Scaling
software with

Henrik Engström

Software Engineer at Typesafe

@h3nk3

Scaling
software with


Copyright Ingeborg van Leeuwen

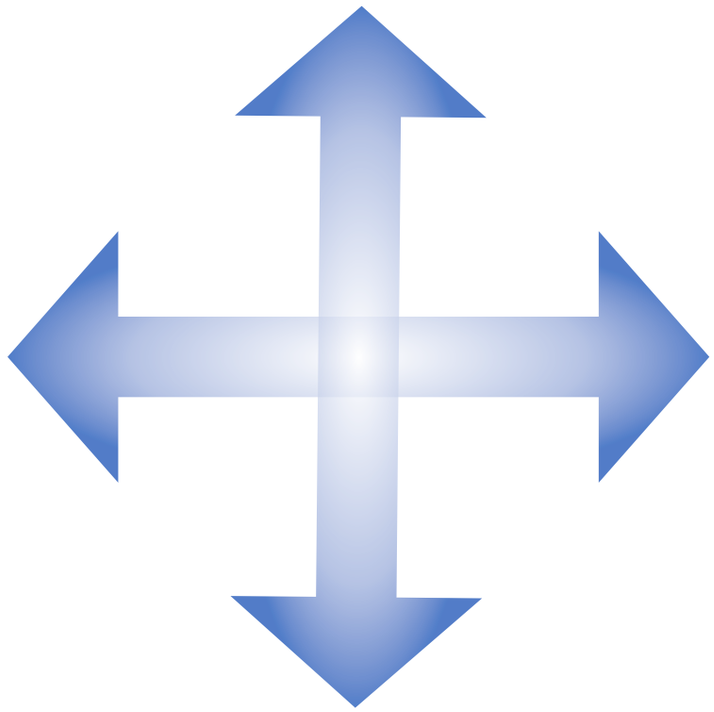
Leverage what you already know

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

- USE Akka from Java or Scala today
- 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
DRW TRADING GROUP
OOYALA
novus
abiquo
foursquare
T8 Webware
CARTOMAPIC
moshi monsters
ROVIO
BBC
navirec
Maritime Poker
PRECOG
Answers.com The world's leading Q&A site
azavea
banksimple
zeebox The best thing to happen to TV since TV



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Manage System Overload

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Program at a Higher Level

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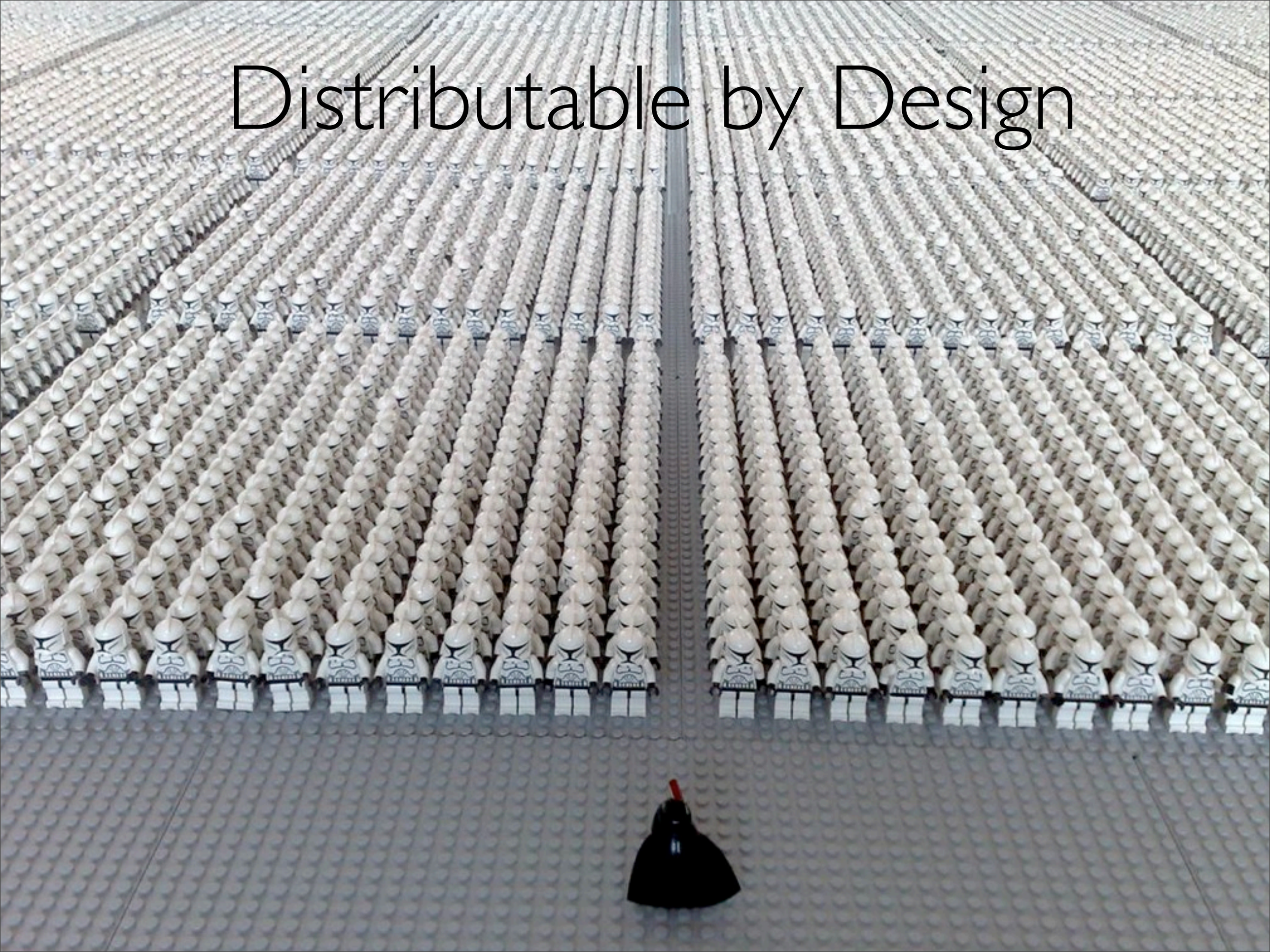
- Proven and superior model for detecting and recovering from errors

Distributable by Design



Distributable by Design

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

Business benefits

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Lower DEVELOPMENT COST

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- Faster to BUILD the system
- Easier to UNDERSTAND the system
- Easier to MAINTAIN the system
- Easier to EVOLVE the system
- You will encounter LESS BUGS

Lower OPERATIONS COST

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- Open Source - Apache 2 license

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- Lower cost caused by unplanned DOWNTIME
- Allows operations team to be more EFFICIENT
  - get control of the system with the Typesafe Console

Address NEW business requirements

Tackle large scale business IT challenges you otherwise wouldn't be able to address, e.g:

- go from batch analytics to real time analytics
- scale your systems along with financial markets or social media volume

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
- 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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- a singleton or service
- a router, load-balancer or pool
- 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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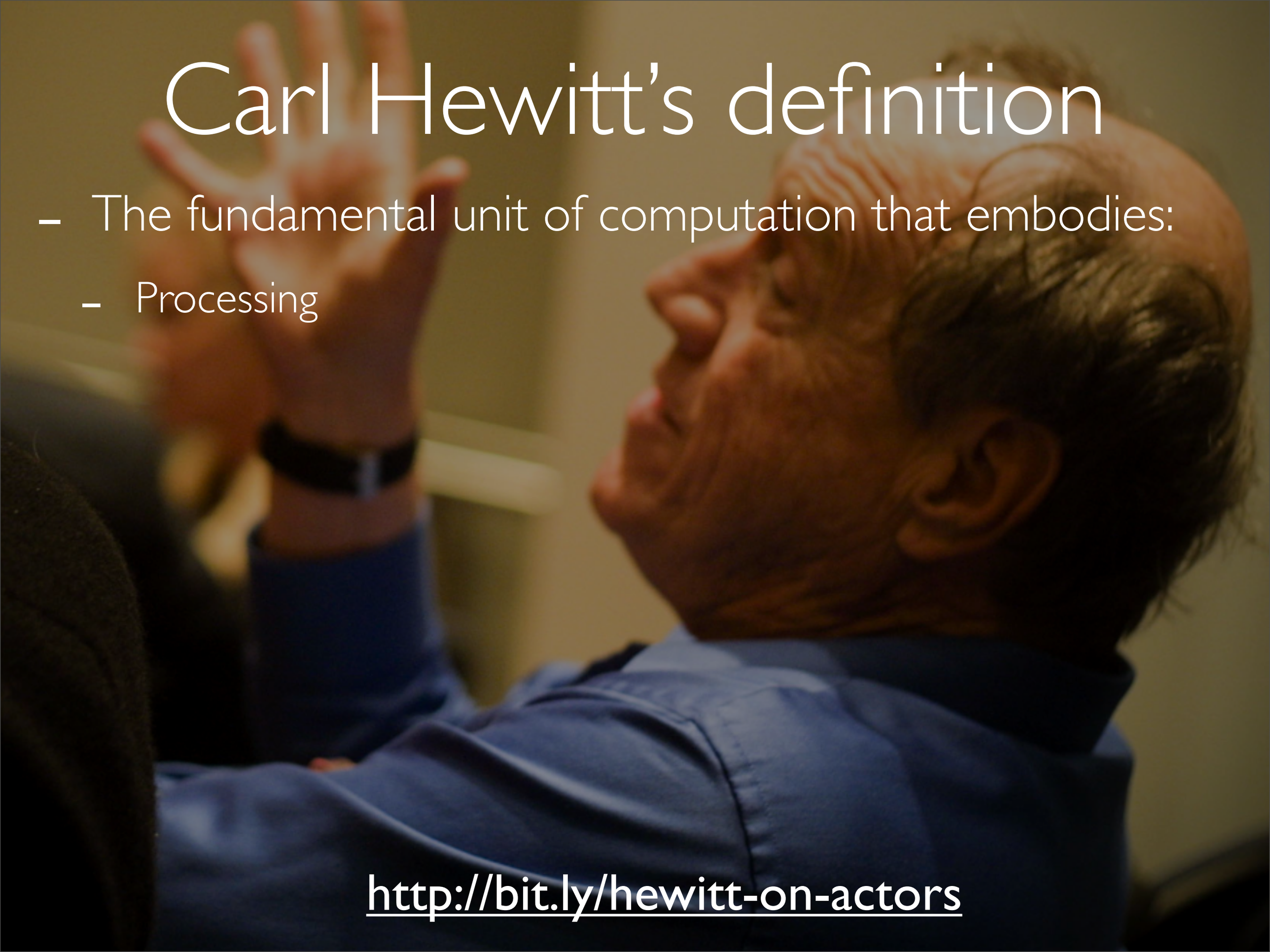

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  - Send messages to Actors it knows
  - Designate how it should handle the next message it receives

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

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 Actor's behavior

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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Typesafe

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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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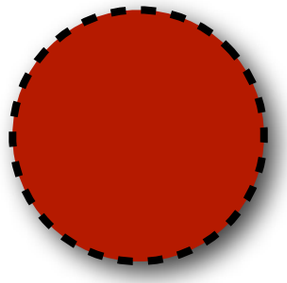
Actors can form hierarchies

Guardian Actor



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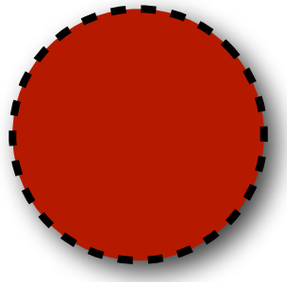

system.actorOf(Props[Foo], "Foo")

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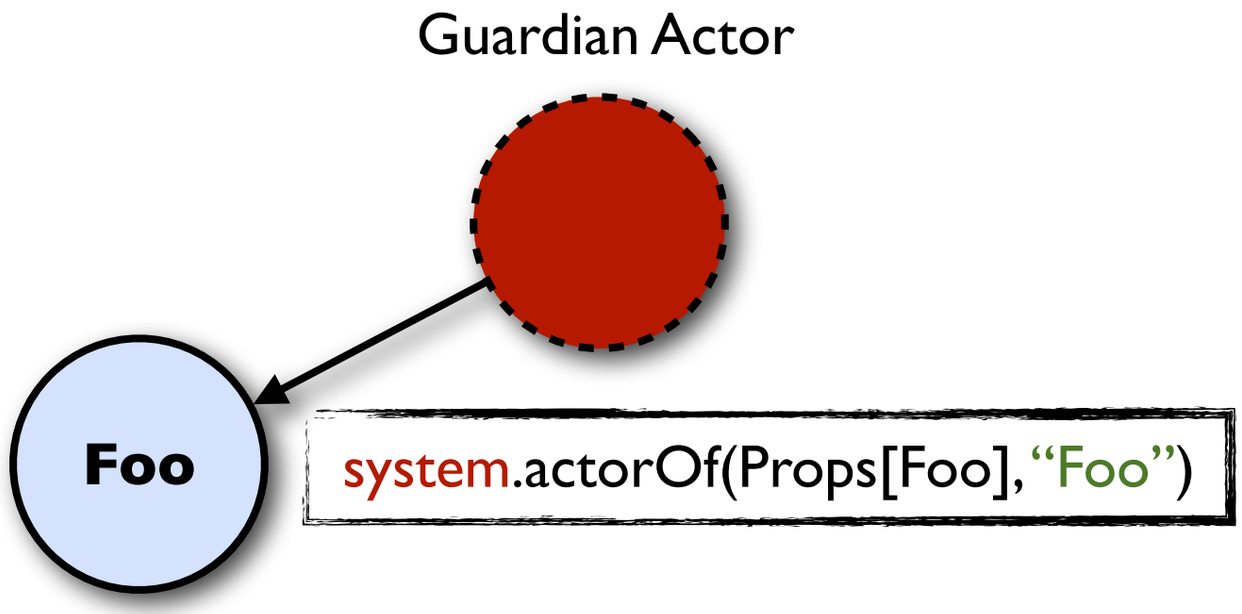

