Akka

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Who is this for?

- Java/Groovy/Scala/Clojure Developers interested in Akka

In One Sentence

> “To help the audience understand Actors, Supervision, Futures, Routers in both Scala and Java”

A Note About My Presentation Style

- Trying to achieve the right mix of demonstration and slides.
- Code for this presentation is available on GitHub: http://github.com/dhinojosa/akka-study.git (http://github.com/dhinojosa/akka-study.git)
- Goal is to provide you with code that you can use and reference long after the presentation.
- Presentation slides are also updated as a pdf on the repository.

About Akka

- Set of libraries used to create concurrent, fault-tolerant and scalable applications.
- It contains many API packages:
- Actors, Logging, Futures, STM, Dispatchers, Finite State Machines, and more…
- We are going to only focus on some of the core items.
- Akka’s managing processes can run on
  - in the Same VM
  - in a Remote VM
- Akka’s Actor’s will replace Scala’s Actors

Game Changer?

Making the case

- No `synchronized`, no `wait`, no `notifyAll`
- No Boilerplate
- Failure Tolerance
- Better Scaling (Up or Out)
- Divide and Conquer
- Scala Actors to be deprecated out of the language in favor of Akka

Starting with Actors

- Based on the Actor Model from Erlang.
- Encapsulates State and Behavior
- Concurrent processors that exchange messages.
- Each message is immutable (cannot be changed, this is required!)
- Each message should not be a closure
- Breath of fresh air if you have suffered concurrency

Recognizing Immutable

What does immutable look like in Java?

```
public class Person {
    private final String firstName;
    private final String lastName;

    public Person(String firstName, String lastName) {
        this.firstName = firstName;
        this.lastName = lastName;
    }

    public String getFirstName() {
        return firstName;
    }

    public String getLastName() {
        return lastName;
    }

    @Override
    public String toString() {...}

    @Override
    public boolean equals(Object o) {...}

    @Override
    public int hashCode() {...}
}
```

What does immutable look like in Scala?

```
case class Person(firstName:String, lastName:String)
```

or

```
class Person(val firstName:String, val lastName:String) {
  override def toString() = {...}
  override def equals(x:AnyRef):Boolean = {...}
  override def hashCode:Int = {...}
}
```

Recognizing closures

What is a closure in Java?

```
import java.util.function.Function;

public class Closures {

  public static Integer foo(Function<Integer, Integer> w) {
     return w.apply(5);
  }

  public static void main(String[] args) {
      Integer x = 3;
      Function<Integer, Integer> y = (Integer z) ->  x + z;
      System.out.println(foo(y)); //8
  }
}
```

What is a closure in Scala?

```
var x = 3
val y = {z:Int => x + z}
def foo(w: Int => Int) = w(5)
println(foo(y)); //8
```

