goto; conference aarhus

UP UP AND OUT:

SCALING SOFTWARE WITH AKKA

Jonas Bonér

CTO Typesafe

@jboner

INTERNATIONAL SOFTWARE DEVELOPMENT CONFERENCE

gotocon.com

Scaling software with

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Scaling
software with

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Akka (Áhkká)

The name comes from the goddess in the Sami (native swedes) mythology that represented all the wisdom and beauty in the world.

It is also the name of a beautiful mountain in Laponia in the north part of Sweden

Manage System Overload

Scale UP & Scale OUT

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How

can we achieve this?

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Let's use Actors

What is an Actor?

What is an Actor?

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

Program at a Higher Level

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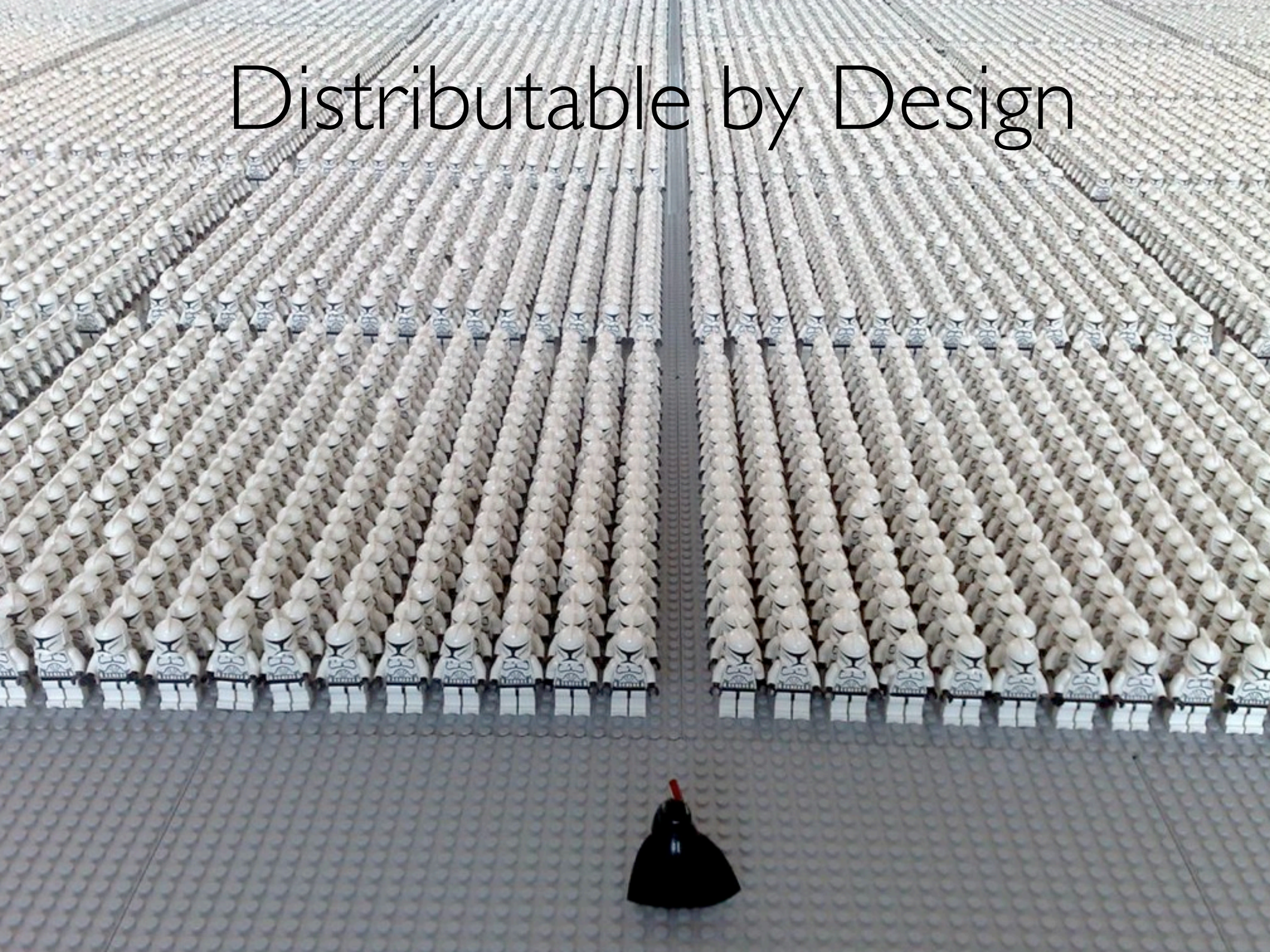
- You get high CPU utilization, low latency, high throughput and scalability - FOR FREE as part of the model
- Proven and superior model for detecting and recovering from errors

Distributable by Design



Distributable by Design

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- You get the PERFECT FABRIC for the CLOUD

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- You get the PERFECT FABRIC for the CLOUD
  - 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

Selection of Akka Production Users

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

What can I use Actors for?

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

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- an out-of-process service

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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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- The fundamental unit of computation that embodies:

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

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  - Processing

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  - Communication
- 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

```
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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}
```

0. DEFINE

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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Create an Actor system

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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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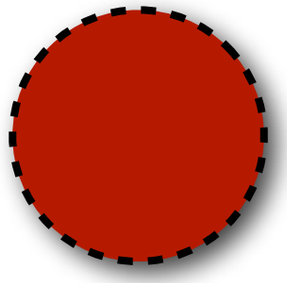
Actors can form hierarchies

Guardian System Actor



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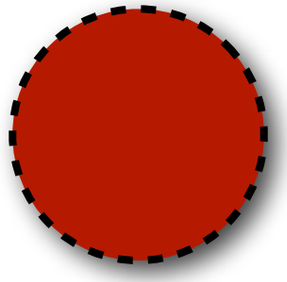
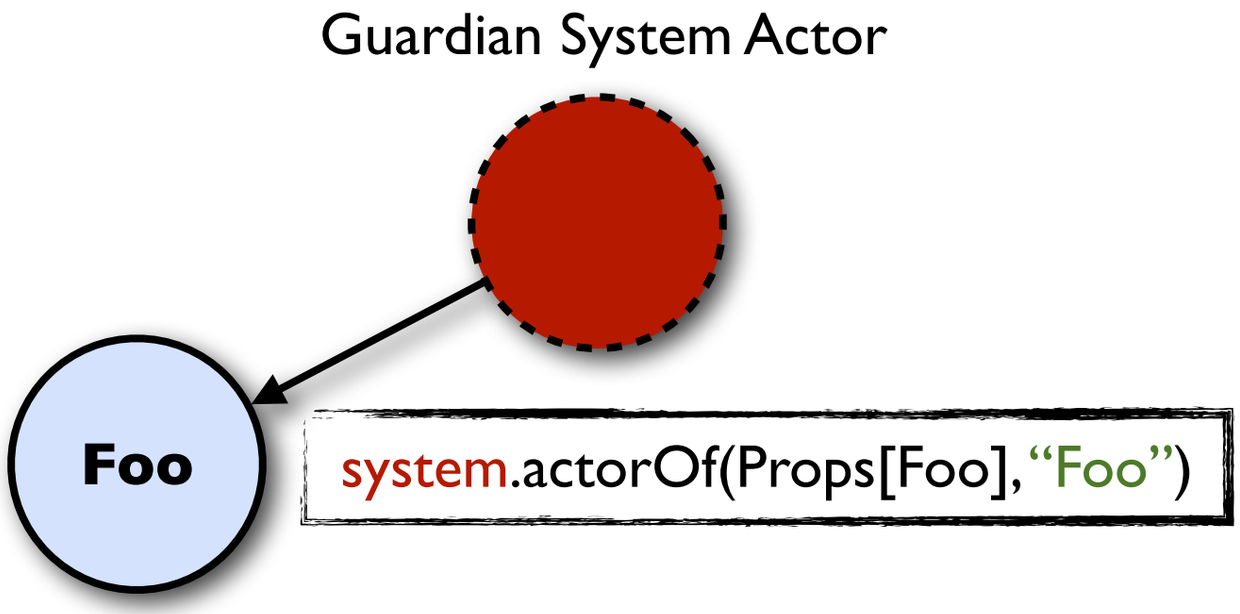


system.actorOf(Props[Foo], "Foo")

Actors can form hierarchies



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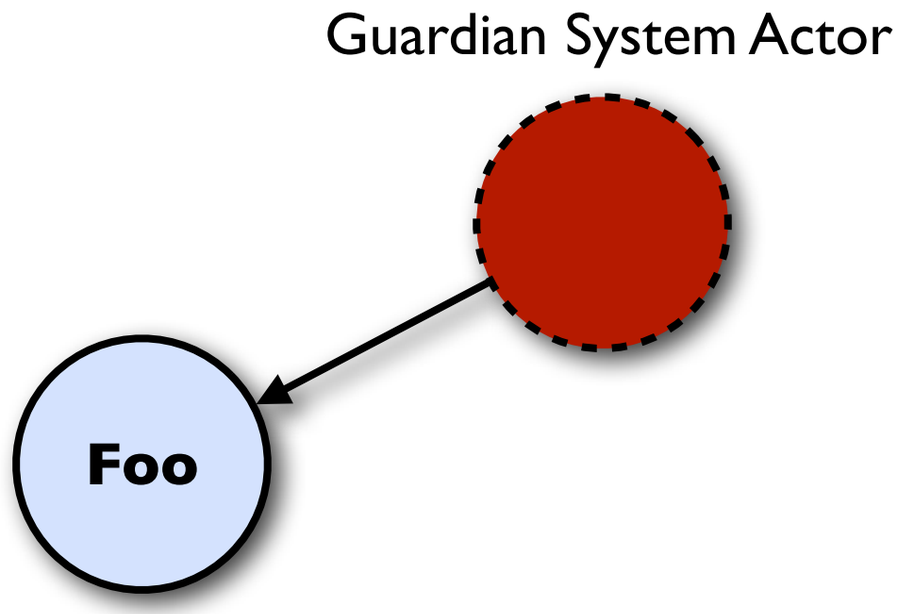
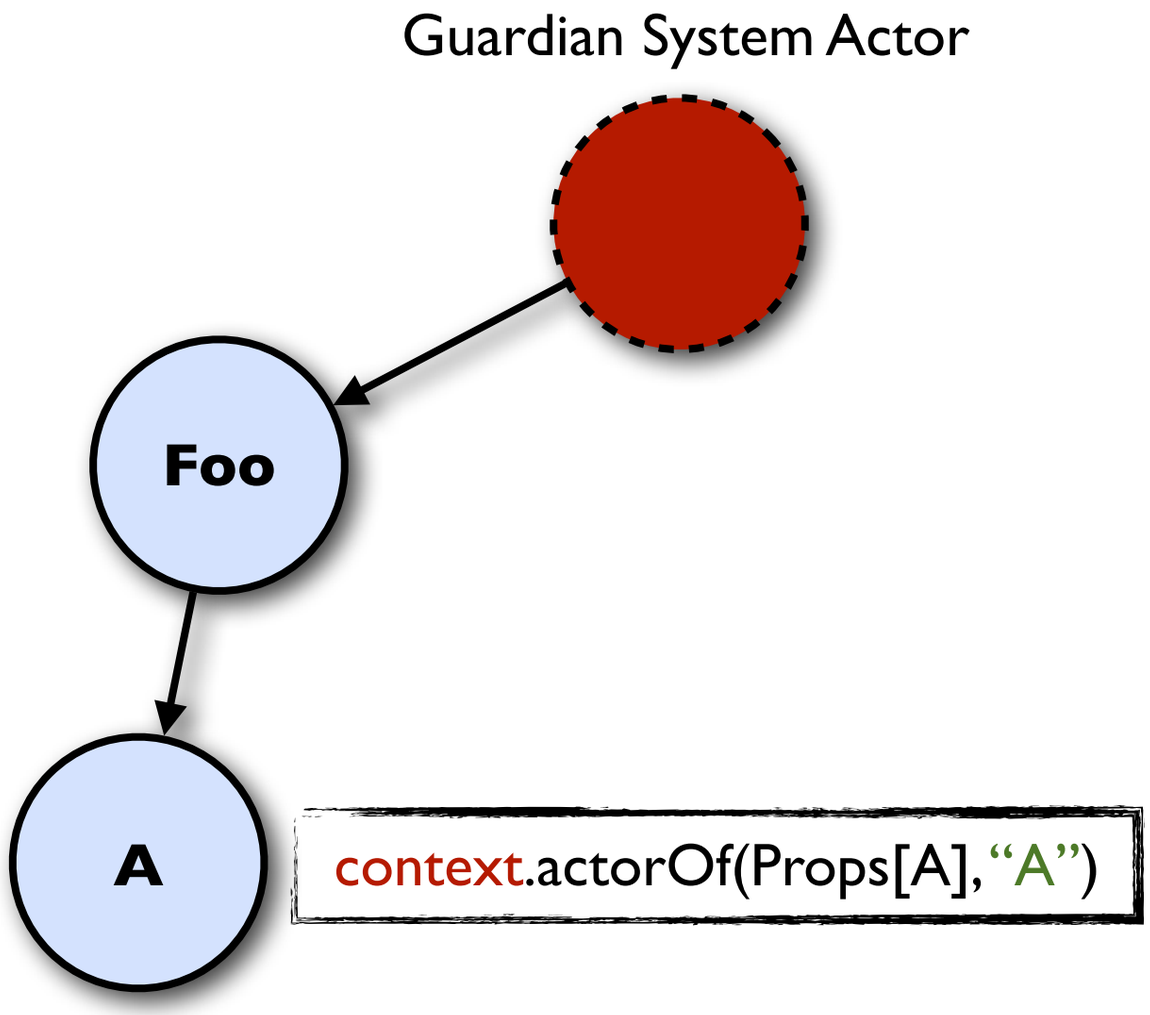



```
context.actorOf(Props[A], "A")
```