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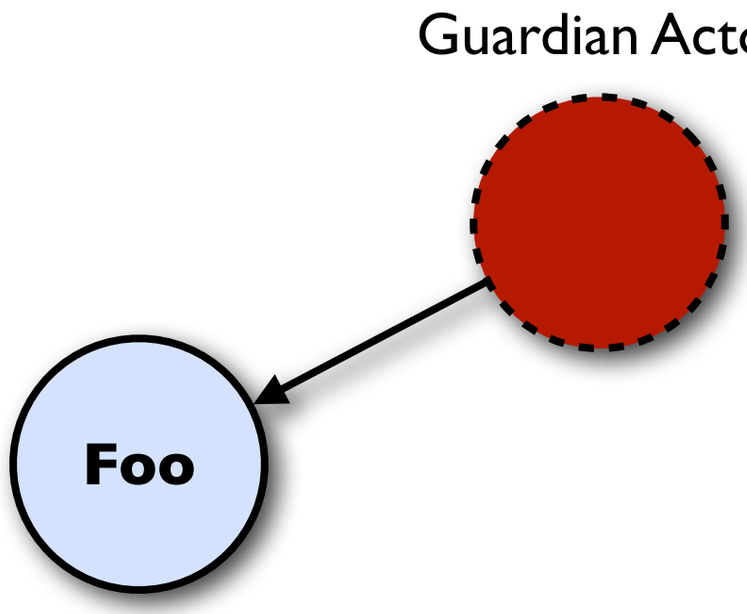


