Akka:

Simpler Concurrency, Scalability & Fault-tolerance through Actors

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We believe that...

- Writing correct concurrent applications is **too hard**

- Scaling out applications is **too hard**

- Writing highly fault-tolerant applications is **too hard**

It doesn't have to be like this

We need to raise the abstraction level

Locks & Threads

are...

...sometimes

plain evil

...but always the

wrong default

"Threads are to Concurrency as Witchcraft is to Physics"

"Hanging by a thread is the punishment for Shared State Concurrency"

- Gilad Bracha

Actors

one tool in the toolbox

Actor Model of Concurrency

- Implements Message-Passing Concurrency
- Share NOTHING
- Isolated lightweight processes
- Communicates through messages
- Asynchronous and non-blocking
- Each actor has a mailbox (message queue)

Actor Model of Concurrency

- Easier to reason about
- Raised abstraction level
- Easier to avoid
  - –Race conditions
  - –Deadlocks
  - –Starvation
  - –Live locks

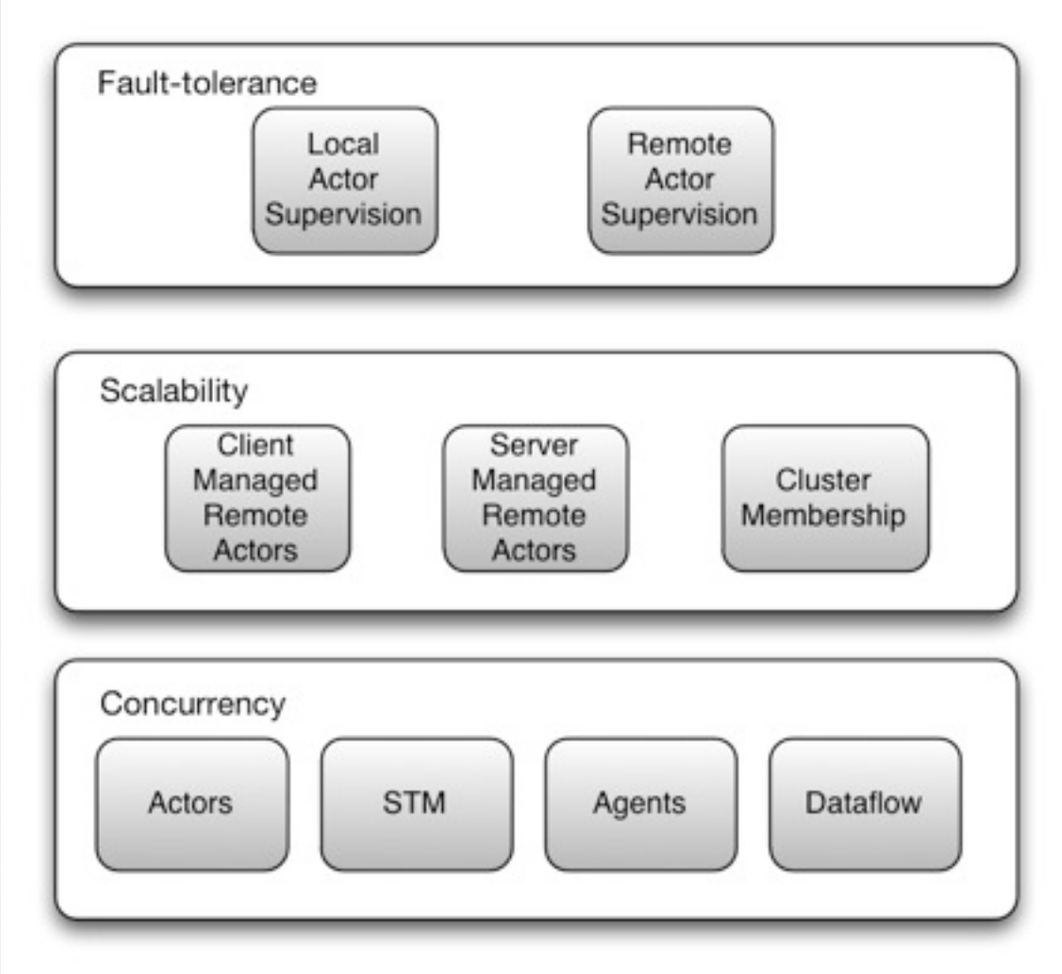
Introducing

STM Actors Agents

Dataflow Distributed Open Source

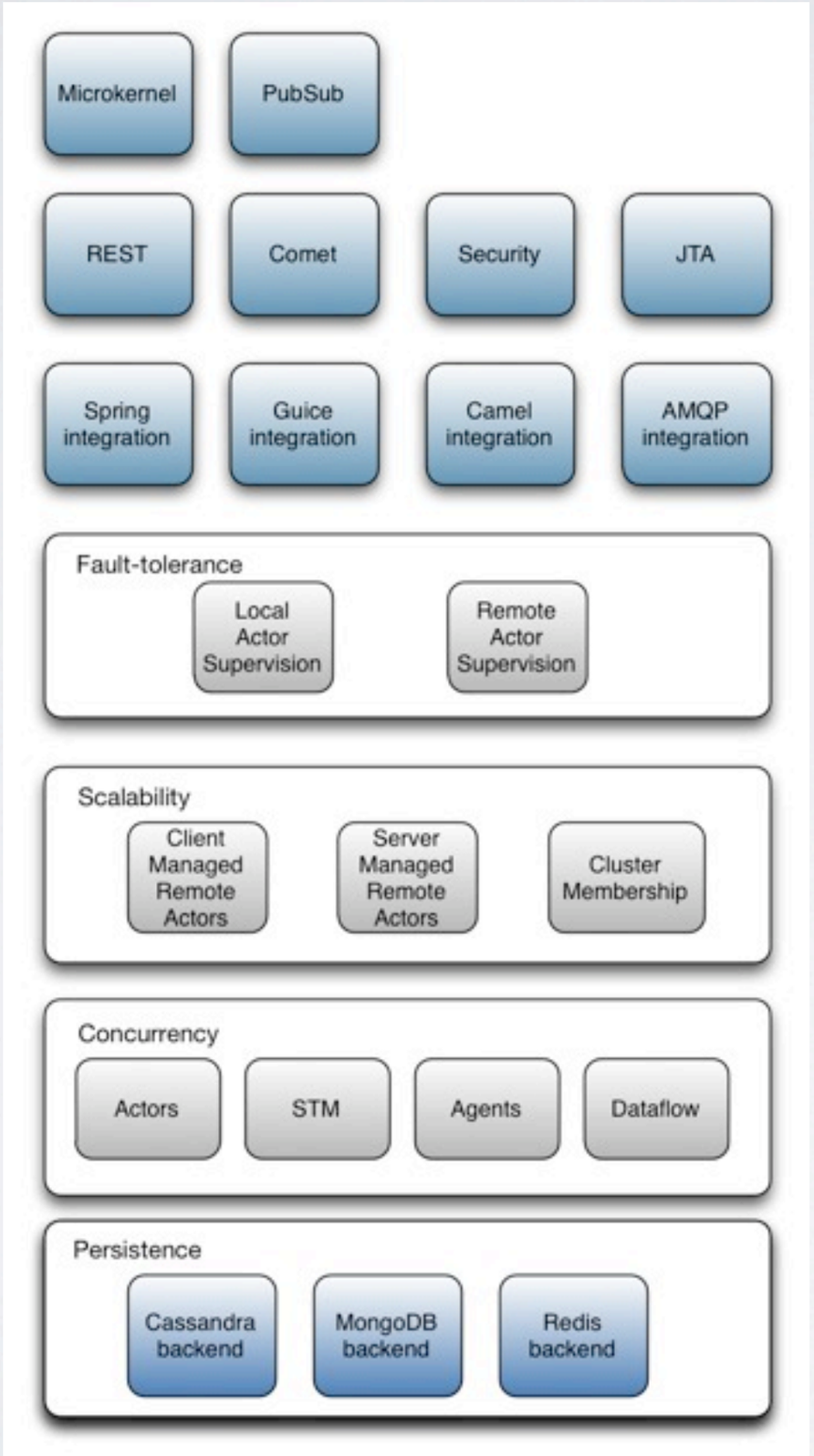
RESTful Secure Persistent

ARCHITECTURE



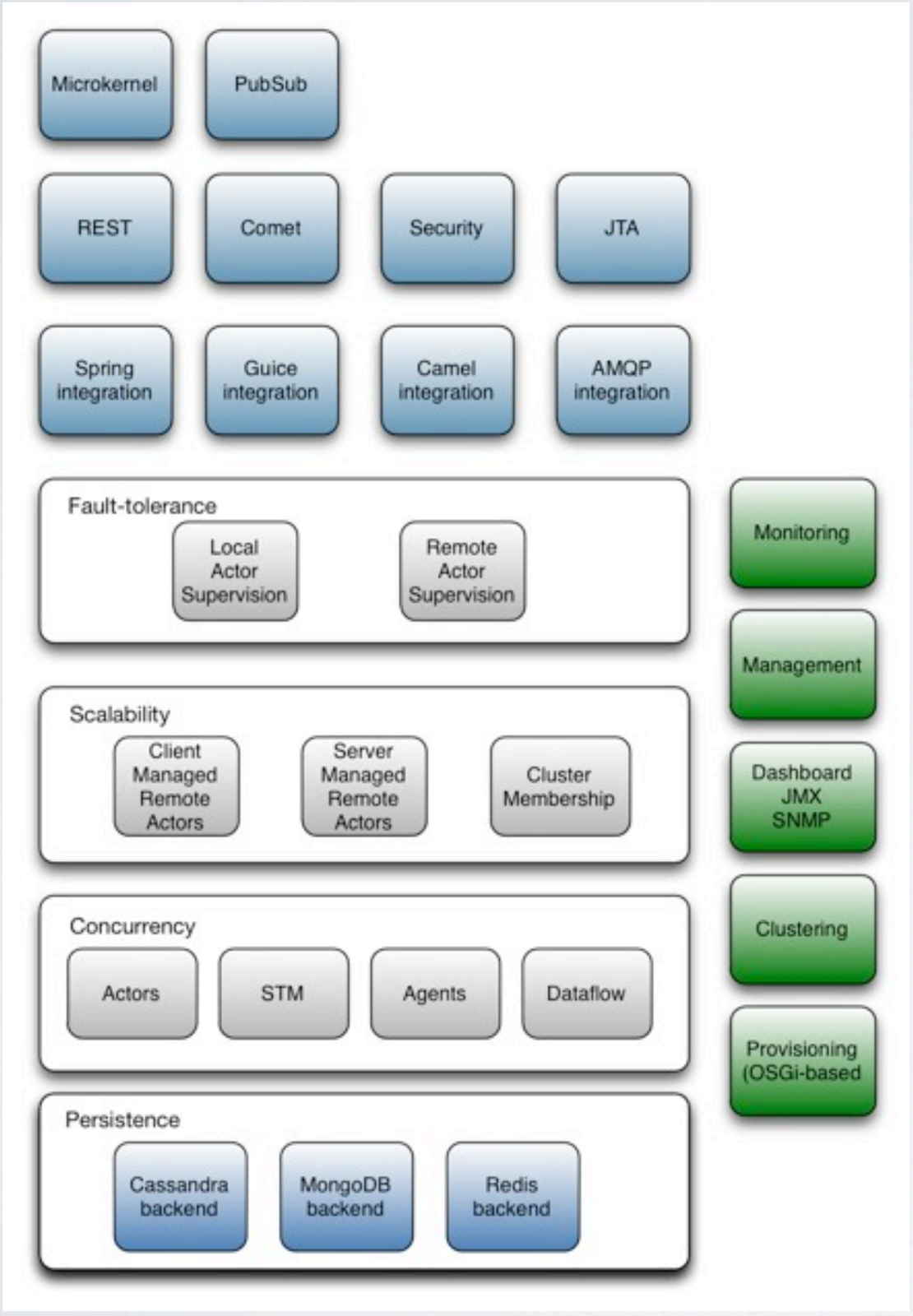
CORE SERVICES

ARCHITECTURE



ADD-ON MODULES

ARCHITECTURE



ENTERPRISE MODULES

Akka Actors

Two different models

- Thread-based
- Event-based
  - Very lightweight (600 bytes per actor)
  - Can easily create millions on a single workstation (6.5 million on 4 G RAM)
  - Does not consume a thread

Actors

```
case object Tick

class Counter extends Actor {
  private var counter = 0

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

Create Actors

```
import Actor._

val counter = actorOf[Counter]
```

counter is an ActorRef

Create Actors

```
val actor = actorOf(new MyActor(..))
```

create actor with constructor arguments

Start actors

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

Start actors

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

Stop actors

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

init & shutdown callbacks

```
class MyActor extends Actor {

  override def init = {
    ... // called after ‘start’
  }

  override def shutdown = {
    ... // called before ‘stop’
  }
}
```

the self reference

```
class RecursiveActor extends Actor {
  private var counter = 0
  self.id = “service:recursive”

  def receive = {
    case Tick =>
      counter += 1
      self ! Tick
  }
}
```

Actors

anonymous

```
val worker = actor {
  case Work(fn) => fn()
}
```

Send: !

```
counter ! Tick
```

fire-forget

Send: !!

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

uses Future under the hood (with time-out)

Send: !!

```
val resultOption = actor !! Message

val result = resultOption
               .getOrElse(defaultResult)

val result = resultOption.getOrElse(
    throw new Exception("Timed out")))
```

returns an Option[ResultType] directly

Send: !!!

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


...
Futures.awaitOne(List(fut1, fut2, ...))
Futures.awaitAll(List(fut1, fut2, ...))
```

returns the Future directly

Reply

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

Reply

```
class SomeActor extends Actor {
  def receive = {
    case User(name) =>
      // store away the sender
      // to use later or
      // somewhere else
      ... = self.sender
  }
}
```

Reply

```
class SomeActor extends Actor {
  def receive = {
    case User(name) =>
      // store away the sender future
      // to resolve later or
      // somewhere else
      ... = self.senderFuture
  }
}
```

Good immutable messages

```
// define the case class
case class Register(user: User)

// create and send a new case class message
actor ! Register(user)

// tuples
actor ! (username, password)

// lists
actor ! List(“bill”, “bob”, “alice”)
```

Akka Dispatchers

Dispatchers

```
object Dispatchers {
  def newExecutorBasedEventDrivenDispatcher(name: String)

  def newExecutorBasedEventDrivenWorkStealingDispatcher(name: String)

  def newThreadBasedDispatcher(actor: ActorRef)

  def newReactorBasedThreadPoolEventDrivenDispatcher(name: String)

  def newReactorBasedSingleThreadEventDrivenDispatcher(name: String)
}
```

Set dispatcher

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

  ...
}

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

EventBasedDispatcher

Fluent DSL

```
val dispatcher =
  Dispatchers.newExecutorBasedEventDrivenDispatcher
dispatcher
    .withNewThreadPoolWithBoundedBlockingQueue(100)
    .setCorePoolSize(16)
    .setMaxPoolSize(128)
    .setKeepAliveTimeInMillis(60000)
    .setRejectionPolicy(new CallerRunsPolicy)
    .buildThreadPool
```

MessageQueues

Unbounded LinkedBlockingQueue

Bounded LinkedBlockingQueue

Bounded ArrayBlockingQueue

Bounded SynchronousQueue

Plus different options per queue

ActorRegistry

```
val actors = ActorRegistry.actors
val actors = ActorRegistry.actorsFor[TYPE]
val actors = ActorRegistry.actorsFor(id)
val actor = ActorRegistry.actorFor(uuid)

ActorRegistry.foreach(fn)
ActorRegistry.shutdownAll
```