Actors can form hierarchies



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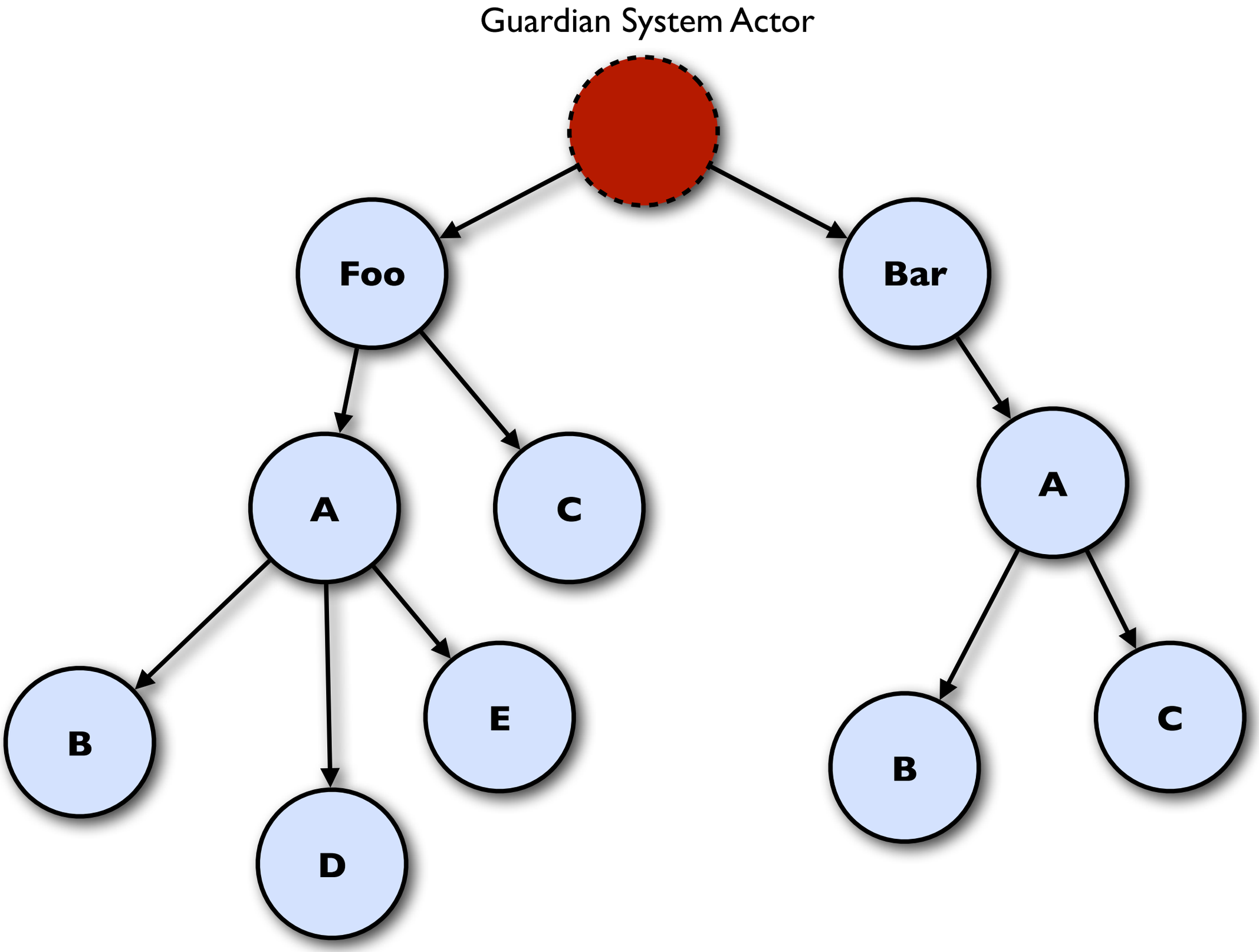
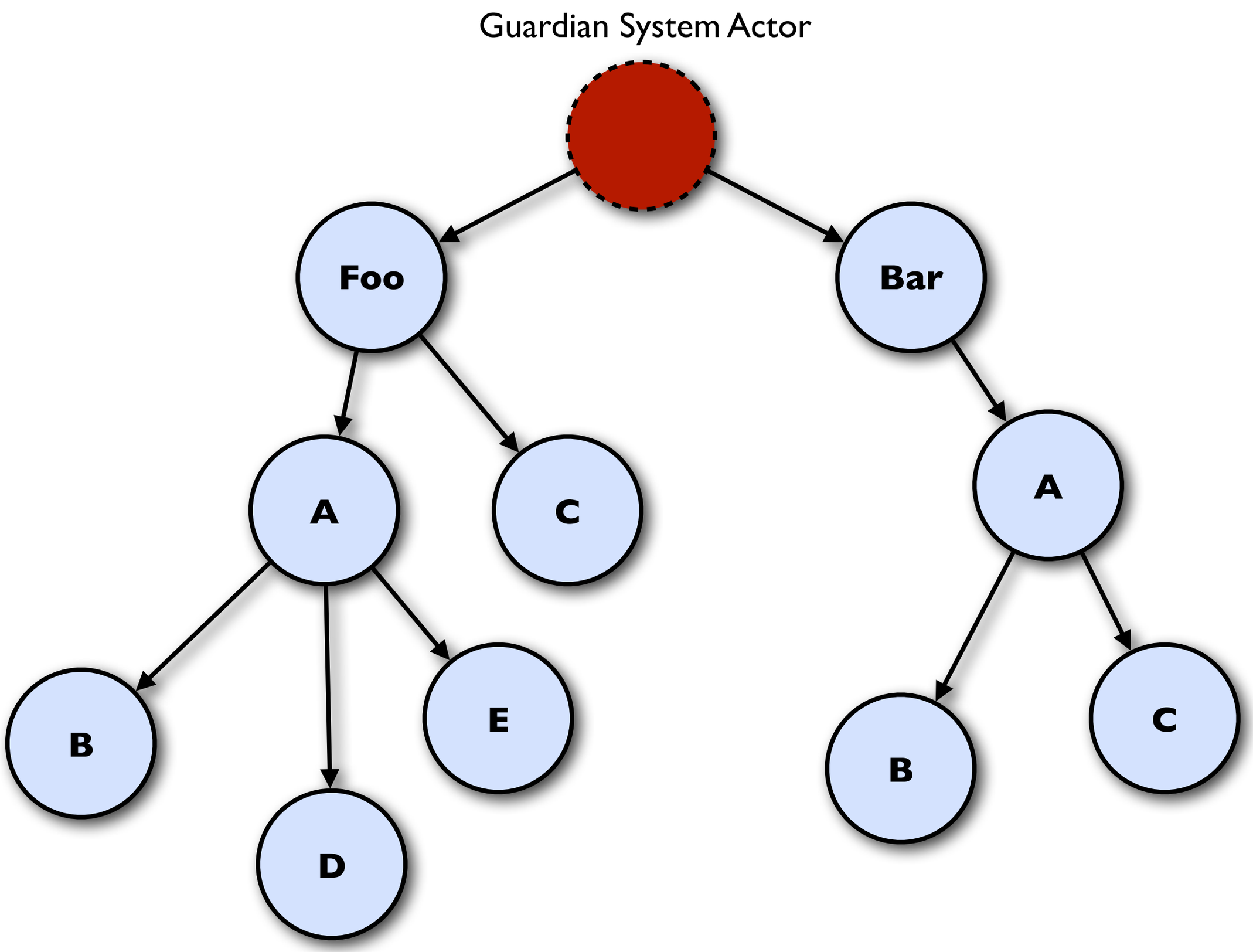


Name resolution - like a file-system



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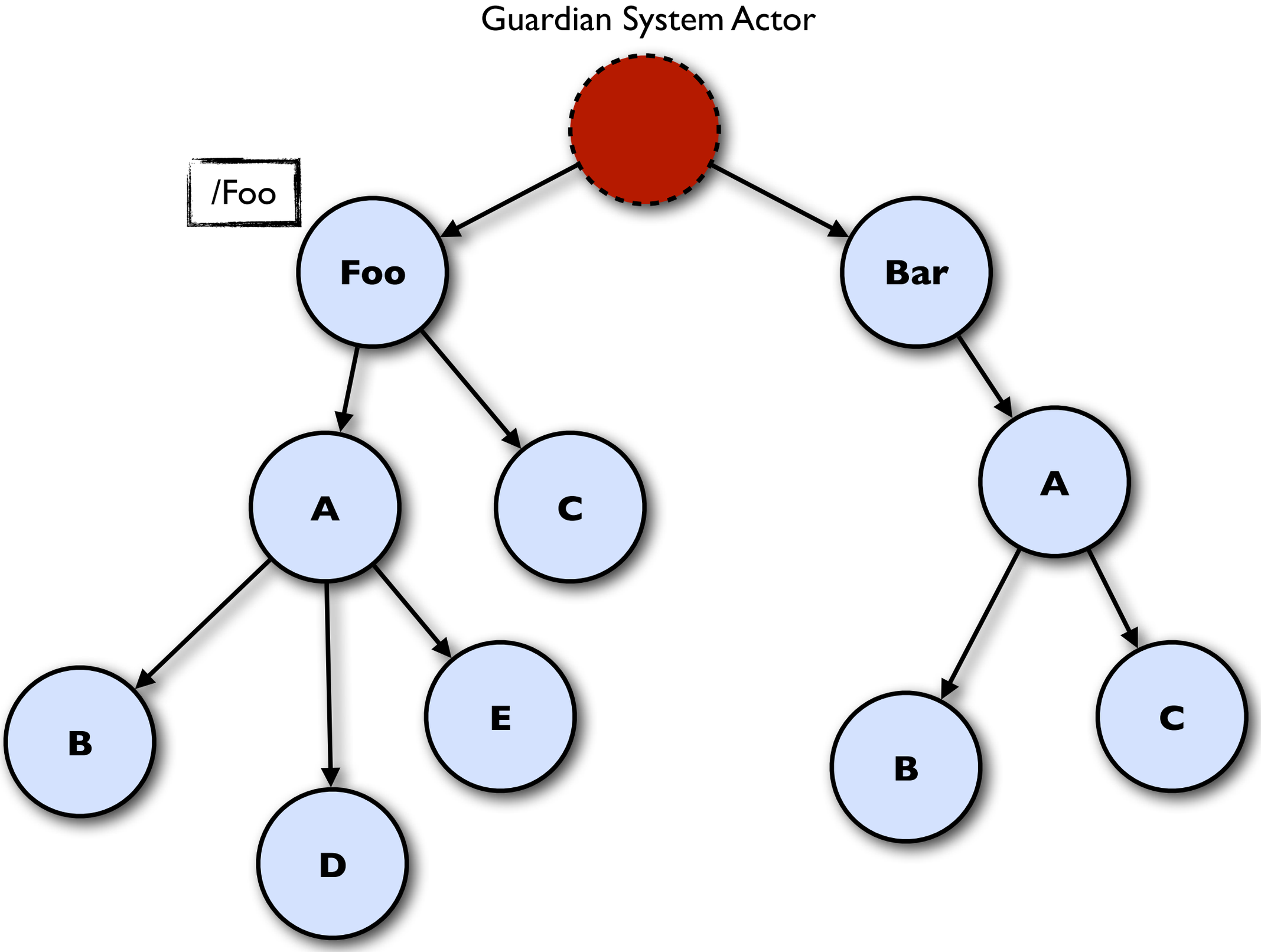

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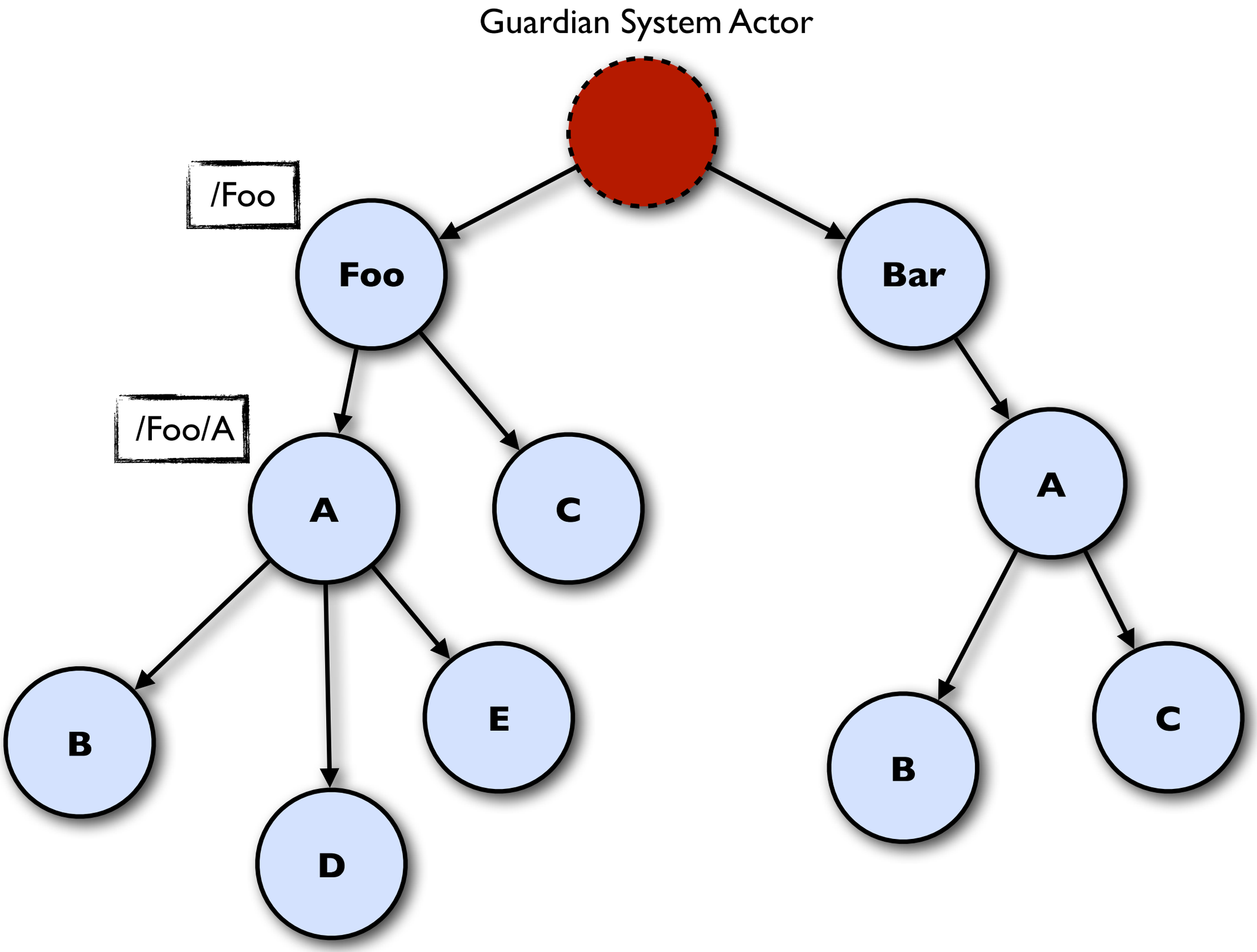