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context.actorOf(Props[A], "A")
```

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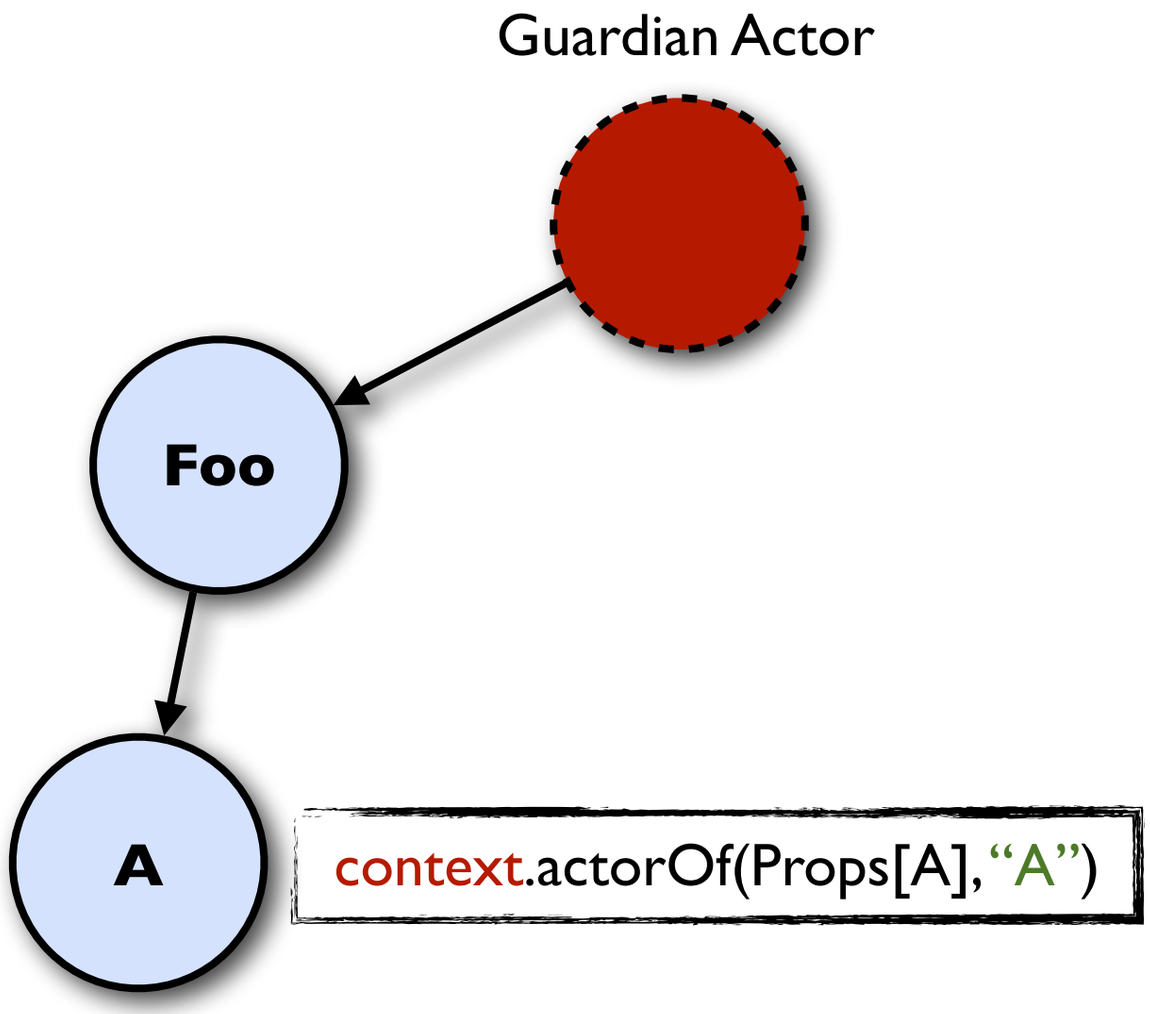

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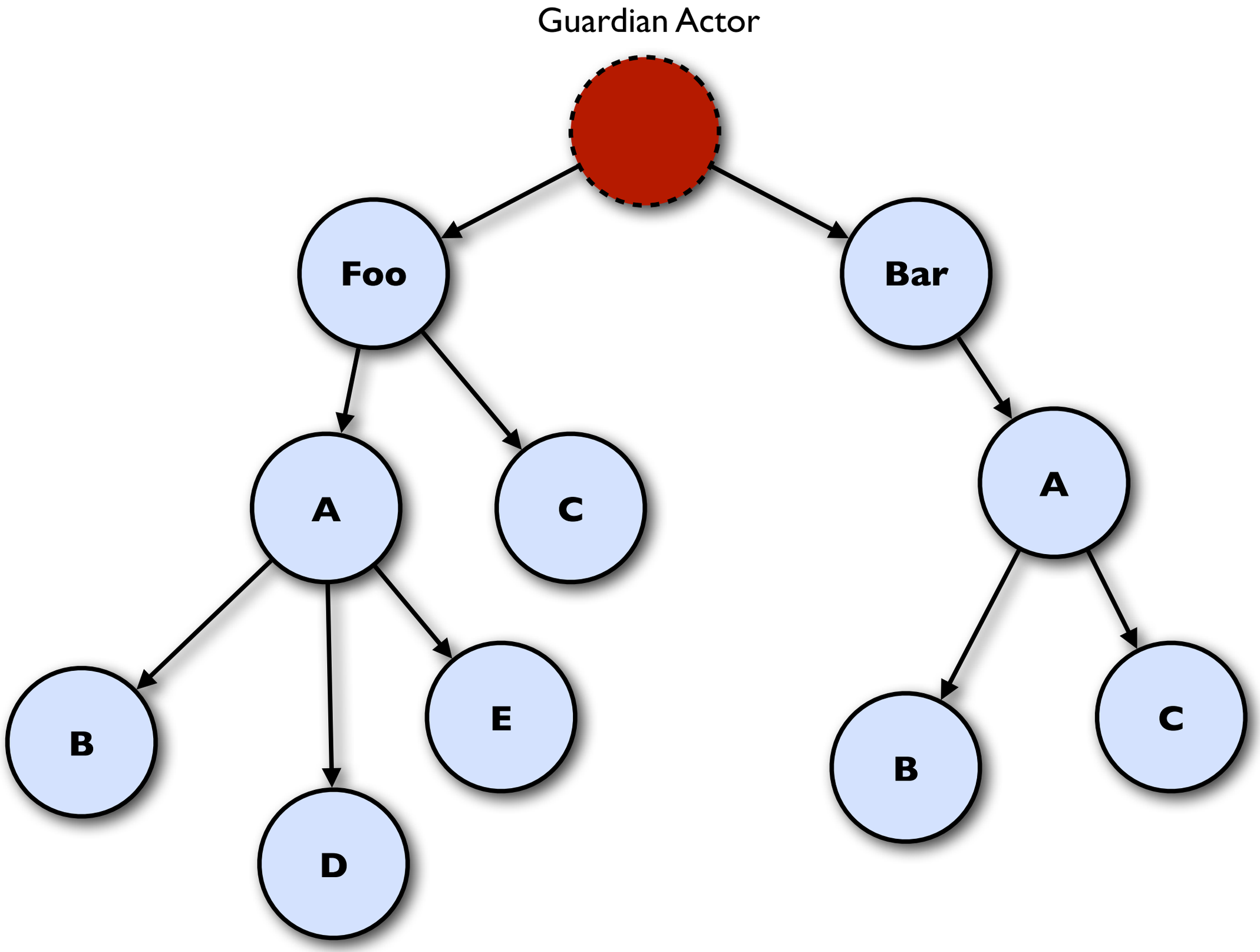
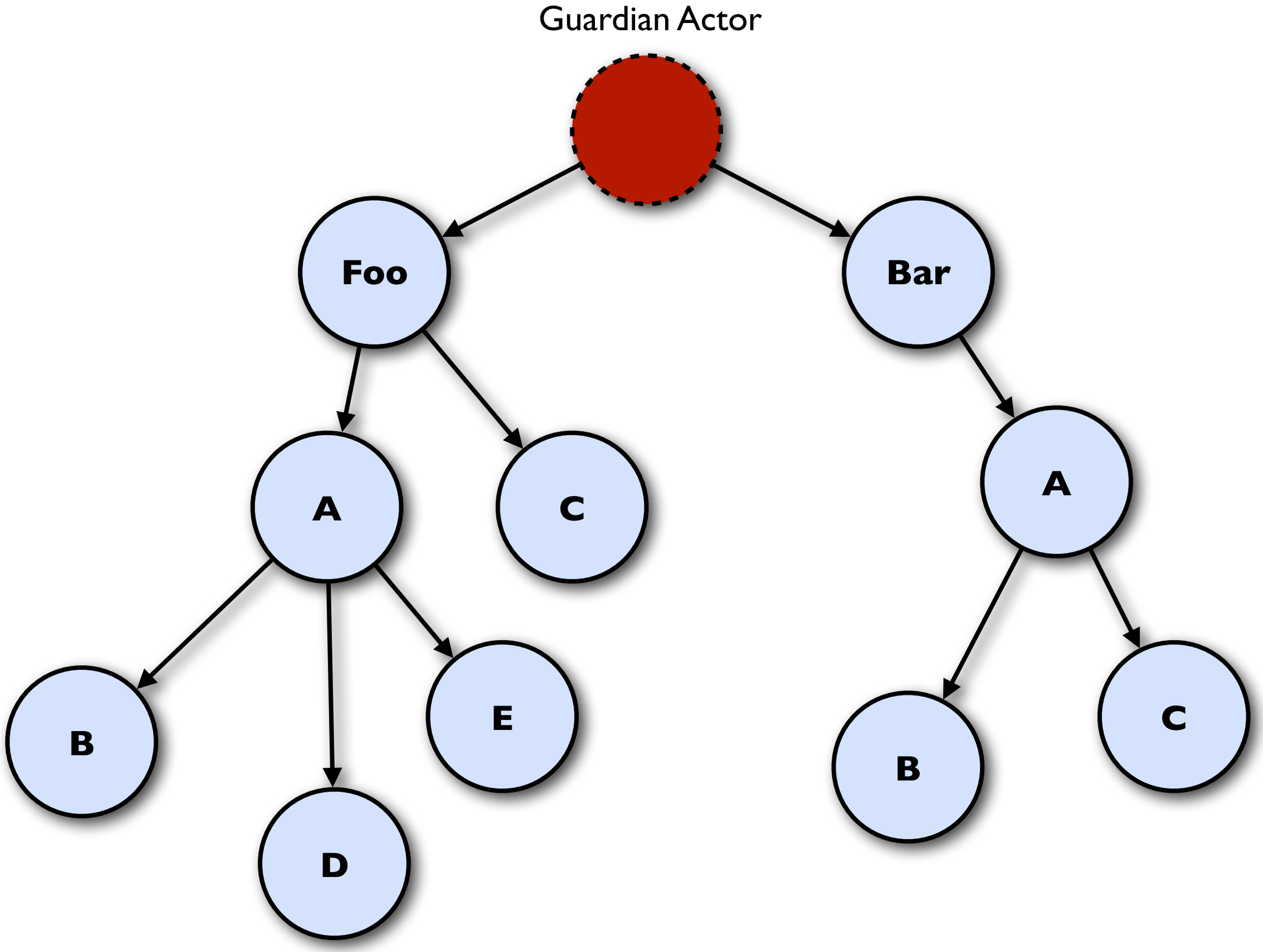


Name resolution - like a file-system



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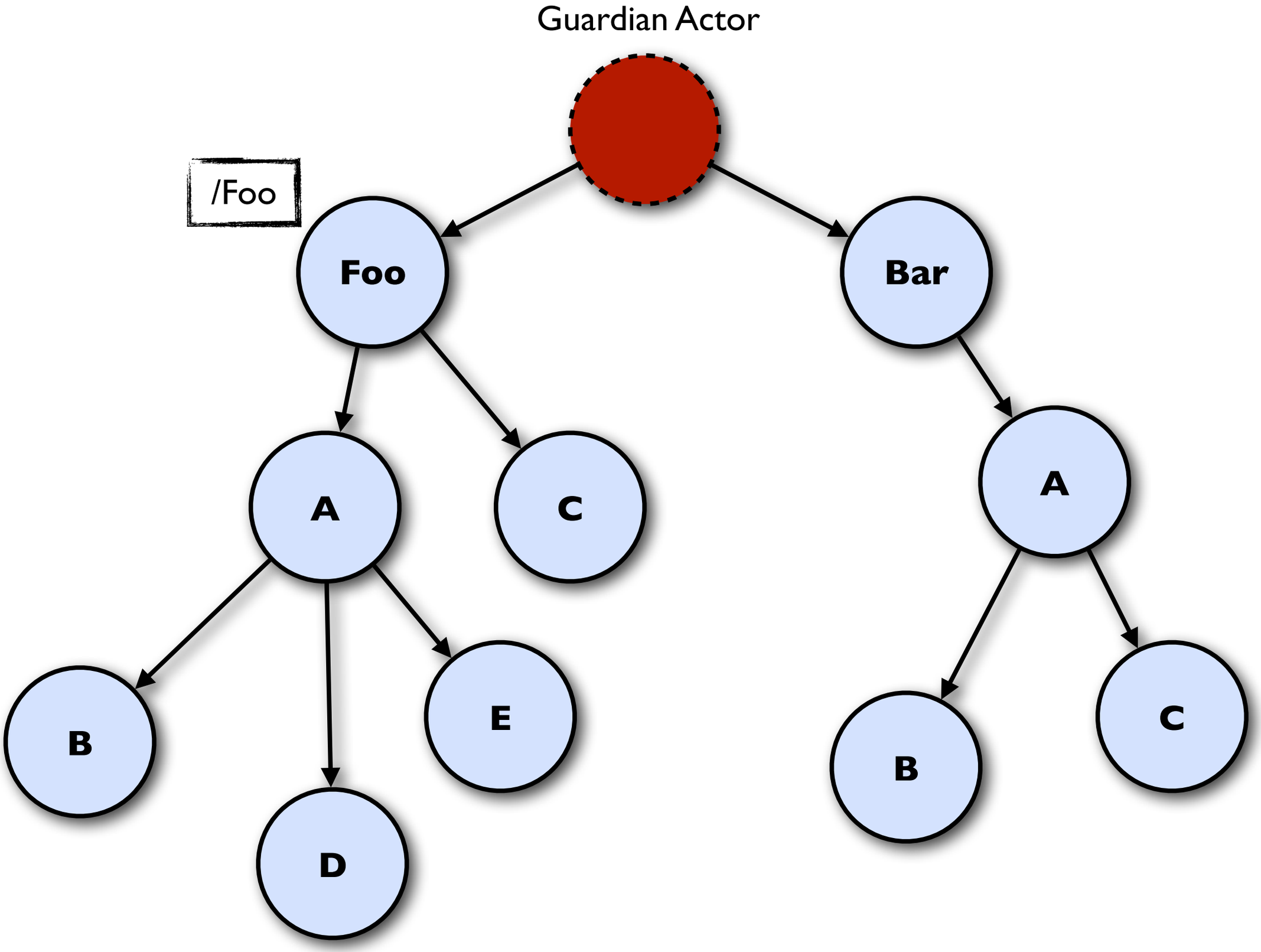

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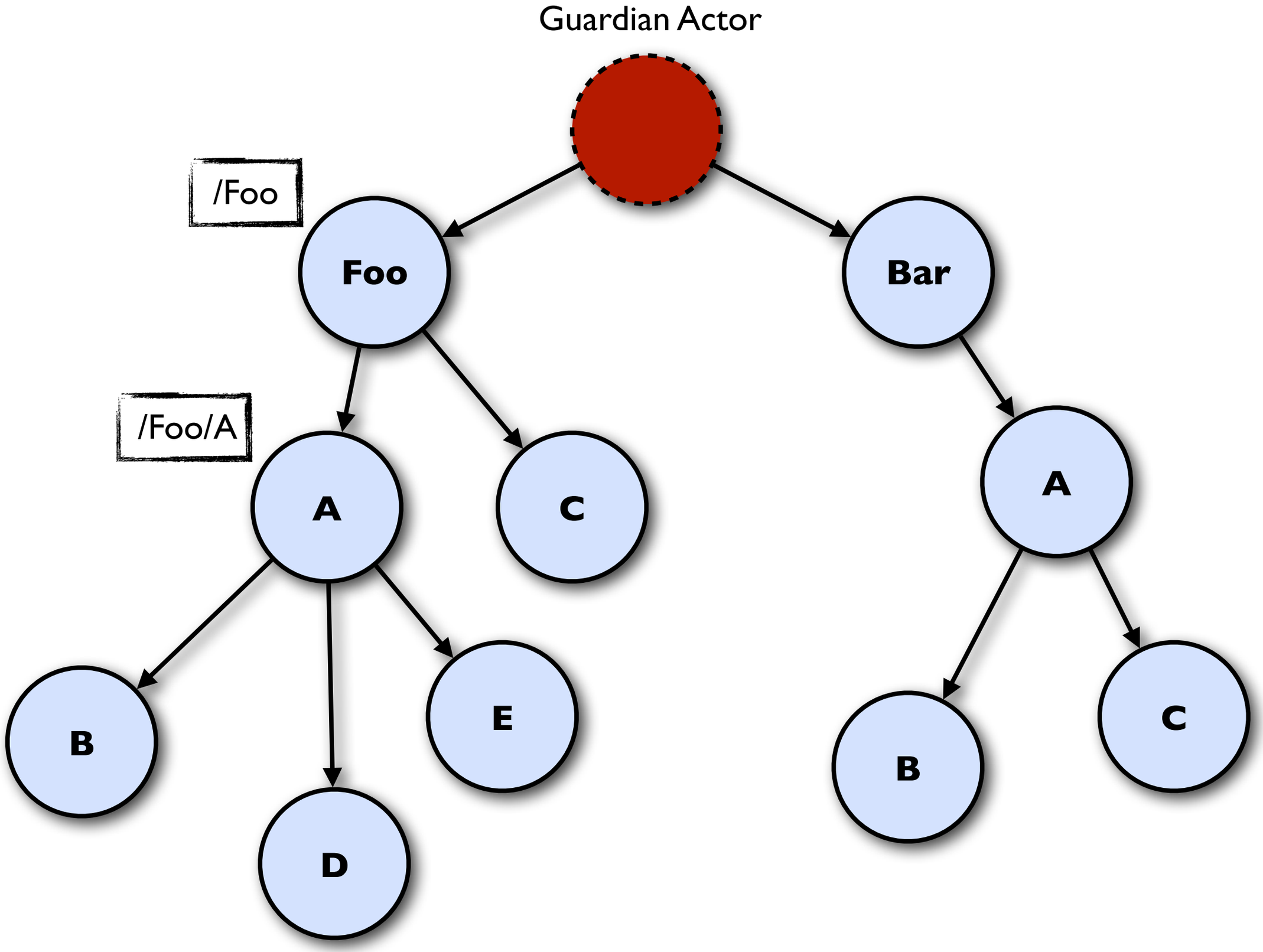

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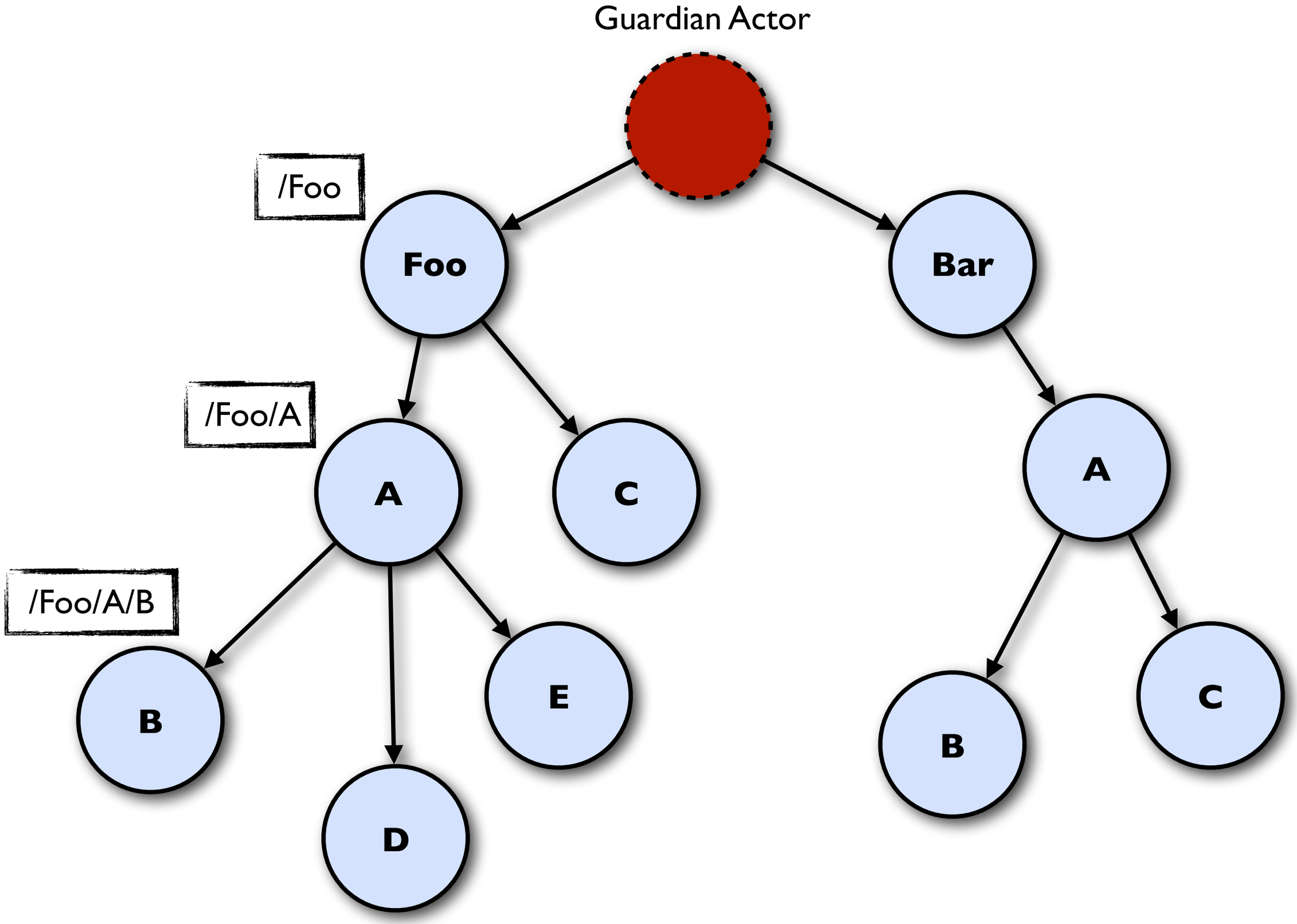

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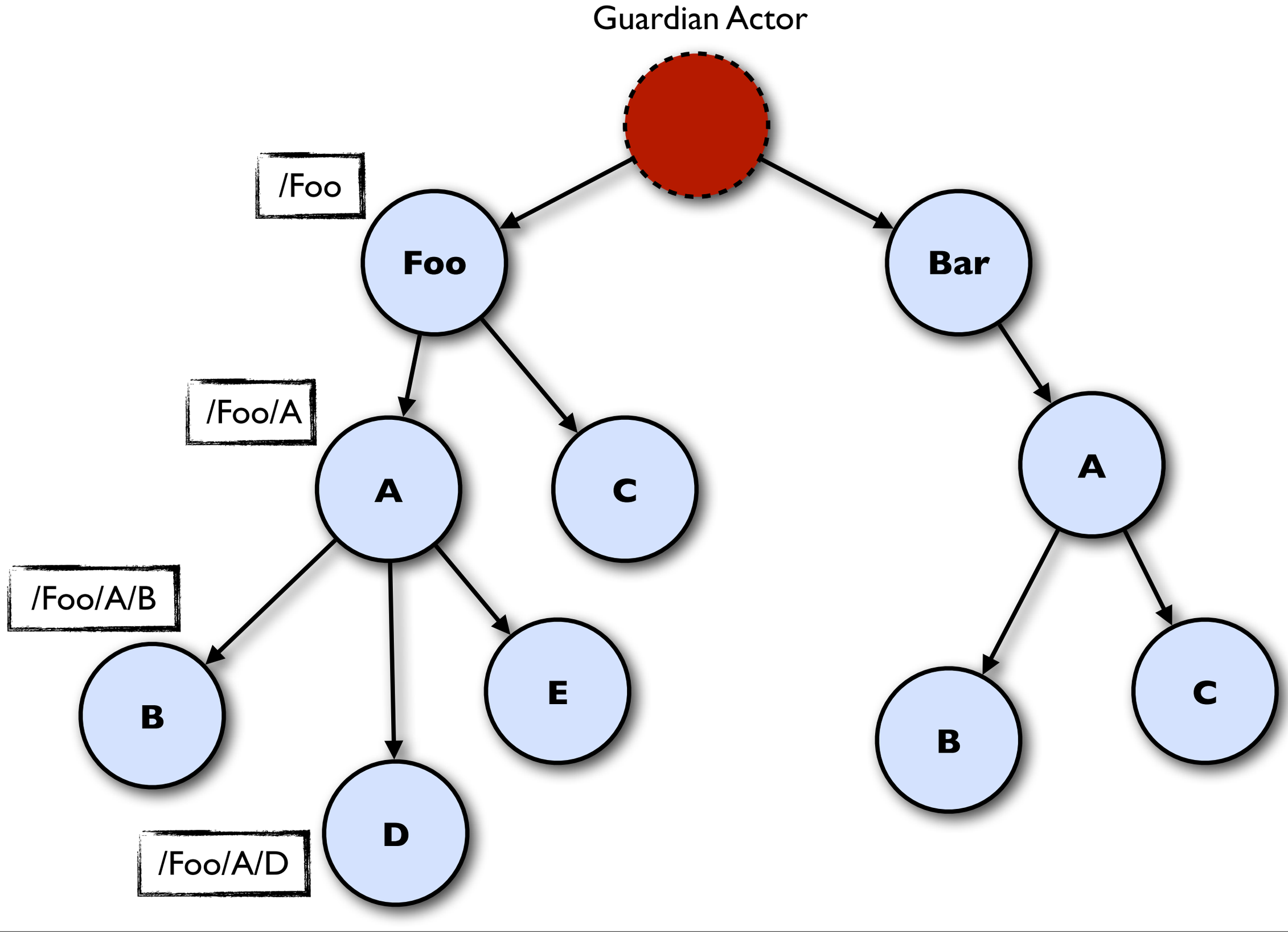

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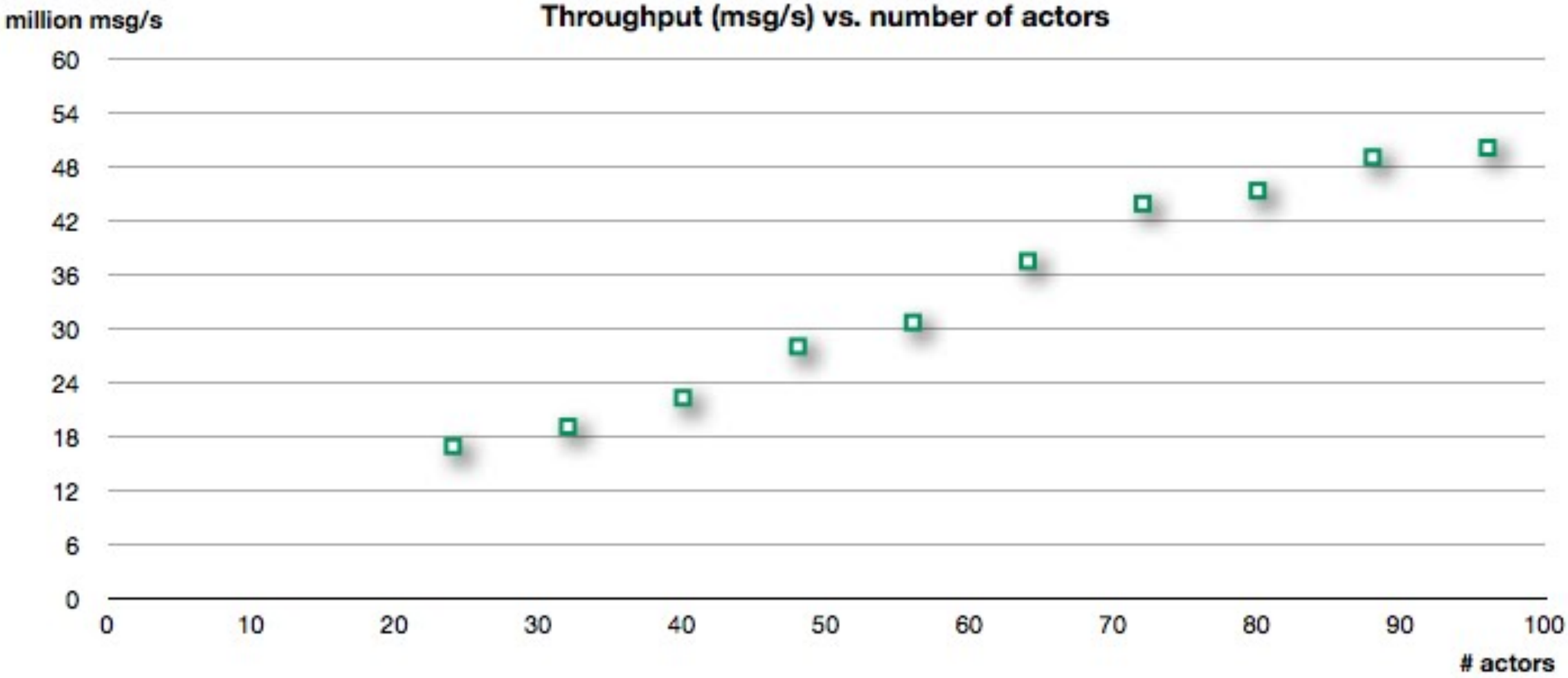
  - Messages is the *kinetic energy* in an Actor system
  - Actors can have lots of buffered *potential energy* but can't do anything with it until it is triggered by a message

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

Full example

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Remote deployment

Just feed the ActorSystem with this configuration

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

Remote deployment

Just feed the ActorSystem with this configuration

Configure a Remote Provider

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For the Greeter actor

Configure a Remote Provider

Define Remote Path

Remote deployment

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    deployment {
      /greeter {
        remote = akka://
      }
    }
  }
```

