Above the Clouds:
Introducing Akka

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The problem

It is way too hard to build:

1. correct highly concurrent systems
2. truly scalable systems
3. fault-tolerant systems that self-heals

...using "state-of-the-art" tools

Introducing akka

Vision

Simpler

- Concurrency
- Scalability
- Fault-tolerance

Vision

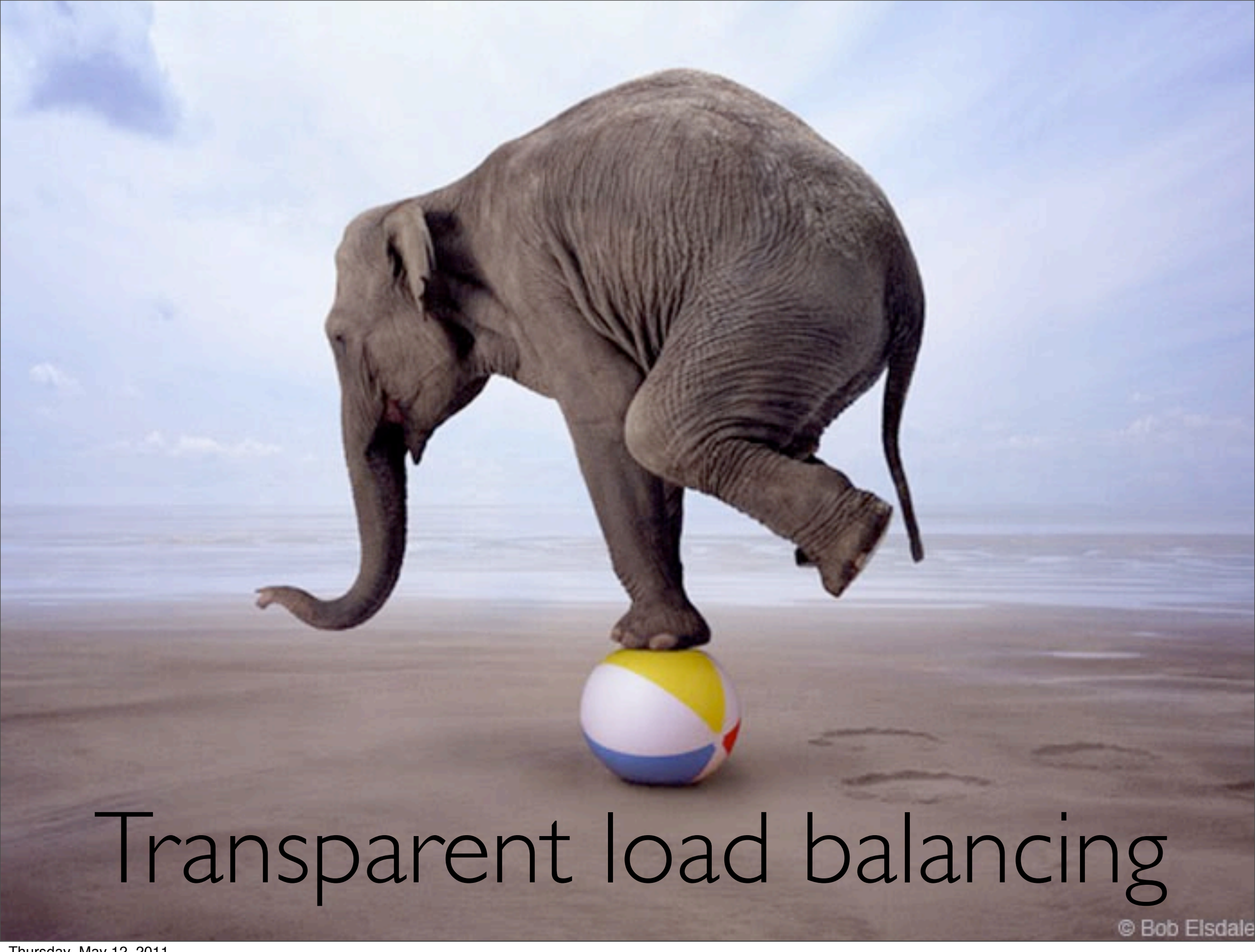
...with a single unified

- Programming model
- Runtime service

Manage system overload

Scale up & Scale out

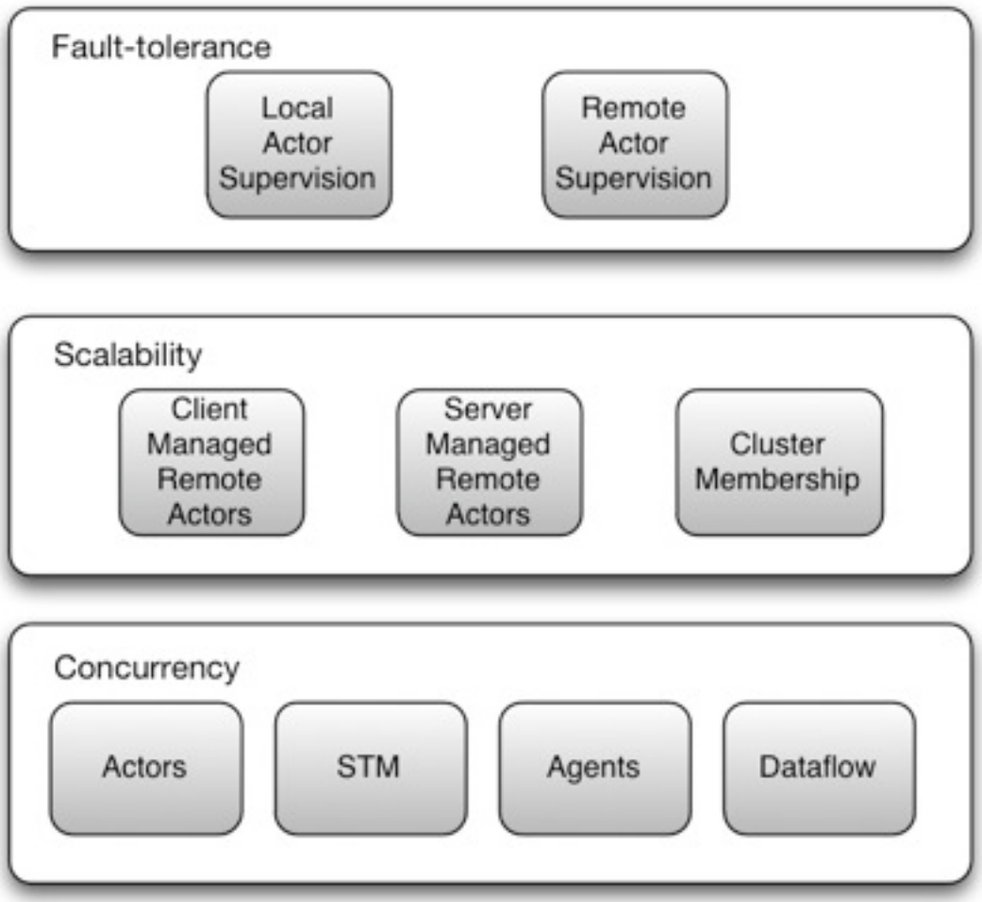
Replicate and distribute for fault-tolerance



Transparent load balancing

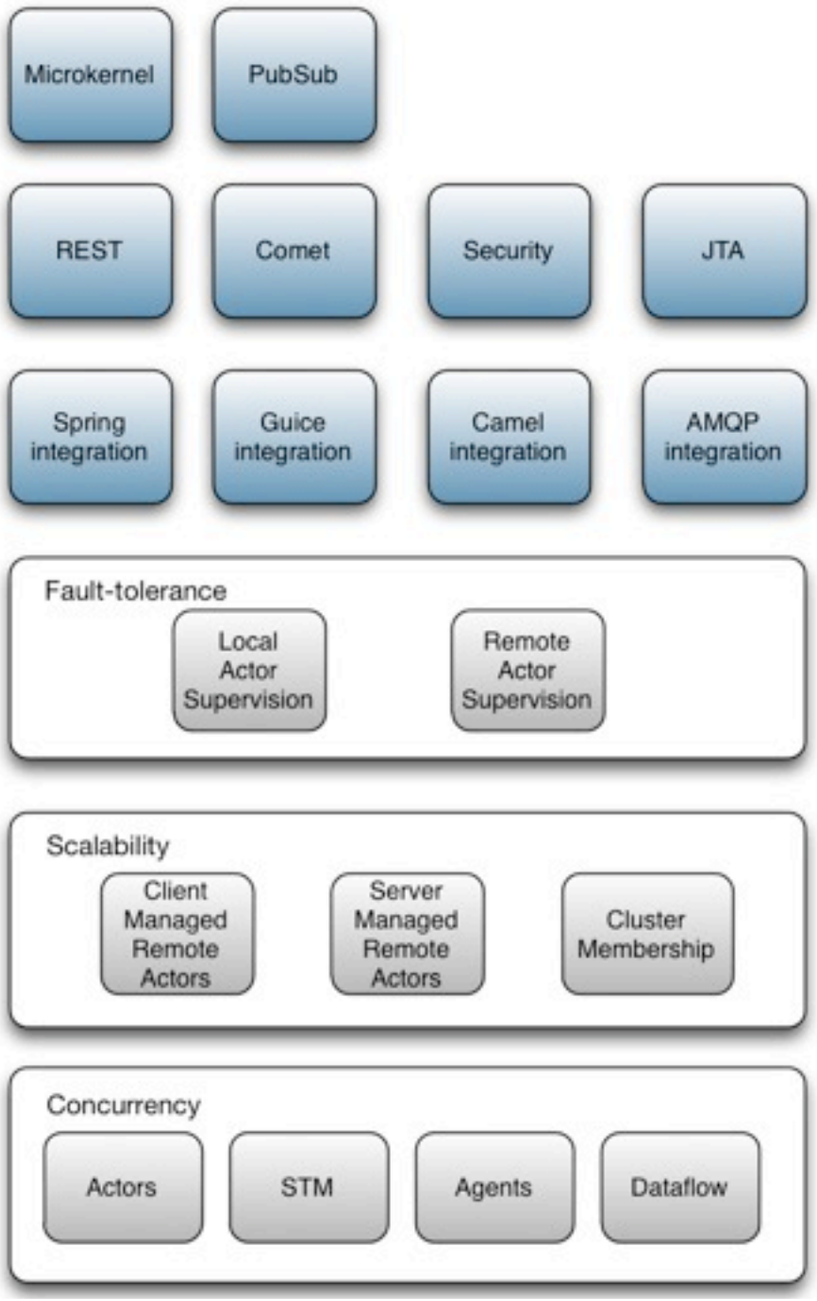
© Bob Elsdale

ARCHITECTURE



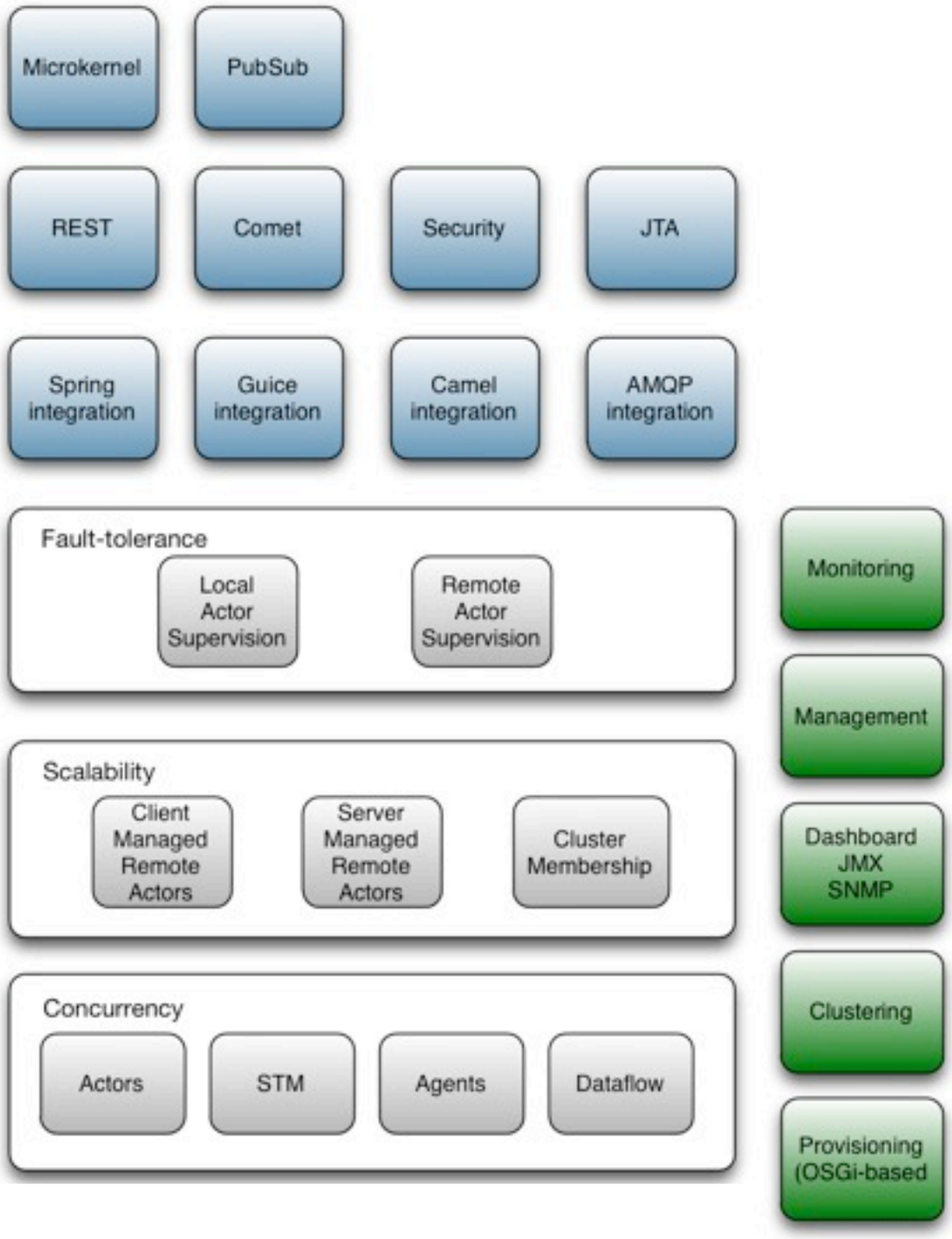
CORE SERVICES

ARCHITECTURE



ADD-ON MODULES

ARCHITECTURE



CLOUDY

AKKA

WHERE IS AKKA USED?

SOME EXAMPLES:

FINANCE

- Stock trend Analysis & Simulation
- Event-driven messaging systems

BETTING & GAMING

- Massive multiplayer online gaming
- High throughput and transactional betting

TELECOM

- Streaming media network gateways

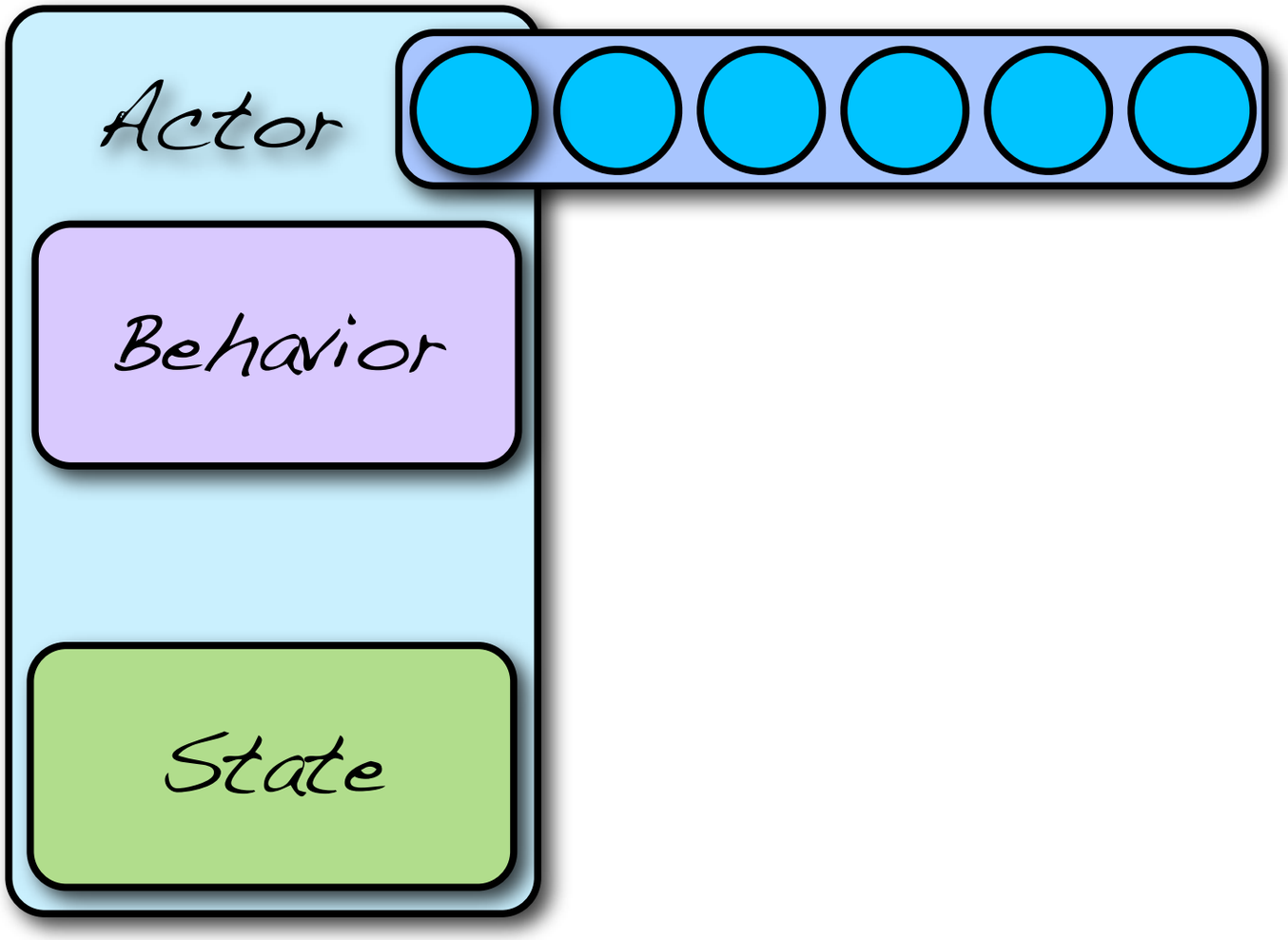
SIMULATION

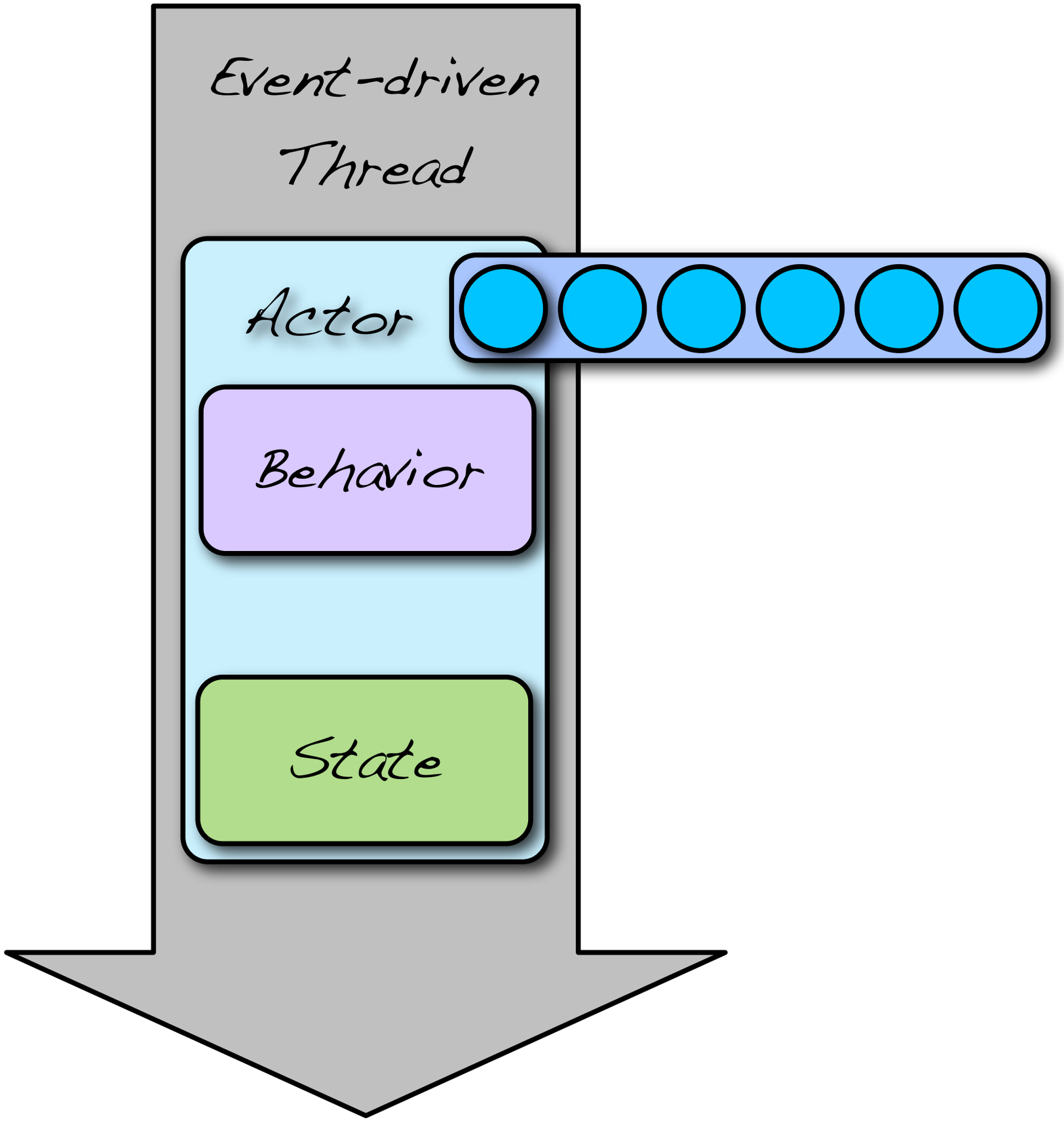
- 3D simulation engines

E-COMMERCE

- Social media community sites

What is an Actor?


Actor
Behavior
State


Event-driven
Thread
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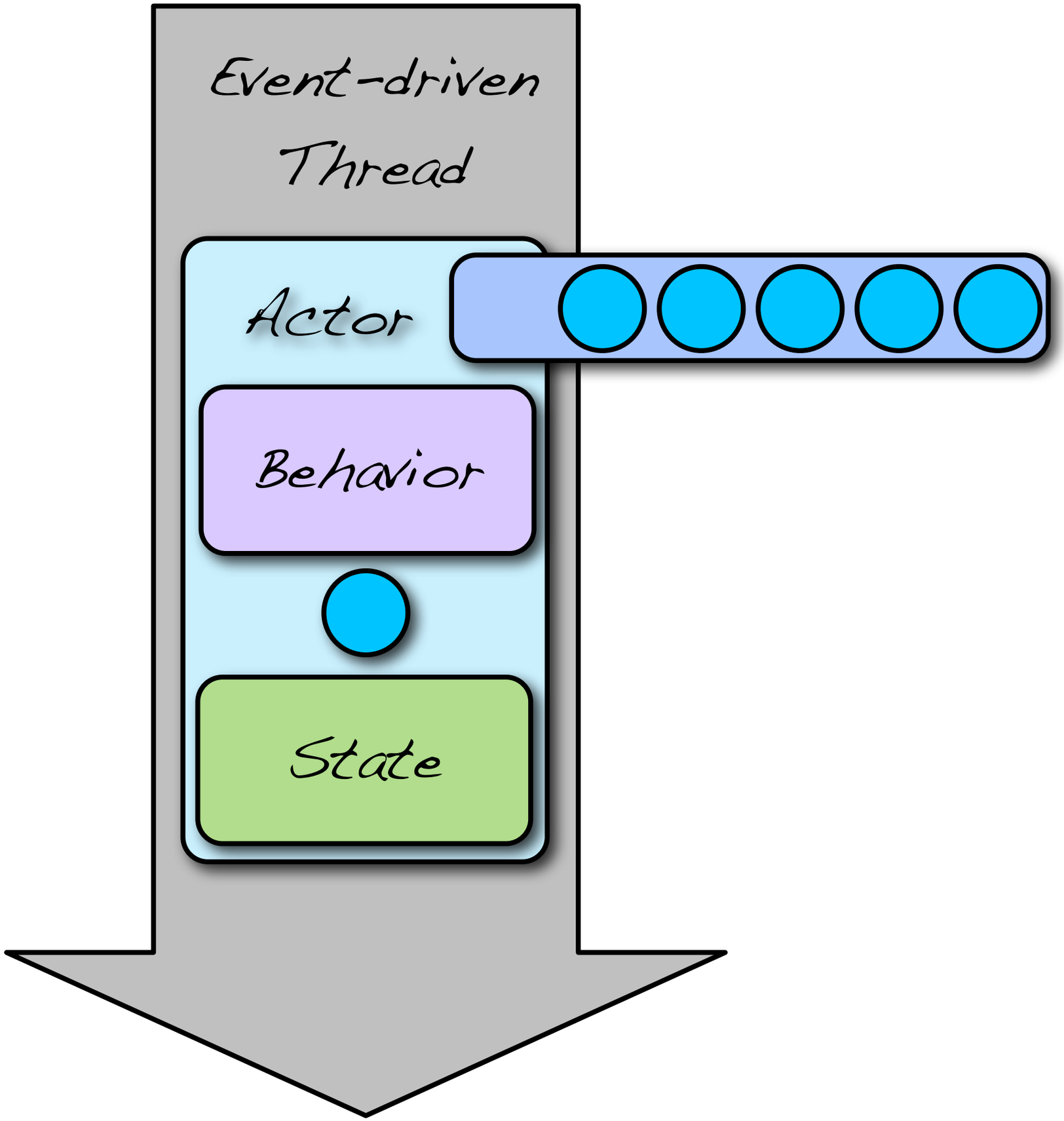
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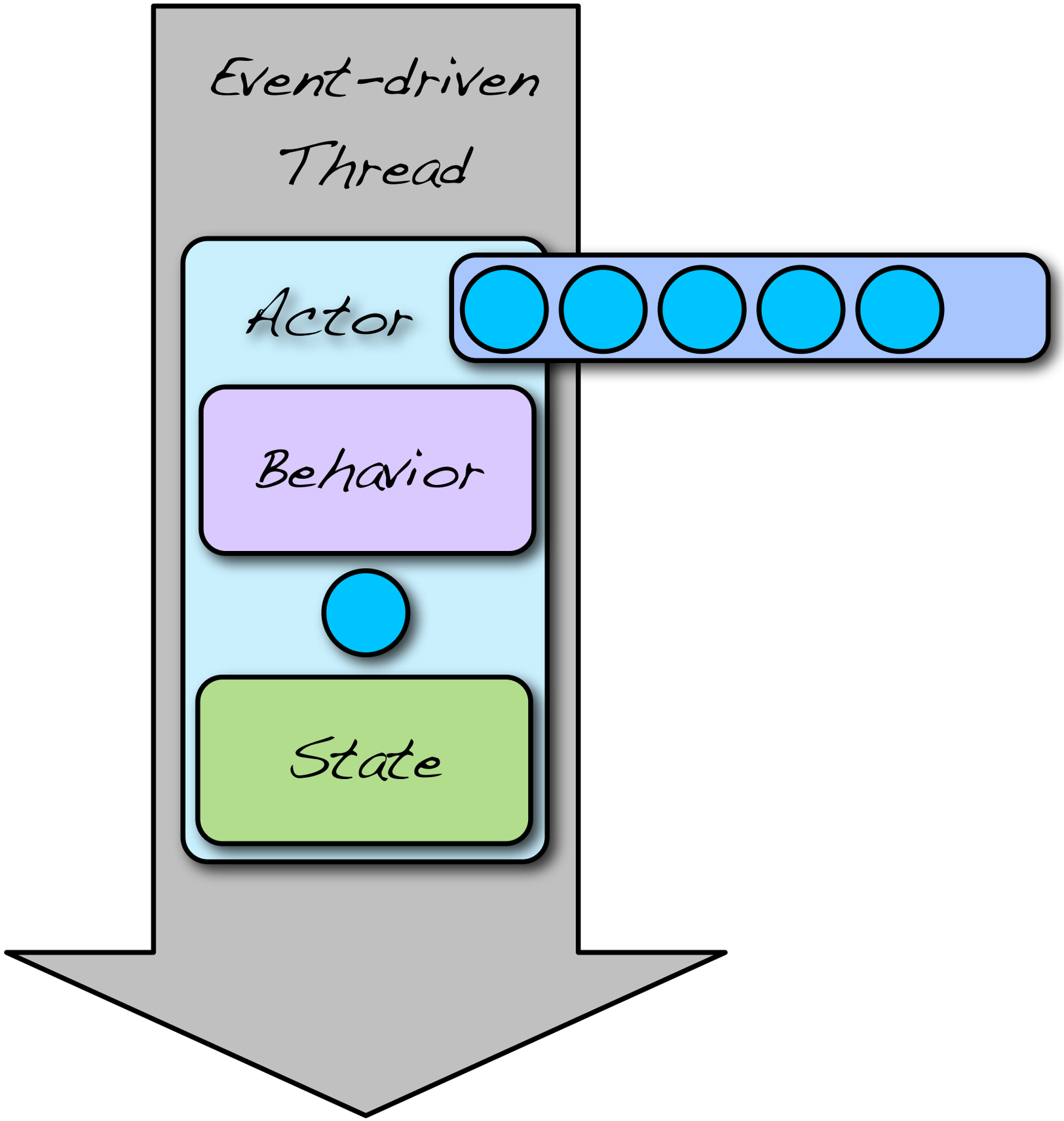
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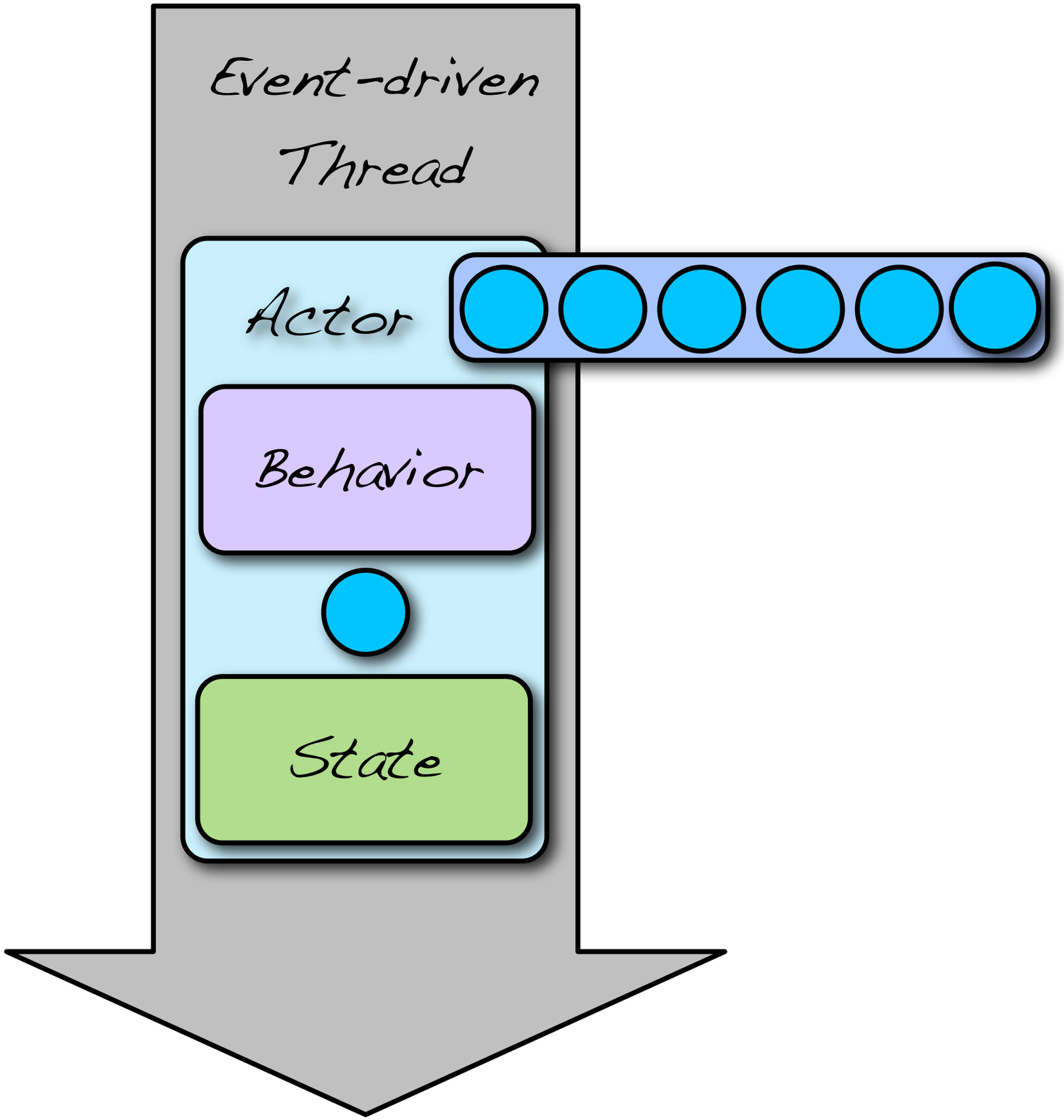
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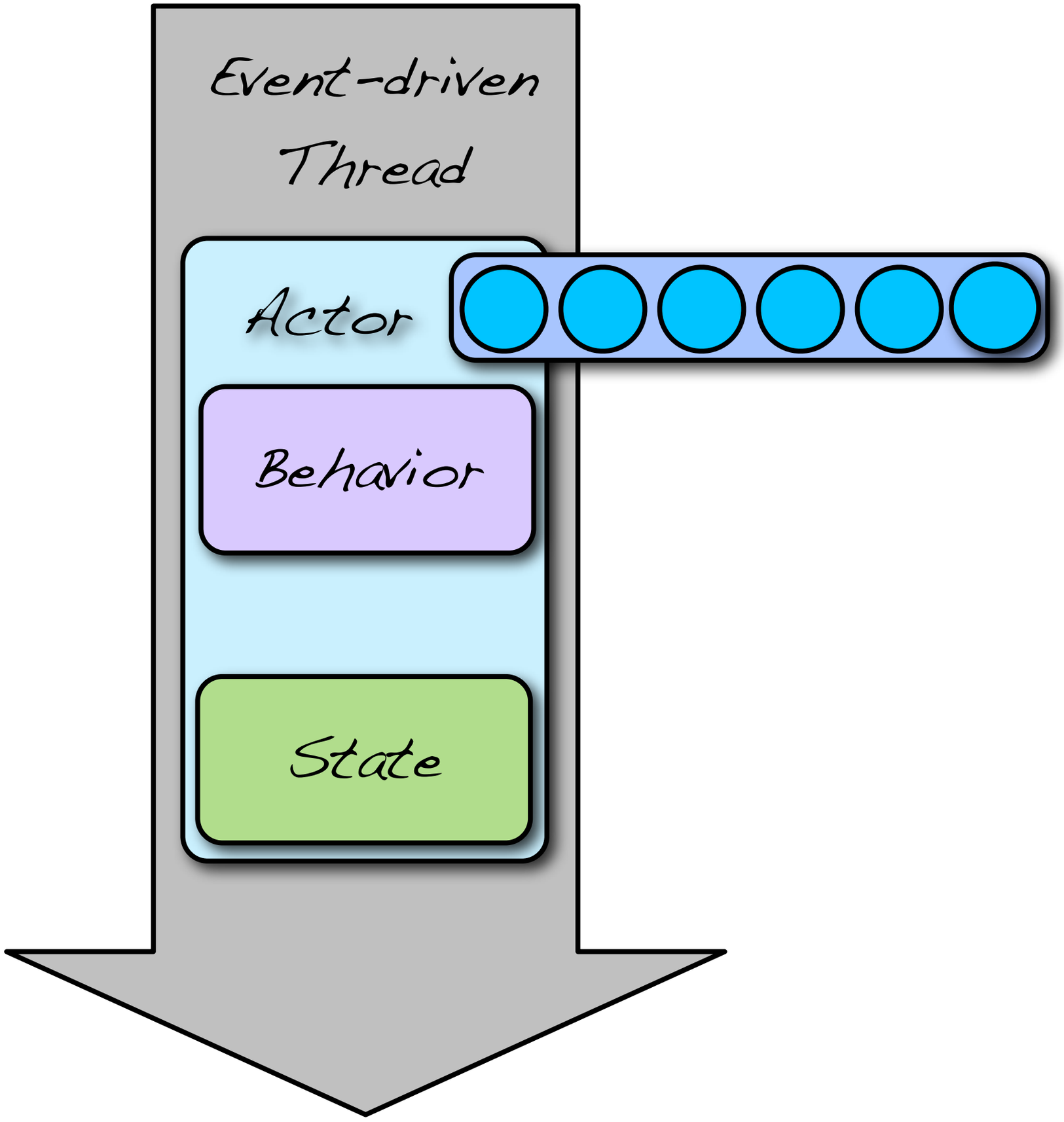
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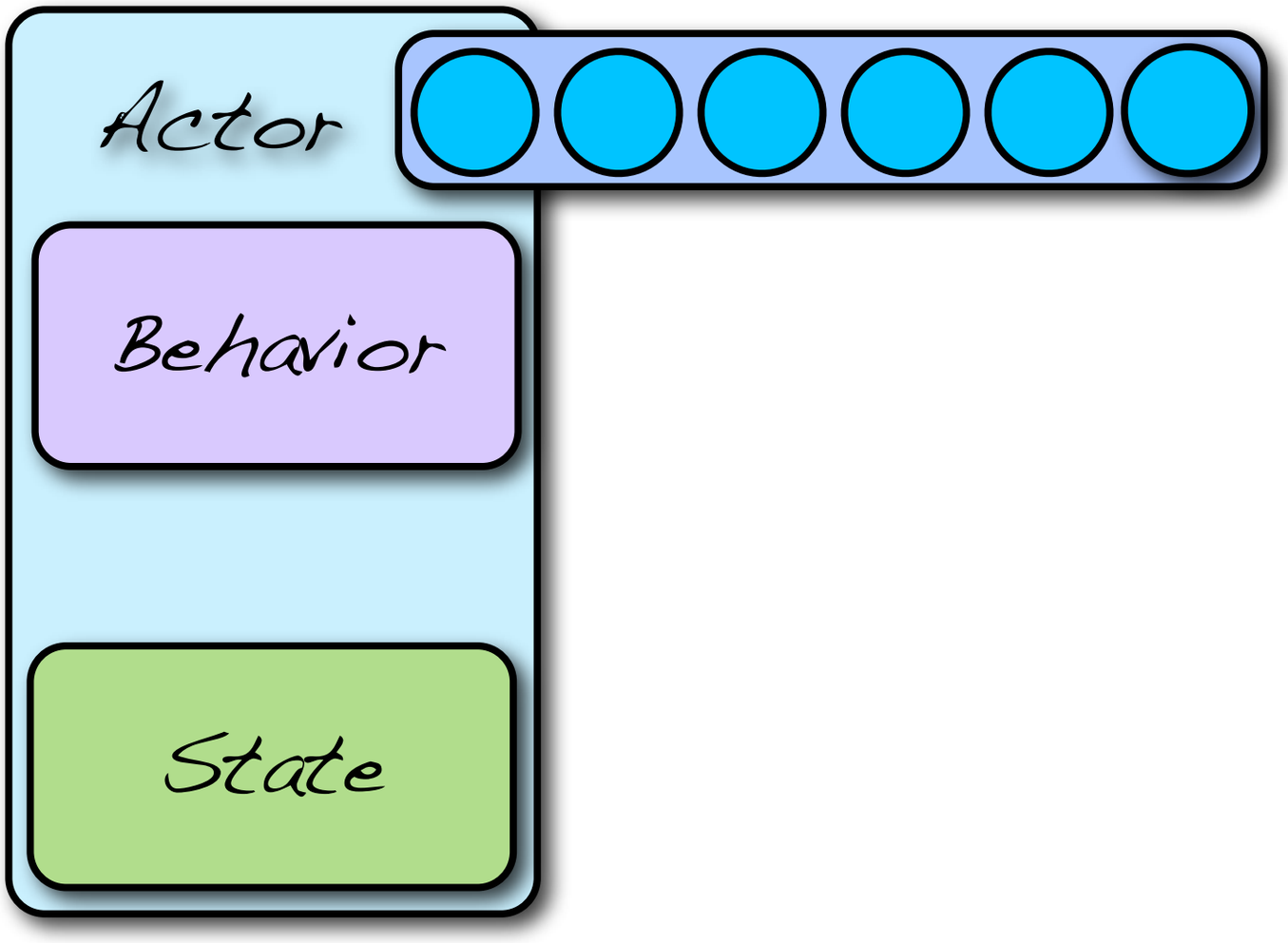
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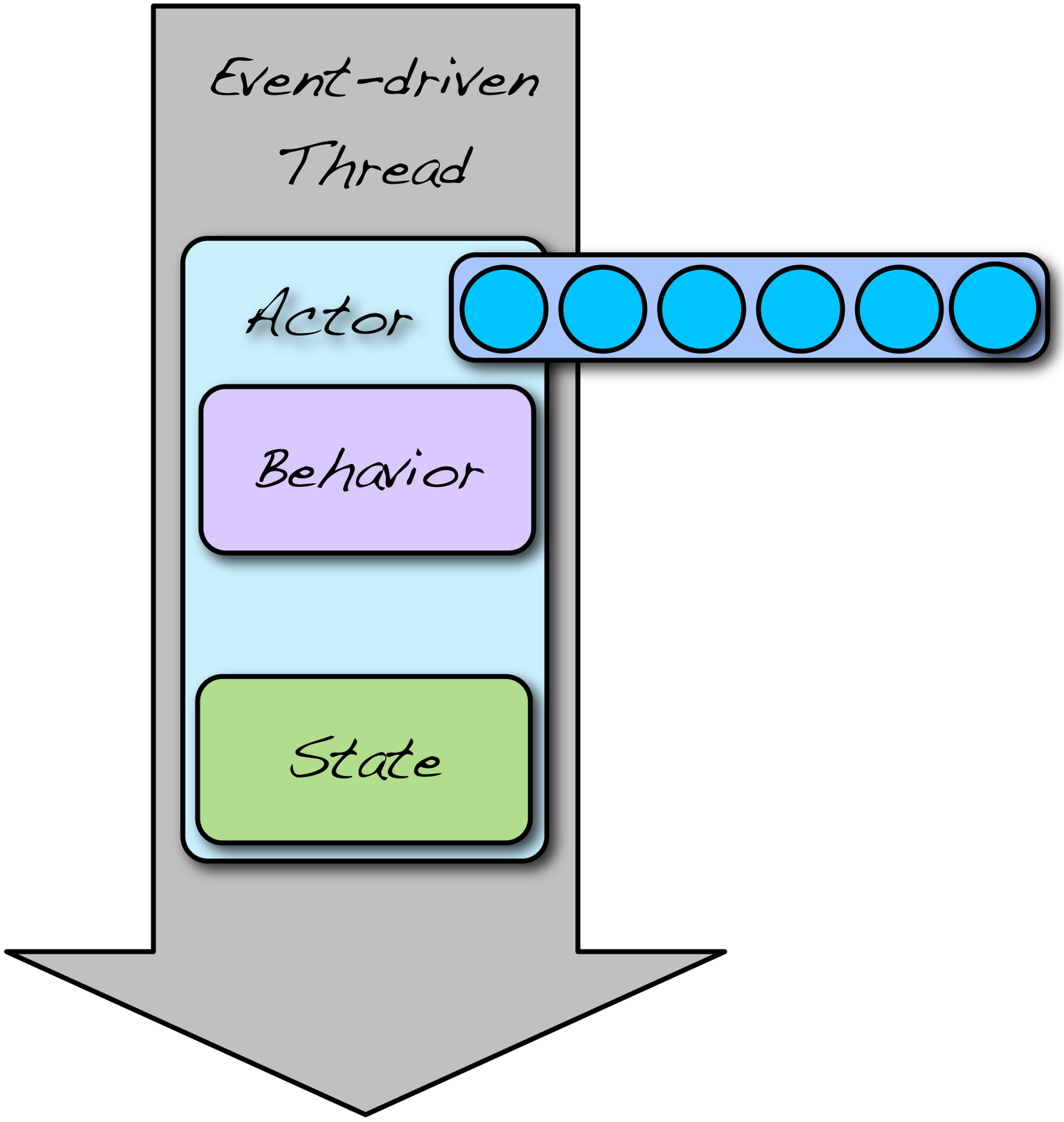
Event-driven
Thread
Actor
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State