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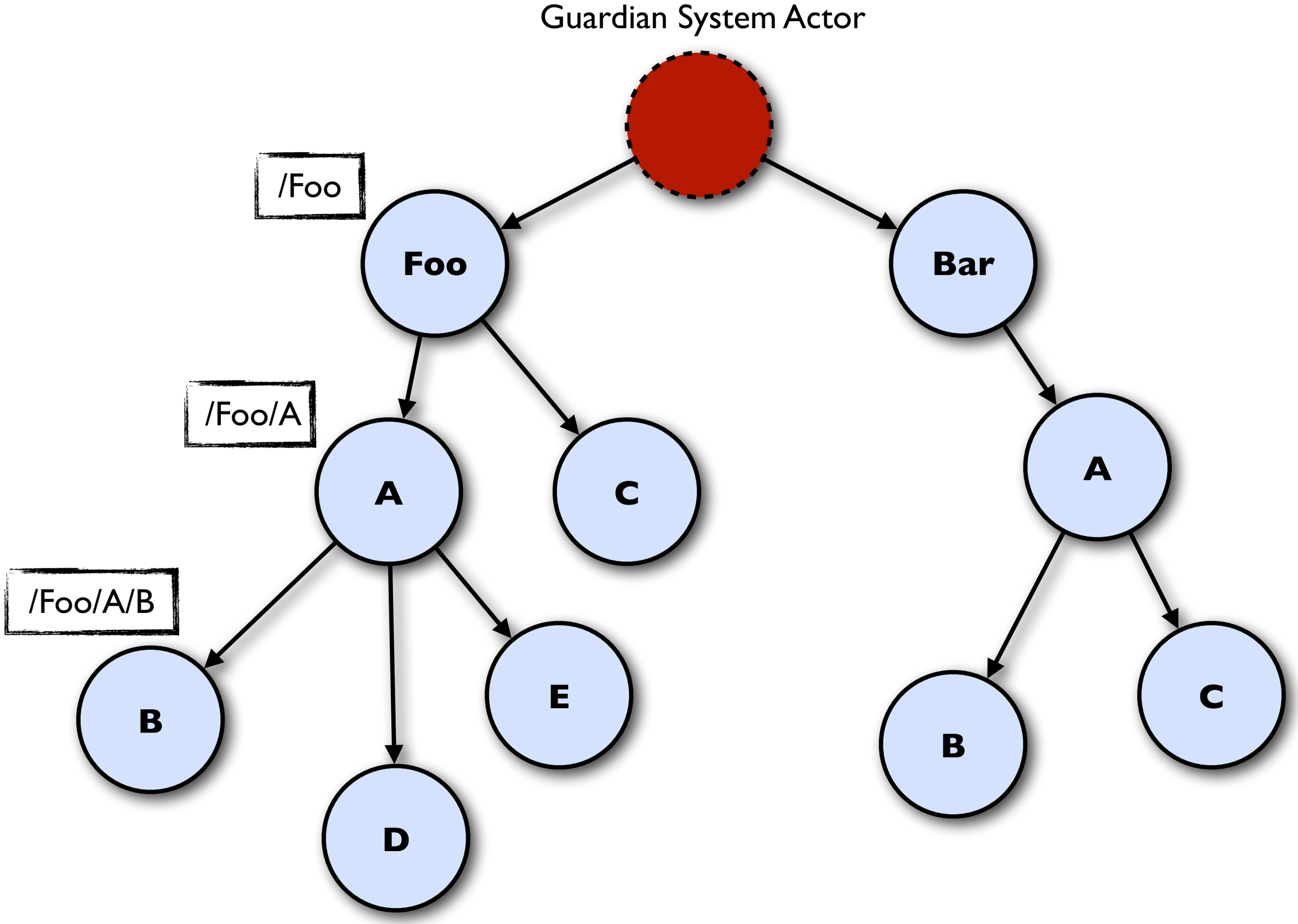

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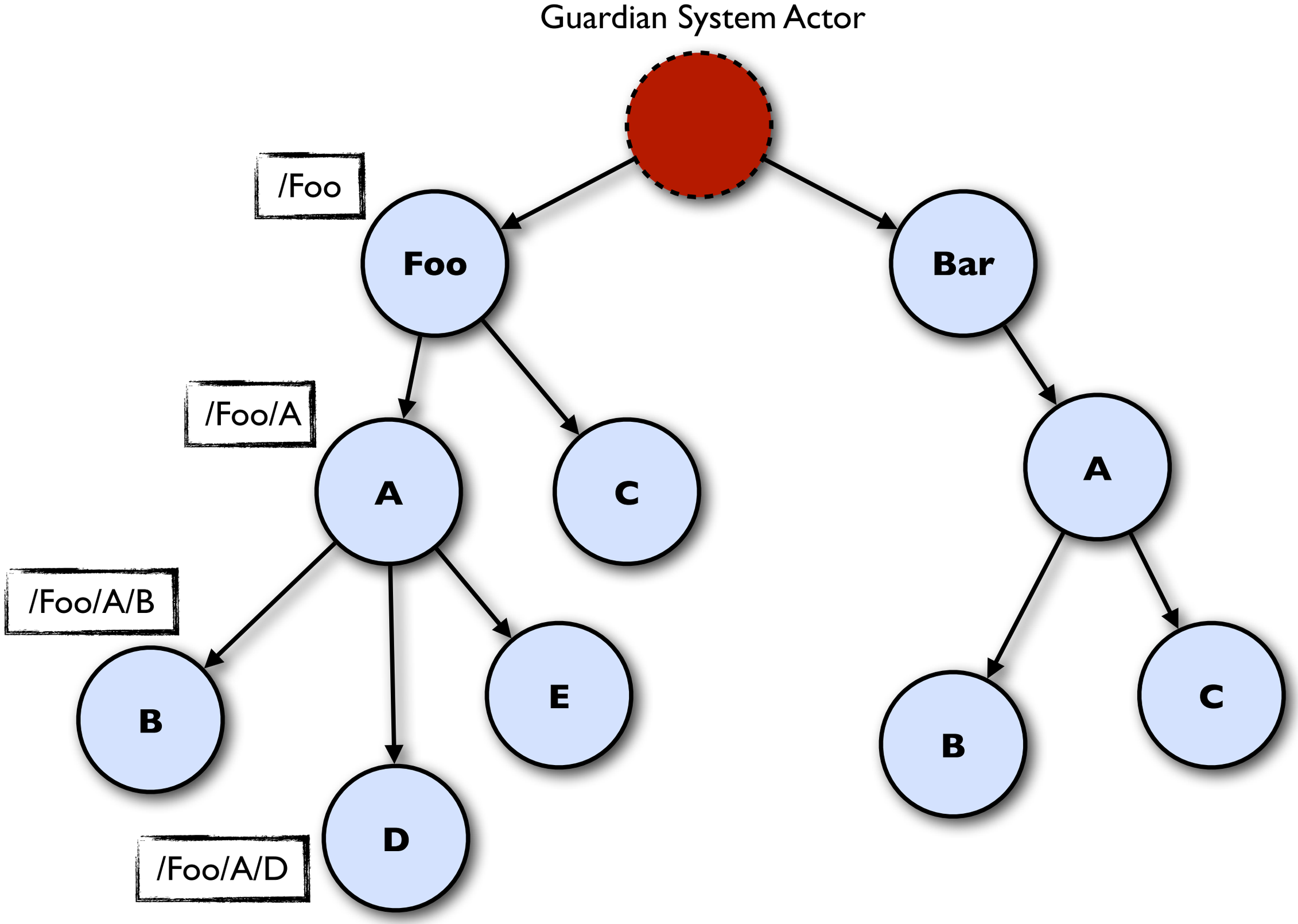

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  - An Actor is passive until a message is sent to it, which triggers something within the Actor
  - Messages is the Kinetic Energy in an Actor system
  - Actors can have lots of buffered Potential Energy but can't do anything with it until it is triggered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

SEND message

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}

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   }
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greeter.tell(new Greeting("Charlie Parker"));
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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