For the Greeter actor

Configure a Remote Provider

Define Remote Path

Protocol

Remote deployment

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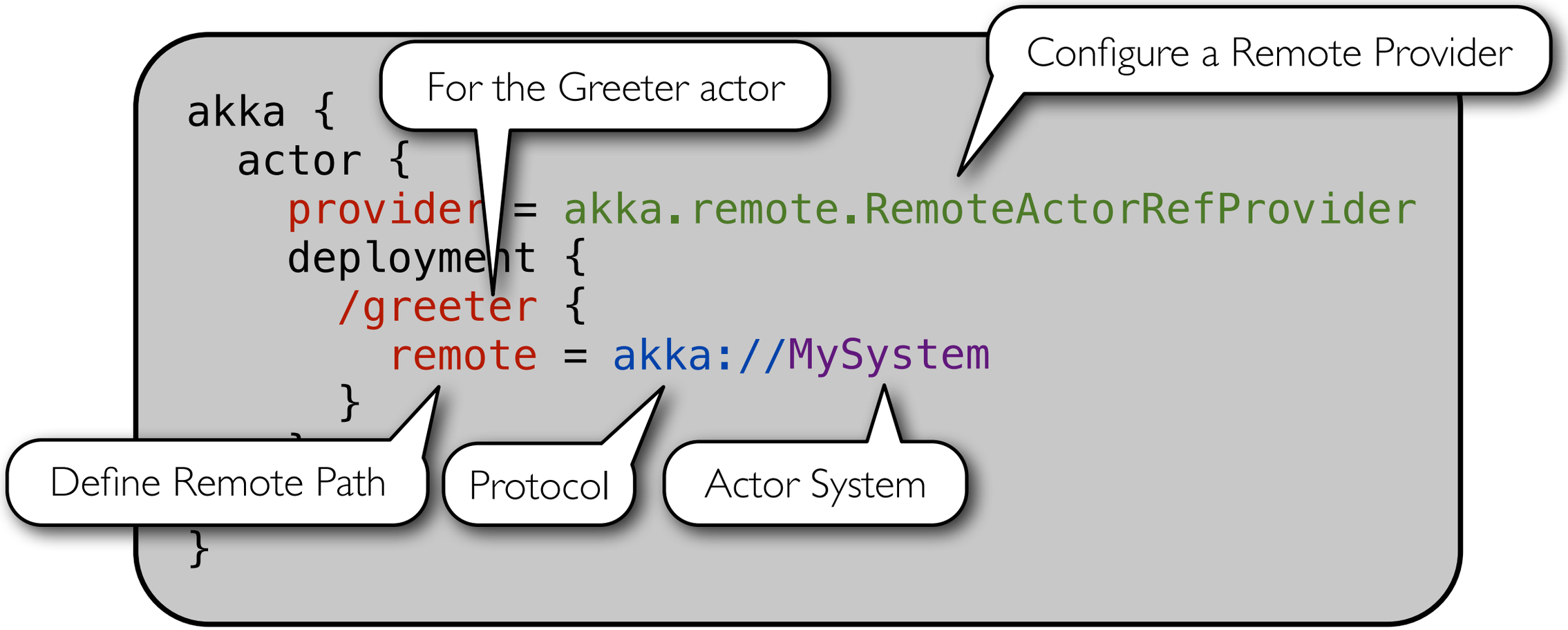

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akka {
  actor {
    provider = akka.remote.RemoteActorRefProvider
    deployment {
      /greeter {
        remote = akka://MySystem@machine1
      }
    }
  }
}
```

For the Greeter actor

Configure a Remote Provider

Define Remote Path

Protocol

Actor System

Hostname

Remote deployment

Just feed the ActorSystem with this configuration

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

For the Greeter actor

Configure a Remote Provider

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
      }
    }
  }
}
```

For the Greeter actor

Configure a Remote Provider

Define Remote Path

Protocol

Actor System

Hostname

Port

Zero code changes

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Routers

Load Balancing

Routers

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

Router + Resizer

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

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

...or from config

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

…or from config

```
akka.actor.deployment {
  /greeter {
    router = round-robin
    resizer {
      lower-bound = 2
      upper-bound = 15
    }
  }
}
```

3. BECOME

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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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- Other: Use your imagination!

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- Implement an FSM (Finite State Machine)
- 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

```
def expectHello: Receive = {
  case Hello(name) =>
    sender ! “Hello there ” + name
    context.become(expectGoodbye)
  case Goodbye(_) => sender ! “What?”
}

def expectGoodbye: Receive = {
  case Hello(_) => sender ! “Not now”
  case Goodbye(_) =>
    sender ! “See ya later dude”
    context.become(expectHello)
}

def receive = expectHello
```

Failure Recovery in Java/C/C# etc.

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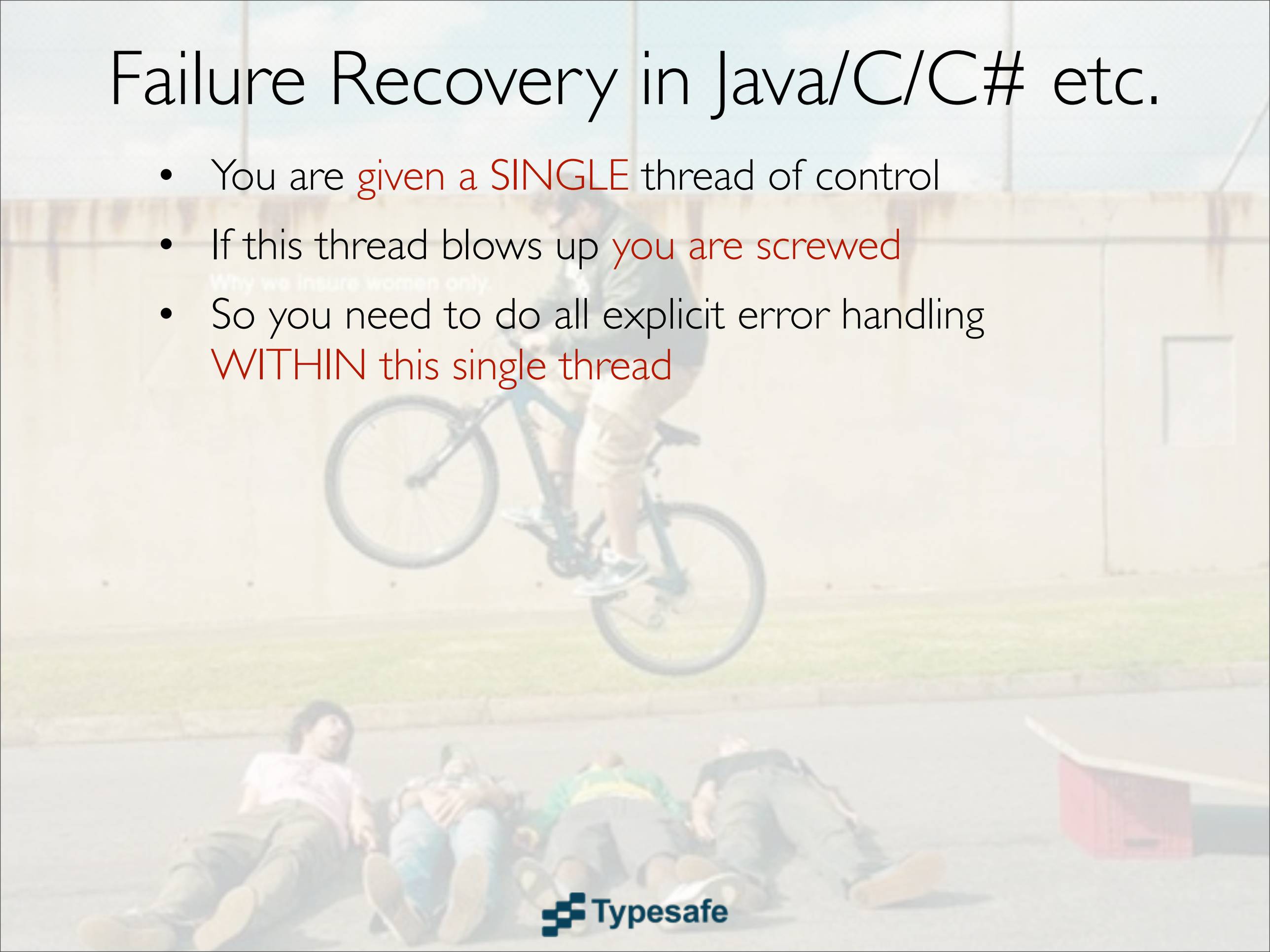

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- This leads to DEFENSIVE programming with:
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  - SCATTERED all over the code base

We can do better than this!!!