Let it crash

fault-tolerance

Stolen from

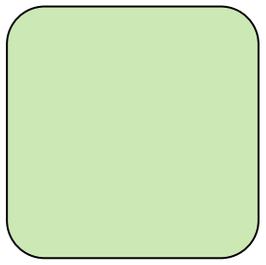
Erlang

9

nines

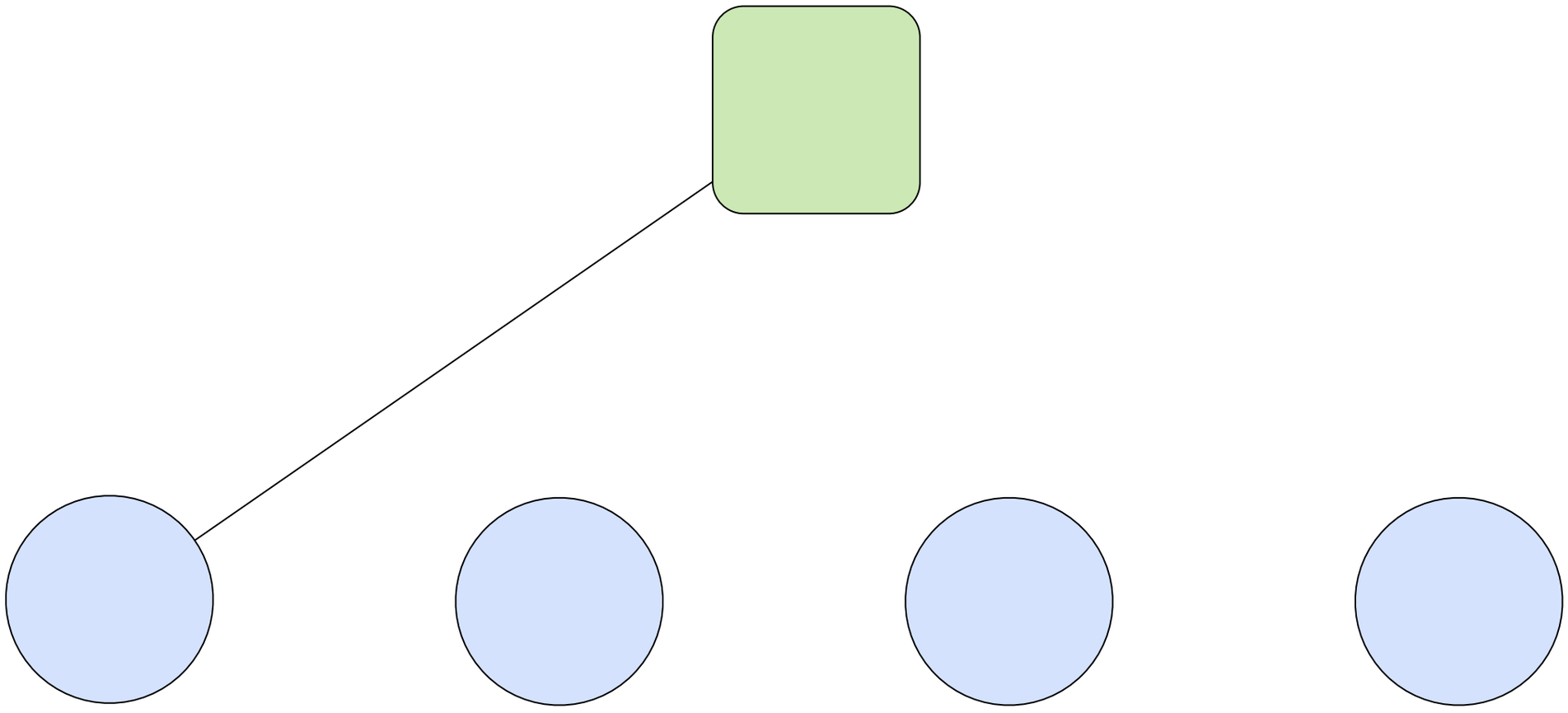
OneForOne

fault handling strategy



OneForOne

fault handling strategy



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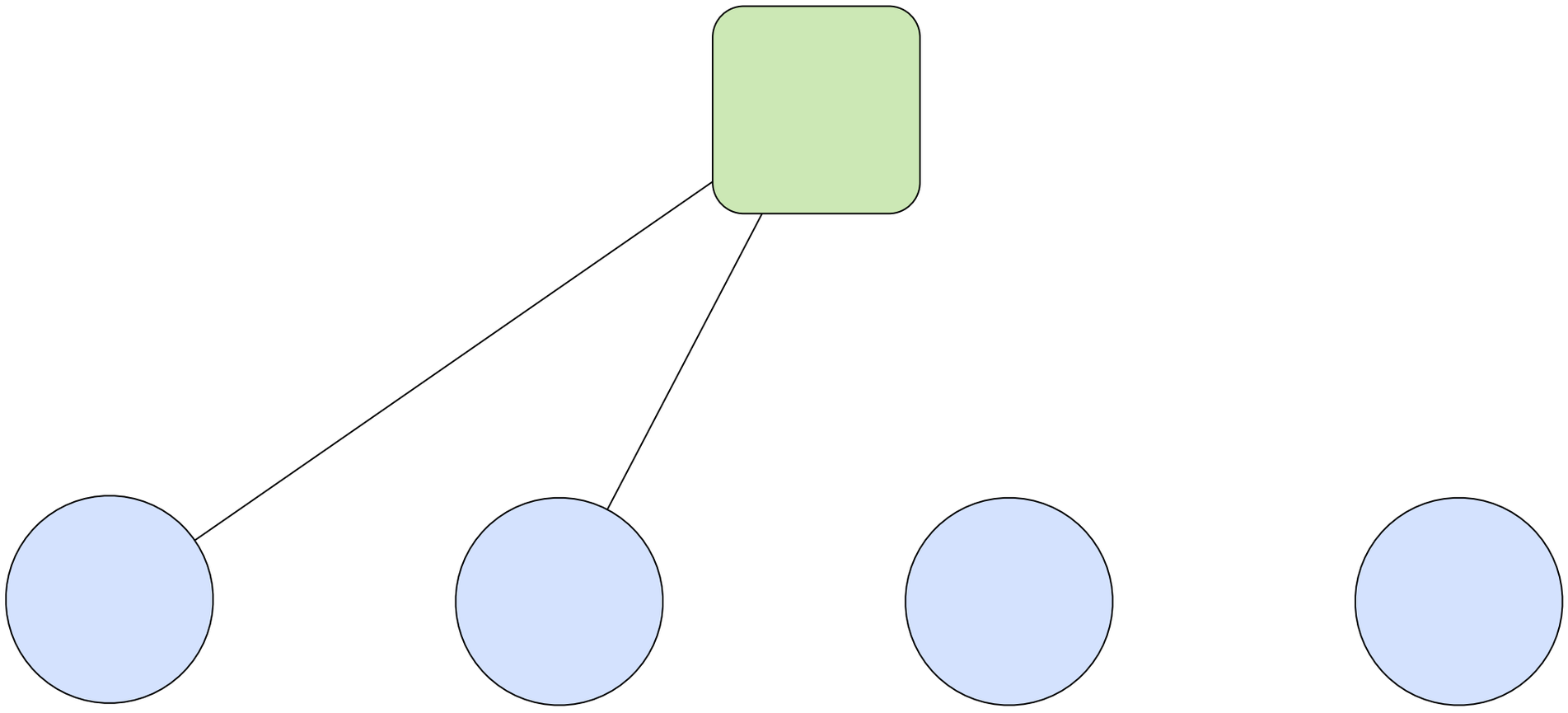
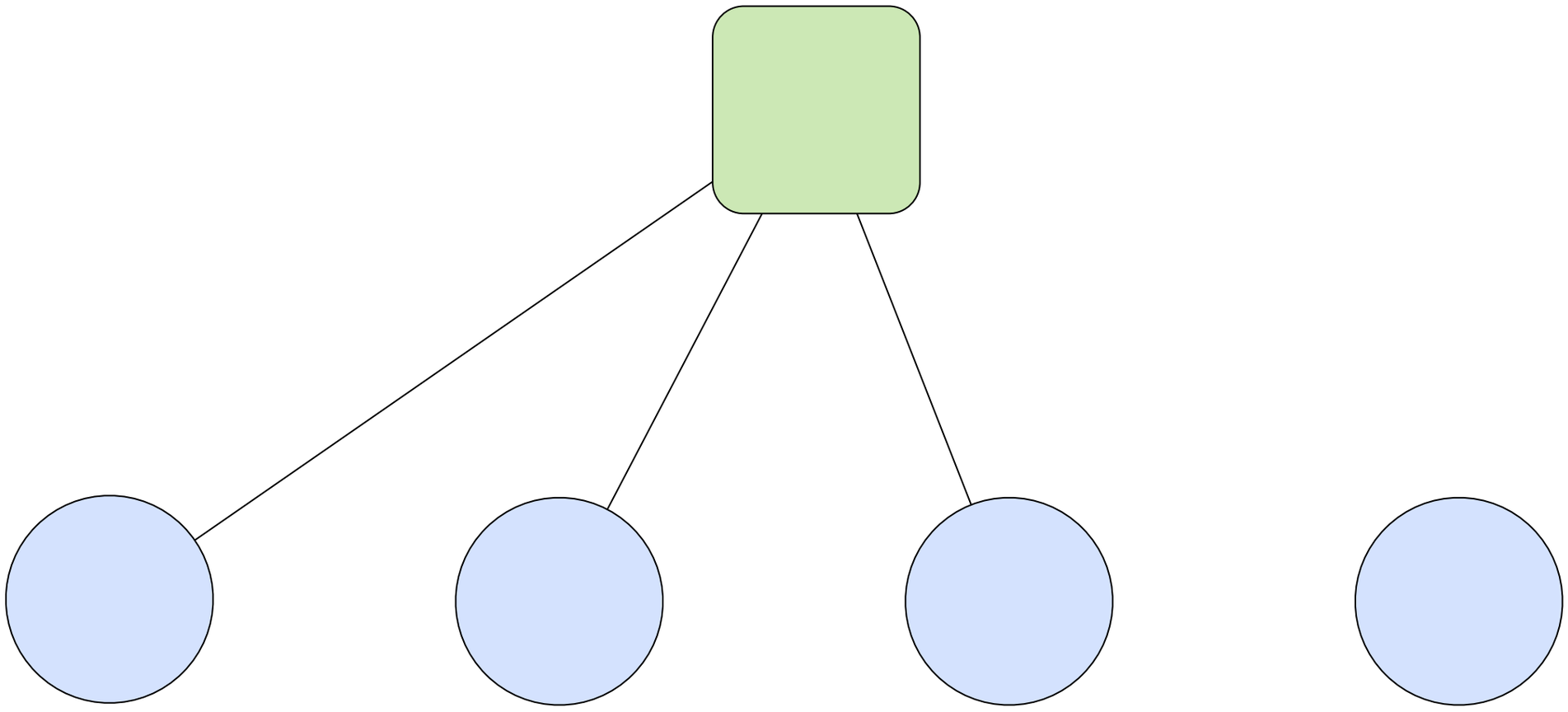


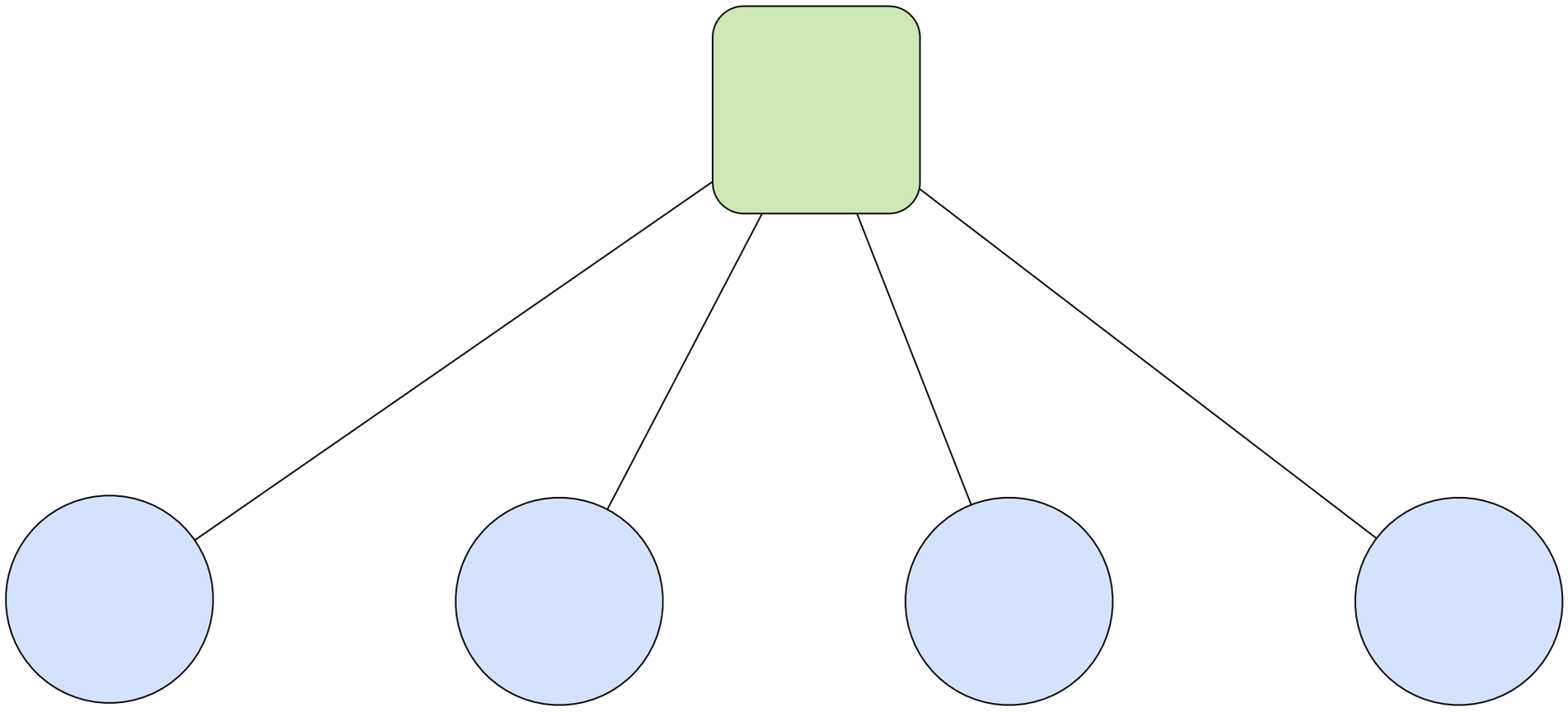
OneForOne

fault handling strategy



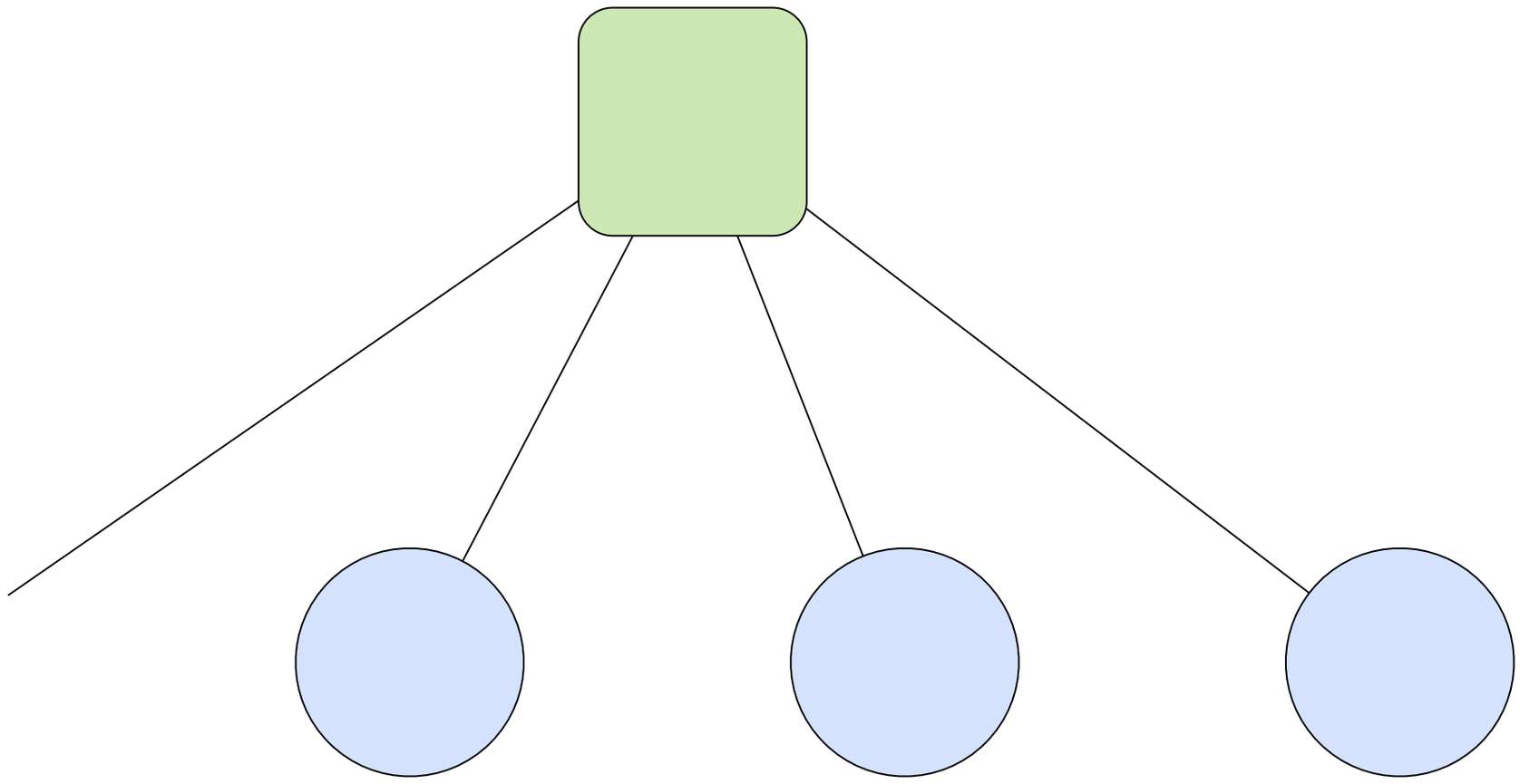
OneForOne

fault handling strategy



OneForOne

fault handling strategy



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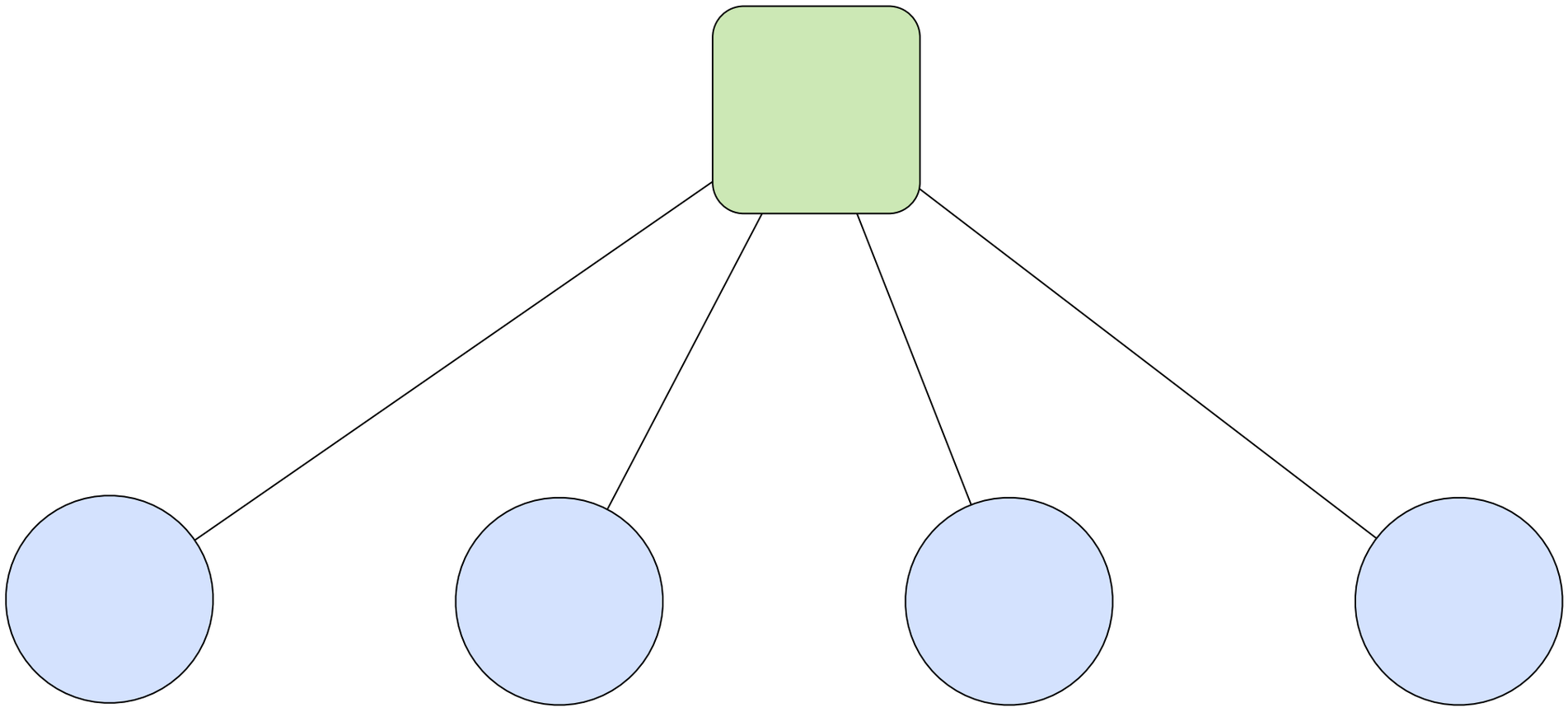

