AmbientTalk: Object-oriented Event-driven programming in Mobile Ad hoc Networks

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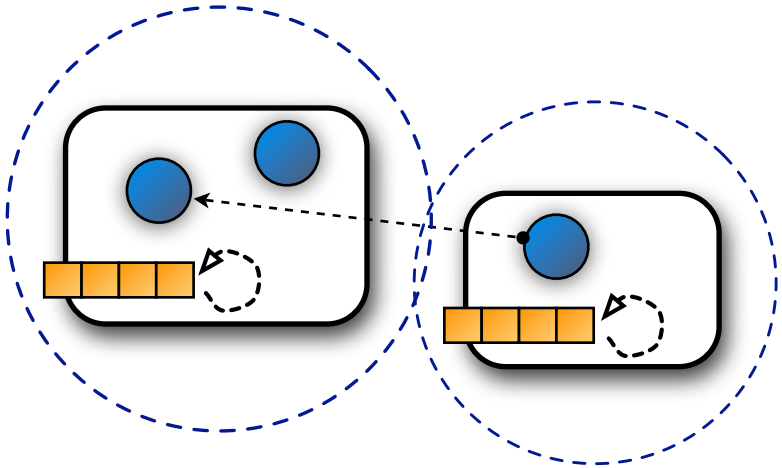
Context

Object-oriented programming languages



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Hardware

Pervasive Computing
(Mobile Networks)

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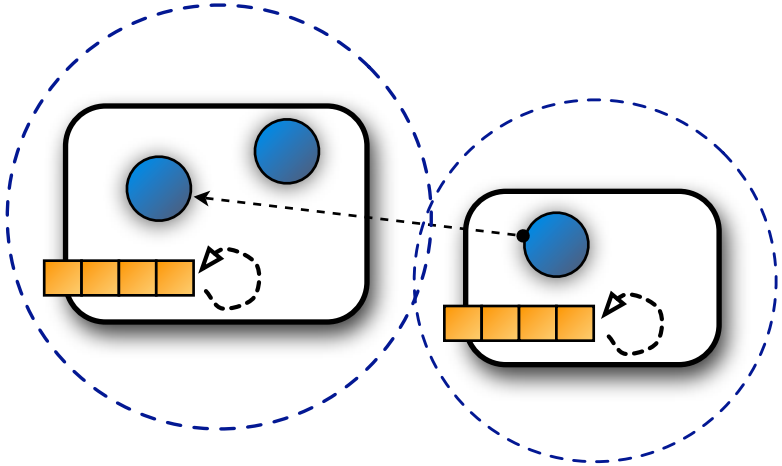

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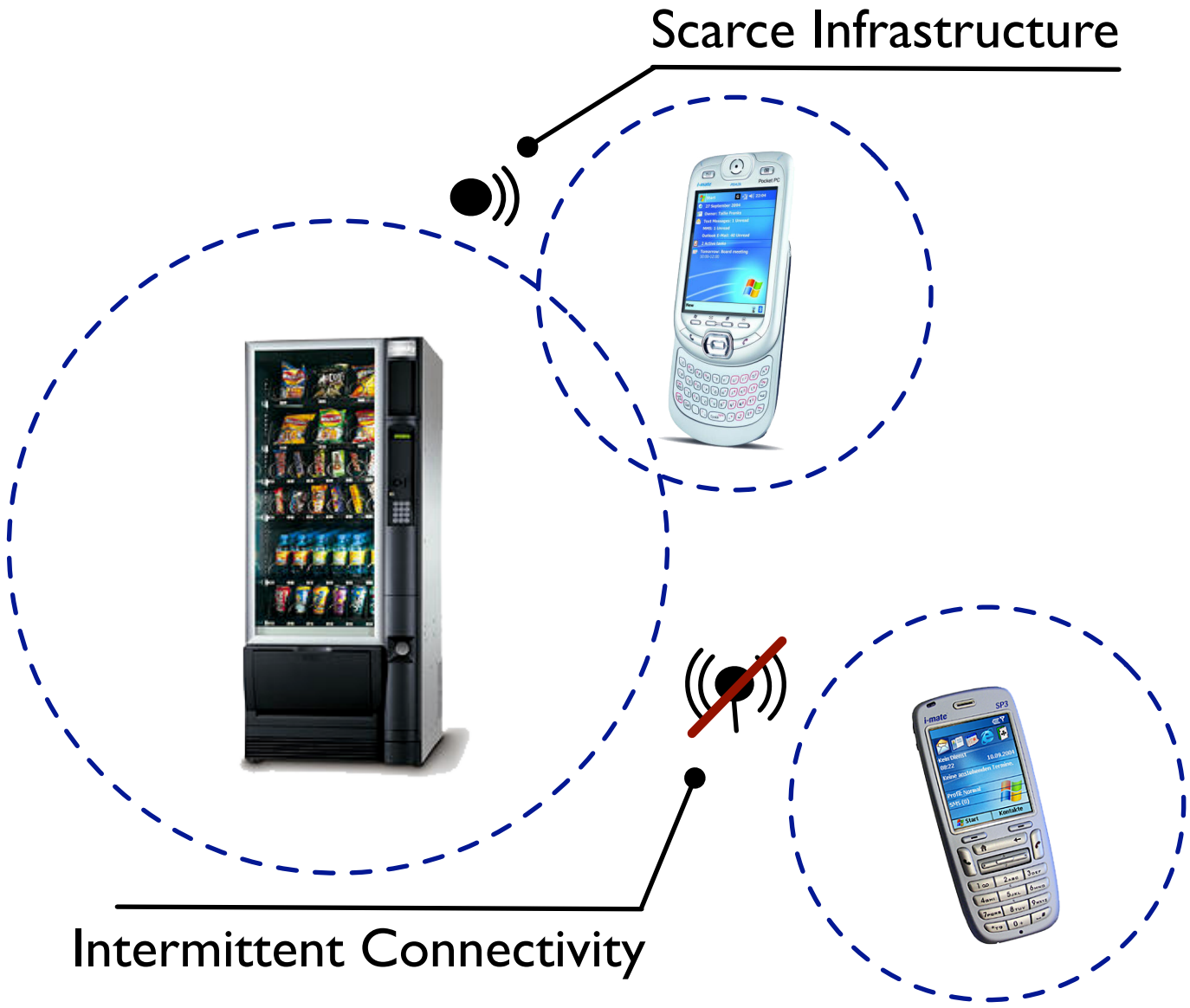

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[Eugster et al. 03]

Decoupling communication in *Time* & *Synchronisation*

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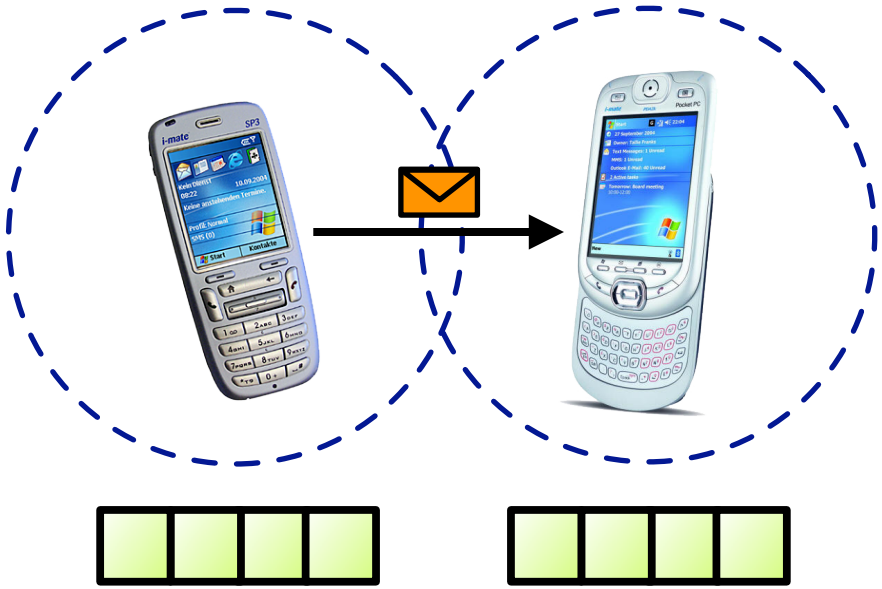

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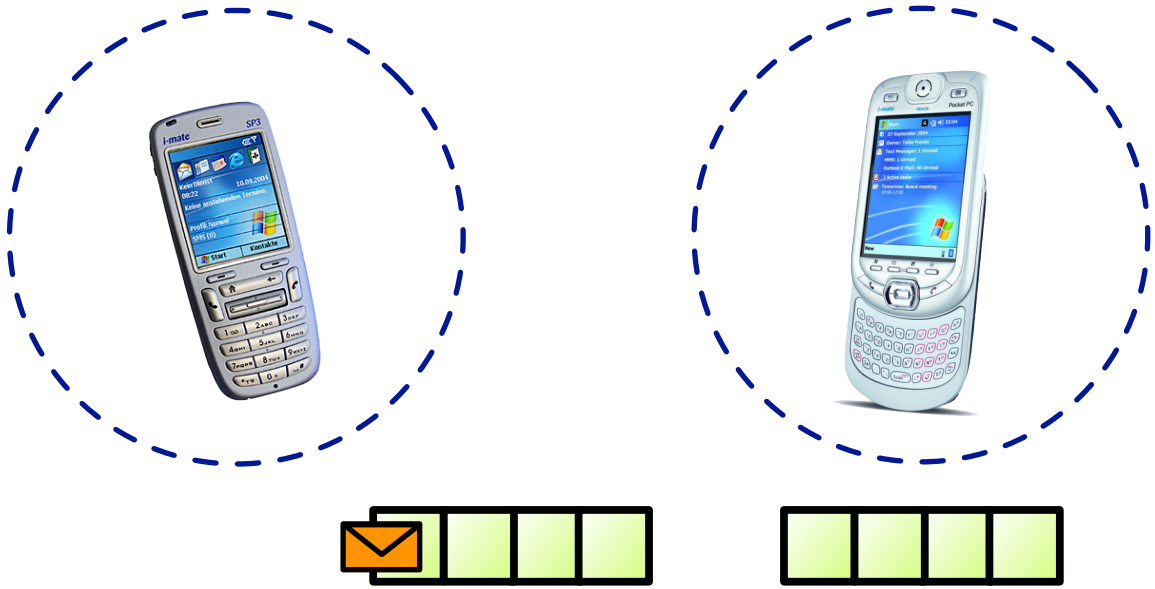

