CS 520 Advanced Programming Languages
Fall Semester, 2009
Doc 21 Scala Actors
Dec 3, 2009

Reference

Programming in Scala, Odersky, Spoon, Venners, Artima Press, 2008

Reading

Programming in Scala, Odersky, Spoon, Venners, Artima Press, 2008
Chapters 30

First Example

```
import scala.actors.Actor

class Example(name: String) extends Actor {
	def act = {
		for (k <- 1 to 10) {
			println(name + " " + k)
		}
	}
}
```

```
val a = new Example("a")
a.start
```

Output

```
a 1
a 2
a 3
a 4
a 5
a 6
a 7
a 8
a 9
a 10
```

act is sort of like run in thread. One does not call it directly. One call start which registers the actor with the scheduler and act is called from a different thread.

Showing Concurrency

```
scala> new Example("a").start; new Example("b").start
a 1
a 2
a 3
a 4
a 5
a 6
a 7
a 8

scala> b 1
b 2
a 9
b 3
a 10
b 4
b 5
etc
```

Yes the two actors are running in different threads.

Multiple Starts allowed

```
import scala.actors.Actor

class Example extends Actor {
	def act = println("run")
}
```

```
val test = new Example
test.start
test.start
```

```
Output
run
run
```

Which is unlike the run method in a thread

Other Concurrent Examples

```
import scala.actors.Actor

class Example(name: String) extends Actor {
	def act = {
		for (k <- 1 to 10) {
			println(name + " " + k)
		}
	}
}

object Main extends Application {
	val a = new Example("a")
	val b = new Example("b")
	a.start
	b.start
}
```

Run as Application

```
scalac example.scala
scala Main
```

Output is interleaved

```
a 1
b 1
a 2
b 2
b 3
a 3
b 4
b 5
a 4
```

Run in interpreter

```
scala
scala>:load example.scala
scala> Main
```

Output is interleaved first time

Output is not interleave on
  second load & run

Singleton Object Actor

```
import scala.actors.Actor

object SampleActor extends Actor {
    def act = {
        for (k <- 1 to 10) {
            println("A " + k)
        }
    }
}
```

```
SampleActor.start
```

Utility actor Method

```
import scala.actors.Actor

val x =  Actor.actor {
           for (k <- 1 to 10) {
                println("Hello " + k)
           }
      }
```

```
Output
Hello 1
Hello 2
Hello 3
Hello 4
Hello 5
Hello 6
Hello 7
Hello 8
Hello 9
Hello 10
```

The contents of the actor method are the act method of the new actor. The new actor is automatically started

Utility actor Method

```
import scala.actors.Actor._

val x =  actor {
          for (k <- 1 to 10) {
               println("Hello " + k)
          }
     }
```

Shorter version

Commonly used

Messages

Asynchronous

- One-way

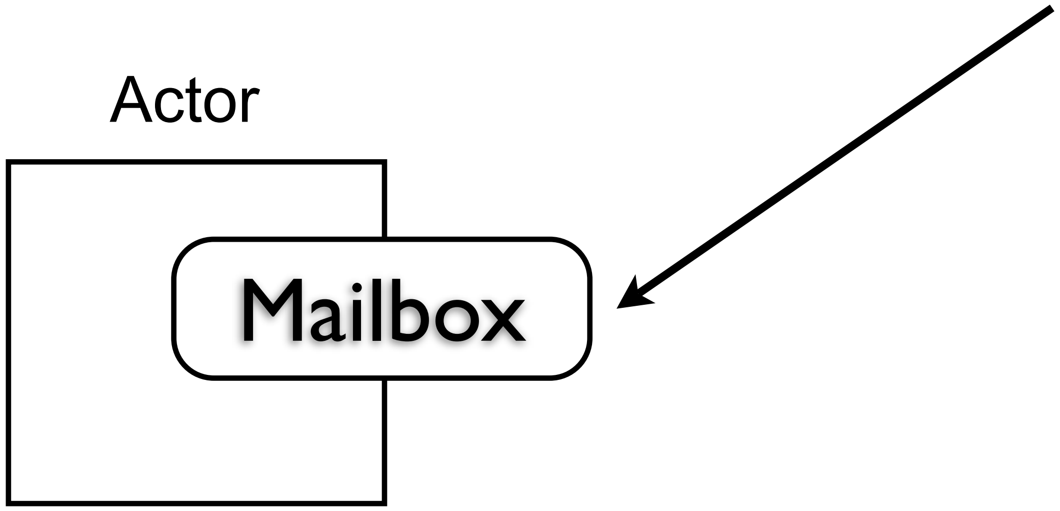
Synchronous

- Futures

Filtering

Mailbox

Message Basics



Each actor has a mailbox. The outside world can send the actor messages, which are placed in the mailbox. The actor then can remove and read messages in the mailbox.