Akka Actors

one tool in the toolbox

Actors

```
case object Tick

class Counter extends Actor {
  var counter = 0

  def receive = {
    case Tick =>
      counter += 1
      println(counter)
  }
}
```

Create Actors

```
val counter = actorOf[Counter]
```

`counter` is an `ActorRef`

Start actors

```
val counter = actorOf[Counter].start
```

Stop actors

```
val counter = actorOf[Counter].start
counter.stop
```

Send: !

```
counter ! Tick
```

fire-forget

Send: !!!

```
// returns a future
val future = actor !!! Message
future.await
val result = future.result
```

returns the Future directly

Future

```
val future1, future2, future3 =
  Future.empty[String]

future1.await
future2.onComplete(f => ...)

future1.completeWithResult(...)
future2.completeWithException(...)
future3.completeWith(future2)

future1 receive {
  case Foo(bar) => “foo”
}.await.result
```

Future

```
val f1 = Futures.future(callable)

val f2 = Futures.firstCompletedOf(futures)
val f3 = Futures.reduce(futures)((x, y) => ..)
val f4 = Futures.fold(zero)(futures)((x, y) => ...)
```

Future

```
val future1 = for {
  a: Int    <- actor !!! "Hello" // returns 5
  b: String <- actor !!! a       // returns "10"
  c: String <- actor !!! 7       // returns "14"
} yield b + "-" + c

val future2 = for {
  a <- actor !!! Req("Hello") collect { case Res(x: Int)    => x }
  b <- actor !!! Req(a)       collect { case Res(x: String) => x }
  c <- actor !!! Req(7)       collect { case Res(x: String) => x }
} yield b + "-" + c
```

Dataflow

```
import Future.flow

val x, y, z = Promise[Int]()

flow {
  z << x() + y()
  println("z = " + z())
}
flow { x << 40 }
flow { y << 2 }
```

Send: !!

```
val result = (actor !! Message).as[String]
```

uses Future under the hood and blocks until timeout or completion

Reply

```
class SomeActor extends Actor {
  def receive = {
    case User(name) =>
      // use reply
      self.reply(“Hi ” + name)
  }
}
```

HotSwap

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

HotSwap

```
actor ! HotSwap {
  // new body
  case NewMessage =>
    ...
}
```

HotSwap

```
self.unbecome()
```

Set dispatcher

```
class MyActor extends Actor {
  self.dispatcher = Dispatchers
    .newThreadBasedDispatcher(self)

  ...
}

actor.dispatcher = dispatcher // before started
```

Remote Actors

Remote Server

```
// use host & port in config
Actor.remote.start()

Actor.remote.start("localhost", 2552)
```

Scalable implementation based on
NIO (Netty) & Protobuf

Two types of remote actors

Client initiated & managed
Server initiated & managed

Client-managed

supervision works across nodes

```
import Actor._

val service = remote.actorOf[MyActor](host, port)

service ! message
```

Server-managed

register and manage actor on server

client gets "dumb" proxy handle

```
import Actor._

remote.register("service:id", actorOf[MyService])
```

server part

Server-managed

```
val service = remote.actorFor(
  “service:id”,
  “darkstar”,
  9999)

service ! message
```

client part

Server-managed

```
import Actor._

remote.register(actorOf[MyService])
remote.registerByUuid(actorOf[MyService])
remote.registerPerSession(
  “service:id”, actorOf[MyService])

remote.unregister(“service:id”)
remote.unregister(actorRef)
```

server part

Remoting in Akka 1.0

Remote Actors

Client-managed

Server-managed

Problem

Deployment (local vs remote) is a dev decision

We get a fixed and hard-coded topology

Can't change it dynamically and adaptively

Needs to be a

deployment & runtime decision

Clustered Actors

(in development for upcoming Akka 2.0)

Address

```
val actor = actorOf[MyActor](“my-service”)
```

Bind the actor to a virtual address

Deployment

- Actor address is virtual and decoupled from how it is deployed
- If no deployment configuration exists then actor is deployed as local
- The same system can be configured as distributed without code change (even change at runtime)

- Write as local but deploy as distributed in the cloud without code change
- Allows runtime to dynamically and adaptively change topology

Deployment configuration

```
akka {
  actor {
    deployment {
      my-service {
        router = "least-cpu"
        clustered {
          home        = "node:test-node-1"
          replicas    = 3
          stateless = on
        }
      }
    }
  }
}
```

Deployment configuration

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Address

Type of load-balancing

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Address

Type of load-balancing

Clustered or Local

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Address

Type of load-balancing

Clustered or Local

Home node

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Address

Type of load-balancing

Clustered or Local

Home node

Nr of replicas in cluster

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        }
      }
    }
```

Address

Type of load-balancing

Clustered or Local

Home node

Stateful or Stateless

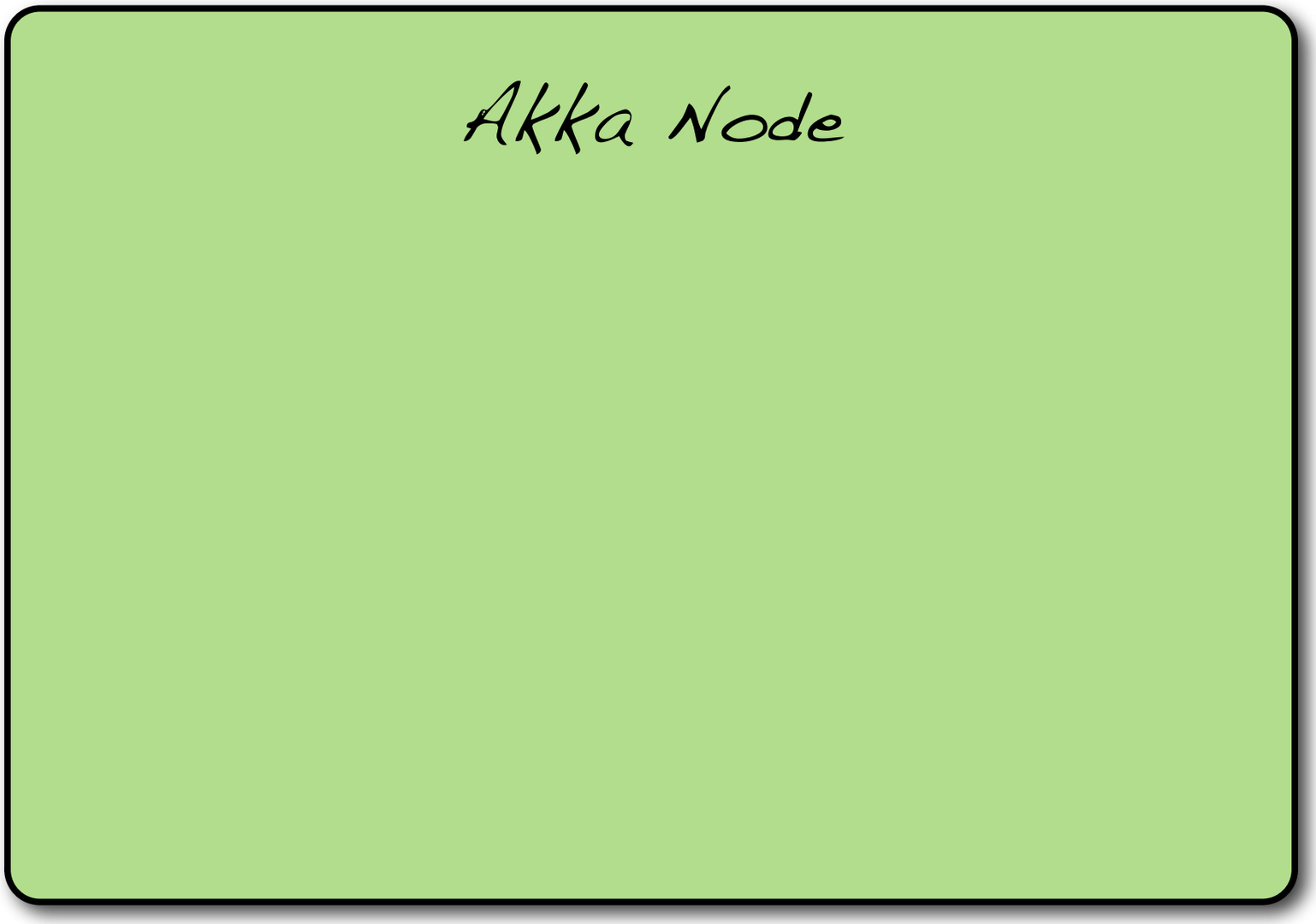
Nr of replicas in cluster

The runtime provides

- Subscription-based cluster membership service
- Highly available cluster registry for actors
- Automatic cluster-wide deployment
- Highly available centralized configuration service
- Automatic replication with automatic fail-over upon node crash
- Transparent and user-configurable load-balancing
- Transparent adaptive cluster rebalancing
- Leader election
- Durable mailboxes - guaranteed delivery

Upcoming features

- Publish/Subscribe (broker and broker-less)
- Compute Grid (MapReduce)
- Data Grid (querying etc)
- Distributed STM (Transactional Memory)
- Event Sourcing


Akka Node

Akka Node

