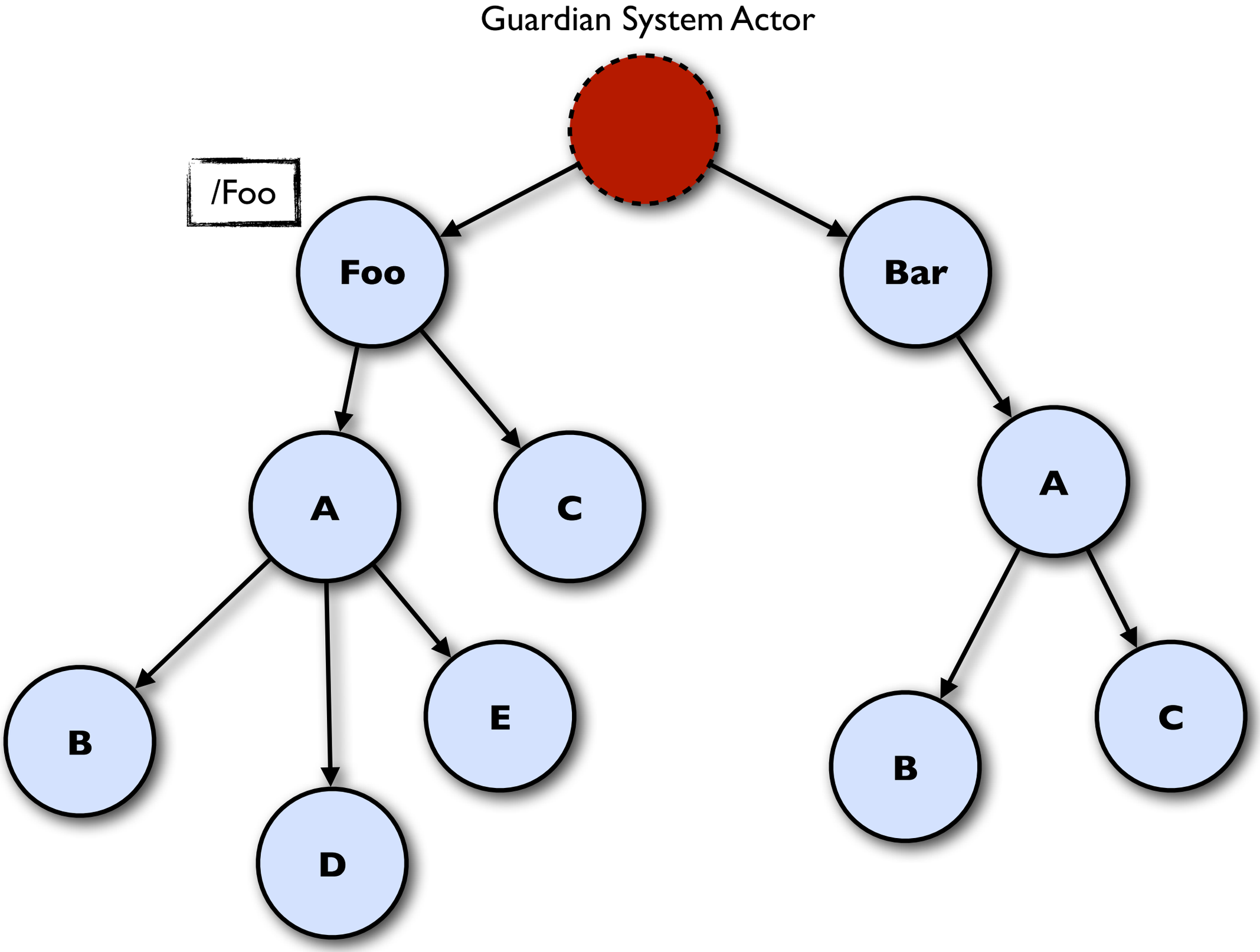

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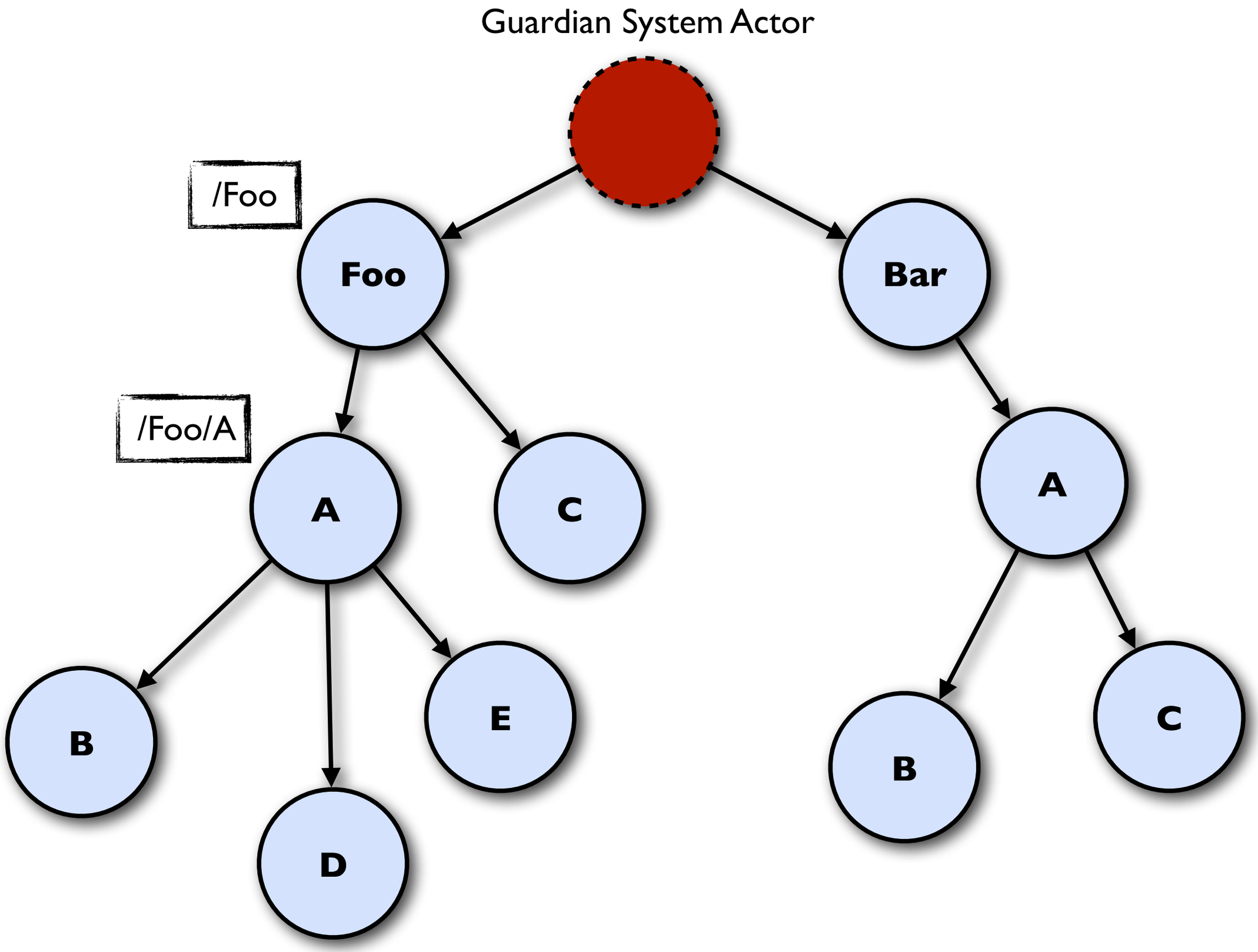

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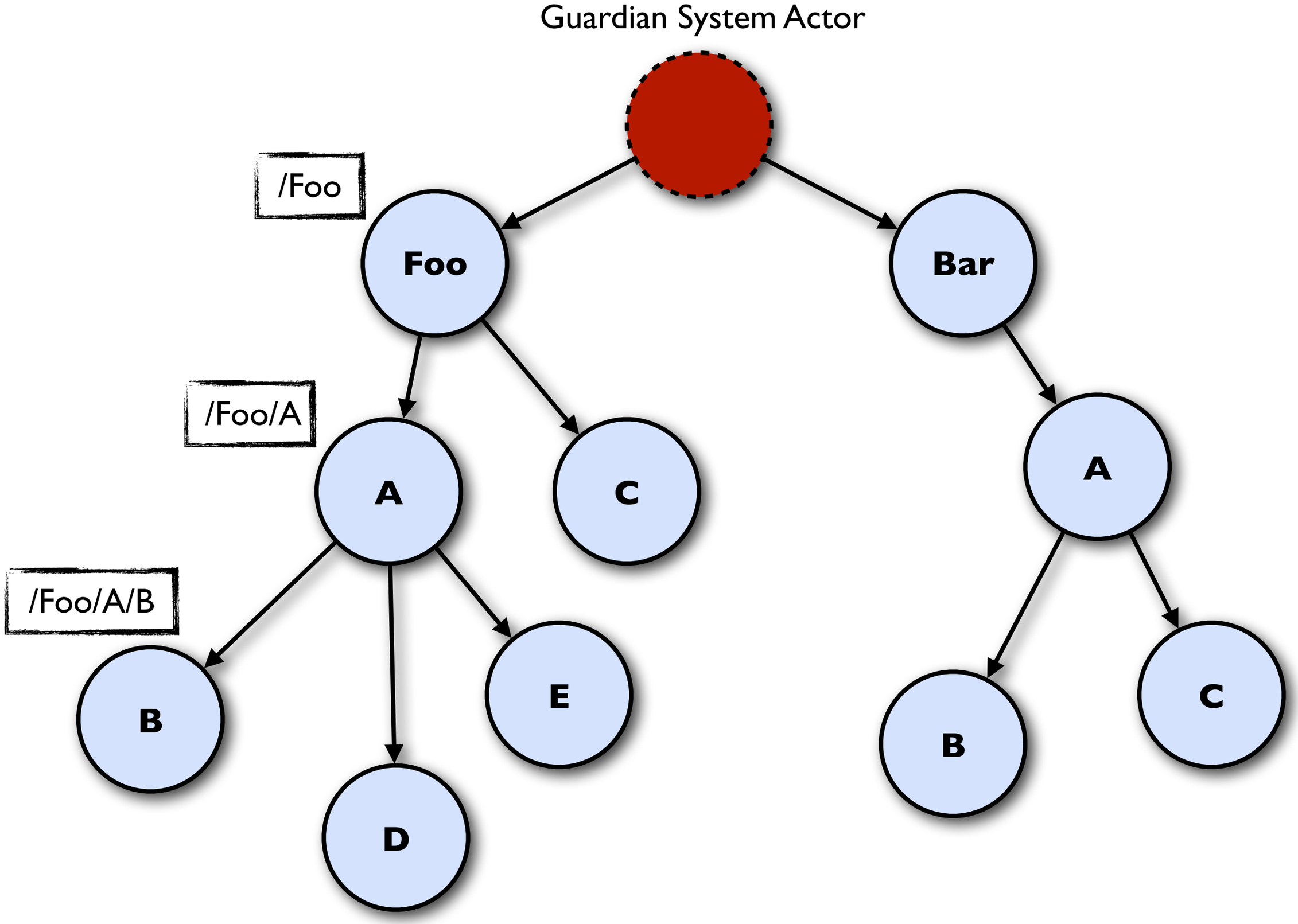