Message Example

```
import scala.actors.Actor

class Basic extends Actor {
    def act = {
        receive {
            case mail =>
                println("I got mail " + mail)
        }
    }
}
```

```
val a = new Basic
a.start
a ! "hi"          //send a message
a ! 12                  //another
message
```

```
 Output
 I got mail hi
```

receive reads one message from the actors mailbox. act only runs once so we only read one message from the mailbox. The second message remains in the mailbox.

Reading Repeatedly

```
import scala.actors.Actor

class Basic extends Actor {
    def act = {
        while (true) {
            receive {
                case mail =>
             println("I got mail " + mail)
            }
        }
    }
}
```

```
val a = new Basic
a.start
a ! "hi"
a ! 12
a ! List(1,2,3)
```

Output

```
I got mail hi
I got mail 12
I got mail List(1, 2, 3)
```

We can send anything in the message.

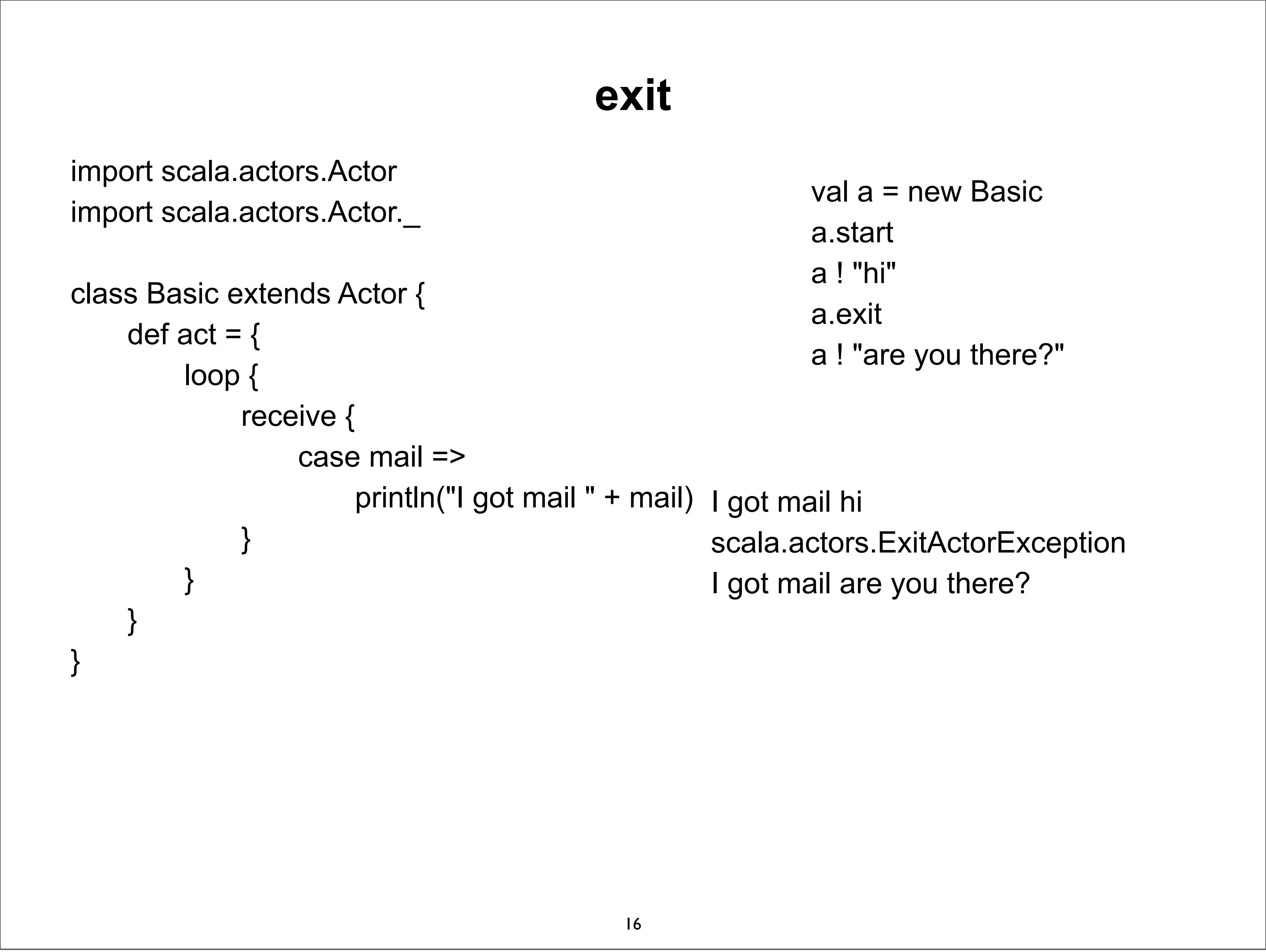
Infinite Loop Shortcut

```
import scala.actors.Actor

class Basic extends Actor {
	def act = {
		Actor.loop {
			receive {
				case mail =>
					println("I got mail " + mail)
			}
		}
	}
}
```

```
import scala.actors.Actor
import scala.actors.Actor._
class Basic extends Actor {
	def act = {
		loop {
			receive {
				case mail =>
					println("I got mail " +
mail)
			}
		}
	}
}
```