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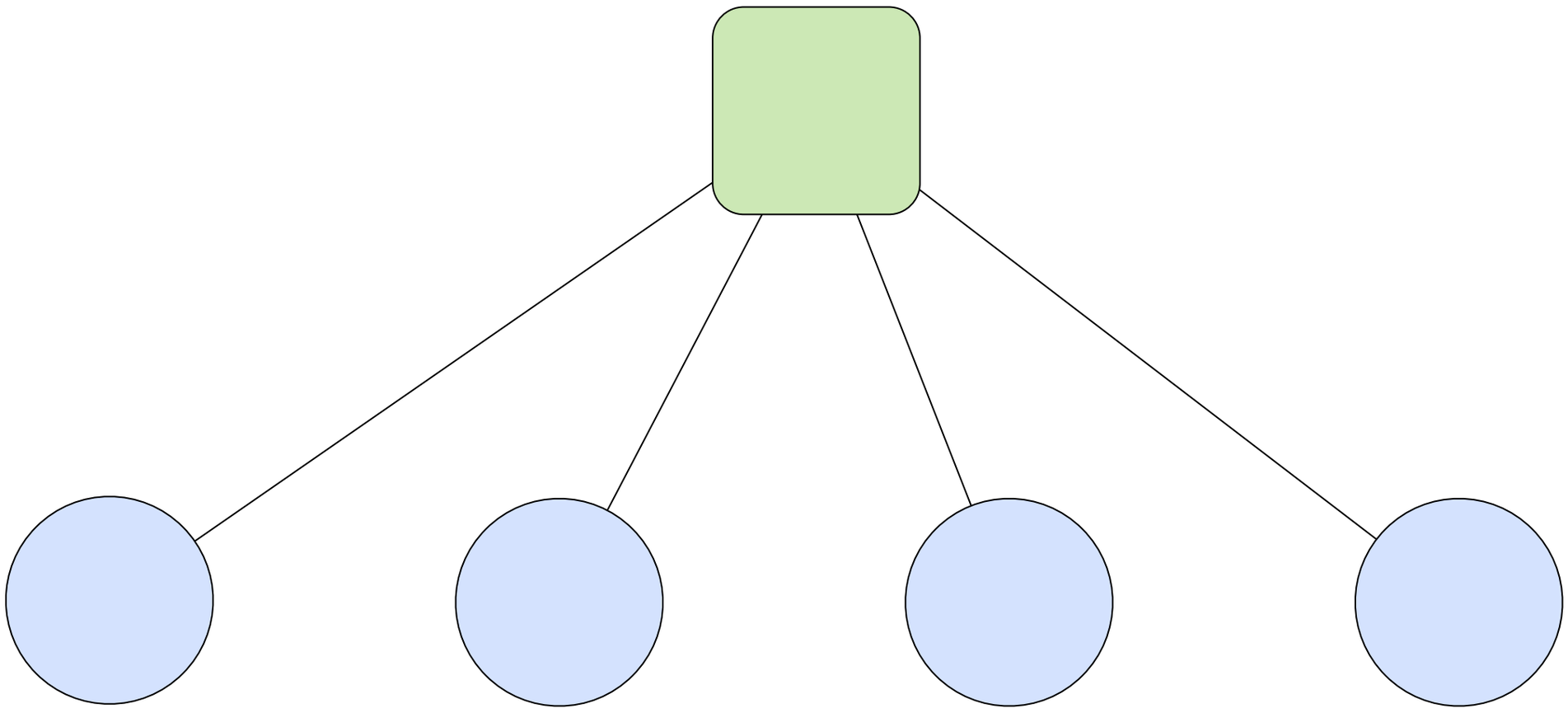

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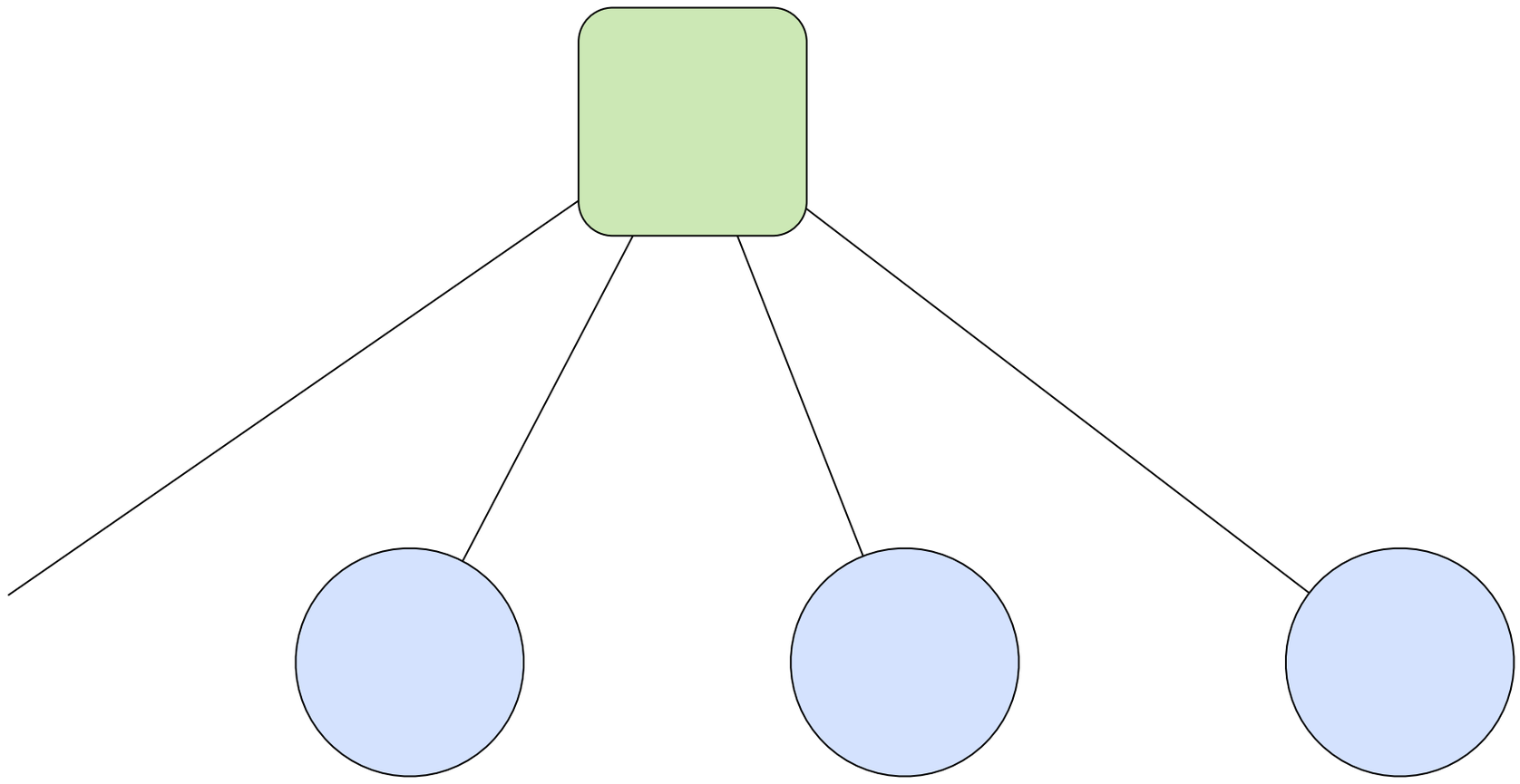
fault handling strategy



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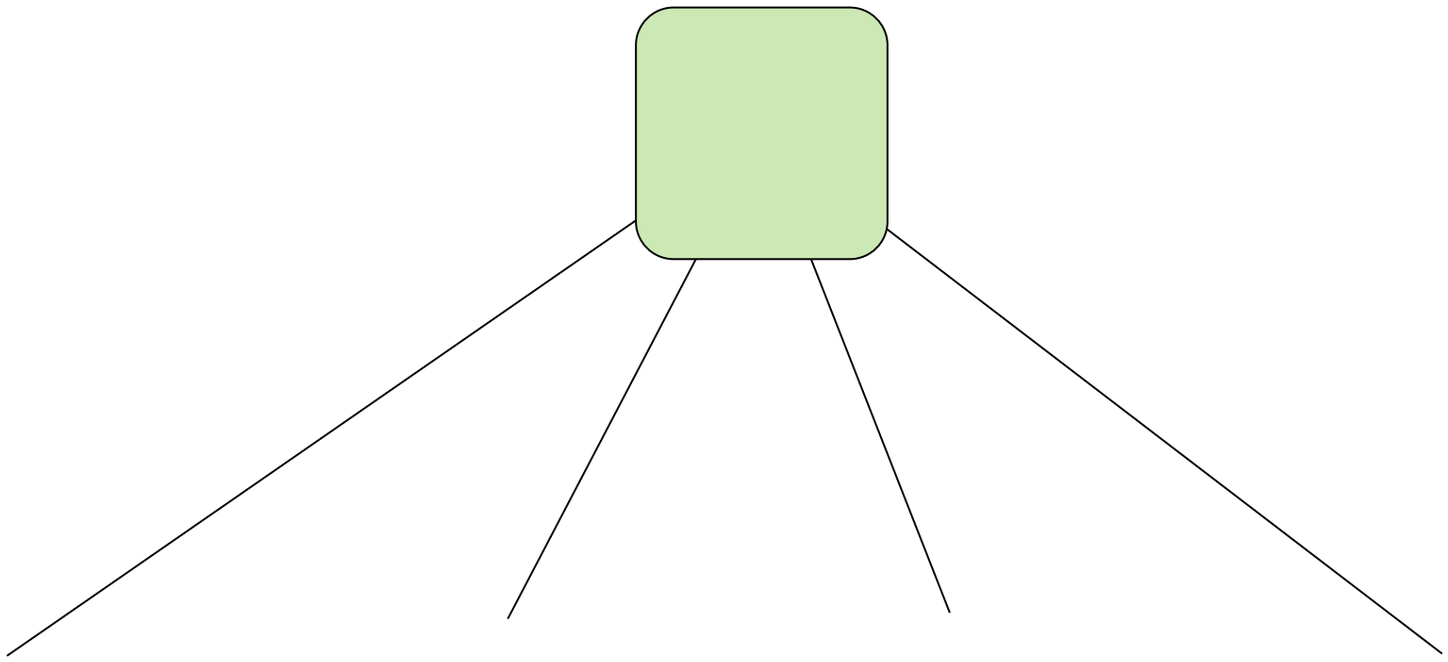

AllForOne

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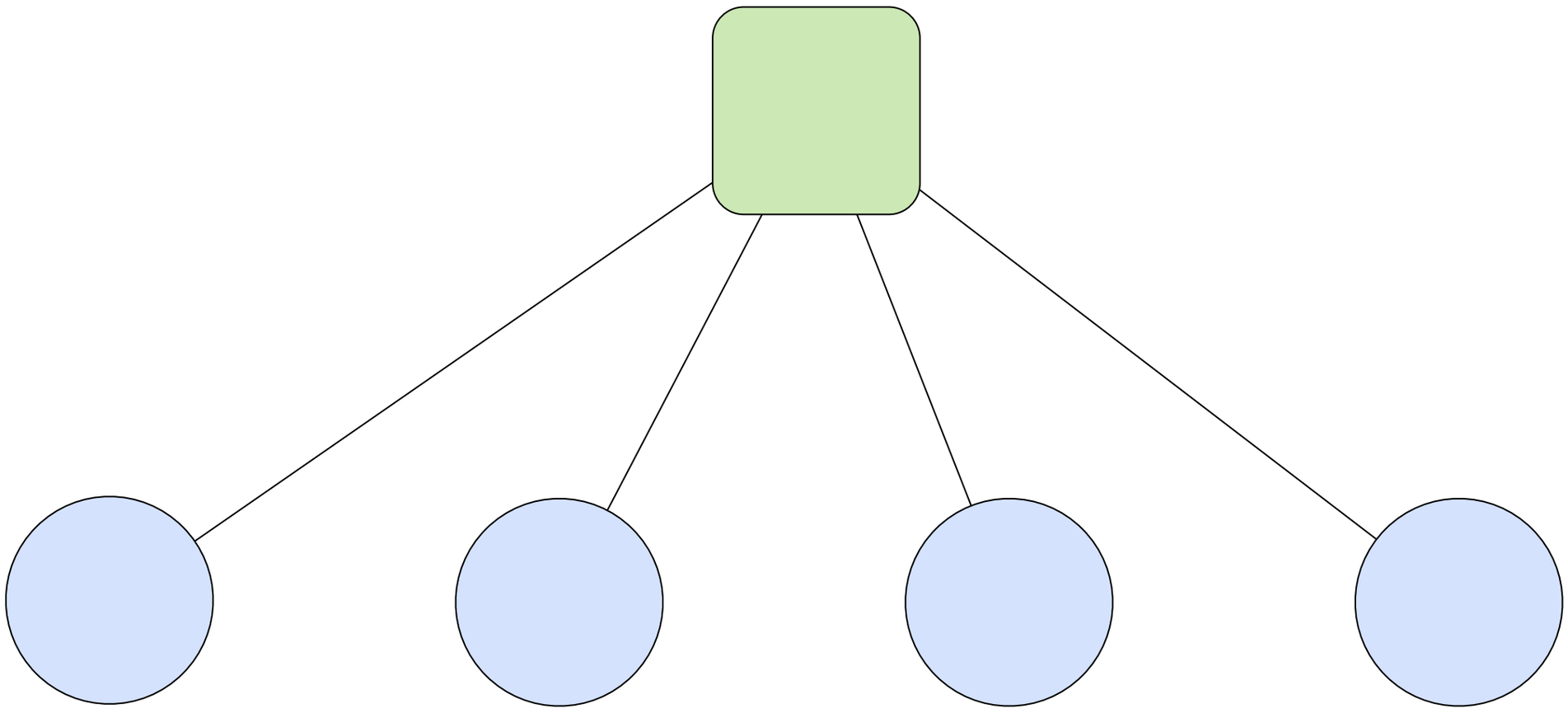
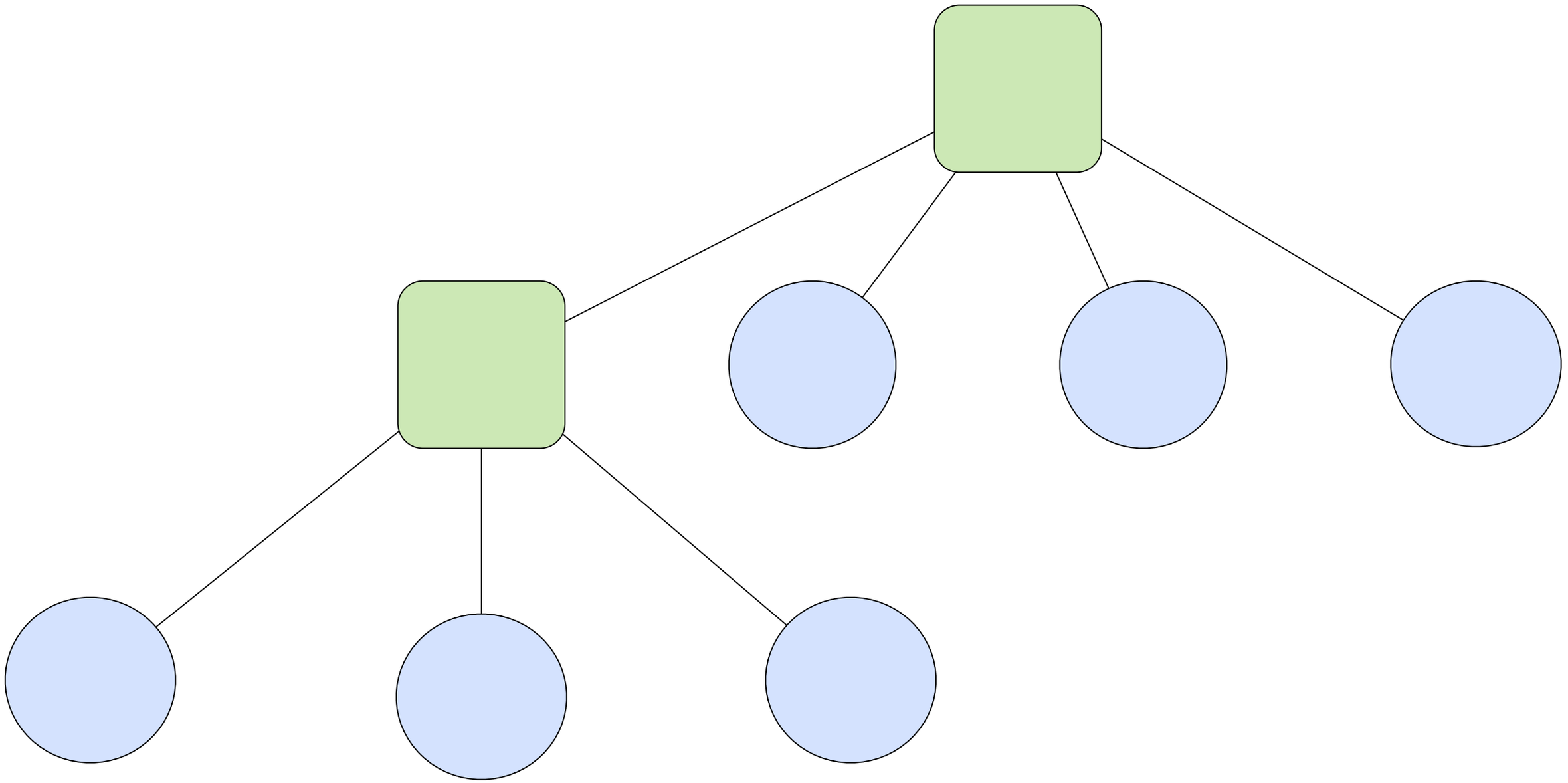
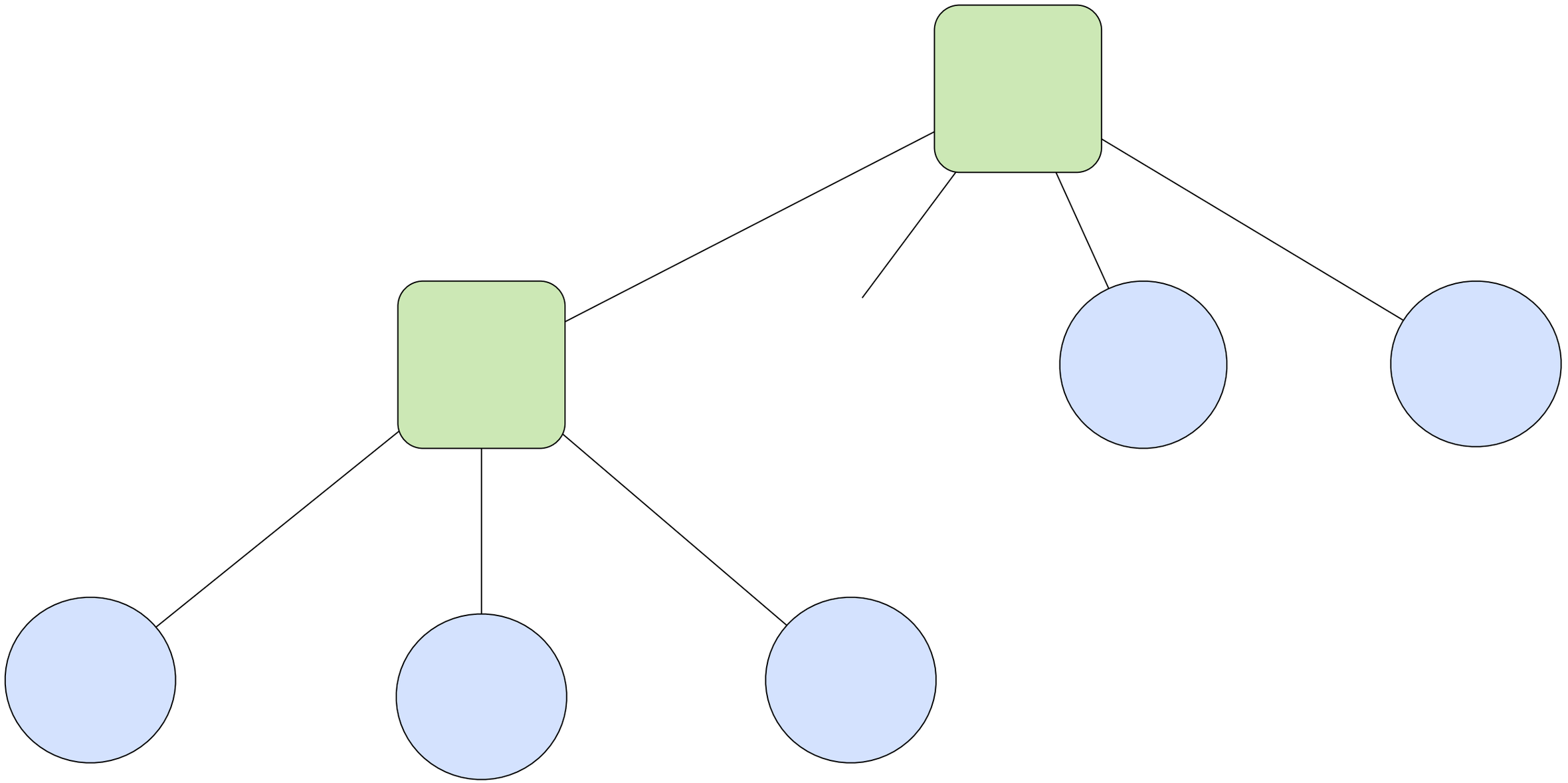


