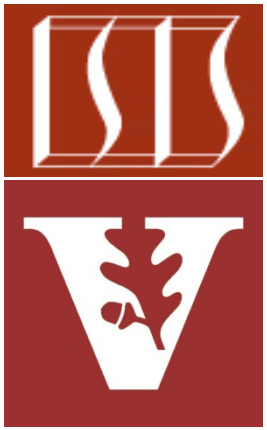
Android Concurrency: Java Synchronization & Scheduling Example (Part 1)



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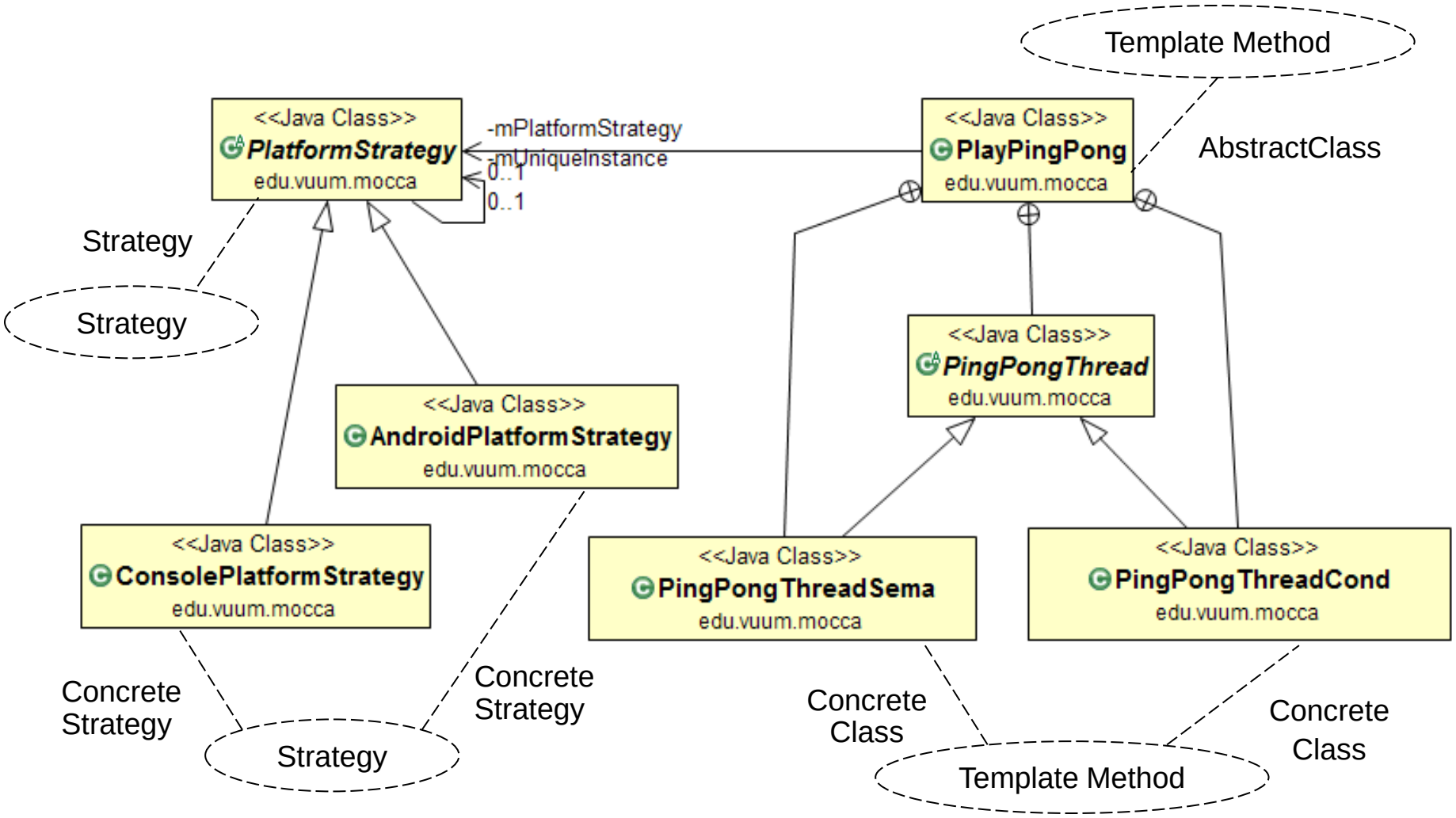
Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA

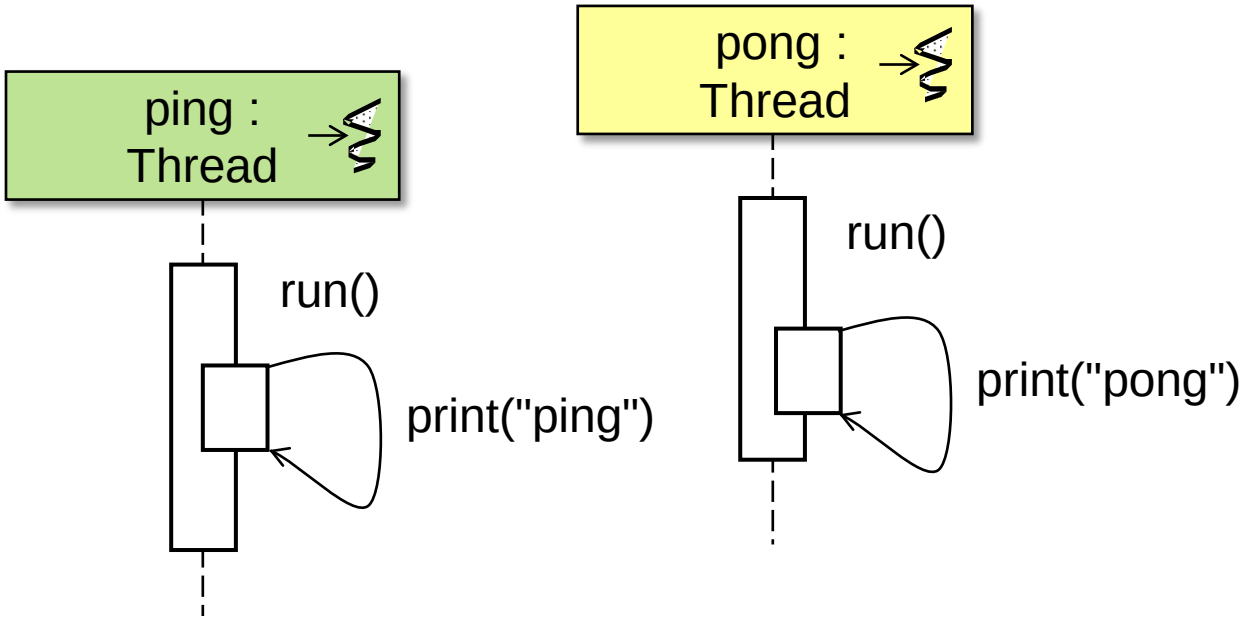
Learning Objectives in this Part of the Module

- Understand the design of a pattern-oriented framework schedules two Java threads that alternate printing “Ping” & “Pong” on the computer console



Outline of a Pattern-Oriented Framework Solution

- The earlier ping-pong program we analyzed was buggy since it lacked proper concurrency control




```
% java PingPongWrong
Ready...Set...Go!
Ping!(1)
Ping!(2)
Ping!(3)
Ping!(4)
Ping!(5)
Ping!(6)
Ping!(7)
Ping!(8)
Ping!(9)
Ping!(10)
Pong!(1)
Pong!(2)
Pong!(3)
Pong!(4)
Pong!(5)
Pong!(6)
Pong!(7)
Pong!(8)
Pong!(9)
Pong!(10)
Done!
```

See prior part on “Motivating Java Synchronization & Scheduling Mechanisms”

Outline of a Pattern-Oriented Framework Solution

- The earlier ping-pong program we analyzed was buggy since it lacked proper concurrency control
  - This output's correct since it coordinates Thread interactions via Java synchronizers

```
% java PlayPingPong
Ready...Set...Go!
Ping!(1)
Pong!(1)
Ping!(2)
Pong!(2)
Ping!(3)
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Done!
```

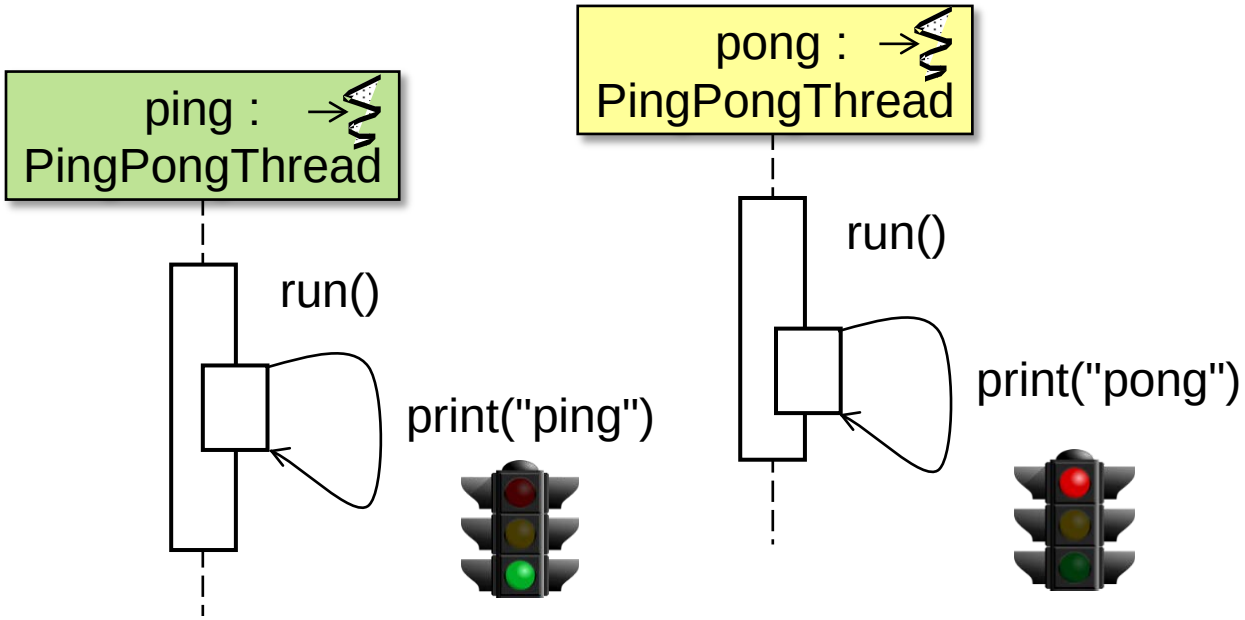

Outline of a Pattern-Oriented Framework Solution

- The earlier ping-pong program we analyzed was buggy since it lacked proper concurrency control
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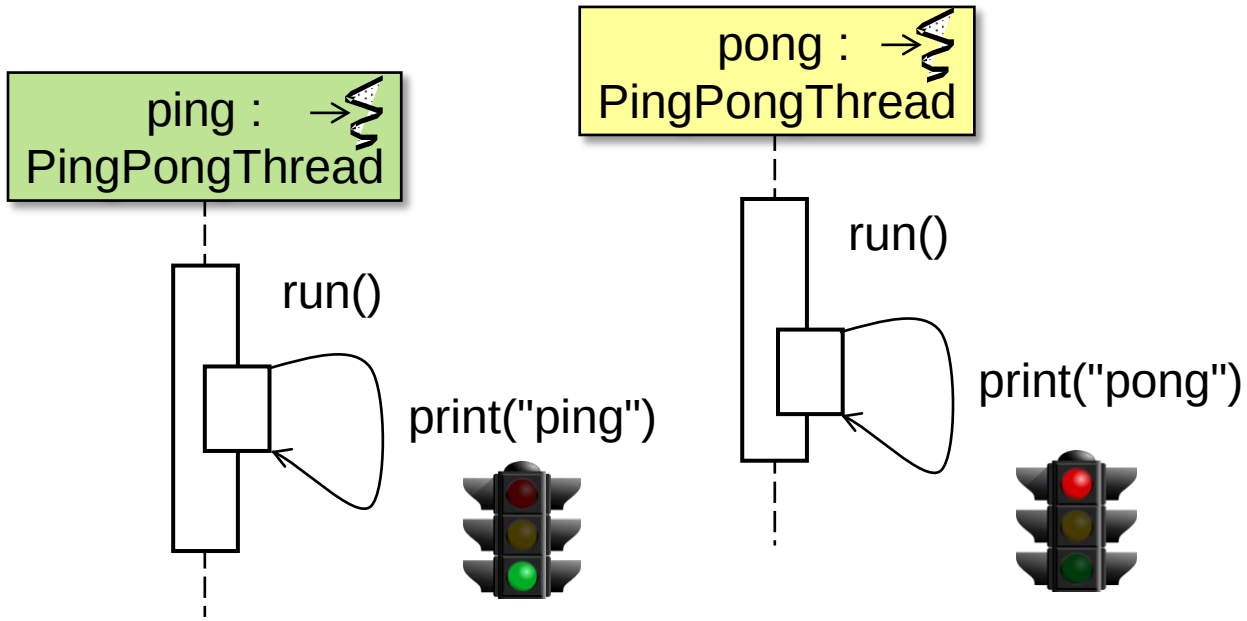
    - e.g., Semaphores, ConditionObjects, & CountDownLatches