Or if you prefer Recursion

```
import scala.actors.Actor

class Basic extends Actor {
    def act = {
        receive {
            case mail => {
                println("I got mail " + mail)
                act
            }
        }
    }
}
```



exit

```
import scala.actors.Actor
import scala.actors.Actor._

class Basic extends Actor {
	def act = {
		loop {
			receive {
				case mail =>
					println("I got mail " + mail)
			}
		}
	}
}
```

```
val a = new Basic
a.start
a ! "hi"
a.exit
a ! "are you there?"
```

```
I got mail hi
scala.actors.ExitActorException
I got mail are you there?
```

exit does "kill" the actor, but it has to be called in the thread running the actor. So the above code does not really work. The actor continues to run.

How to use exit

```
import scala.actors.Actor
import scala.actors.Actor._

class Basic extends Actor {
	def act = {
		loop {
			receive {
				case "die" => exit
				case mail =>
					println("I got mail " + mail)
			}
		}
	}
}
```

```
val a = new Basic
a.start
a ! "hi"
a ! "die"
a ! "are you there?"
```

Output

```
I got mail hi
```

The Syntax

```
receive {case mail => println("I got mail " + mail)}
```

↕

```
val partialFunction: PartialFunction[Any,Unit] =
   {case mail =>  println("I got mail " + mail)}
receive (partialFunction)
```

receive is a method. I for one am glad for the syntactic sugar of the top version

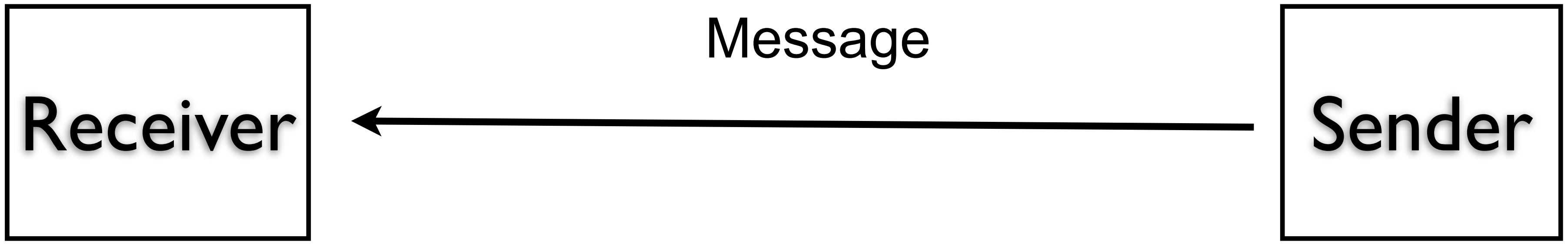
Mailbox

```
import scala.actors.Actor
import scala.actors.Actor._

class MailboxExample extends Actor {
    def act = {
        loop {
            receive {
                case "size" => println(mailboxSize)
                case "quit" => {
                    println("goodby")
                    exit
                }
            }
        }
    }
}
```

```
val test = new MailboxExample
test.start
test ! 10
test ! "cat"
test ! "size"
test ! 12
test ! "size"
test ! "quit"
```

```
2
3
goodby
```