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Just

LET IT CRASH

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4. SUPERVISE

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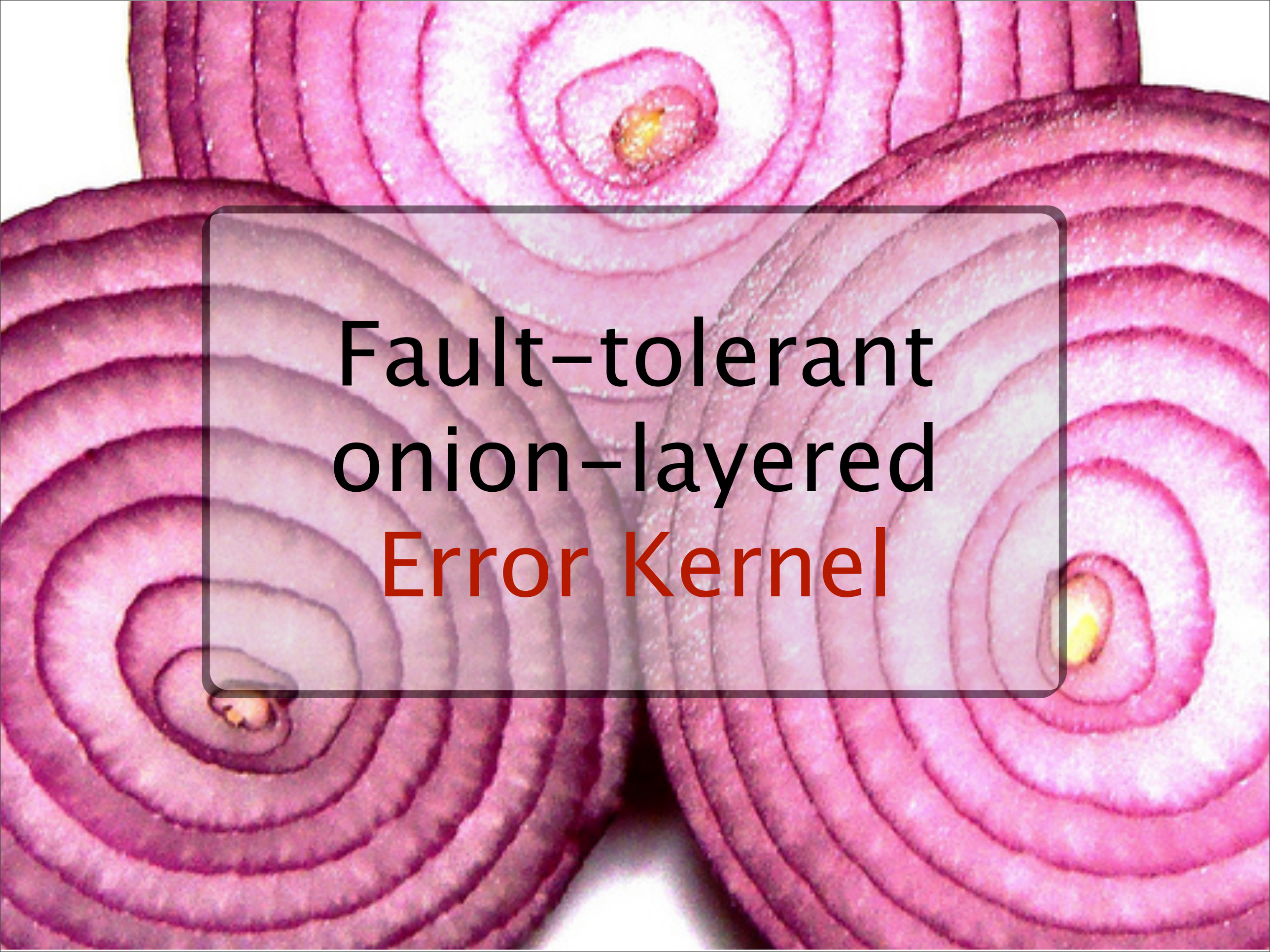
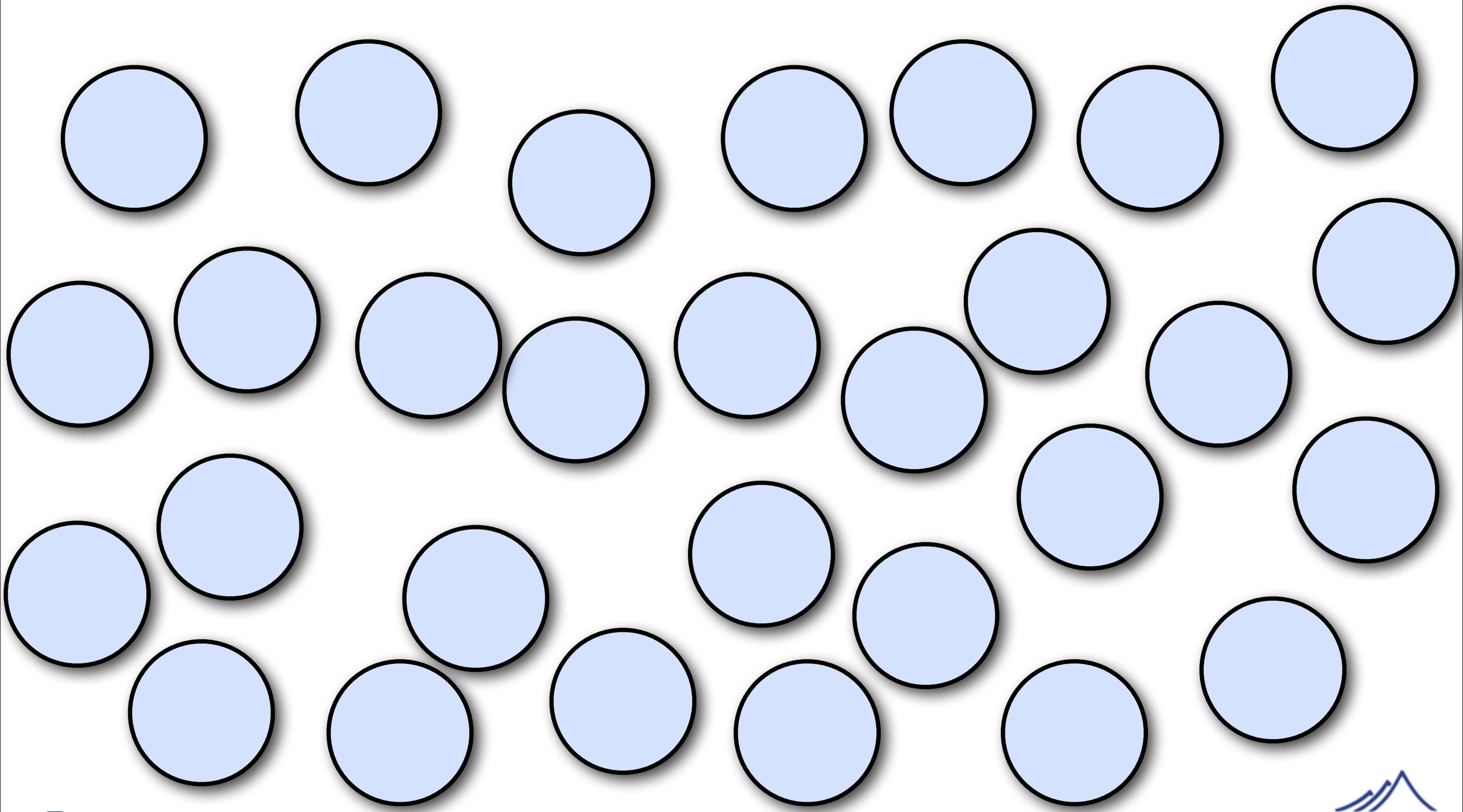
4. SUPERVISE

- 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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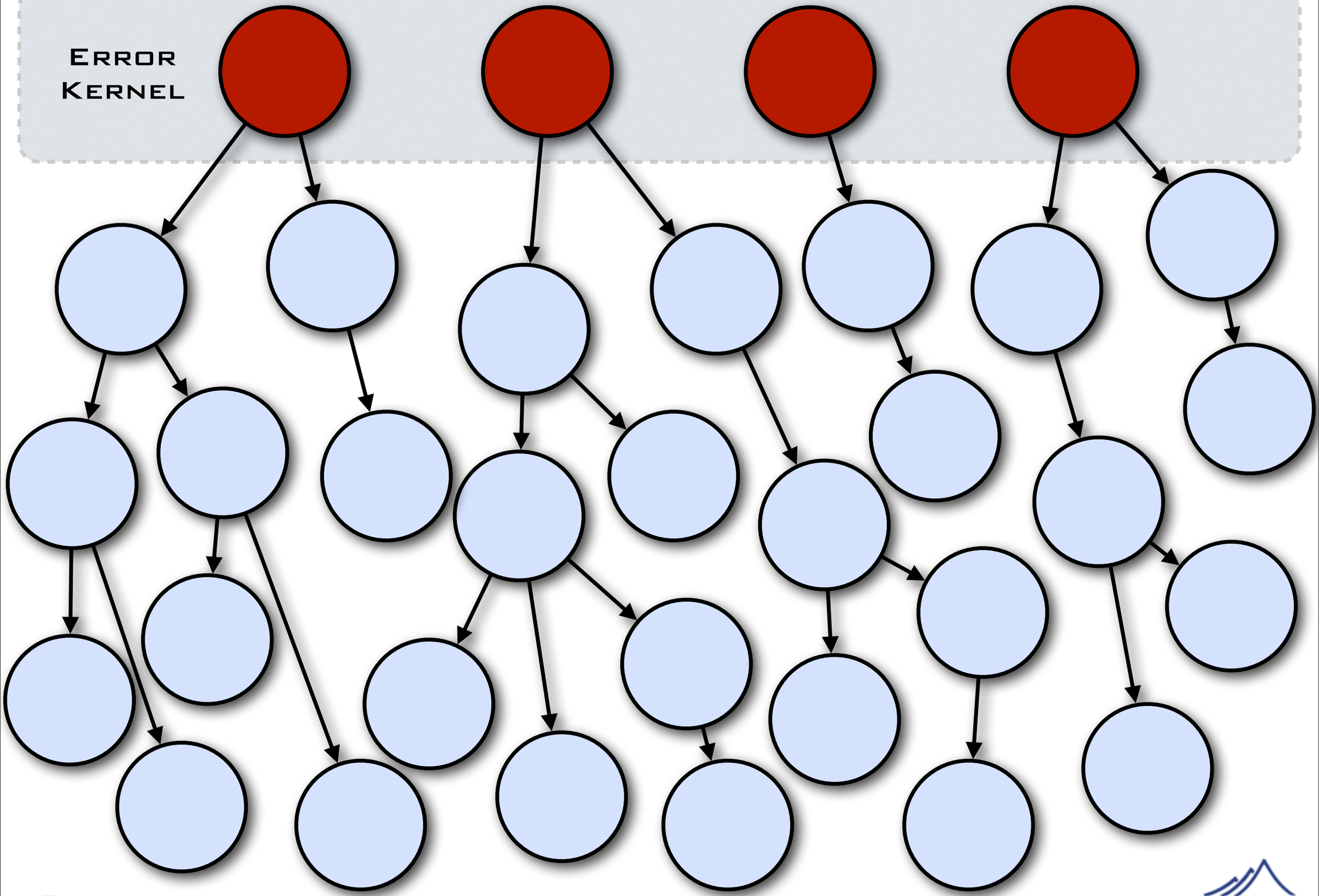
Error Kernel



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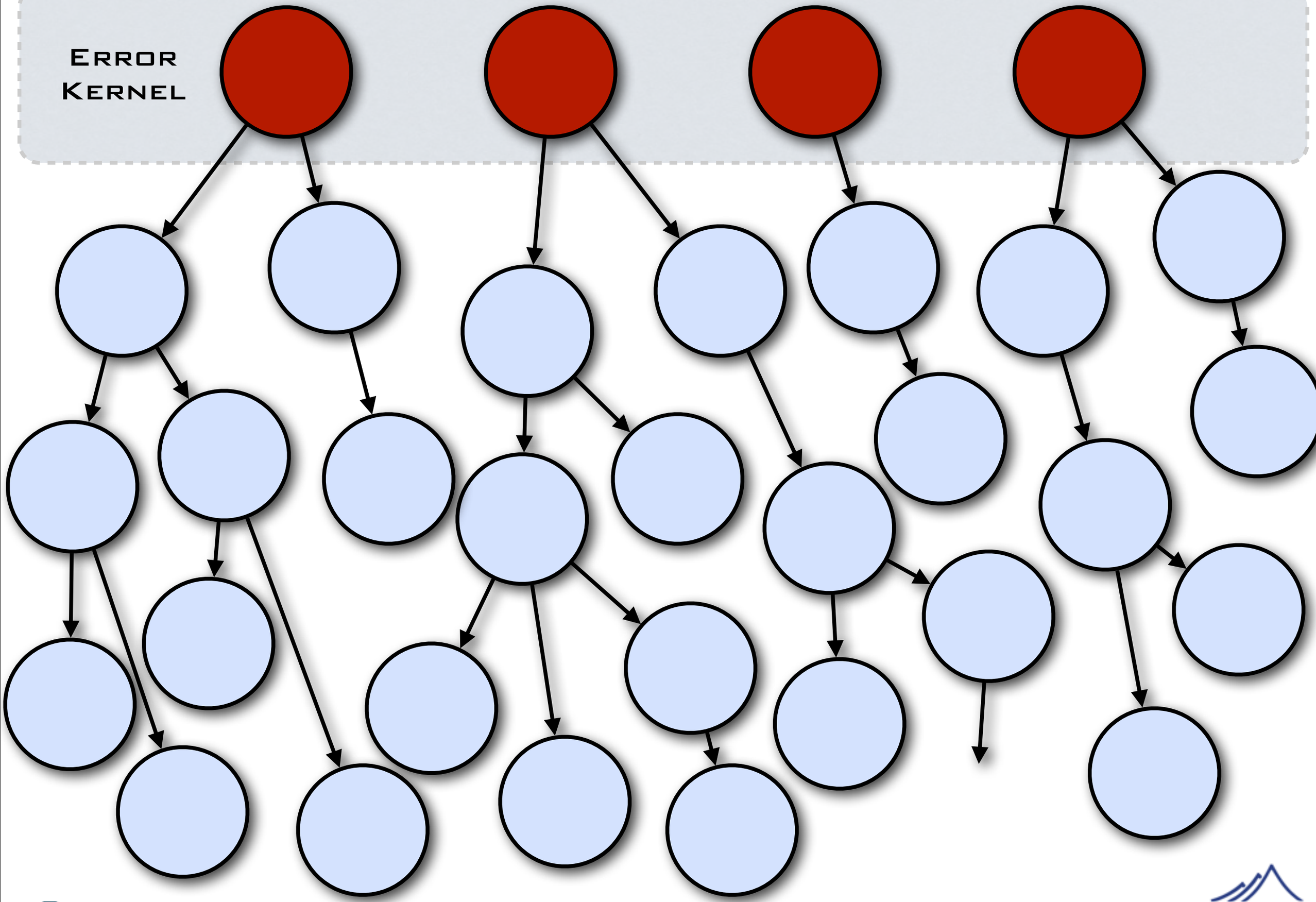