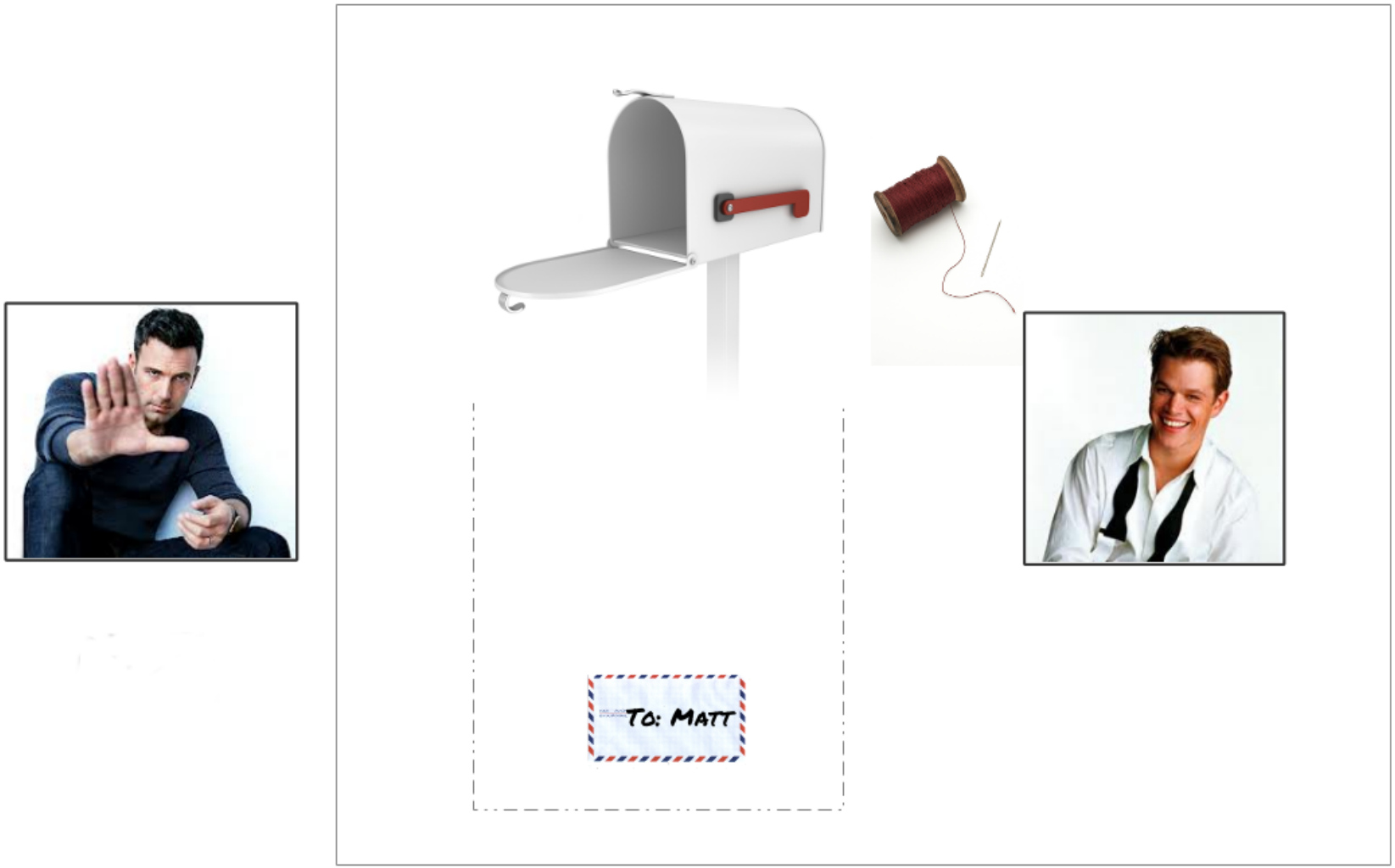
Inside the Actor’s Studio

Love Note Written

Love Note Sent

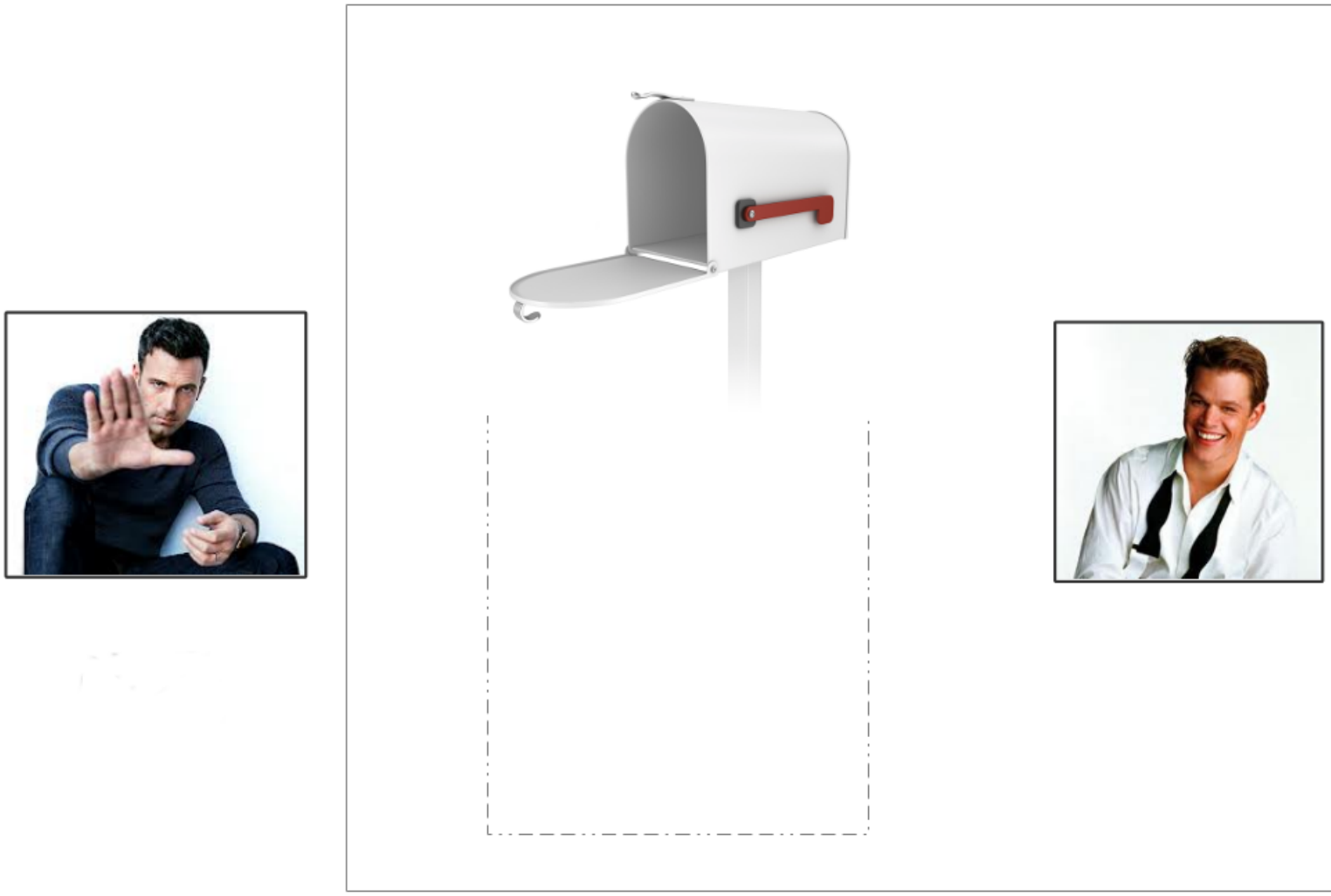
To: Matt