Asynchronous - One Way



The message is sent. No reply is sent to the sender and the sender does not wait for a reply

Asynchronous - One Way - !

```
import scala.actors.Actor
import scala.actors.Actor._

class Basic extends Actor {
    def act = {
        loop {
            receive {
                case "die" => exit
                case mail =>
                    println("I got mail " + mail)
            }
        }
    }
}
```

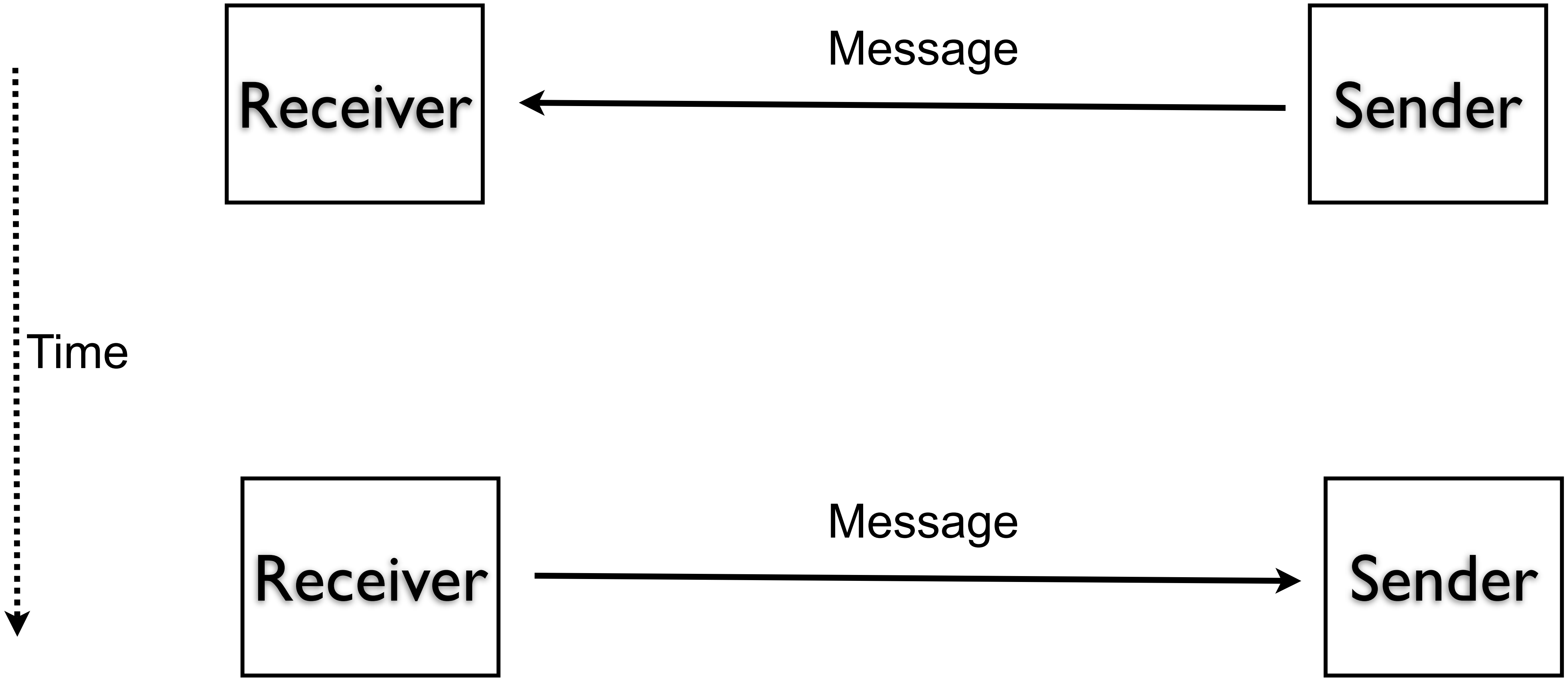
```
val a = new Basic
a.start
a ! "hi"
a ! "die"
a ! "are you there?"
```

Output

```
I got mail hi
```

! sends an asynchronous message.