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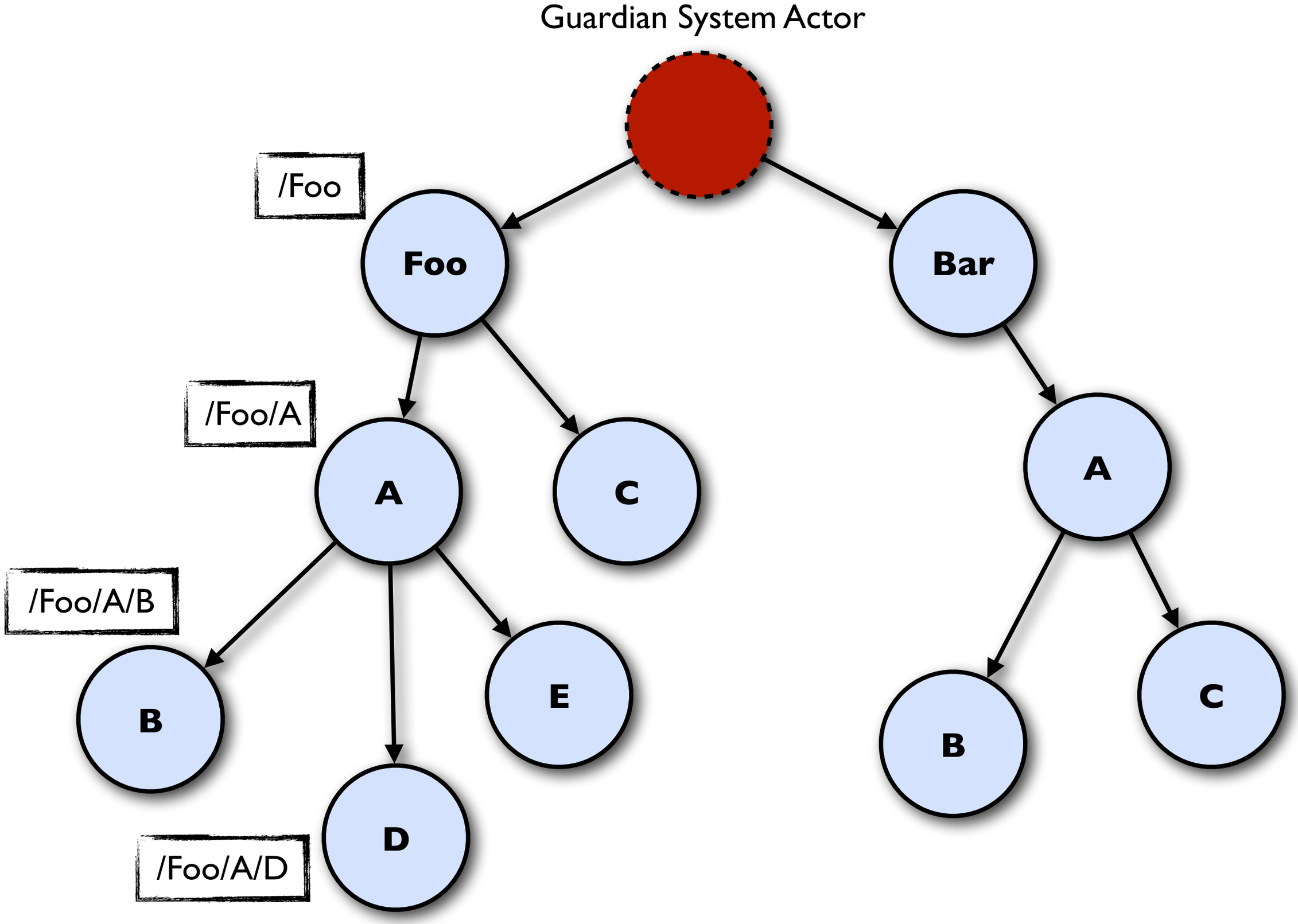

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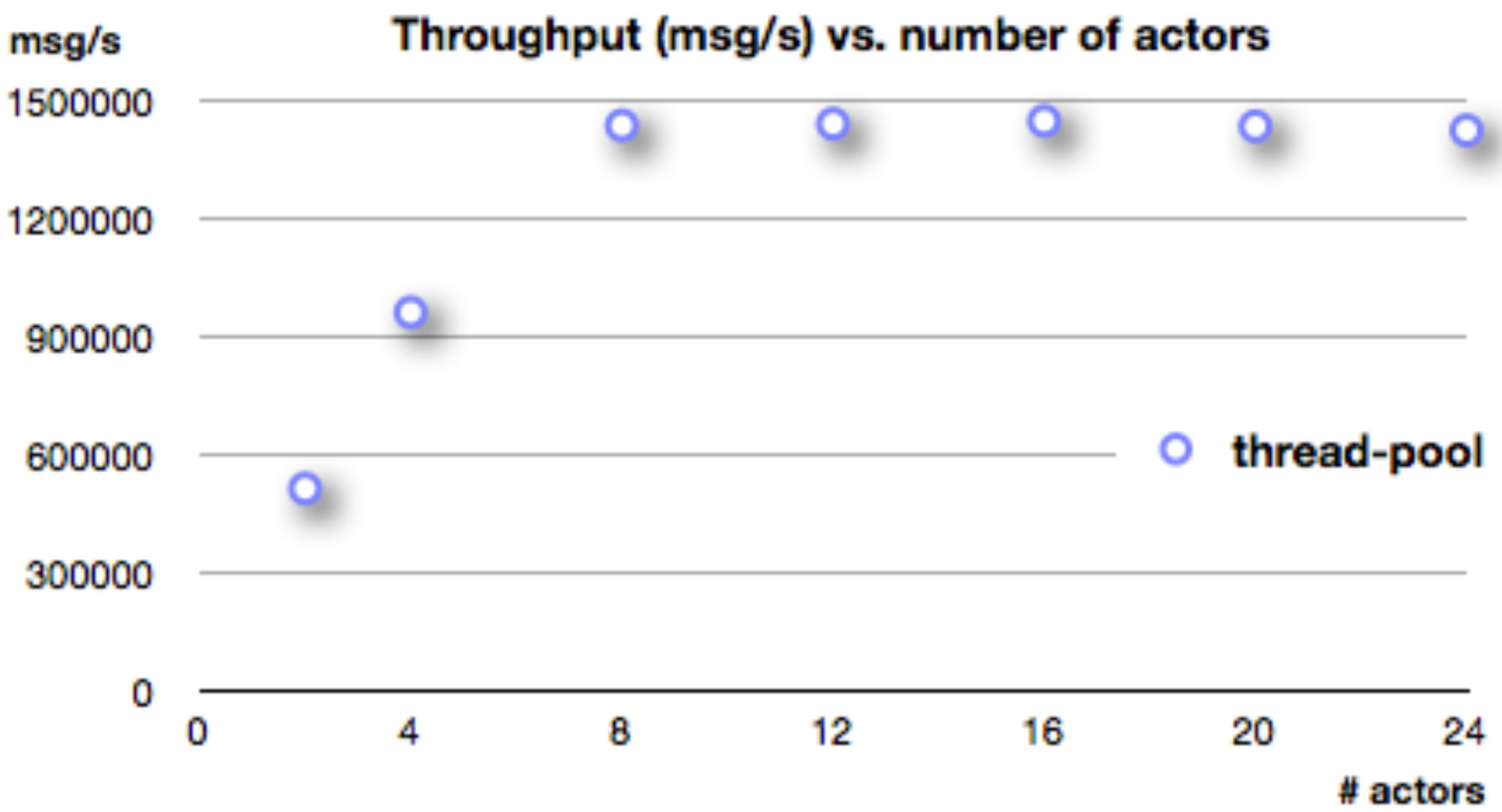
  - Messages is the Kinetic Energy in an Actor system
  - Actors can have lots of buffered Potential Energy but can't do anything with it until it is triggered by a message

ThreadPoolExecutor

@ 48 cores



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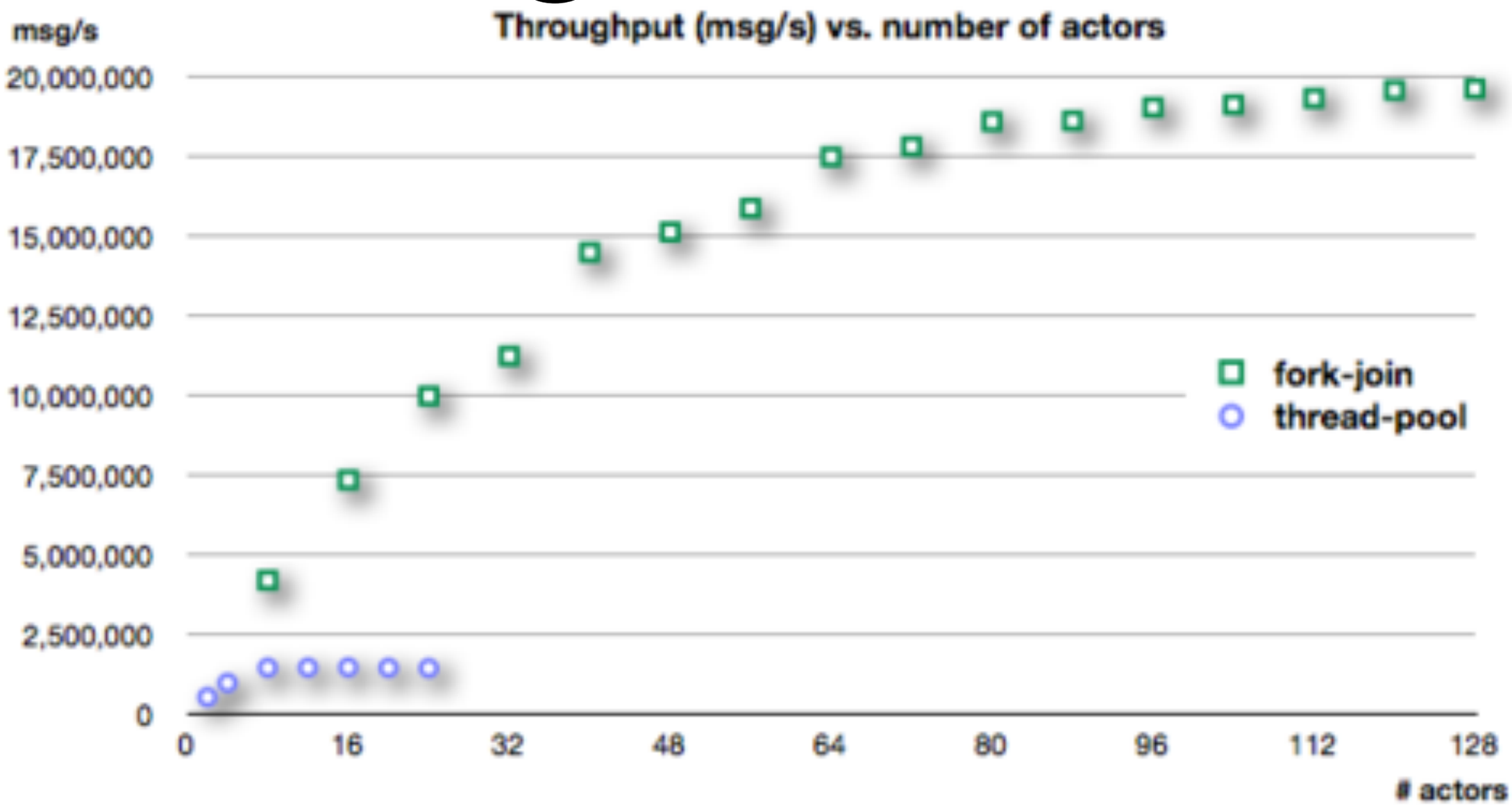
new ForkJoinPool

@ 48 cores



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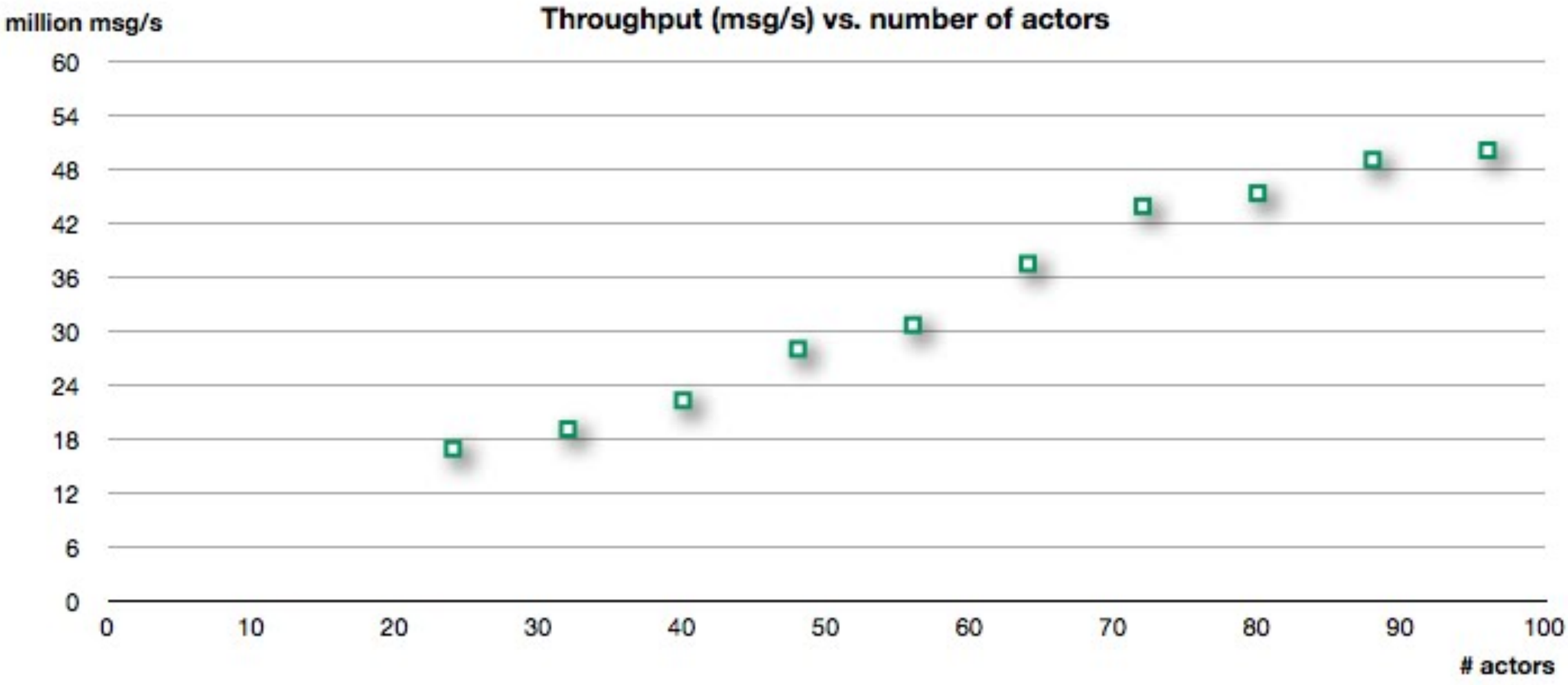
Throughput on a single box @ 48 cores