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Pong!(10)
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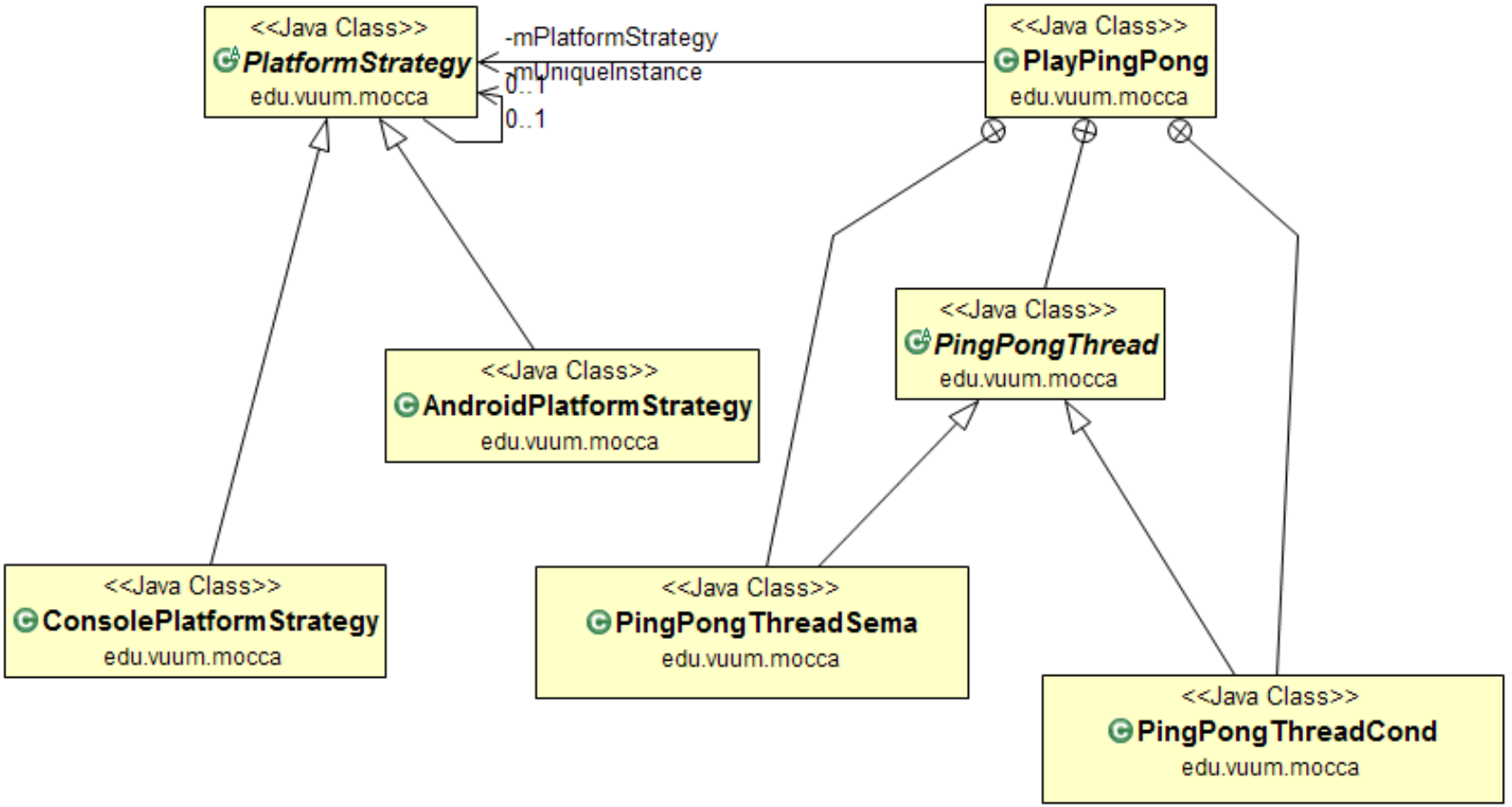
- This video examines the object-oriented design of the synchronized ping-pong program



Outline of a Pattern-Oriented Framework Solution

- The earlier ping-pong program we analyzed was buggy since it lacked proper concurrency control
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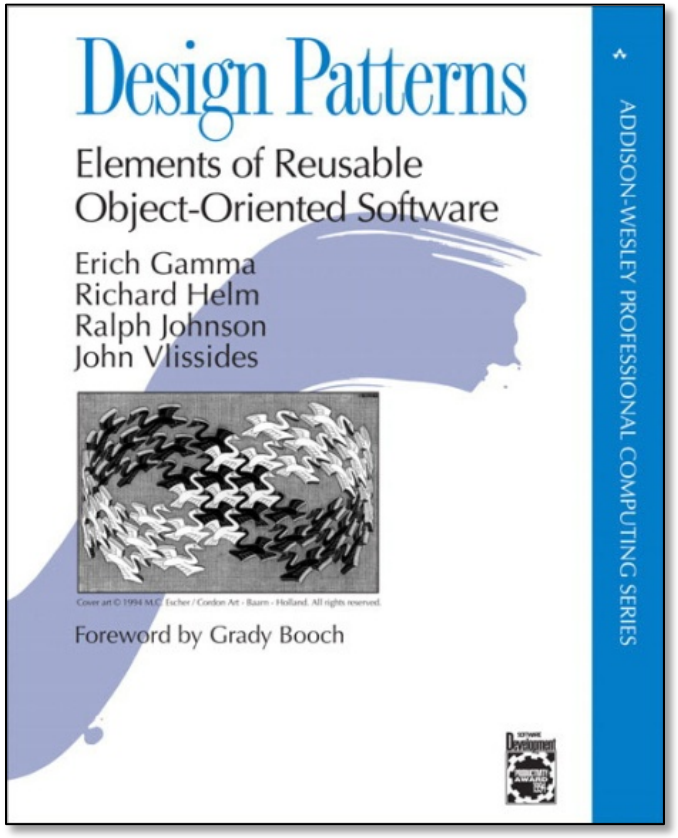
- "Gang-of-Four" patterns are applied to enhance the framework-based solution



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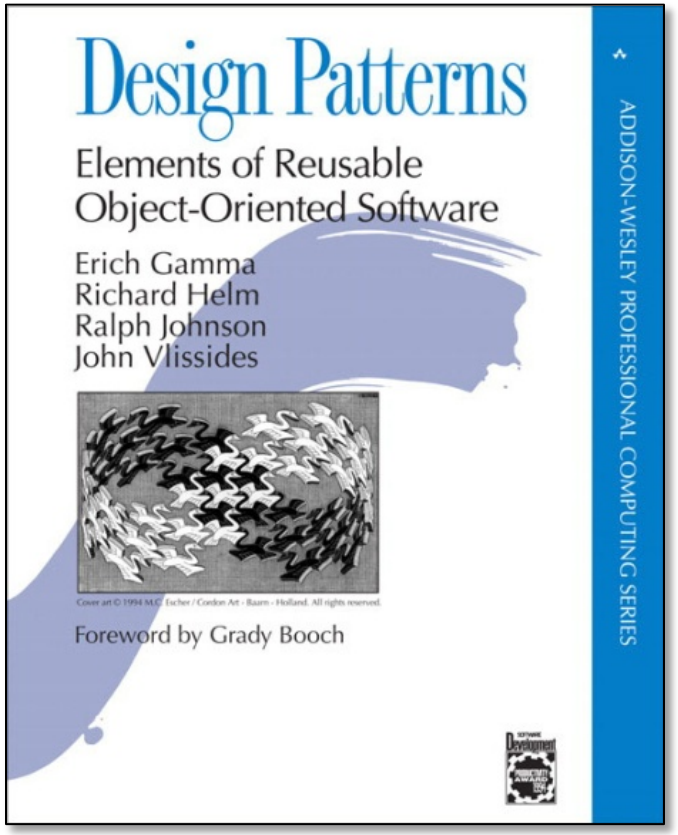

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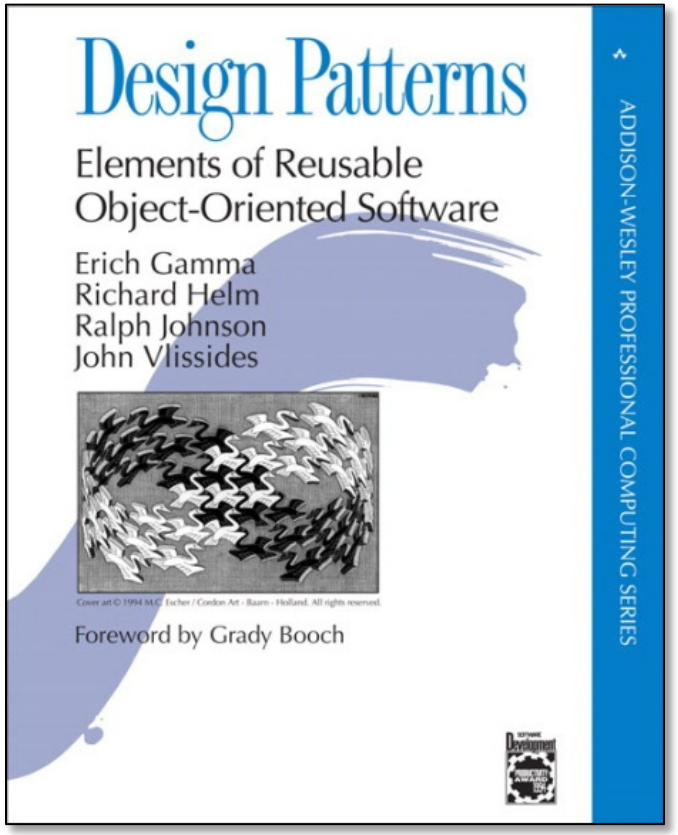

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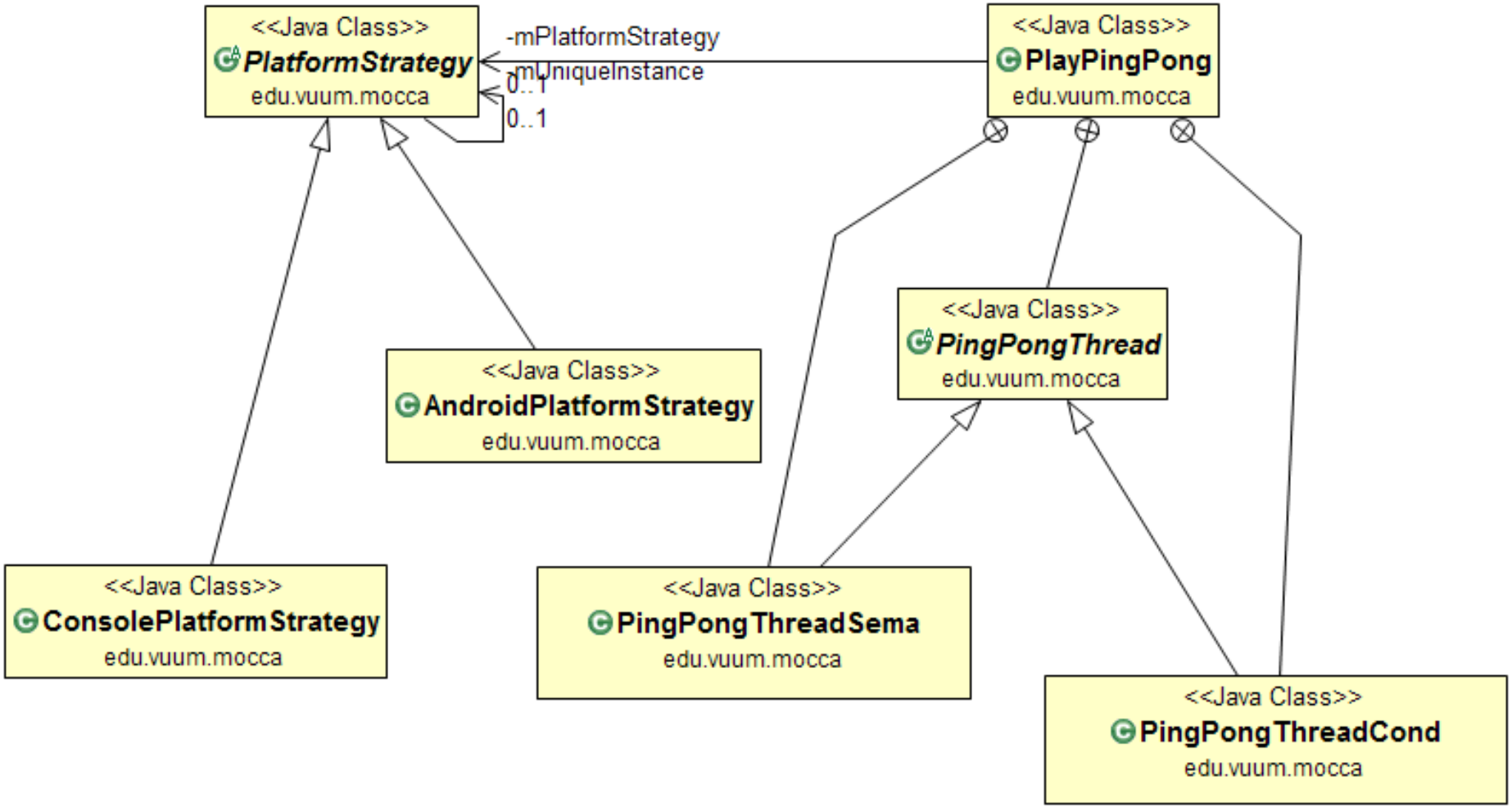
See upcoming section on "Android Concurrency Frameworks"