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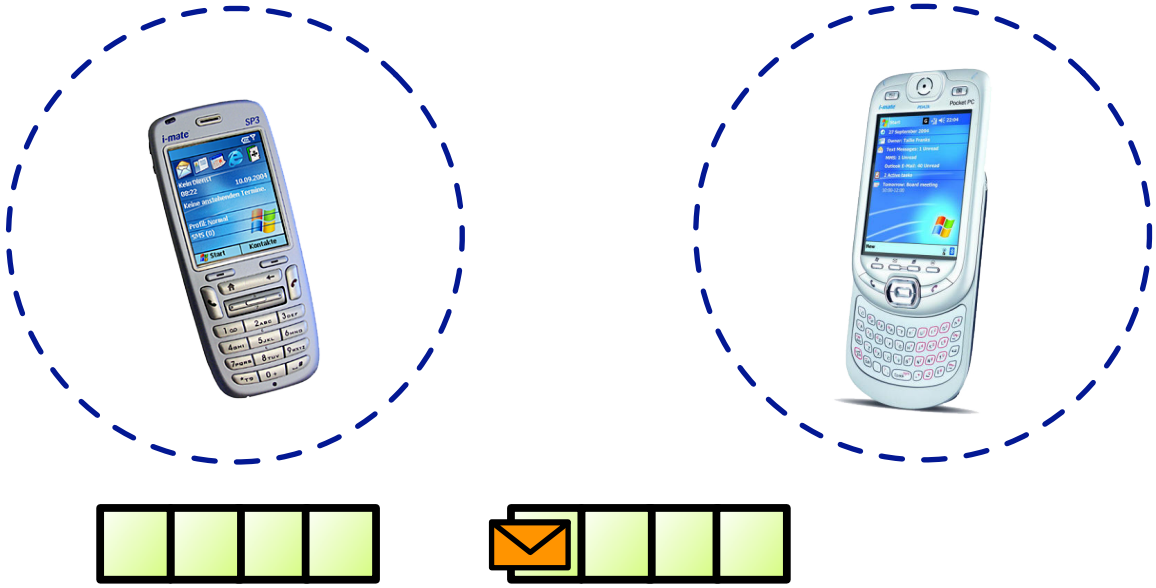

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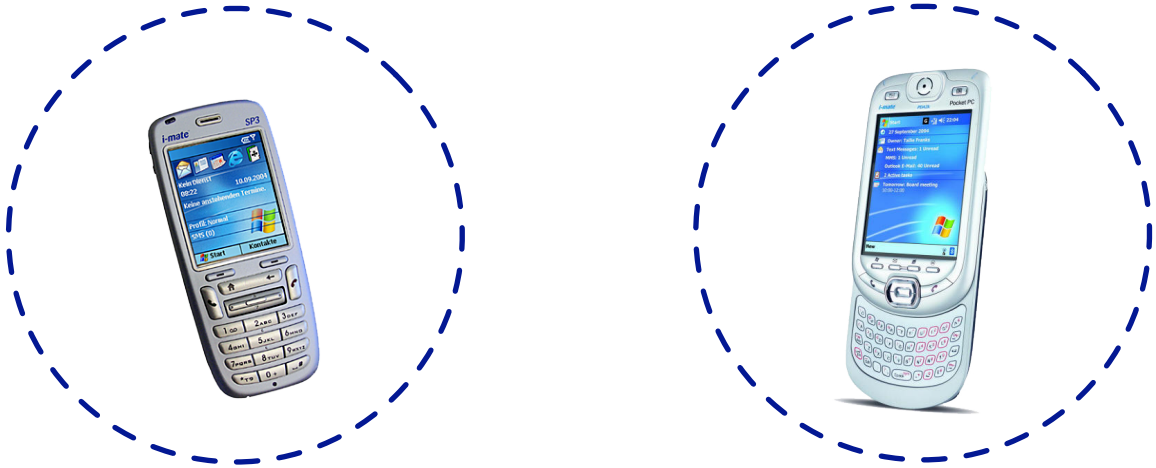

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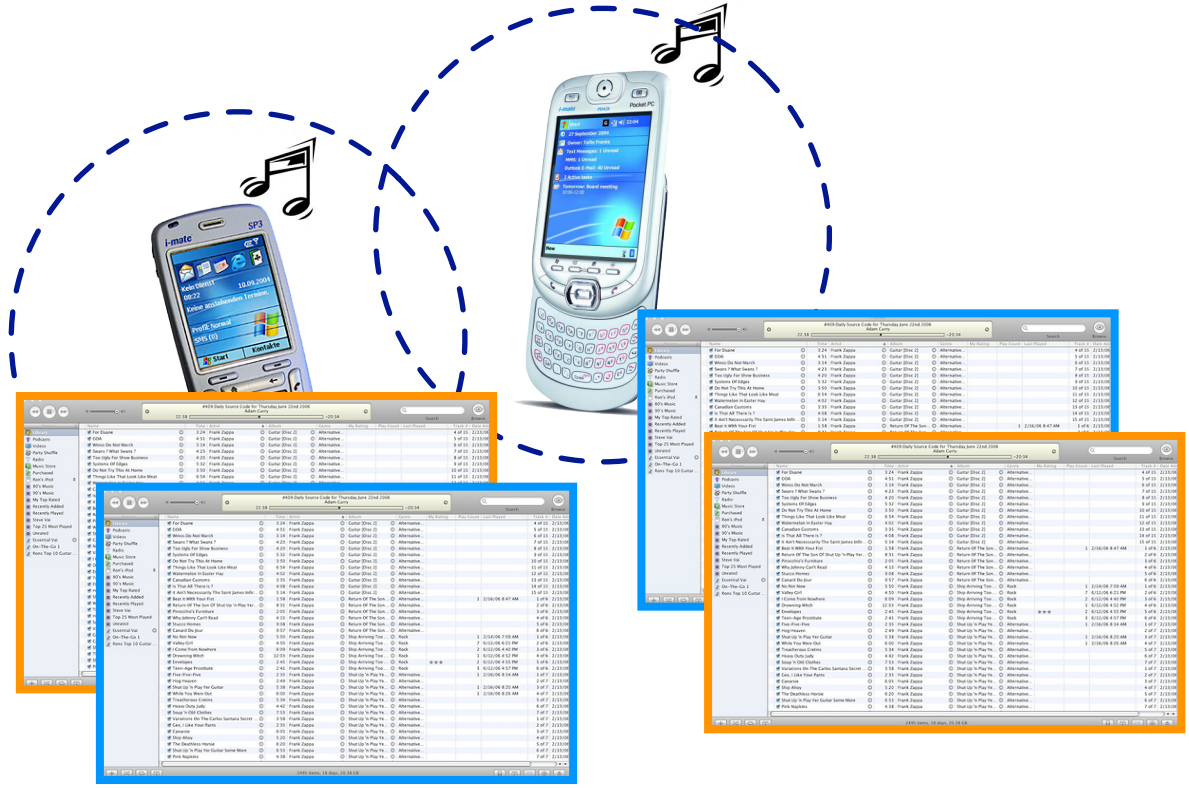

Example: music player

AmbientTalk: the language

- Distributed prototype-based object-oriented language
- Event-driven concurrency based on actors [Agha86]
- Future-type asynchronous message sends
- Built-in publish/subscribe engine for service discovery of remote objects

AmbientTalk: the project

- Started in 2005
- Small team: 3-6 people
- Interpreter (not optimised)
- Pure Java implementation
- Runs on J2ME/CDC phones

Objects

```
def Window := object: {
  def title := "Untitled";
  def init(t) {
    title := t;
    super := ClosedWindow;
  }
  def show() {
    super := OpenWindow;
  }

  def OpenWindow := object: {
    def draw() { ... }
  }
  def ClosedWindow := object: {
    def draw() { ... }
  }
}
```

- Prototypes
- Delegation
- Trait composition
- First-class delegation

```
def w := Window.new("Test");
w.draw();
```

Extensible language

```
def fac(n) {
  if: (n = 0) then: {
    1
  } else: {
    n * fac(n-1)
  }
}
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def Button := jlobby.java.awt.Button;
def b := Button.new("test");
b.addActionListener(object: {
  def actionPerformed(ae) {
    system.println("button pressed");
  }
});
```

Extensible language

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- Block closures
- Keyworded messages
- Interfacing with JVM
- Reflection

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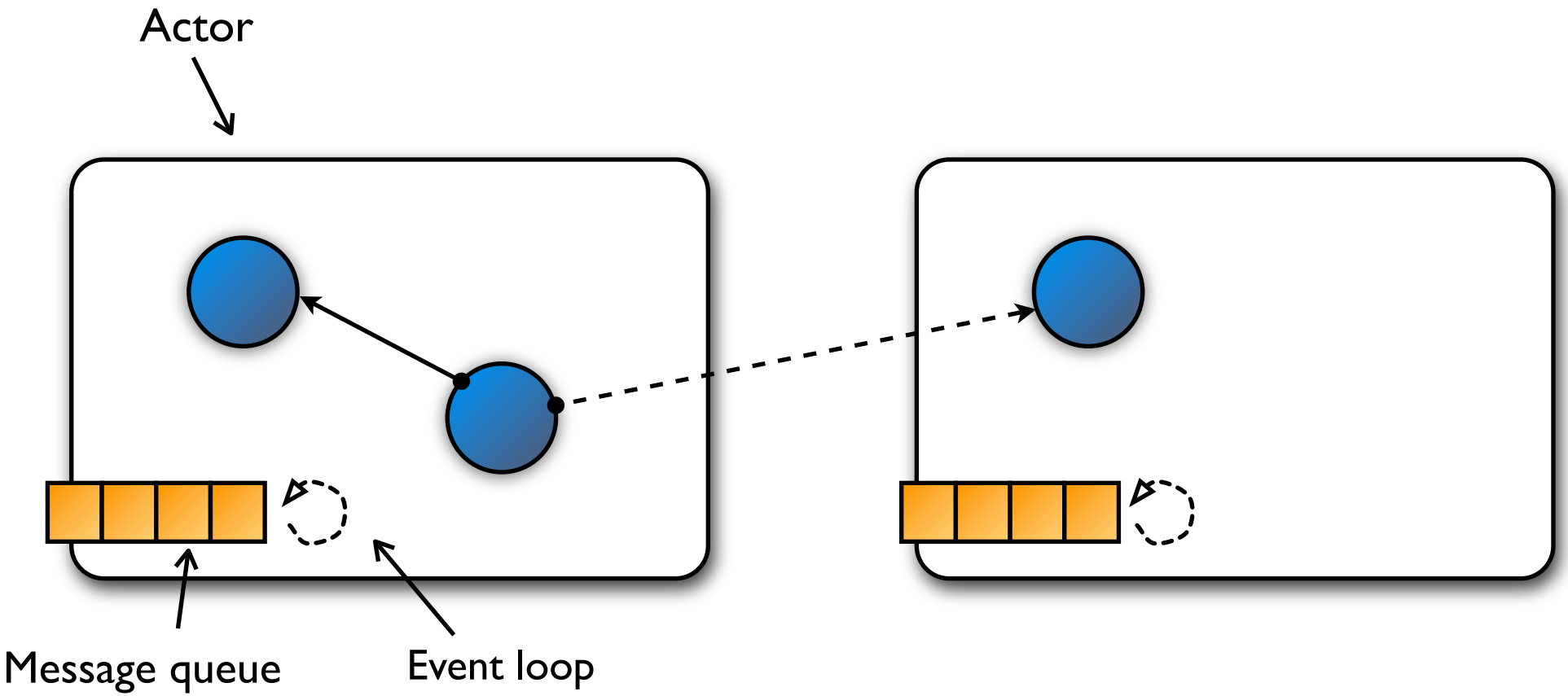
Event loop concurrency

Based on E programming language [Miller05]