+50 million messages per second

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SEND message

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Send the message

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Full example

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Remote deployment

Just feed the ActorSystem with this configuration

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

Typesafe

akka

Remote deployment

Just feed the ActorSystem with this configuration

Configure a Remote Provider

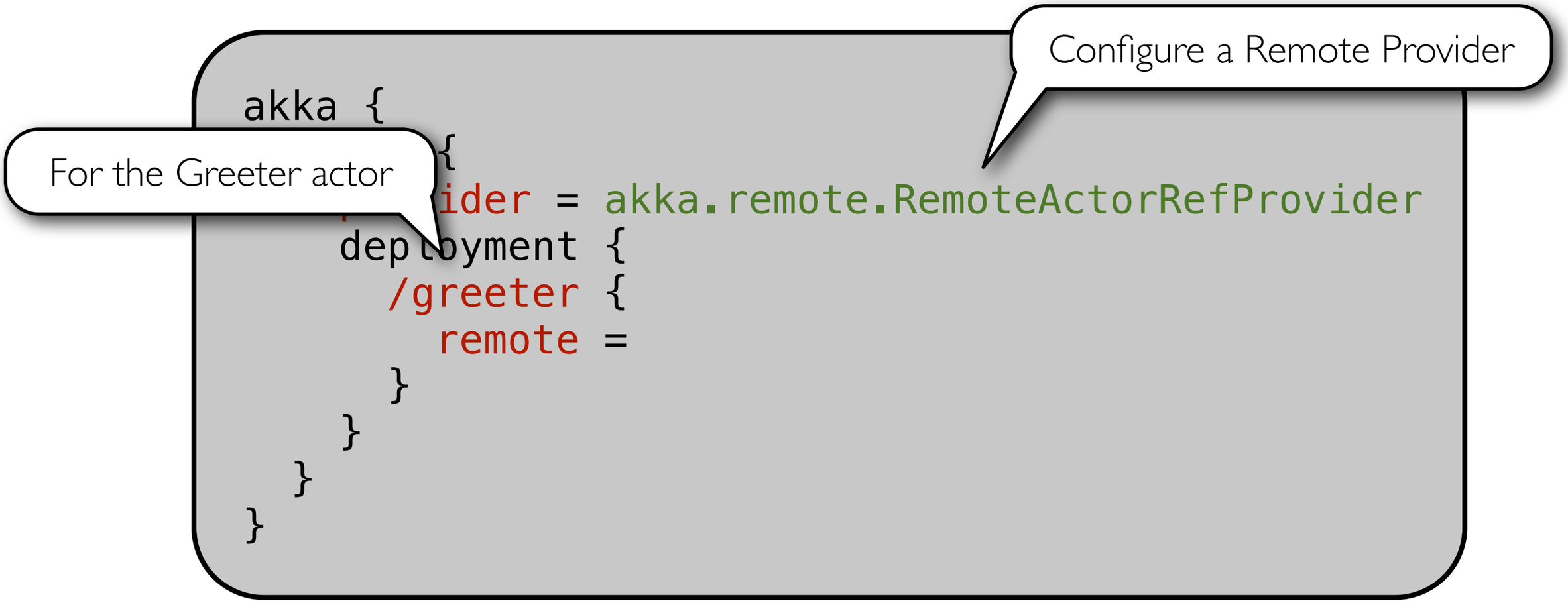
```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote =
      }
    }
  }
}
```

Typesafe

akka

Remote deployment

Just feed the ActorSystem with this configuration



Typesafe

akka

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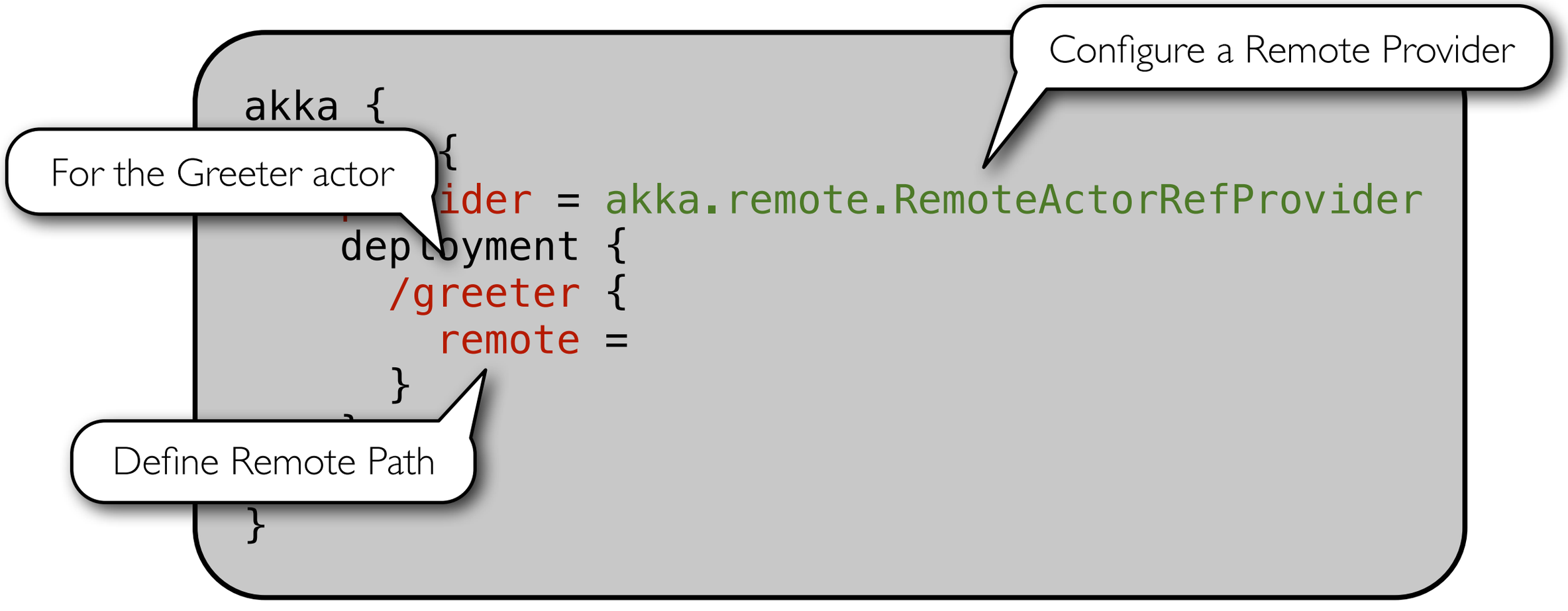

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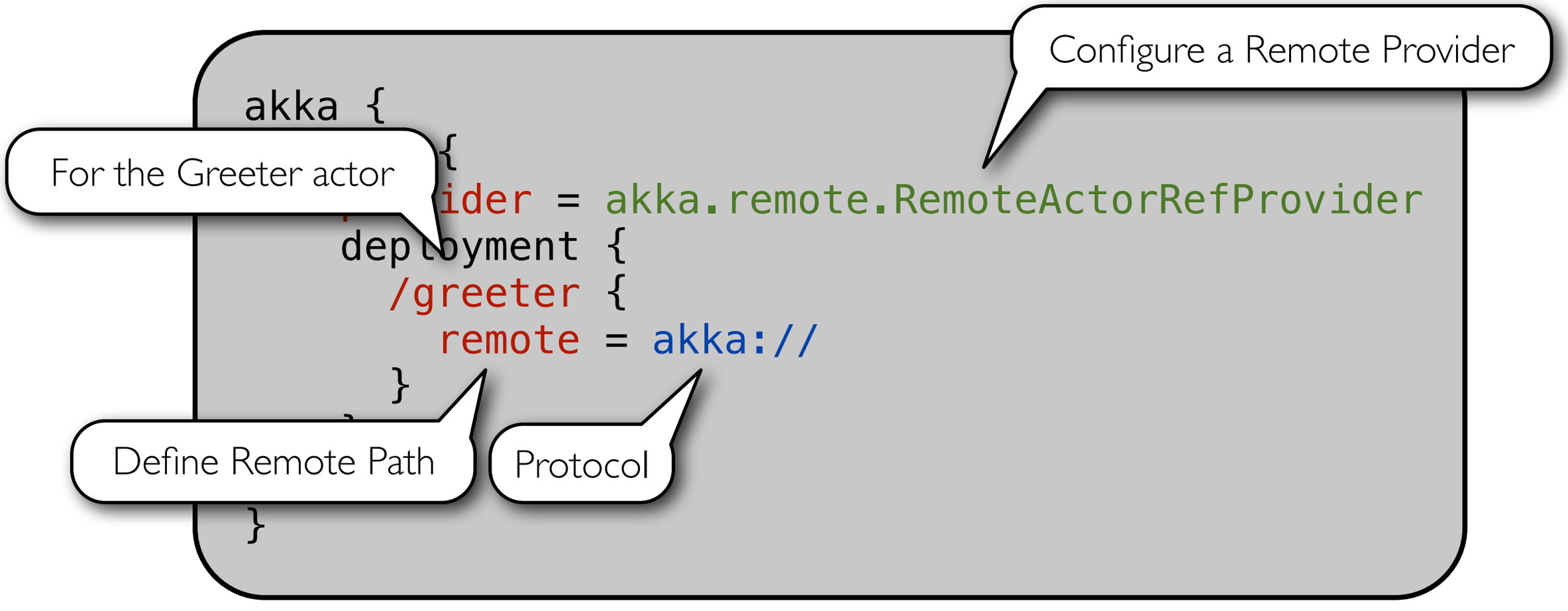

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akka

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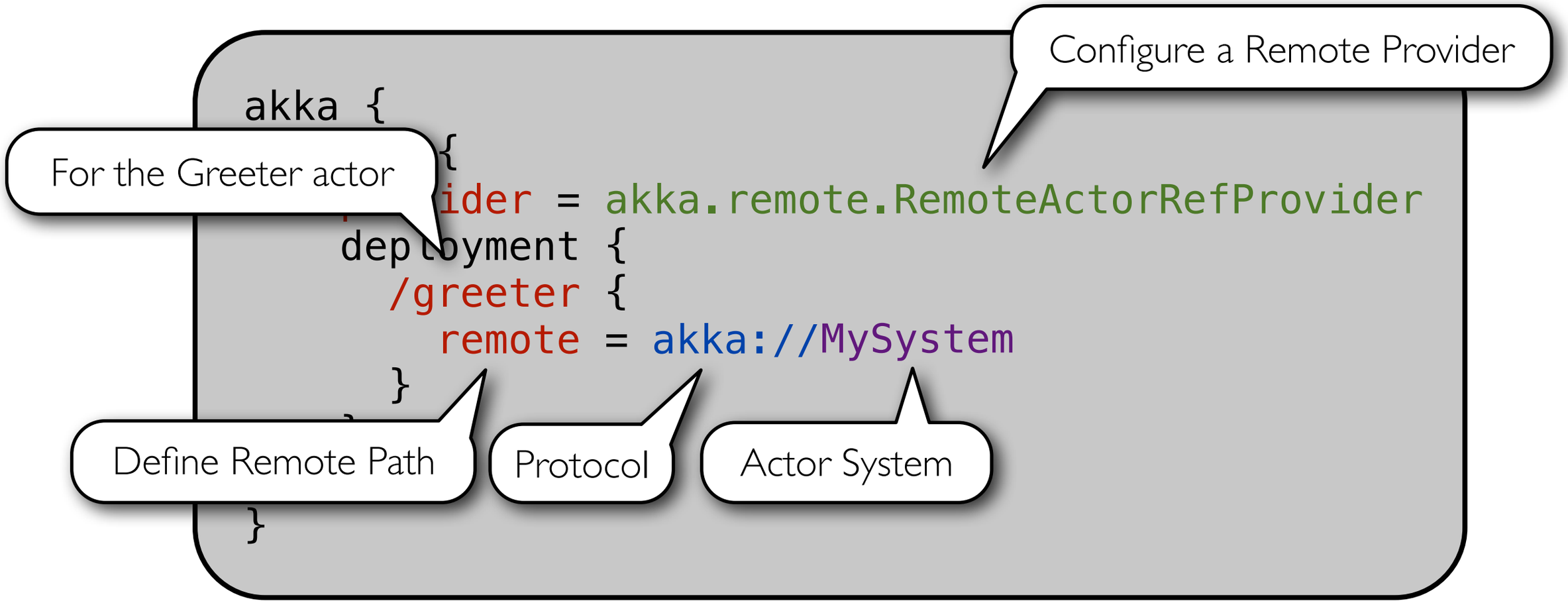

