Lecture 21
akka Java in Detail
Recall akka

• Open-source implementation of actors model
  – Originally developed for Scala language
  – Ported also to Java

• Key concepts
  – ActorSystem
  – UntypedActor
  – ActorRef
  – onReceive()
  – tell()
  – Patterns.ask()
Dynamic Actor Creation

• In Java we saw that tasks can create other tasks
• In akka Java, actors can also create other actors!
  – Actor creation so far has been done using calls to `actorOf()` method of `ActorSystem` object
  – It may also be done by calling `actorOf()` method of `ActorContext` object
    • An `ActorContext` object is the environment surrounding an actor
    • To get the `ActorContext` of an `UntypedActor` actor, call `getContext()` instance method
Supervision

• Every actor has exactly one supervising actor
  – When one actor creates another using first actor’s context, first actor is supervisor of second
    • First actor often also called parent
    • Second usually called child or subordinate
  – What about actors created via ActorSystem actorOf()? 
    • Every actor system three top-level actors (called guardians) that are started automatically
      – / The root guardian
      – /system The System guardian (child of /)
      – /user The Guardian Actor (child of /)
    • When an object is created using actorOf() in ActorSystem, it is by default made a child of /user

• What supervisors do
  – Delegate tasks to children
  – Take remedial action when children fail

• Supervision is basis of fault tolerance in akka
Getting Supervisory Information

• **ActorContext** has methods for retrieving parent, child information
  - `ActorRef parent()`
    Return parent of actor associated with context
  - `java.lang.Iterable<ActorRef> getChildren()`
    Return children as a Java Iterable
  - `ActorRef getChild(String name)`
    Return child having given name, or null if there is no such child

• To find parent of given actor, invoke following in body of actor definition:
  `getContext().parent()`
Supervisory Hierarchy

• Supervision relationship induces a tree
  – Every actor (except '/') has exactly one parent
  – Every actor has \( \geq 0 \) children
• Every actor can be identified via path (ActorPath) in tree
• To get path of ActorRef, use `path()` instance method
• For actorA
  – Parent: user
  – Children: actorB1, actorB2
  – Path: `/user/actorA`
How an Actor Can Find Its Name

- `getName()`? `name()`? No
  No such instance methods in `UntypedActor`
- `getSelf().getName()`? `getSelf().name()`? No
  No such instance methods in `ActorRef`
- `getContext().getName()`? `getContext().name()`? No
  No such instance methods in `ActorContext`
- **Solution:** go through `ActorPath`
  - `ActorPath` objects have `name()` method returning name (String) of actor at that path
  - So, `getSelf().path().name()` returns name of yourself
Supervision in Detail

• When an actor fails (i.e. throws an exception) a special system message is sent to its parent
  – Systems messages have their own message queue; they are not handled by onReceive()
  – No guarantees about precedence of system messages over regular messages

• Parent actor has four choices in akka
  1. Resume the failed child in child’s accumulated internal state
  2. Restart the failed child in its initial state
  3. Stop the failed child permanently
  4. Escalate (i.e. fail itself, handing off responsibility to its own parent)

• Communication associated with these choices is via system messages that are handled by special system-message queue
  This queue is only used for supervision (i.e. parent-child) communication
Resumption of Failed Child

• `onReceive()` method in child is re-invoked
  – Message being processed when failure occurred is lost
  – Processing of messages in child’s message queue resumes

• When to do this?
  – Maybe if transient system fault caused failure
  – Maybe if there is a bug in child that doesn’t affect its ability to process future messages
Restarting a Failed Child

• Idea
  – Create new actor instance
  – Replace actor instance in ActorRef for failed child with new instance
    • Path unchanged
    • So is name
  – Invoke onReceive() method of new actor instance to start processing messages in message queue
• Message processed during failure is lost, but no pending messages in failed child’s mailbox are

```scala
ActorRef
onReceive() {
...
}
```

UntypedActor

Keep this
Replace this
Stopping an Actor

• Stopping a child during supervision involves a general actor-stopping technique
• ActorContext objects include following method
  ```java
  void stop(ActorRef actor)
  ```
  – Stops actor
  – Processing of current message completes first, however
• What about messages in mailbox when actor is stopped? And those sent to stopped actor?
  – These are called dead letters
  – akka uses a special actor (/deadLetters) to handle these
  – There are also mechanisms for retrieving them
• What about children?
  – They are stopped also,
  – This percolates downwards through supervision hierarchy, to children’s children, children’s children’s children, etc.
Actors Can Stop Other Actors ...

- ... even themselves!
- If following is executed in UntypedActor ...
  `getContext().stop(getSelf())`
- ... then it stops itself! (And consequently its children, grandchildren, etc.)
  - When an actor is stopped, its supervisor is notified
  - So are other actors that are monitoring this actor
  - akka buzzwords for this: DeathWatch, DeathPact
    - Special `Terminated` messages (these are not system messages, so are delivered to regular mailboxes) are sent to actors that have registered with stopped actor
    - Registration is done via `watch()` method in `ActorContext`
    - De-registration: `unwatch()` method in same class
Failure Escalation

• As name suggests, escalation in response to child failure means that parent fails by throwing same exception as child
• Parent’s parent then must handle failure
Details of Supervision

• Each UntypedActor object contains a SupervisorStrategy object
  – To obtain SupervisorStrategy object, execute actor’s supervisorStrategy() instance method
  – This method may be overridden in order to customize supervision approach

• The SupervisorStrategy determines how failures of children will be handled
Two Kinds of SupervisorStrategy

• AllForOneStrategy (subclass of SupervisorStrategy)
  – If one child fails, apply supervision strategy to all of the children, not just the failing one
  – Used if children are tightly coupled

• OneForOneStrategy (also subclass of SupervisorStrategy)
  – Apply supervision strategy only to failing child; other children left unaffected
  – Used if children are largely independent
Deciders

• **Core of a SupervisionStrategy:** *decider*
  - A decider maps exception classes to directives, which describe which of four mechanisms to use to recover
  - A directive has one of four forms: Escalate, Restart, Resume, Stop

• You may customize a *SupervisionStrategy* by changing the decider

• There is also a default decider
akka and the Java Memory Model

• Actors do not (intentionally) share memory
• In a local application (single JVM), one still needs to worry about visibility
• akka guarantees the following
  – If one actor sends a message to another, then pending writes before the send are guaranteed to be visible after the receipt
  – Pending writes after an actor reads a message are visible when the actor reads the next message