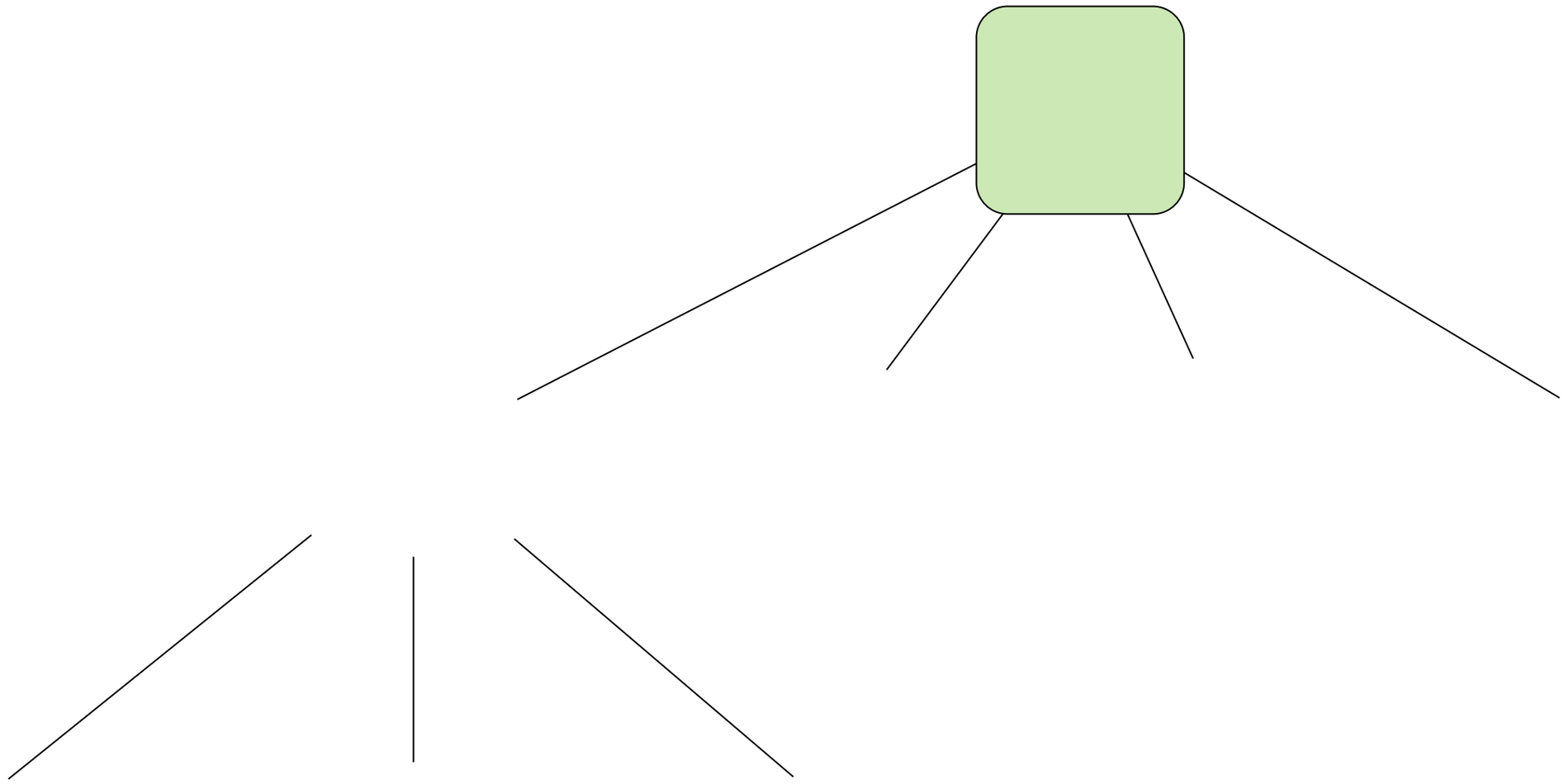
Supervisor hierarchies



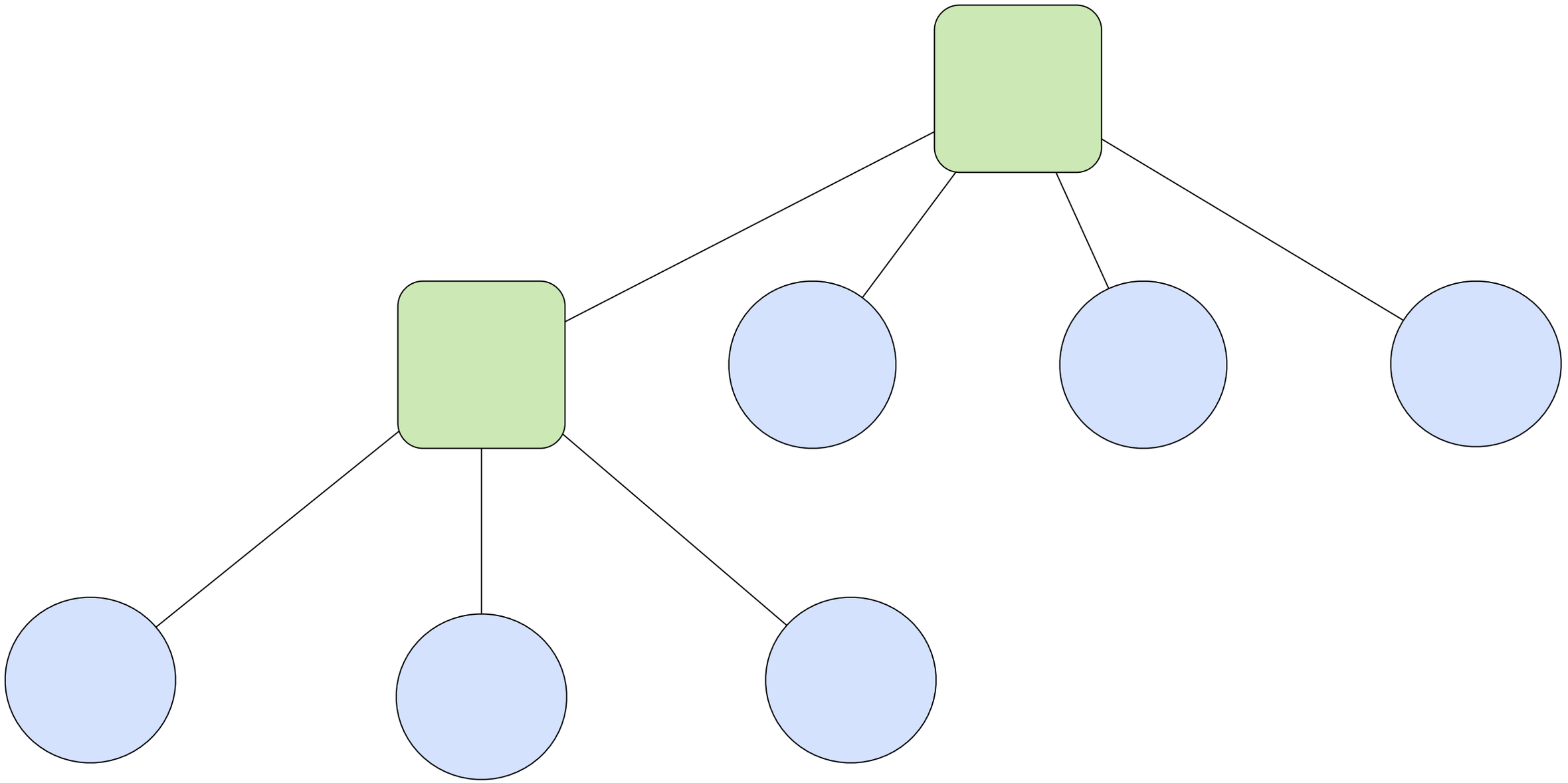
Supervisor hierarchies



Supervisor hierarchies



Supervisor hierarchies



Fault handlers

```
AllForOneStrategy(
  maxNrOfRetries,
  withinTimeRange)

OneForOneStrategy(
  maxNrOfRetries,
  withinTimeRange)
```

Linking

```
link(actor)
unlink(actor)

startLink(actor)
spawnLink[MyActor]
```

trapExit

```
trapExit = List(
  classOf[ServiceException],
  classOf[PersistenceException])
```

Supervision

```
class Supervisor extends Actor {
  import self._
  trapExit = List(classOf[Throwable])
  faultHandler =
    Some(OneForOneStrategy(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
  }
}
```

Remote Actors

Remote Server

```
// use host & port in config
RemoteNode.start

RemoteNode.start("localhost", 9999)
```

Scalable implementation based on
NIO (Netty) & Protobuf

Two types of

remote actors

- Client-initated and managed
- Server-initiated and managed

Client-managed

supervision works across nodes

```
// methods in Actor class

spawnRemote[MyActor](host, port)

spawnLinkRemote[MyActor](host, port)

startLinkRemote(actor, host, port)
```

Client-managed

moves actor to server
client manages through proxy

```
val actorProxy = spawnLinkRemote[MyActor](
  “darkstar”,
  9999)

actorProxy ! message
```

Server-managed

register and manage actor on server
client gets “dumb” proxy handle

```
RemoteNode.register(
  “service:id”, actorOf[MyService])
```

server part

Server-managed

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

handle ! message
```

client part

Cluster Membership

```
Cluster.relayMessage(
  classOf[TypeOfActor], message)

for (endpoint <- Cluster)
  spawnRemote[TypeOfActor](
                endpoint.host,
                endpoint.port)
```

STM

another tool in the toolbox

What is STM?

STM: overview

- See the memory (heap and stack) as a transactional dataset
- Similar to a database
  - begin
  - commit
  - abort/rollback
- Transactions are retried automatically upon collision
- Rolls back the memory on abort

Managed References

- Separates Identity from Value
  - Values are immutable
  - Identity (Ref) holds Values
- Change is a function
- Compare-and-swap (CAS)
- Abstraction of time
- Must be used within a transaction

Managed References

```
val ref = Ref(Map[String, User]())

val users = ref.get

val newUsers = users + (“bill” -> User(“bill”))

ref.swap(newUsers)
```

Transactional datastructures

```
val users = TransactionalMap[String, User]()

val users = TransactionalVector[User]()
```

STM: API

```
import Transaction.Local._

atomic {
  ...
  atomic { // nested transactions compose
    ... // do something within a transaction
  }
}
```

Actors + STM =

Transactors

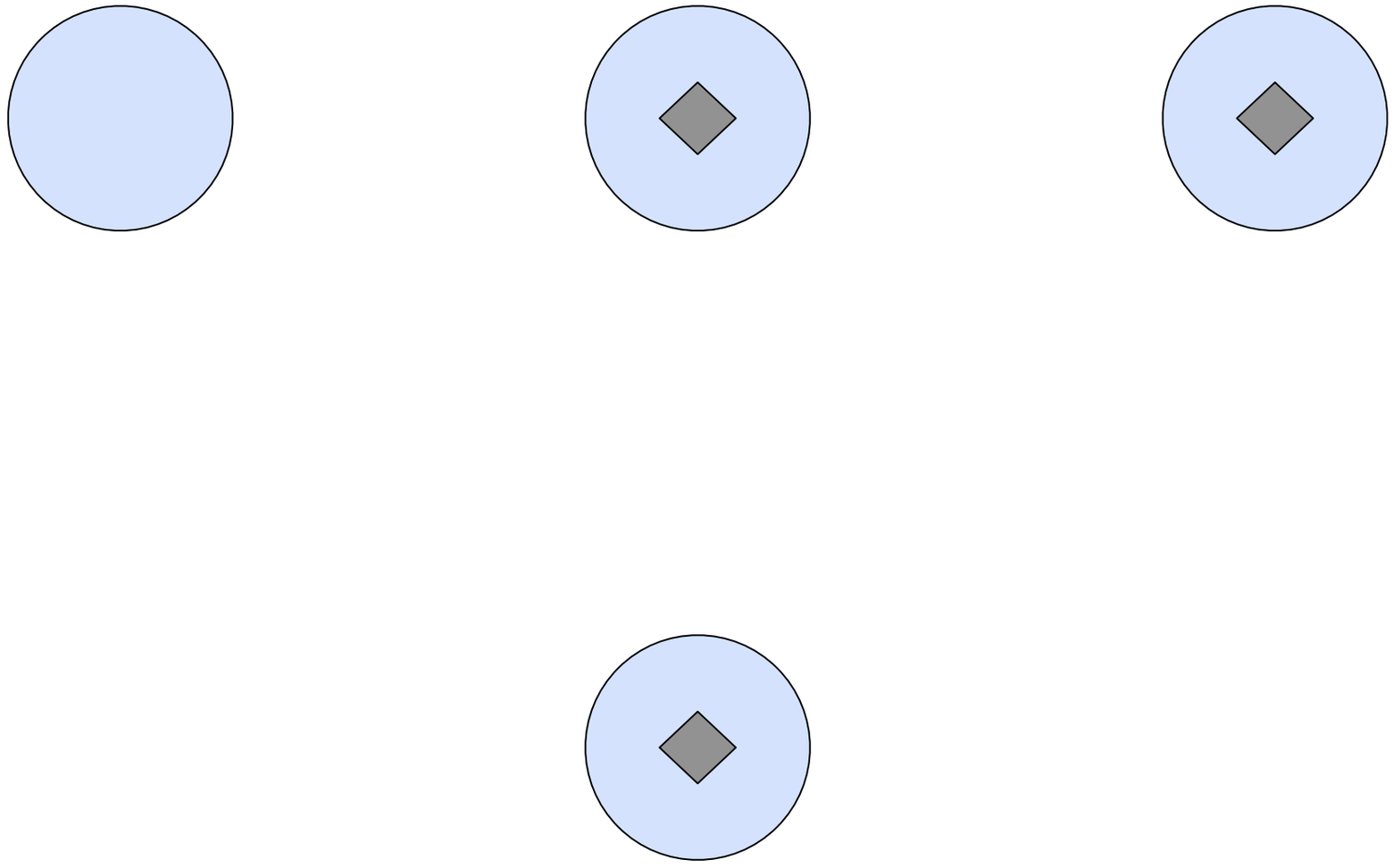
Transactors