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Configure a Remote Provider

For the Greeter actor

```
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Typesafe

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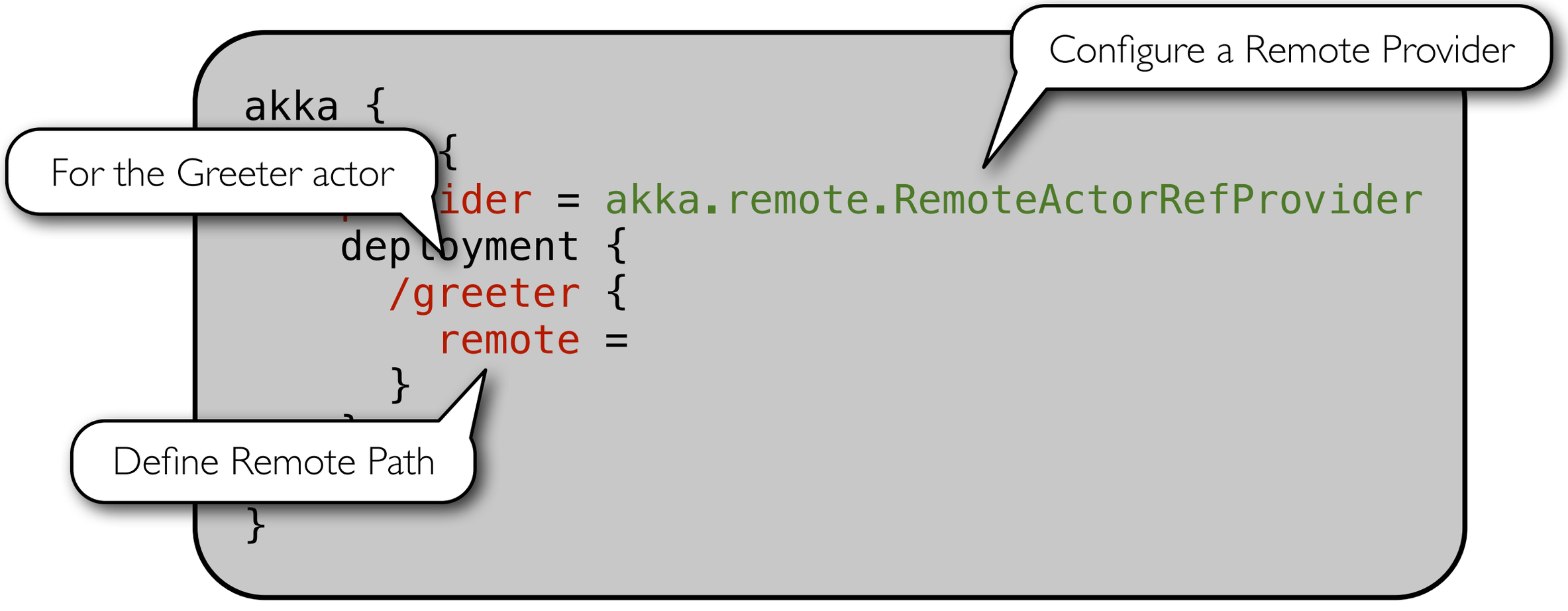

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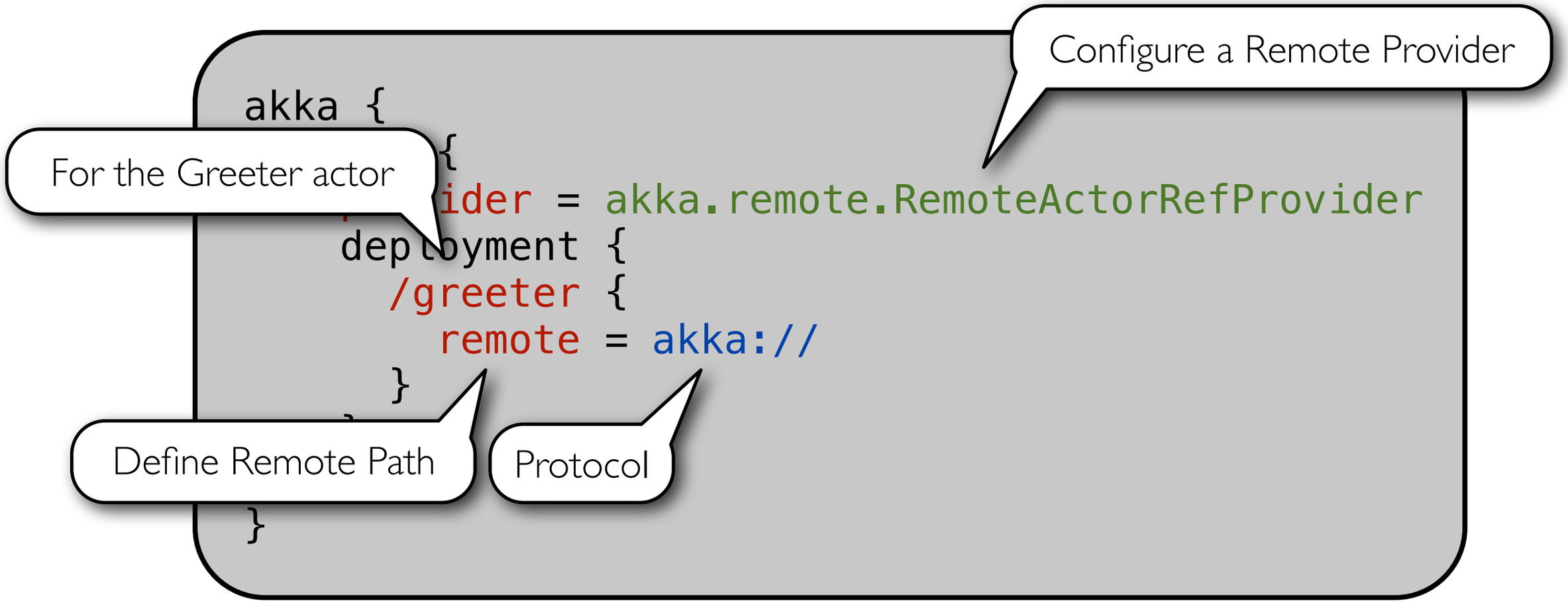

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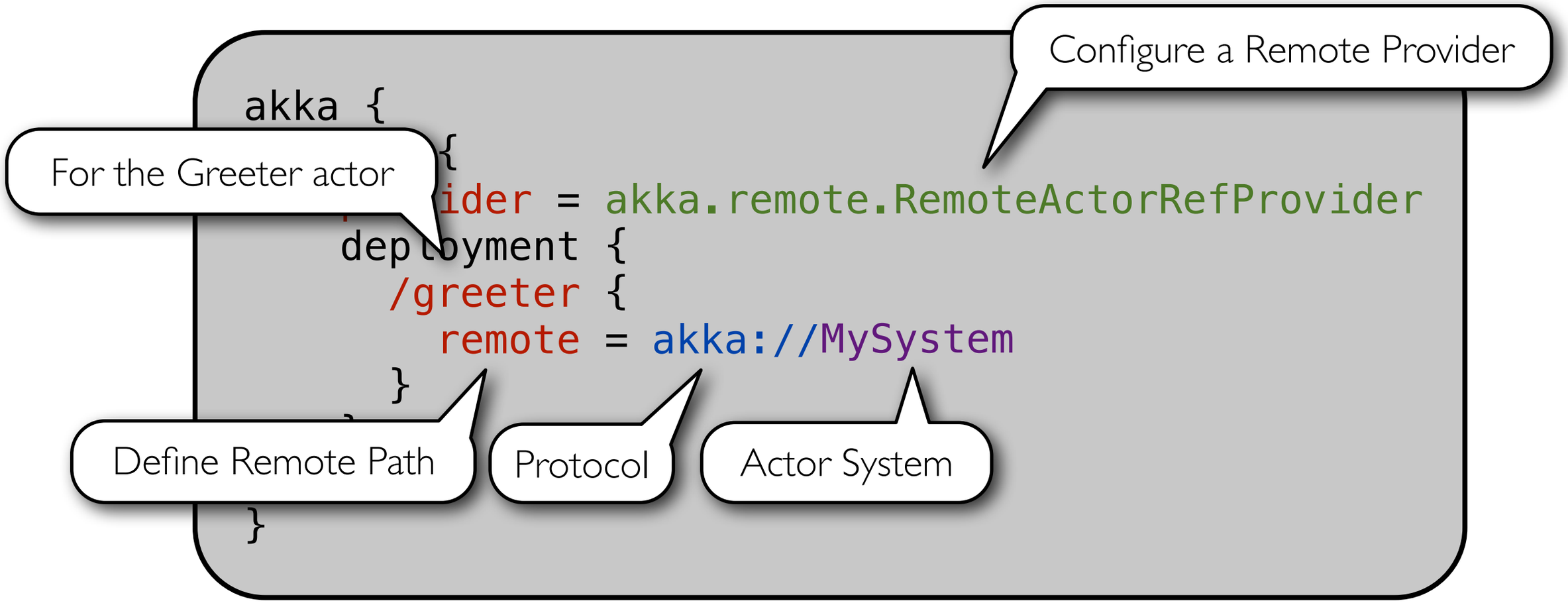

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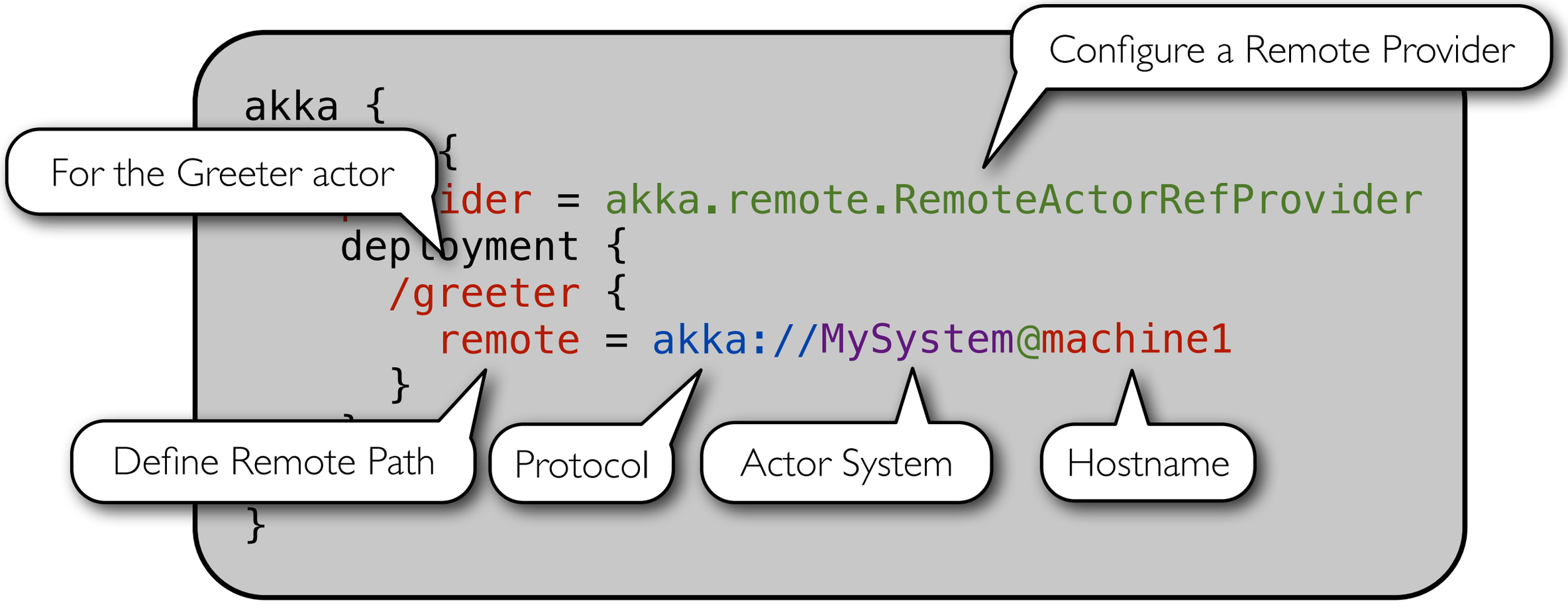

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```
akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1:2552
      }
    }
  }
}
```

Configure a Remote Provider

For the Greeter actor

Define Remote Path

Protocol

Actor System

Hostname

Port

Remote deployment

Just feed the ActorSystem with this configuration

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

Configure a Remote Provider

For the Greeter actor

Define Remote Path

Protocol

Actor System

Hostname

Port

Zero code changes

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akka

3. BECOME

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- BECOME - dynamically redefines Actor's behavior

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3. BECOME

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- 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

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- Implement graceful degradation
- Spawn up (empty) generic Worker processes that can become whatever the Master currently needs
- etc. 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

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

Load Balancing

Routers

```
ActorRef router =
  system.actorOf(
    new Props(SomeActor.class).withRouter(
      new RoundRobinRouter(5)));
```

Router + Resizer

```
int lowerBound = 5;
int upperBound = 20;

ActorRef router =
  system.actorOf(
    new Props(ExampleActor1.class).withRouter(
      new RoundRobinRouter(
        new DefaultResizer(
          lowerBound, upperBound))));
```

Java7 concurrency

New concurrency utilities in Java 7

- Fork/Join framework
  - For parallelizing divide and conquer algorithms
- ThreadLocalRandom
  - For minimizing contention using random numbers
- Phaser
  - More flexible CyclicBarrier

Fork/Join

Algorithm

Fork:

Recursively decompose large tasks into sub tasks

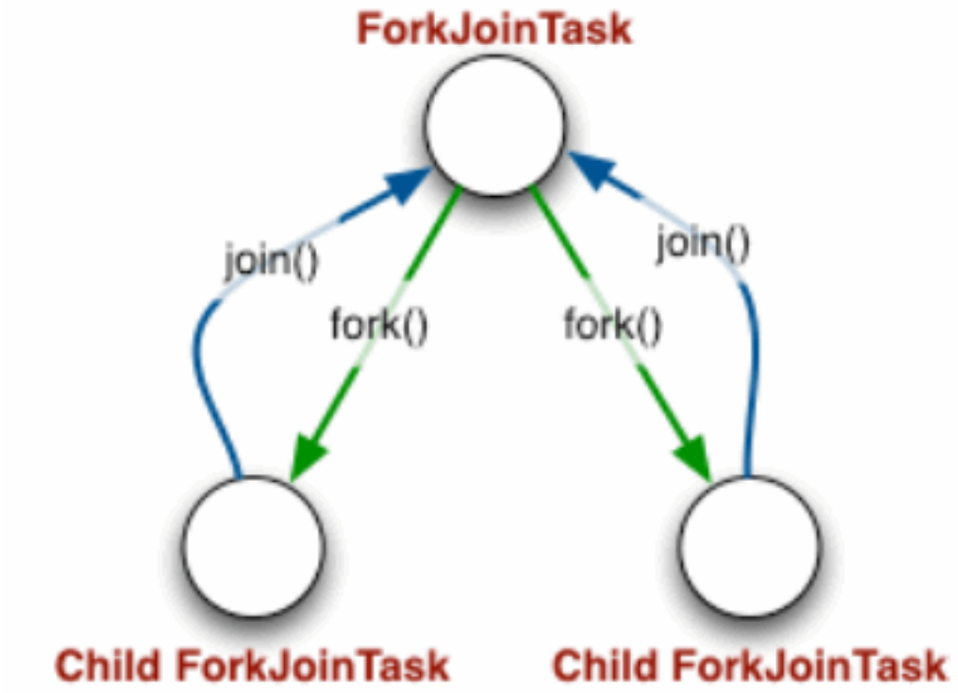
Join:

Await results of recursive tasks and combine

Algorithm

Fork:

Recursively decompose large tasks into sub tasks



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Algorithm

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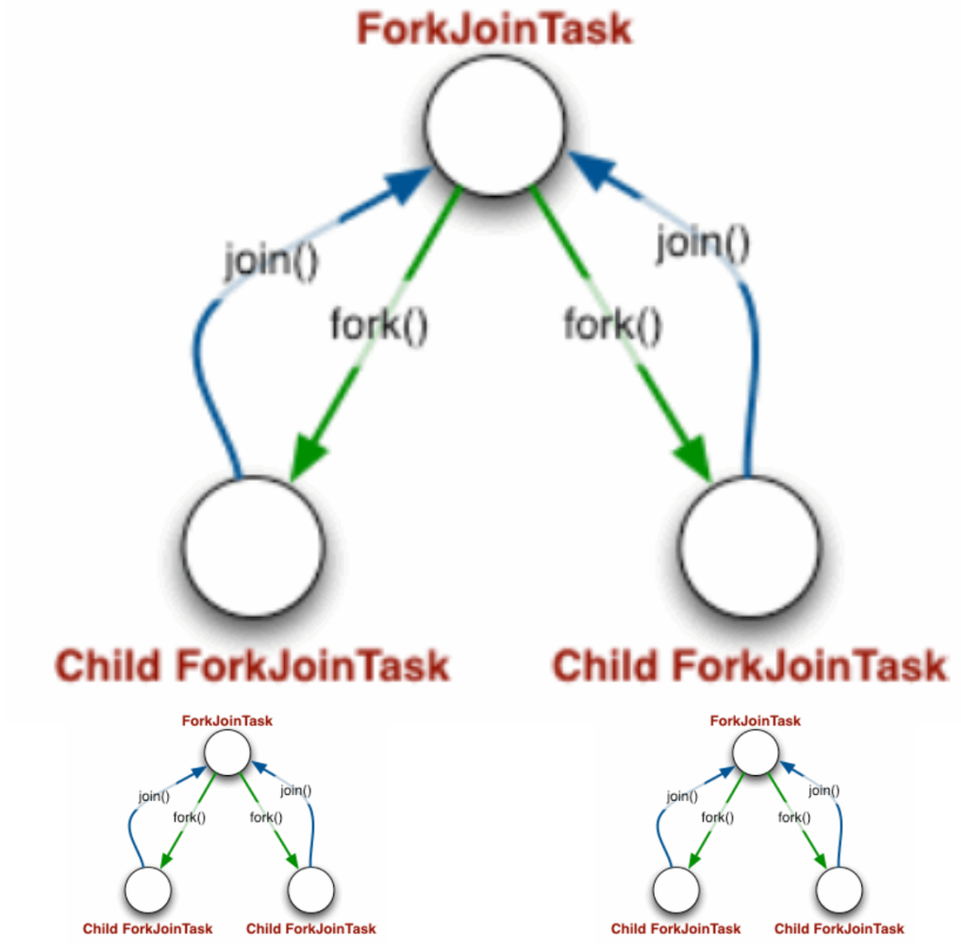