Asynchronous - With Separate Return



Asynchronous - Return to sender

```
import scala.actors.Actor._

class Adder extends Actor {
    def act = {
        loop {
            receive {
                case x: Int => sender ! x + 1
            }
        }
    }
}
```

```
class Requester(adder: Actor) extends Actor {
    def act = {
        adder ! 3
        receive {
            case x: Int => println("Answer " + x)
        }
    }
}
```

```
val a = new Adder
a.start
val sender = new Requester(a)
sender.start
```

The sender method returns a reference to the acter/thread that send the current message

Asynchronous - With return address

```
import scala.actors.Actor._

class Adder extends Actor {
    def act = {
        loop {
            receive {
                case (x: Int, receiver:Actor) =>
                    receiver ! x + 1
            }
        }
    }
}
```

```
class Receiver extends Actor {
    def act = {
        loop {
            receive {
                case x: Int =>
                    println("Answer "
+ x)
            }
        }
    }
}
```

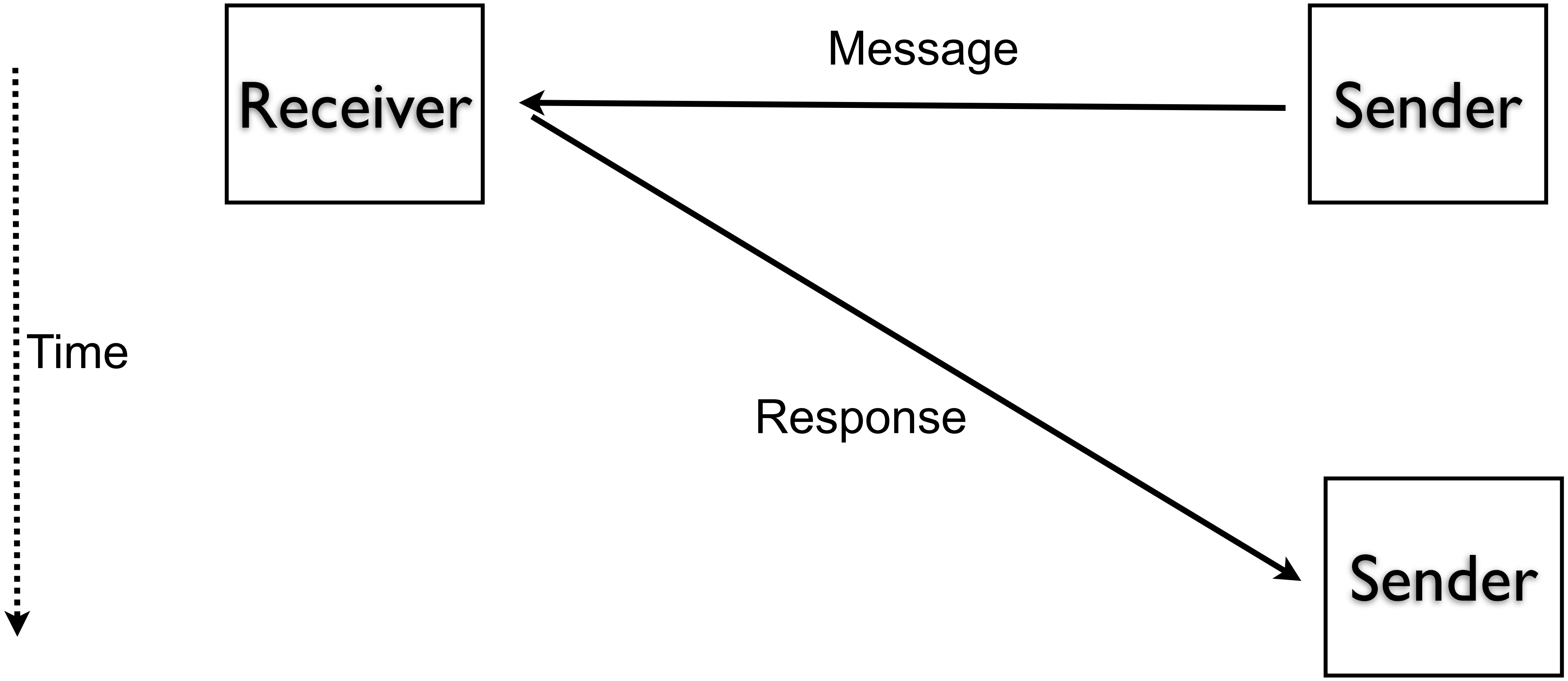
Using the Example

```
val a = new Adder
a.start
val sender = new Receiver
sender.start
a ! (12, sender)
a ! 12
a ! (3, sender)
a ! "cat"
```