```
class UserRegistry extends Transactor {

  private val storage =
    TransactionalMap[String, User]()

  def receive = {
    case NewUser(user) =>
      storage + (user.name -> user)
    ...
  }
}
```

Transactors



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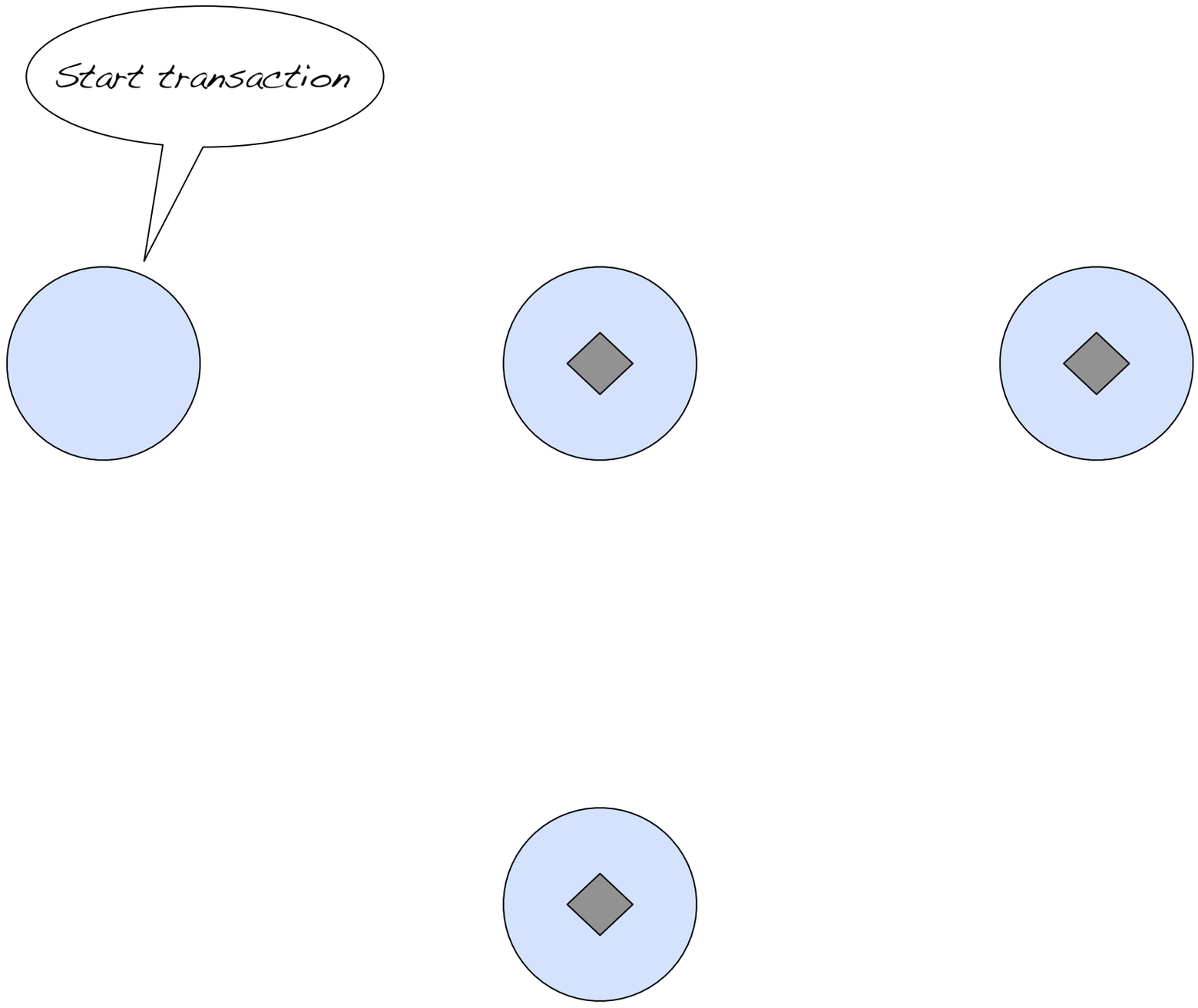

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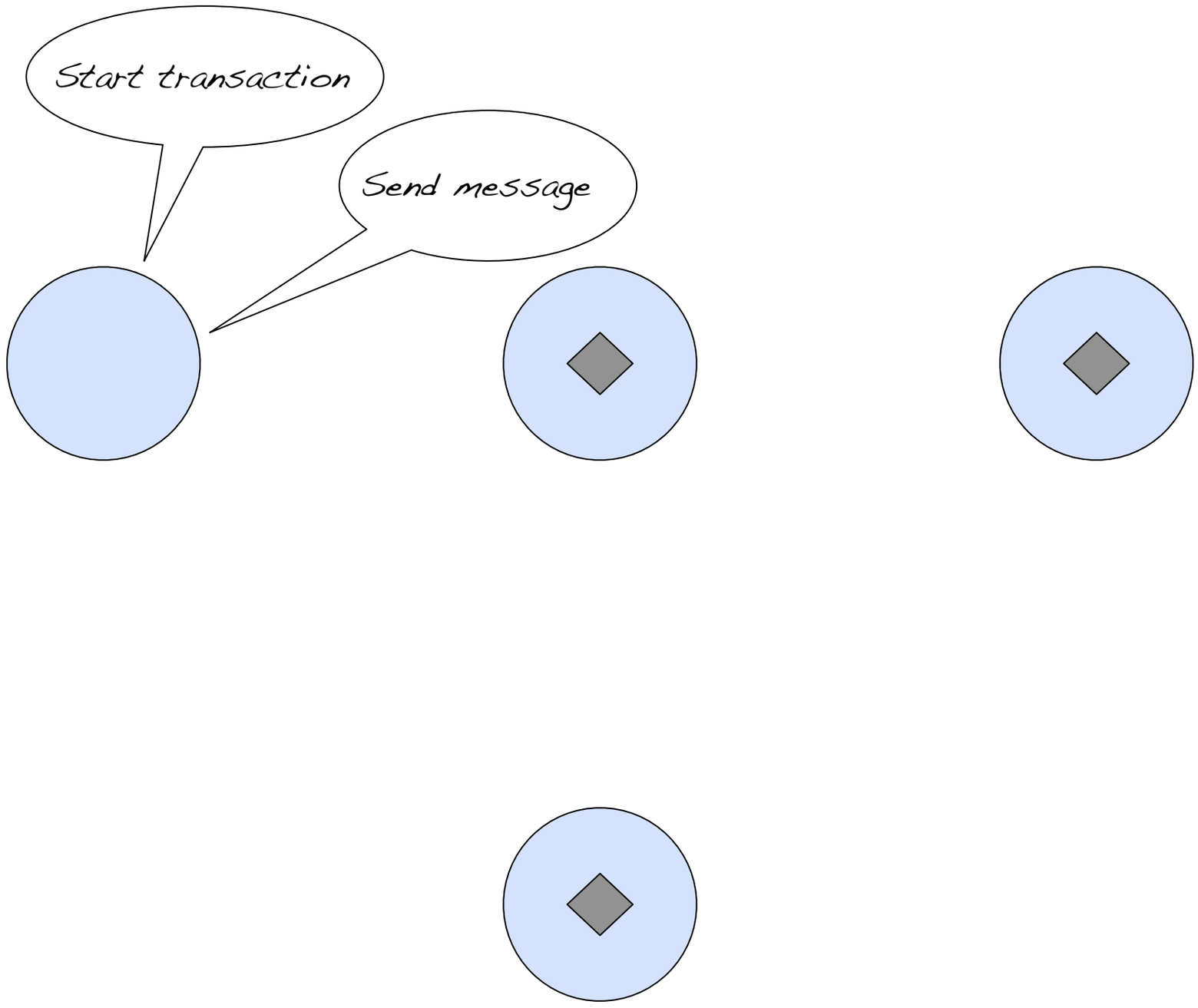

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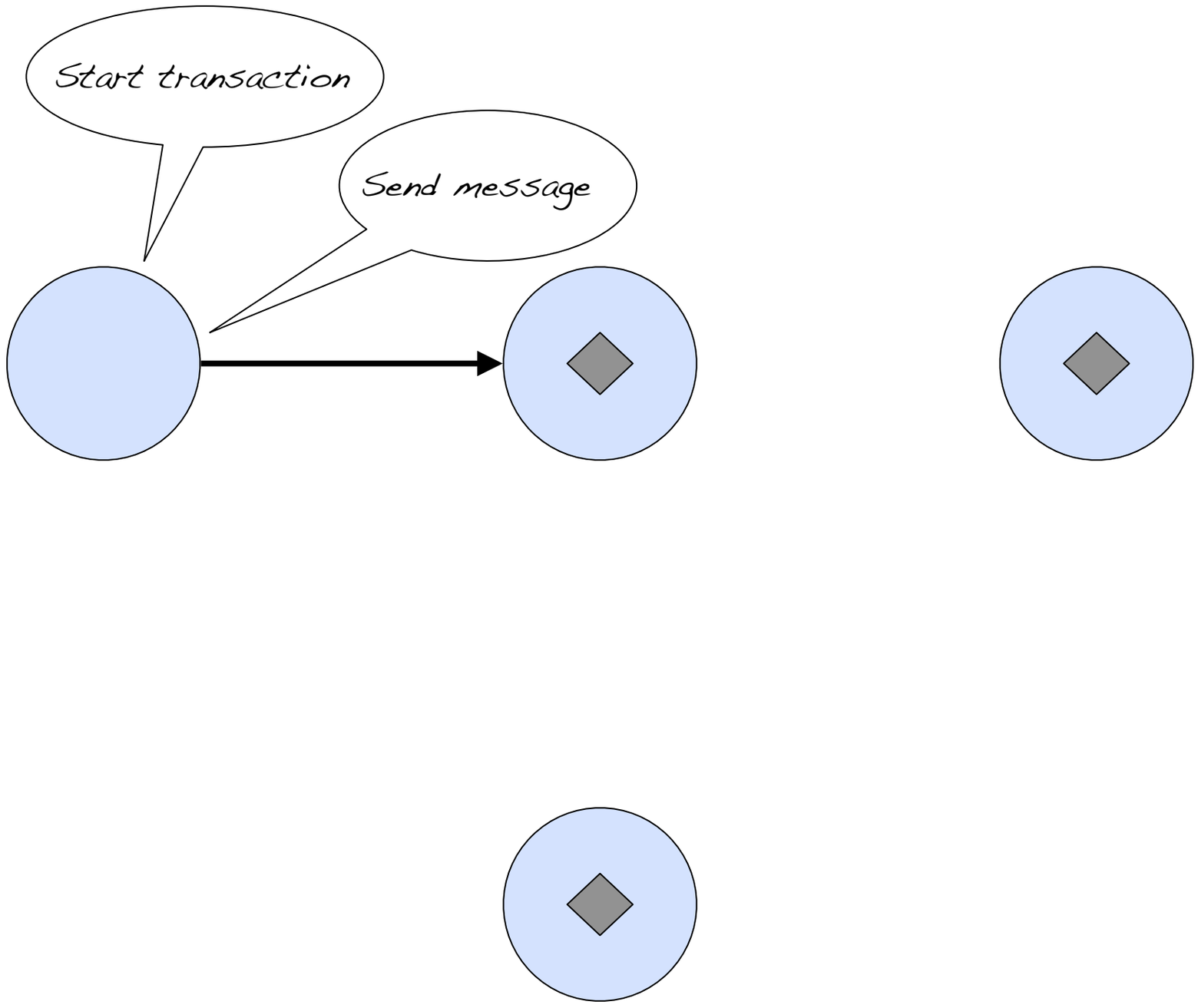

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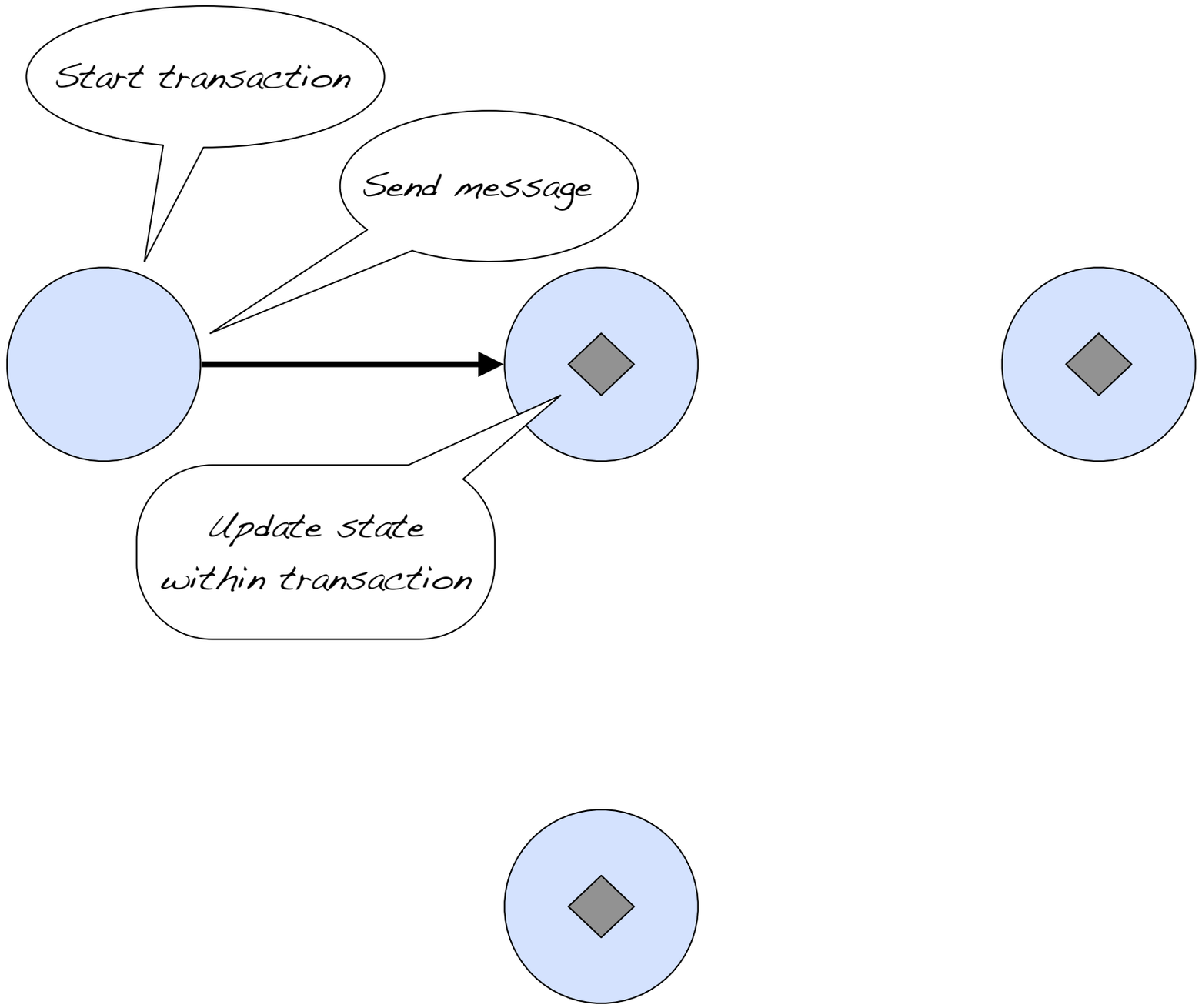

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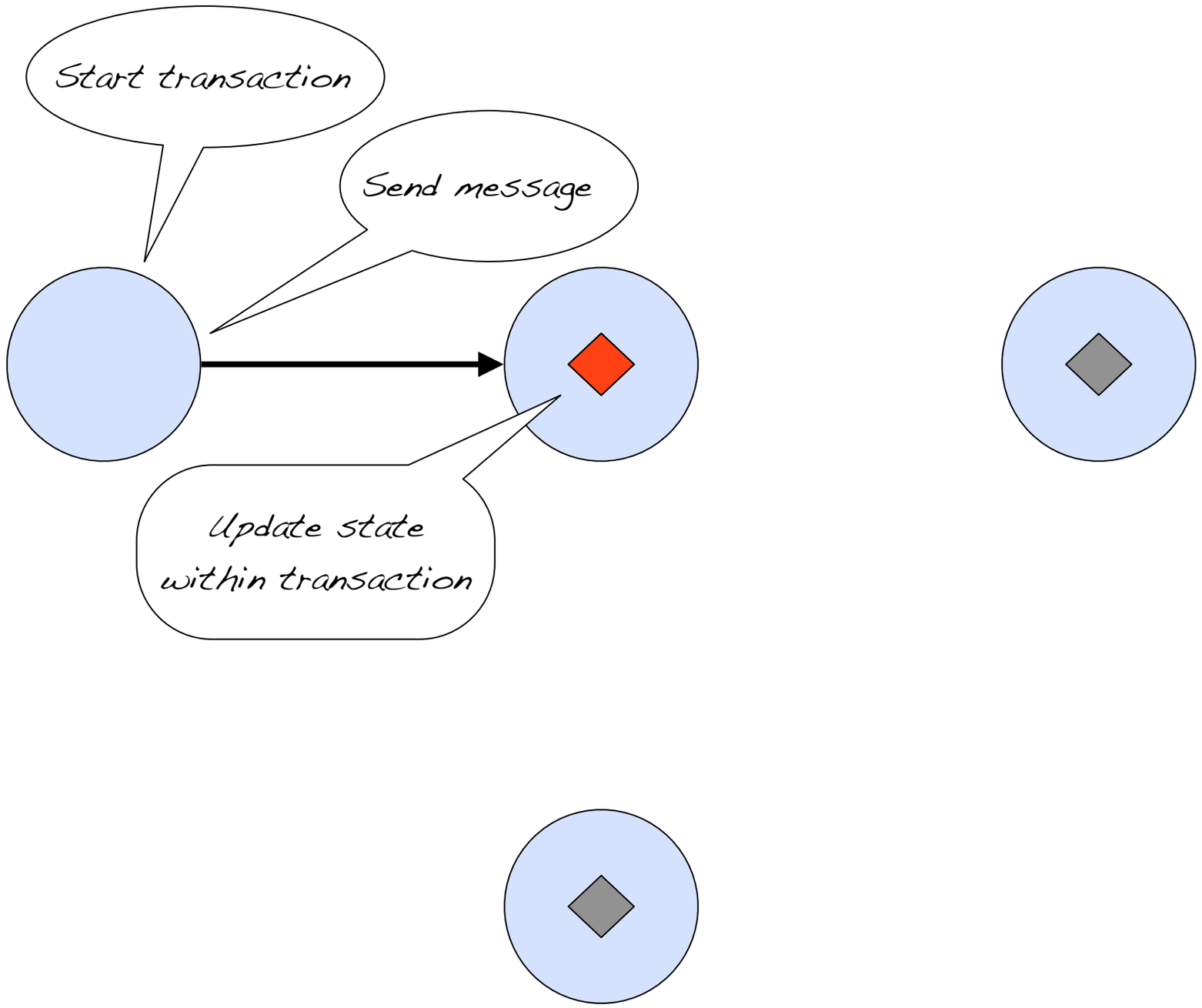