```
val ping = actorOf[Ping](“ping”)
val pong = actorOf[Pong](“pong”)

ping ! Ball(pong)
```

Akka Node

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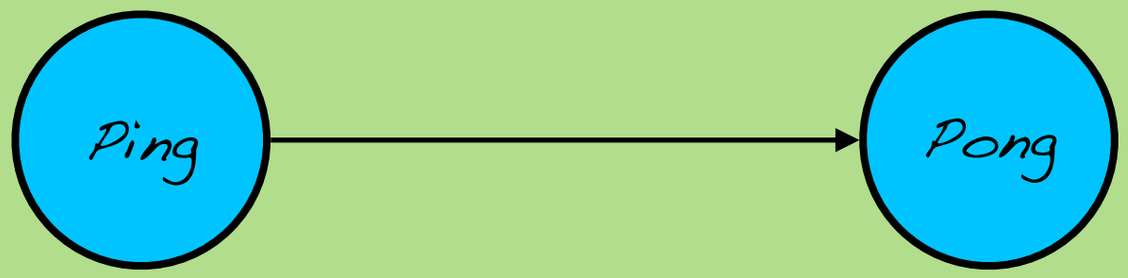


Akka
Cluster Node


Ping


Pong

Akka
Cluster Node

Akka
Cluster Node

Akka
Cluster Node

Ping

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Cluster Node

Akka
Cluster Node

Akka
Cluster Node

Ping

Pong

Akka
Cluster Node

Akka
Cluster Node

Akka Cluster Node

Akka Cluster Node