Love Note Processed By Thread

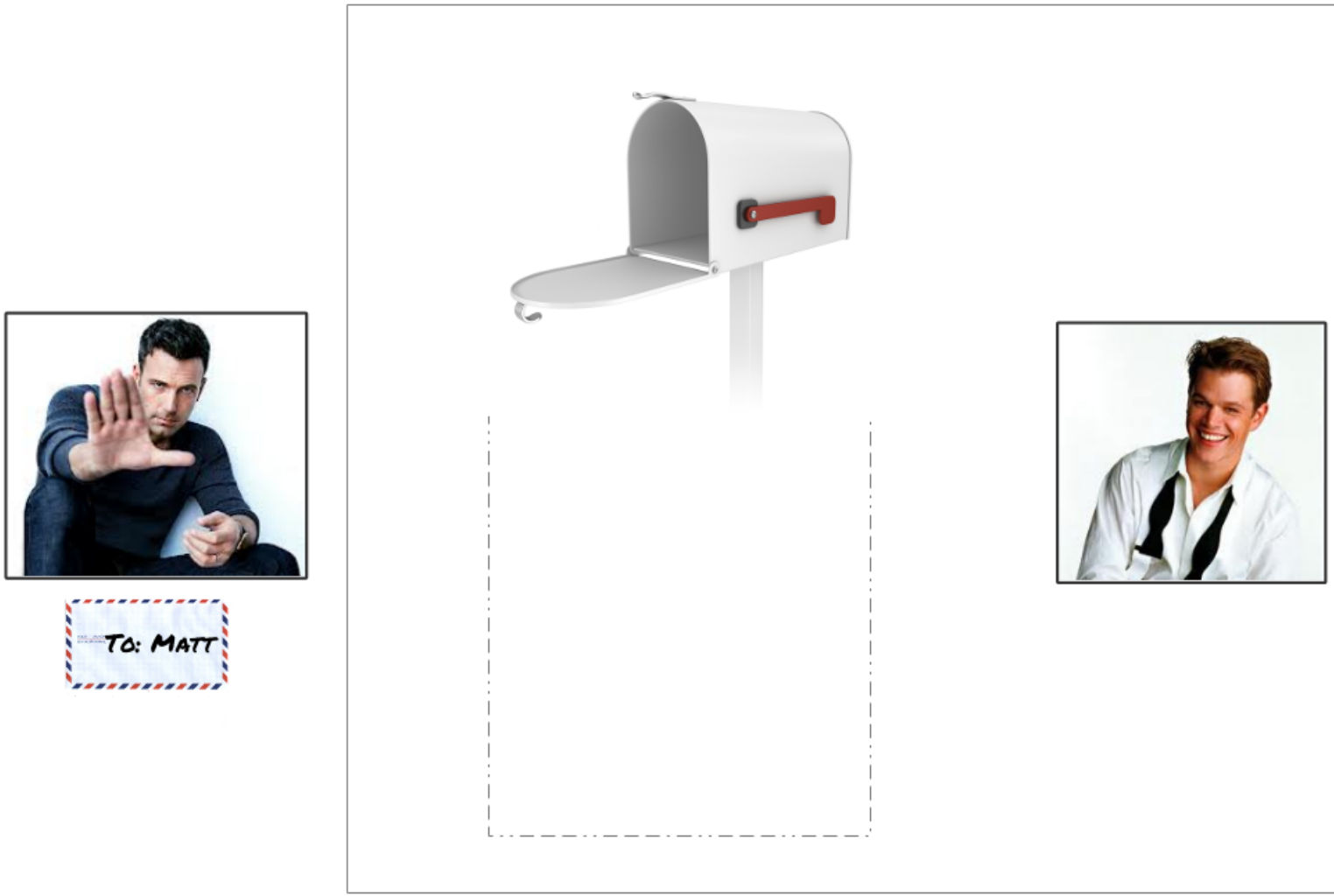


Love Note Processed By Thread

Thread goes away



Flooding Matt Damon with Messages