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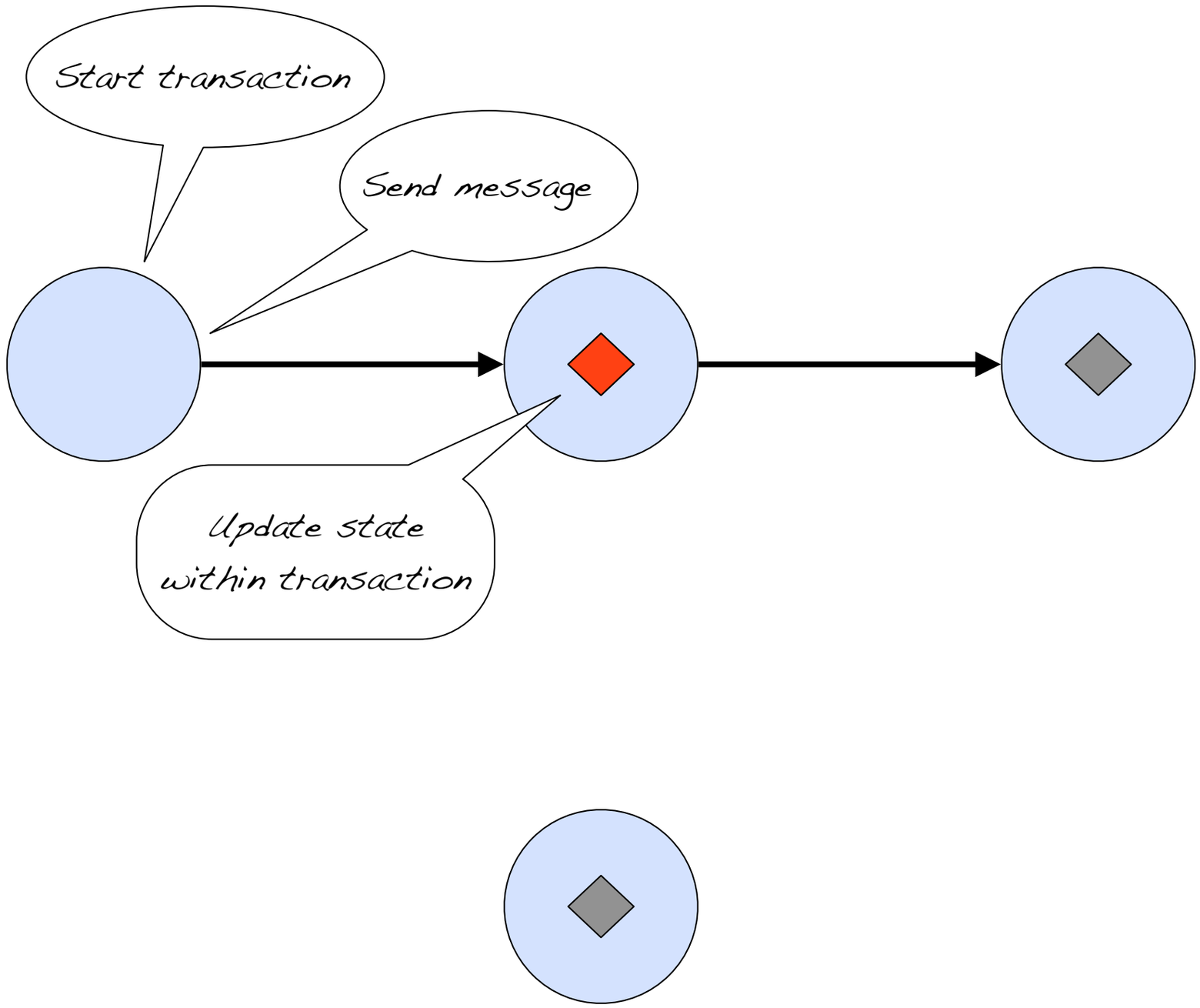

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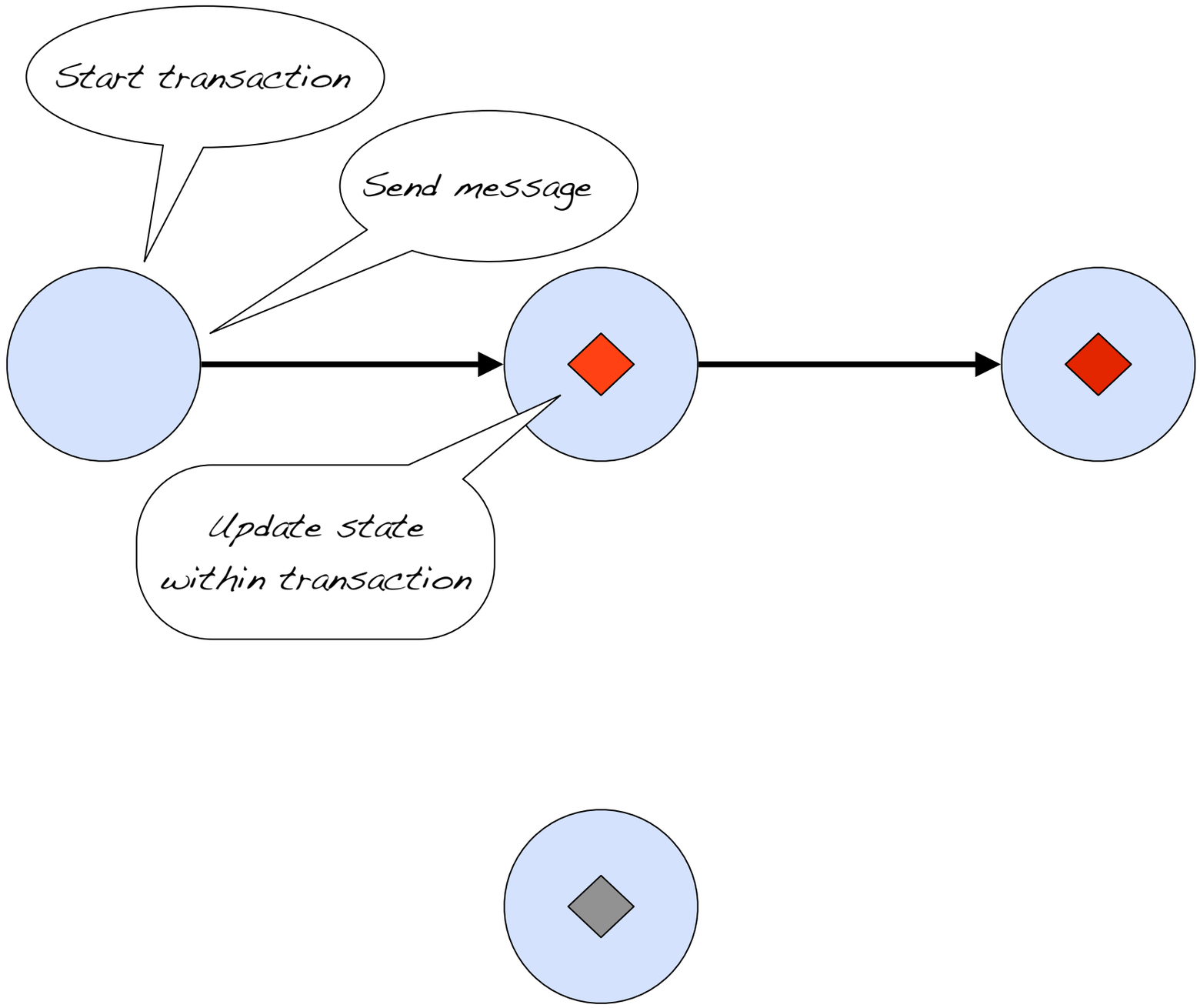

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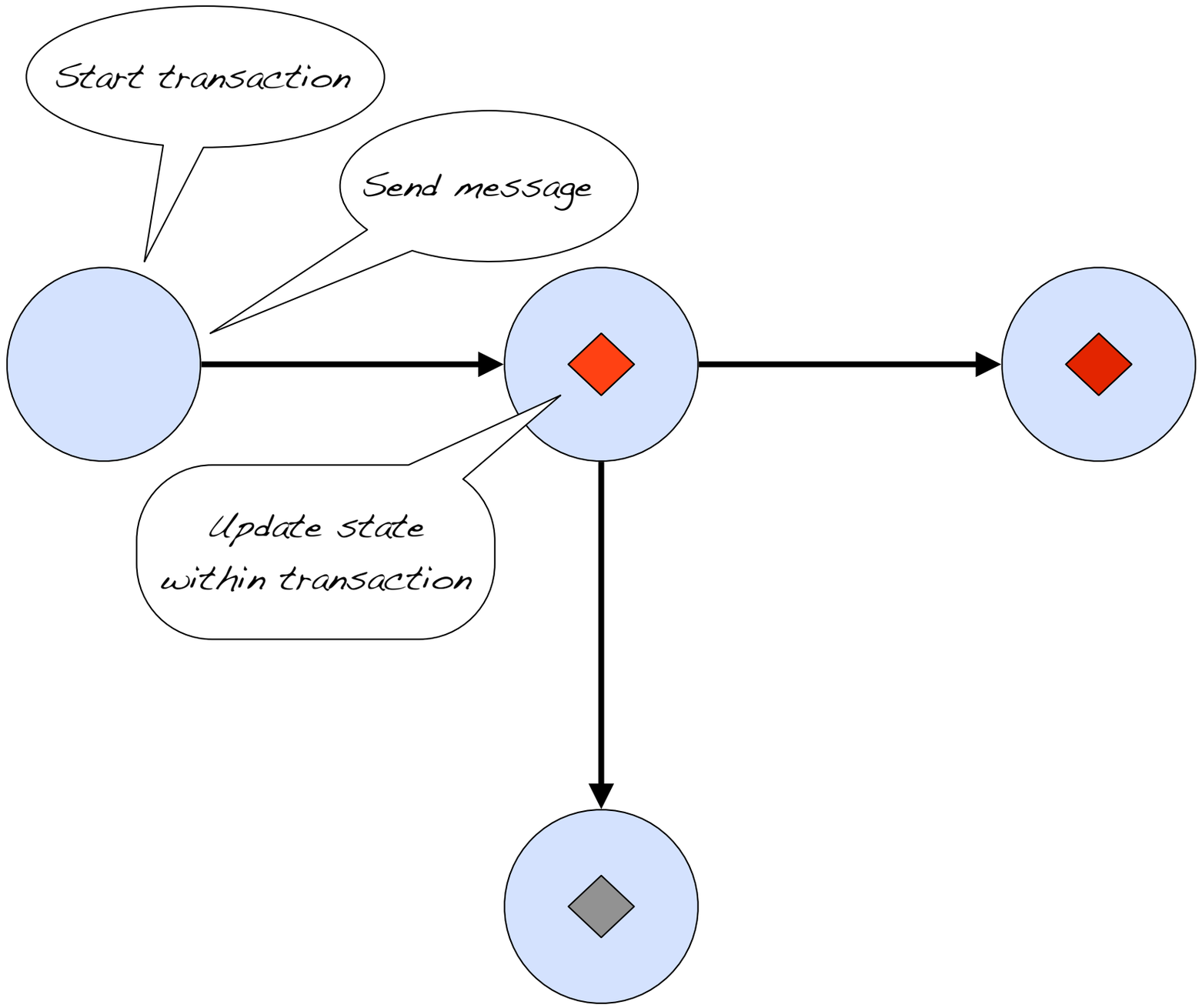

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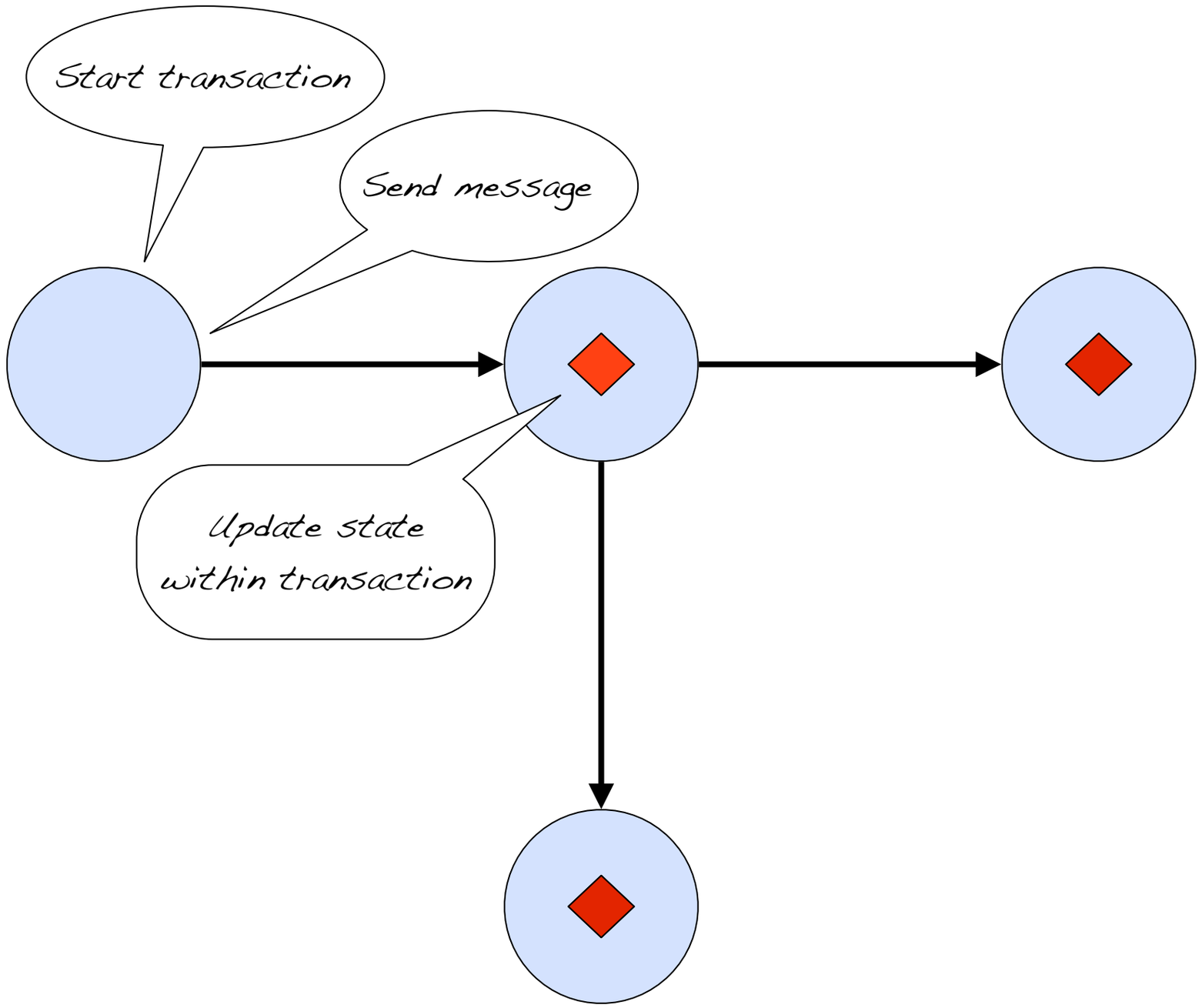

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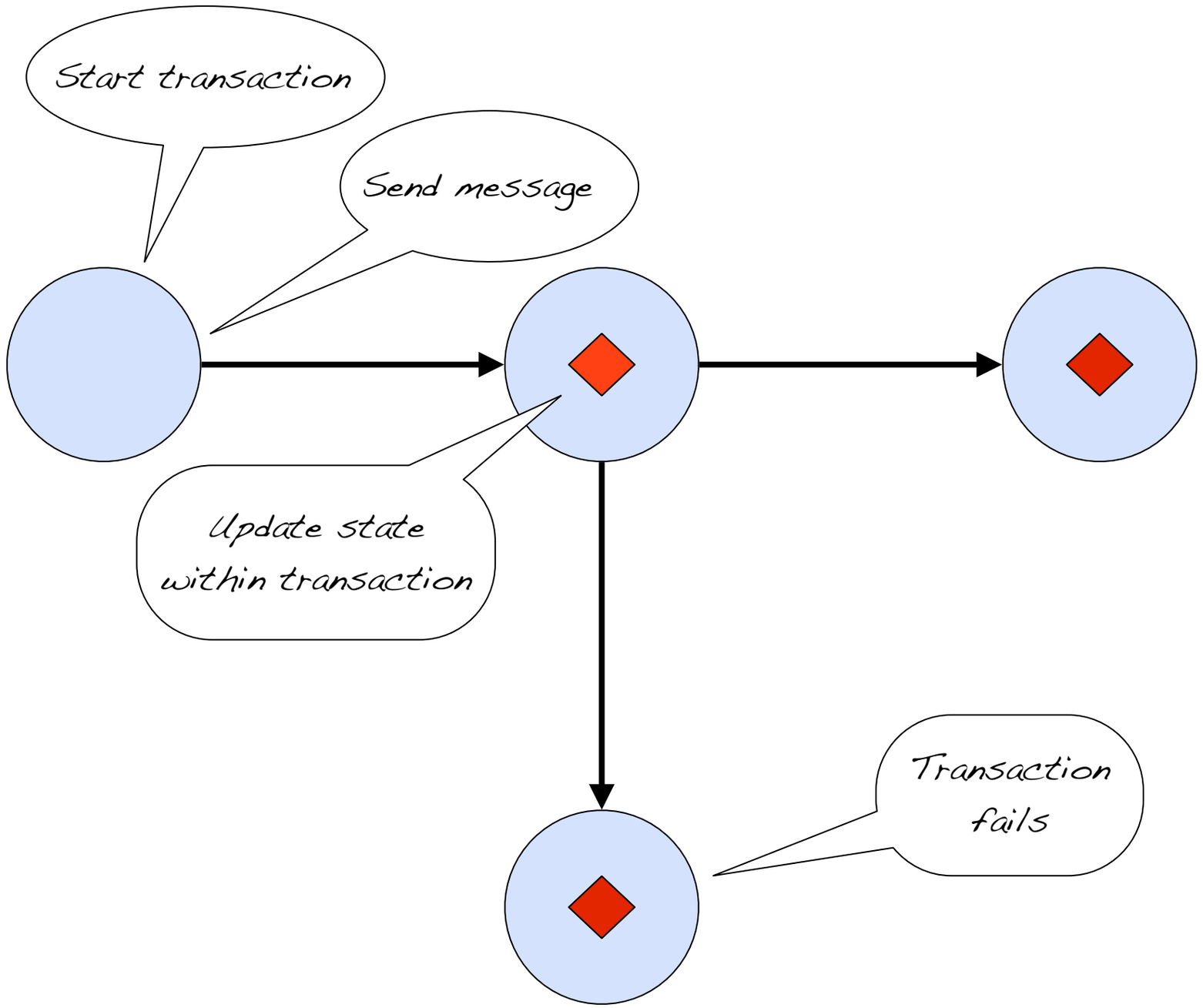

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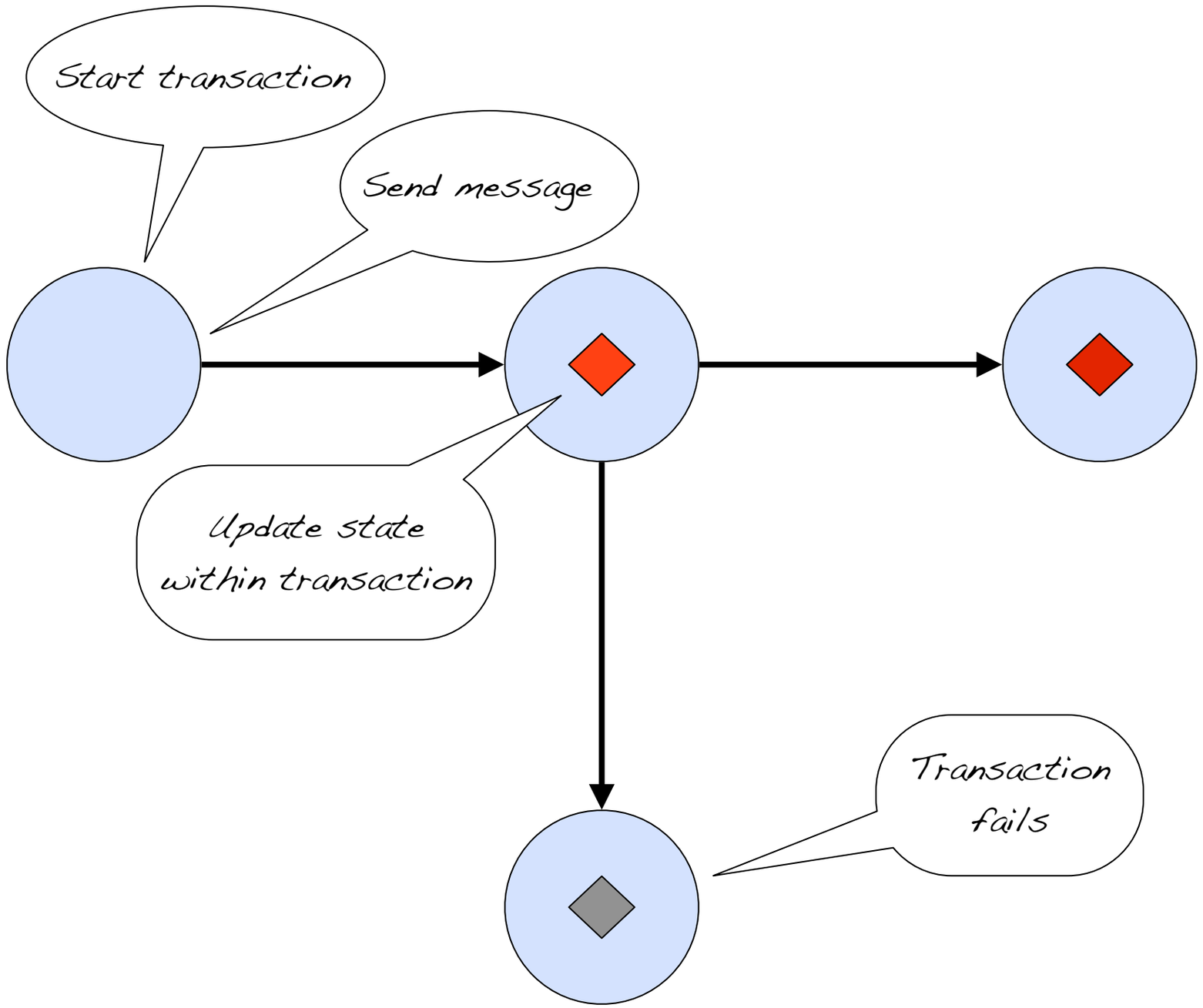

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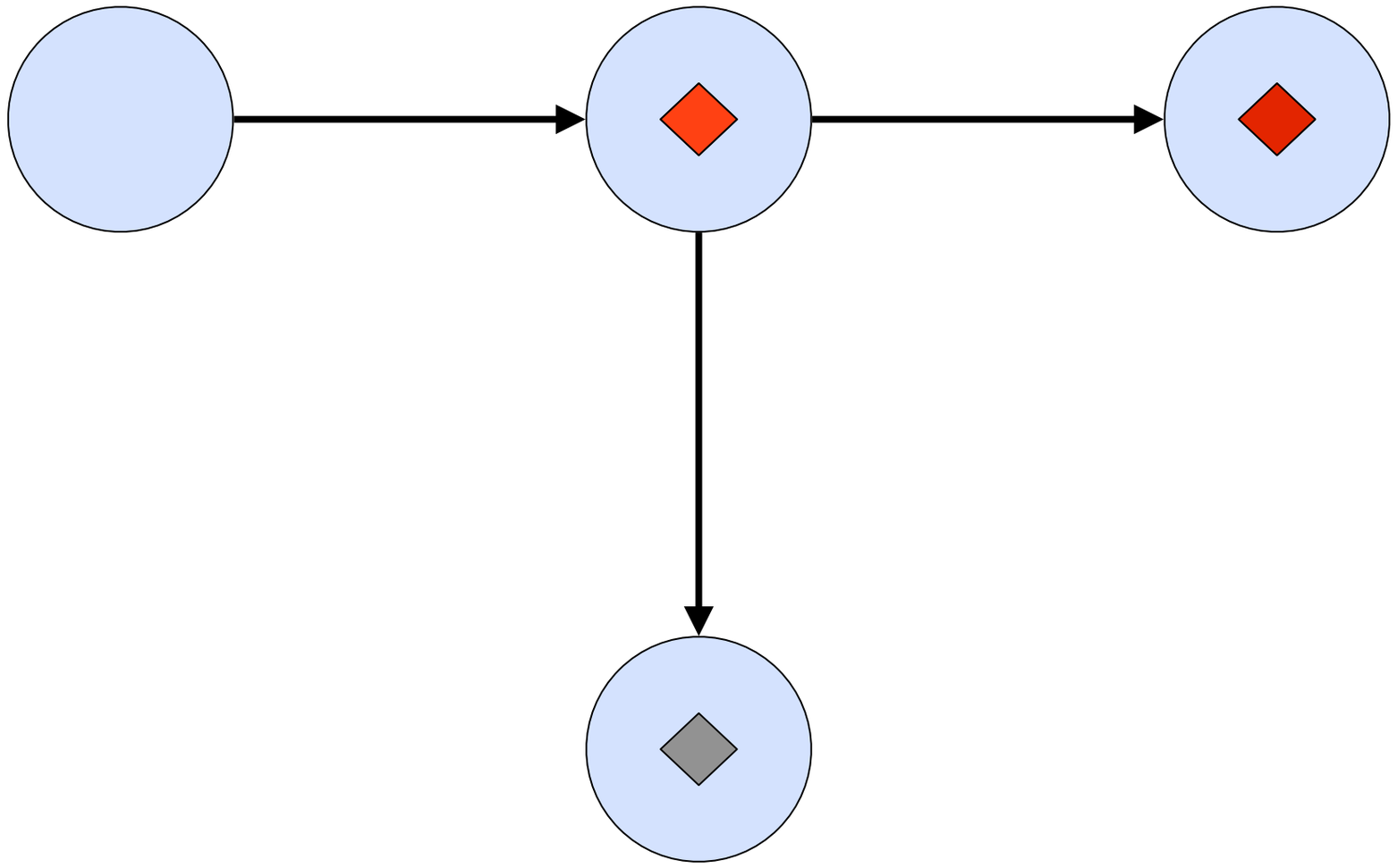