```
akka {
  actor {
    deployment {
      ping {}
      pong {
        router = "round-robin"
        clustered {
          replicas  = 3
          stateless = on
        }
      }
    }
}
```

Ping

Pong

Akka Cluster Node

Akka Cluster Node

Akka Cluster Node

Akka
Cluster Node

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```

Ping

Pong

Akka
Cluster Node

Akka
Cluster Node

Akka
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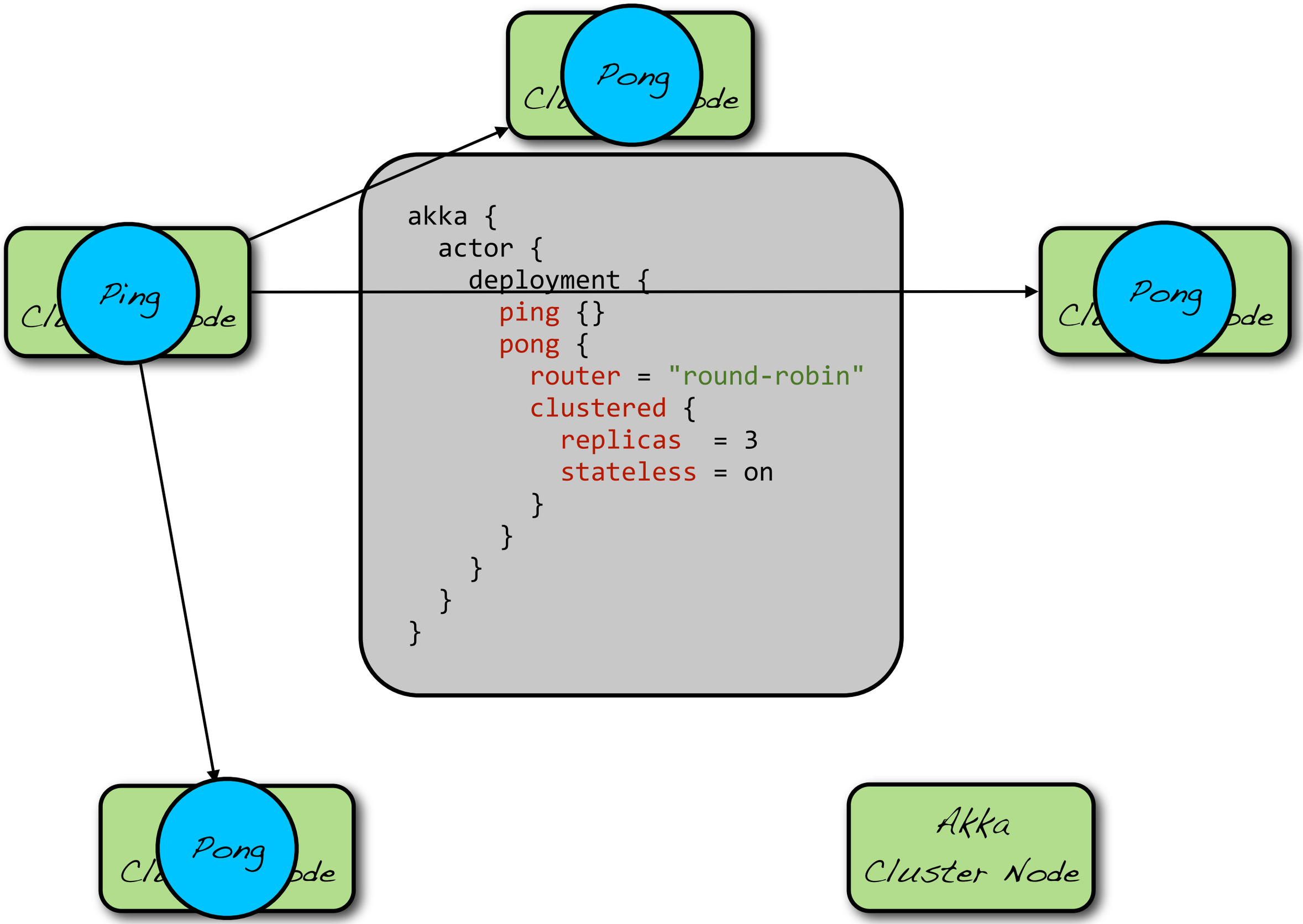
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}
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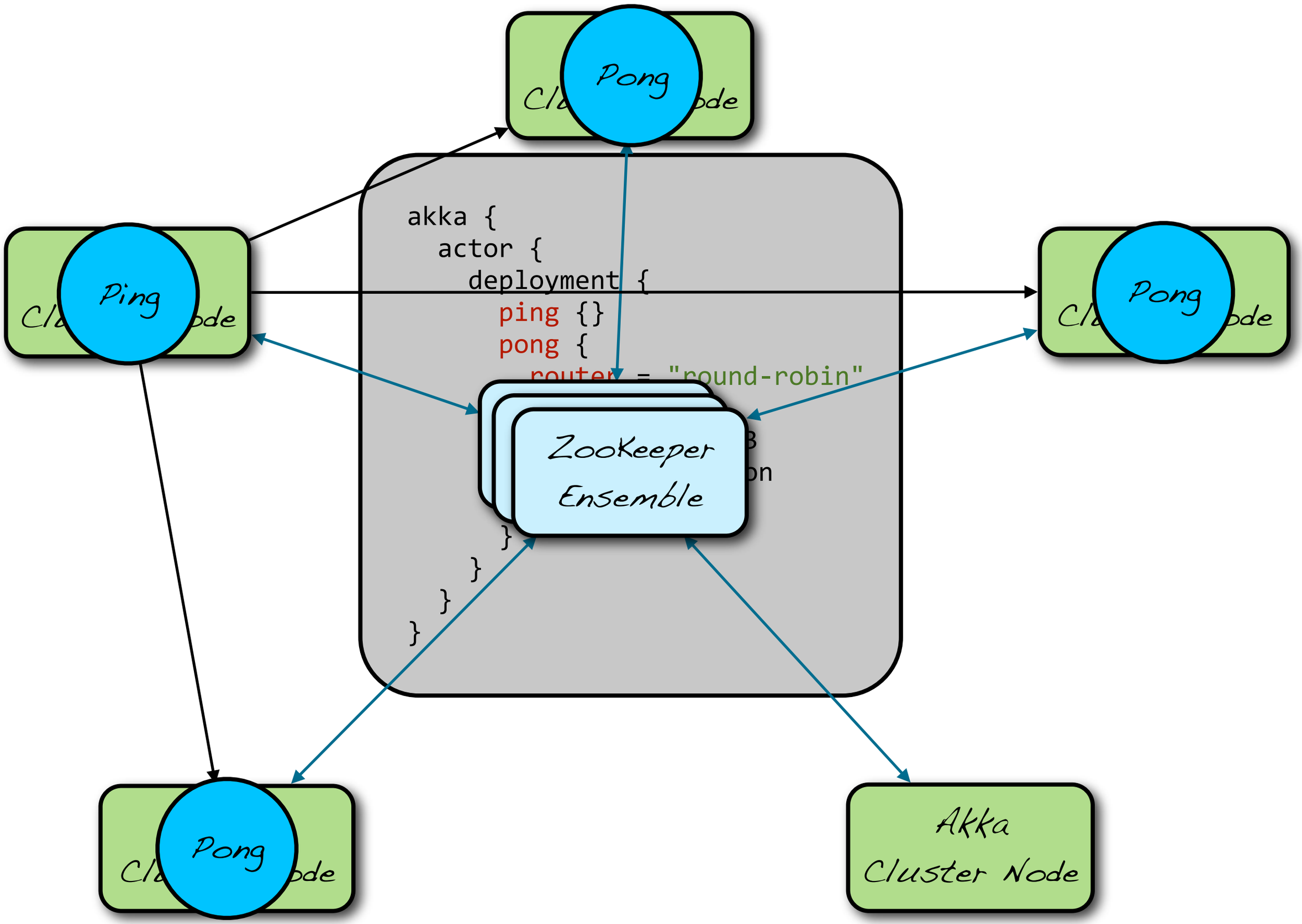
Akka
Cluster Node


Pong
Ping
Pong
akka {
actor {
deployment {
ping {}
pong {
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}
}
}
}
}
ZooKeeper
Ensemble
Pong
Akka
Cluster Node

Let it crash

fault-tolerance

The Erlang model

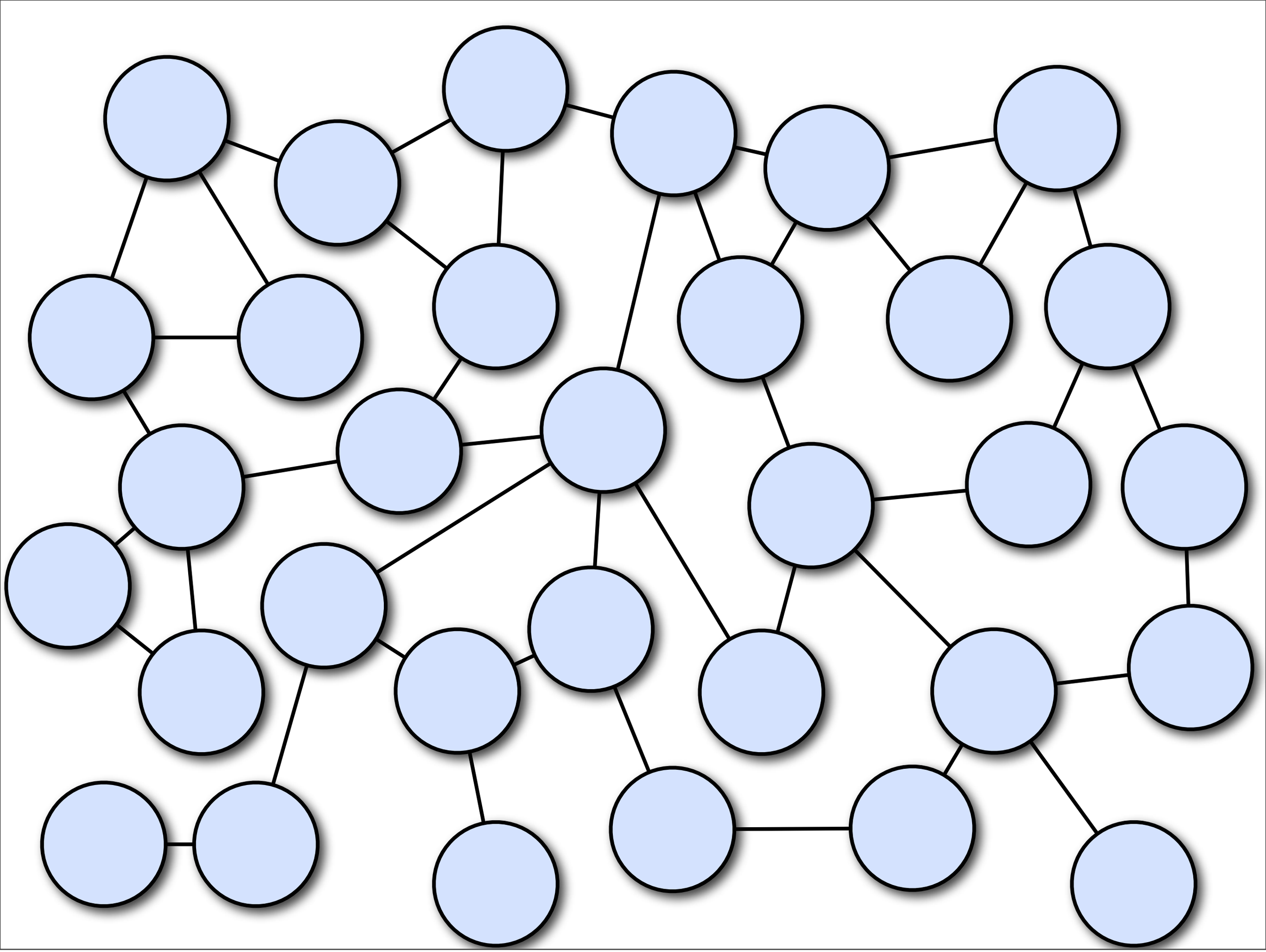
9

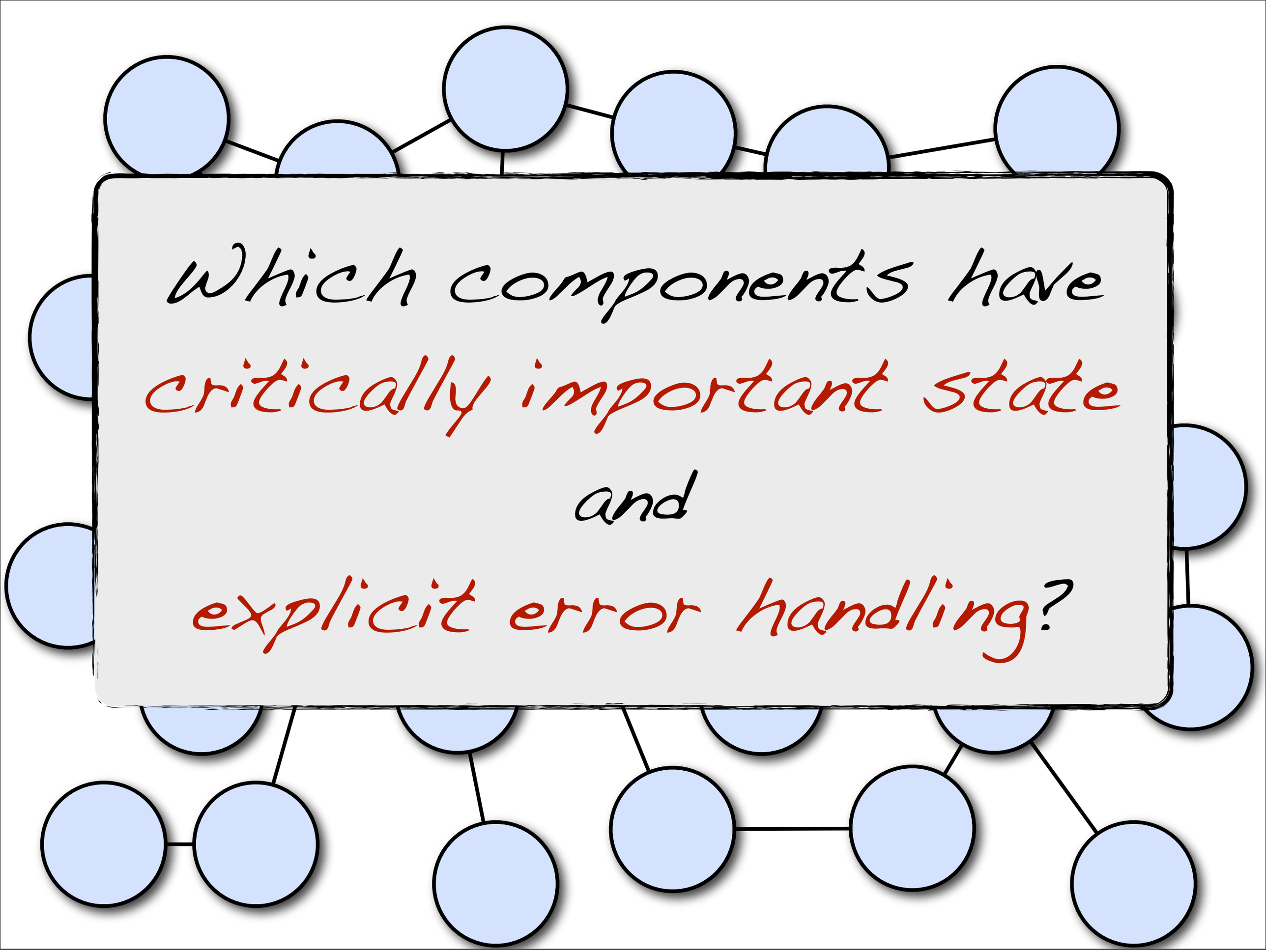
nines

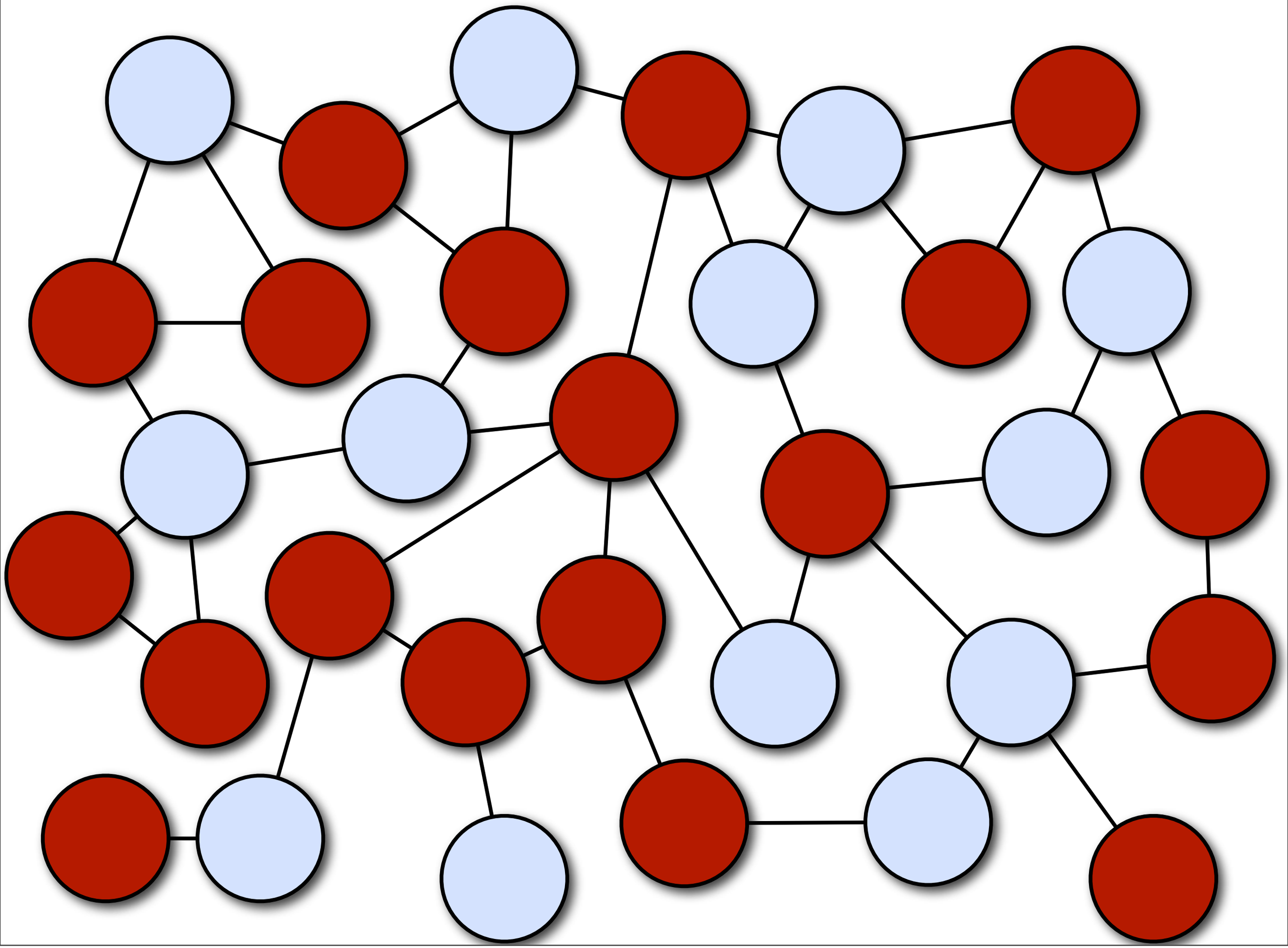