Object-Oriented Design of the Ping-Pong Program

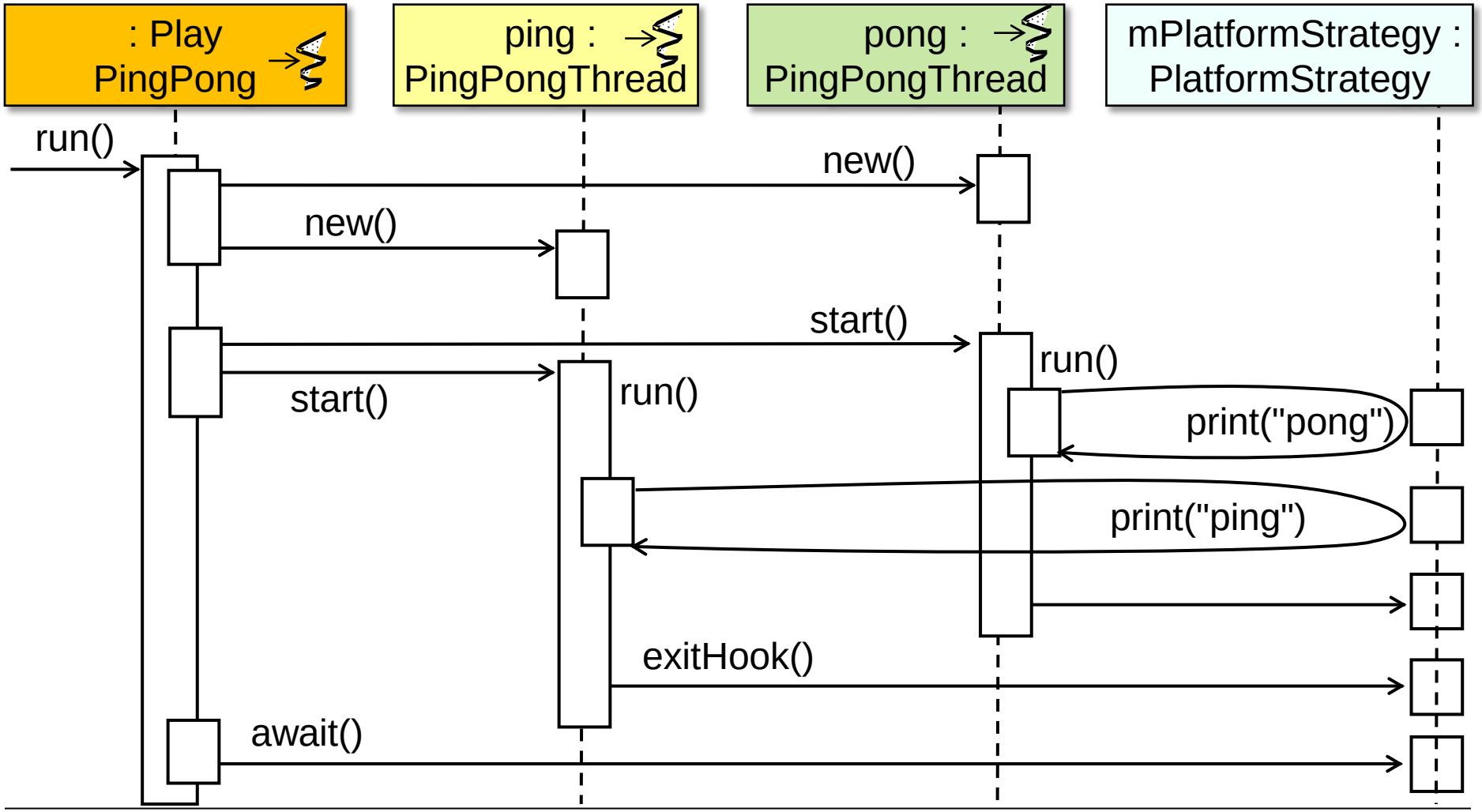
Design of the Ping-Pong Program

- UML class diagram for the ping-pong program



Design of the Ping-Pong Program

- UML sequence diagram for the ping-pong program



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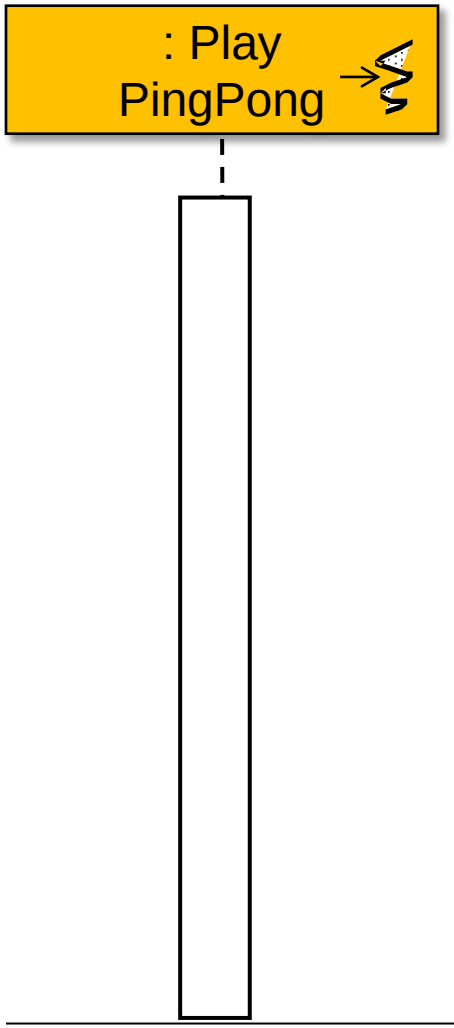

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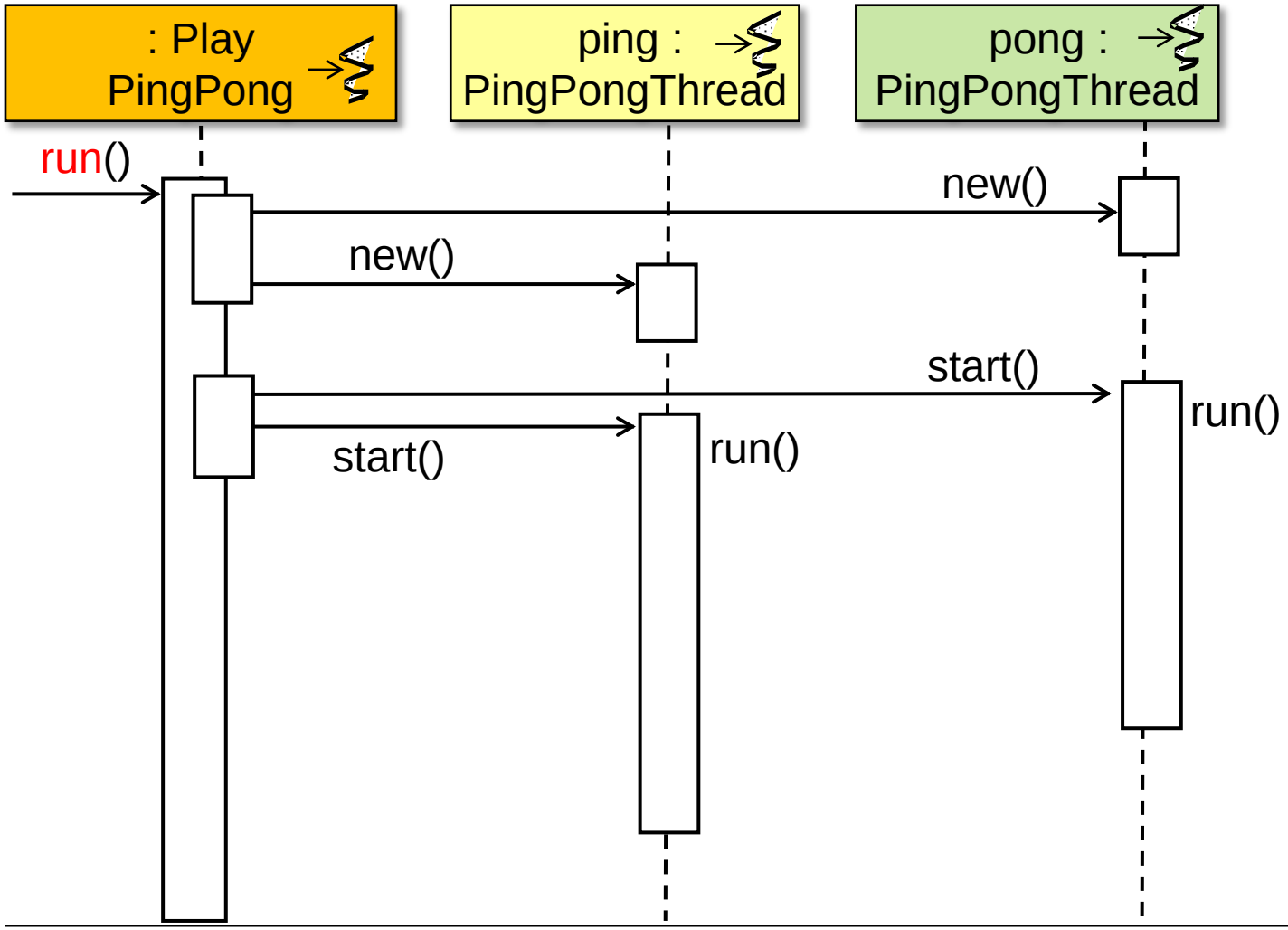

Design of the Ping-Pong Program

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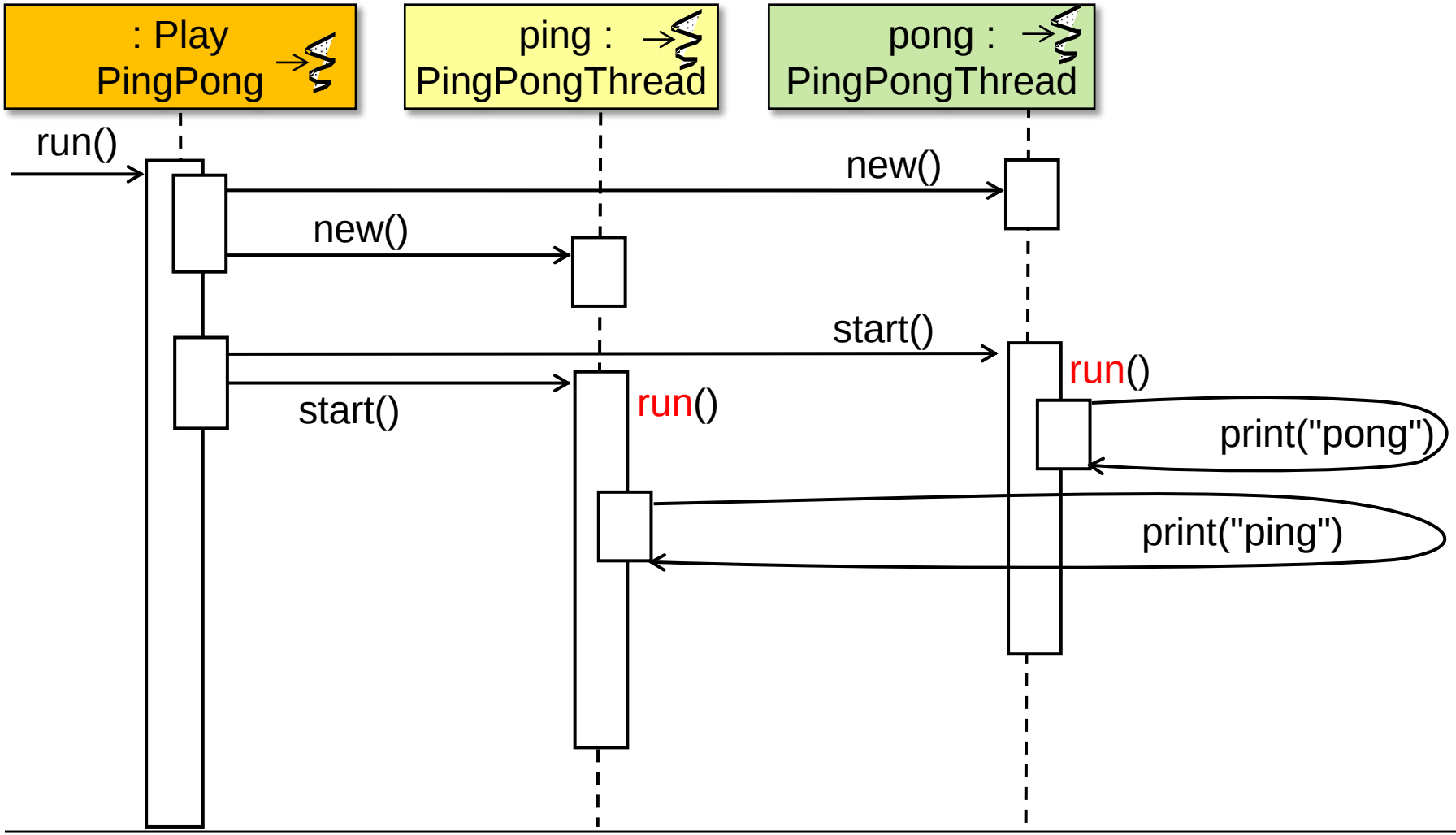
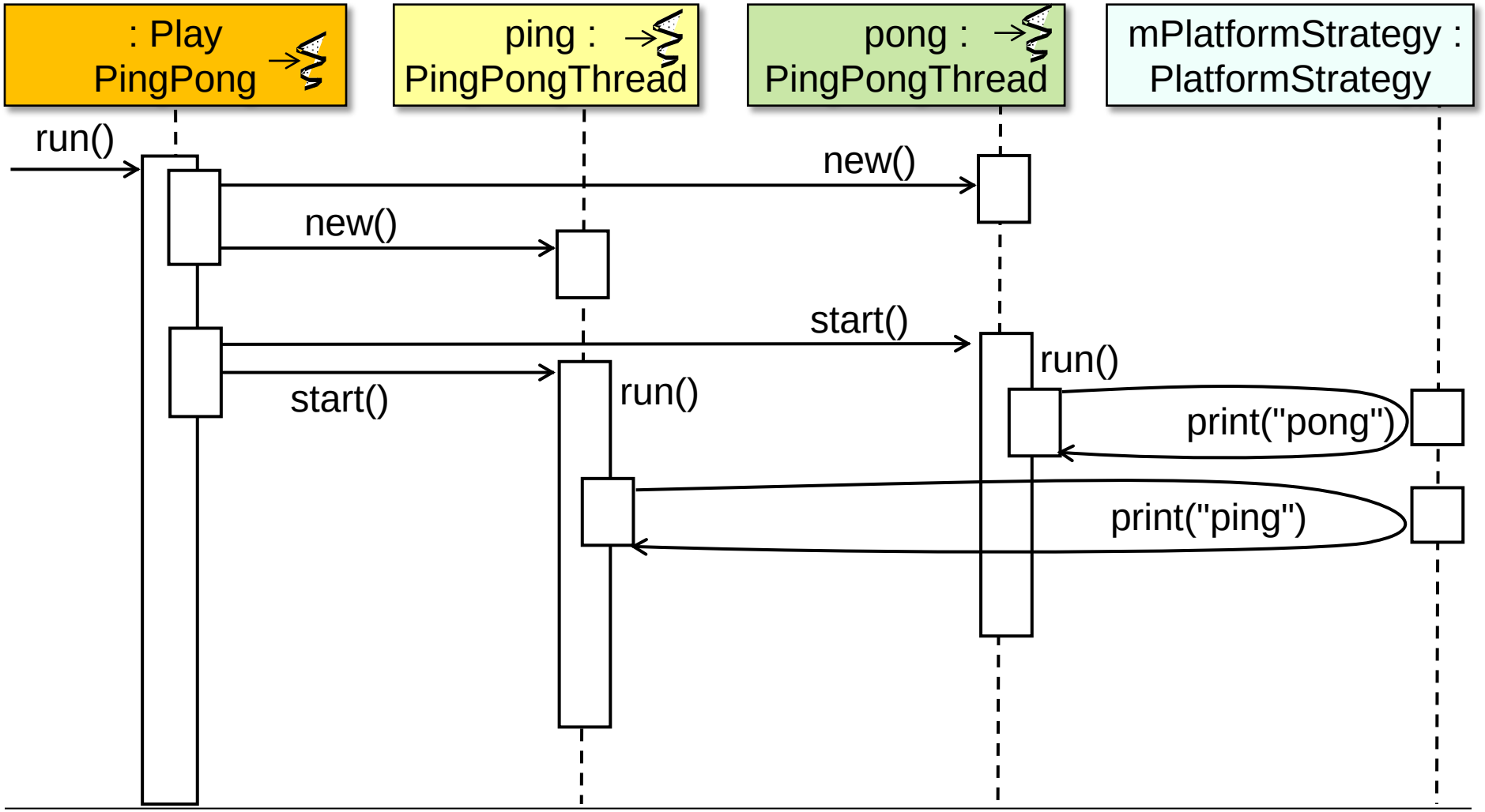