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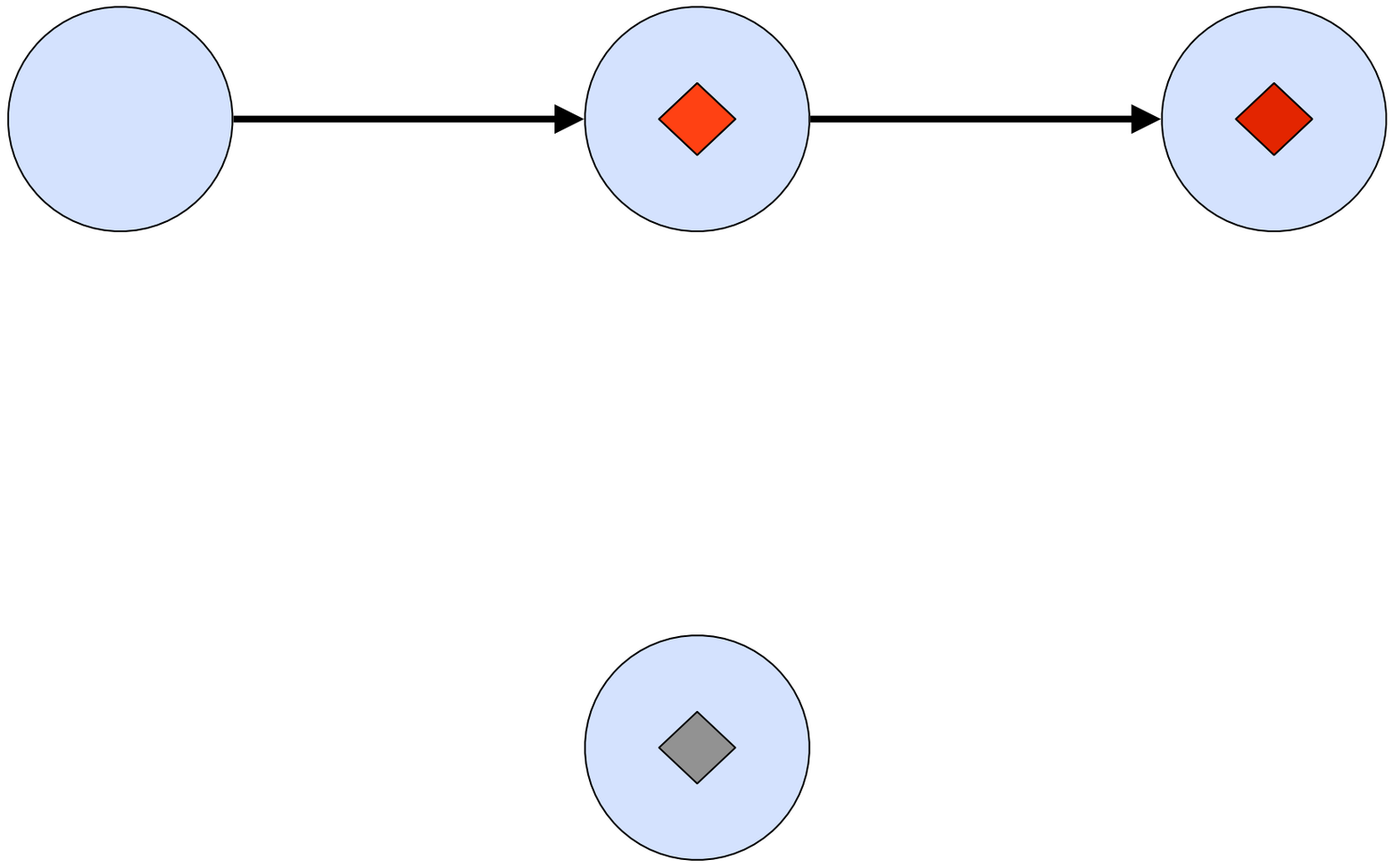

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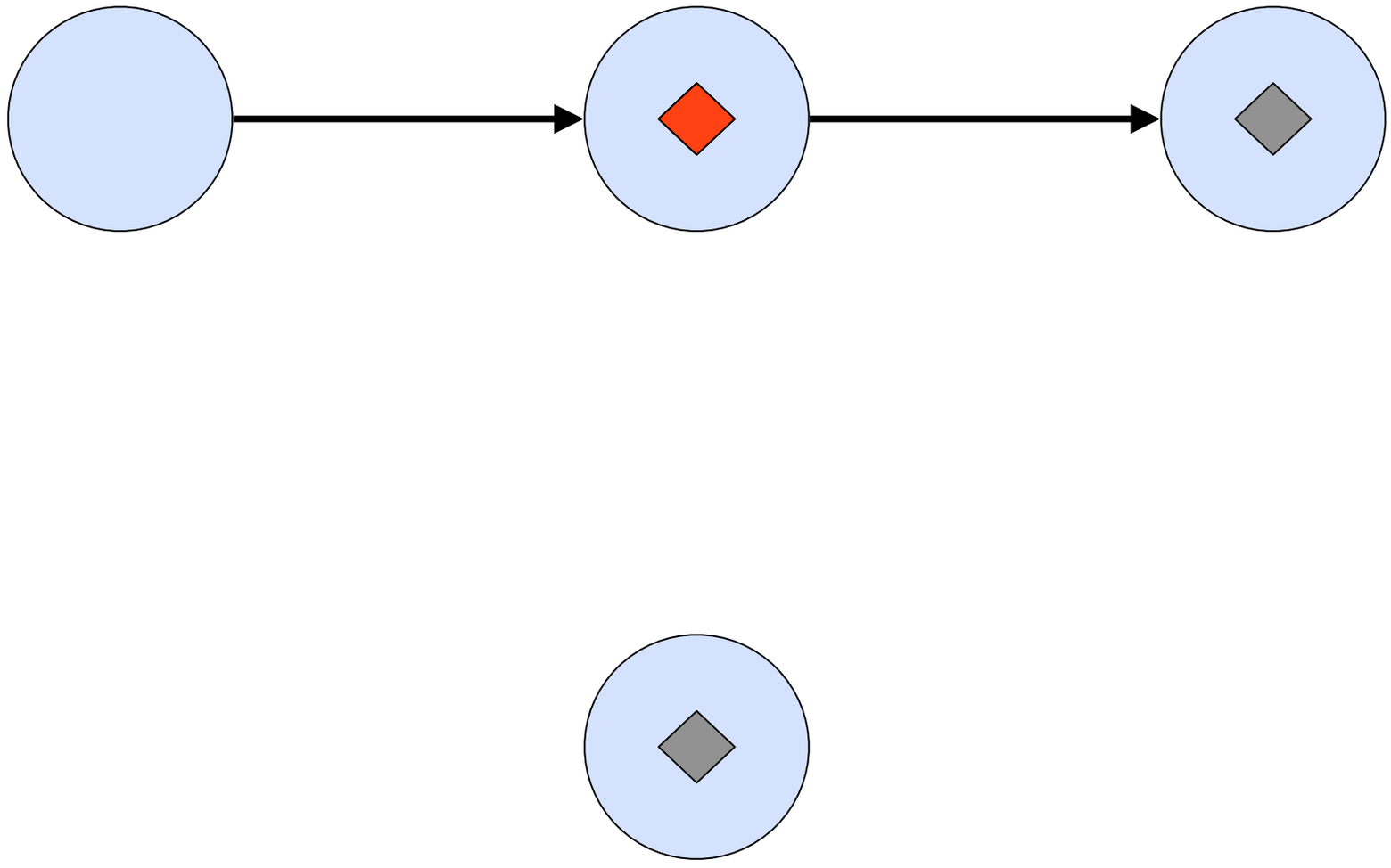

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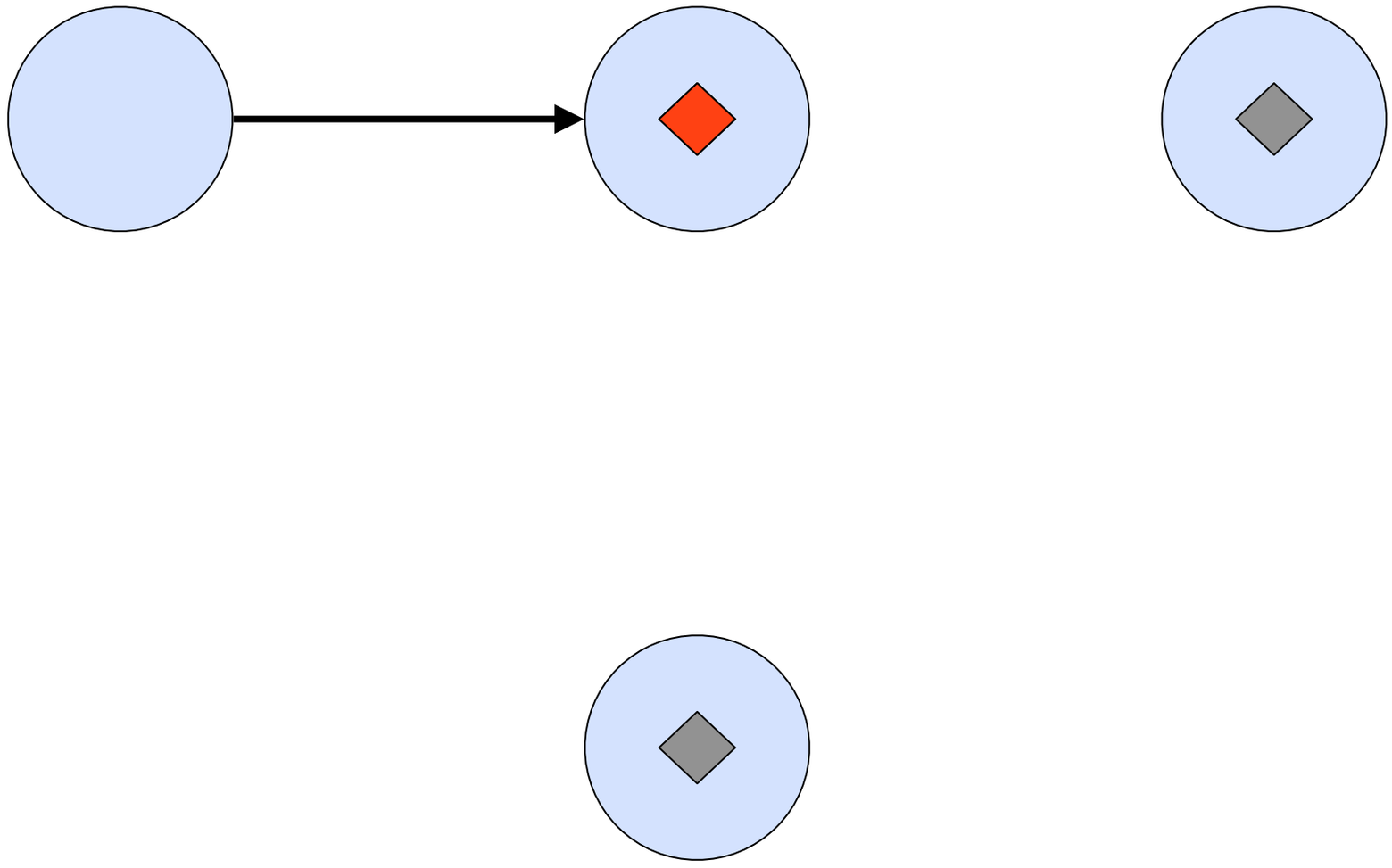

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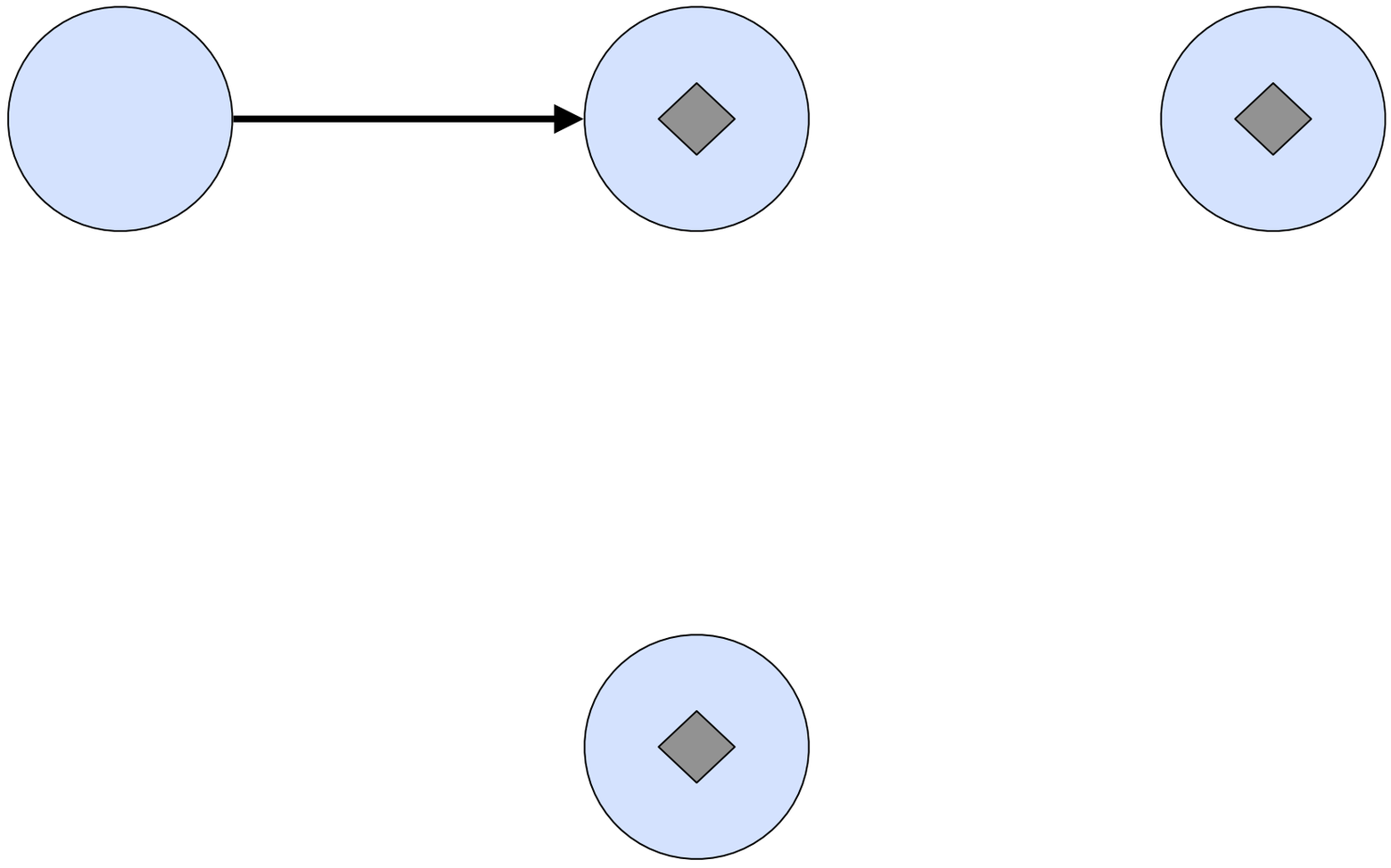

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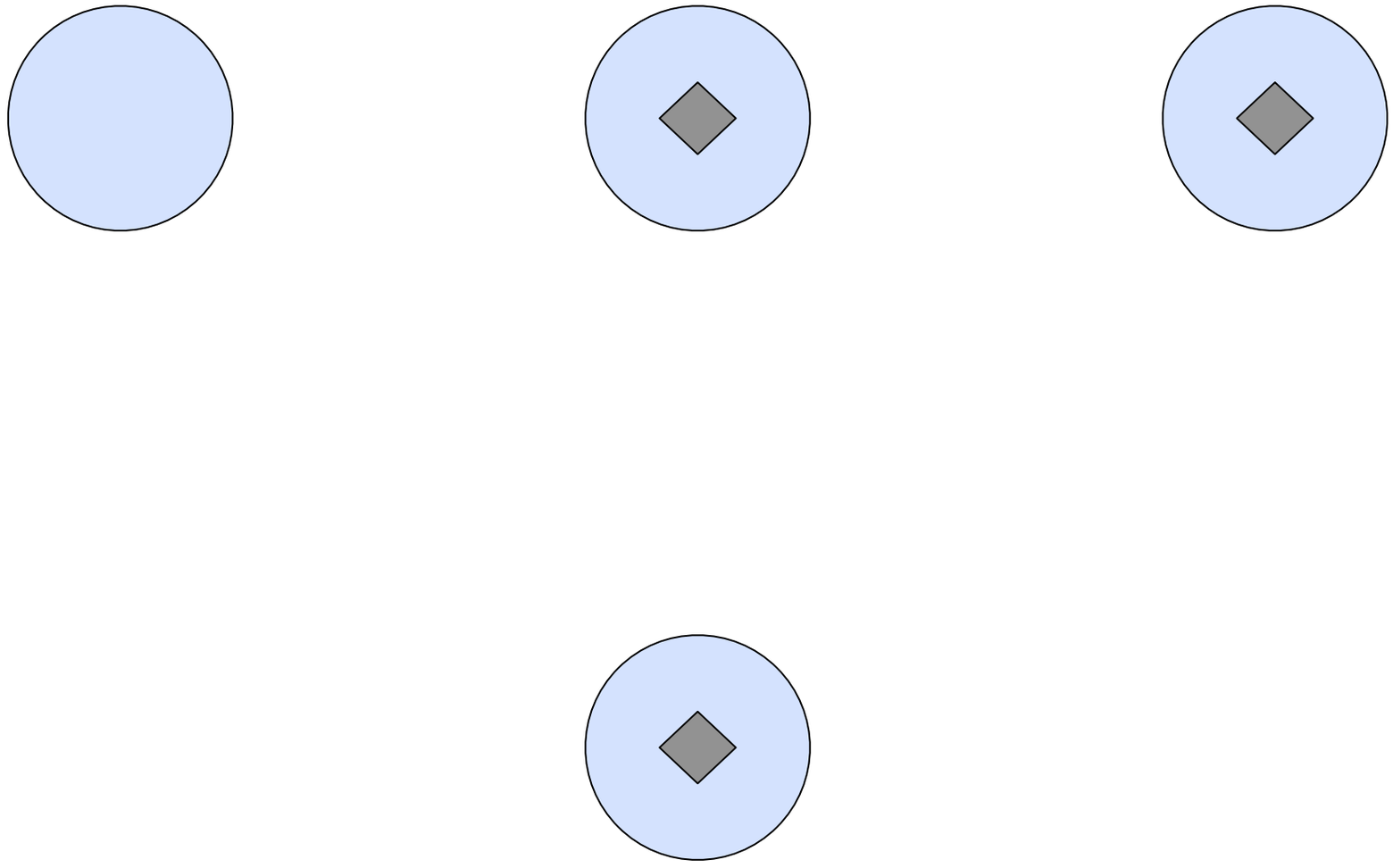

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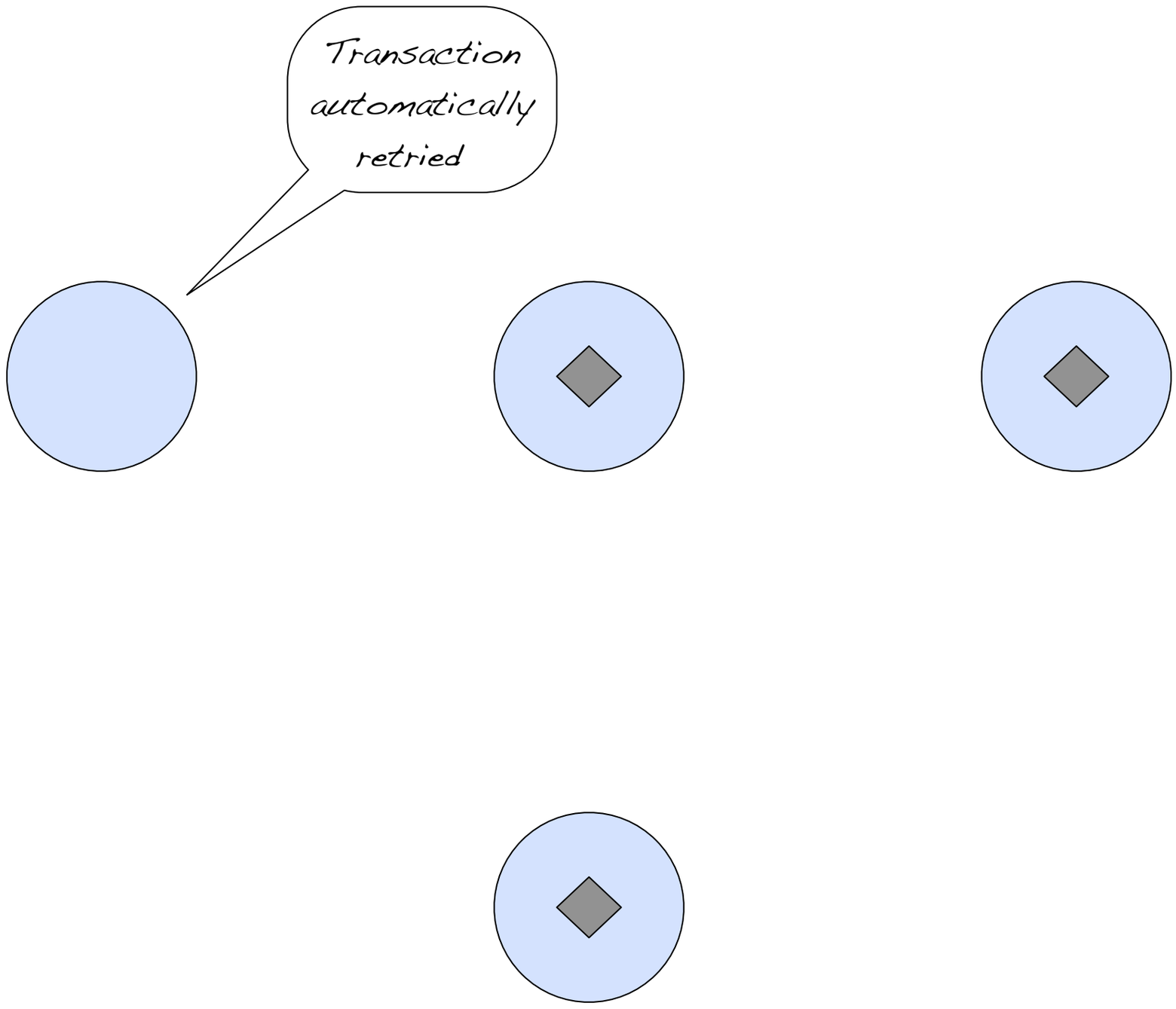

Agents

yet another tool in the toolbox

Agents