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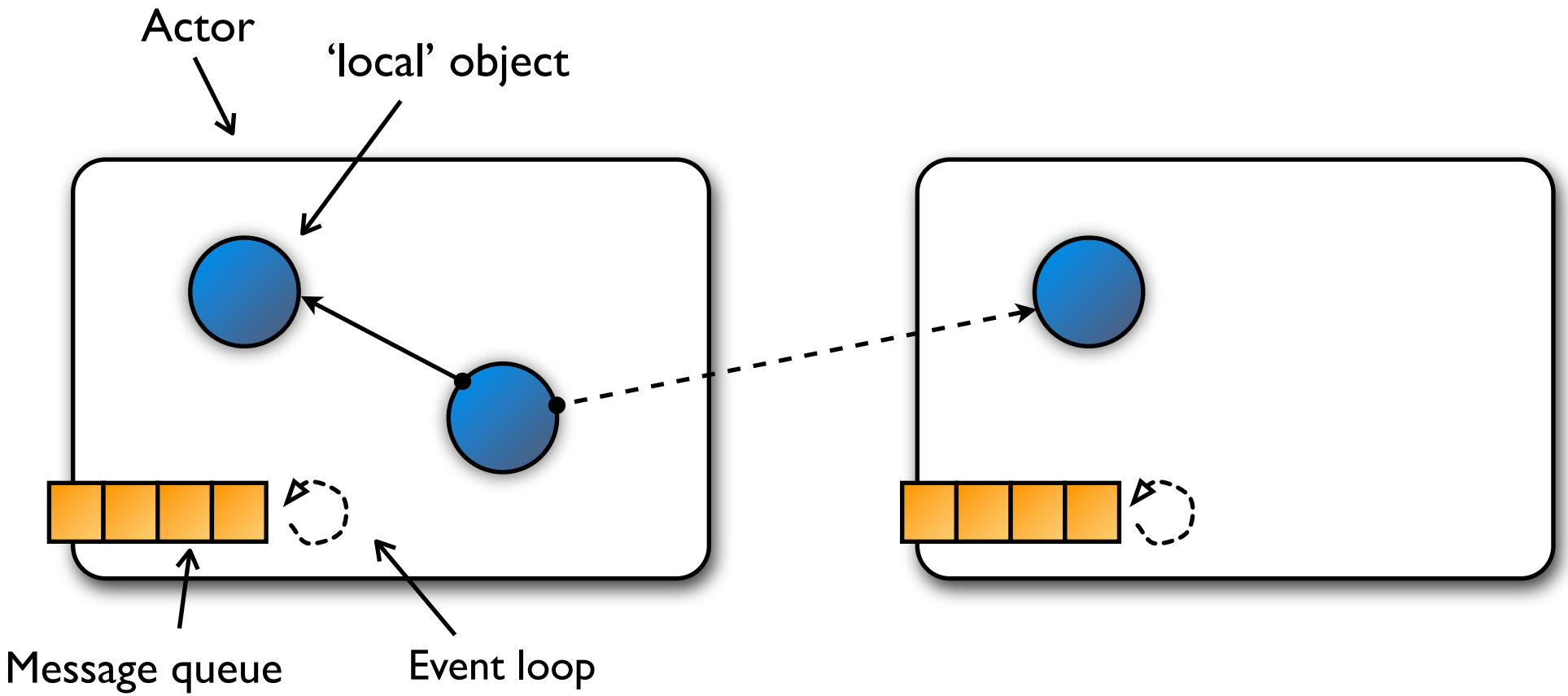

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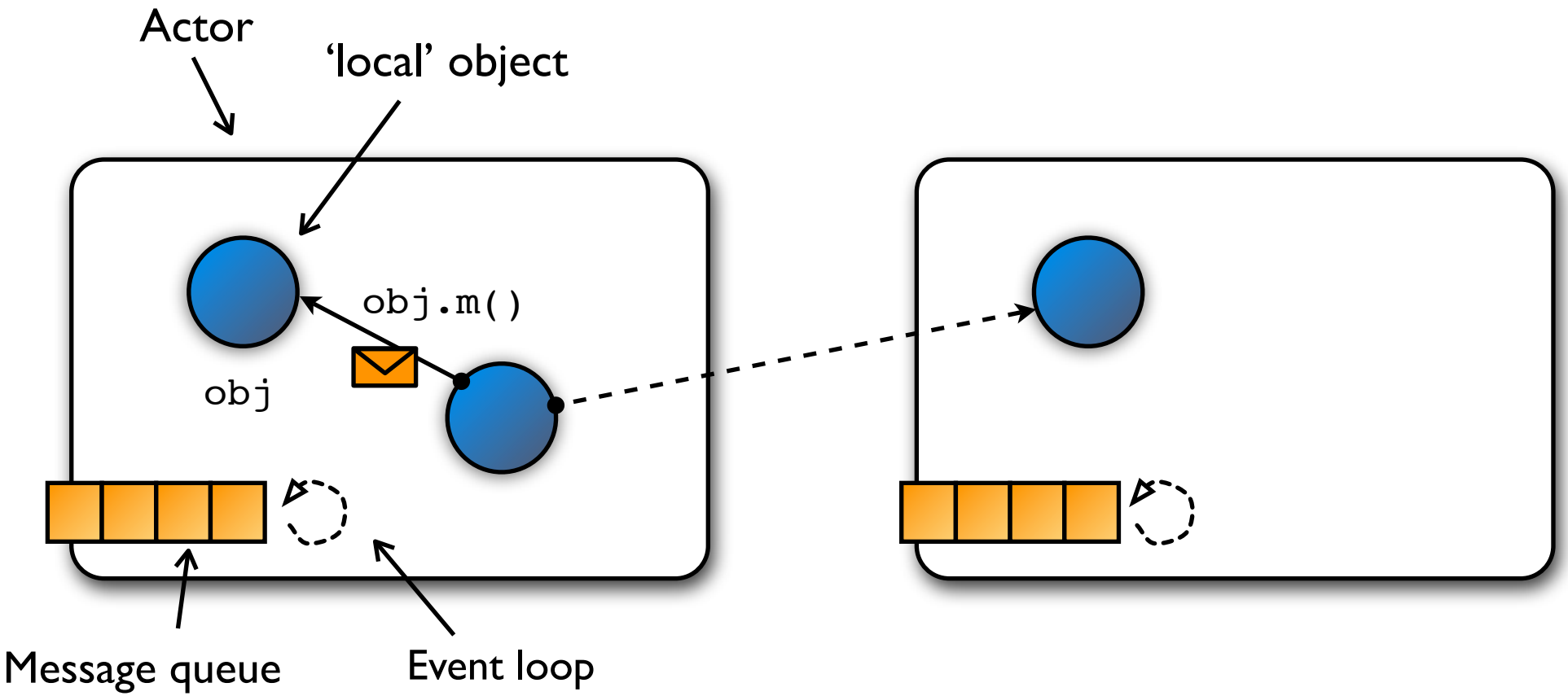

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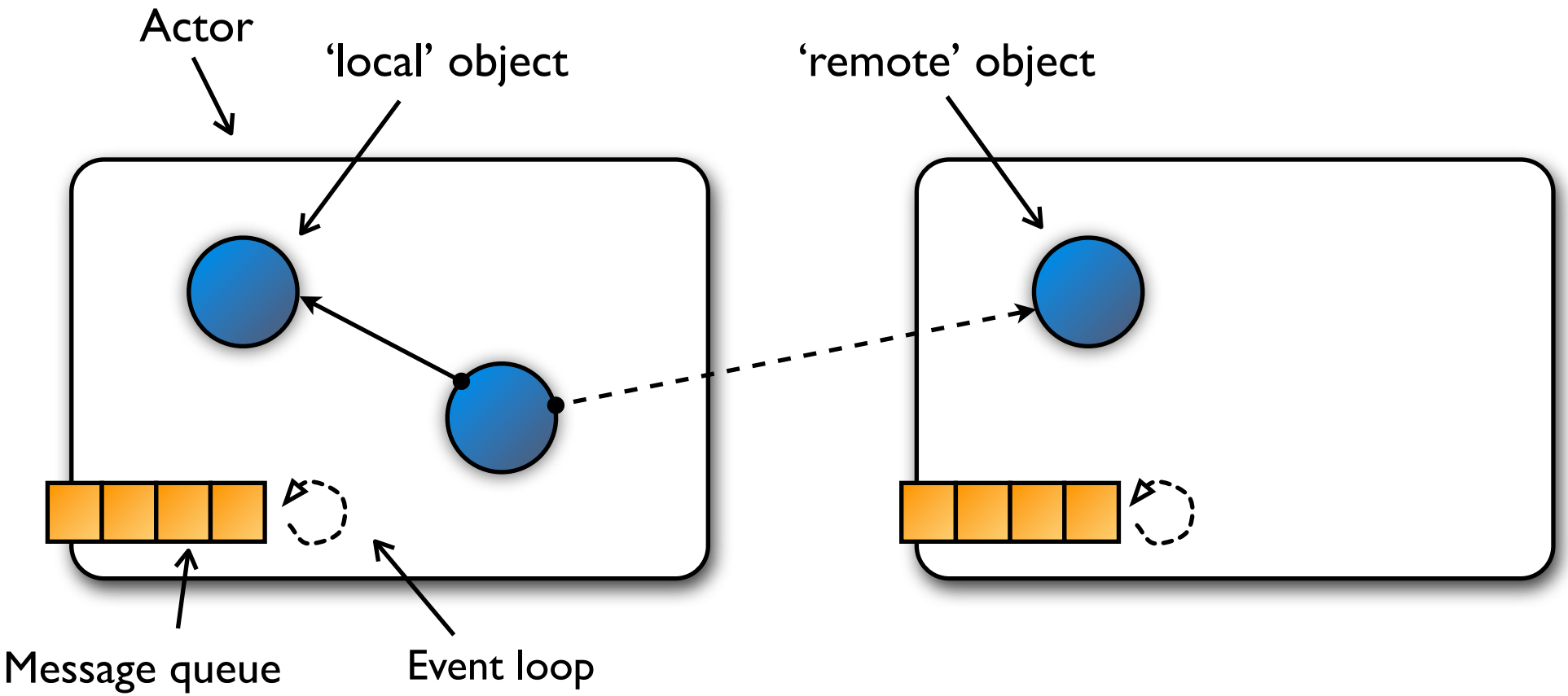

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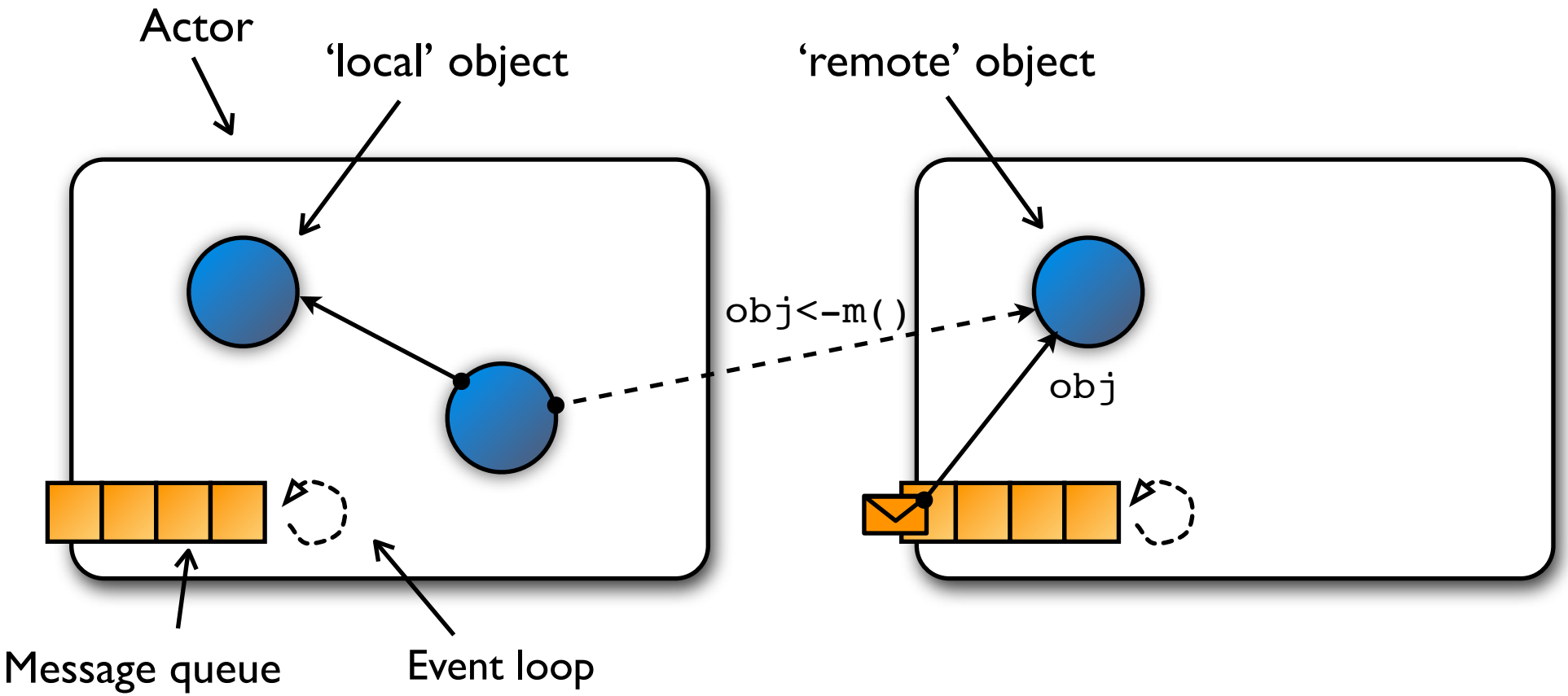