Algorithm

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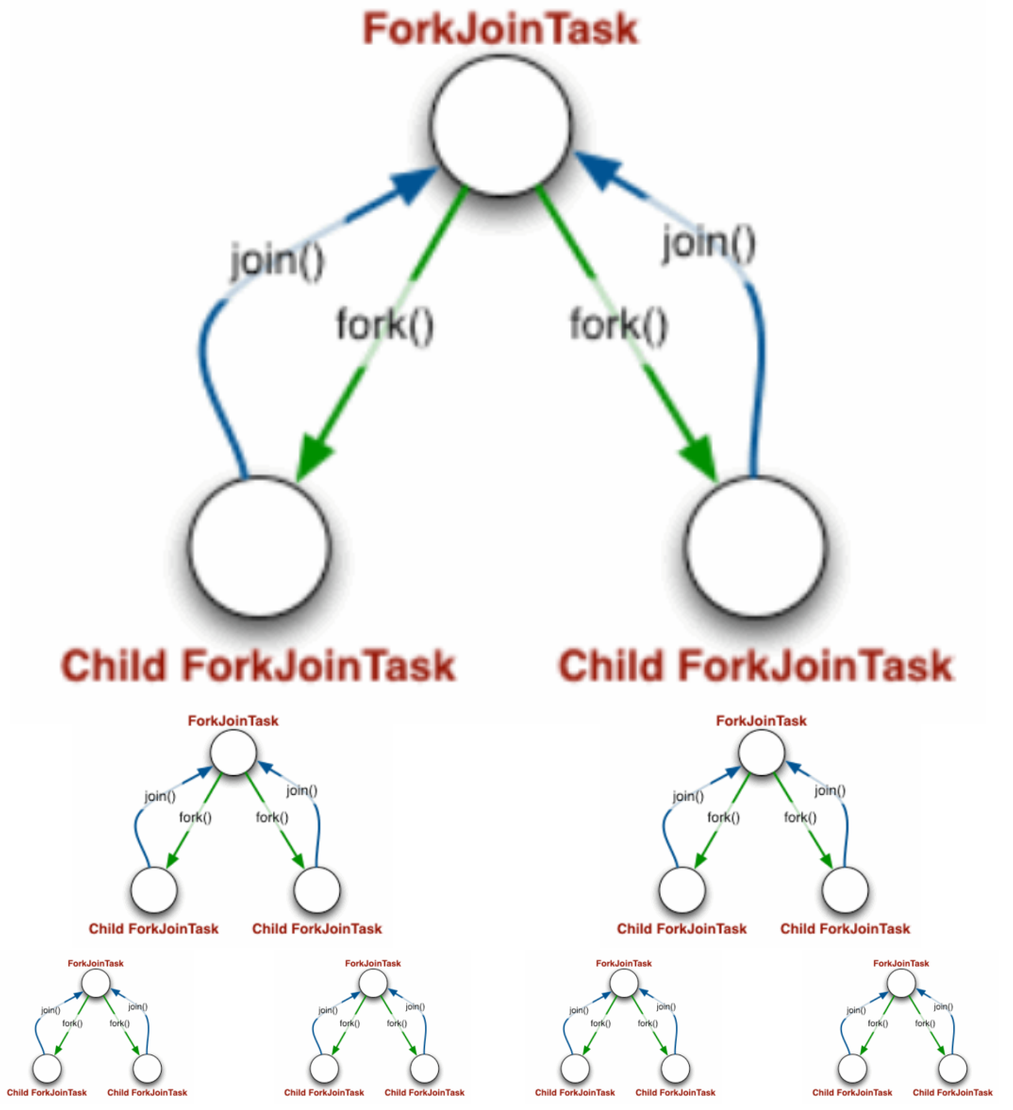

Using Work Stealing

ParallelArray

```
ParallelArray<Student> students =
    new ParallelArray<Student>(fjPool, data)

double bestGpa = students
     .withFilter(isSenior)
     .withMapping(selectGpa)
     .max();
```

Other uses of Fork/Join

- Scala Parallel Collections
  - `collection.par foreach print`
  - `collection.par map (_ + 1)`
- Upcoming Java Parallel Collections?
- Akka
  - ForkJoinPool-based Dispactcher
  - ThreadLocalRandom

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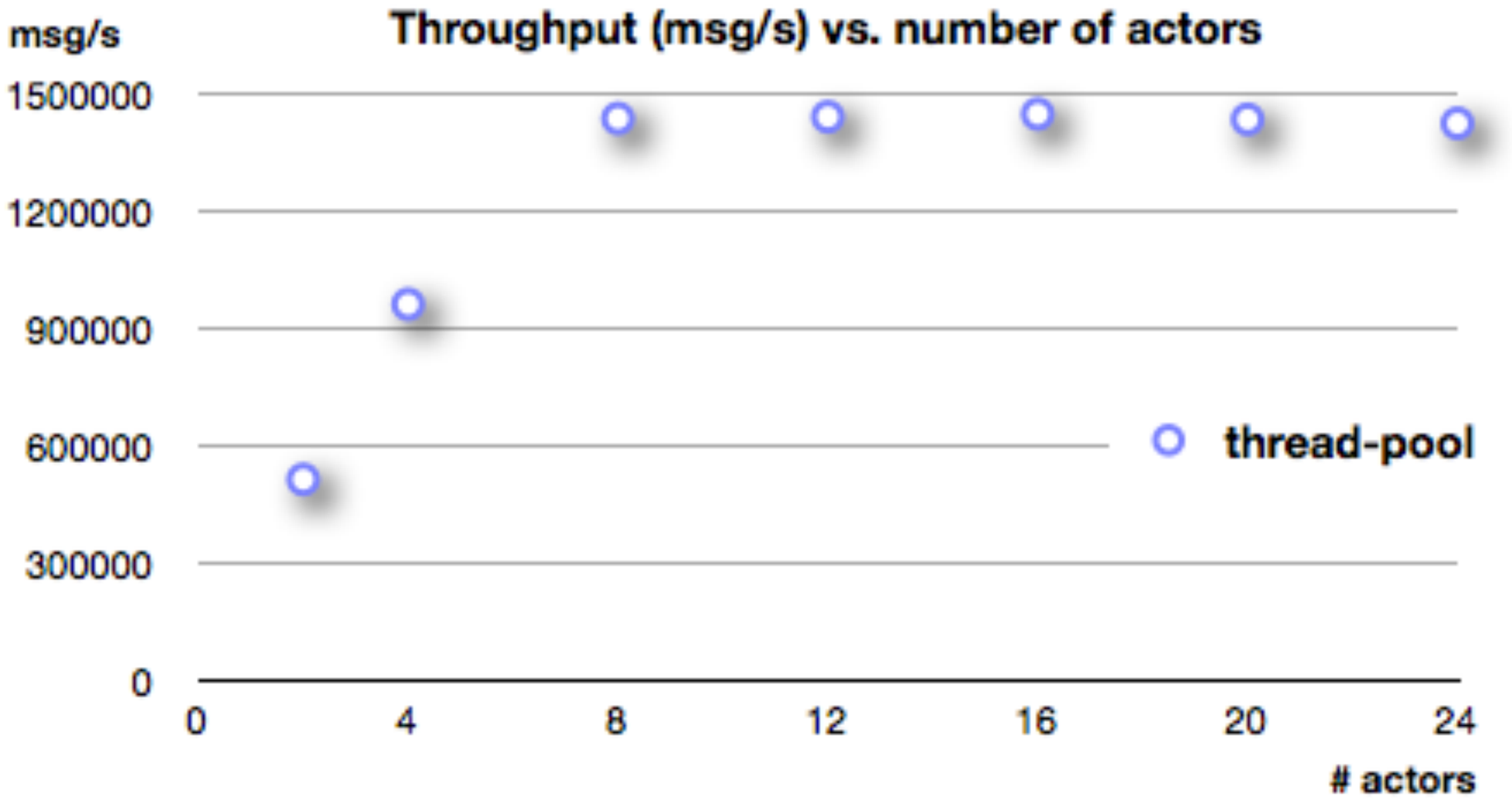
How does
Akka use
Fork/Join?

It started with a benchmark on our single 48-core box

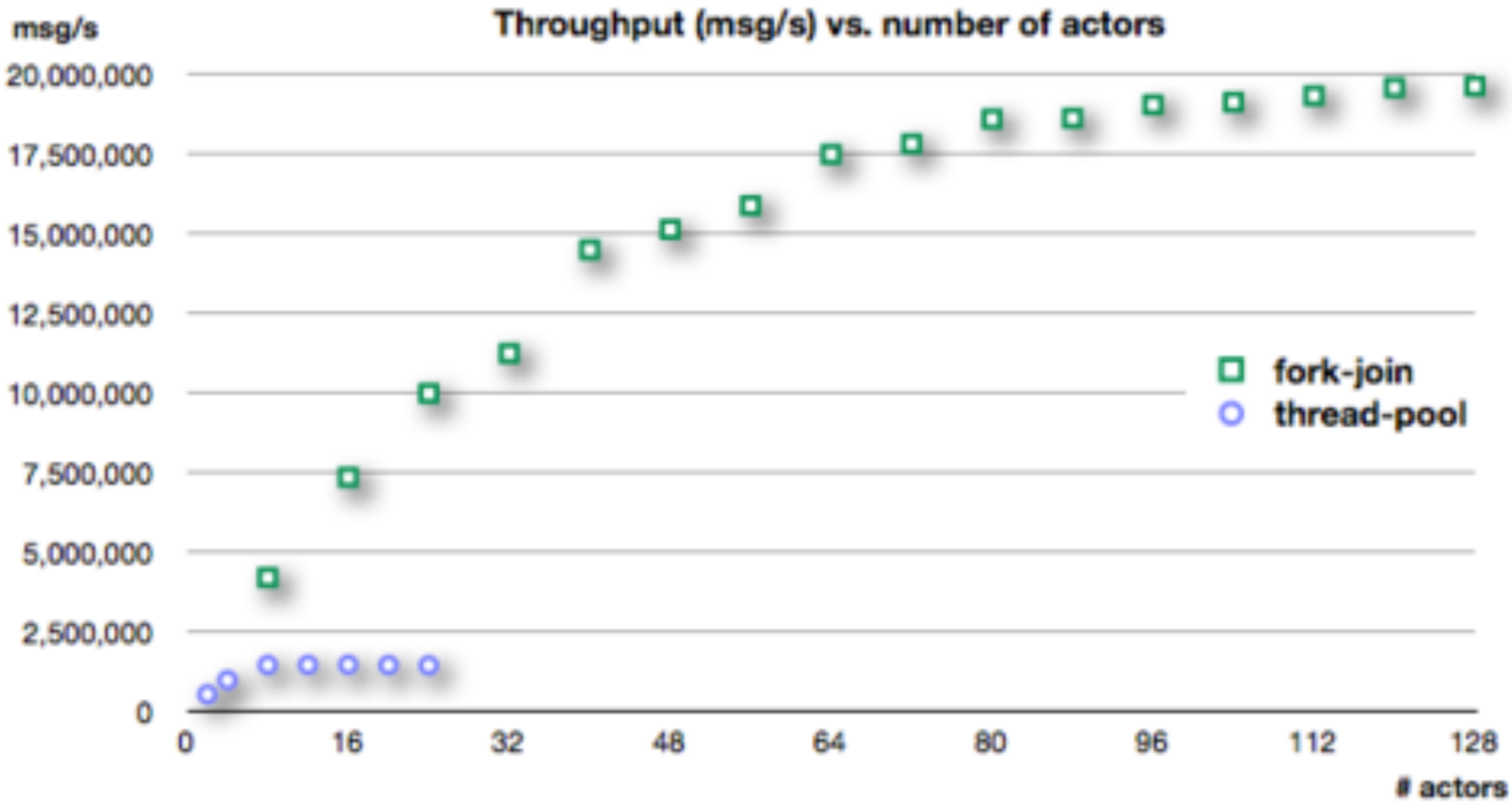
Default dispatcher using ThreadPoolExecutor



This doesn't look to good

```
procs -----------memory---------- ---swap-- -----io---- -system-- ----cpu----
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa
 5  0      0 129633352 167004 424232    0    0     0     0 36903 72191  6  1 93  0
 2  0      0 129633360 167008 424232    0    0     0     4 38242 74654  5  1 93  0
 3  0      0 129633368 167008 424232    0    0     0     0 39025 76396  6  1 93  0
 4  0      0 129633376 167008 424232    0    0     0     0 39703 77407  3  1 96  0
 3  0      0 129633376 167008 424232    0    0     0     0 38870 75973  6  2 93  0
 3  0      0 129633376 167008 424232    0    0     0    20 36709 71608  6  2 93  0
 2  0      0 129633248 167008 424232    0    0     0     0 39180 76520  5  1 94  0
```

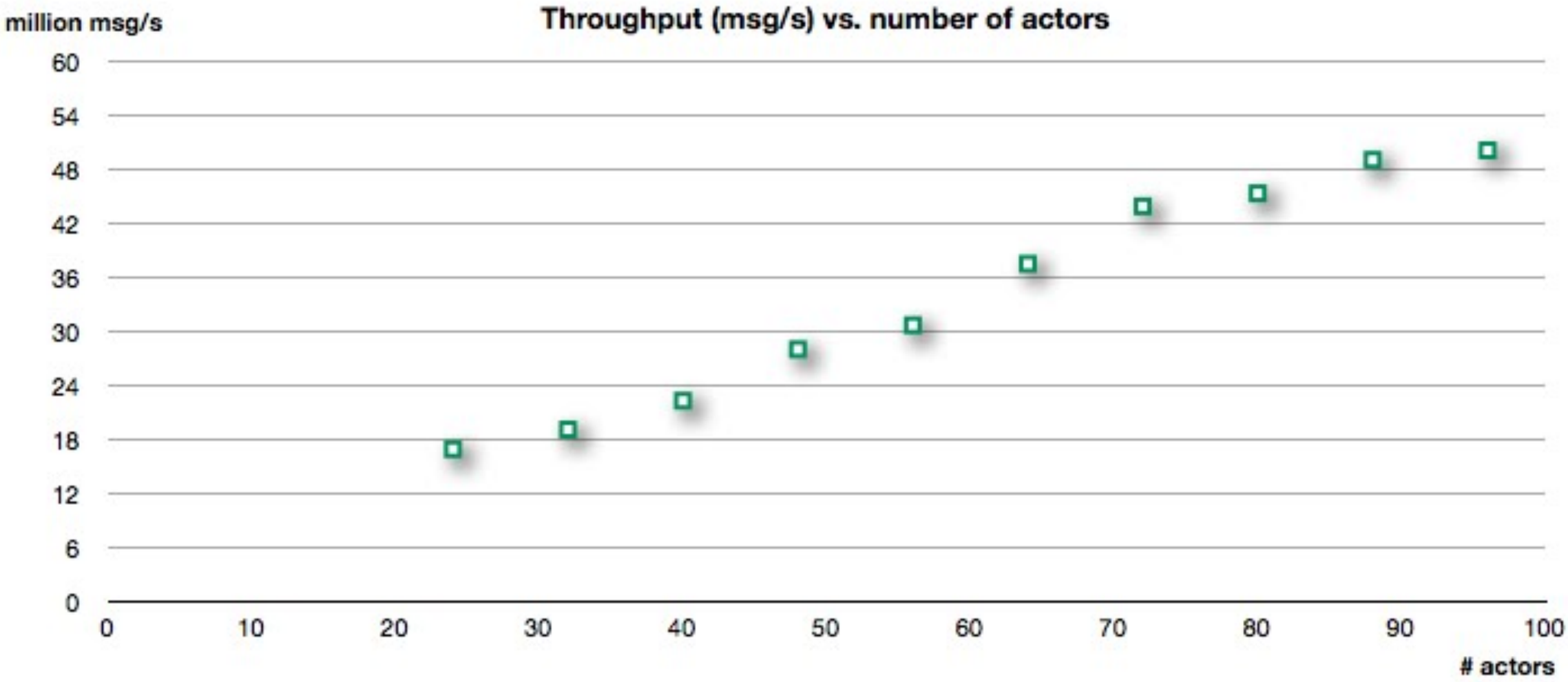
new ForkJoinPool



This looks much better

```
procs -----------memory---------- ---swap-- -----io---- -system-- ----cpu----
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa
49  0      0 129483104 167744 424400    0    0     0     0 12698 1331 97  0  3  0
48  0      0 129483472 167744 424400    0    0     0     0 12395  744 98  0  1  0
48  0      0 129482728 167744 424400    0    0     0     0 12600 1331 97  0  3  0
48  0      0 129409456 167744 424400    0    0     0     0 12534  875 99  0  1  0
48  0      0 129402032 167744 424400    0    0     0     0 12384  750 98  0  2  0
48  0      0 129401536 167744 424400    0    0     0     0 12739 1329 97  0  3  0
```