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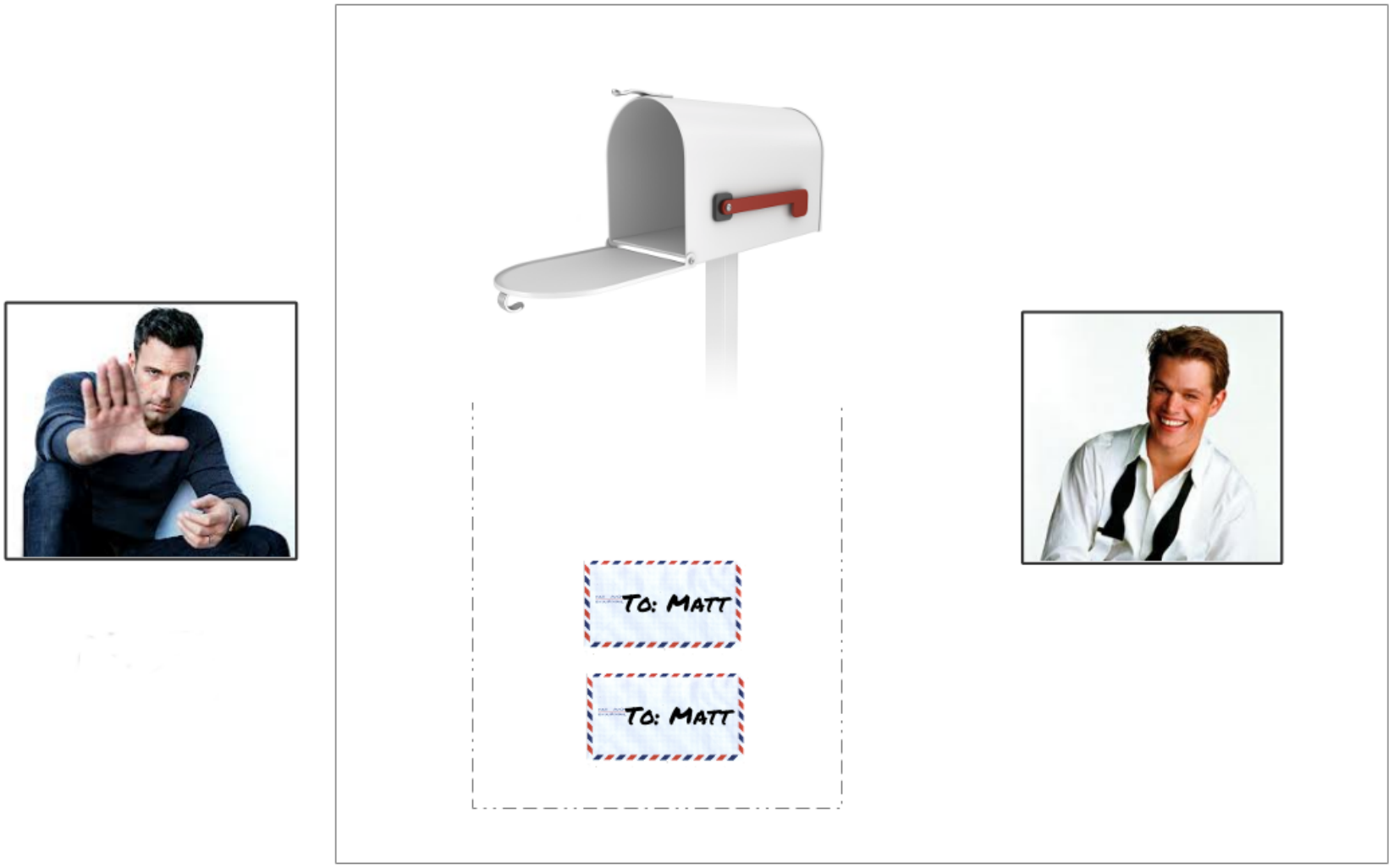
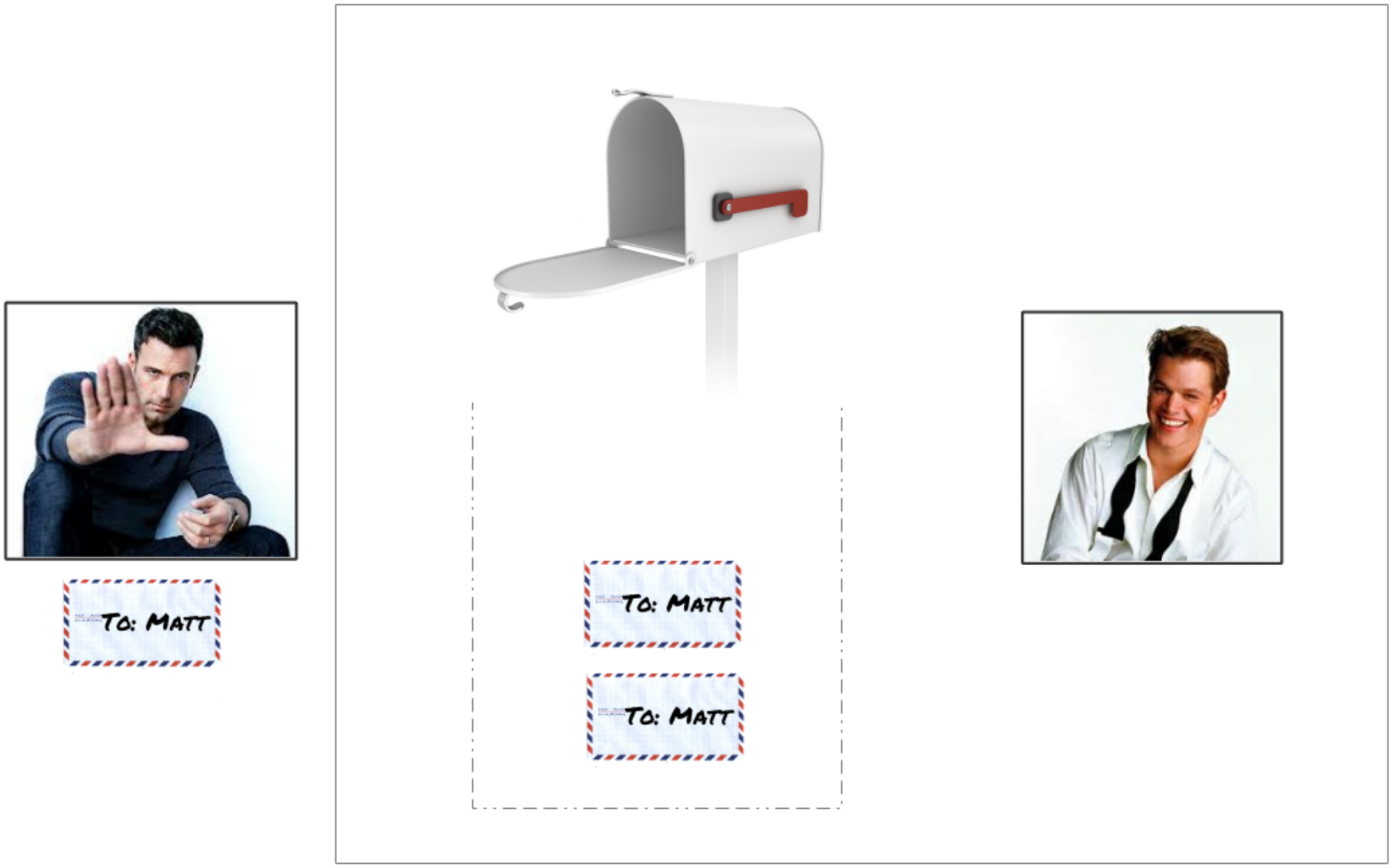
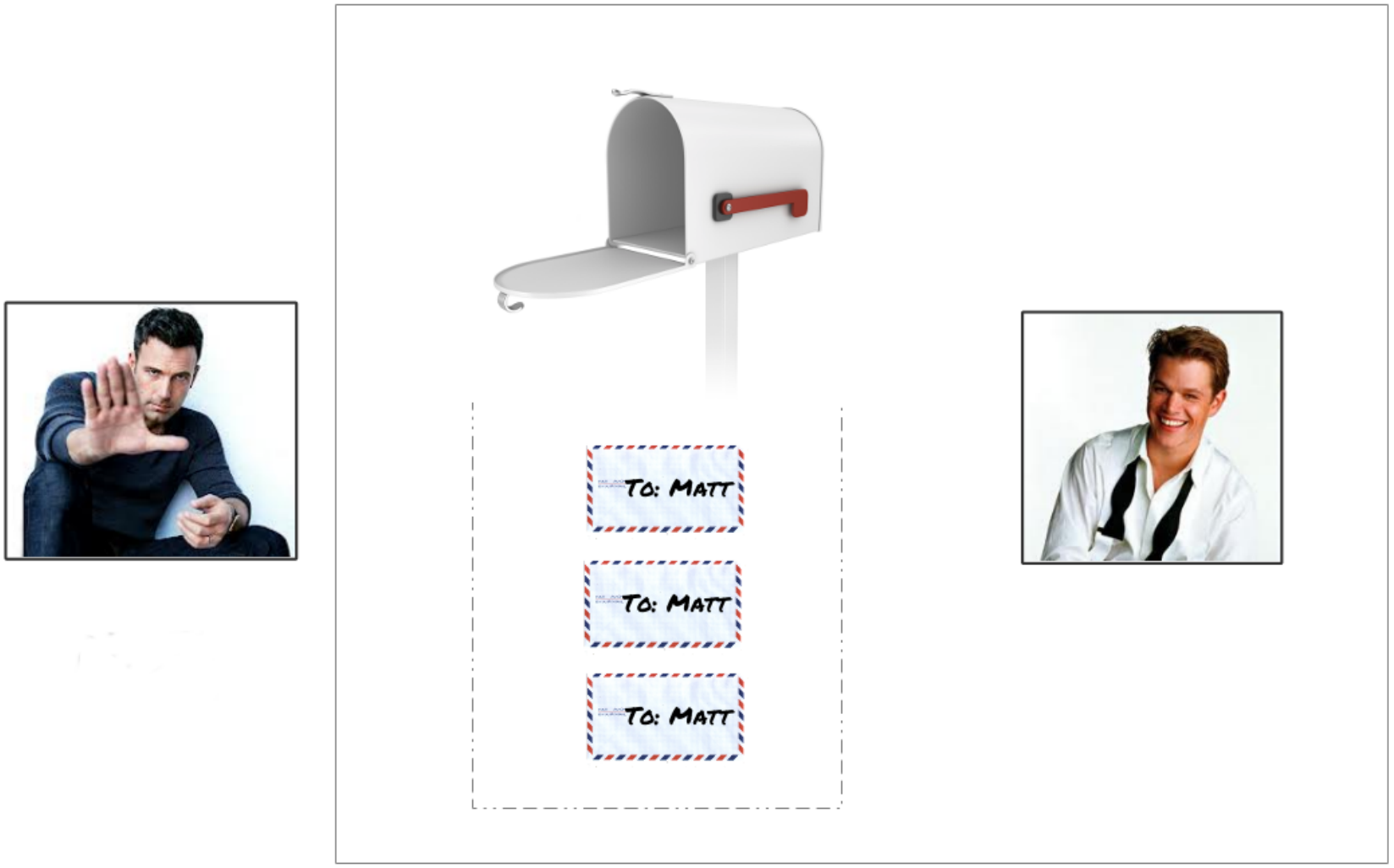