Output

```
Answer 13
Answer 4
```

Synchronous



Sender blocks until receiver replies

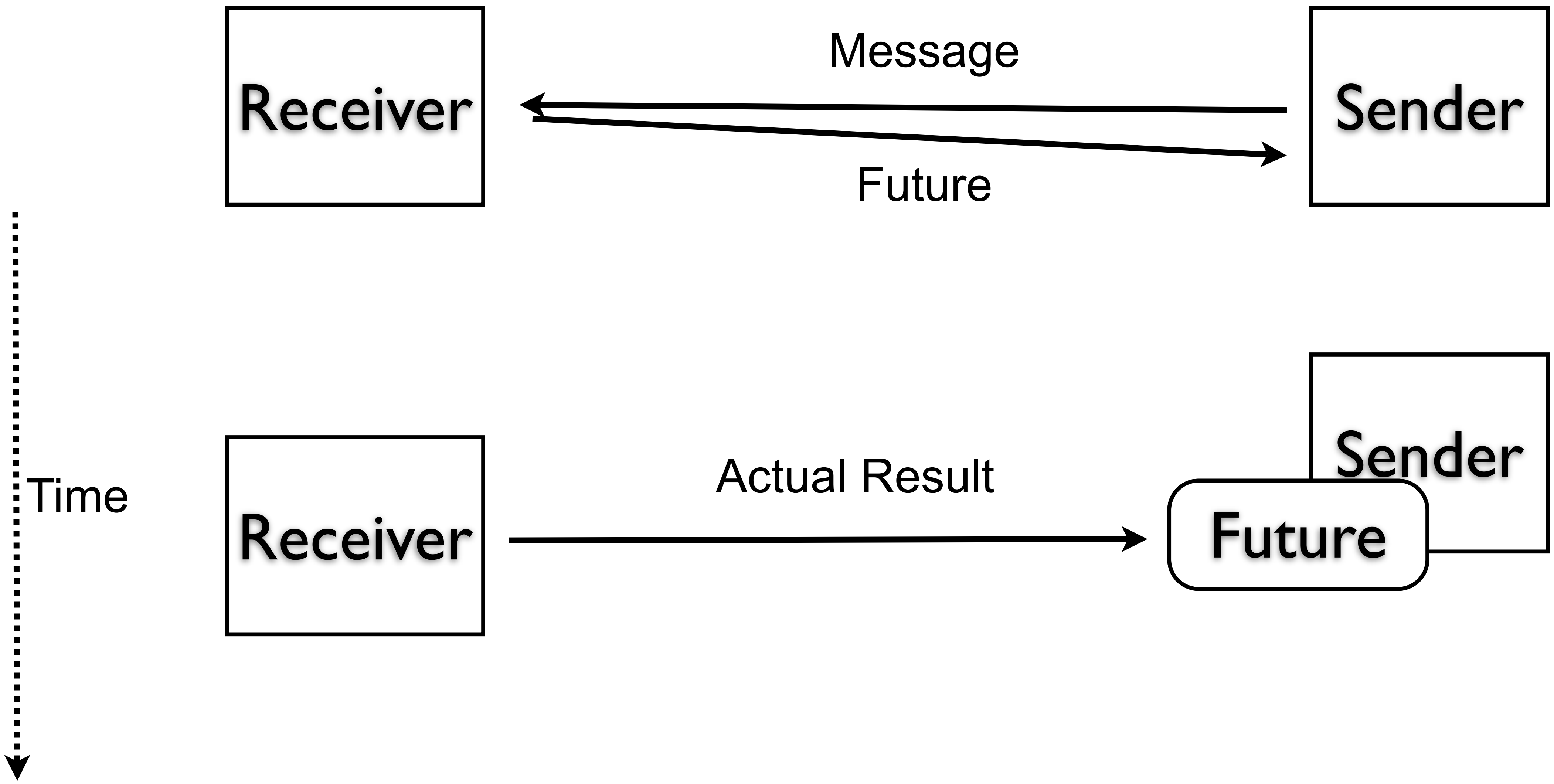
Synchronous Messages - !?

```
import scala.actors.Actor._
import scala.actors.Actor

class Adder extends Actor {
	def act = {
		var answer:Int = 0
		loop {
			receive {
				case x:Int => reply( x + 1)
			}
		}
	}
}
```

```
val a = new Adder
a.start

val answer: Any = a !? 3

a.exit
```

!? blocks until it receives an answer

Synchronous with Future



Sender block when it requests a value from the future until the value is actually available.