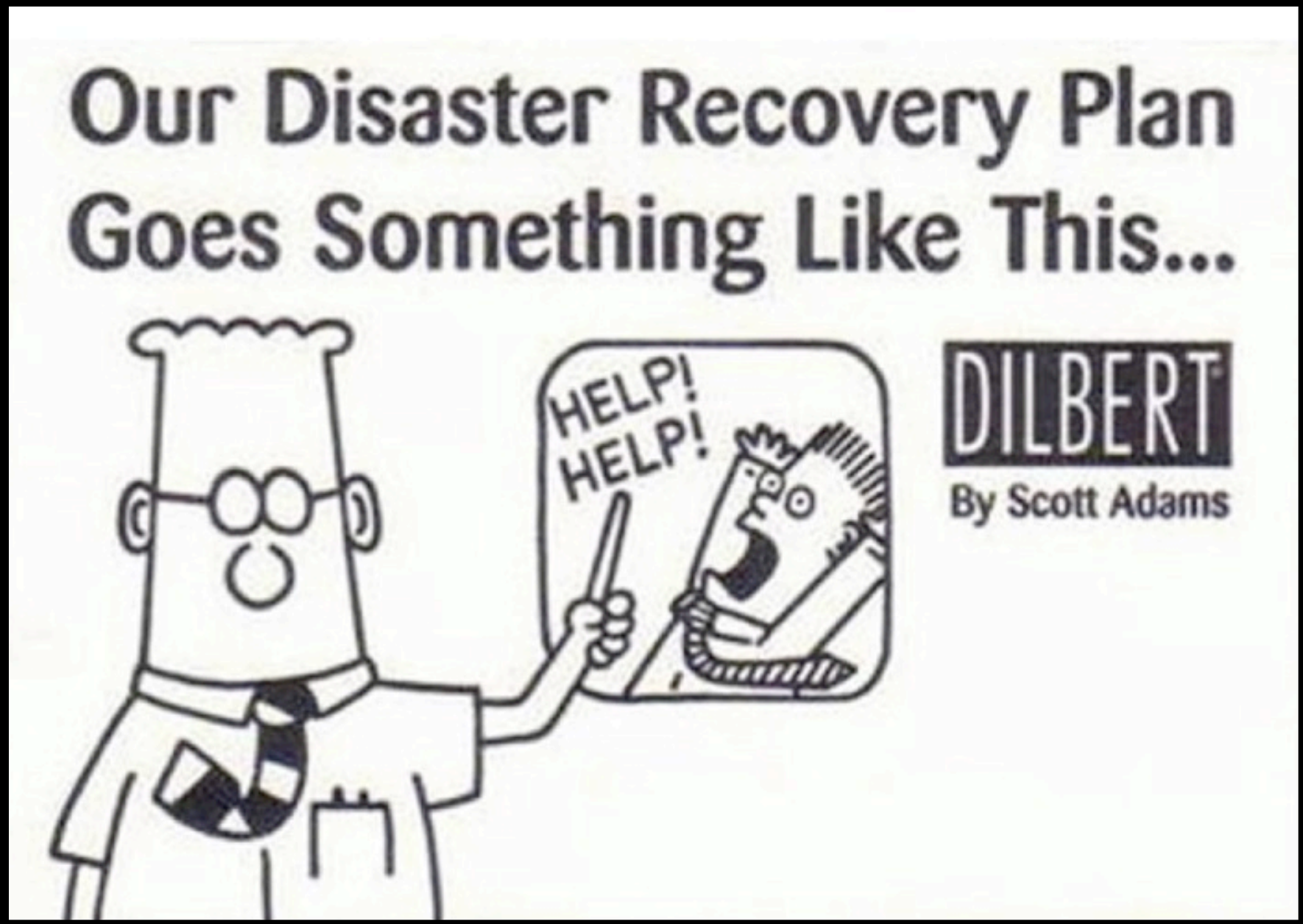
After tweaking it some more...



+50 million

messages per second

Failure Recovery



Failure Recovery in Java/C/C# etc.

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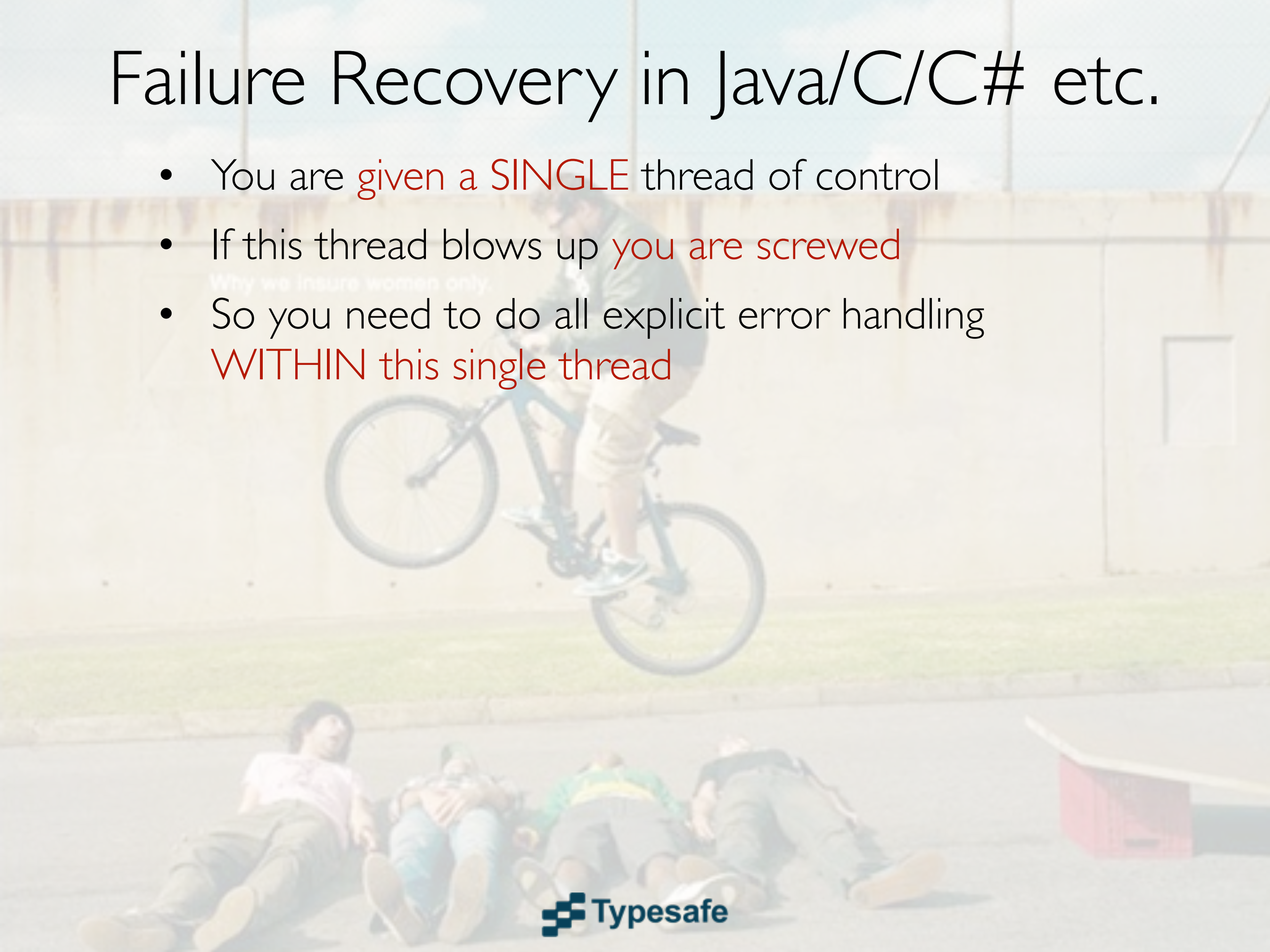

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We can do better than this!!!

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Just

LET IT CRASH

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4. SUPERVISE

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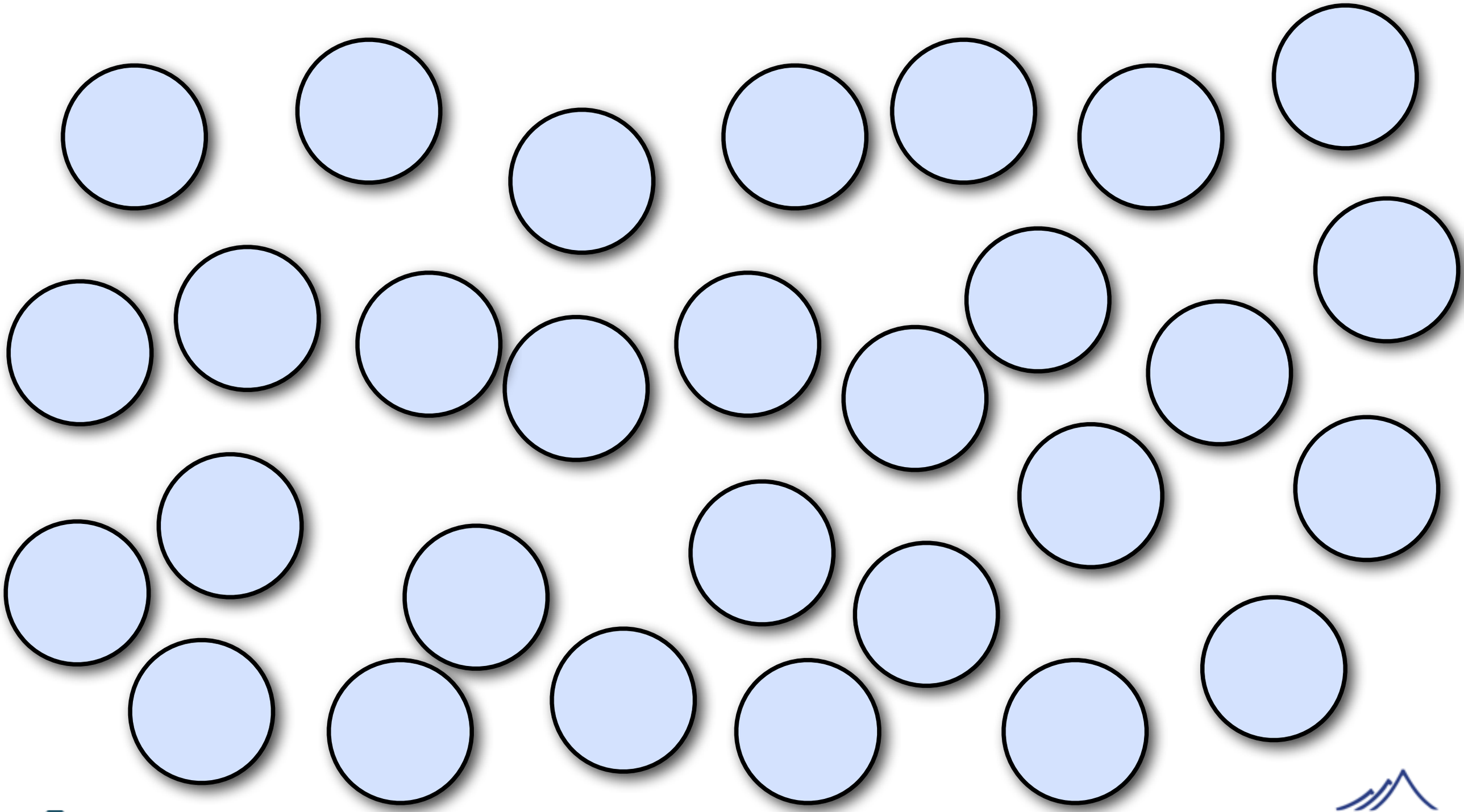
- SUPERVISE - manage another Actor's failures
- Error handling in actors is handle by letting Actors monitor (supervise) each other for failure
- This means that if an Actor crashes, a notification will be sent to his supervisor, who can react upon the failure
- This provides clean separation of processing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