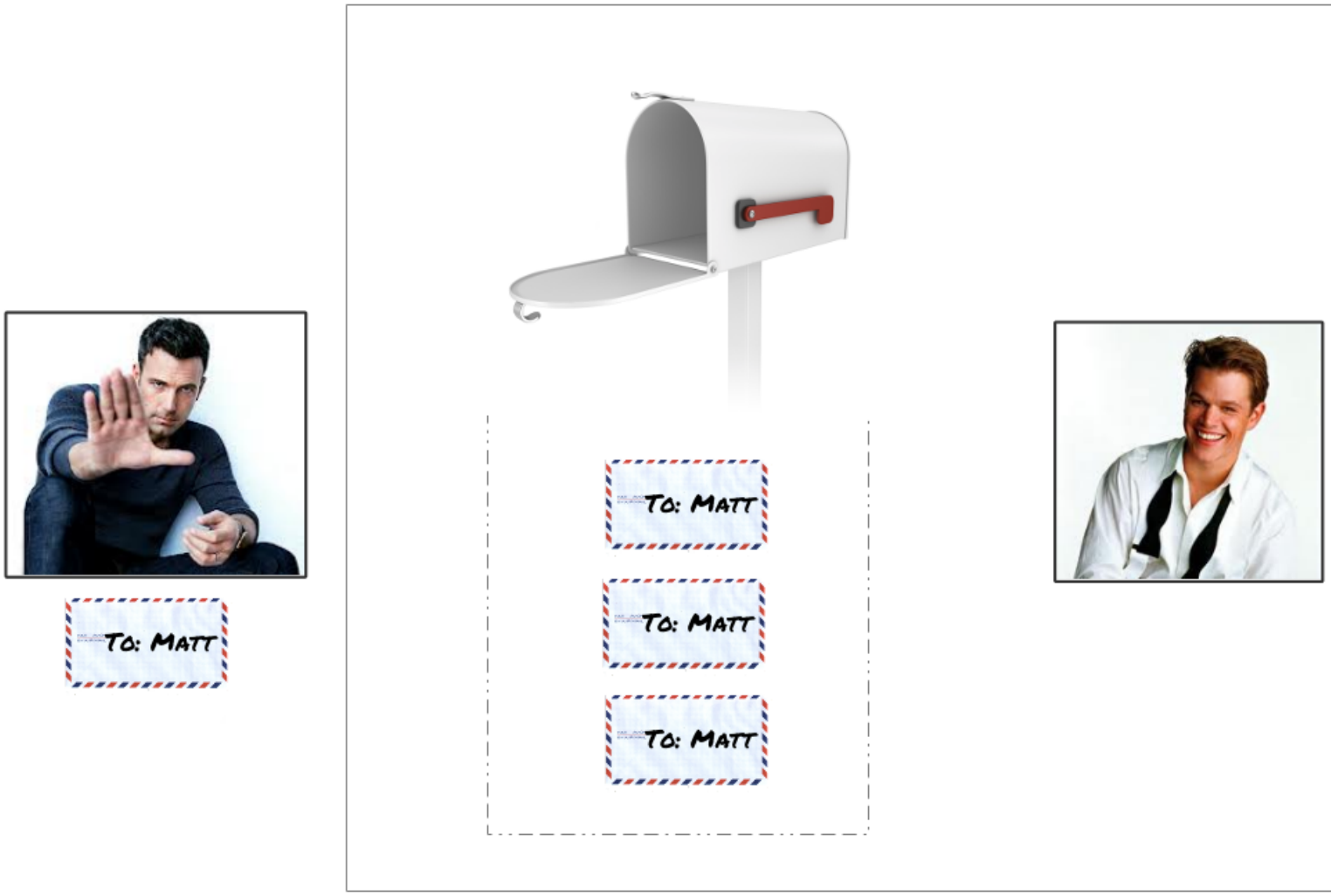
Flooding Matt Damon with Messages



Flooding Matt Damon with Messages



Flooding Matt Damon with Messages



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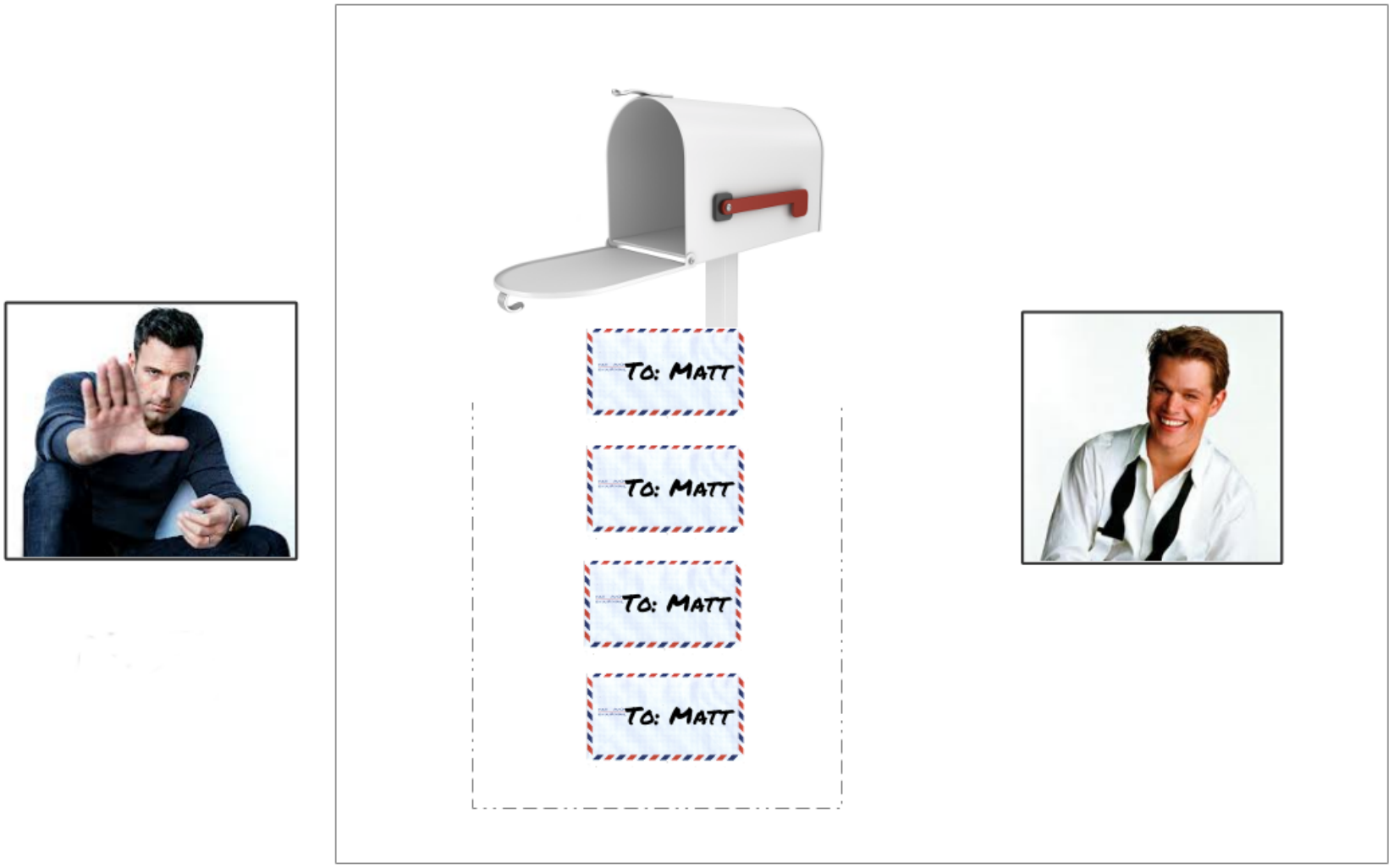