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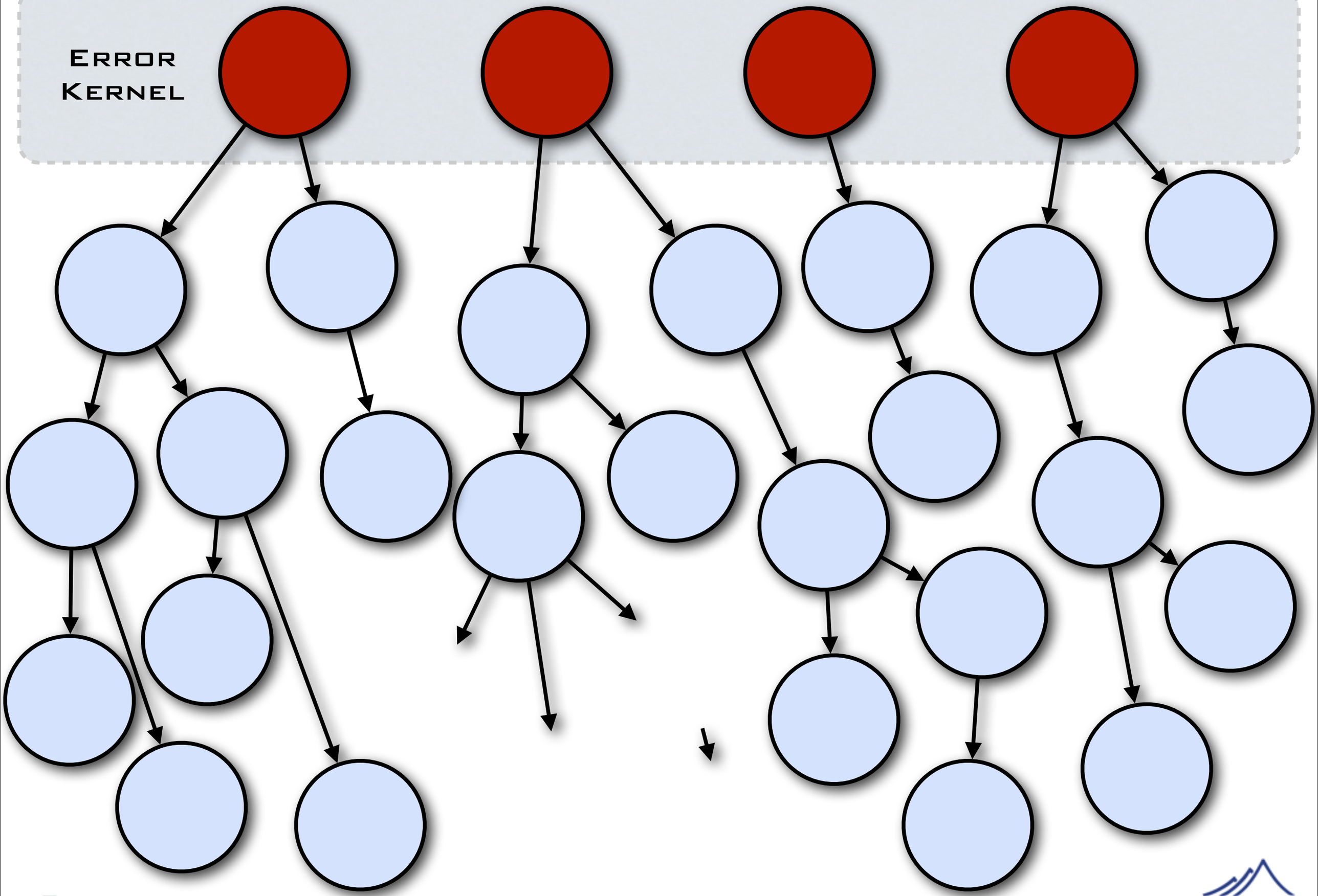

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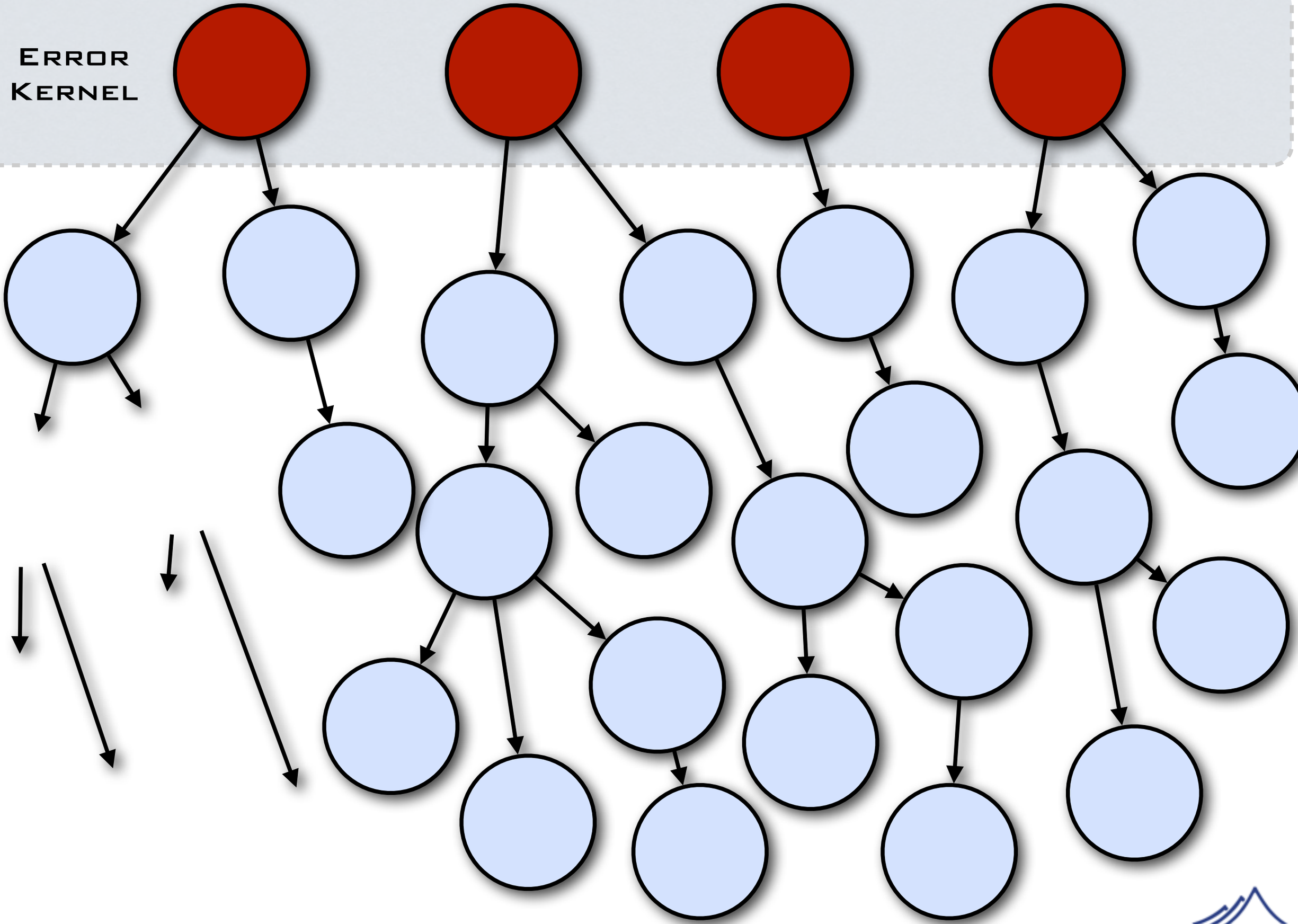