Fault-tolerant onion-layered Error Kernel

Error Kernel



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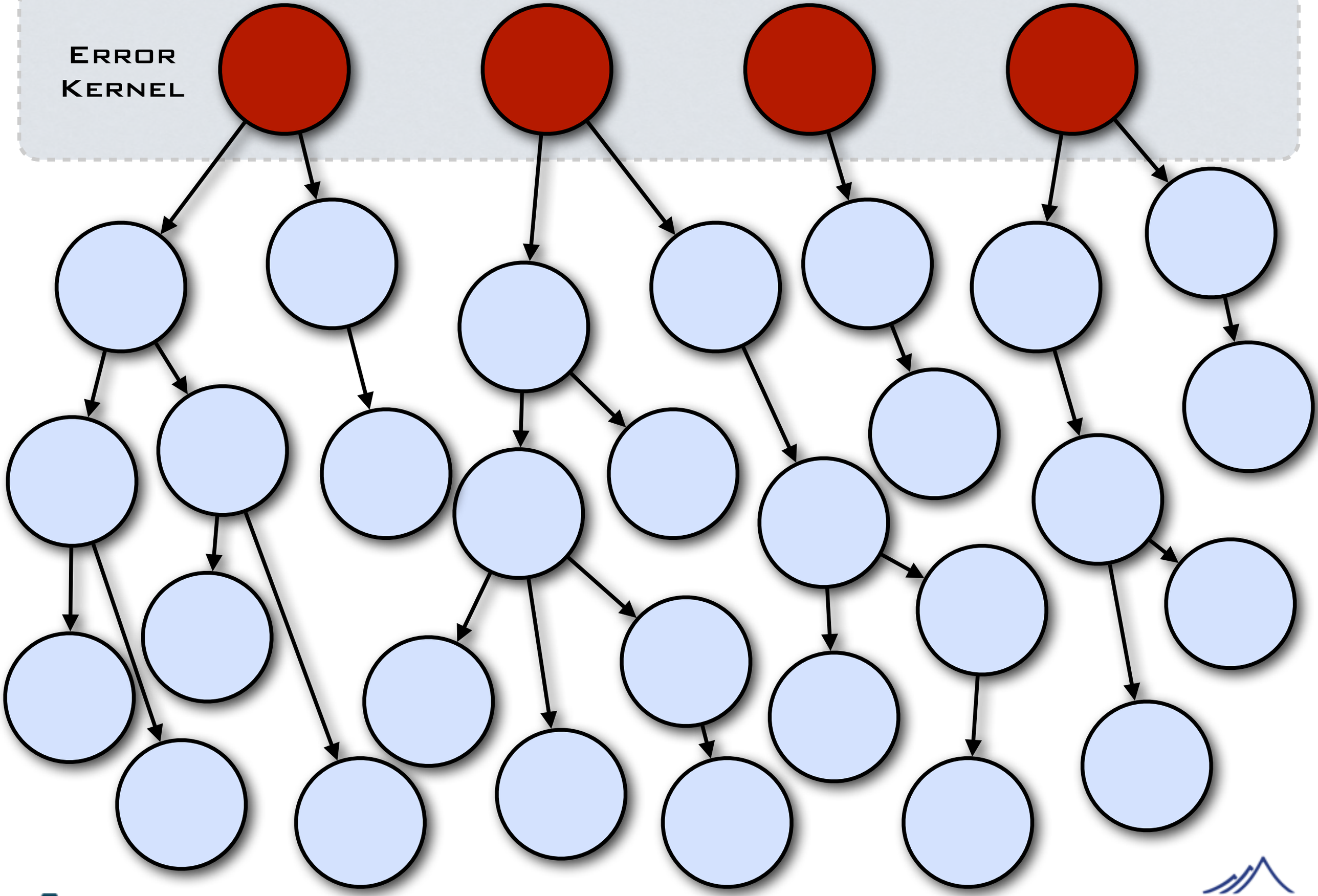

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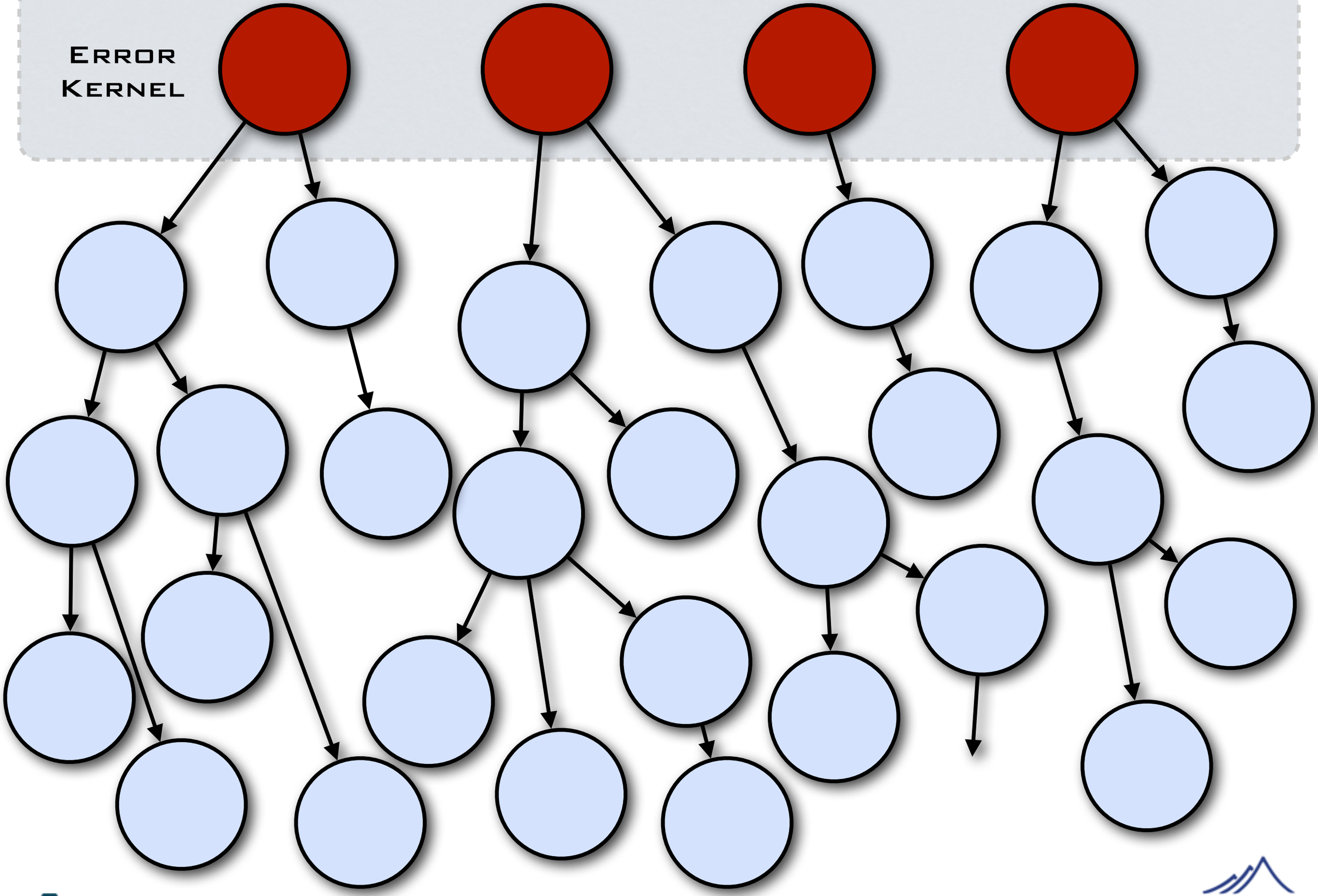

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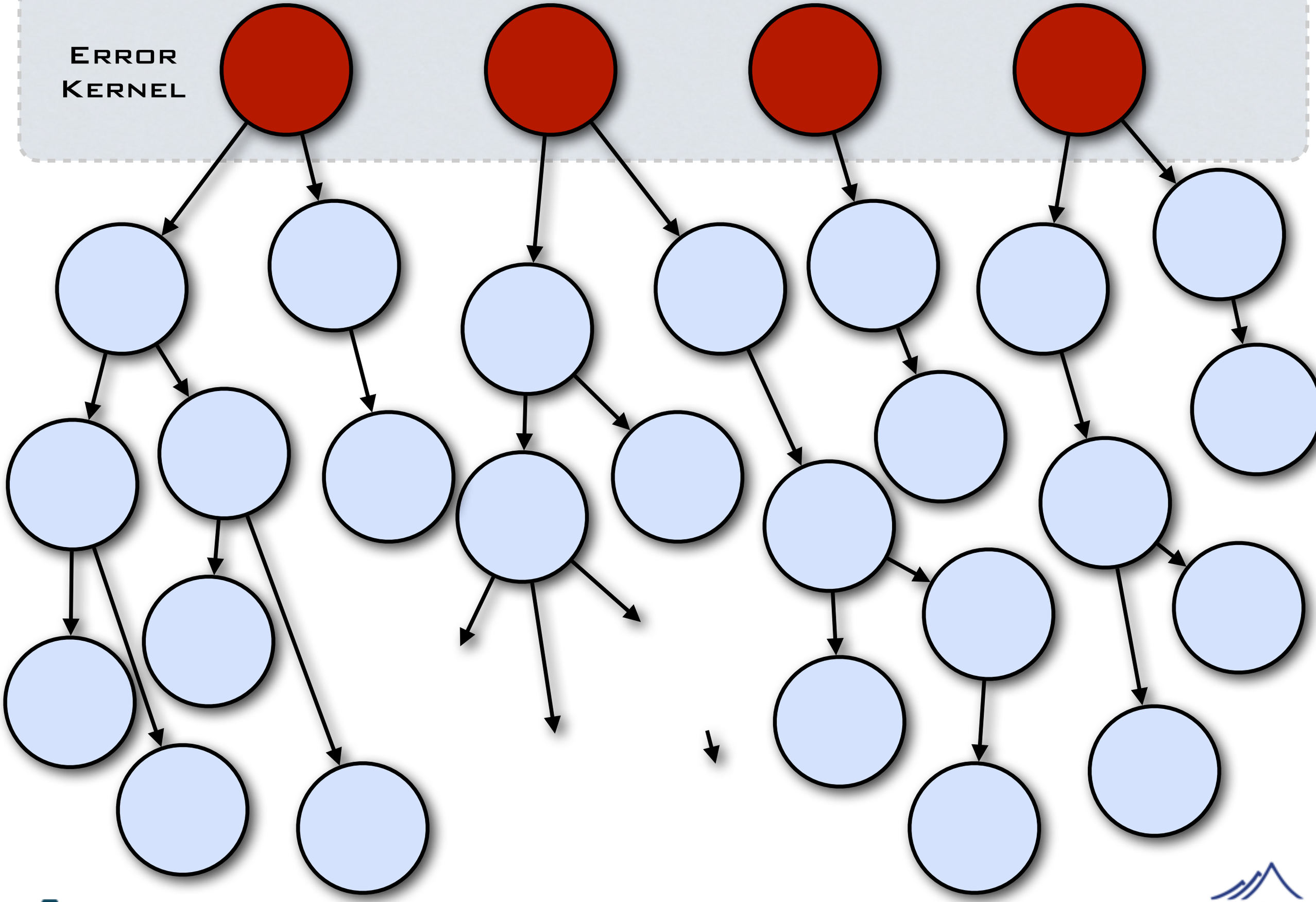

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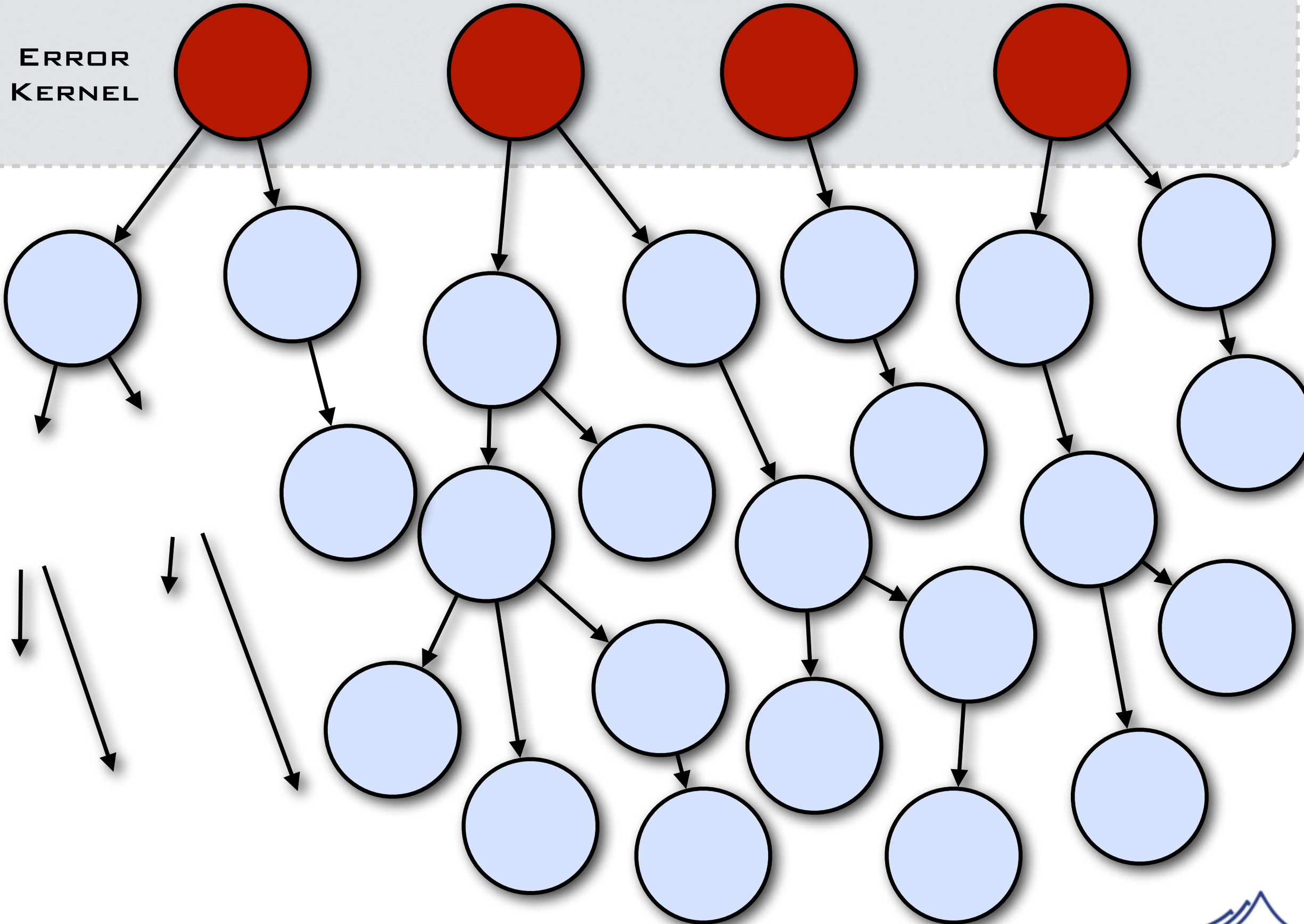