A pair of synchronizers controls the order in which “ping” & “pong” are called

Design of the Ping-Pong Program

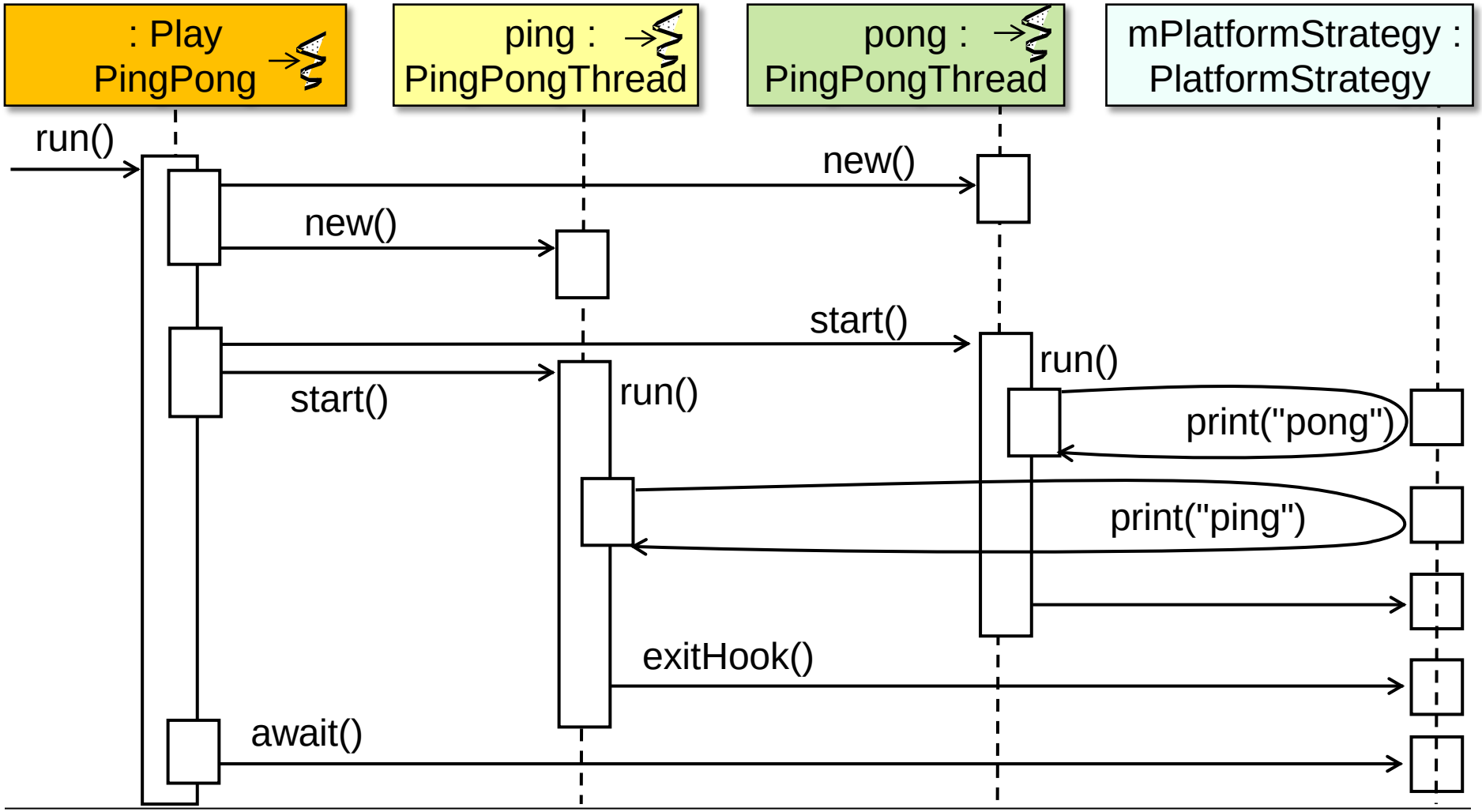
- UML sequence diagram for the ping-pong program



PlatformStrategy can be configured to support different runtime environments

Design of the Ping-Pong Program

- UML sequence diagram for the ping-pong program

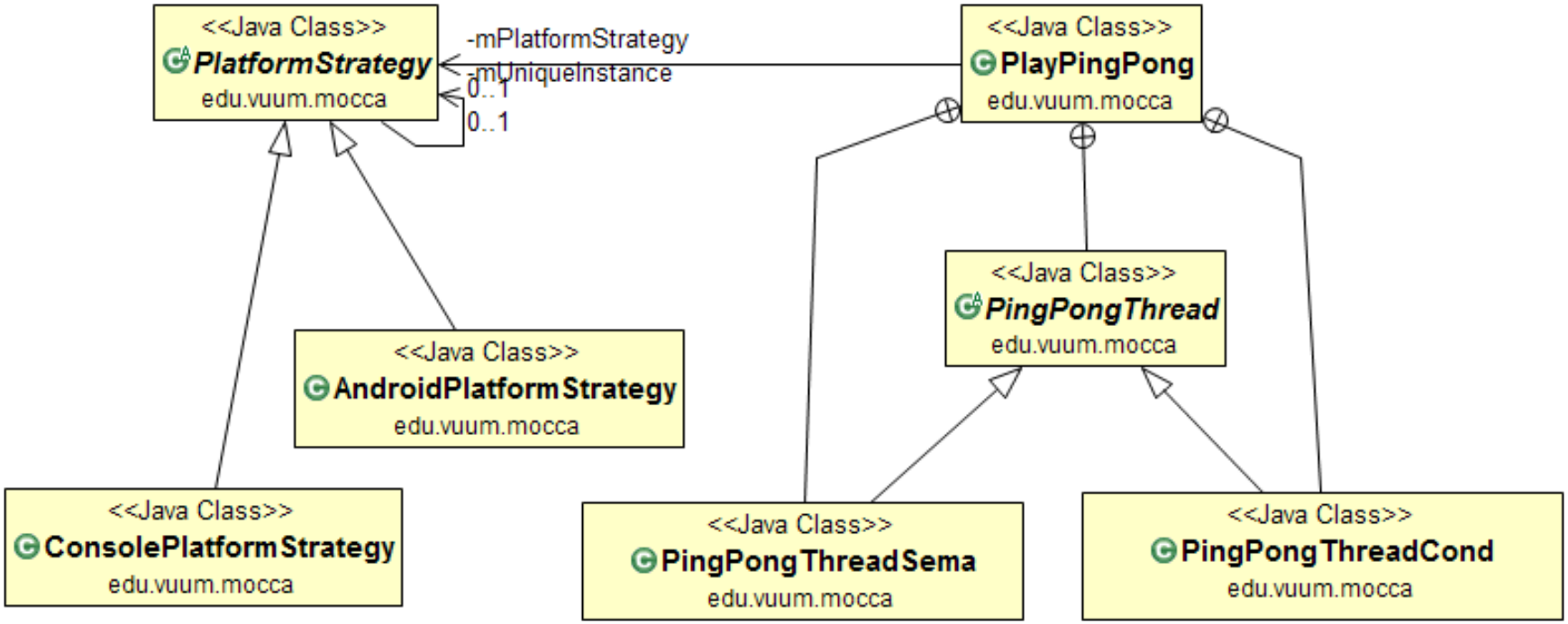


Extending this program is easy since it's pattern-oriented & framework-based

Pattern-Oriented Software Architecture of the Ping-Pong Program

Ping-Pong Pattern-Oriented Software Architecture

- Patterns guide the design of the ping-pong program classes



Ping-Pong Pattern-Oriented Software Architecture

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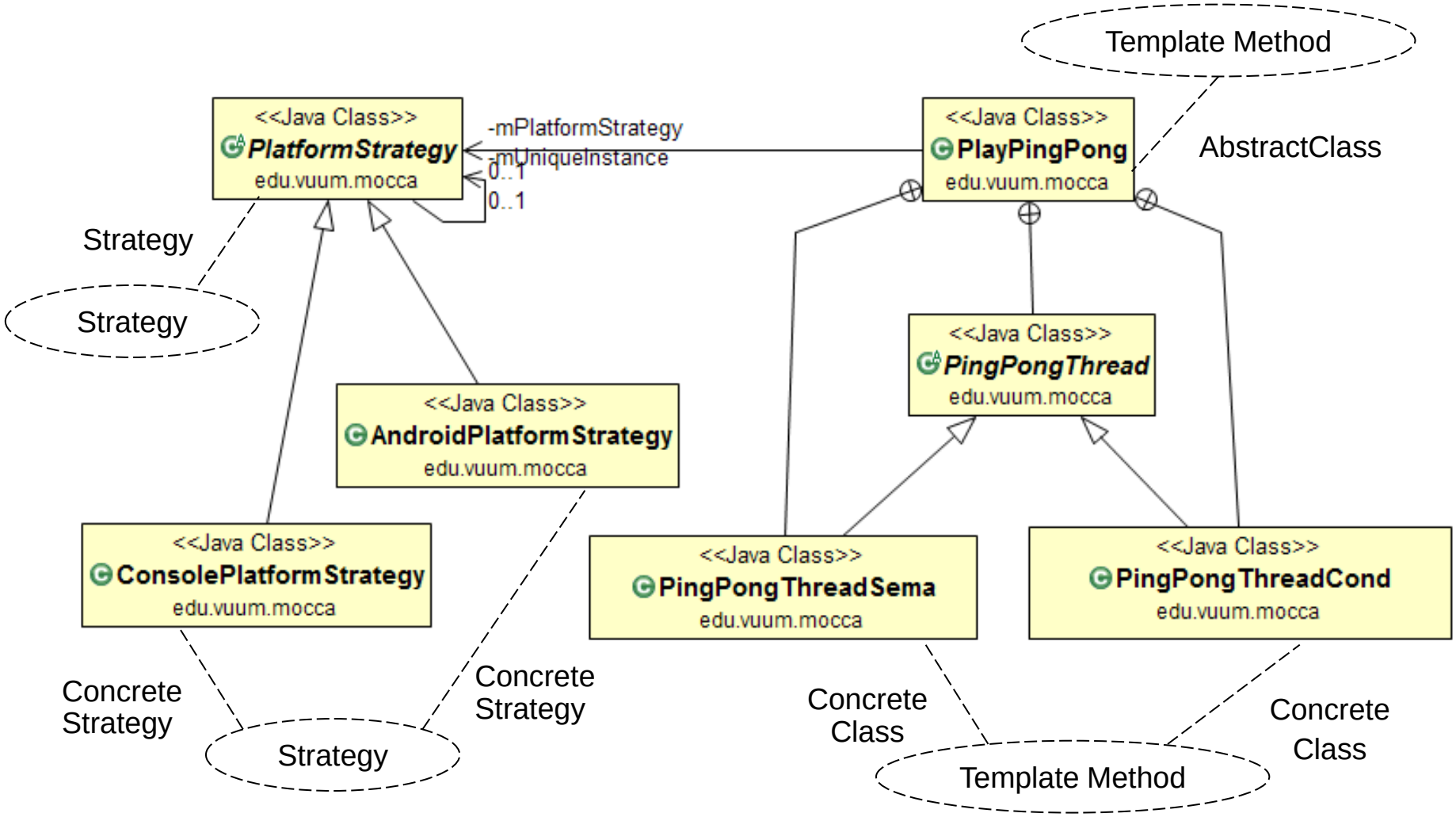