...let's take a

standard OO

application




Which components have
critically important state
and
explicit error handling?



Classification of State

- Scratch data
- Static data
  - Supplied at boot time
  - Supplied by other components
- Dynamic data
  - Data possible to recompute
  - Input from other sources; data that is impossible to recompute

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Classification of State

- Scra
- Stati
  - Sup
  - Sup
- Dyna
  - Dat

nts

e

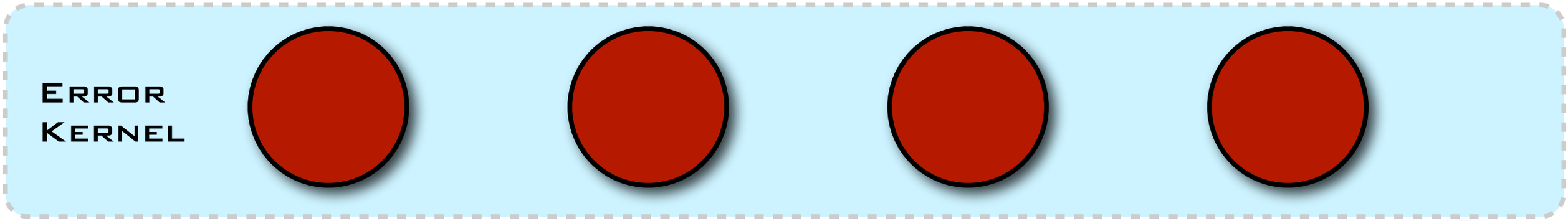
Must be

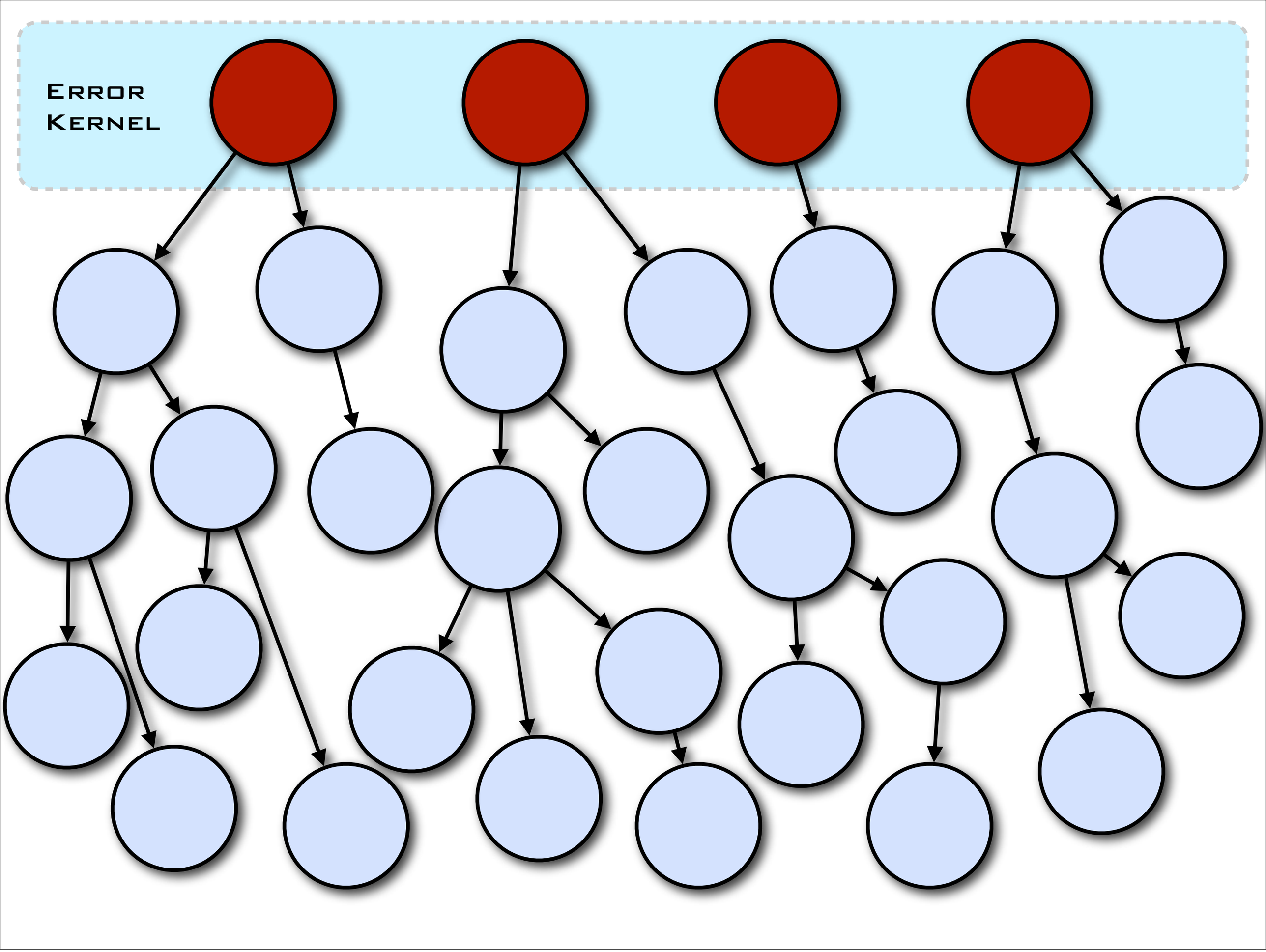
protected

by any means

- Input *from other sources*; data that is *impossible to recompute*

Fault-tolerant onion-layered Error Kernel


Error
Kernel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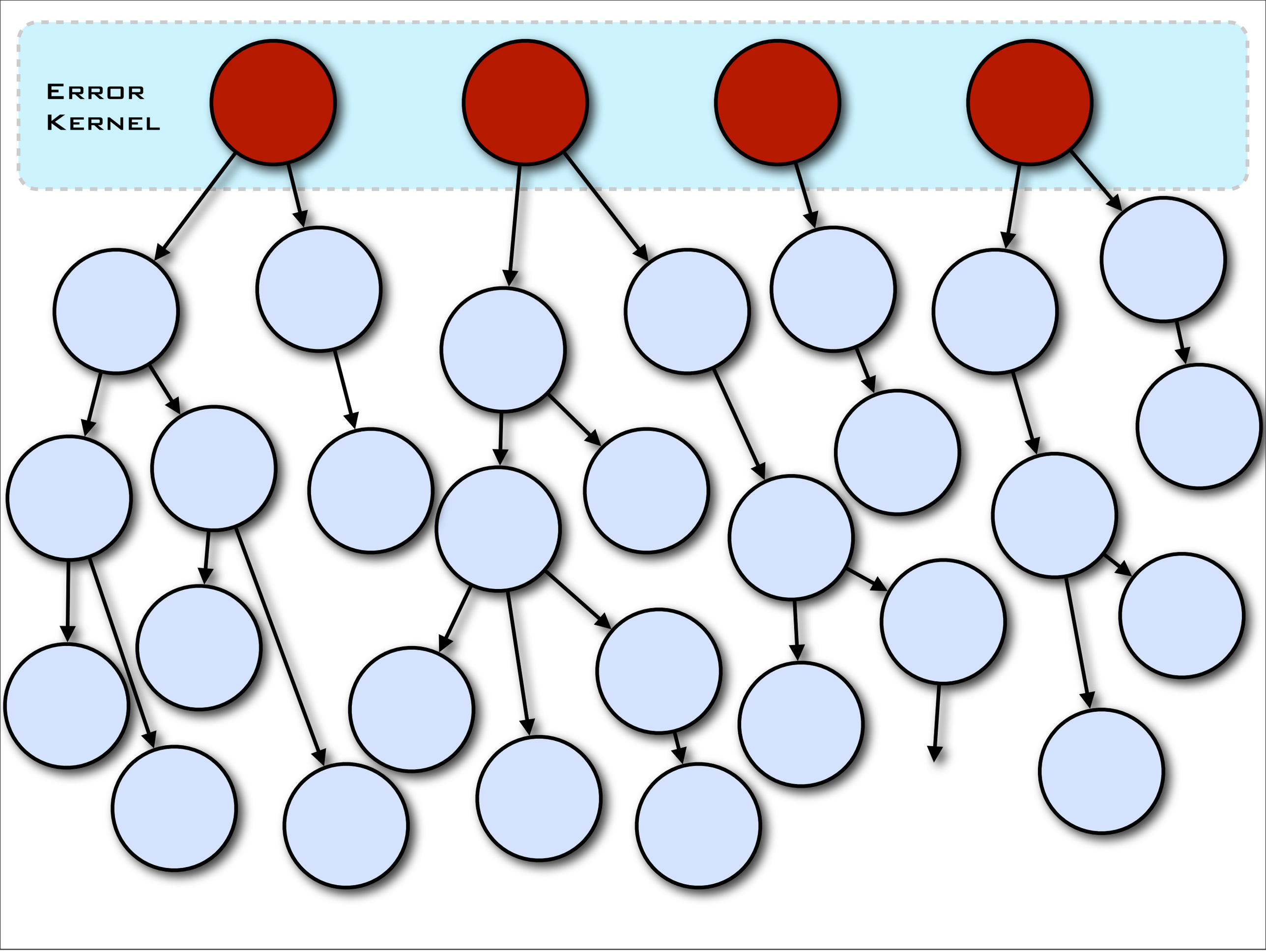
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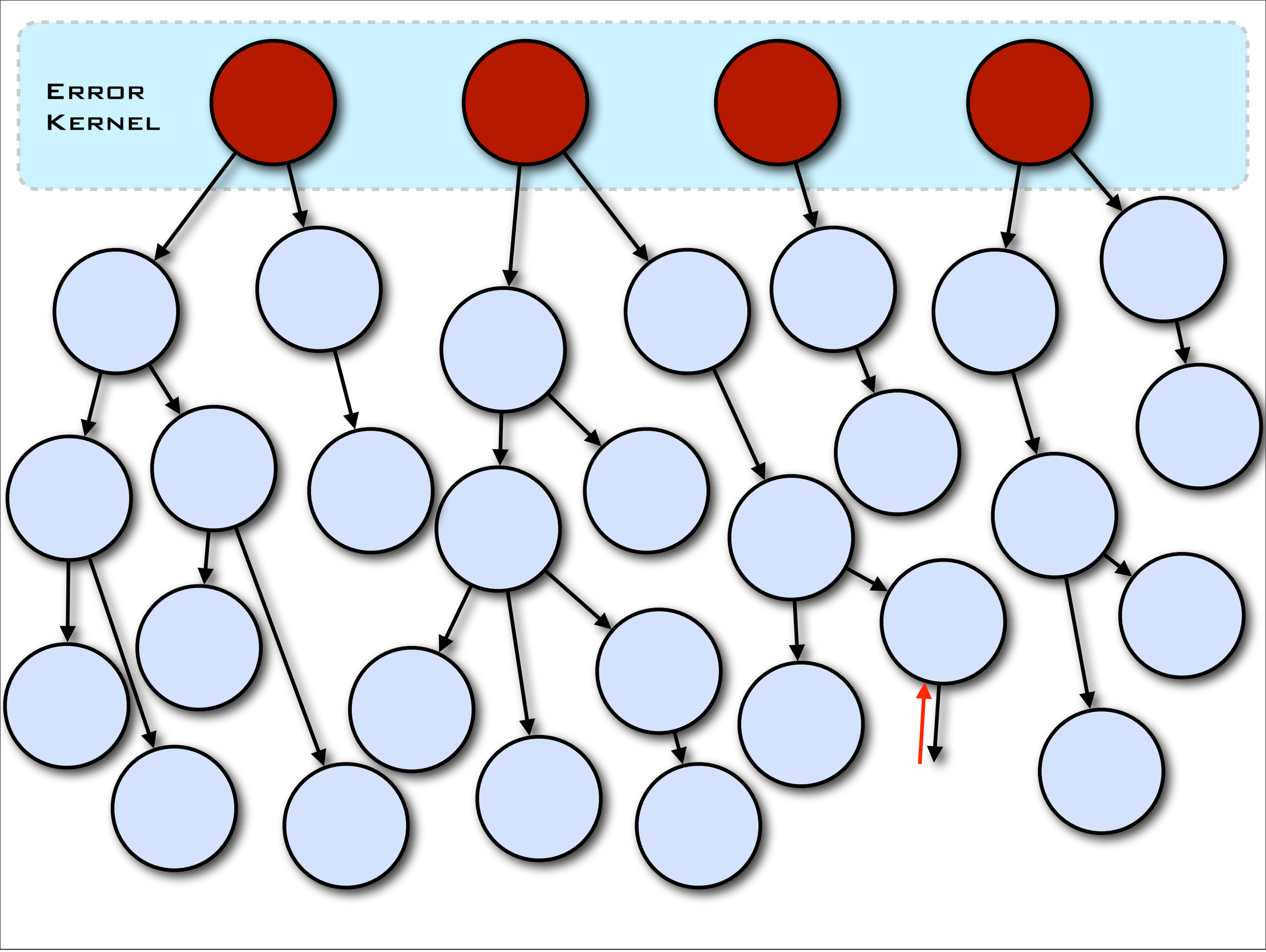
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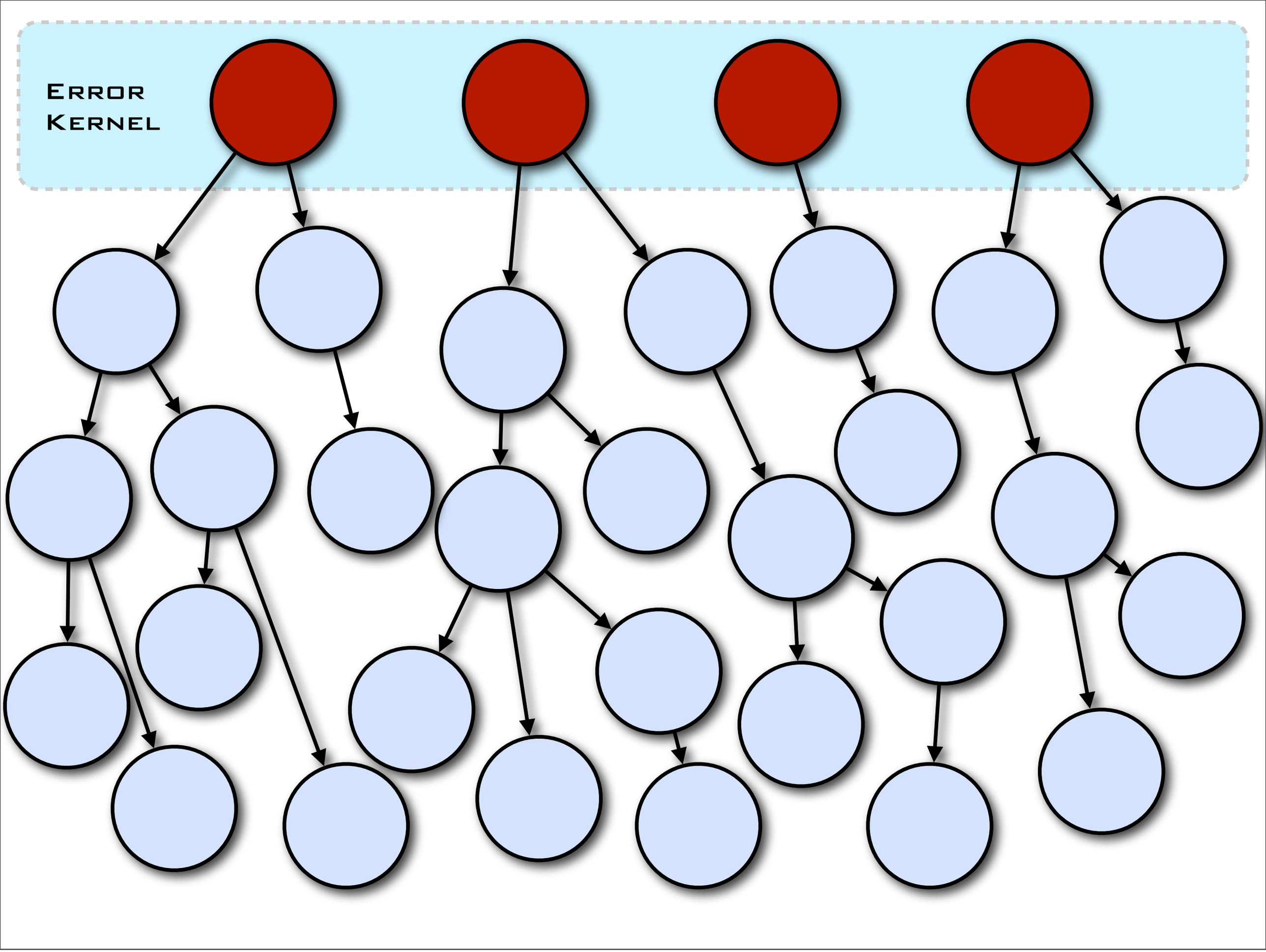