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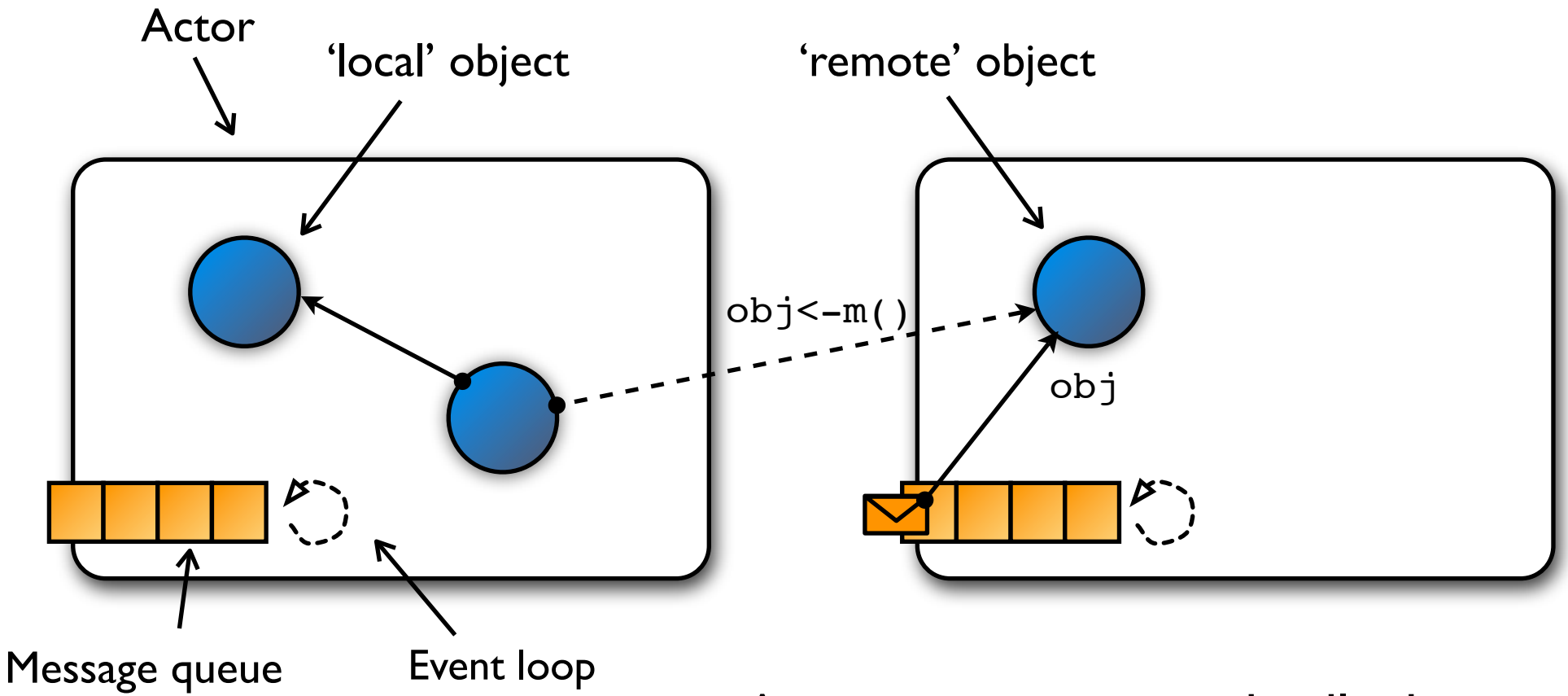
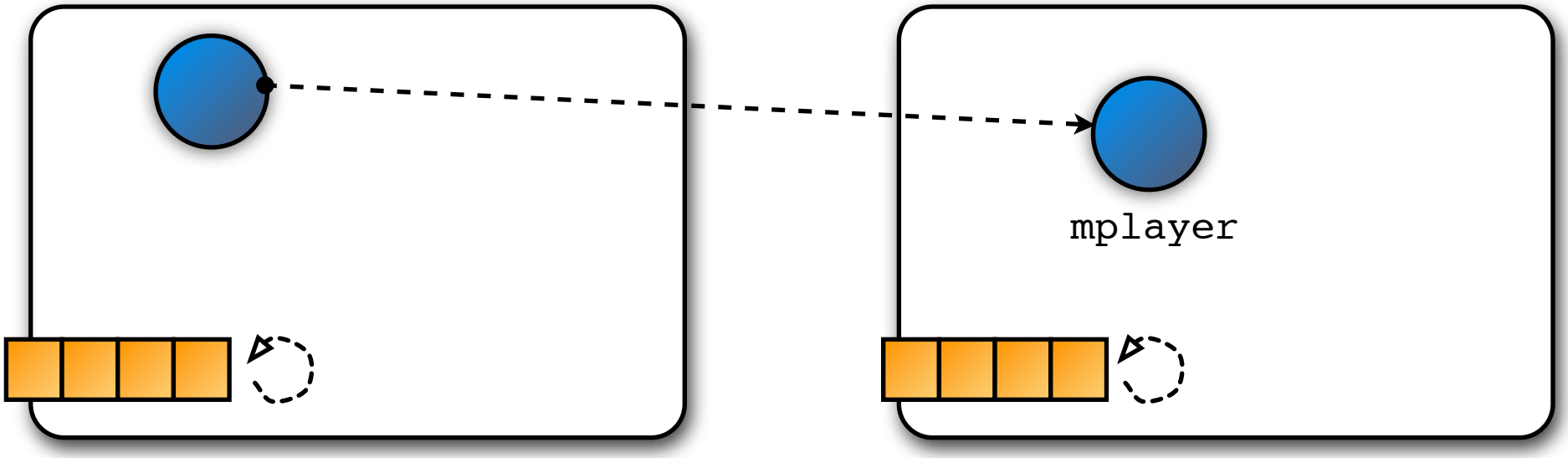


Actors cannot cause deadlock

No race conditions on objects

Futures

```
def future := mplayer<-numSongsInLibrary()
```



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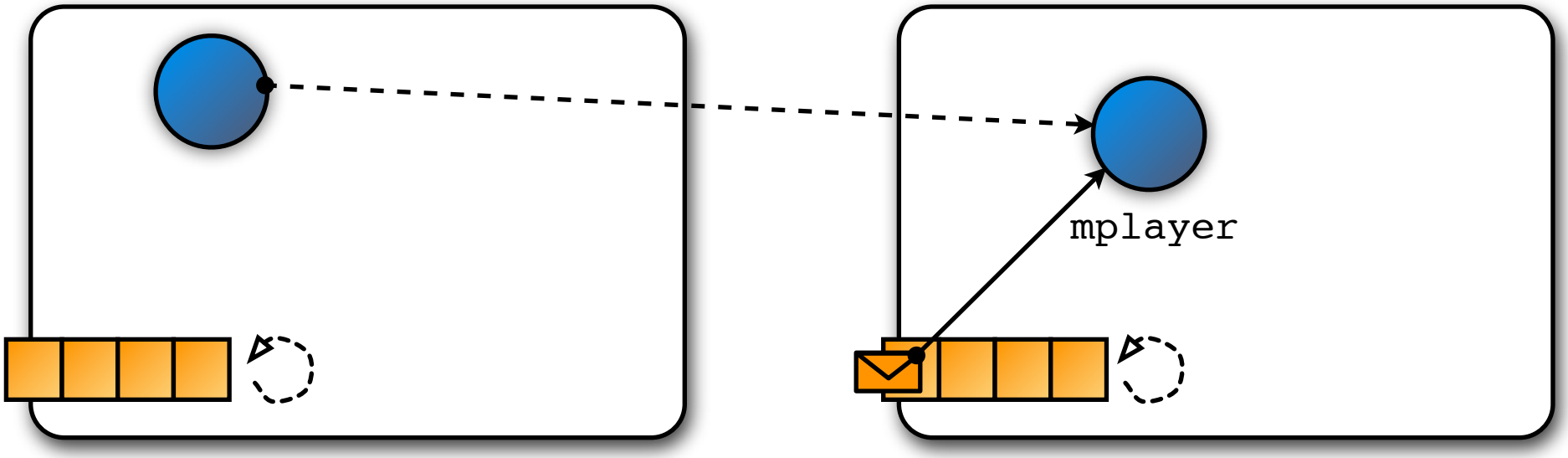

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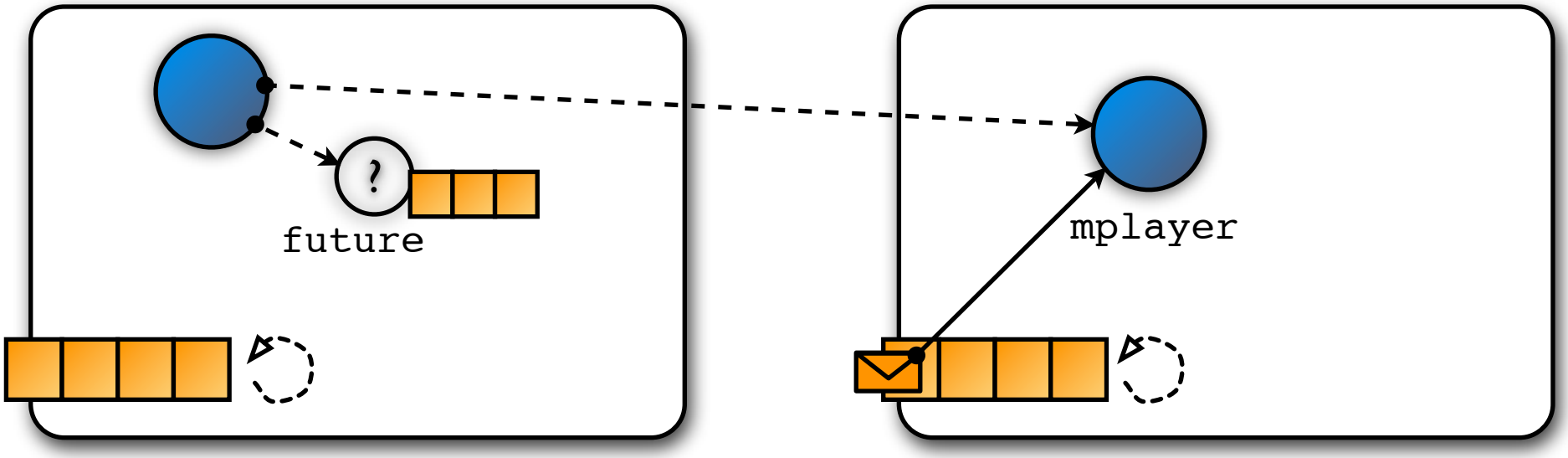