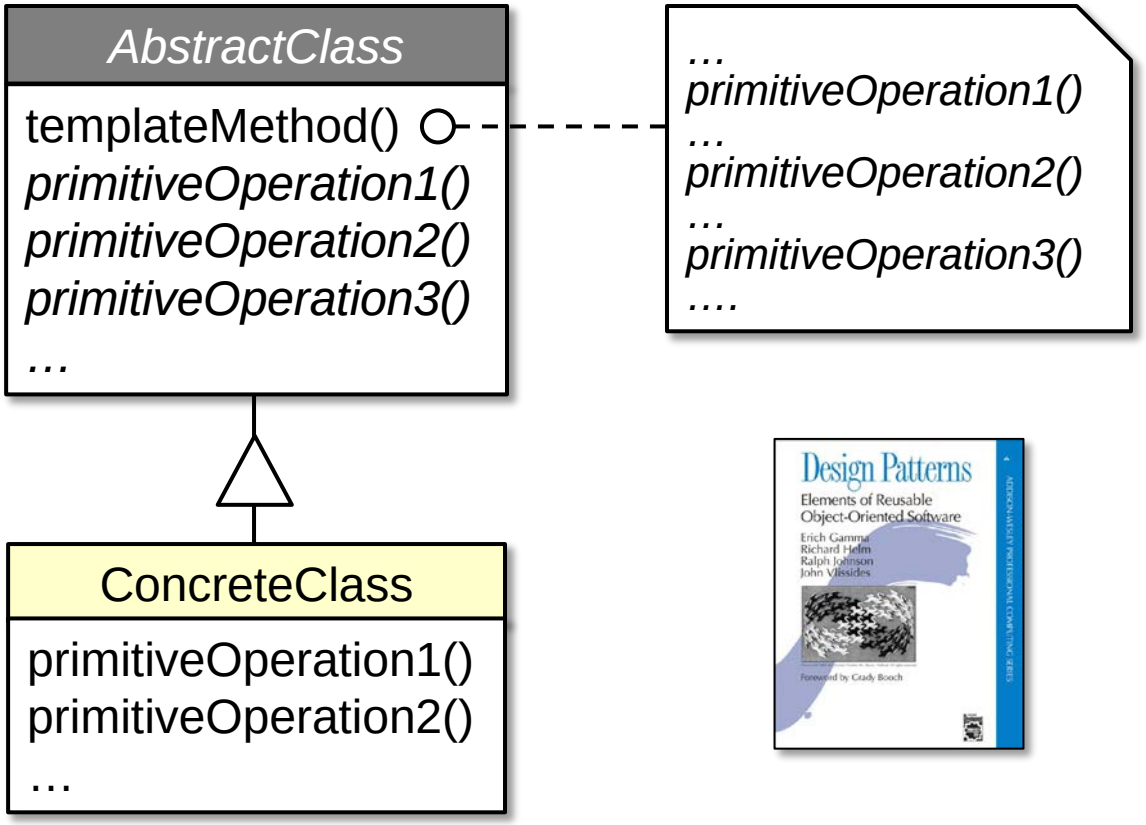
Motivation: Maximize Systematic Reuse

- Systematic reuse is a powerful method of producing quality software
  - Involves creating or acquiring reusable assets & then consistently using & evolving them

See earlier part on “Overview of Patterns & Frameworks (Part 1)”

Overview of the Template Method Pattern

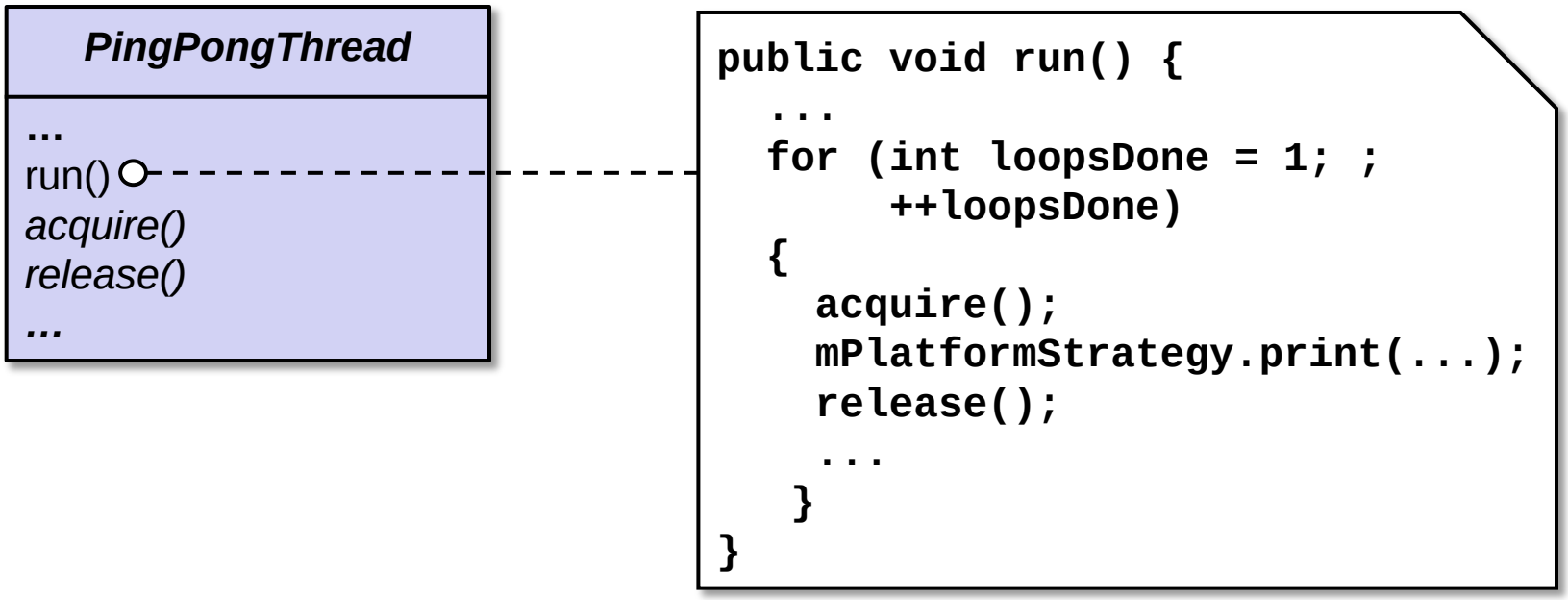
- *Template Method* provides a skeleton of an algorithm in a method, deferring some steps to subclasses



See en.wikipedia.org/wiki/Template_method_pattern for more info

Applying the Template Method Pattern

- *Template Method* increases systematic reuse by implementing the ping/ping algorithm in the base class, but allowing subclasses to override its acquire() & release() hook methods to schedule printing via different mechanisms



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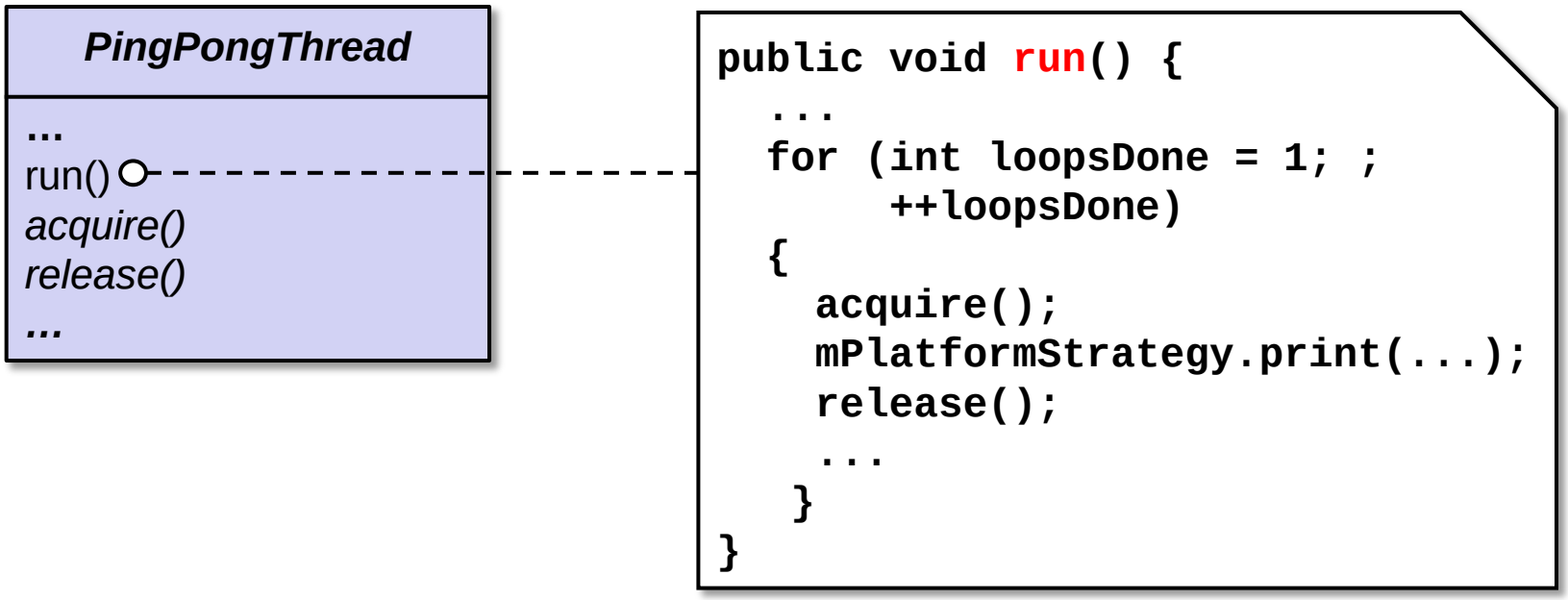

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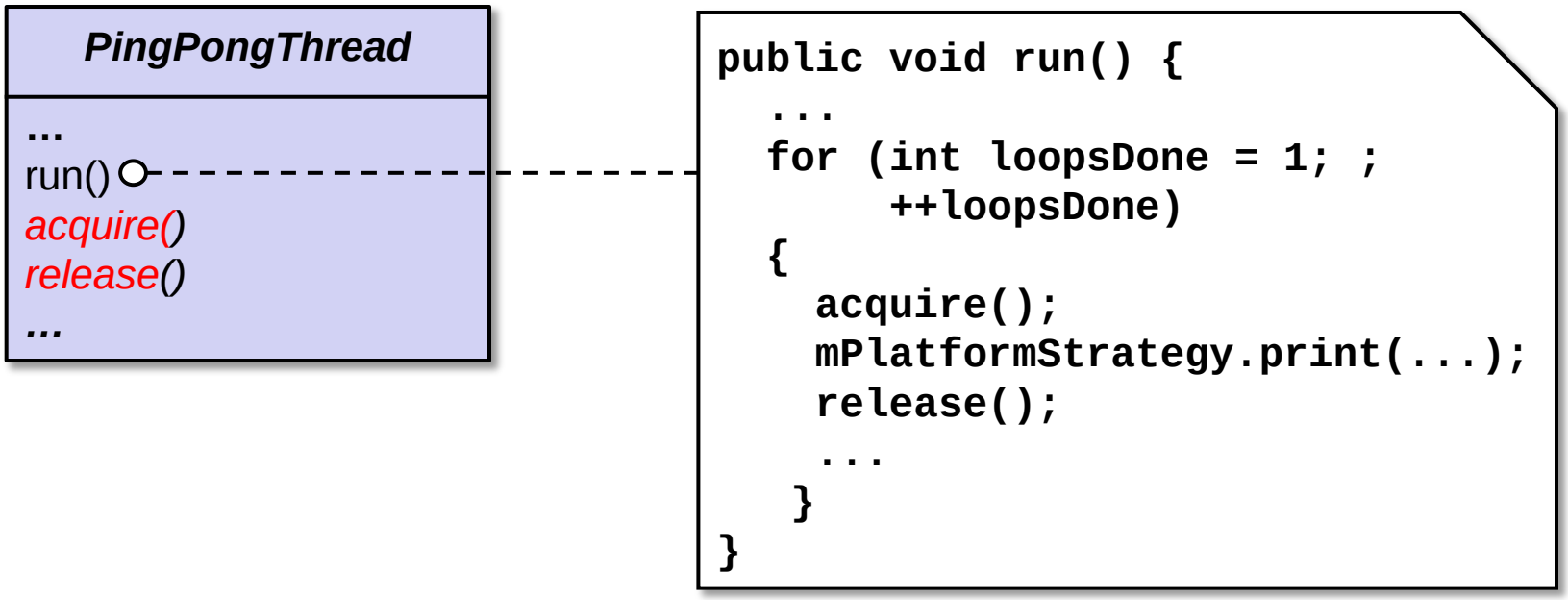