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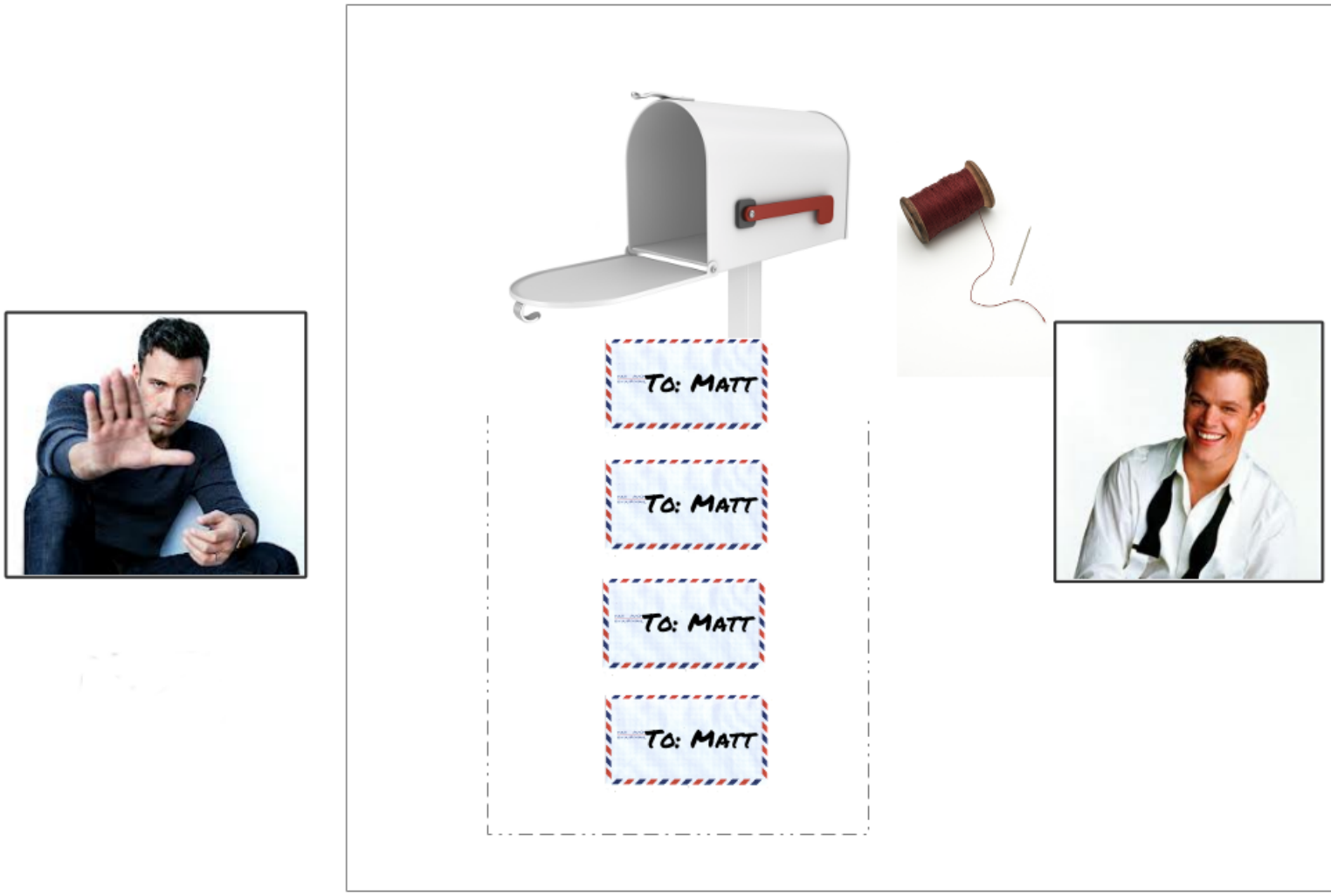
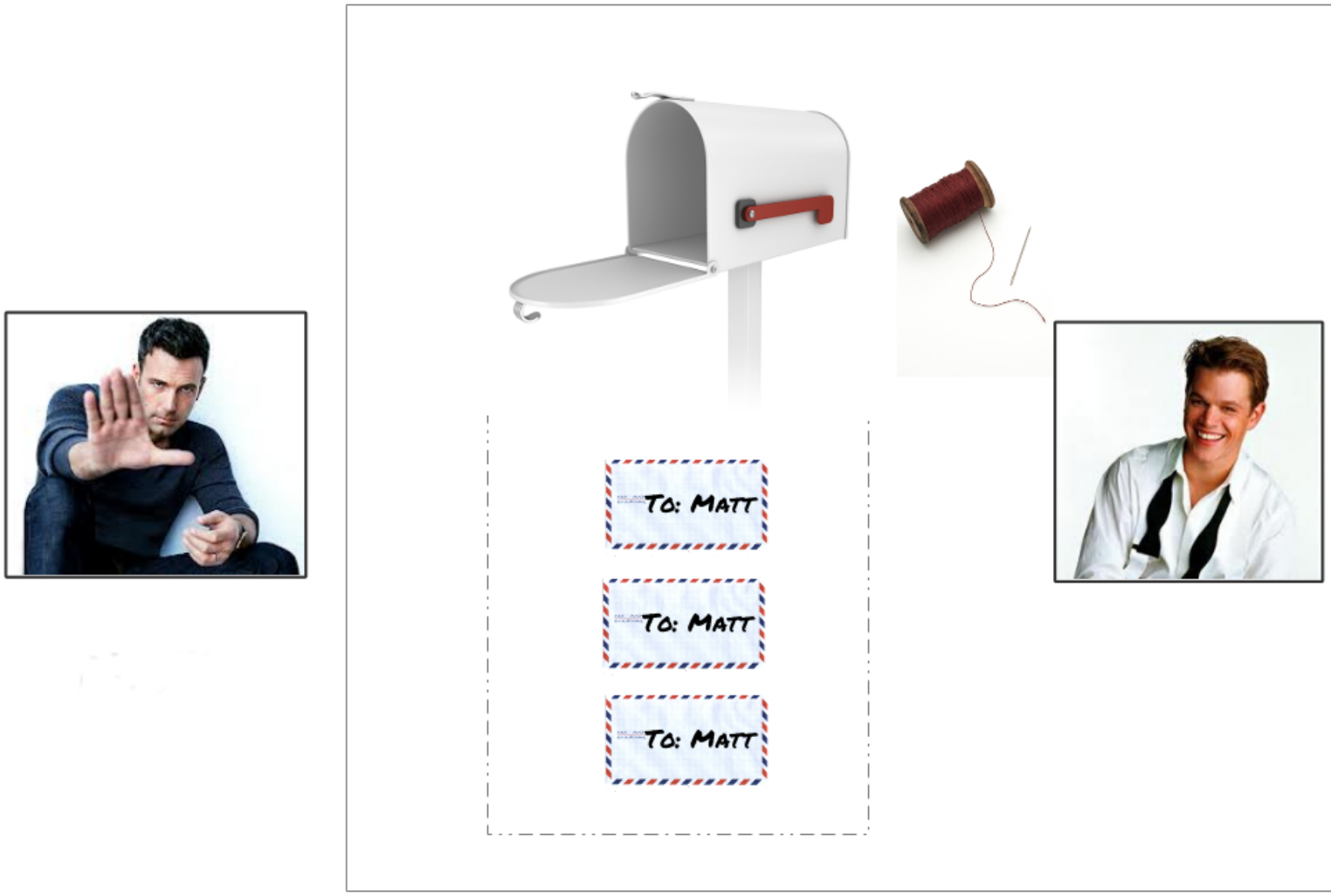
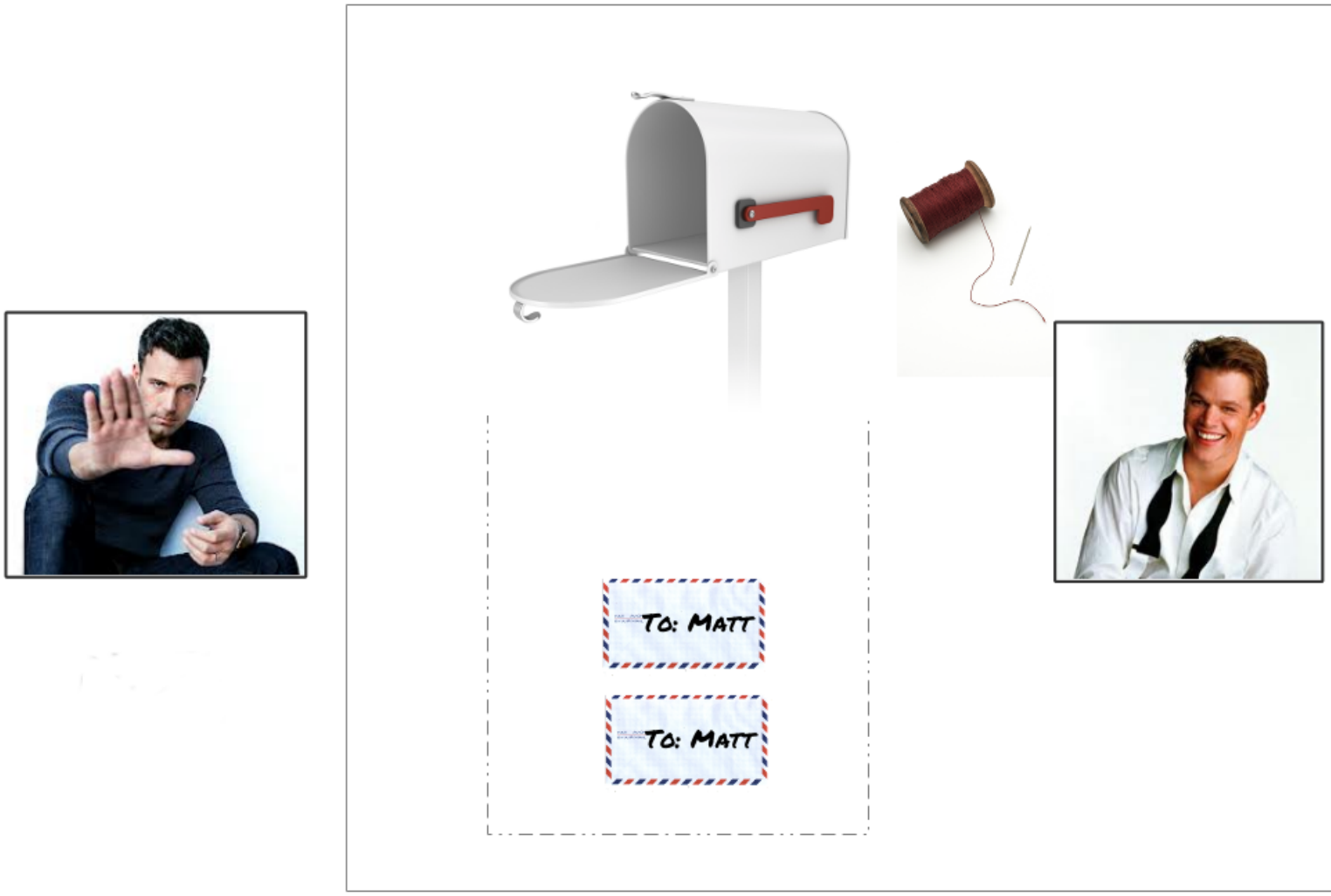