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akka

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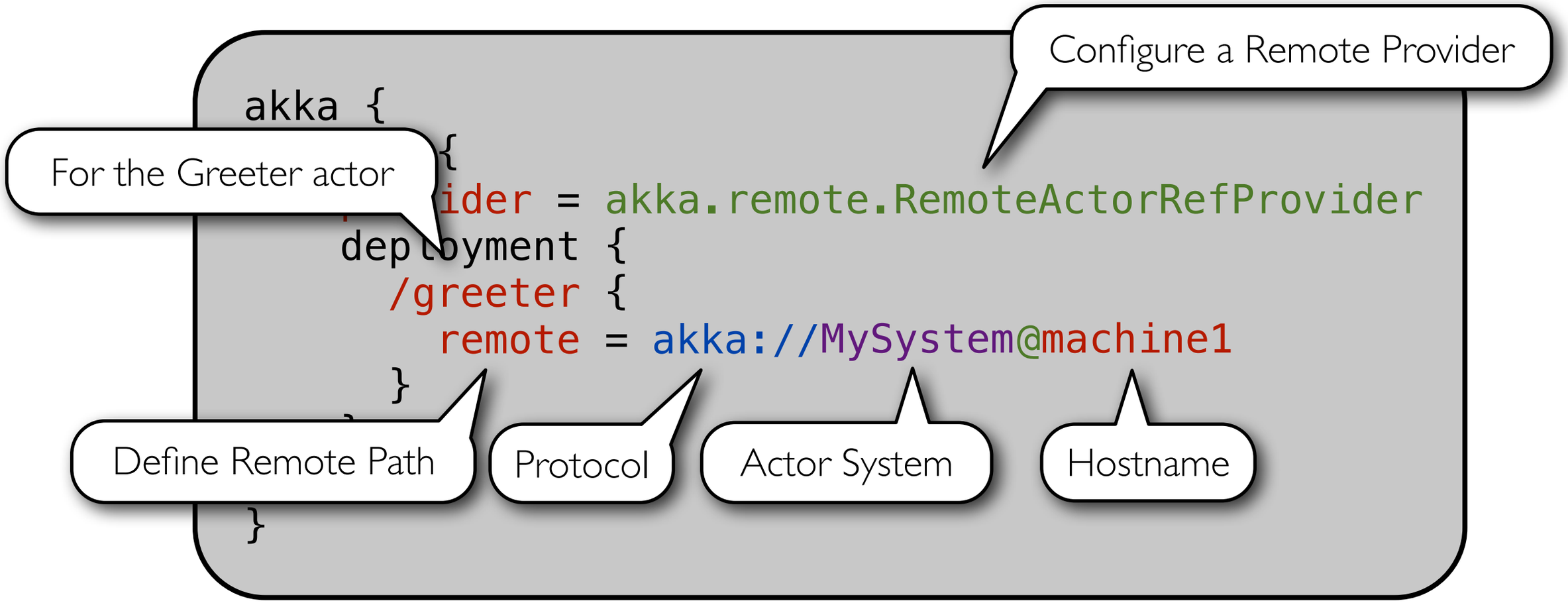

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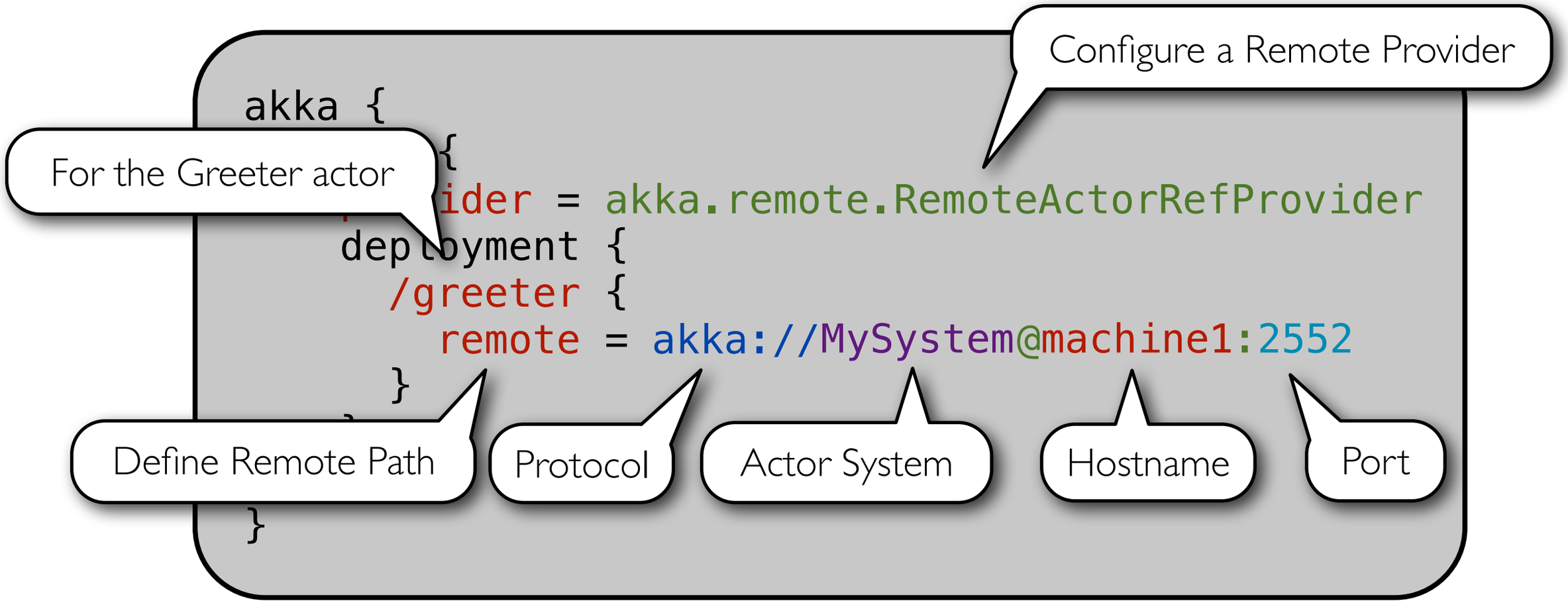

Typesafe

akka

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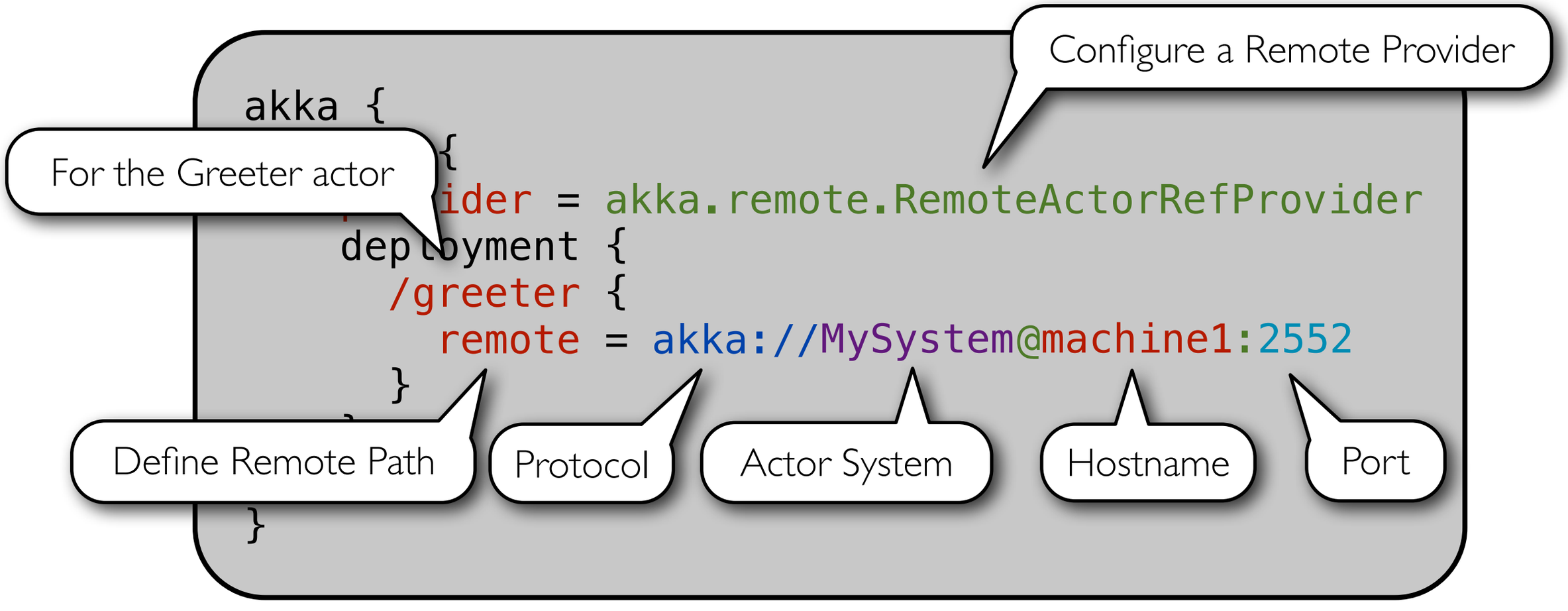

Zero code changes

Typesafe

akka

Routers

Load Balancing

Routers

```
ActorRef routerActor =
  getContext().actorOf(
    new Props(ExampleActor.class).
    withRouter(new RoundRobinRouter(nrOfInstances))
  );
```

Router + Resizer

```
Resizer resizer =
  new DefaultResizer(lowerBound, upperBound);

ActorRef routerActor =
  getContext().actorOf(
    new Props(ExampleActor.class).
    withRouter(new RoundRobinRouter(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

Typesafe

akka

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- BECOME - dynamically redefines Actor's behavior

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- BECOME - dynamically redefines Actor's behavior
- Triggered reactively by receive of message
- 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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- Implement graceful degradation
- Spawn up (empty) generic Worker processes that can become whatever the Master currently needs
- Other: Use your imagination!
- Very useful once you get the used to it

become

```
context.become(new Procedure[Object]() {
  void apply(Object msg) {
    // new body
    if (msg instanceof NewMessage) {
      NewMessage newMsg = (NewMessage)msg;
      ...
    }
  }
});
```

become

Actor context available from within an Actor

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      ...
    }
  }
});
```

Failure Recovery

Failure Recovery in Java/C/C# etc.

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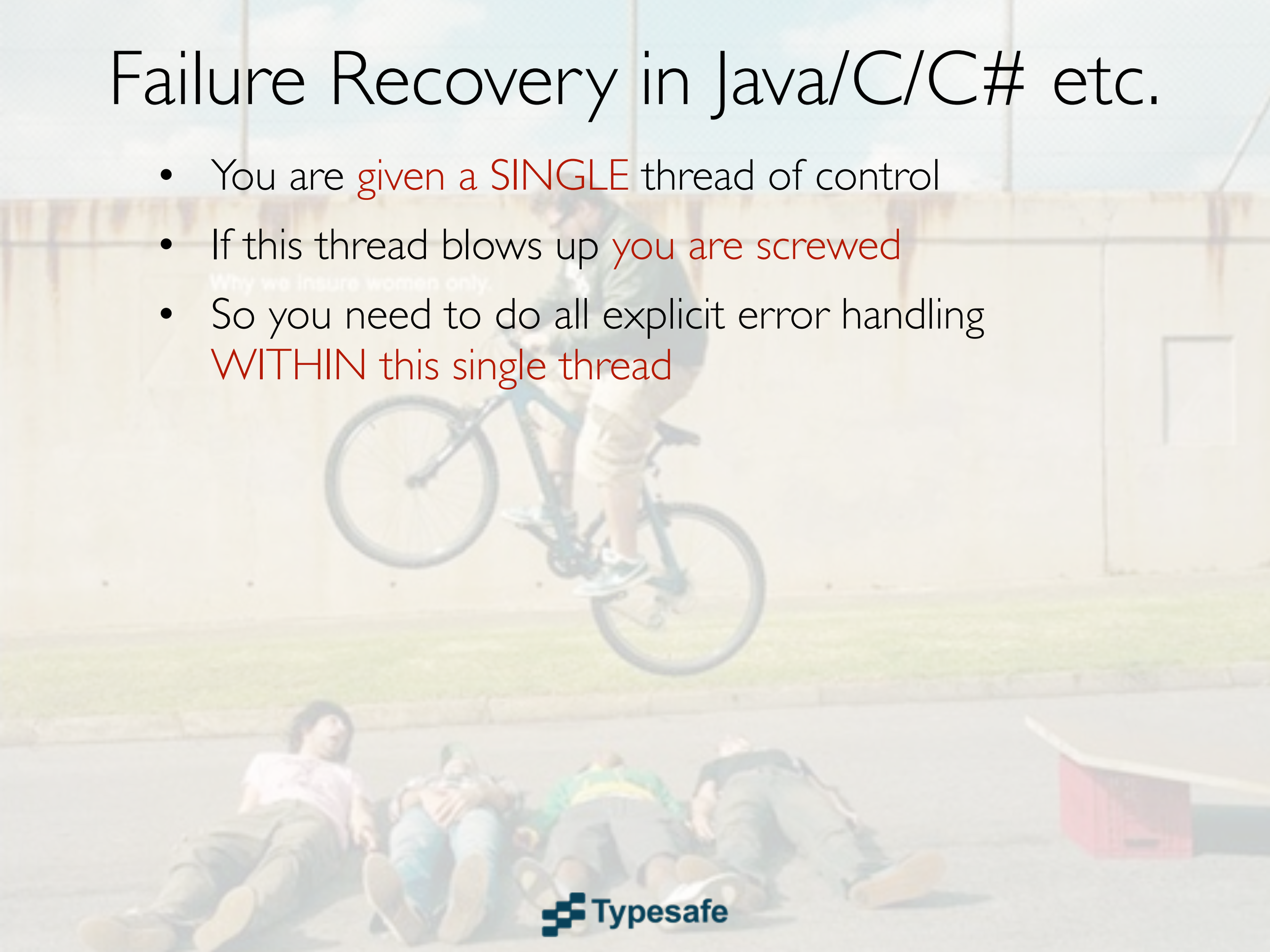

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We can do better than this!!!