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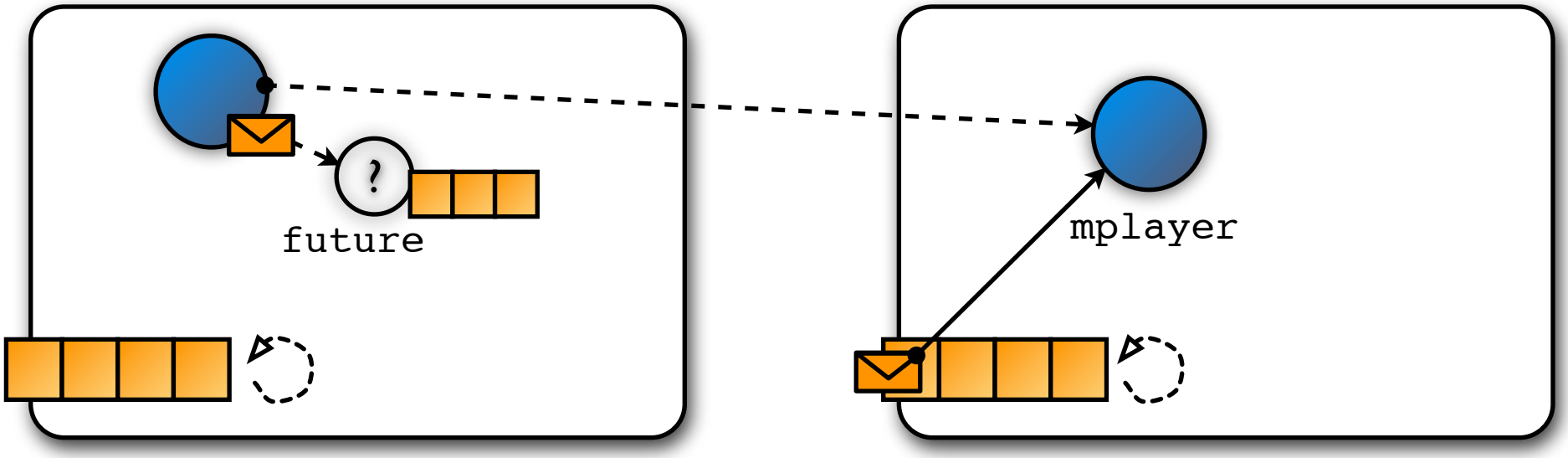

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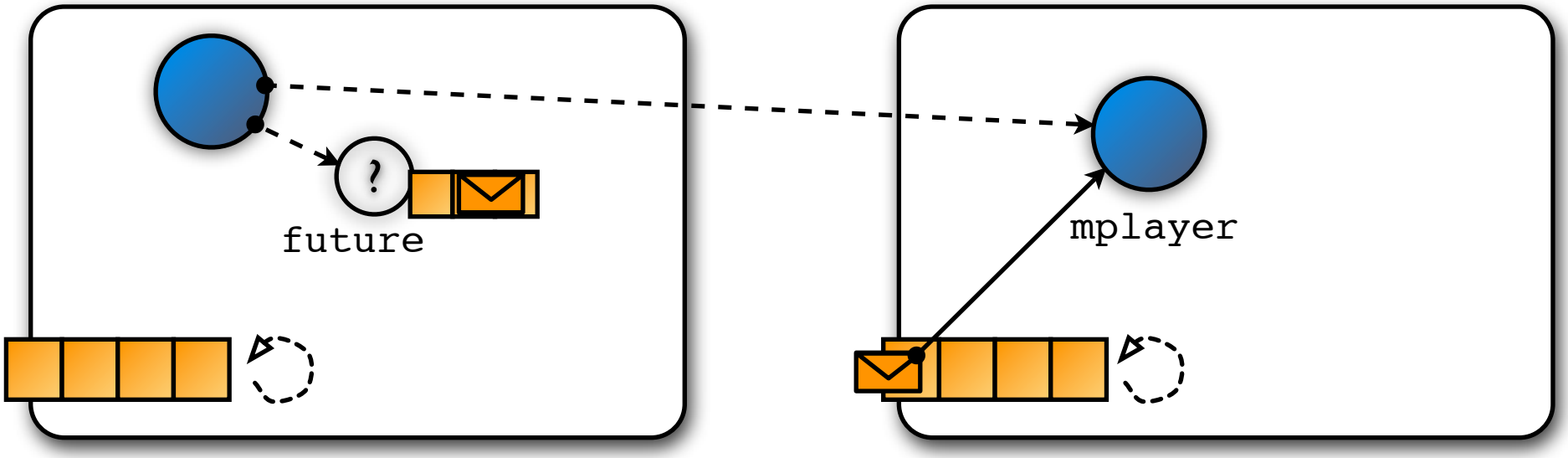

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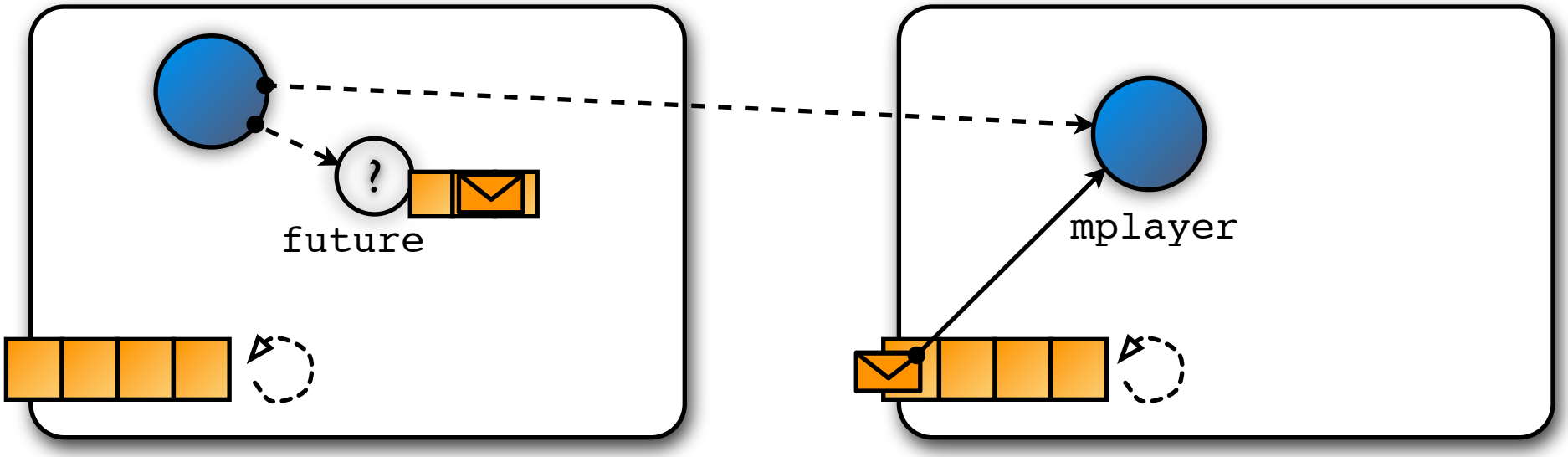


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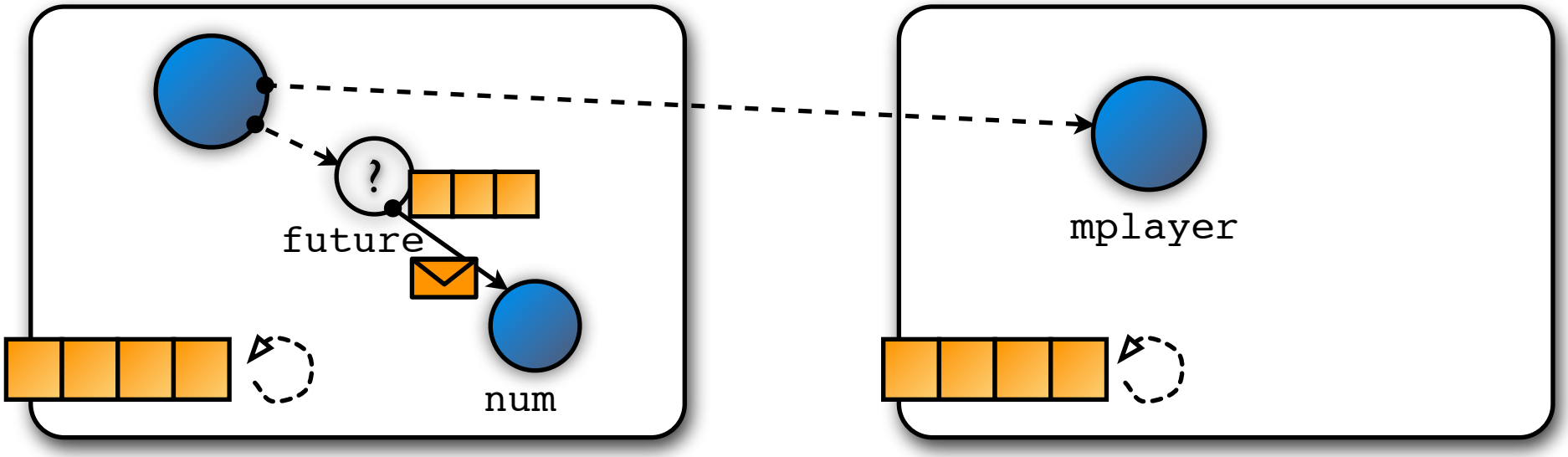