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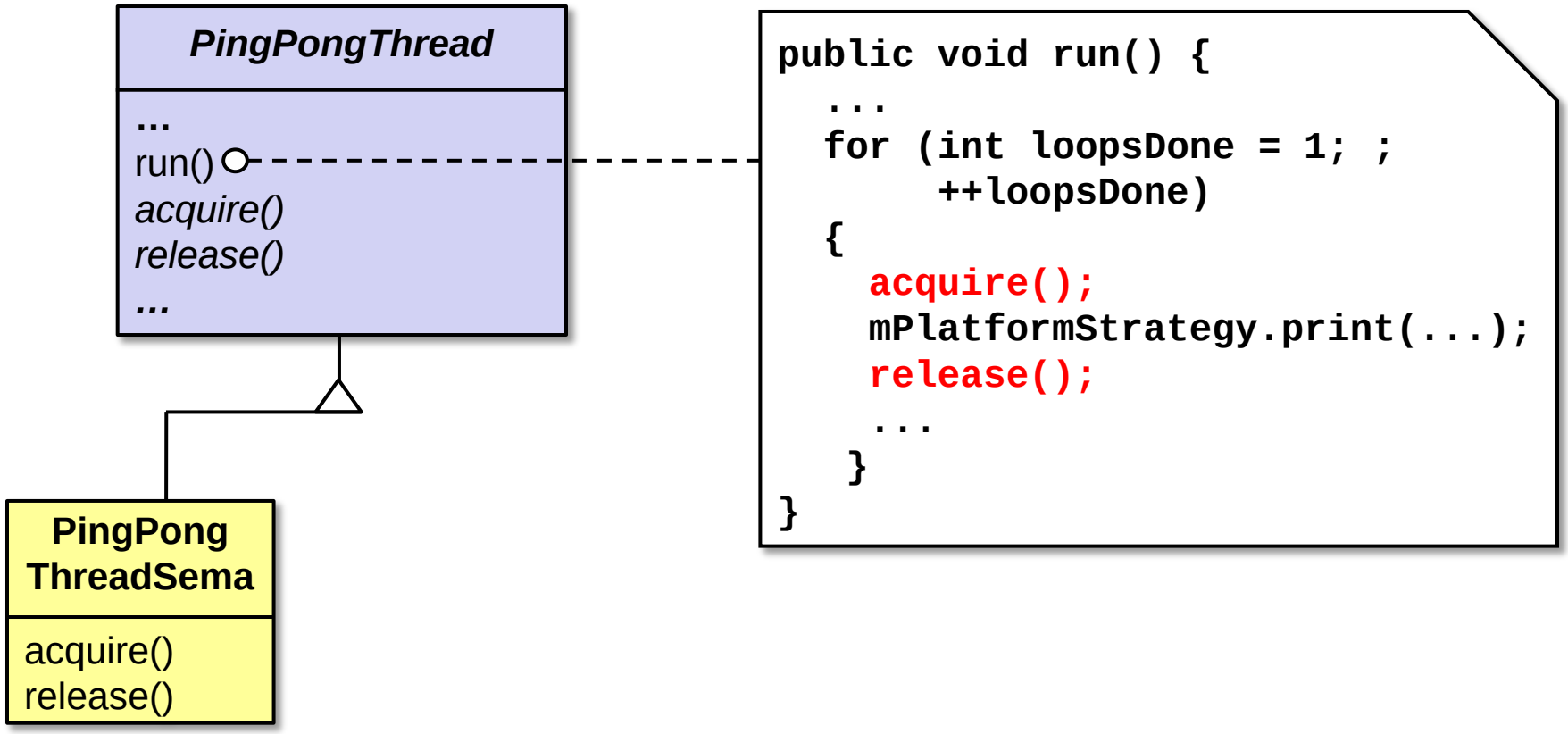

See next part on “Java Synchronization & Scheduling Example (Part 2)”

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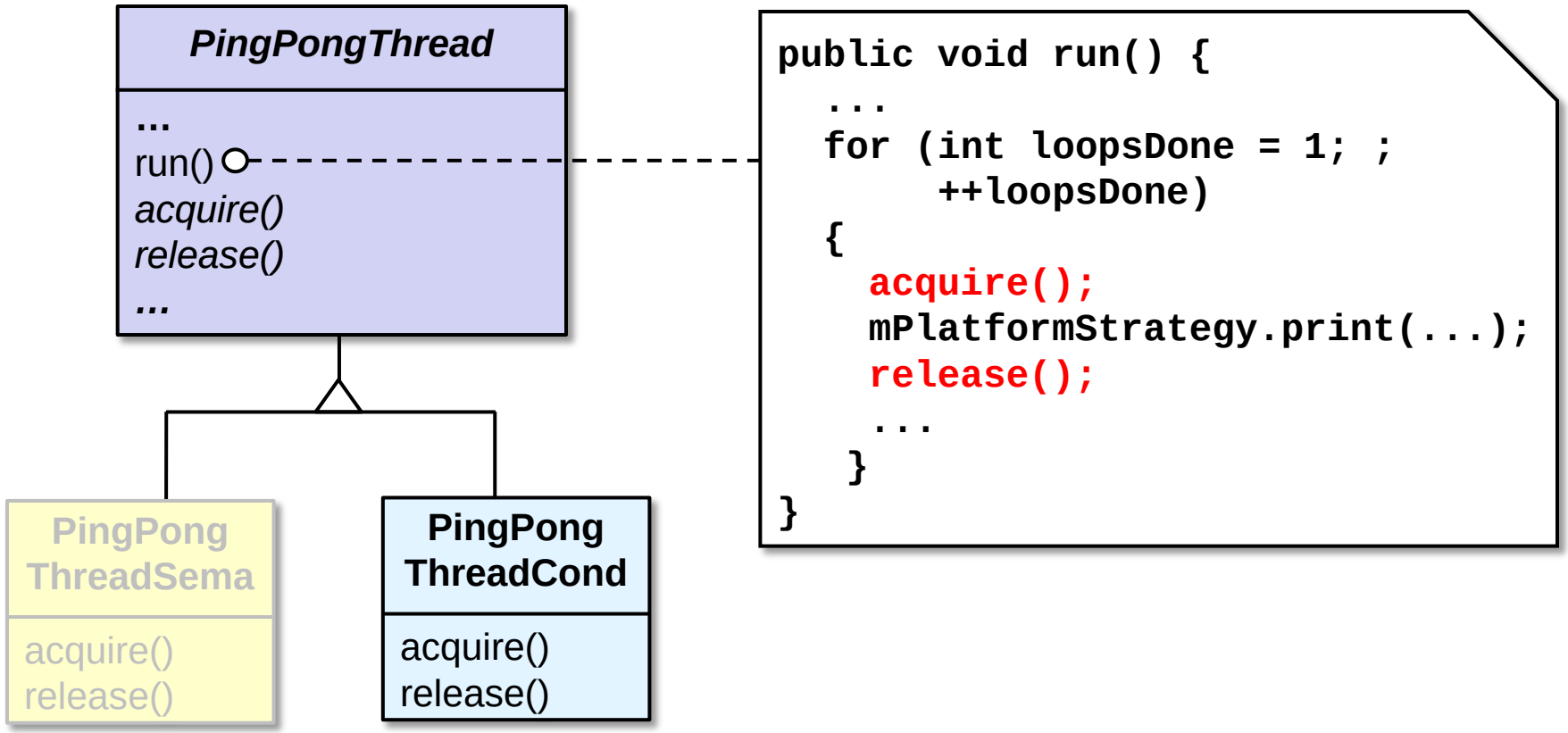
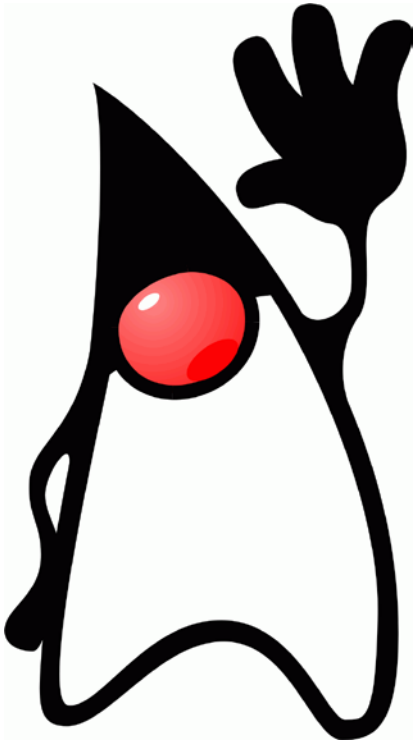


See next part on “Java Synchronization & Scheduling Example (Part 2)”

Applying the Strategy Pattern to the Ping-Pong Program

Motivation: Maximize Portability

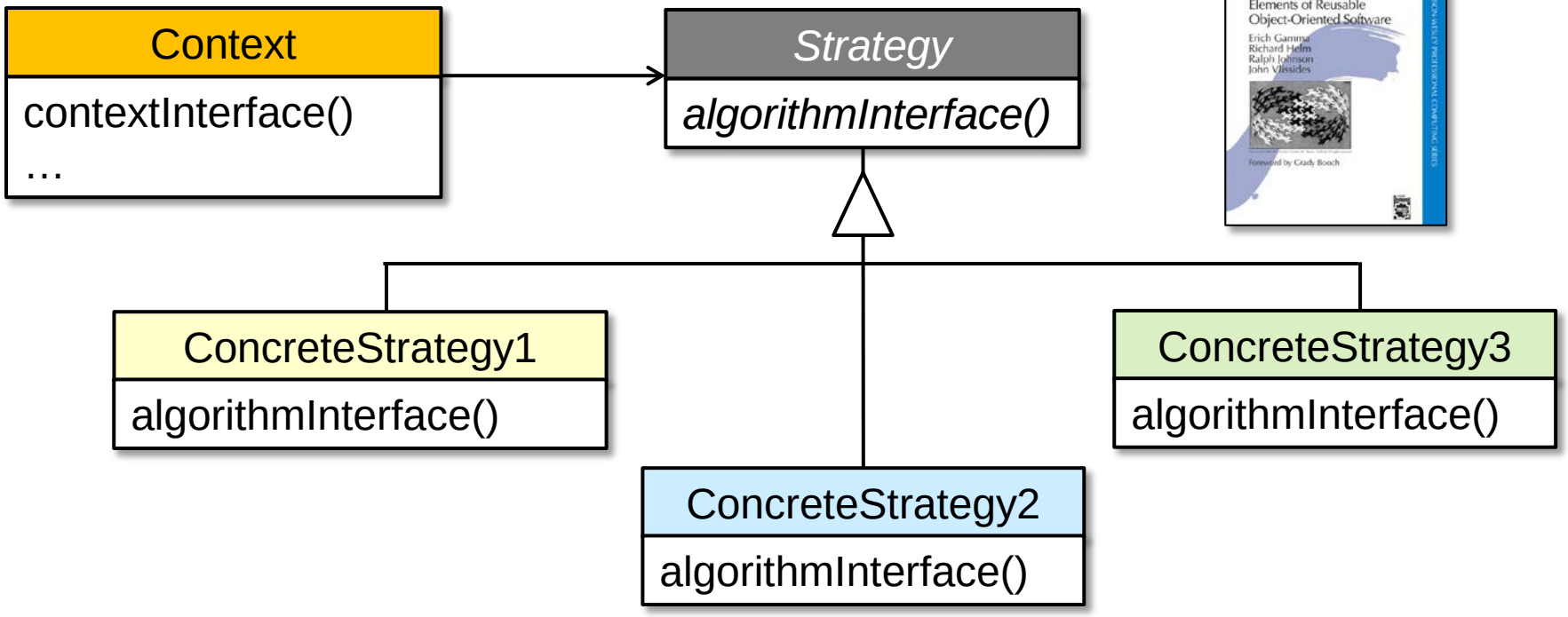
- Portability enables the same implementation to be applied in different operating environments
  - It increases the potential user base & market size



en.wikipedia.org/wiki/Software_portability has more on portability

Overview of the Strategy Pattern

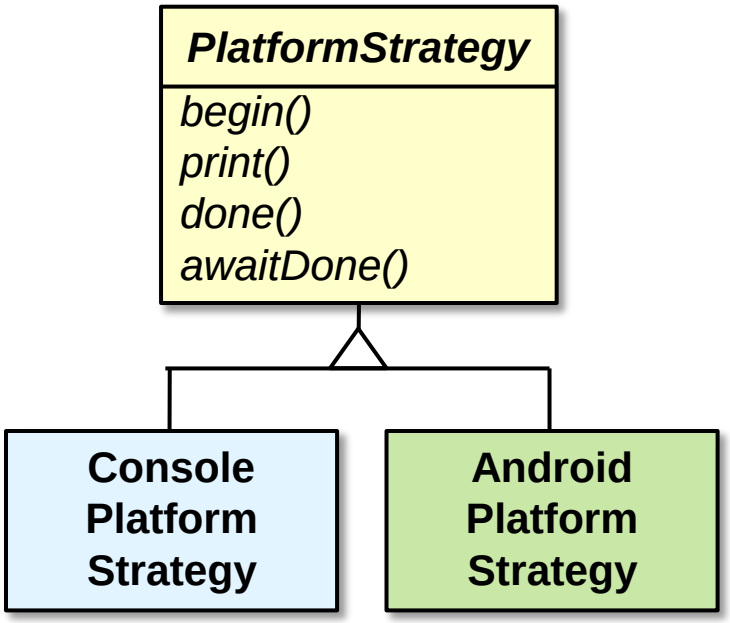
- *Strategy* defines a family of algorithms, encapsulate each one, & make them interchangeable to let clients & algorithms vary independently



See en.wikipedia.org/wiki/Strategy_pattern for more info

Applying the Strategy Pattern

- *Strategy* enhances portability by factoring out different ways of printing "ping" & "pong" on different types runtime platforms