Typesafe

Just

LET IT CRASH

Typesafe

akka

Typesafe

akka

4. SUPERVISE

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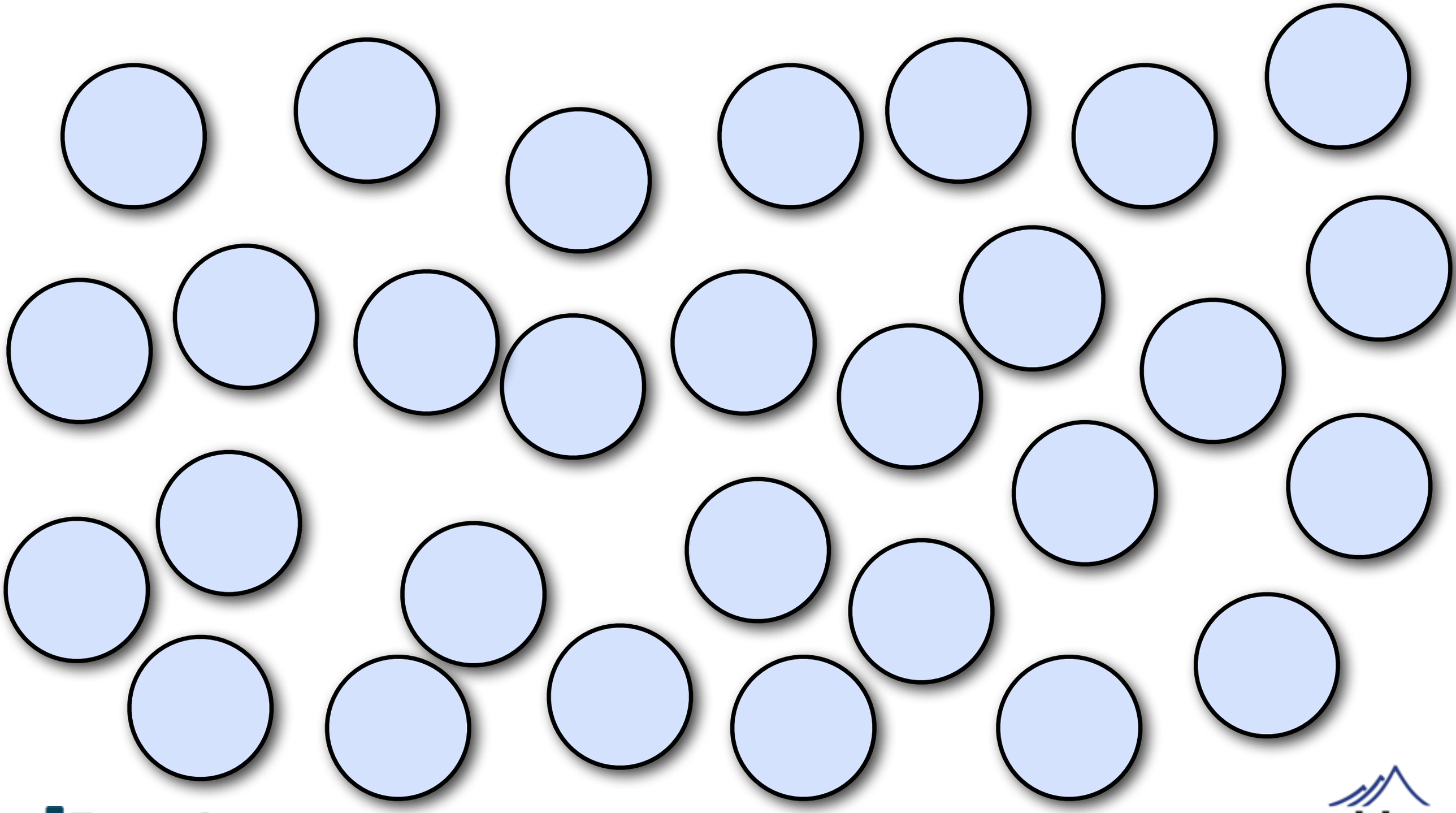
- SUPERVISE - manage another Actor's failures
- Error handling in actors is handle by letting Actors monitor (supervise) each other for failure
- This means that if an Actor crashes, a notification will be sent to his supervisor, who can react upon the failure
- This provides clean separation of processing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

Fault-tolerant onion-layered Error Kernel

Error Kernel



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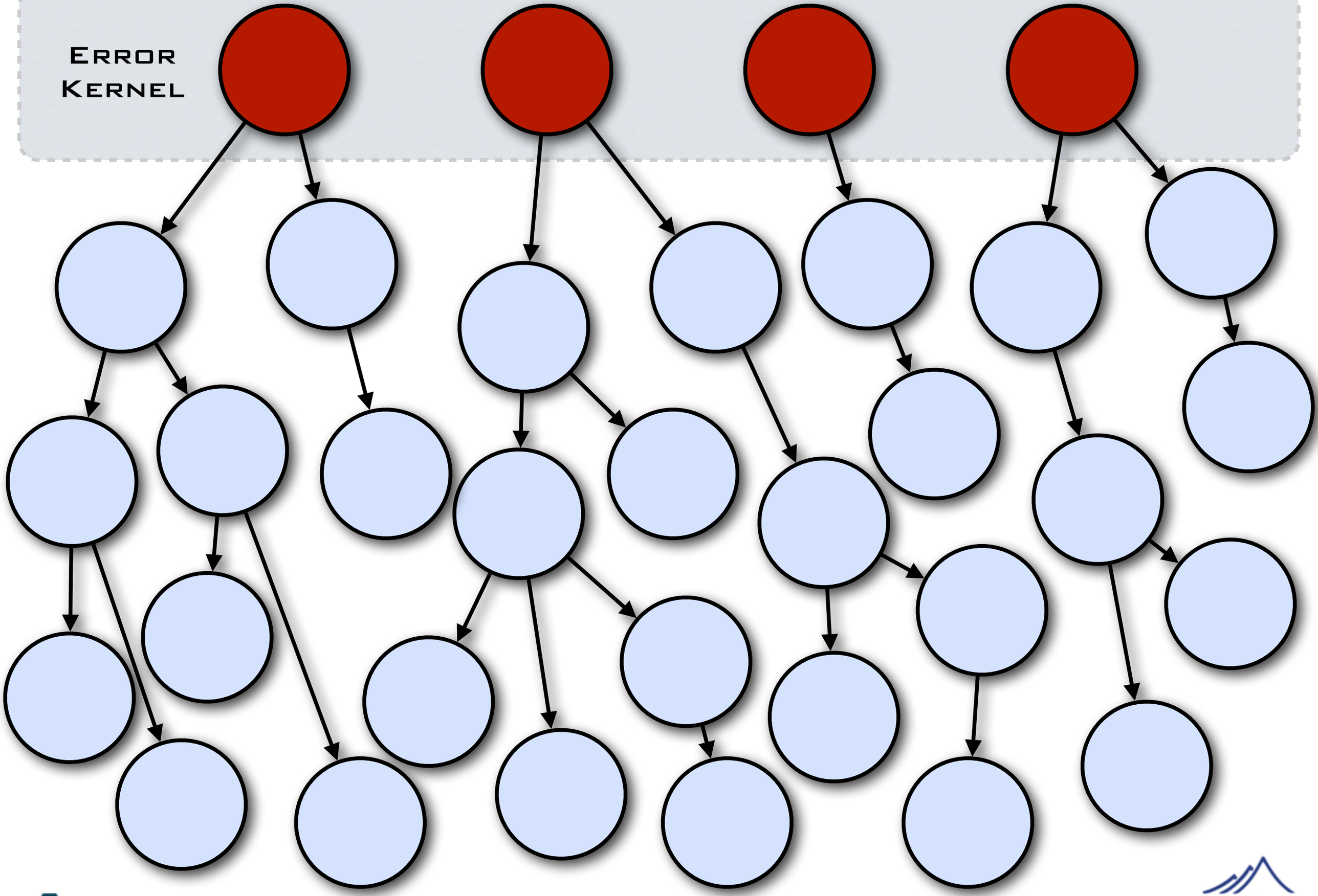

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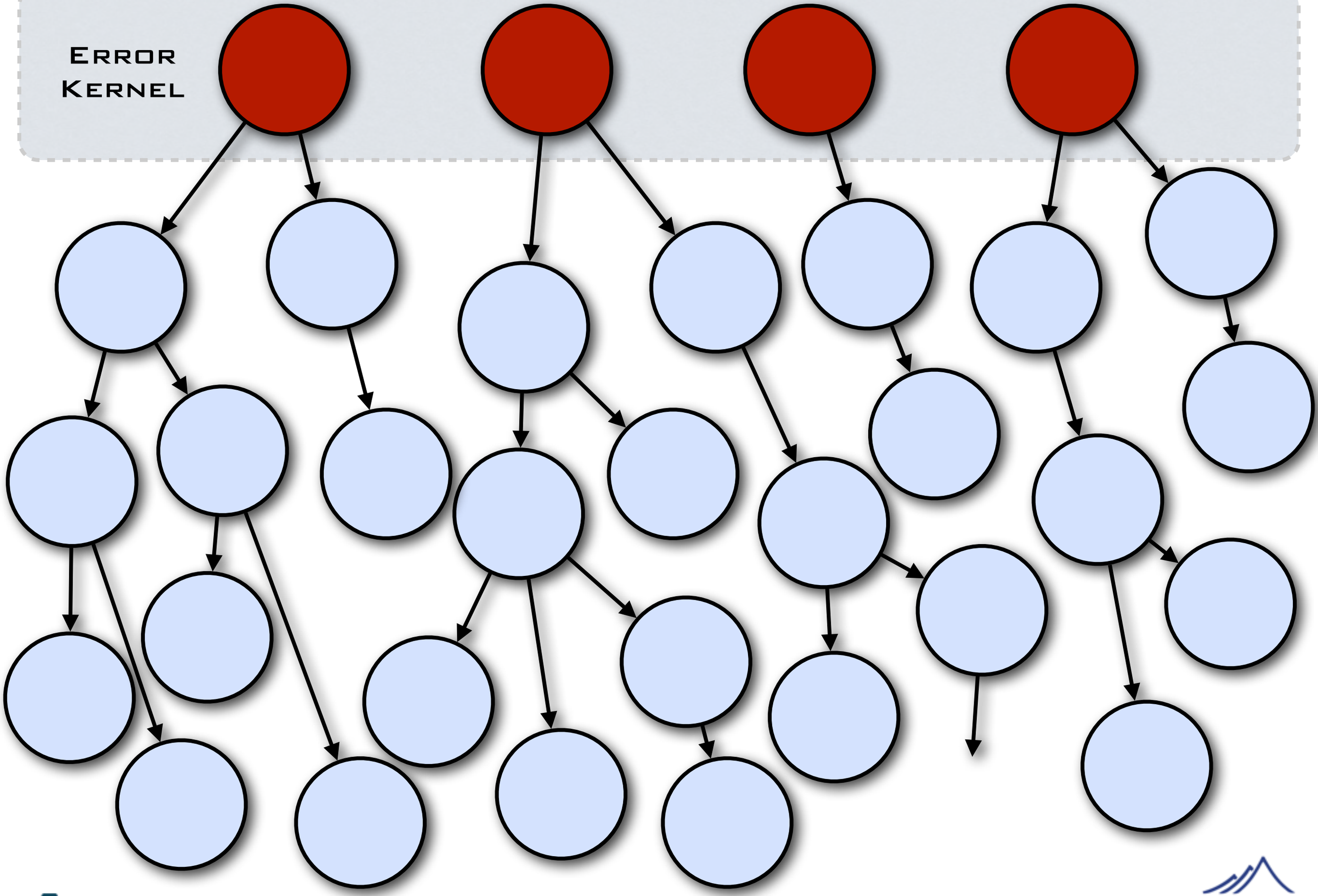