Flooding Matt Damon with Messages



Flooding Matt Damon with Messages

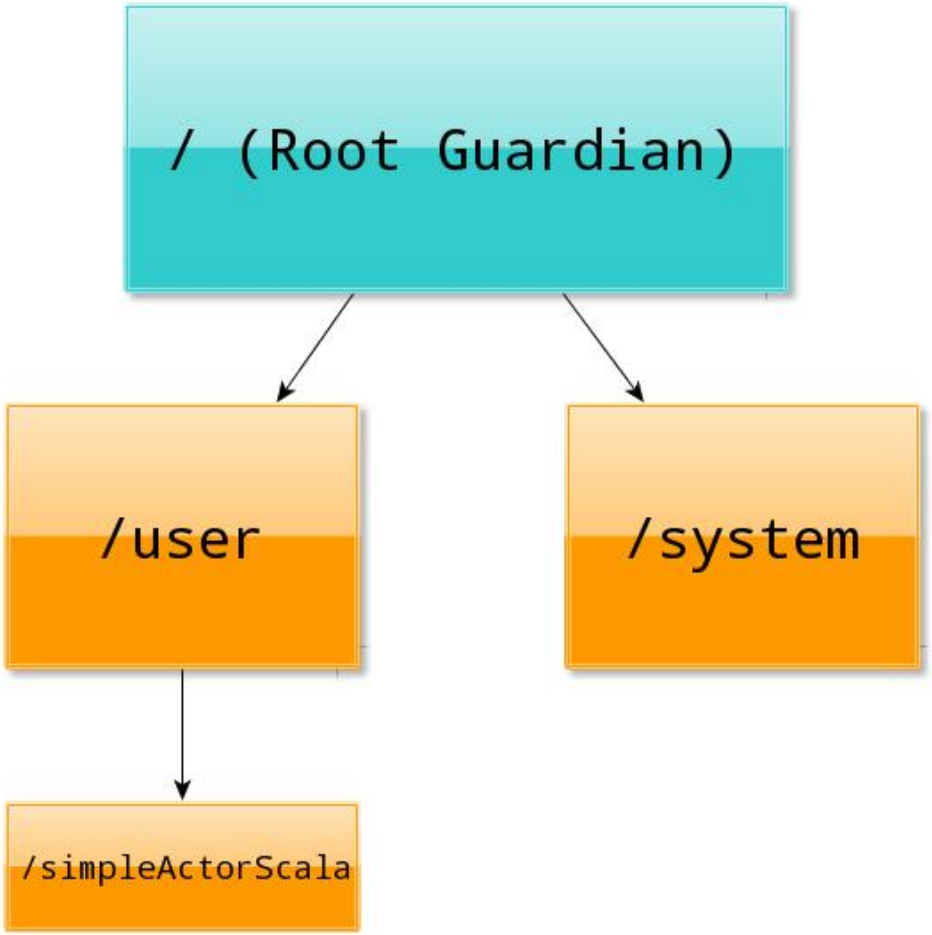


Flooding Matt Damon with Messages

Flooding Matt Damon with Messages

Demo: Setting up Actors

Anatomy of the Actor System




```
akka://{system.name}/user/{actor.name}
```

Paths

- Can be Local

```
akka://my-sys/user/service-a/worker1
```

- Can be Remote

```
akka://my-sys@host.example.com:5678/user/service
```

- Can be Clustered

```
cluster://my-cluster/service-c
```

- Can be Relative

```
../brother-actor
```

Location Transparency

- Vertical and Horizontal Growth
- Horizontal Growth driven by Remoting systems
- Vertical Growth driven by routers
- All configuration based

More about `actorOf()`

- Creates an actor onto a `ActorSystem`
- Creates an actor given the a set of properties to describe the Actor
- Creates an Actor with an identifiable name, if provided
- Returns an `ActorRef`
- If `actorOf` is called *inside* of another actor, that new actor becomes a child of that actor

`actorSelection()`

- Was `ActorFor` which is now deprecated
- Actor references can be looked up using `actorSystem.actorSelection(...)` method.
- `actorSystem.actorSelection` returns a `ActorSelection` object that abstracts over local or remote reference.
- `ActorSelection` can be used as long as the actor is alive.
- Only ever looks up an existing actor, i.e. does not create one.
- The actor must exist or you will receive an EmptyLocalActorRef
- For Remote Actor References, a search by path on the remote system will occur.

About `ActorRef`s

- Any subtype of ActorRef
- ActorRef is the only way to interact with an Actor
- Intent is to send messages to Actor that it represents, proxy.
- Each actor has reference to `self()` refers to it's own reference.
- Each actor also has reference to the `sender()`, the actor that sent the message.
- Any reference can be sent to another actor so that actor can send messages to it.