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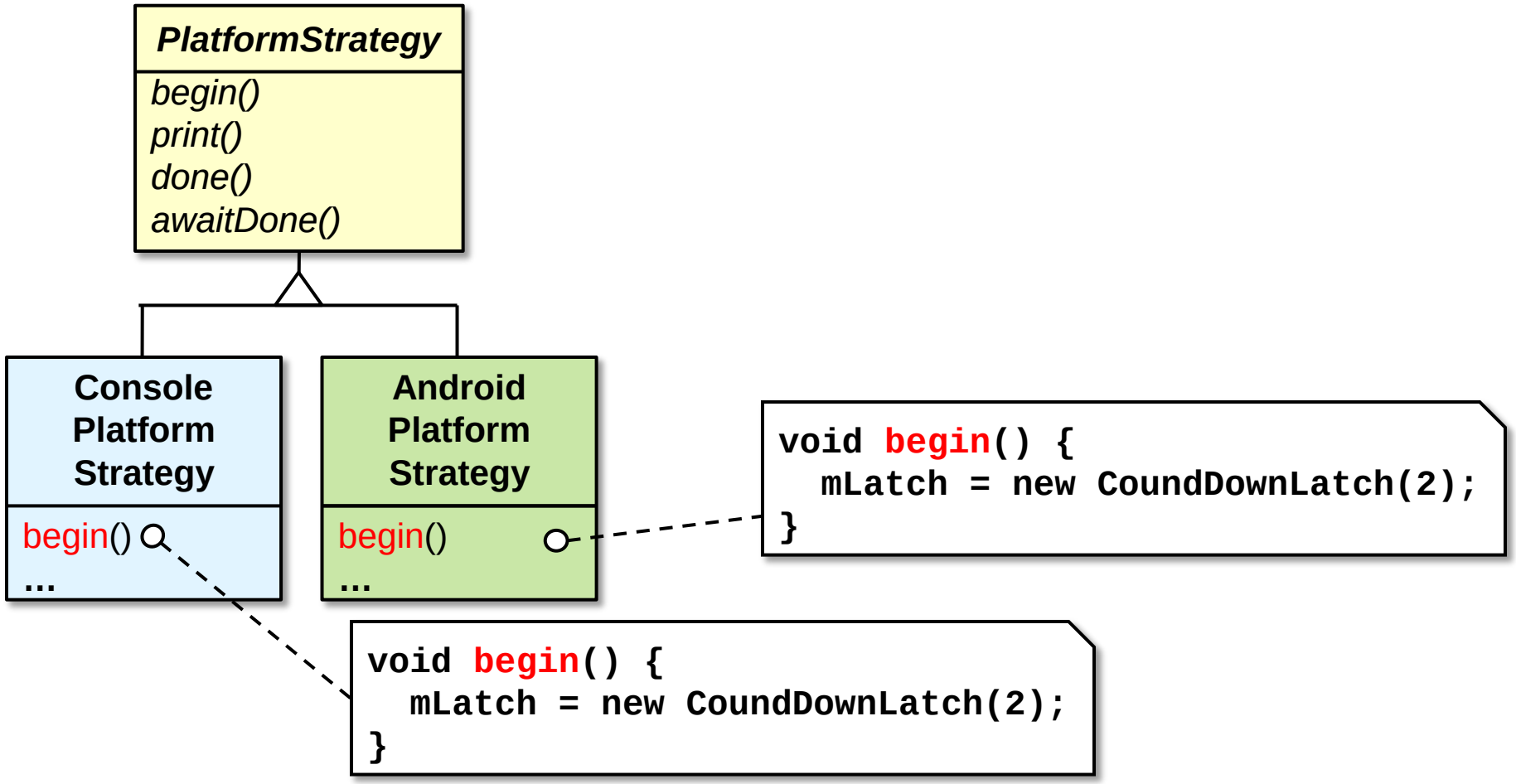

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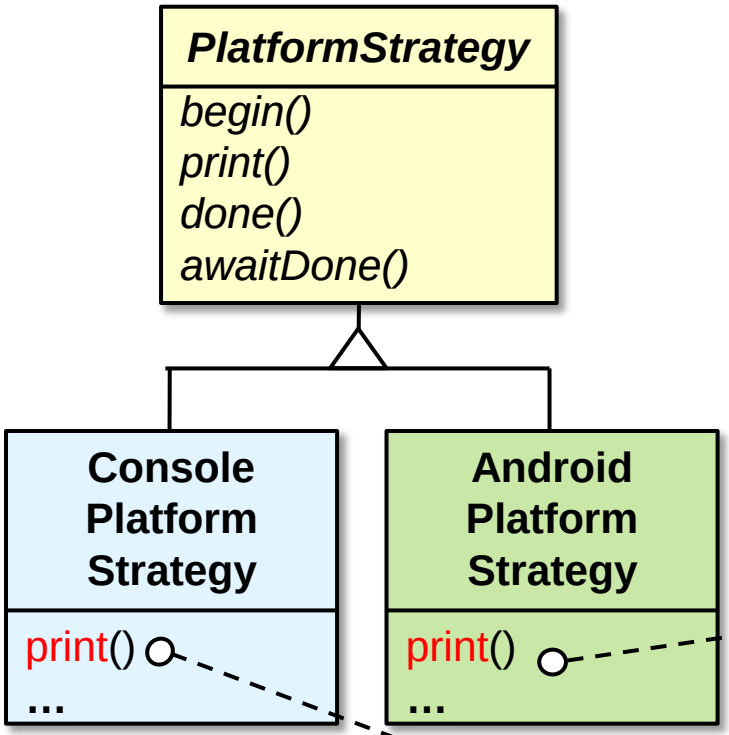


```
void print(outputString) {
  ....runOnUiThread
    (new Runnable() {
       public void run() {
         mTextView.append(outputString);
  }});
  ...
}
```

```
void print(String outputString) {
  System.out.println(outputString);
}
```

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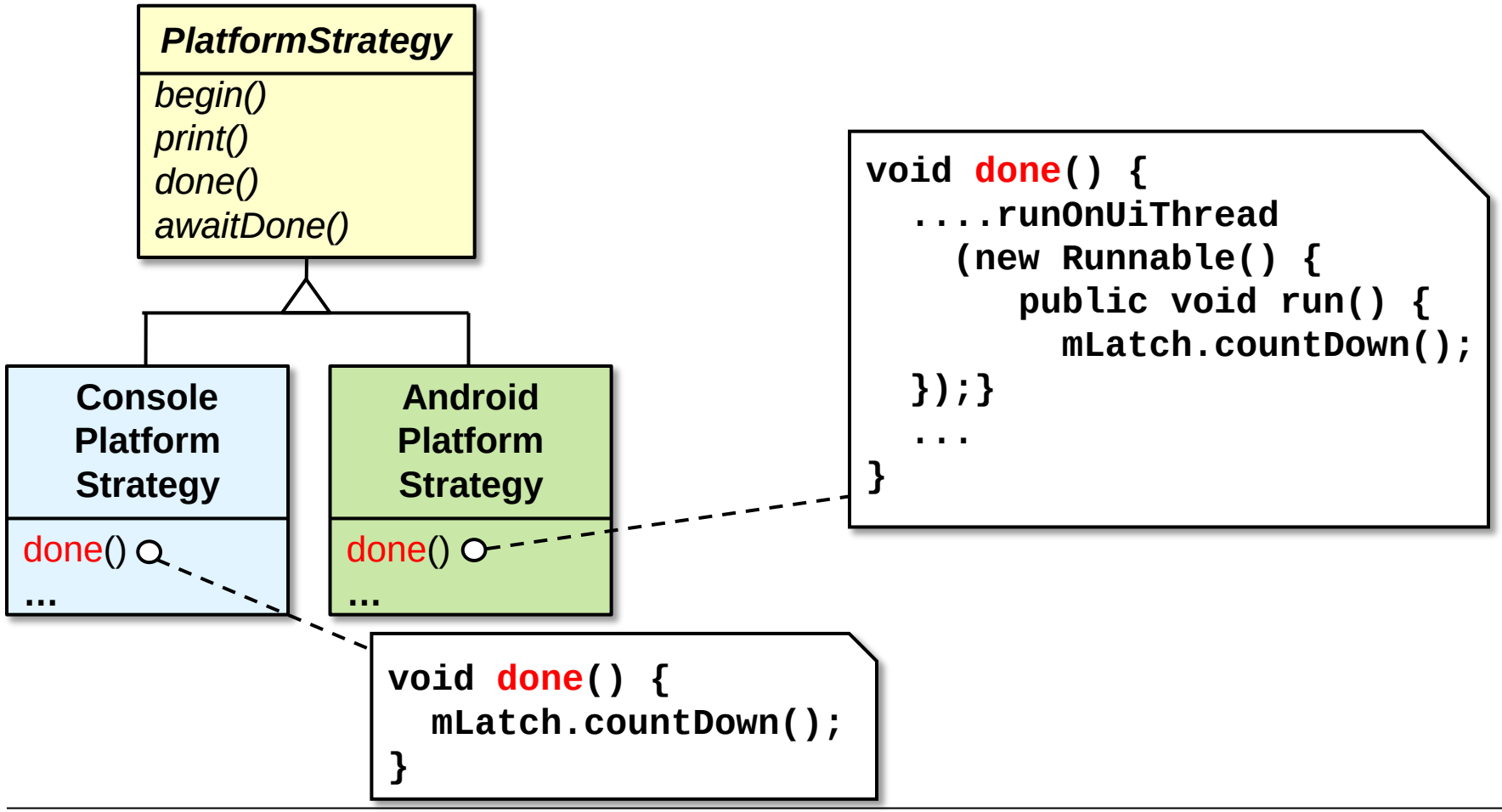

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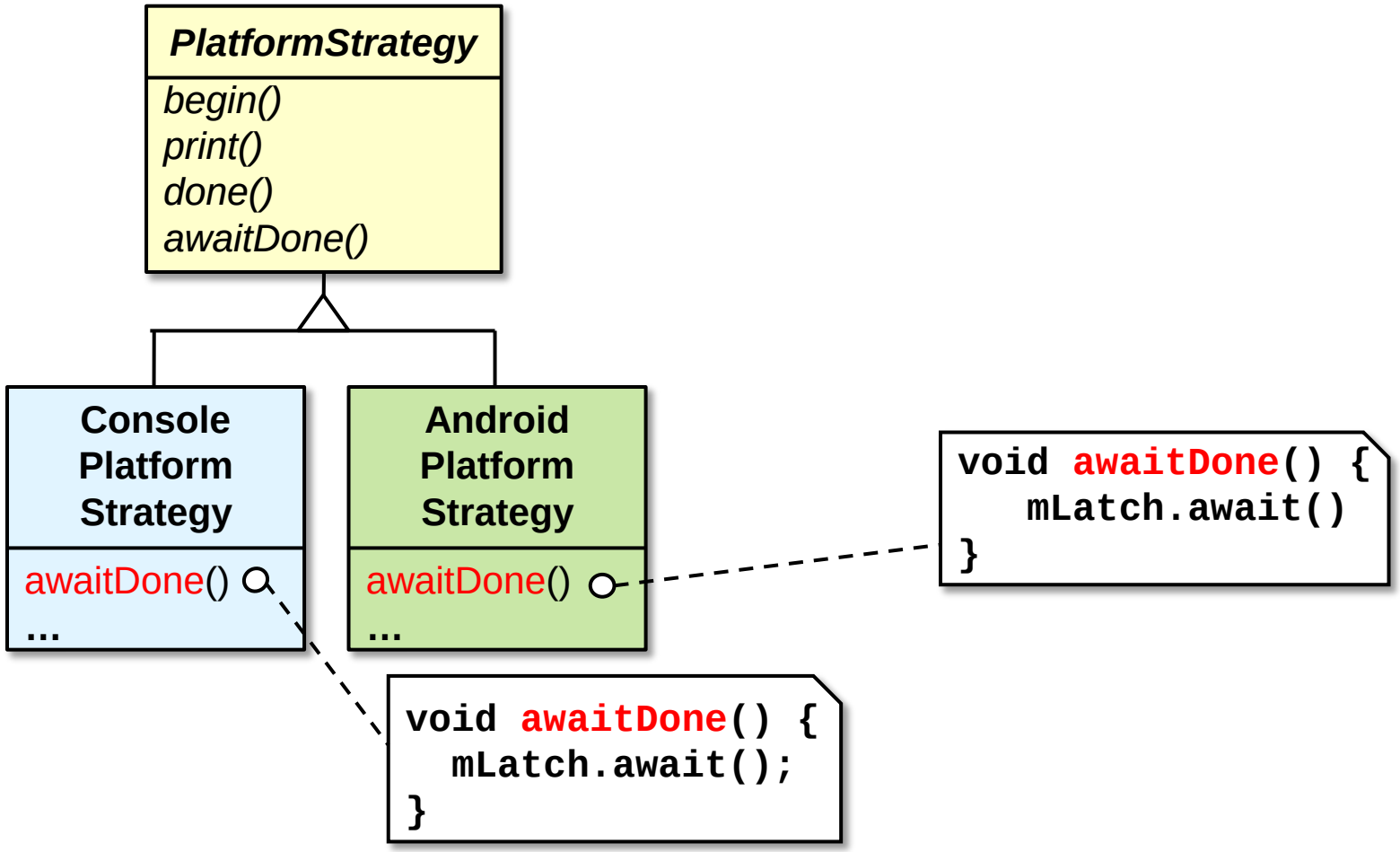


See earlier part on "Java CountDownLatch"