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akka

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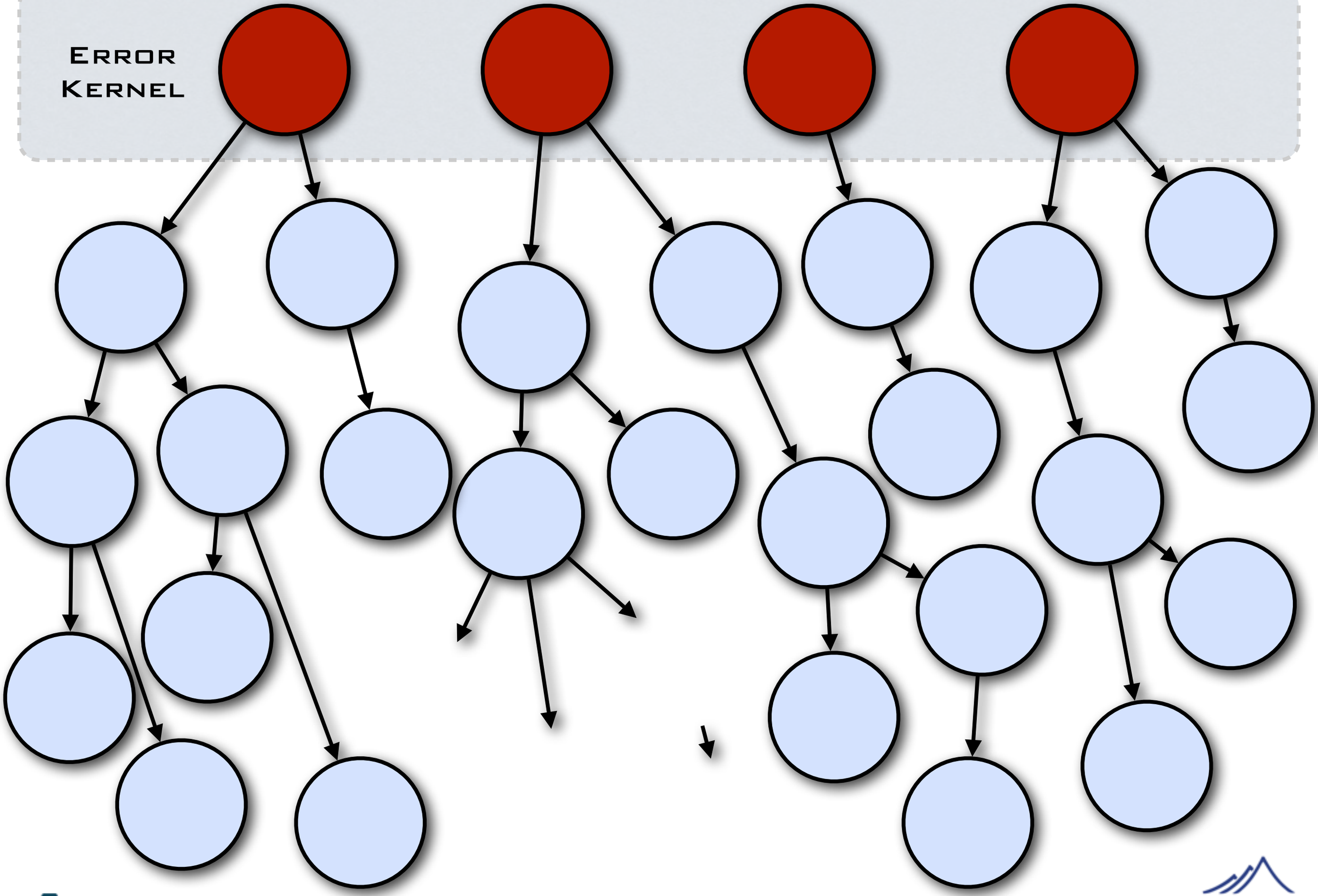

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akka

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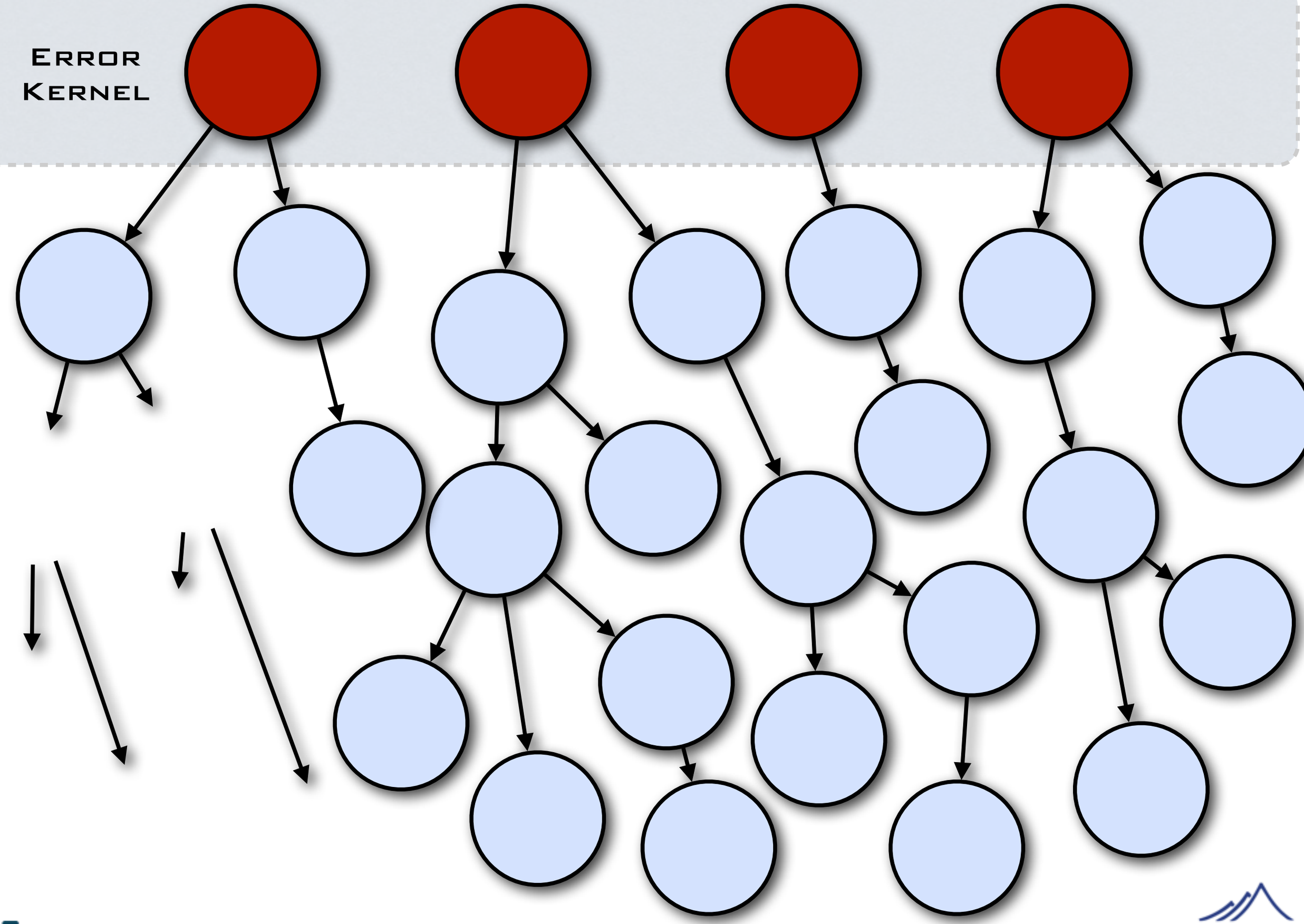

Typesafe

akka

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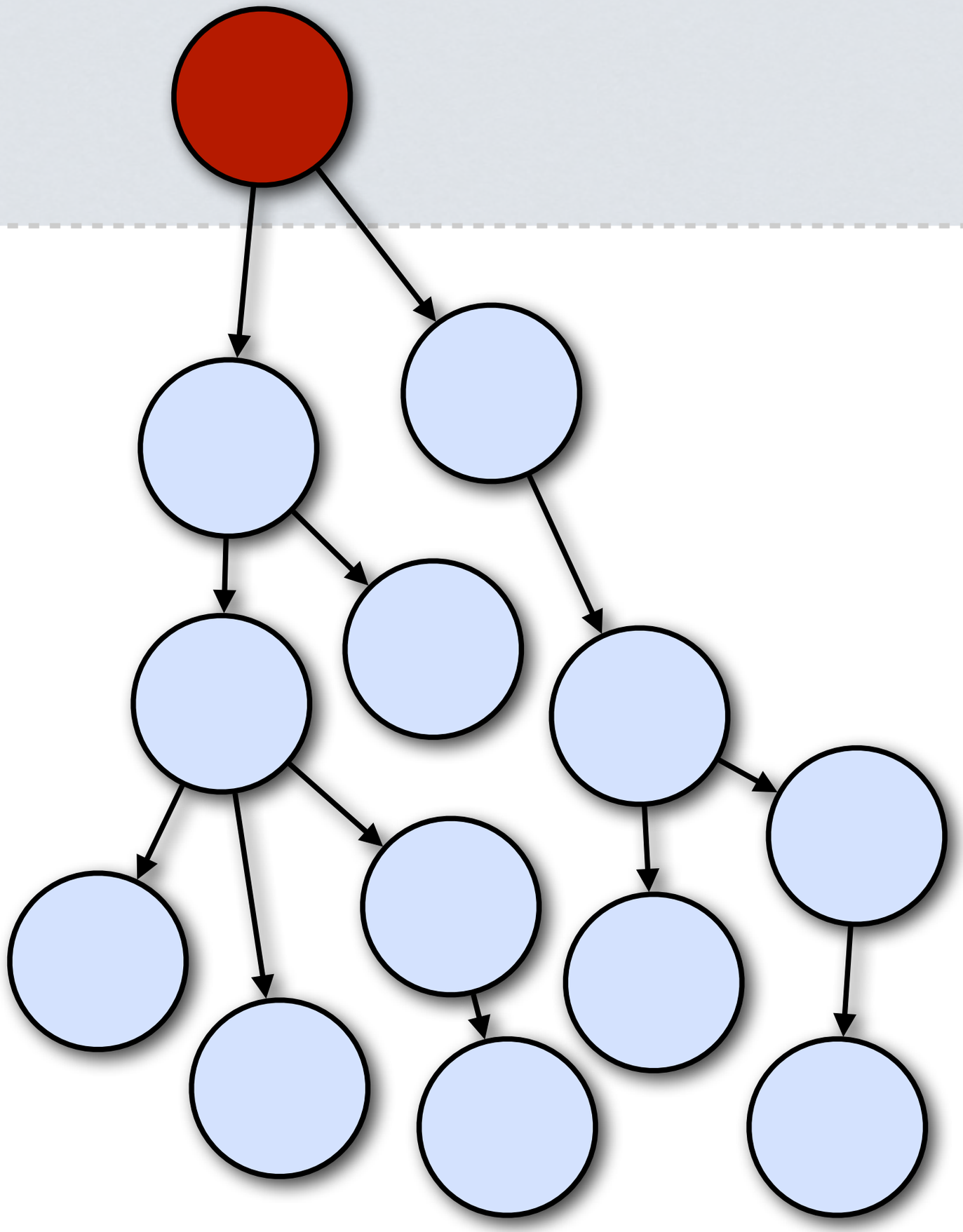
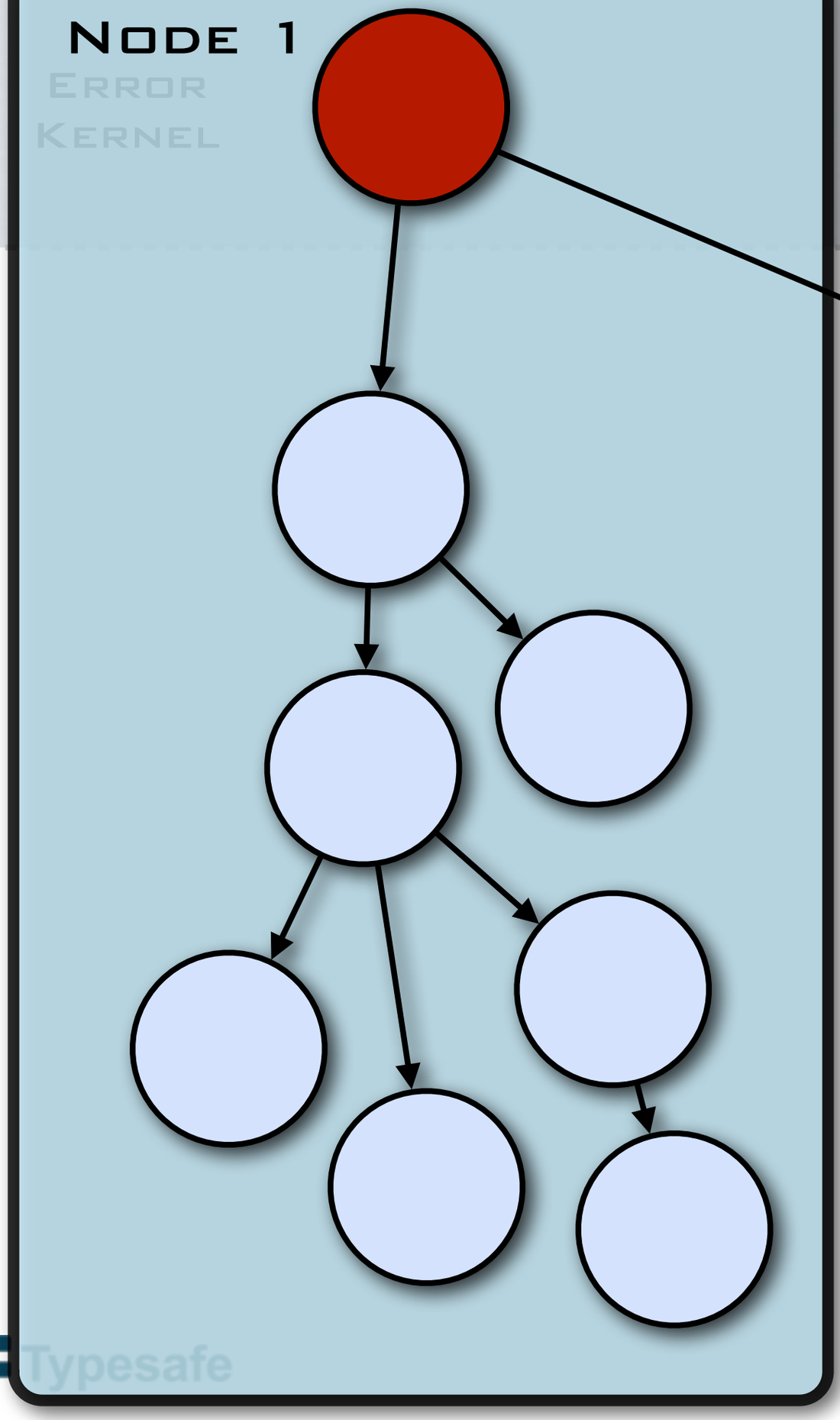
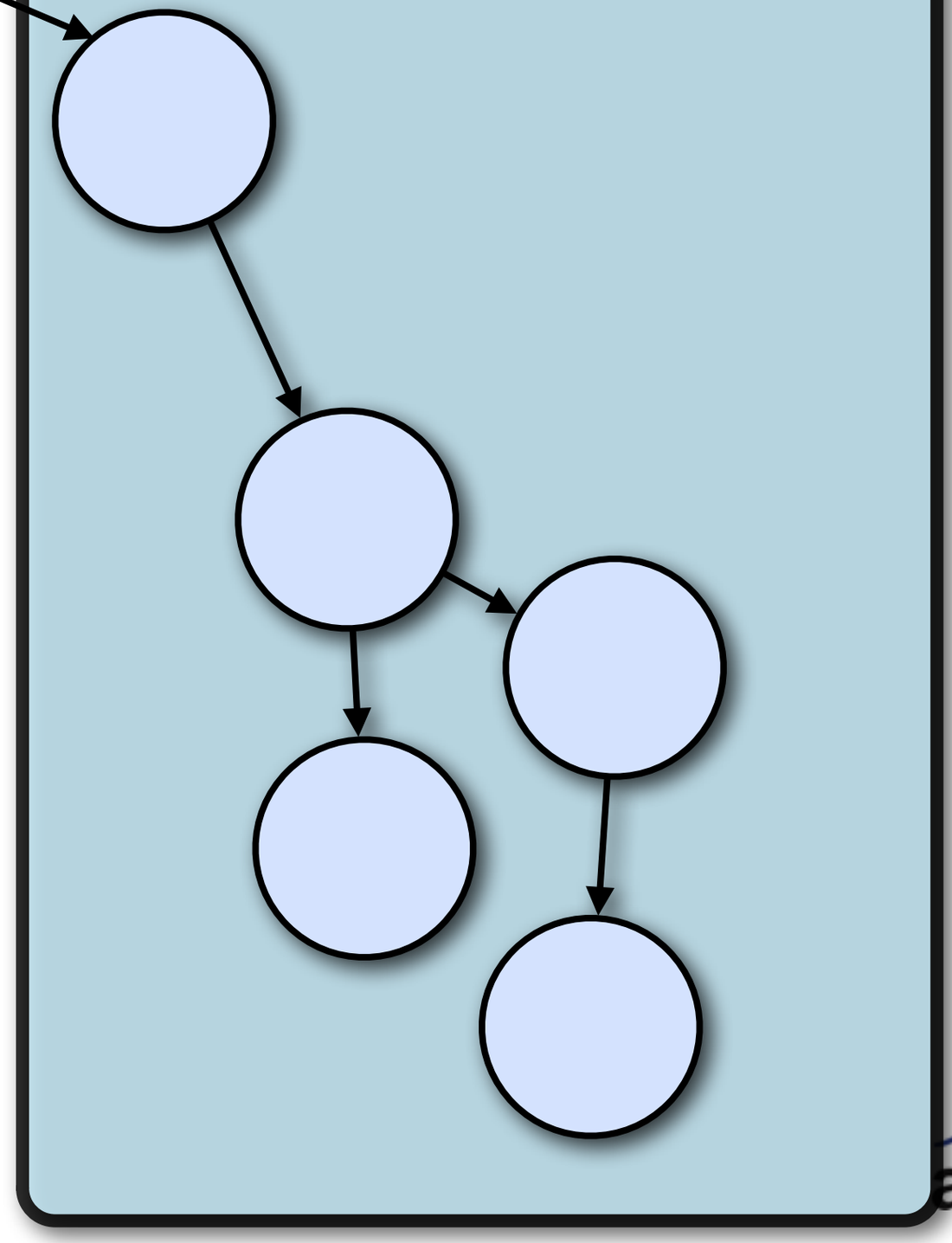