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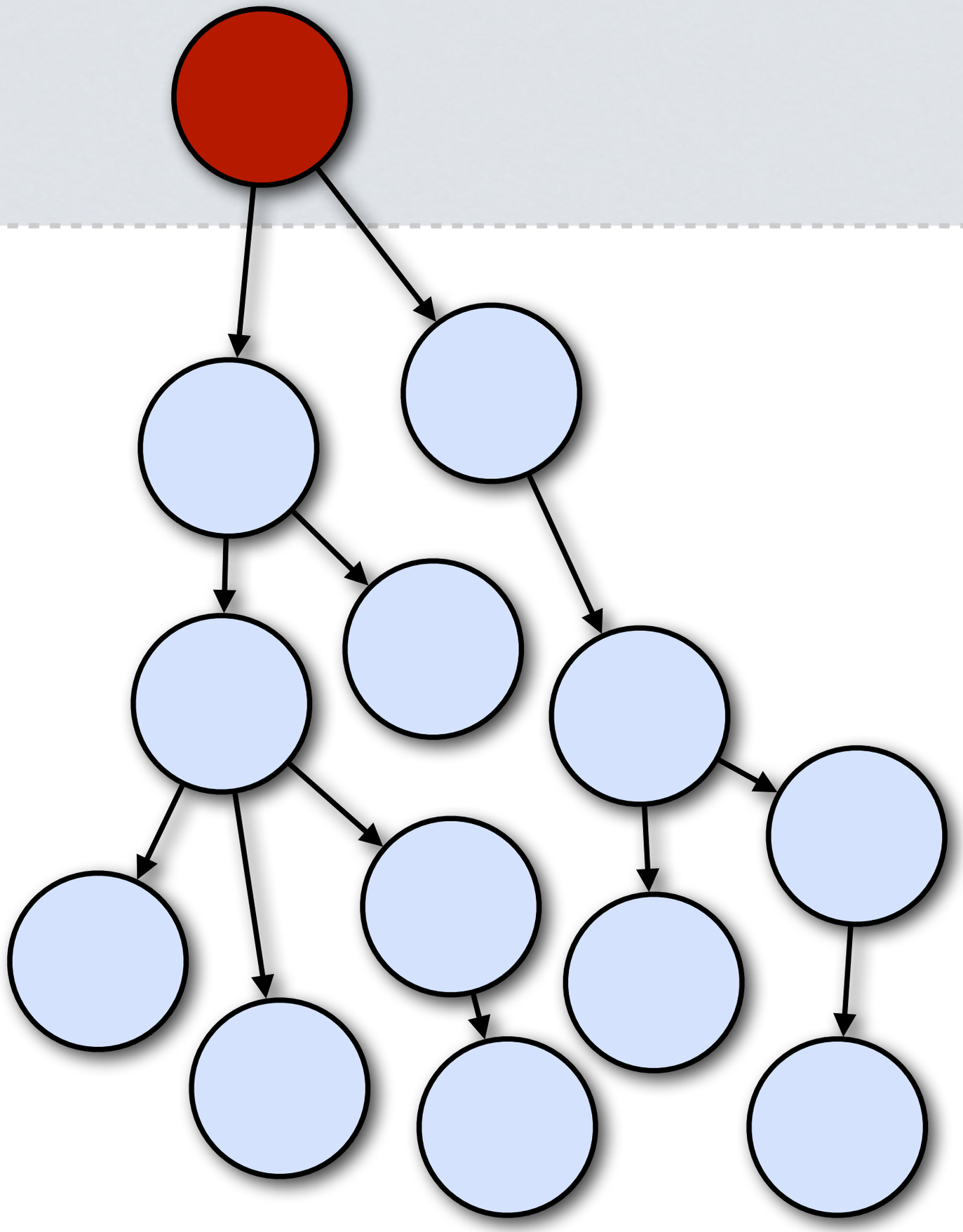
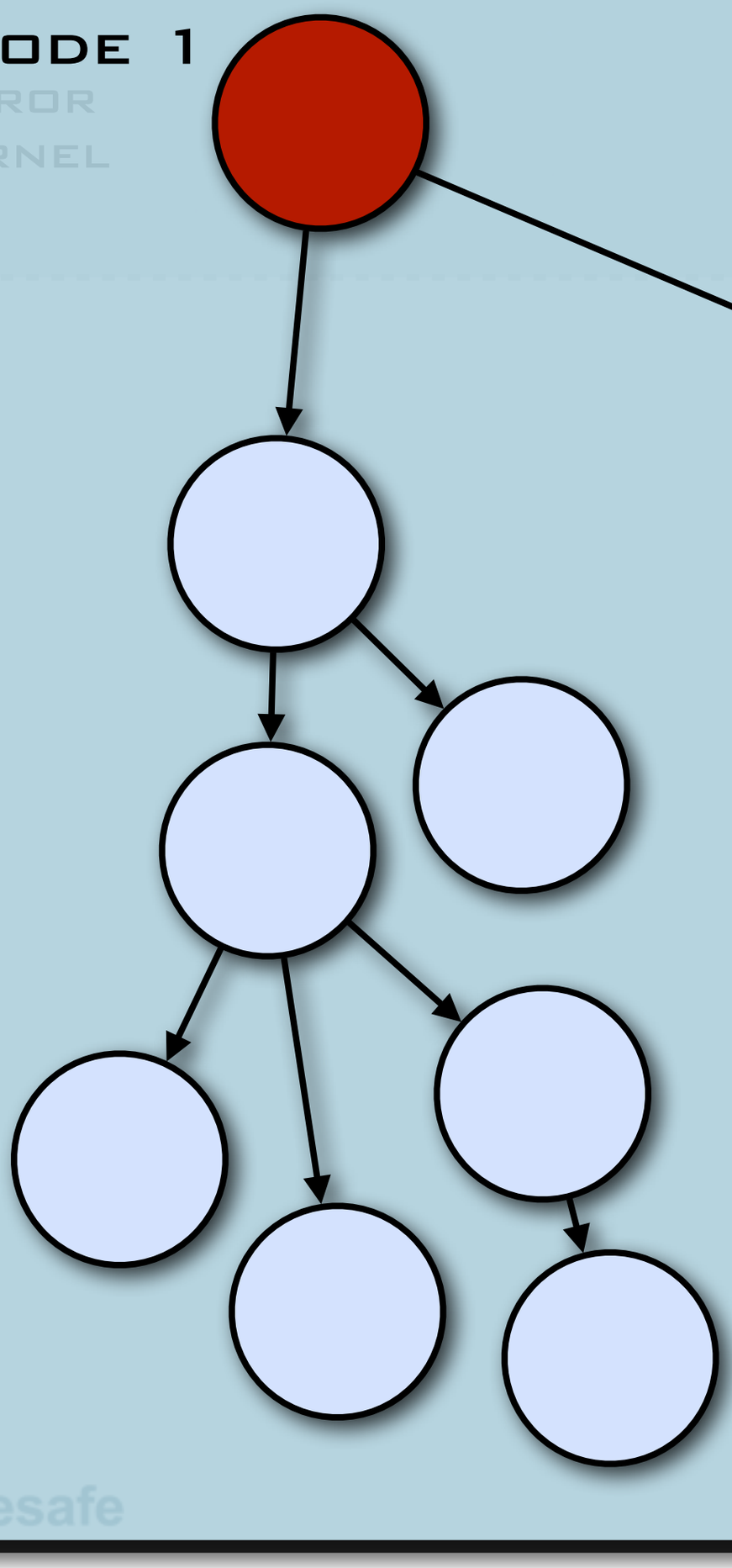
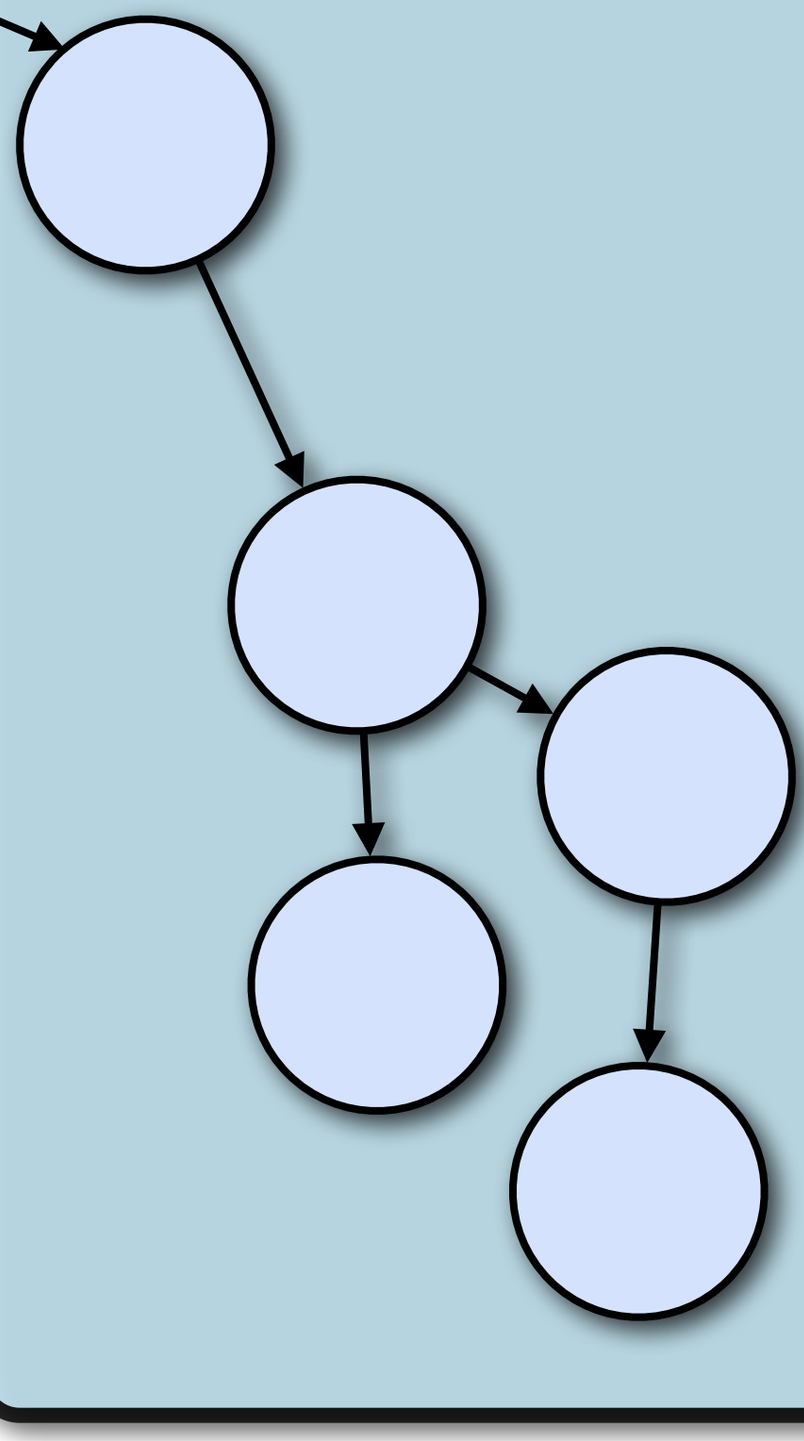


Node 1

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

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```
class Supervisor extends Actor {
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      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
  }
}
```

Akka Camel

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Consumer

```
class Consumer1 extends Consumer {
  def endpointUri =

  def receive = {
    case msg: CamelMessage ⇒
      println("received %s" format msg.bodyAs[String])
  }
}
```

Consumer

```
class Consumer1 extends Consumer {
  def endpointUri = “file:data/input/actor”

  def receive = {
    case msg: CamelMessage ⇒
      println("received %s" format msg.bodyAs[String])
  }
}
```

Consumer

```
class Consumer1 extends Consumer {
  def endpointUri =

  def receive = {
    case msg: CamelMessage ⇒
      println("received %s" format msg.bodyAs[String])
  }
}
```

Consumer

```
class Consumer1 extends Consumer {
  def endpointUri = “jetty:http://localhost:8877/camel/default”

  def receive = {
    case msg: CamelMessage ⇒
      println("received %s" format msg.bodyAs[String])
  }
}
```

Producer

```
class OrderActor extends Actor with Producer with Oneway {
  def endpointUri = "jms:queue:Orders"
}

val system = ActorSystem("some-system")
val orderActor = system.actorOf(Props[OrderActor])