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Exporting objects

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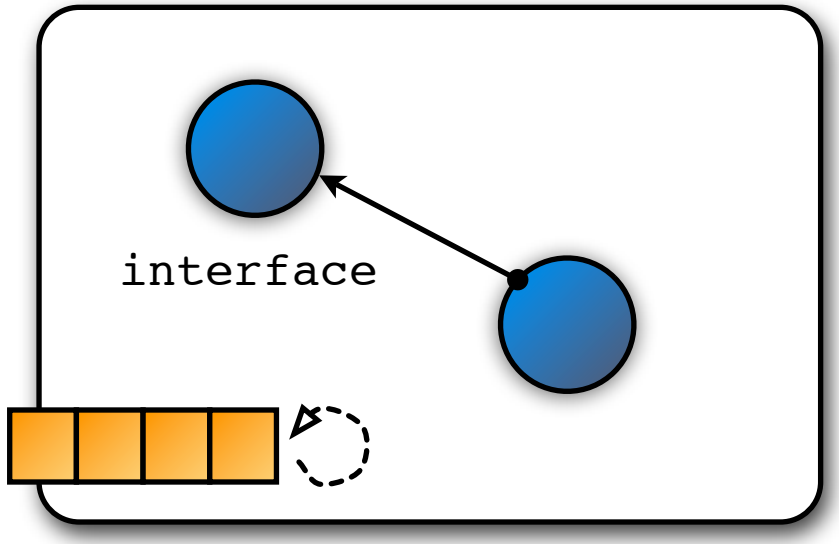
deftype MusicPlayer;