Node 1

Error Kernel



Node 2



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SUPERVISE Actor

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

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```
class Supervisor extends UntypedActor {
  private SupervisorStrategy strategy = new OneForOneStrategy(
    10,
    Duration.parse("1 minute"),
    new Function<Throwable, Directive>() {
      @Override public Directive apply(Throwable t) {
        if (t instanceof ArithmeticException)       return resume();
        else if (t instanceof NullPointerException) return restart();
        else                                        return escalate();
    }
  });

  @Override public SupervisorStrategy supervisorStrategy() {
```

Typesafe

akka

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        else                                        return escalate();
    }
  });

  @Override public SupervisorStrategy supervisorStrategy() {
    return strategy;
  }

  ActorRef worker = context.actorOf(new Props(Worker.class));

  public void onReceive(Object message) throws Exception {
    if (message instanceof Integer) worker.forward(message);
  }
}
```

Manage failure

```
class Worker extends UntypedActor {
  …
  @Override
  public void preRestart(Throwable cause, Option<Object> msg){
    … // clean up before restart
  }

  @Override
  public void postRestart(Throwable cause){
    … // init after restart
  }
}
```

This was

Akka **2.0**

Akka **2.1+**

Akka Cluster

Experimental module in 2.1

Highlights

- Automatic cluster-wide deployment
- Decentralized P2P gossip-based cluster membership
- Leader "election"
- Adaptive load-balancing (based on runtime metrics)
- Automatic replication with automatic fail-over upon node crash
- Automatic adaptive cluster rebalancing
- Highly available configuration service

Gossiping Protocol

Gossiping Protocol

Used for:

Gossiping Protocol

Used for:

- Cluster Membership

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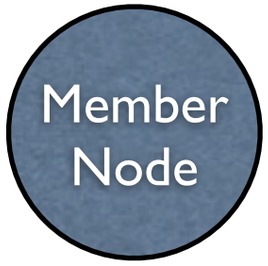
- Leader "election"

Node ring with gossiping members



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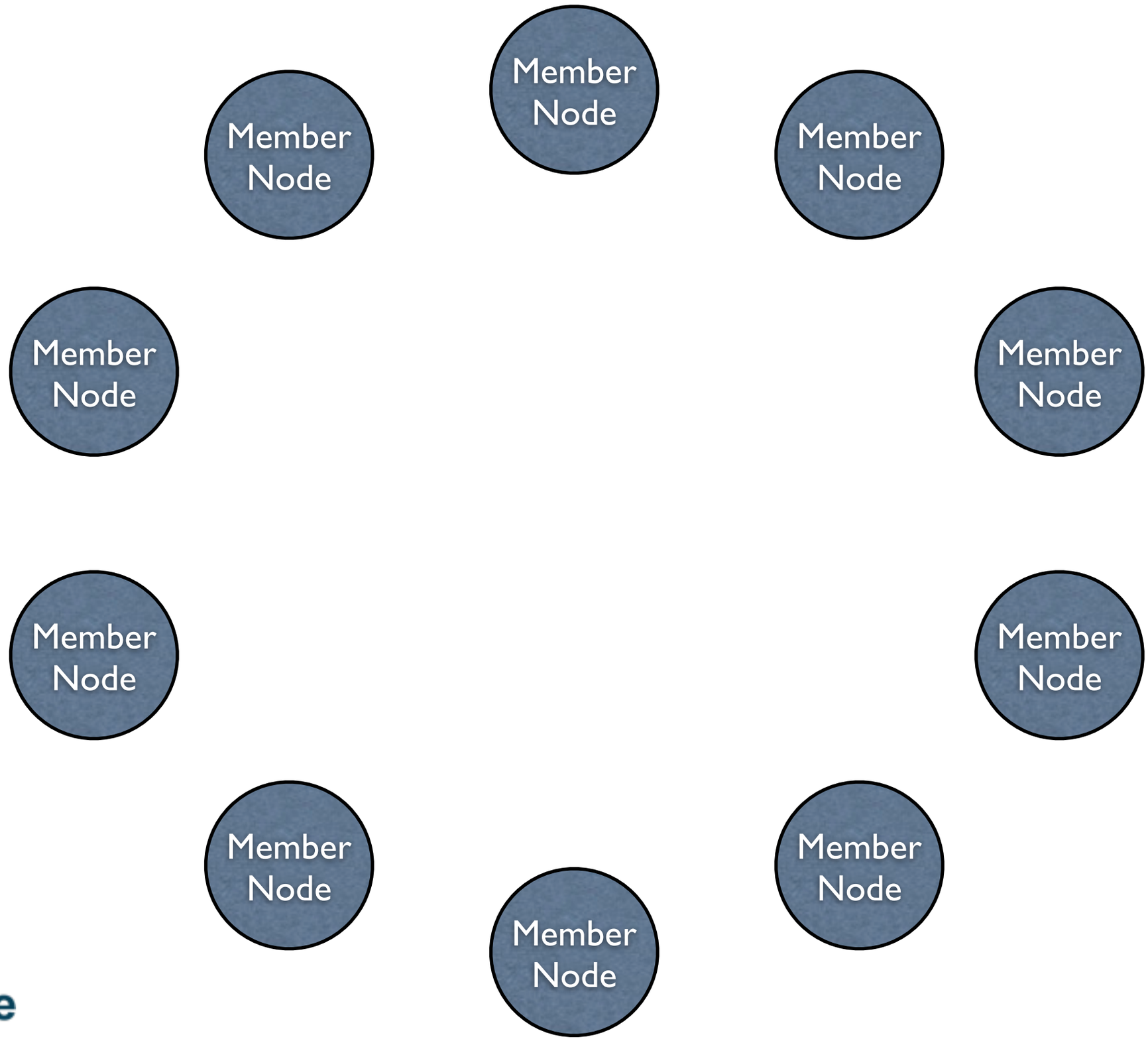

Typesafe

akka

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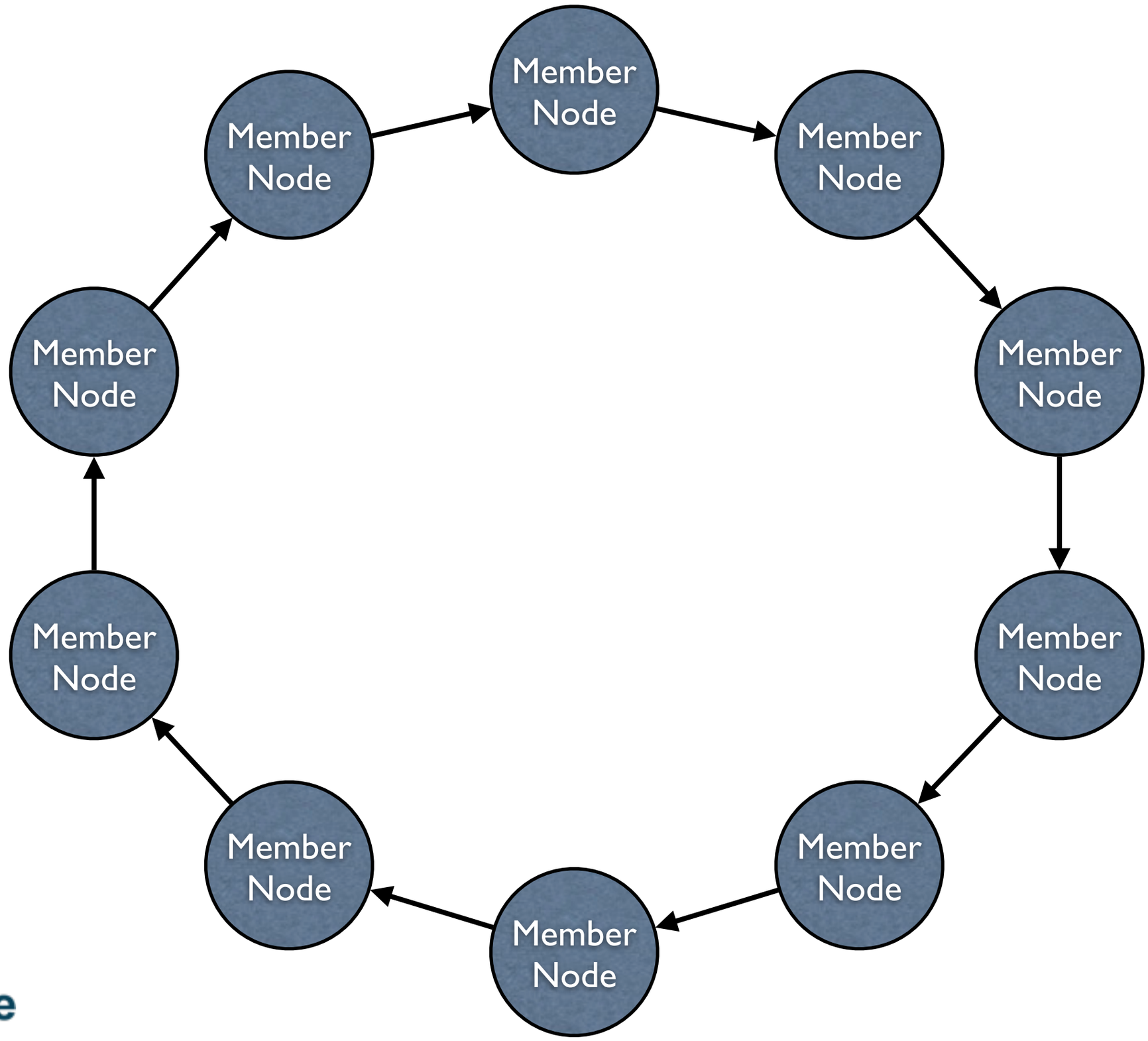