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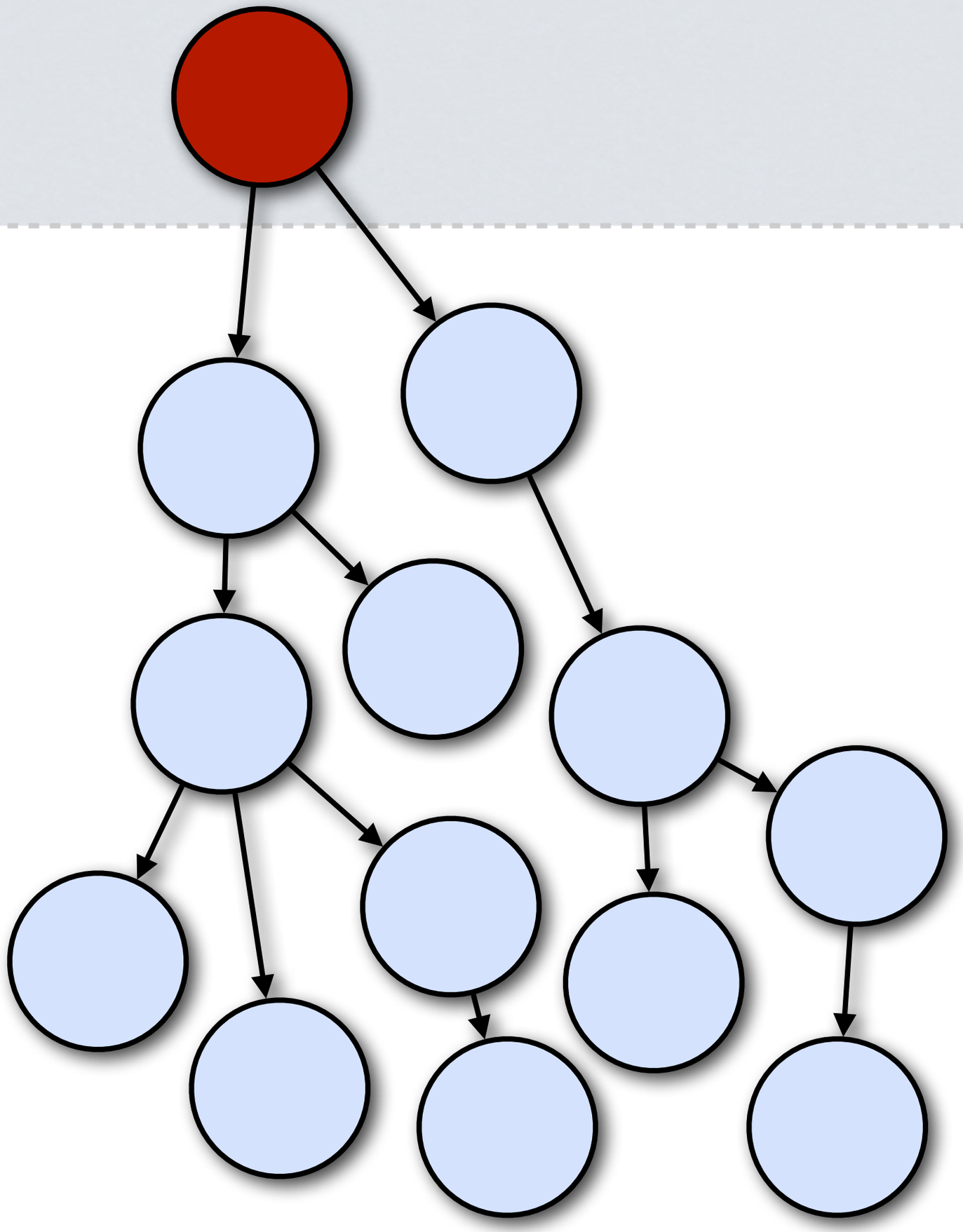
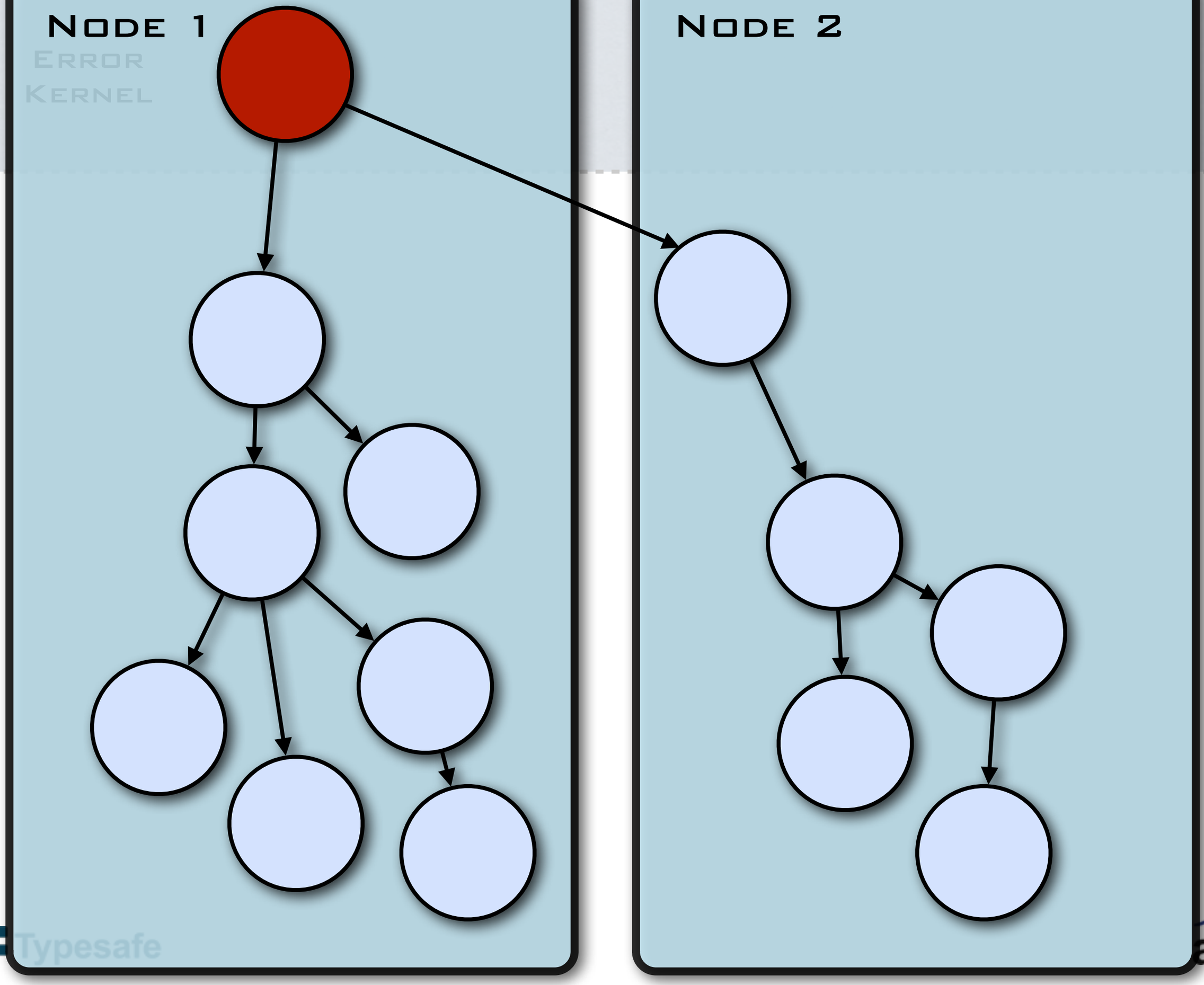


Node 1

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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Which is usually sufficient.
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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() {
```

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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 Actor {
  ...

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

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

This was

Akka **2.x**

This was

Akka **2.x**

Well...it's a start...

...we have much much more

...we have much much more

TestKit

Cluster

FSM

IO

HTTP/REST

EventBus

Durable Mailboxes

Pub/Sub

Camel

Microkernel

TypedActor

SLF4J

AMQP

ZeroMQ

Dataflow

Transactors

Agents

Spring

Extensions

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

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

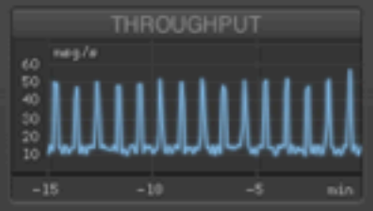
Search (or 'help')

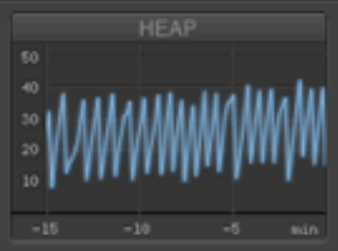
NODES | DISPATCHERS | ACTORS | TAGS

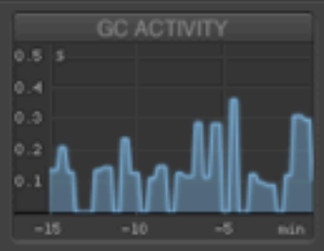
NODES
Nodes in your system

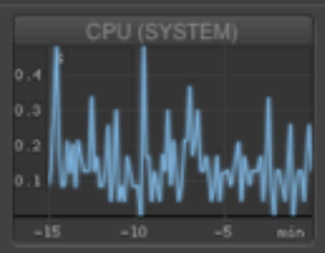
node1
7 actors | 2 dispatchers

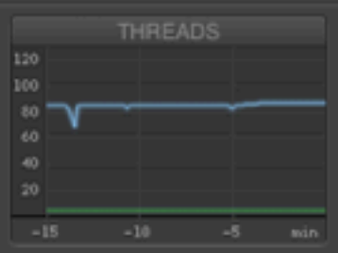
MAX MAILBOX: 68
MEAN MAILBOX: 12.51
PEAK RATES: 35.41 · 26.11
REMOTE ERR.: 0











MACHINE

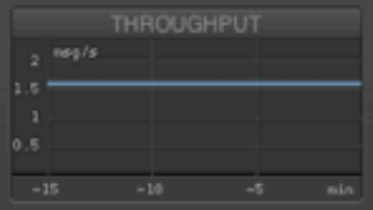
Max Heap:	8105 MB
Used Heap:	1232 MB
Memory Usage:	76.70 %
Running Actors:	6
Processors:	4
Up Time:	13832 mins

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

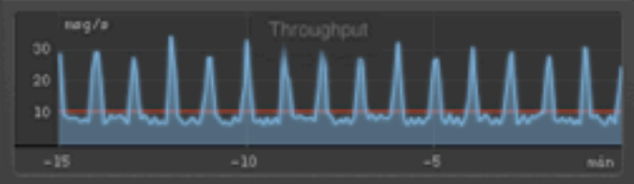
MAX MAILBOX: 1
MEAN MAILBOX: 0
PEAK RATES: - - -
REMOTE ERR.: 0



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

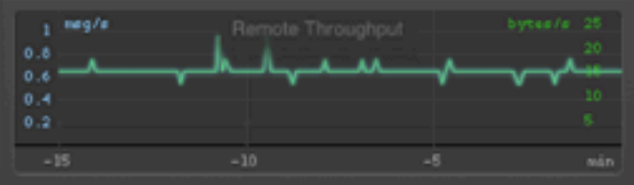
Errors:	30
Warnings:	15
Deadlocks:	20
Dead letters:	0

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

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

d:*

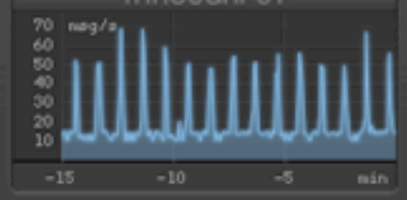
NODES | DISPATCHERS | ACTORS | TAGS

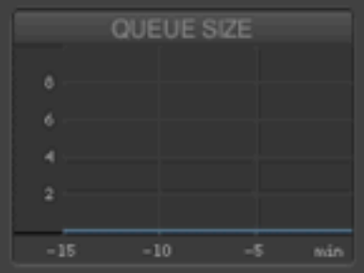
DISPATCHERS
Dispatchers for your query

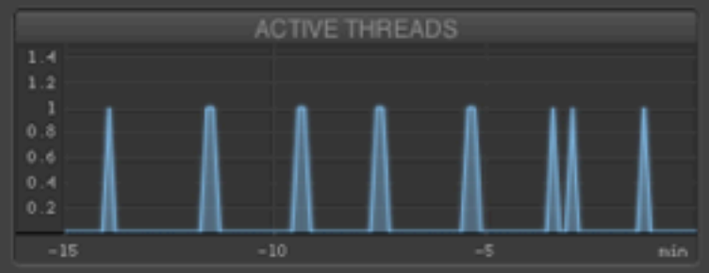
akka.actor.default-dispatcher

NODE: node1

TYPE: Dispatcher-FJ







ACTOR COUNTS

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

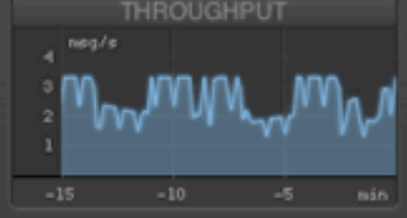
ACTOR RATES

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

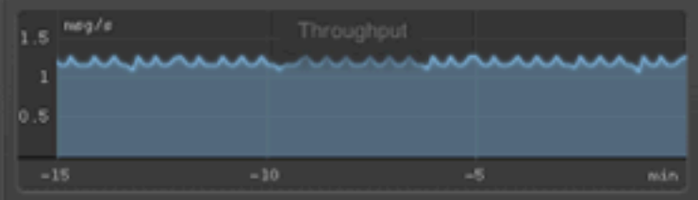
TYPE: Dispatcher-TP

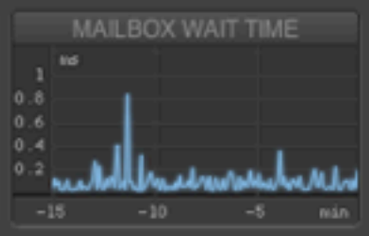


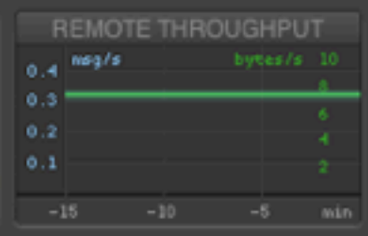
ACTOR
Actor for your query

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

get it and learn more

http://akka.io

http://letitcrash.com

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EOF