def interface := object: {
  def openSession() {
    ...
  }
}

export: interface as: MusicPlayer;
```



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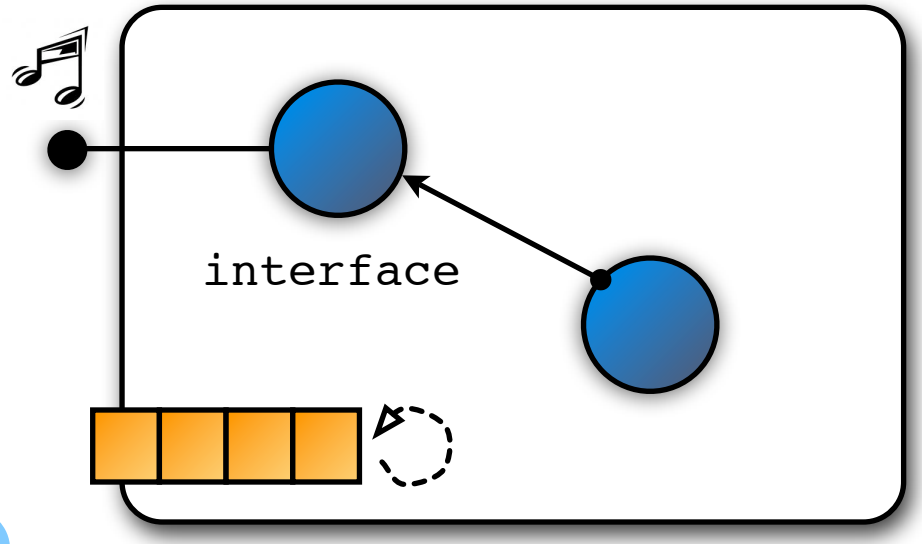

Ambient References

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def mplayerFuture := ambient: MusicPlayer;
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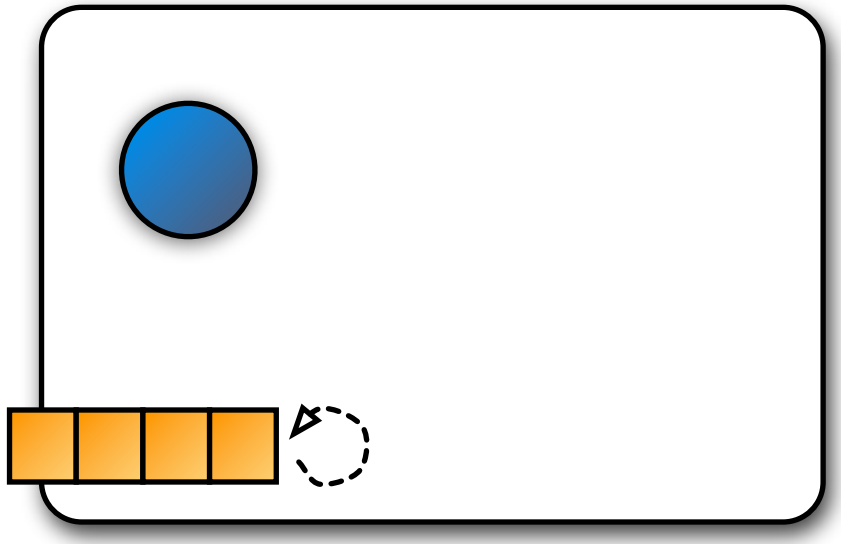

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- Immediately returns future for object to be discovered

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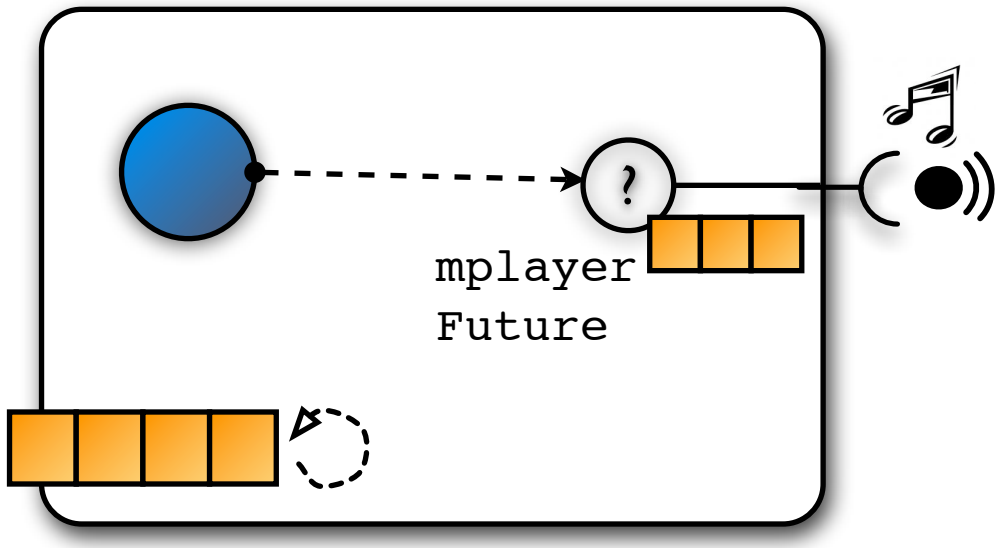

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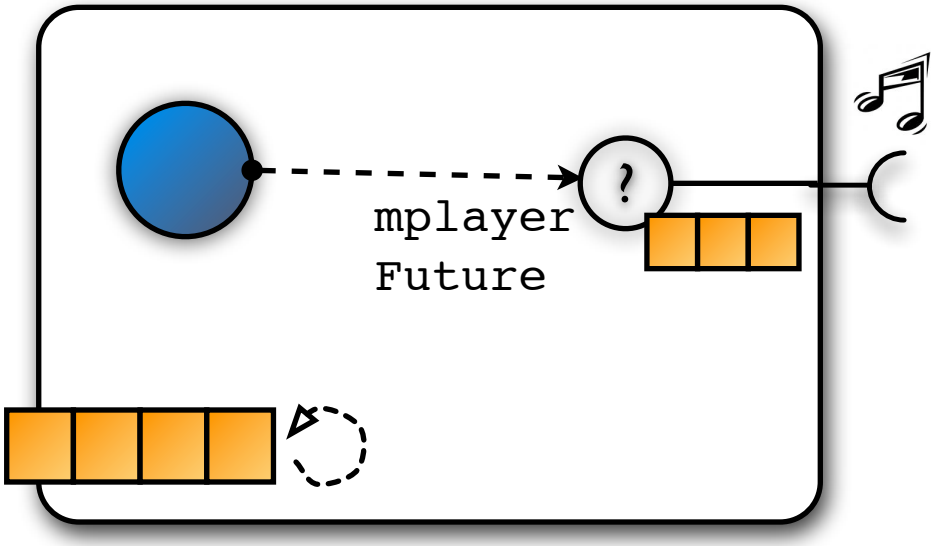

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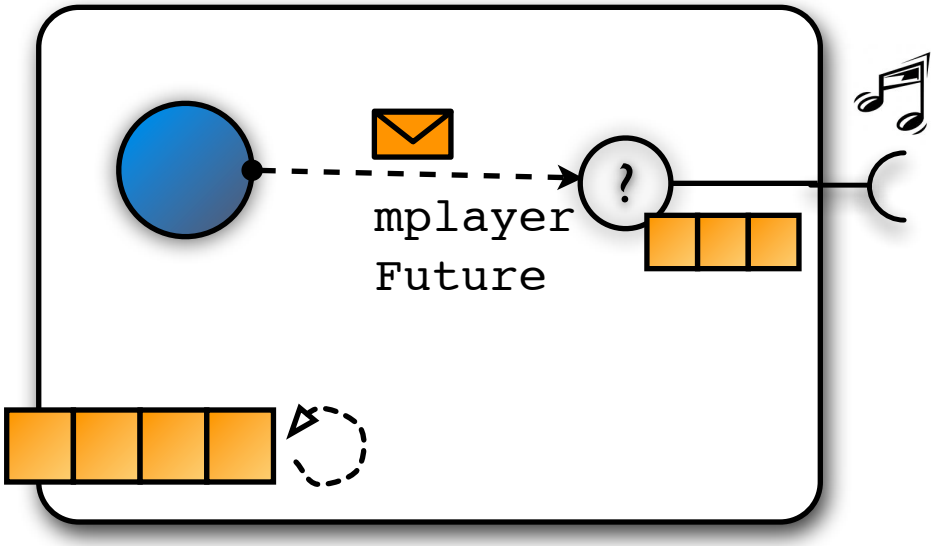

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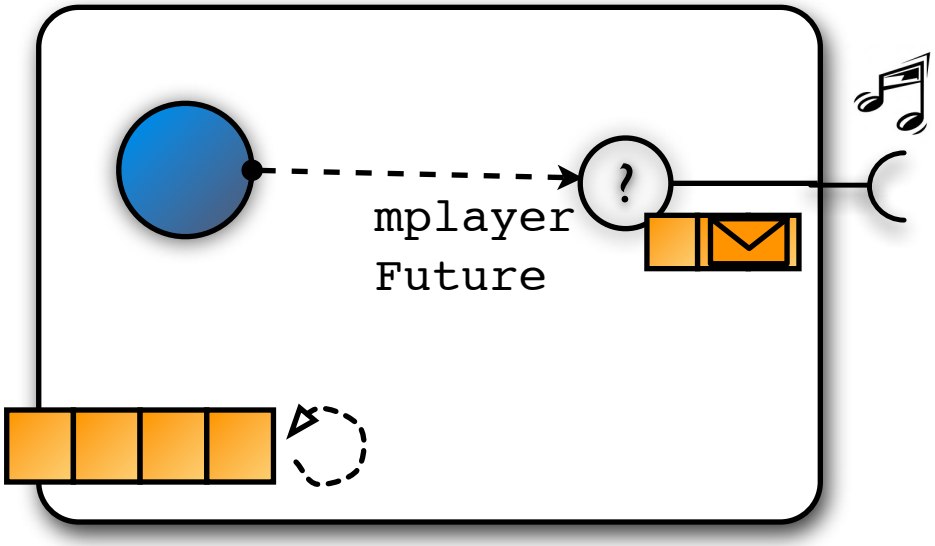

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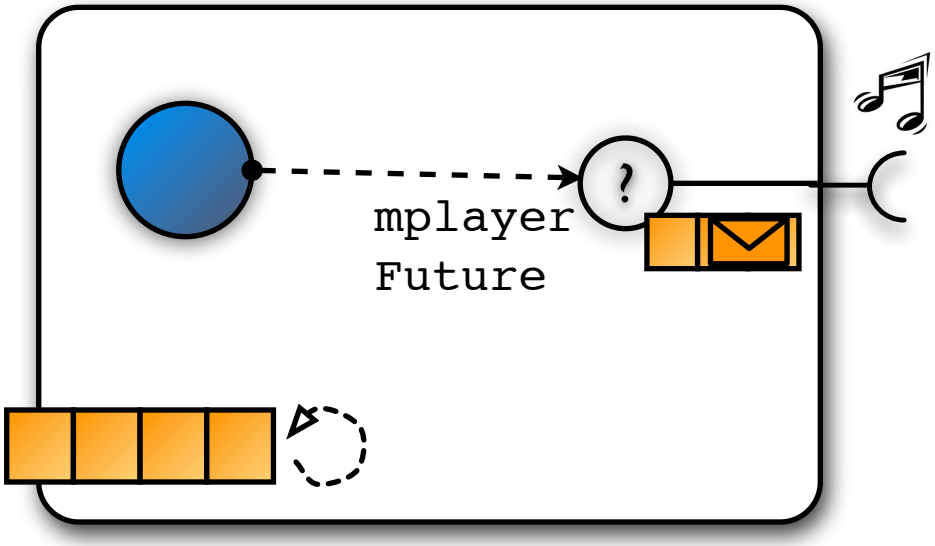


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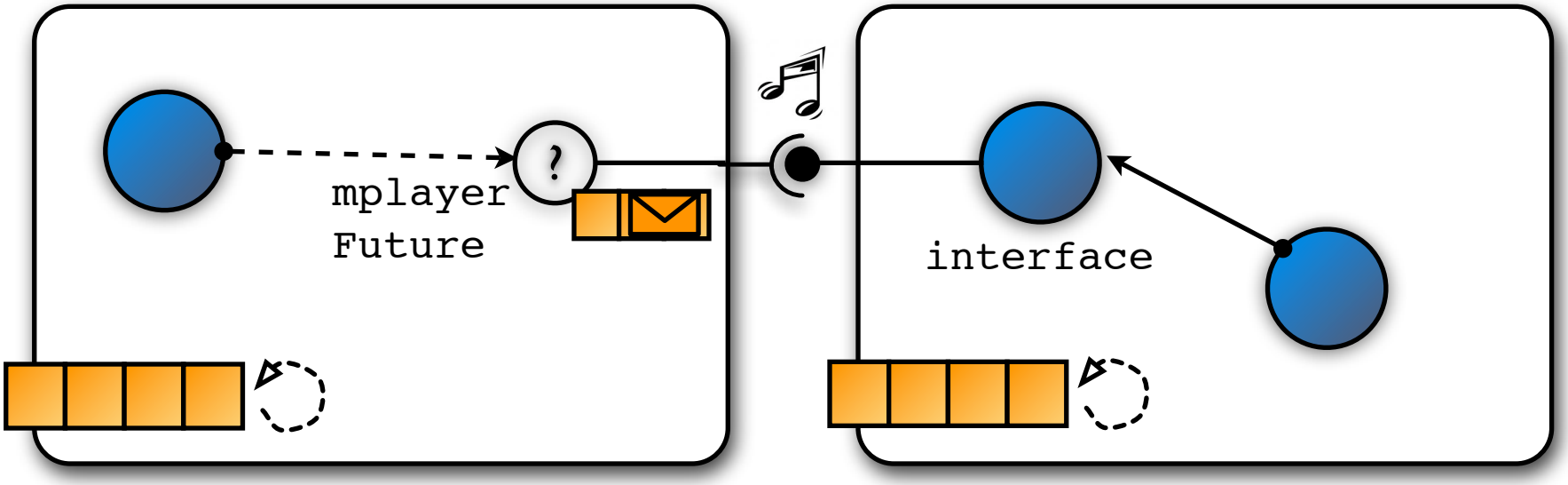


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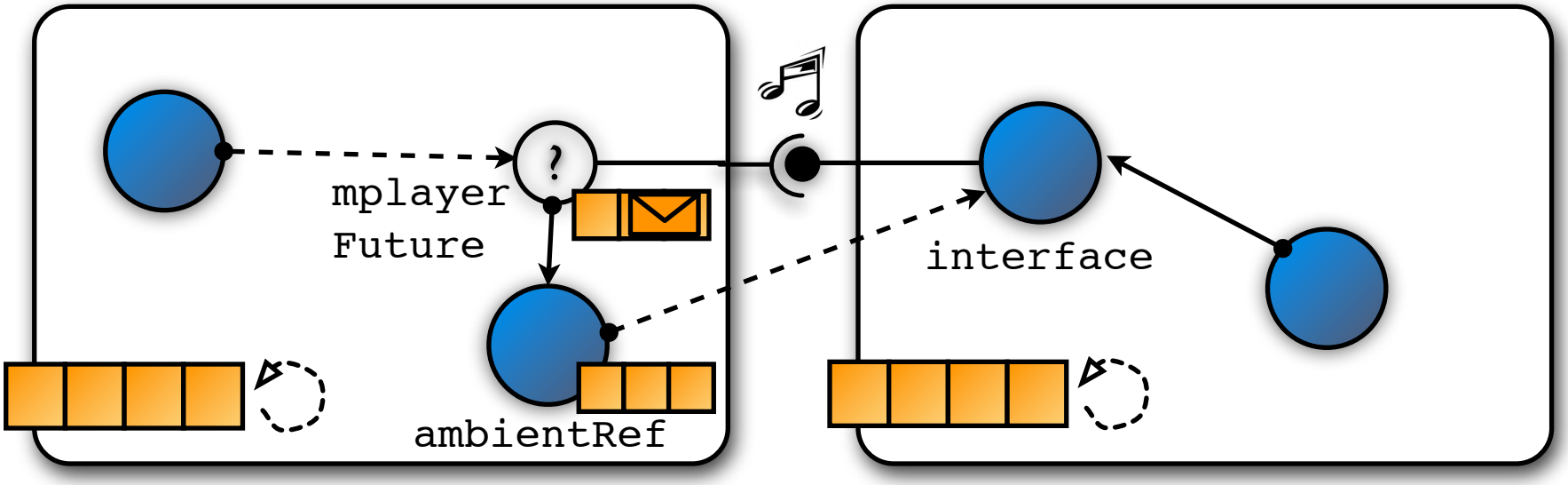


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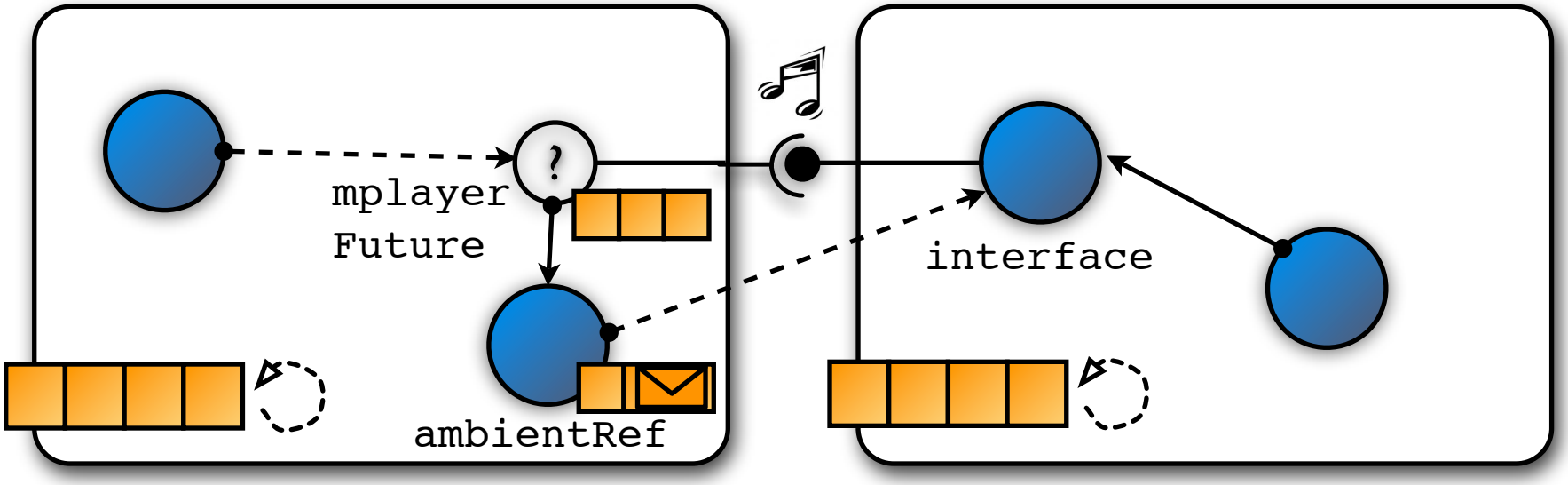


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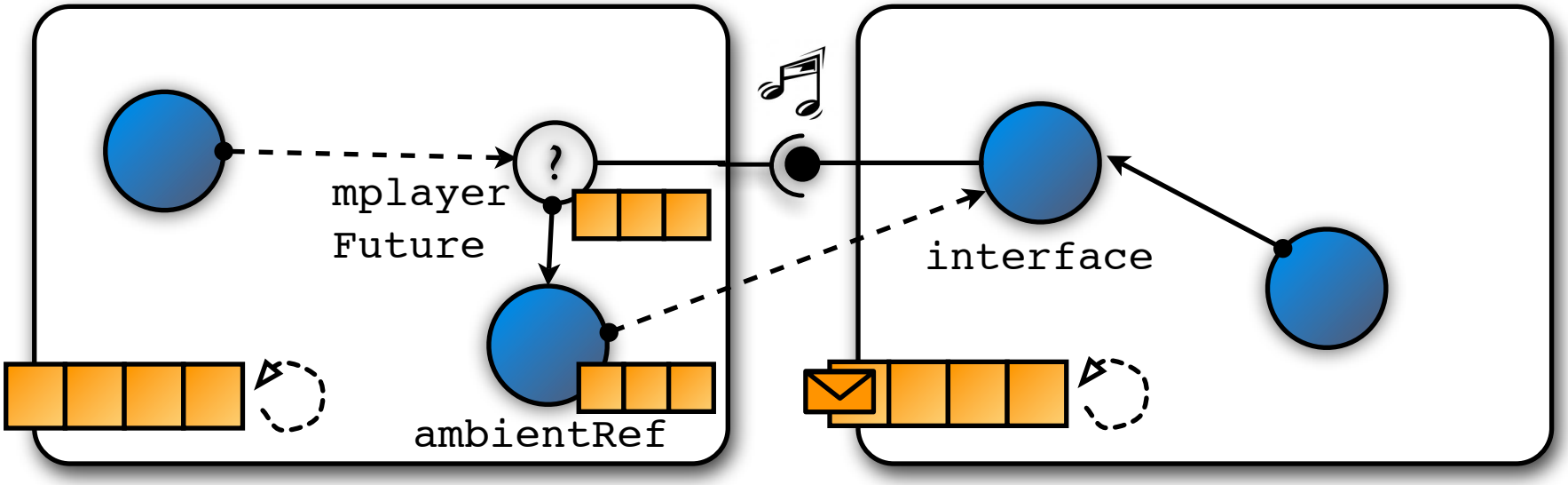


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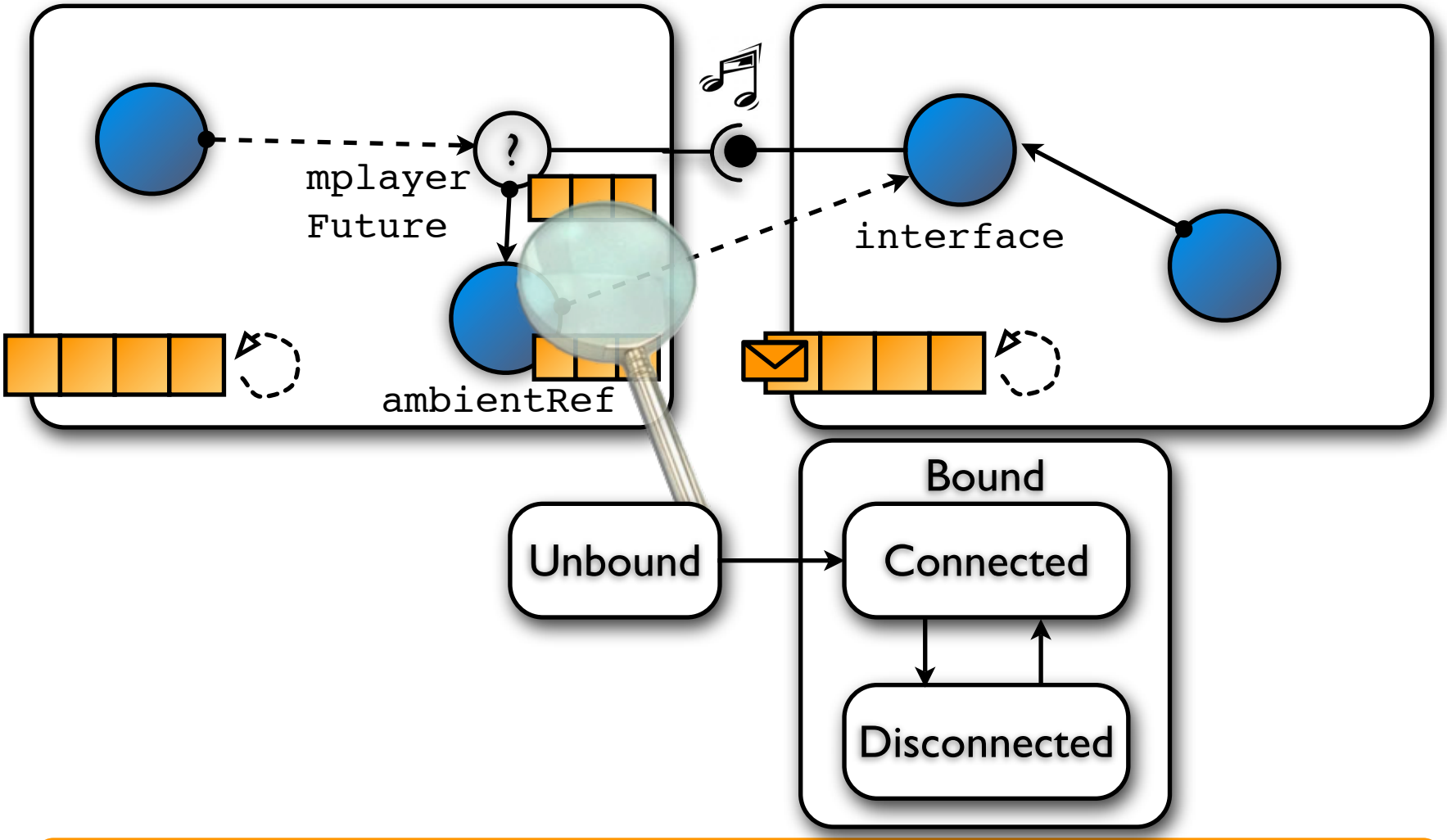
