Actors are Distributed

Principles of Functional Programming

Roland Kuhn

The Impact of Network Communication

Compared to in-process communication:

- data sharing only by value
- lower bandwidth
- higher latency
- partial failure
- data corruption

Multiple processes on the same machine are quantitatively less impacted, but qualitatively the issues are the same.

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Distributed computing breaks assumptions made by the synchronous programming model.

Actors are Distributed

Actor communication is asynchronous, one-way and not guaranteed.

Actor encapsulation makes them look the same, regardless where they live.

Actors are “Location Transparent”, hidden behind `ActorRef`.

Actor Paths

Every actor system has an Address, forming scheme and authority of a hierarchical URI.

Actor names form the URI's path elements:

```
val system = ActorSystem(”HelloWorld”)
val ref = system.actorOf(Props[Greeter], ”greeter”)
println(ref.path)
// prints: akka://HelloWorld/user/greeter
```

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Remote address example: `akka.tcp://HelloWorld@10.2.4.6:6565`

Every actor is identified by at least one URI.

The Difference between ActorRef and ActorPath

Actor names are unique within a parent, but can be reused.

- ActorPath is the full name, whether the actor exists or not.
- ActorRef points to an actor which was started; an *incarnation*.

ActorPath can only optimistically send a message.

ActorRef can be watched.

ActorRef example: `akka://HelloWorld/user/greeter#43428347`

Resolving an ActorPath

```scala
import akka.actor.{ Identify, ActorIdentity }
case class Resolve(path: ActorPath)
case class Resolved(path: ActorPath, ref: ActorRef)
case class NotResolved(path: ActorPath)

class Resolver extends Actor {
  def receive = {
    case Resolve(path) =>
      context.actorSelection(path) ! Identify((path, sender()))
    case ActorIdentity((path, client), Some(ref)) =>
      client ! Resolved(path, ref)
    case ActorIdentity((path, client), None) =>
      client ! NotResolved(path)
  }
}
```

Relative Actor Paths

Looking up a grand-child:

- `context.actorSelection(”child/grandchild”)`

Looking up a sibling:

- `context.actorSelection(”../sibling”)`

Looking up from the local root:

- `context.actorSelection(”/user/app”)`

Broadcasting using wildcards:

- `context.actorSelection(”/user/controllers/*”)`

What is a Cluster?

A set of nodes (actor systems) about which all members are in agreement.

These nodes can then collaborate on a common task.

The Formation of a Cluster

A single node can declare itself a cluster ("join itself").

A single node can join a cluster:

- a request is sent to any member
- once all current members know about the new node it is declared part of the cluster

Information is spread using a gossip protocol.

Starting Up a Cluster (1)

Prerequisites:

- `"com.typesafe.akka" %% "akka-cluster" % "2.2.1"`
- configuration enabling cluster module:

```
akka {
  actor {
    provider = akka.cluster.ClusterActorRefProvider
  }
}
```

  in `application.conf` or as `-Dakka.actor.provider=...`

Starting Up a Cluster (2)

```
class ClusterMain extends Actor {
  val cluster = Cluster(context.system)
  cluster.subscribe(self, classOf[ClusterEvent.MemberUp])
  cluster.join(cluster.selfAddress)

  def receive = {
    case ClusterEvent.MemberUp(member) =>
      if (member.address != cluster.selfAddress) {
        // someone joined
      }
  }
}
```

This will start a single-node cluster on port 2552.

Starting Up a Cluster (3)

This needs configuration `akka.remote.netty.tcp.port = 0`.

```
class ClusterWorker extends Actor {
  val cluster = Cluster(context.system)
  cluster.subscribe(self, classOf[ClusterEvent.MemberRemoved])
  val main = cluster.selfAddress.copy(port = Some(2552))
  cluster.join(main)

  def receive = {
    case ClusterEvent.MemberRemoved(m, _) =>
      if (m.address == main) context.stop(self)
  }
}
```

Cluster-Aware Routing (1)

```scala
class ClusterReceptionist extends Actor {
  val cluster = Cluster(context.system)
  cluster.subscribe(self, classOf[MemberUp])
  cluster.subscribe(self, classOf[MemberRemoved])

  override def postStop(): Unit = {
    cluster.unsubscribe(self)
  }

  def receive = ...
}
```

Cluster-Aware Routing (2)

```scala
def receive = awaitingMembers

val awaitingMembers: Receive = {
  case current: ClusterEvent.CurrentClusterState =>
    val addresses = current.members.toVector map (_.address)
    val notMe = addresses filter (_ != cluster.selfAddress)
    if (notMe.nonEmpty) context.become(active(notMe))
  case MemberUp(member) if member.address != cluster.selfAddress =>
    context.become(active(Vector(member.address)))
  case Get(url) => sender() ! Failed(url, ”no nodes available”)
}

def active(addresses: Vector[Address]): Receive = ...
```

Cluster-Aware Routing (3)

```
def active(addresses: Vector[Address]): Receive = {
  case MemberUp(member) if member.address != cluster.selfAddress =>
    context.become(active(addresses :+ member.address))
  case MemberRemoved(member, _) =>
    val next = addresses filterNot (_ == member.address)
    if (next.isEmpty) context.become(awaitingMembers)
    else context.become(active(next))
  ...
}
```

Cluster-Aware Routing (4)

```
def active(addresses: Vector[Address]): Receive = {
  ...
  case Get(url) if context.children.size < addresses.size =>
    val client = sender()
    val address = pick(addresses)
    context.actorOf(Props(new Customer(client, url, address)))
  case Get(url) =>
    sender() ! Failed(url, ”too many parallel queries”)
}
```

Remote Deployment (1)

```scala
class Customer(client: ActorRef, url: String, node: Address) extends Actor {
  implicit val s = context.parent

  override val supervisorStrategy = SupervisorStrategy.stoppingStrategy
  val props = Props[Controller].withDeploy(Deploy(scope = RemoteScope(node)))
  val controller = context.actorOf(props, ”controller”)
  context.watch(controller)

  context.setReceiveTimeout(5.seconds)
  controller ! Controller.Check(url, 2)

  def receive = ...
}
```

Remote Deployment (2)

```
implicit val s = context.parent

def receive = ({
  case ReceiveTimeout =>
    context.unwatch(controller)
    client ! Receptionist.Failed(url, ”controller timed out”)
  case Terminated(_) =>
    client ! Receptionist.Failed(url, ”controller died”)
  case Controller.Result(links) =>
    context.unwatch(controller)
    client ! Receptionist.Result(url, links)
}: Receive) andThen (_ => context.stop(self))
```