orderActor ! <order amount="42" currency="EUR" itemId="9"/>
```

Akka Cluster

Experimental module in 2.1

What's New?

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

Gossiping Protocol

Gossiping Protocol

Used for:

Gossiping Protocol

Used for:

- Cluster Membership

Gossiping Protocol

Used for:

- Cluster Membership
- Configuration data

Gossiping Protocol

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- *Partitioning data*

Gossiping Protocol

Used for:

- Cluster Membership
- Configuration data
- Leader Determination
- *Partitioning data*
- *Naming 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 = 15

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

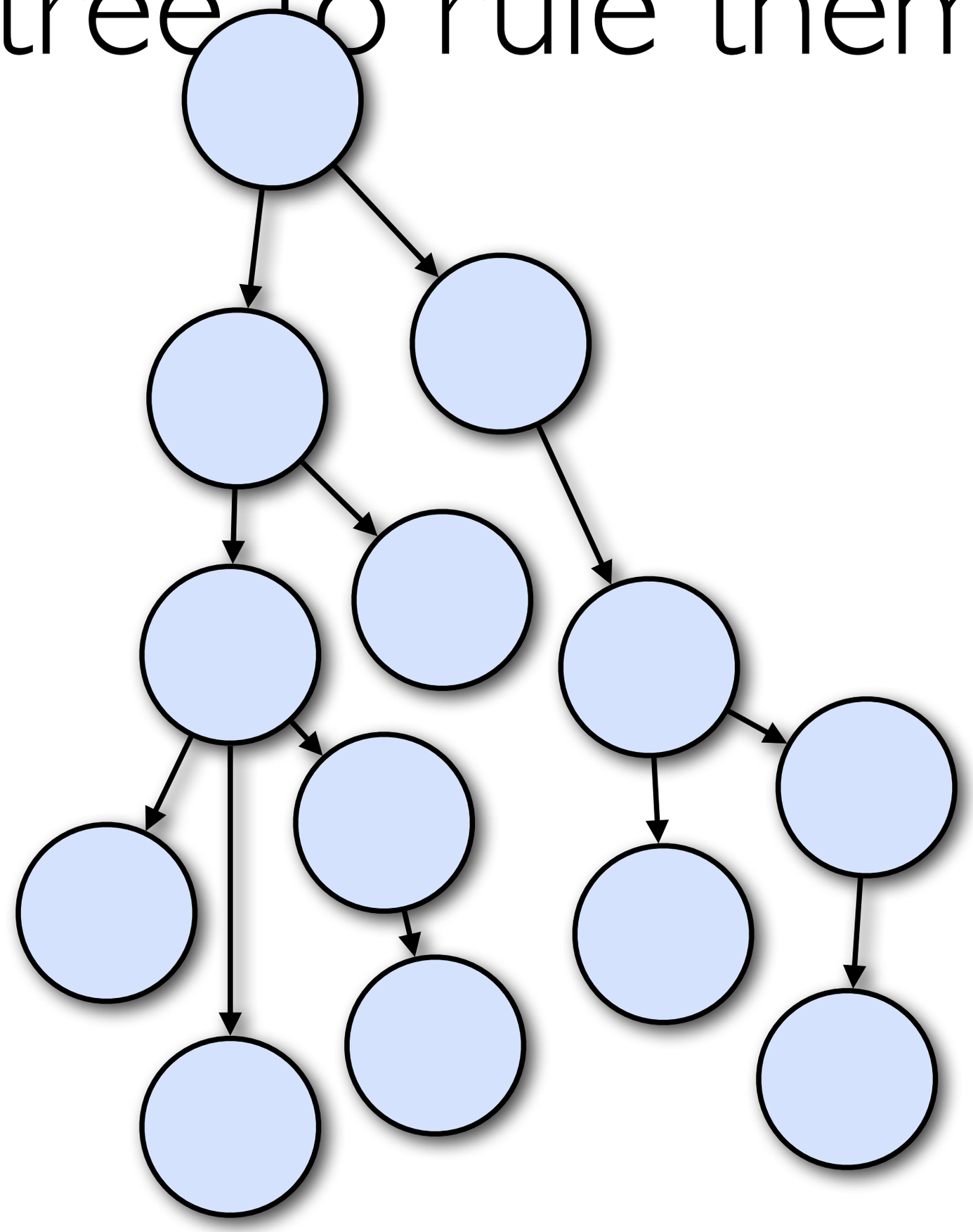
Rollins

... when the Cluster grows up

One tree to rule them all

- Coltrane has one Actor tree per node
- Rollins still has this as physical substrate
- Cluster tree is mapped to local sub-trees

One tree to rule them all



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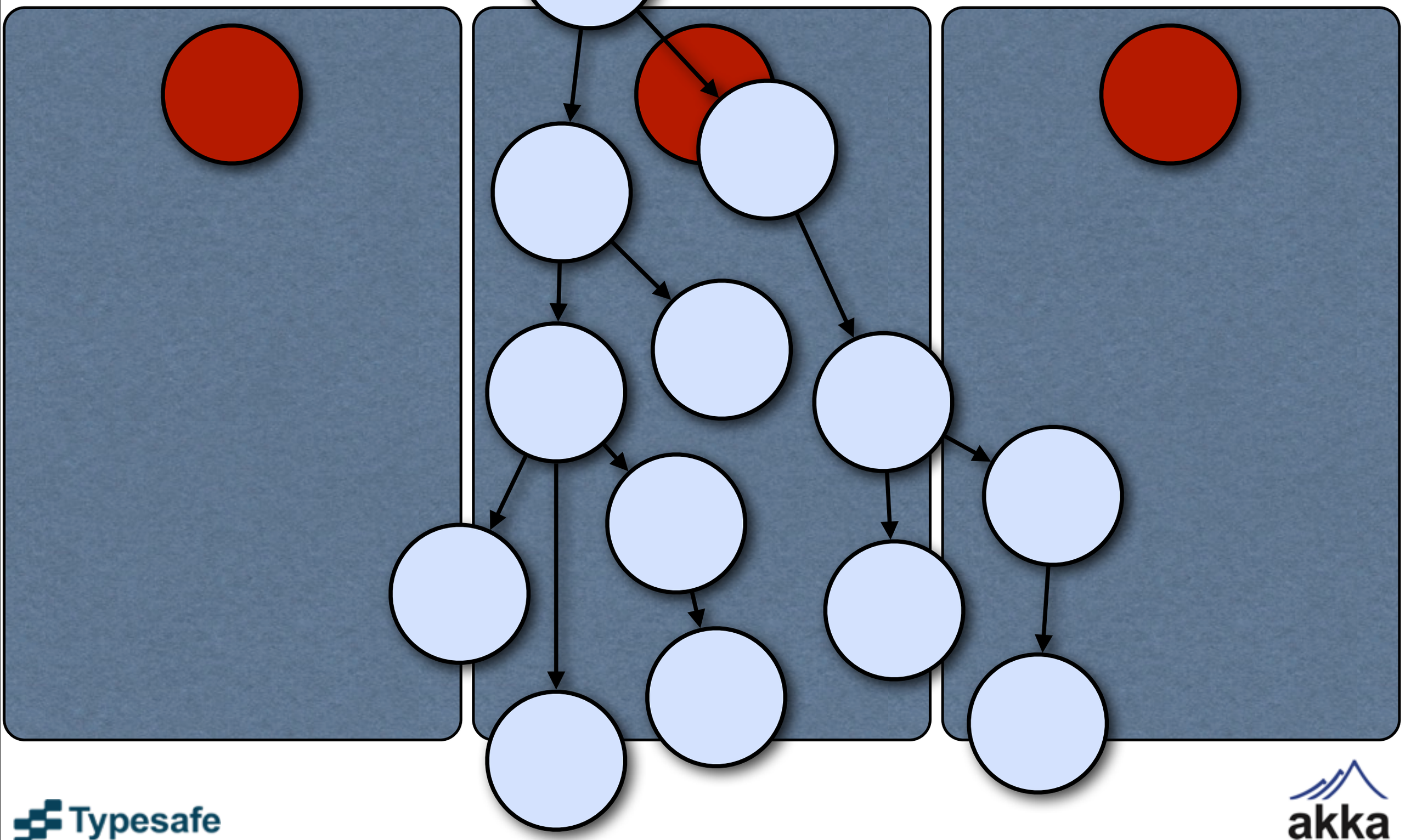
One tree to rule them all



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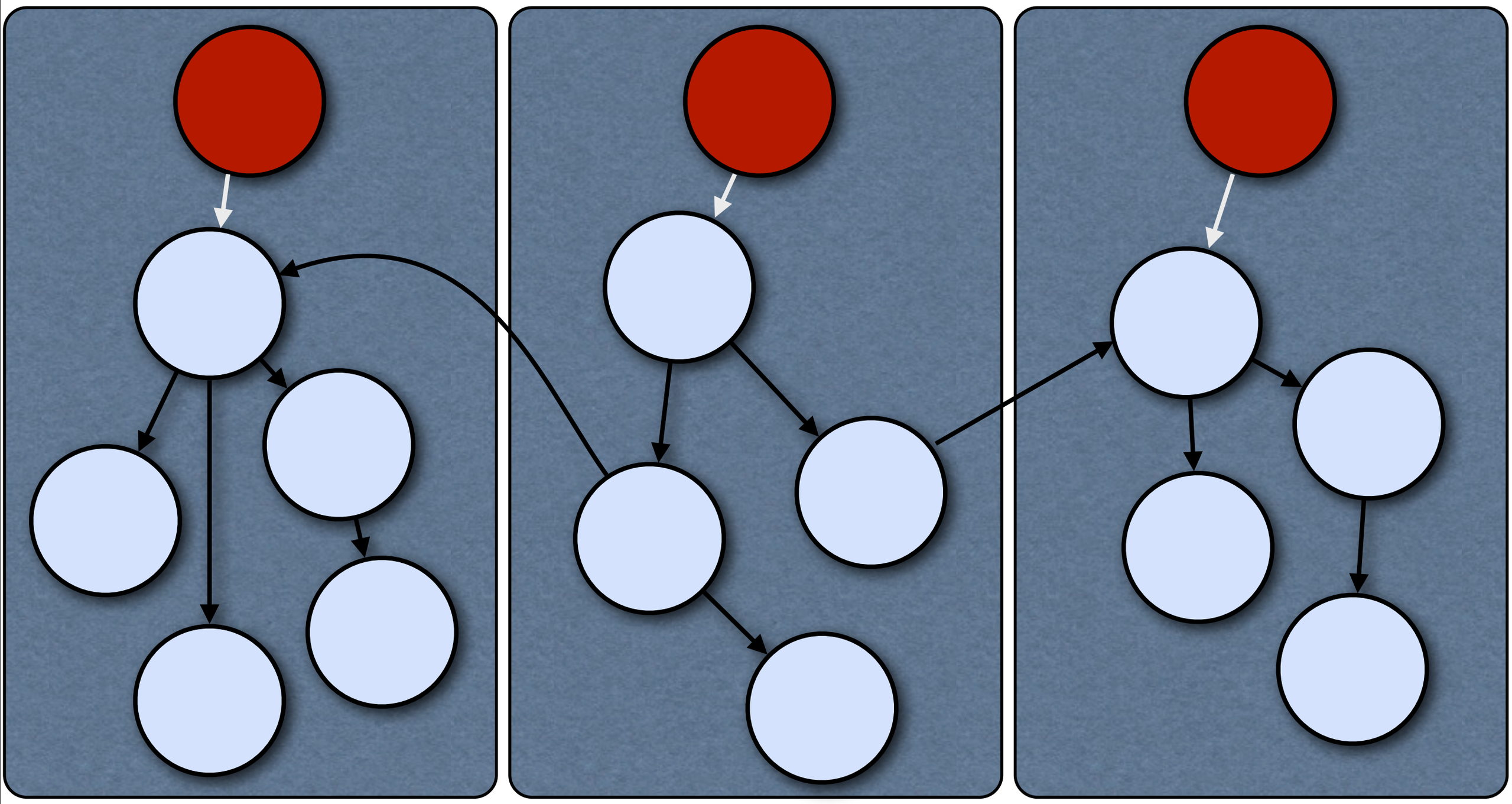

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The Magic Sauce

- 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*

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

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

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

Durable Mailboxes

FSM

TestKit

Pub/Sub

EventBus

TypedActor

IO

Pooling

Microkernel

Dataflow

ZeroMQ

SLF4J

Transactors

Agents

Extensions

get it and learn more

http://akka.io

http://letitcrash.com

http://typesafe.com

EØF

Akka

Typesafe

akka

Case Studies

- Royal Netherlands Marechaussee
- Gilt

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RNM

- Main function is to combat
  - illegal residence, smuggling, trafficking, etc.
  - cross-border crimes
- Challenges
  - collect data for traffic profiling
  - observe vehicles + select ones to be stopped
  - respond to quick alerts

RNM

- Solution
  - Akka because
    - ease of use
    - leverages existing Java investments
    - scalability and performance
- Been in production since August 1st 2012
- Further information:
  - http://www.typesafe.com/public/case-studies/DBP-case-study.pdf

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Gilt

- Online shopping of top designer labels
- Uses so called “flash sales”
- Gilt live

Gilt

- RoR => Java => Scala
  - scalability issues with RoR
  - uses modern web technology: web sockets => Play! web framework

- "Akka is key to handling traffic" - a huge % of Gilt's business is done between 12:00 PM and 12:10 PM. Gilt uses both actors and futures to handle the load.
- Read more: http://www.typesafe.com/public/case-studies/Gilt%20Live%20Case%20Study

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E0F

Case Studies

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The Typesafe Console

Typesafe

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About the Console

- Monitors Akka applications
- Implemented in Scala, Akka and Play
- Comes as part of the Typesafe subscription
- Aim: It should be possible to have running at *all time* in production

Architecture

Console

Your Monitored Application

Instrumented Akka

Analyze

Query

Mongo DB

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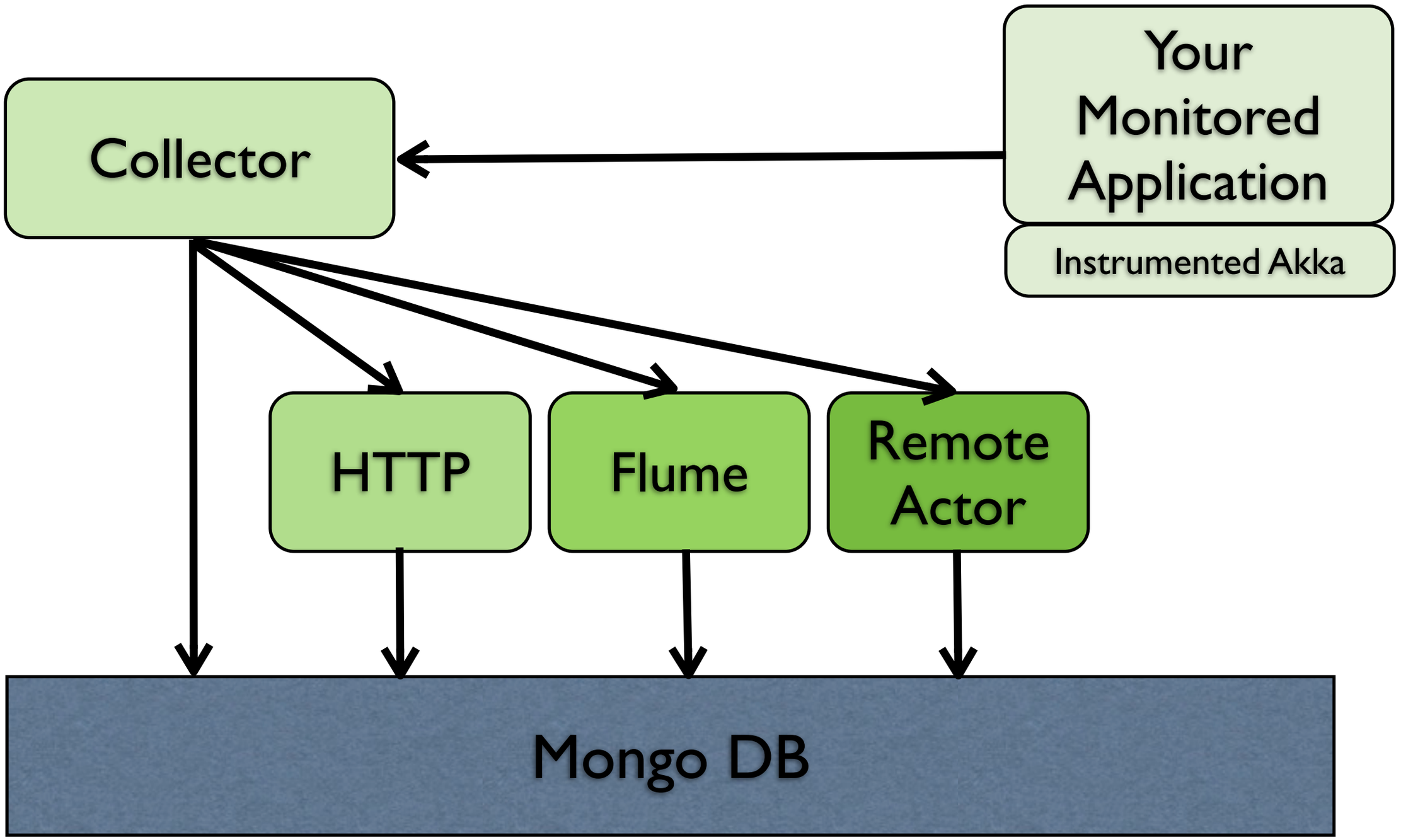
Trace Module

- Aspect Load Time Weaving
- Stores data in ThreadLocal
- Batch store via socket into offline storage
- Tracing works for
  - Within one ActorSystem and between ActorSystems
  - Between remote ActorSystems
  - for all operations in Akka
- Available for Akka 1.3, 2.0.x, 2.1 (soon)

Trace Event Example

```
// JSON PAYLOAD
{
"_id" : BinData(3,"4RHh8WFt3T6JkhKx9rj2qQ=="),
"annotation" :
{ "type" : "received", "actor" : "akka://MyAS/user/ActorA"}
"trace" : BinData(3,"4RHh8ZFx2z6JkhKx9rj2qQ=="),
"parent" : BinData(3,"4RHh8UAf3T6JkhKx9rj2qQ=="),
"sampled" : 1,
"node" : "MyNode",
"actorSystem" : "MyActorSystem",
"host" : "10.0.1.234",
"timestamp" : NumberLong("1346248552246"),
"nanoTime" : NumberLong("1346248552246712000")
 // ...
}
```

Under the hood



Trace API

- Collect data in "hot path"
  - Tracer(system).markStart("myPath")
  - Tracer(system).markEnd("myPath")
- Collect application specific data
  - Tracer(system).record("login","user1")

Deployment

- Text based configuration = DevOps :-)
- Simple Setup
  - JVM1 : Your application
  - JVM2 : Query and Analyze modules
  - JVM3 : Console
  - One MongoDB instance

Deployment

- Advanced setup
  - JVM 1-m : Your application
  - JVM m-n : Analyze
  - JVM n1 : Query
  - JVM n2 : Console
  - 2 Mongo DB instances: Data + Statistics

Demo

Thx

@h3nk3

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