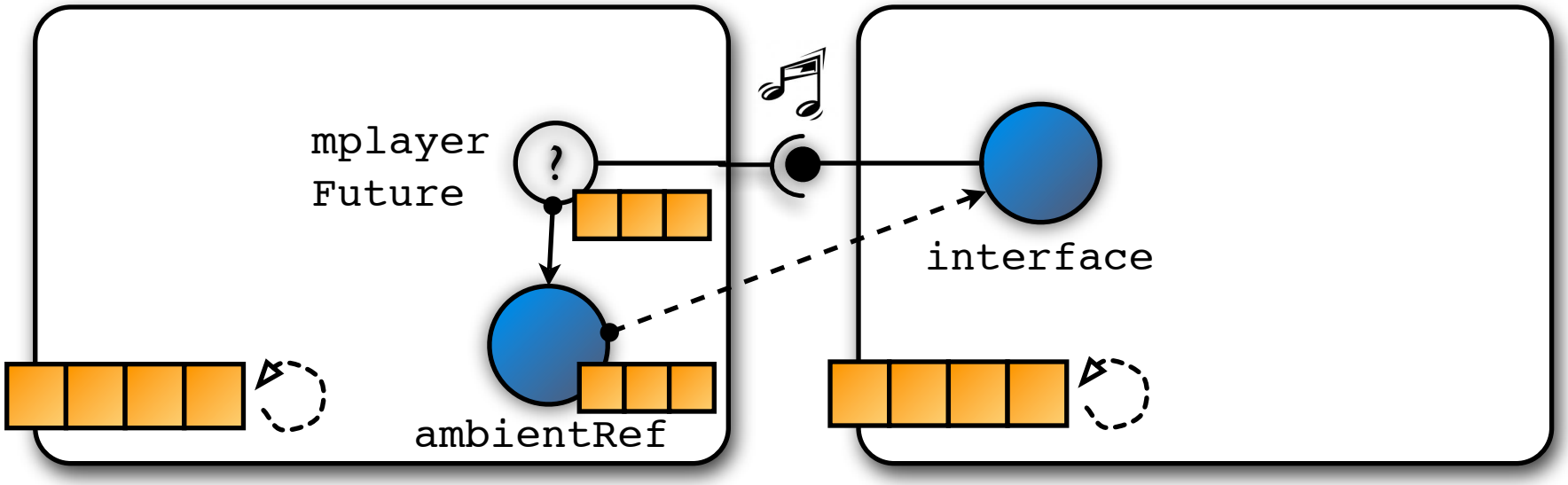


Failure handling

- Event handlers on ambient references:

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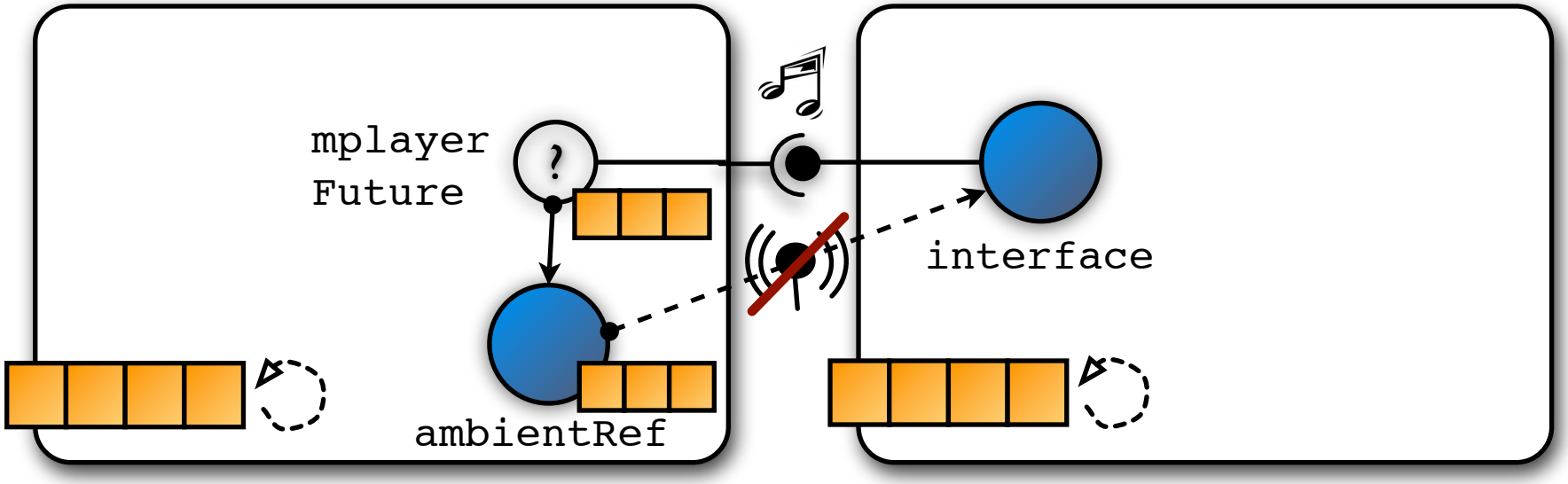


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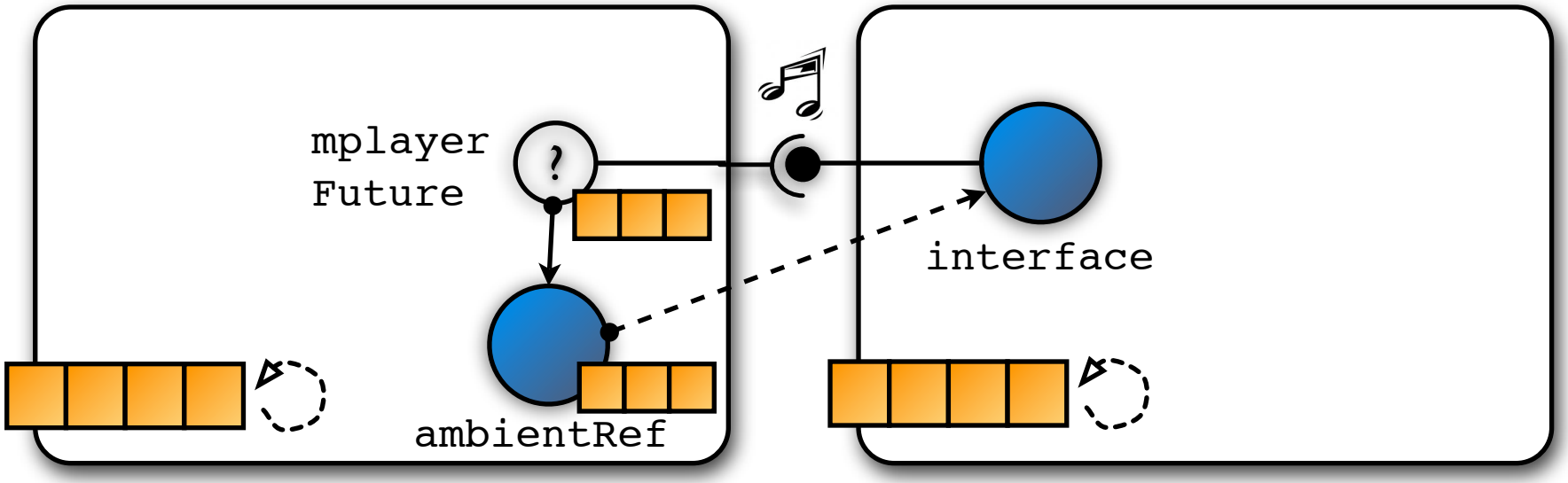


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Failure Handling

- Leased references which eventually expire
- Futures + timeouts

```
when: o<-m()@Timeout(minutes(10)) becomes: { |v|
  // process return value
} catch: TimeoutException using: { |e|
  // deal with timeout
}
```

Variations

- Past experiments:
  - ambient 'omni'-references: broadcasting
  - content-based discovery
- Future experiments:
  - Customisable message delivery guarantees
  - First-class proximity: restrict spatial scope of ambient references

Lessons Learned

- AmbientTalk = OO + Events:
  - Block closures as nested event handlers
  - Futures: non-blocking synchronisation
  - Buffered asynchronous messaging abstracts over intermittent connectivity
  - Ambient references: space-decoupled remote object references

Conclusion

- MANETs: loosely coupled collaboration
- AmbientTalk: actor-based OO language
- Deal with universal MANET characteristics at the language level:


Intermittent Connectivity: time & sync-decoupled references


Scarce Infrastructure: space-decoupled references

http://prog.vub.ac.be/amop