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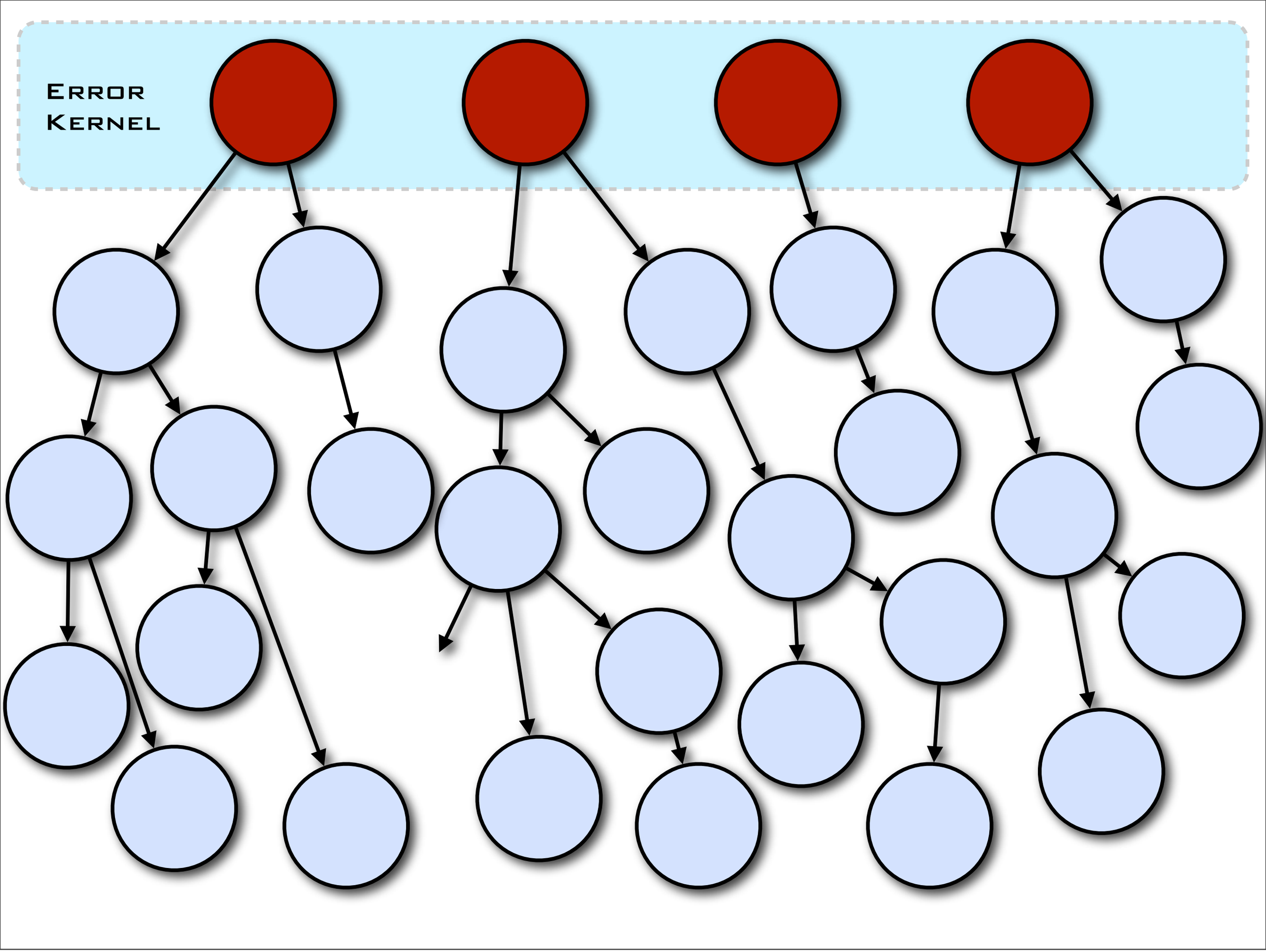
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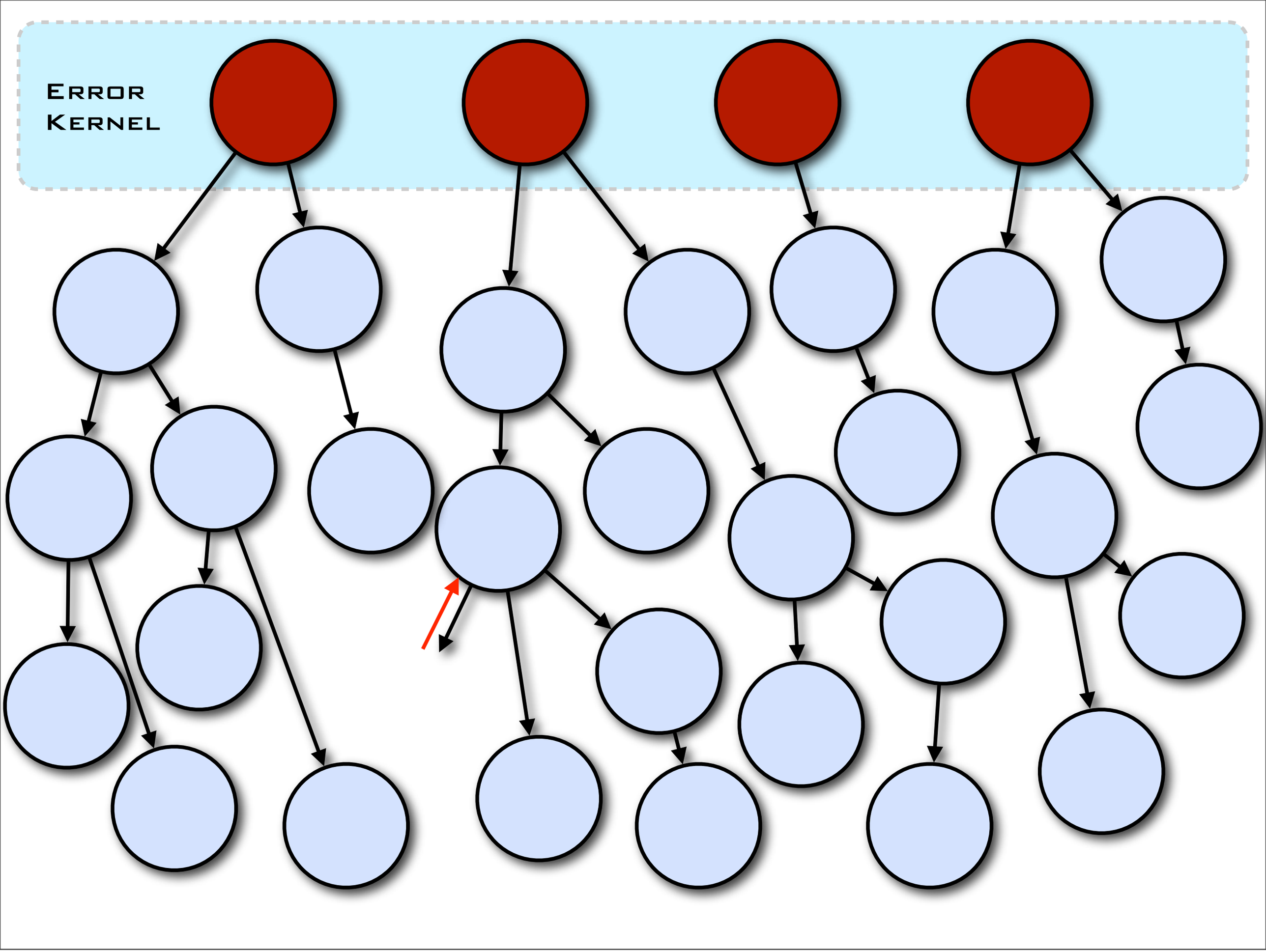
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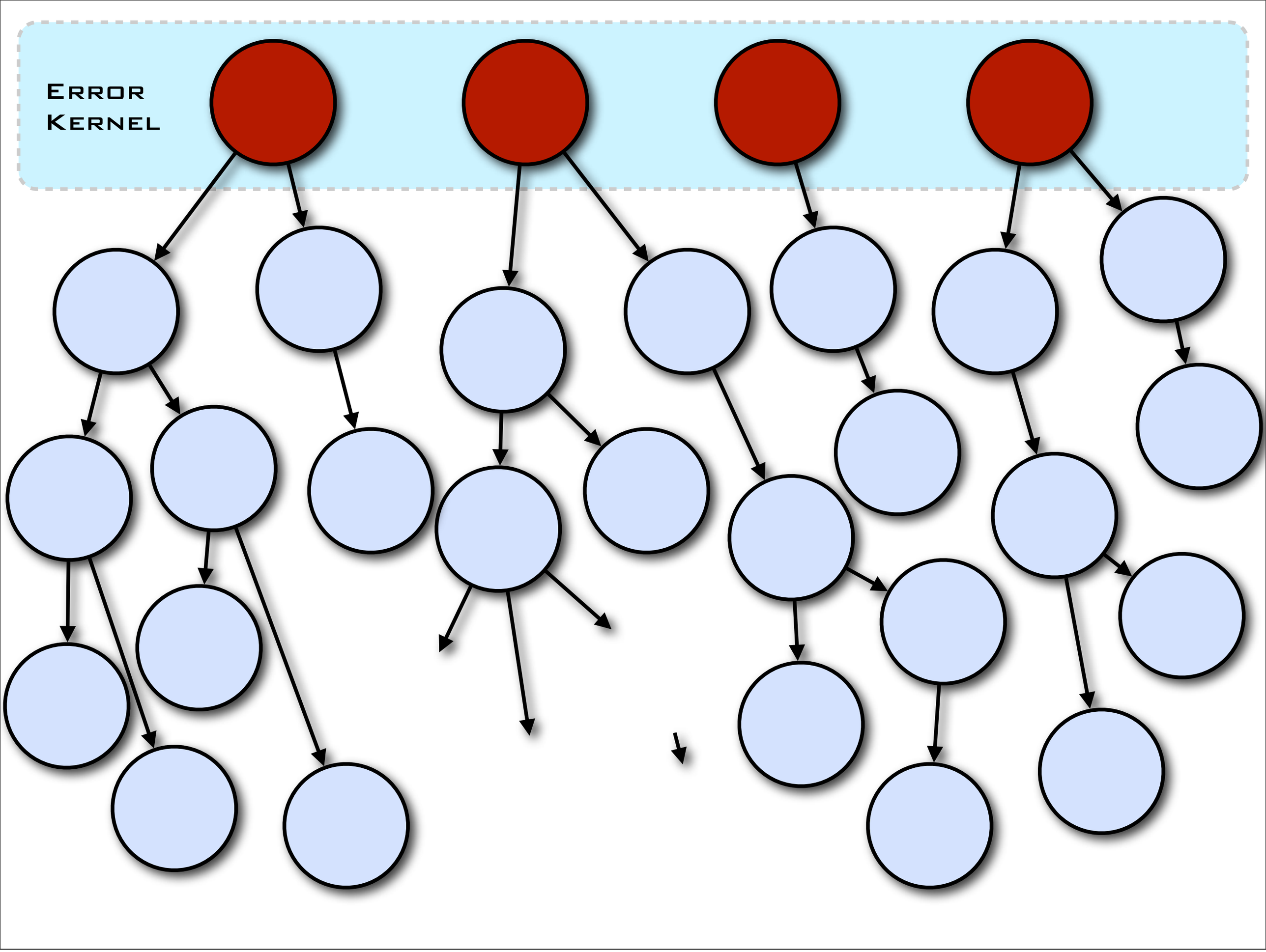
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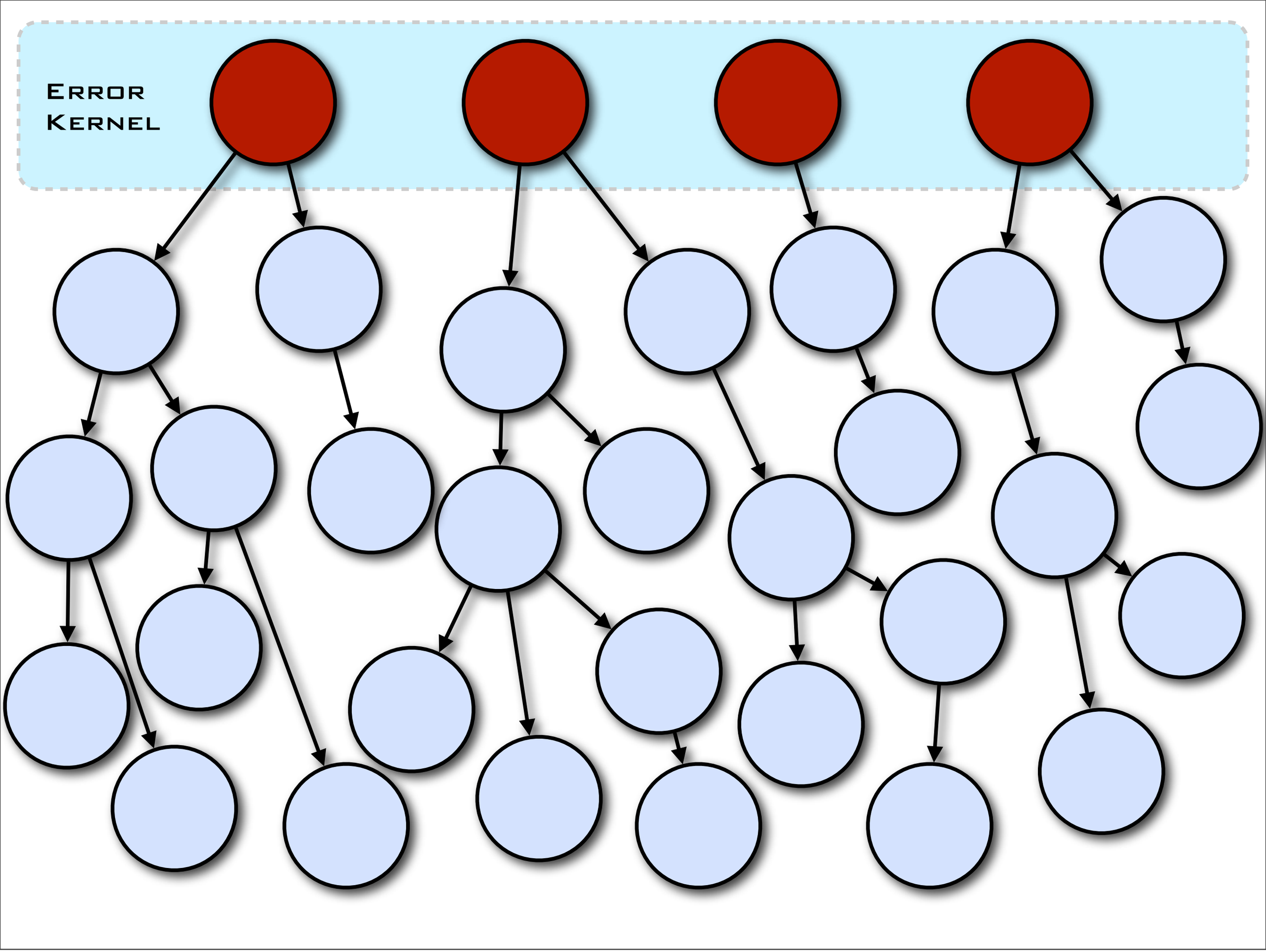
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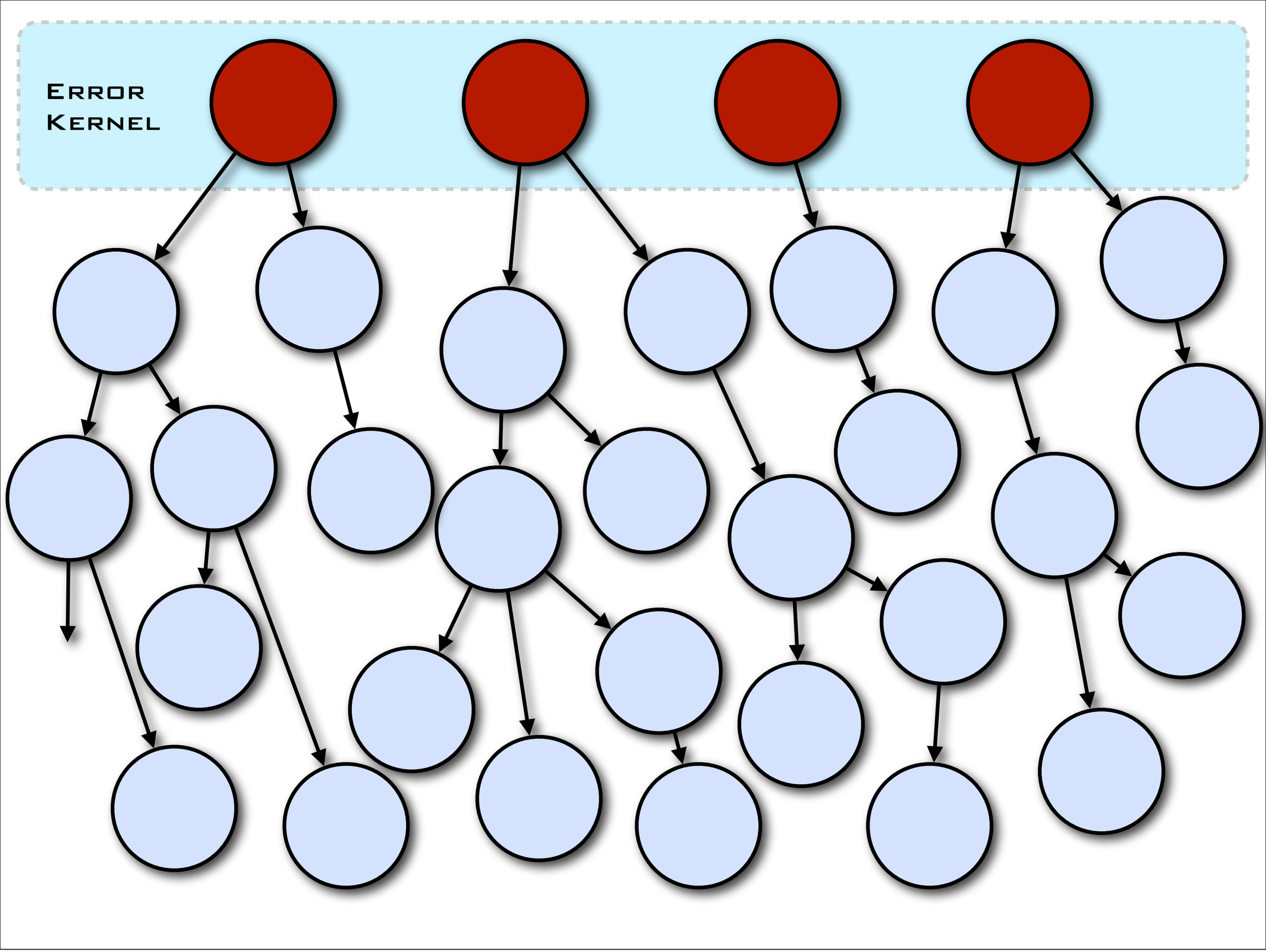
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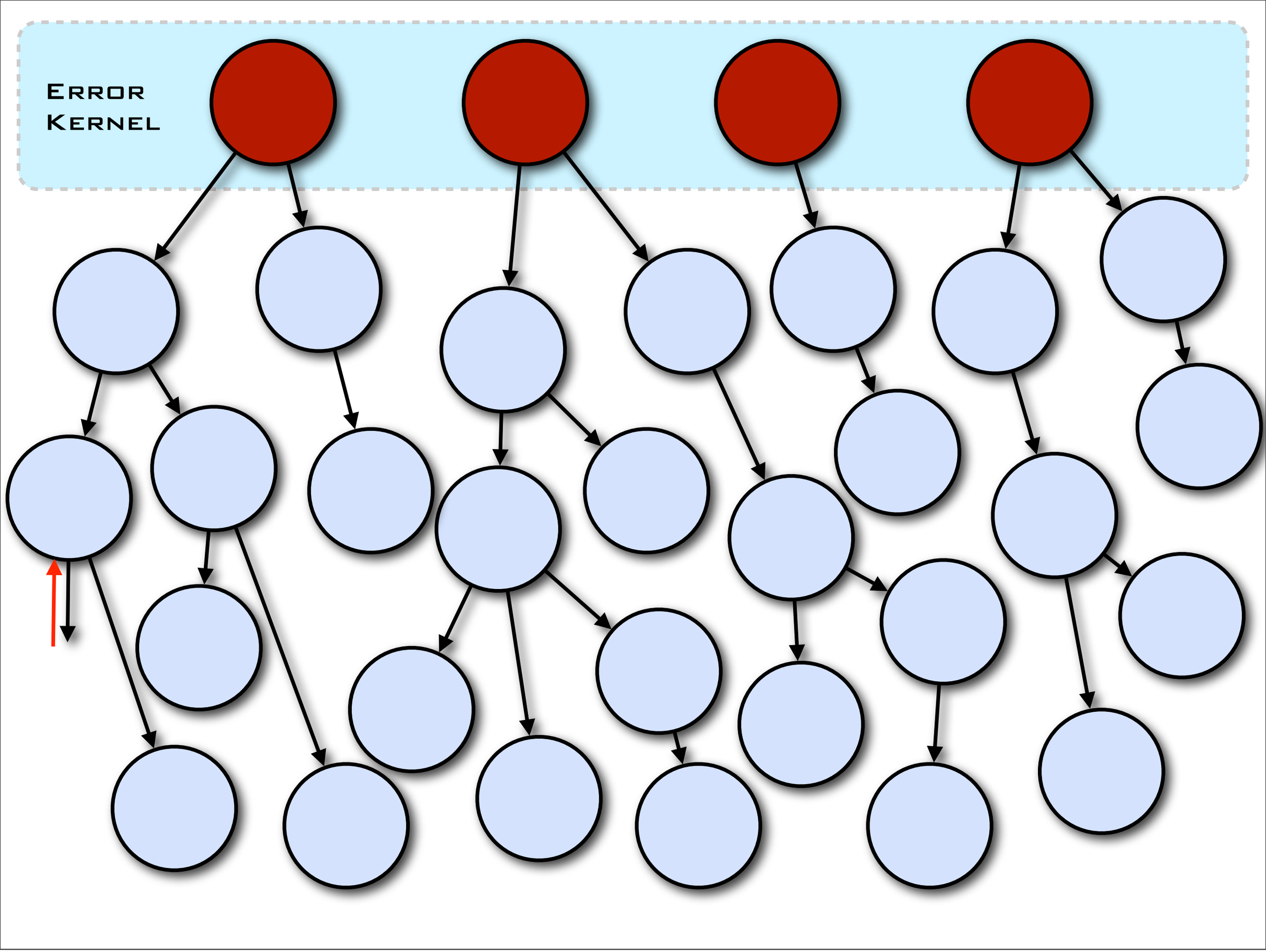
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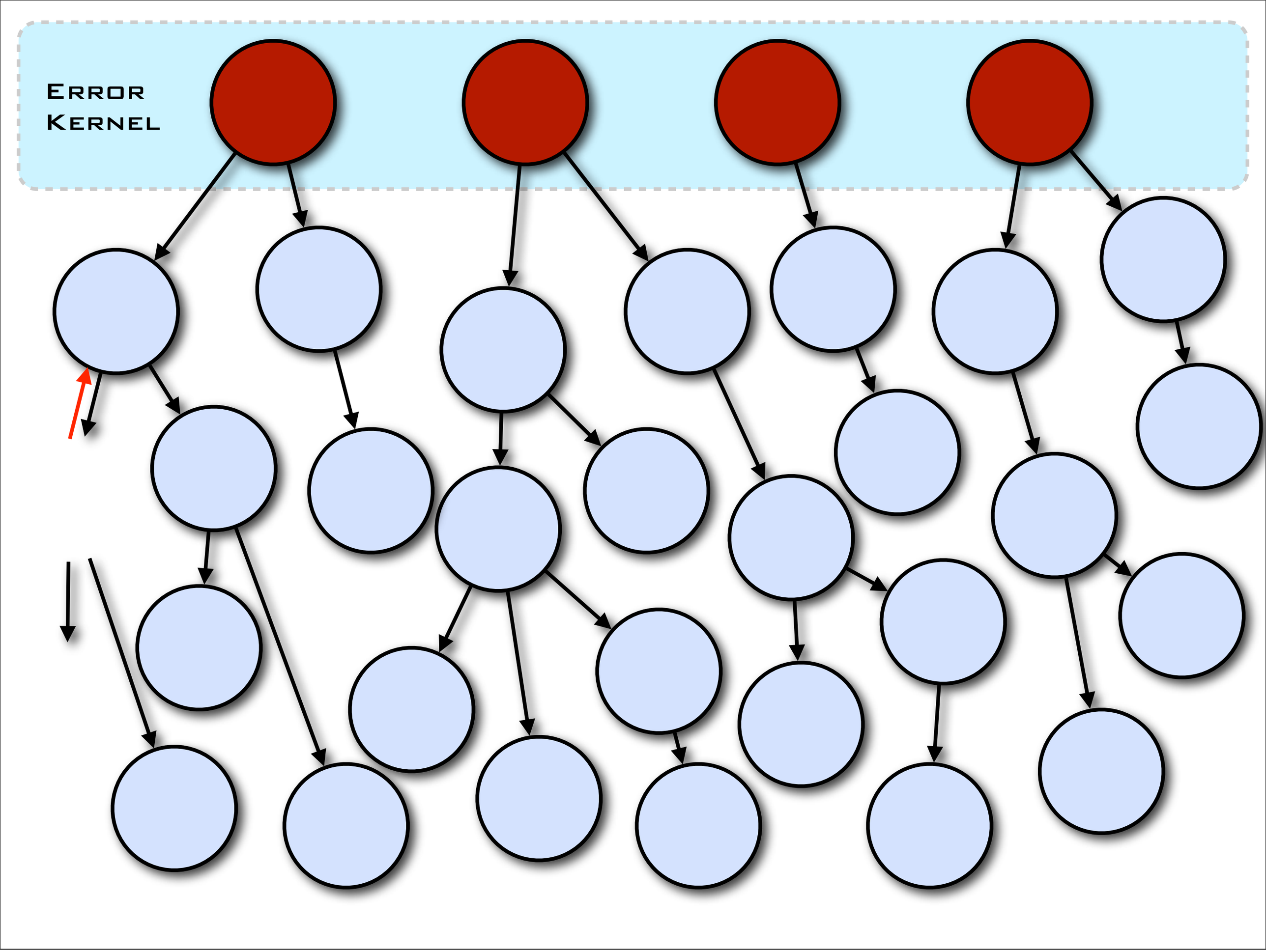
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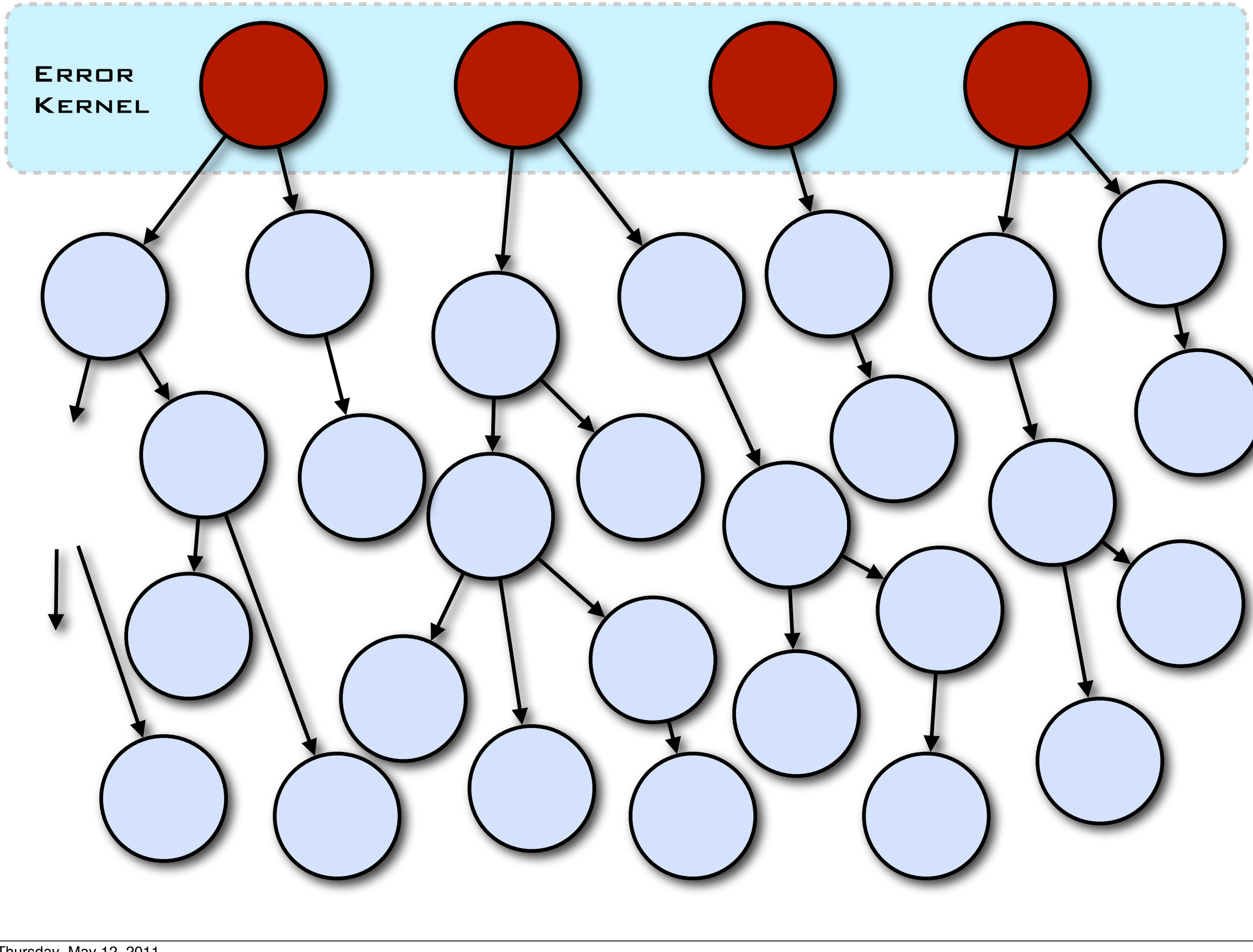
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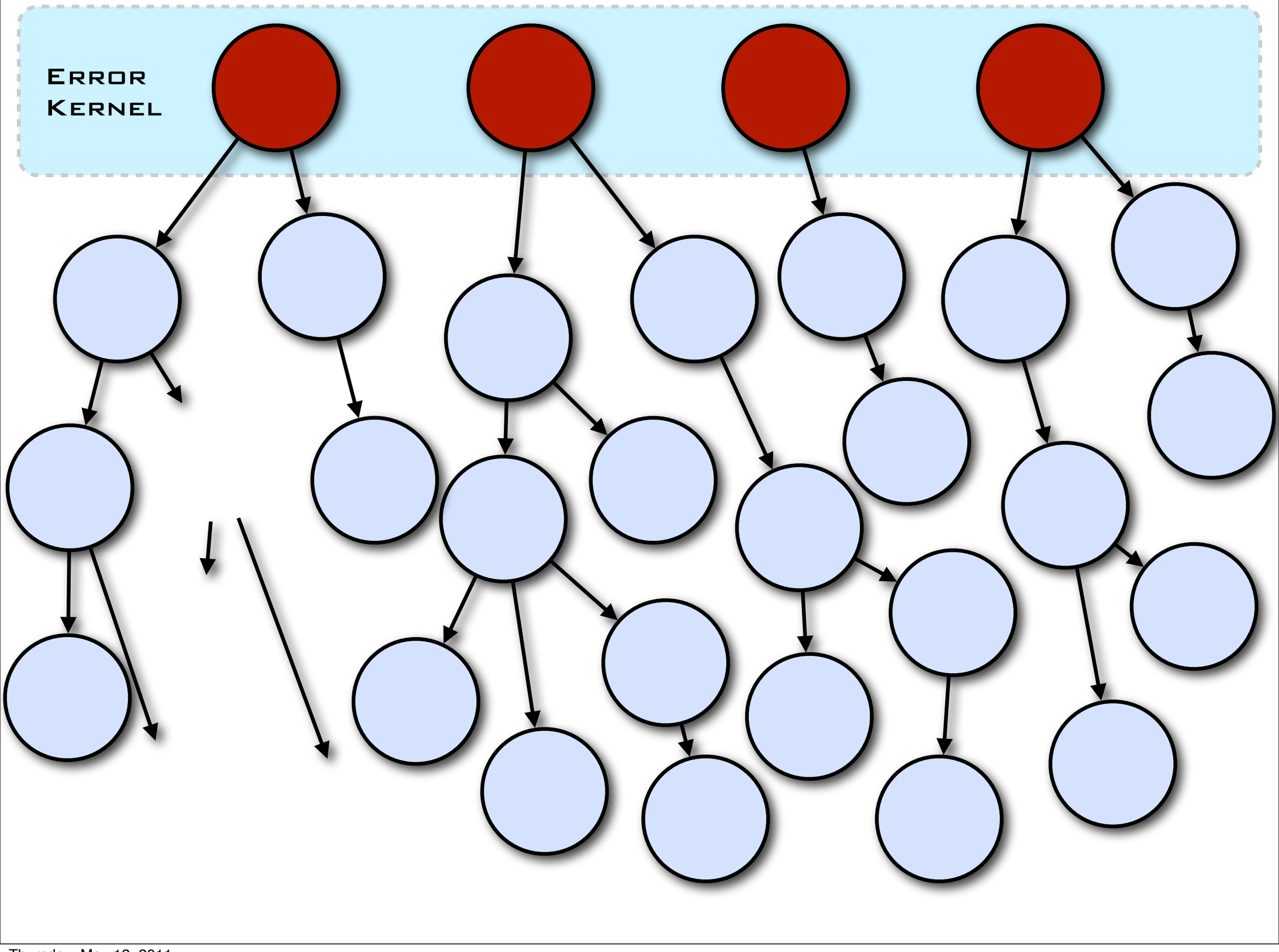
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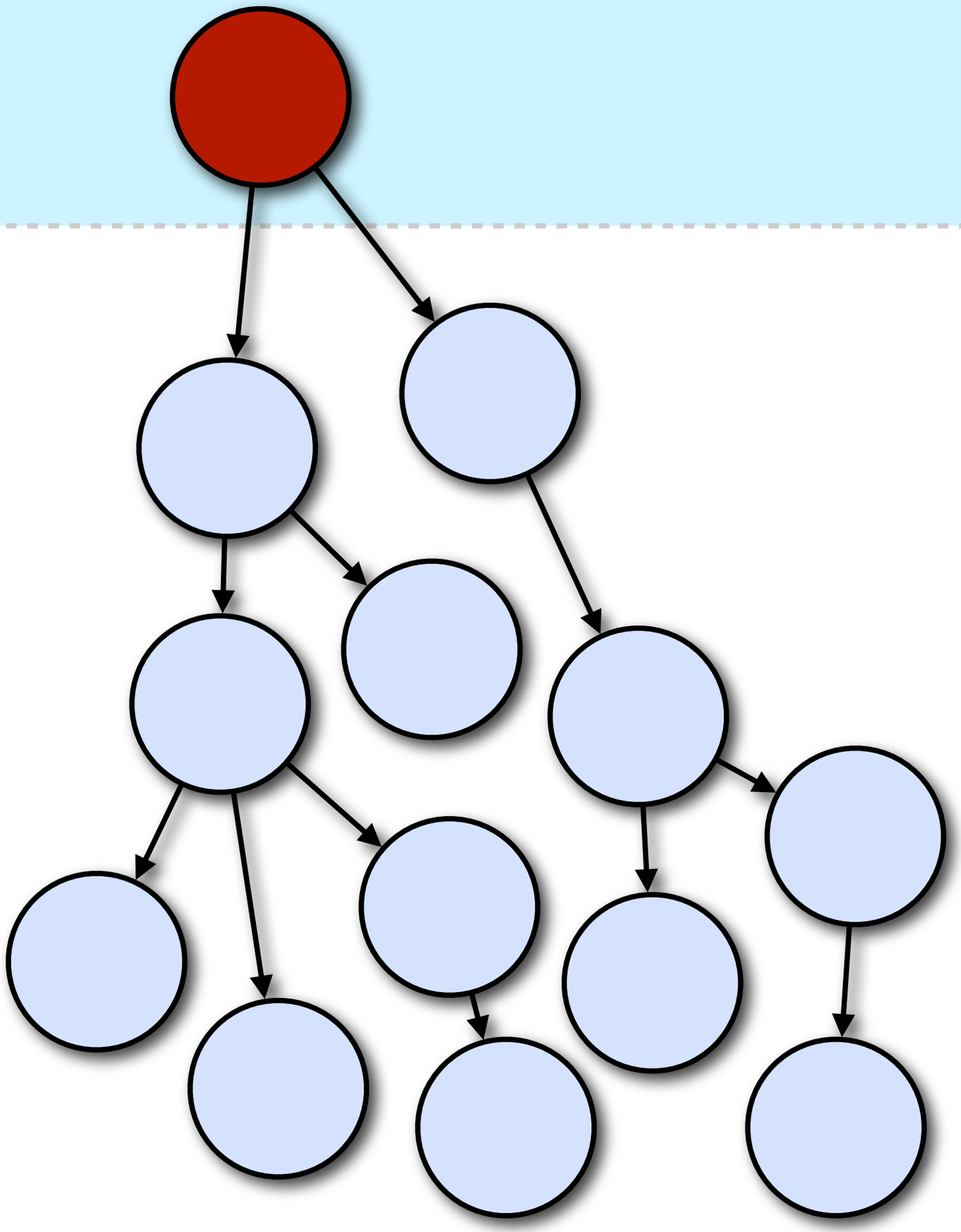
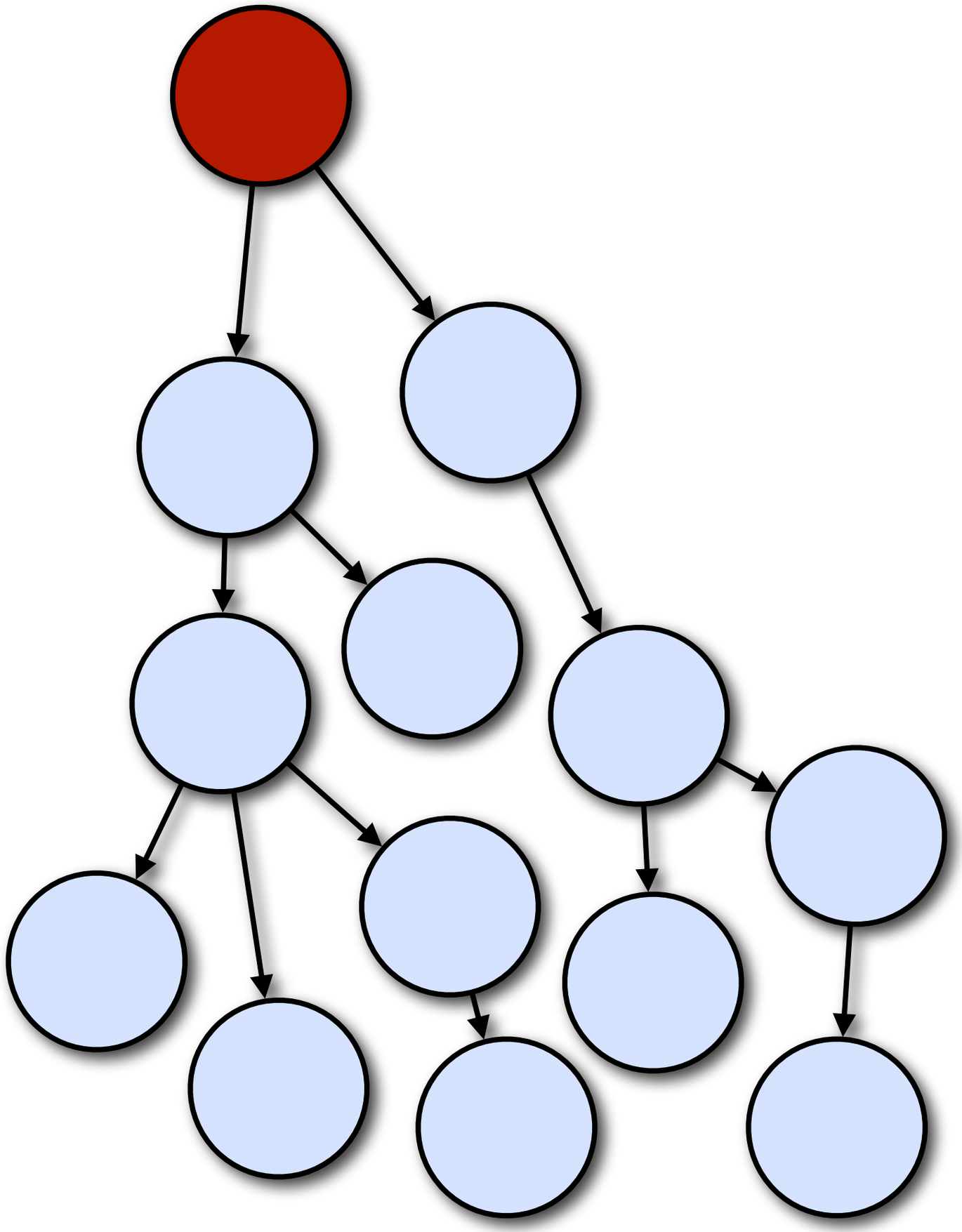
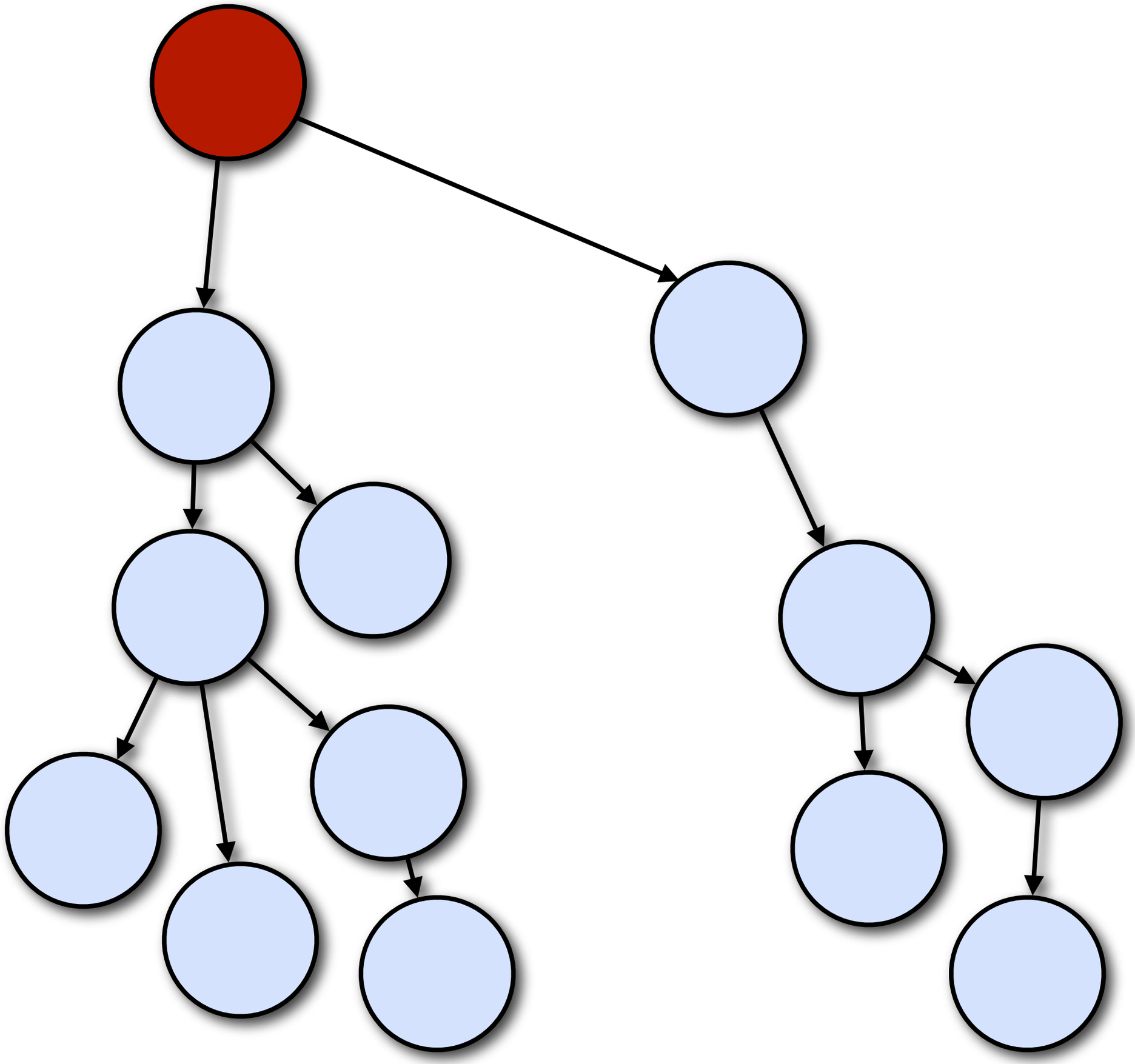