```
val agent = Agent(5)

// send function asynchronously
agent send (_ + 1)

val result = agent() // deref
... // use result

agent.close
```

Cooperates with STM

(some of the)

Modules

Akka Spring

Spring integration

```
<beans>
  <akka:active-object id="myActiveObject"
                      target="com.biz.MyPOJO"
                      transactional="true"
                      timeout="1000" />

  ...
</beans>
```

Spring integration

```
<akka:supervision id="my-supervisor">

  <akka:restart-strategy failover="AllForOne"
                         retries="3"
                         timerange="1000">
    <akka:trap-exits>
      <akka:trap-exit>java.io.IOException</akka:trap-exit>
    </akka:trap-exits>
  </akka:restart-strategy>

  <akka:active-objects>
    <akka:active-object target="com.biz.MyPOJO"
                        lifecycle="permanent"
                        timeout="1000">
      <akka:restart-callbacks pre="preRestart"
                              post="postRestart"/>
    </akka:active-object>
  </akka:active-objects>
</akka:supervision>
```

Akka Camel

Camel: consumer

```
class MyConsumer extends Actor with Consumer {
  def endpointUri = "file:data/input"

  def receive = {
    case msg: Message =>
      log.info("received %s" format
      msg.bodyAs(classOf[String]))
  }
}
```

Camel: consumer

```
class MyConsumer extends Actor with Consumer {
  def endpointUri =
    "jetty:http://0.0.0.0:8877/camel/test"

  def receive = {
    case msg: Message =>
      reply("Hello %s" format
            msg.bodyAs(classOf[String]))
  }
}
```

Camel: producer

```
class CometProducer
  extends Actor with Producer {

  def endpointUri =
    "cometd://localhost:8111/test"
}
```

Camel: producer

```
val producer = actorOf[CometProducer].start

val time = "Current time: " + new Date
producer ! time
```

Akka Persistence

Akka Persistence API

```
// transactional Cassandra-backed Map
val map = CassandraStorage.newMap

// transactional Redis-backed Vector
val vector = RedisStorage.newVector

// transactional Mongo-backed Ref
val ref = MongoStorage.newRef
```

Turns the STM into ACID

Get data by id

```
// transactional Cassandra-backed Map
val map = CassandraStorage.getMap(uuid)

// transactional Redis-backed Vector
val vector = RedisStorage.getVector(uuid)

// transactional Mongo-backed Ref
val ref = MongoStorage.getRef(uuid)
```

For Redis only (so far)

```
val queue: PersistentQueue[ElementType] =
  RedisStorage.newQueue

val set: PersistentSortedSet[ElementType] =
  RedisStorage.newSortedSet
```

Akka Deployment

Deployment

- ☑ Deploy as dependency JAR in WEB-INF/lib etc.
- ☑ Run as microkernel
- ☑ Soon OSGi-enabled, then drop in any OSGi container (Spring DM server, Karaf etc.)

...and much more

REST

Security

Web

Comet

AMQP

JTA

Guice

Learn more

http://akkasource.org

EOF

?