Other Types of References

- Pure Local Actor References
- Local Actor References
- Local Actor References with Routing
- Remote Actor References
- Promise Actor References
- Dead Letter Actor References
- Cluster Actor References

Actor References within Actor

- `self()` reference to the `ActorRef` of the actor
- `sender()` reference sender Actor of the last received message, typically used as described in Reply to messages
- `context()` exposes contextual information for the actor and the current message.

Lifecycle Methods

- `preStart()` - Lifecycle call when the actor is started
- `preRestart()` - Lifecycle call before the actor is restarted
- `postRestart()` - Lifecycle call after the actor is restarted
- `postStop()` - Lifecycle call after the actor stopped

Futures and Promises

`java.util.concurrent`

- Contains an `Executor`
- `Executor` manages independent threading tasks and decouples task submission from task execution
- Contains an `ExecutorService` that takes `Runnable` or `Callable` tasks and comes complete with a lifecycle and monitoring systems

The `Executor`

```
public interface Executor {
   void execute(Runnable command);
}
```

`ExecutorService`

- An `ExecutorService` is a subinterface of `Executor`
- Provides the ability to create and track `Future`s from `Runnable` and `Callable`s
- Services can be started up and shut down
- Can create your own
- Likely will use `Executors` class to create `ExecutorServices`

Snippet of `ExecutorService`

```
public interface ExecutorService extends Executor {
  ...
   <T> Future<T> submit(Callable<T> task);
   <T> Future<T> submit(Runnable task, T result);
   Future<?> submit(Runnable task);
  ...
}
```

Executors

- Utility Factory that can create `ExecutionServices`

`FixedThreadPool`

- `Executors.newFixedThreadPool()`
- *“Creates a thread pool that reuses a fixed number of threads operating off a shared unbounded queue.”* according to the API
- Keeps threads constant and uses the queue to manage tasks waiting to be run
- If a thread fails, a new one is created in its stead
- If all threads are taken up, it will wait on an unbounded queue for the next available thread

`SingleThreadExecutor`

- `Executors.newSingleThreadExecutor()`
- *“Creates an Executor that uses a single worker thread operating off an unbounded queue.”*
- If a thread terminates due to a failure during execution prior to shutdown, a new one will take its place if needed to execute subsequent tasks.

`CachedThreadPool`

- `Executors.newCachedThreadPool()`
- Factory method is a flexible thread pool implementation that will reuse previously constructed threads if they are available
- If no existing thread is available, a new thread is created and added to the pool
- Threads that have not been used for sixty seconds are terminated and removed from the cache

`ScheduledThreadPool`

- `Executors.newScheduledThreadPool()`
- Can run your tasks after a delay or periodically
- This method does not return an `ExecutorService`
- Returns a ScheduledExecutorService which contains methods to help you set not only the task but the delay or periodic schedule

`Future`

- An asynchronous computation
- Contains methods determine completion of said computation
- Can be in running state, completed state, or have thrown an Exception

`Future` interface

```
public interface Future<V> {
    boolean cancel(boolean mayInterruptIfRunning);
    boolean isCancelled();
    boolean isDone();
    V get() throws
         InterruptedException, ExecutionException;
    V get(long timeout, TimeUnit unit)
         throws InterruptedException,
           ExecutionException, TimeoutException;
}
```

Demo: `Future`s with `java.util.concurrent`

Futures in `scala.concurrent`

- Data structures used to retrieve the result of some concurrent operation.
- It can be retrieved “synchronously” (blocked) or “asynchronously” (unblocked)
- `Future`s need an `ExecutionContext` in scope in order to work

Promises


TICKET
KEEP THIS COUPON
TICKET
KEEP THIS COUPON
TICKET
KEEP THIS COUPON

Demo: `Future`s and `Promise`s with `scala.concurrent`

Ask

- Actors can be asked for return information from an actor using the ask pattern
- Performance Hit especially with remote actors
- Will return a `Future` so that you can wait for an answer

Demo: Ask an `Actor` in Java and Scala

A quick intro to HOCON

- "Human-Optimized Config Object Notation"
- Uses Typesafe Configuration Library https://github.com/typesafehub/config (https://github.com/typesafehub/config)
- JSON Like Features
- Typical configuration file: *application.conf*

Sample HOCON Configuration

```
db.default.driver=org.h2.Driver
db.default.url="jdbc:h2:mem:play"
db.default.user=sa
db.default.password=""
```

Sample HOCON Configuration (Alternate 1)

```
db {
  default.driver=org.h2.Driver
  default.url="jdbc:h2:mem:play"
  default.user=sa
  default.password=""
}
```

Sample HOCON Configuration (Alternate 2)

```
db {
  default {
    driver=org.h2.Driver
    url="jdbc:h2:mem:play"
    user=sa
    password=""
  }
}
```

`application.conf`

- Contains Settings for Actor Systems
- All HOCON (Human Optimized Config Object Notation)
- One *application.conf* per application
- Typically stored src/main/resources

Logical and Physical Paths

- A logical path is seen as if one element is a without recognizing if one actor is remote
- A physical path is the direct path from an actor to it’s ActorSystem. Never spans the JVM

Demo: Setting up and running remote actors on remote systems

Fault Tolerance

- Each actor
  - Can be a parent, and create children
  - Only an actor can create a child
  - Is responsible for their children (a.k.a. subordinate)
- When failure occurs
  - A child or all children are suspended
  - Parent determines the next course of action
  - Mailbox contents are maintained

One for One Strategy

- Each child is treated is separately
- Typically the normal one that should be used
- Default if no strategy is defined

All for One Strategy

- Each child will be given the same treatment
- If one fails, they all essentially "fail"
- Used if tight coupling between children is required

Default Fault Tolerance Behavior

- `ActorInitializationException` will stop the failing child actor
- `ActorKilledException` will stop the failing child actor
- `Exception` will restart the failing child actor
- Other types of `Throwable` will be escalated to parent actor

Actor References within Actor (Repeat)

- `self()` reference to the `ActorRef` of the actor
- `sender()` reference sender Actor of the last received message, typically used as described in Reply to messages
- `context()` exposes contextual information for the actor and the current message.

Demo: Fault Tolerance

Routers

- Actor that reroutes message to other actors
- Different Strategies available
- Create your own

Out of the Box Routers

- `RoundRobinRoutingLogic`
  - Round Robin Distribution
  - Chooses either number of Routees **or** a list of Routees **not both**.
- `RandomRoutingLogin`
  - Chooses a routee randomly
- `SmallestMailboxRouter`
  - Chooses non-suspended routee with the least messages in its mailbox
- `BroadcastRouter`
  - Sends messages to all the routees!

Out of the Box Routers (Continued)

- `ScatterGatherFirstCompletedRouter`
  - Sends messages to all routees, gets a `Future`,
  - Whichever routee responds first, that reponse will be sent to the `sender()`
- `ConsistentHashingRouter`
  - Consistent Hashing
  - Special type of map where remapping of keys is limited
  - K/n mapping keys will be remapped
    - K is the number of keys
    - n is the number of slots

Demo: Routers

Questions?

Thank You

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