Synchronous - With Future

```
import scala.actors.Actor._
import scala.actors.Actor

class Adder extends Actor {
    def act = {
        var answer:Int = 0
        loop {
            receive {
                case x:Int => {
                        Thread.sleep(1000)
                        reply( x + 1)
                    }
            }
        }
    }
}
```

```
import scala.actors.Future
val a = new Adder
a.start

val answer: Future[Any] = a !! 3

val start = System.currentTimeMillis()
val value: Any = answer()
val end = System.currentTimeMillis()

a.exit
println(end - start)
```

Output

```
1005
```

!! returns immediately. However it returns a future object. When you try to access the value in the future the code blocks until the value is available

Future isSet

```
val a = new Adder
a.start

val answer: Future[Any] = a !! 3
var value: Any = 0
{if (answer.isSet)
	value = answer()
else
	println("not ready")}
```

Synchronous with timeout

```
val a = new Adder
a.start
val millisecondsToWait = 1500
val answer: Option[Any] = a !?(millisecondsToWait,3)
if (!answer.isEmpty)
      println(answer.get)
```

React & Receive

react

- Reads a message from the mail box
- Does not return
- Allows scheduler to use one thread to handle multiple actors

receive

- Reads a message from the mail box
- One thread per actor

React verses Receive

```
class Receiver extends Actor {
	def act = {
		println("Before receive")
		receive {
			case _ => println("receive test")
		}
		println("After receive")
	}
}
```

```
val a = new Receiver
a.start
a ! 1
```

Output

```
Before receive
receive test
After receive
```

React verses Receive

```
class Reactor extends Actor {
      def act = {
            println("Before react")
            react {
                  case _ => println("React test")
            }
            println("After react")
      }
}
```

```
val a = new Reactor
a.start
a ! 1
```

```
    Output
  Before react
  React test
```

Mutable Message data

```
import scala.actors.Actor

class MutableExample extends Actor {
	def act = {
		receive {
			case x:Array[Int] => x(0) = 30
			}
		}
	}
}
```

```
var data = Array(2,1)
val actor = new MutableExample
actor.start
actor ! data

println(data(0))
```

```
Output
10
```

The data in messages is shared between

Don't use mutable data in messages

Sieve Example - Collector

```
import scala.actors.Actor
import scala.actors.Actor._

class Collector extends Actor {
	def act = {
		loop {
			receive {
				case x:Int => println(x)
				case "quit" => exit
			}
		}
	}
}
```

Sieve Example - Filter

```
class Filter(primes:List[Int],endActor:Collector) extends Actor {
    val prime: Int = primes.head
    val next: Actor = if (primes.length > 1)
                            new Filter(primes.tail, endActor)
                        else endActor
    next.start
    def act = {
        loop {
            receive {
                case x:Int => if (x%prime != 0) next ! x
                case "quit" => {
                    println("goodby")
                    next ! "quit"
                    exit
                }
            }
        }
    }
}
```

Sieve Example - Using

```
val smallPrimes = List(2,3,5,7,11,13,17,23)
val seive = new Filter(smallPrimes, new Collector)
seive.start
for (x <- 2 to 100)
      seive ! x
seive ! "quit"
```

Remote Actors

Local Actors

- Run in same JVM
- May be run in separate thread

Remote Actors

- Run in different JVM
- May be run on machines

Messages sent to Remote Actors

- Must be serializable

Remote Actor Server

```
import scala.actors.Actor
import scala.actors.Actor._
import scala.actors.remote.RemoteActor

class RemoteAdder(port: Int) extends Actor {
    def act() {
        RemoteActor.alive(port)
        RemoteActor.register('Adder, self)
        println("go")
        loop {
            receive {
                case n:Int =>reply(n + 1)
            }
        }
    }
}
```

Starting the server

```
val port = 8888
val server = new RemoteAdder(port)
server.start()
```

Based on http://youshottheinvisibleswordsman.co.uk/2009/04/01/remoteactor-in-scala/

Accessing the Server

```
import scala.actors.remote.RemoteActor
import scala.actors.remote.Node

val remoteport = 8888
val peer = Node("10.0.1.192", remoteport)
val server = RemoteActor.select(peer, 'Adder)
val answer = server !? 10
println(answer)
```