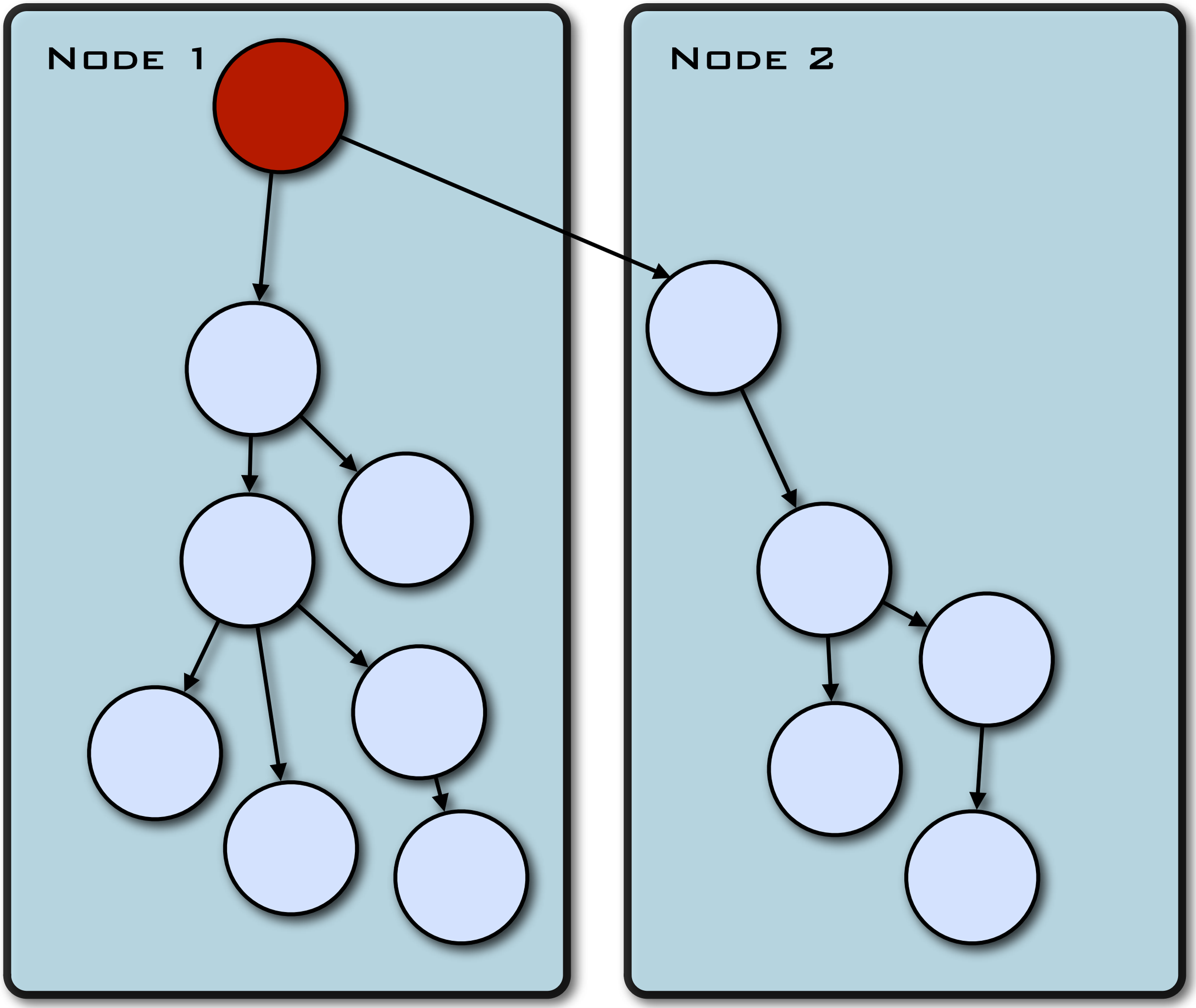
Kernel

Error Kernel








Node 1
Node 2

Linking

```
link(actor)
unlink(actor)

startLink(actor)
spawnLink[MyActor]
```

Fault handlers

```
AllForOneStrategy(
   errors,
   maxNrOfRetries,
   withinTimeRange)

OneForOneStrategy(
   errors,
   maxNrOfRetries,
   withinTimeRange)
```

Supervision

```
class Supervisor extends Actor {
  faultHandler = AllForOneStrategy(
    List(classOf[IllegalStateException])
    5, 5000))

  def receive = {
    case Register(actor) => link(actor)
  }
}
```

Manage failure

```
class FaultTolerantService extends Actor {
  ...
  override def preRestart(reason: Throwable) = {
    ... // clean up before restart
  }
  override def postRestart(reason: Throwable) = {
    ... // init after restart
  }
}
```

...and much much more

STM

FSM

HTTP

Camel

Microkernel

Guice

JTA

Dataflow

OSGi

AMQP

scalaz

Spring

Security

Akka 1.1

To be released today

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EOF