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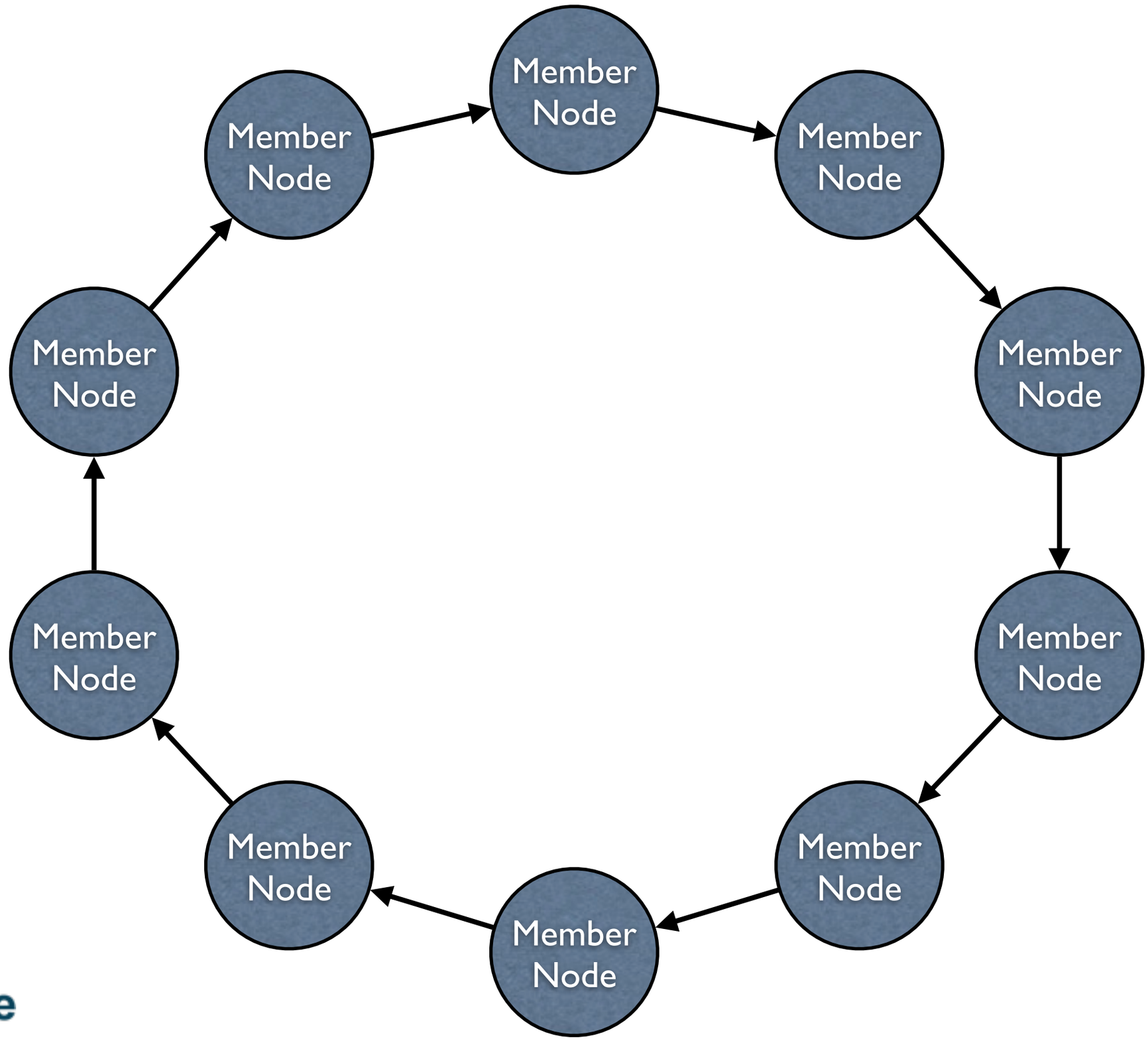

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- Convergence
- Leader can be deterministically determined
- Accrual Failure Detector
- Push/Pull Gossip
- Seed Nodes

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
    }
  }
}
```

Cluster Specification

doc.akka.io/docs/akka/snapshot/cluster/cluster.html

Cluster User Guide

doc.akka.io/docs/akka/snapshot/cluster/cluster-usage.html

Cluster Code

github.com/akka/akka/tree/master/akka-cluster

Typesafe **Console**

free for developers later in the fall

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

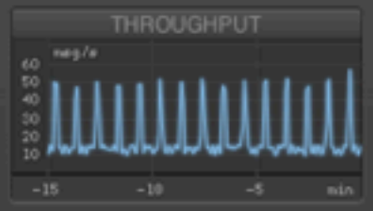
Search (or 'help')

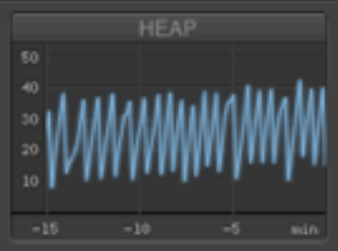
NODES | DISPATCHERS | ACTORS | TAGS

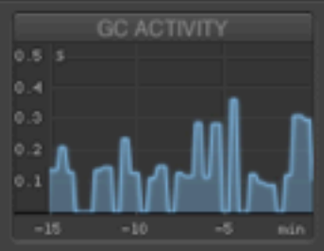
NODES
Nodes in your system

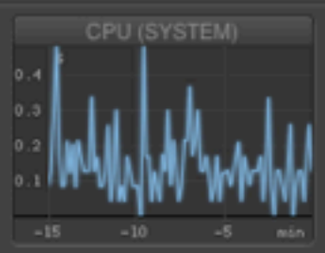
node1
7 actors | 2 dispatchers

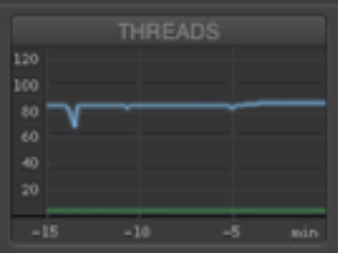
MAX MAILBOX: 68
MEAN MAILBOX: 12.51
PEAK RATES: 35.41 · 26.11
REMOTE ERR.: 0











MACHINE

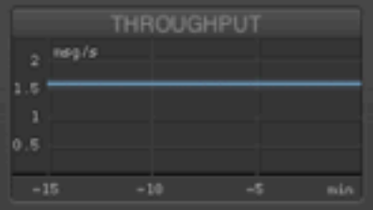
Max Heap:	8105 MB
Used Heap:	1232 MB
Memory Usage:	76.70 %
Running Actors:	6
Processors:	4
Up Time:	13832 mins

NETWORK

Rx Rate:	321 KB/s
Tx Rate:	395 KB/s
TCP Established:	91
TCP Resets:	0
Rx Errors:	0
Tx Errors:	0

node2
2 actors | 1 dispatcher

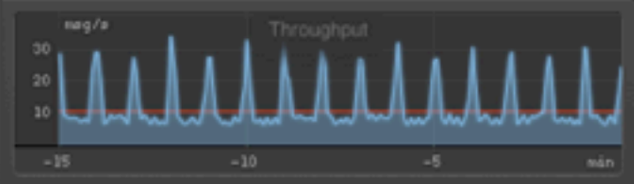
MAX MAILBOX: 1
MEAN MAILBOX: 0
PEAK RATES: - - -
REMOTE ERR.: 0



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

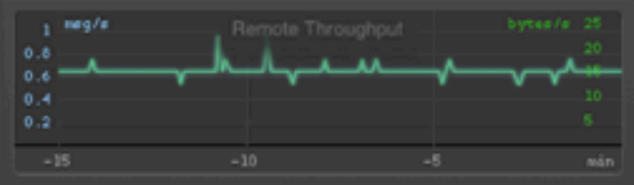
Errors:	30
Warnings:	15
Deadlocks:	20
Dead letters:	0

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:*

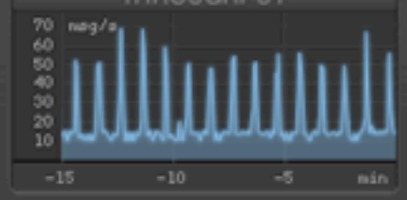
NODES | DISPATCHERS | ACTORS | TAGS

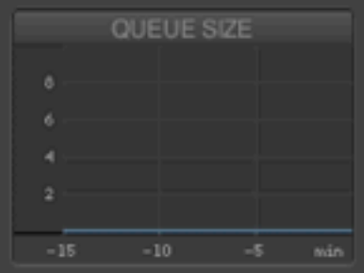
DISPATCHERS
Dispatchers for your query

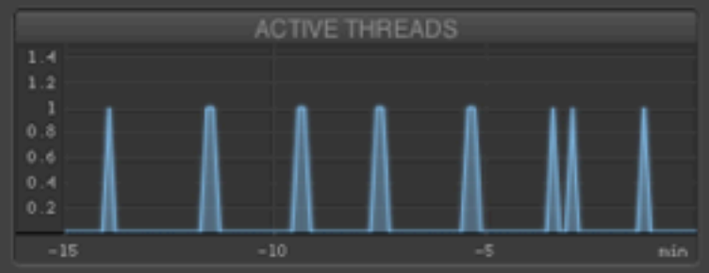
akka.actor.default-dispatcher

NODE: node1

TYPE: Dispatcher-FJ







ACTOR COUNTS

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

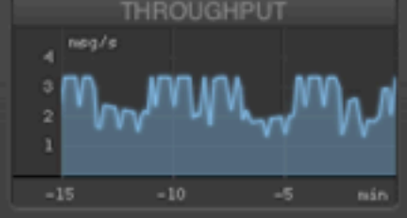
ACTOR RATES

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

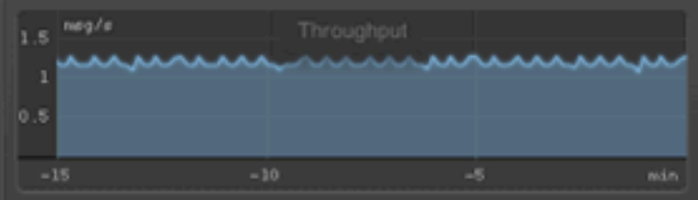
TYPE: Dispatcher-TP

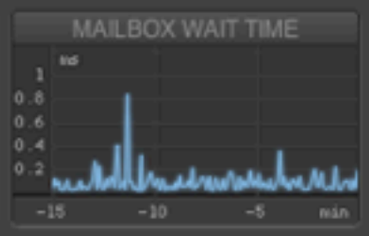


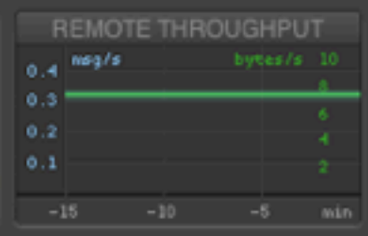
ACTOR
Actor for your query

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

Lots of statistics

- message rates and peaks
- individual trace events linked as trace trees or spans
- latency between predefined or user defined points
- latency distributions
- actor supervisor hierarchies

- actor mailbox queue size and delays
- actor message dispatcher status
- status of remoting and system errors
- metadata about the system
- JVM and OS health

live demo

http://console-demo.typesafe.com

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

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

Routing

TestKit

FSM

Durable Mailboxes

Pub/Sub

EventBus

Camel

IO

Pooling

Microkernel

TypedActor

SLF4J

ZeroMQ

Dataflow

Transactors

Agents

Extensions

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