Applying the Factory Method Pattern to the Ping-Pong Program

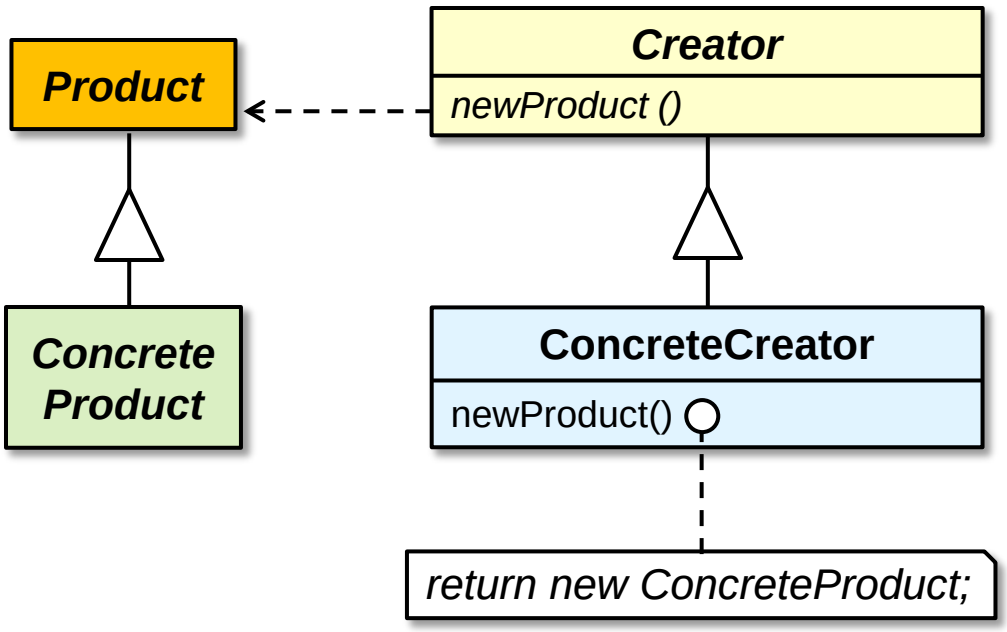
Motivation: Maximize Flexibility

- Flexibility enables designs to adapt more readily in response to external or internal changes in requirements or environments

See informativearchitecture.wordpress.com/2011/10/04/software-flexibility

Overview of the Factory Method Pattern

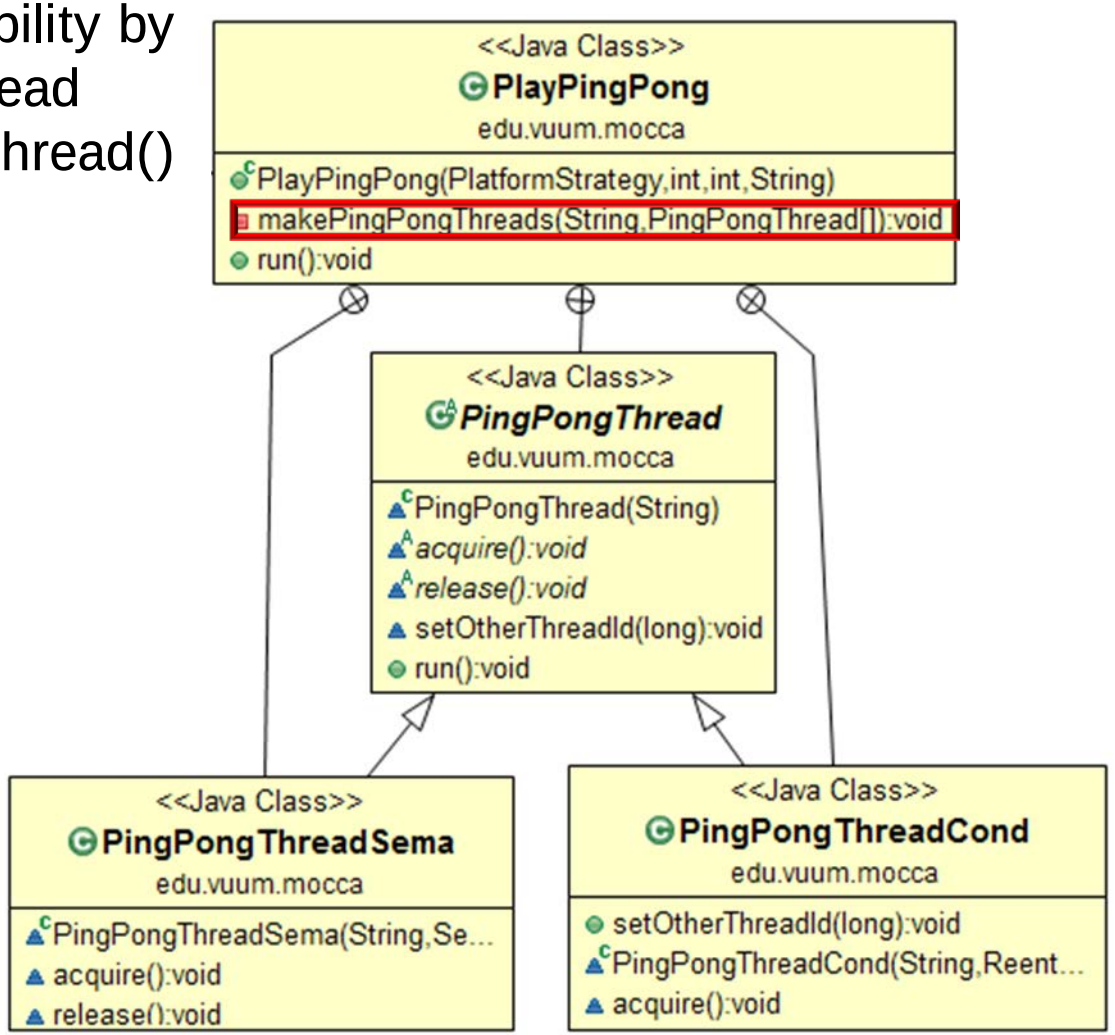
- *Factory Method* provides an interface for creating an object, but leaves the choice of the object's concrete type to a subclass



See en.wikipedia.org/wiki/Factory_method_pattern for more info

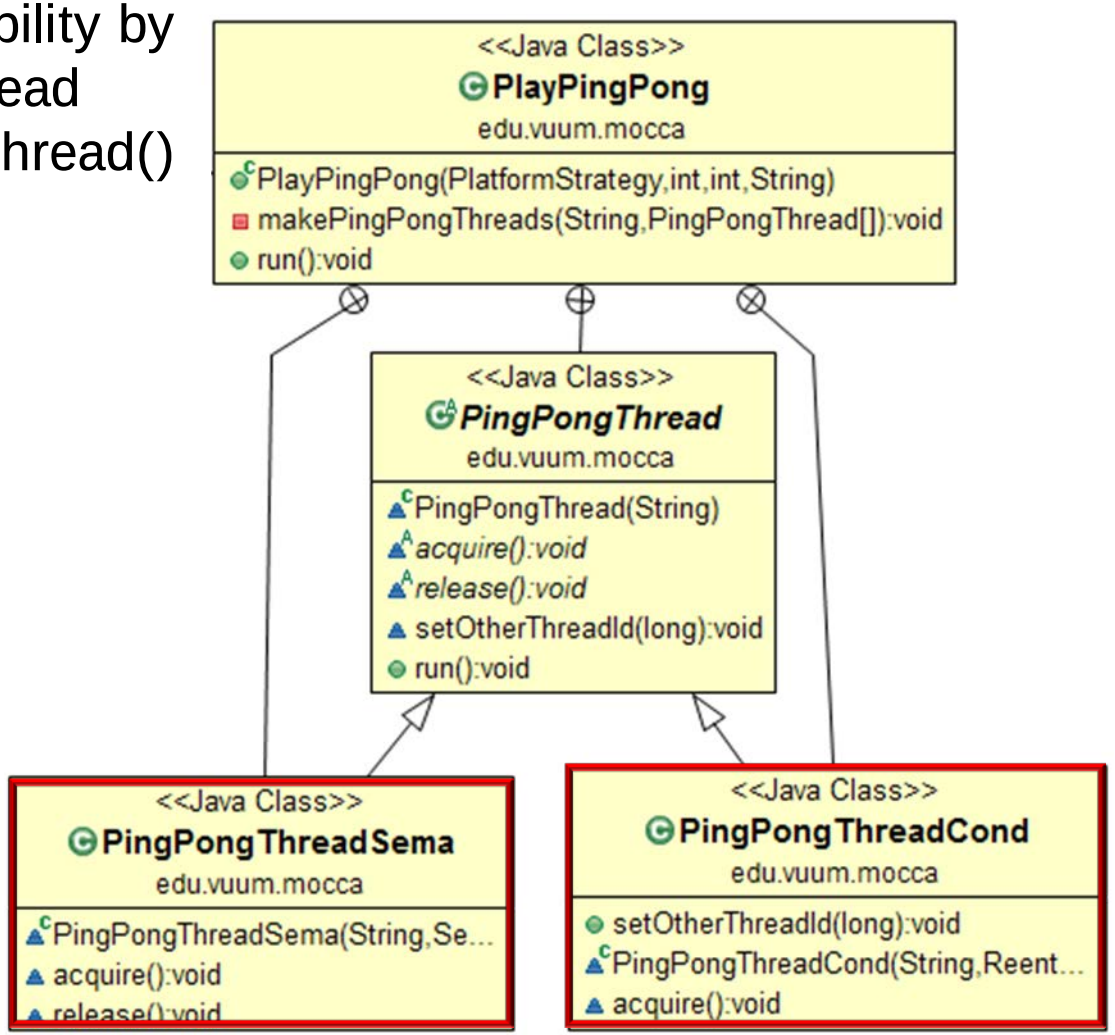
Applying the Factory Method Pattern

- *Factory Method* enhances flexibility by creating different PingPongThread subclasses via makePingPointThread()



Applying the Factory Method Pattern

- *Factory Method* enhances flexibility by creating different PingPongThread subclasses via makePingPointThread()



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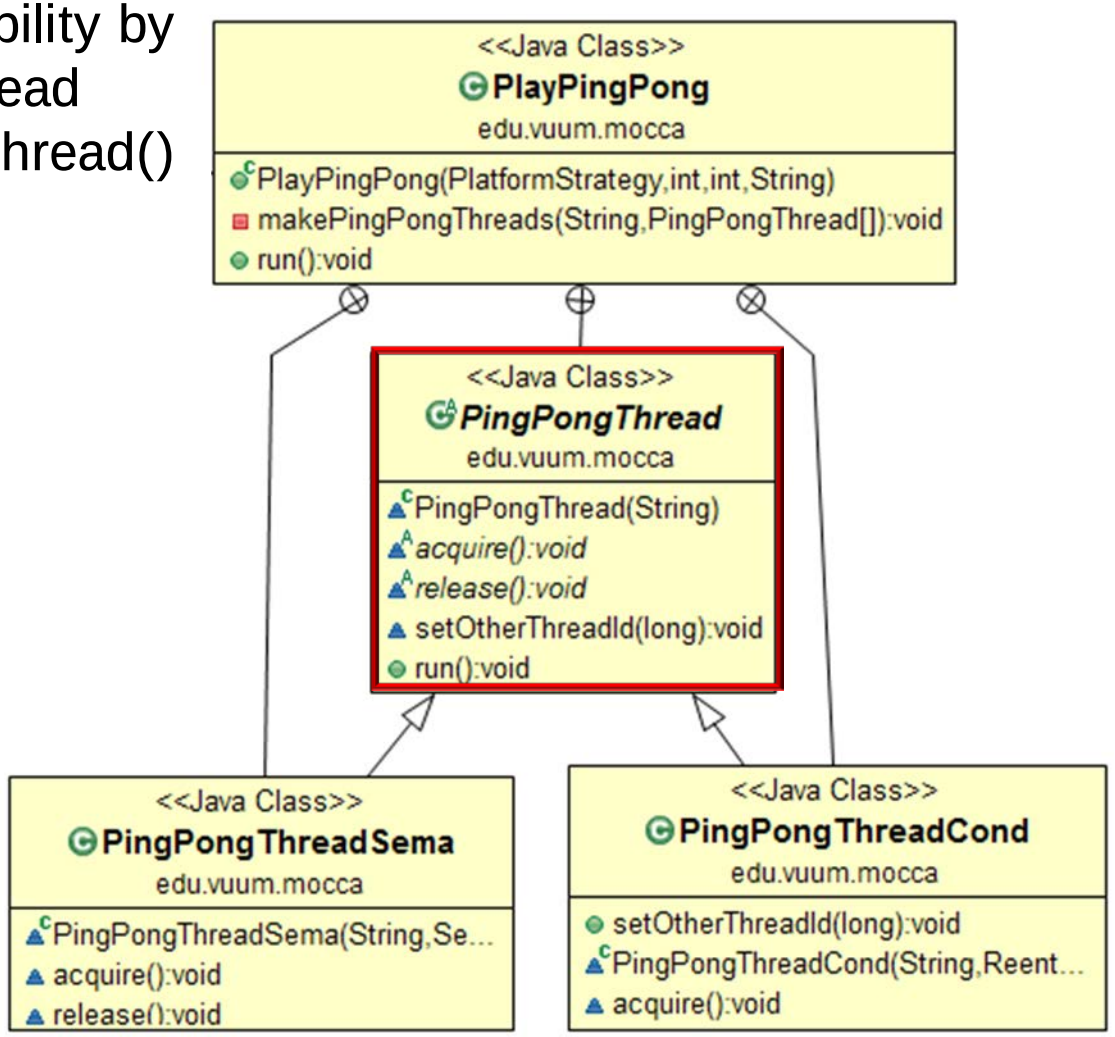

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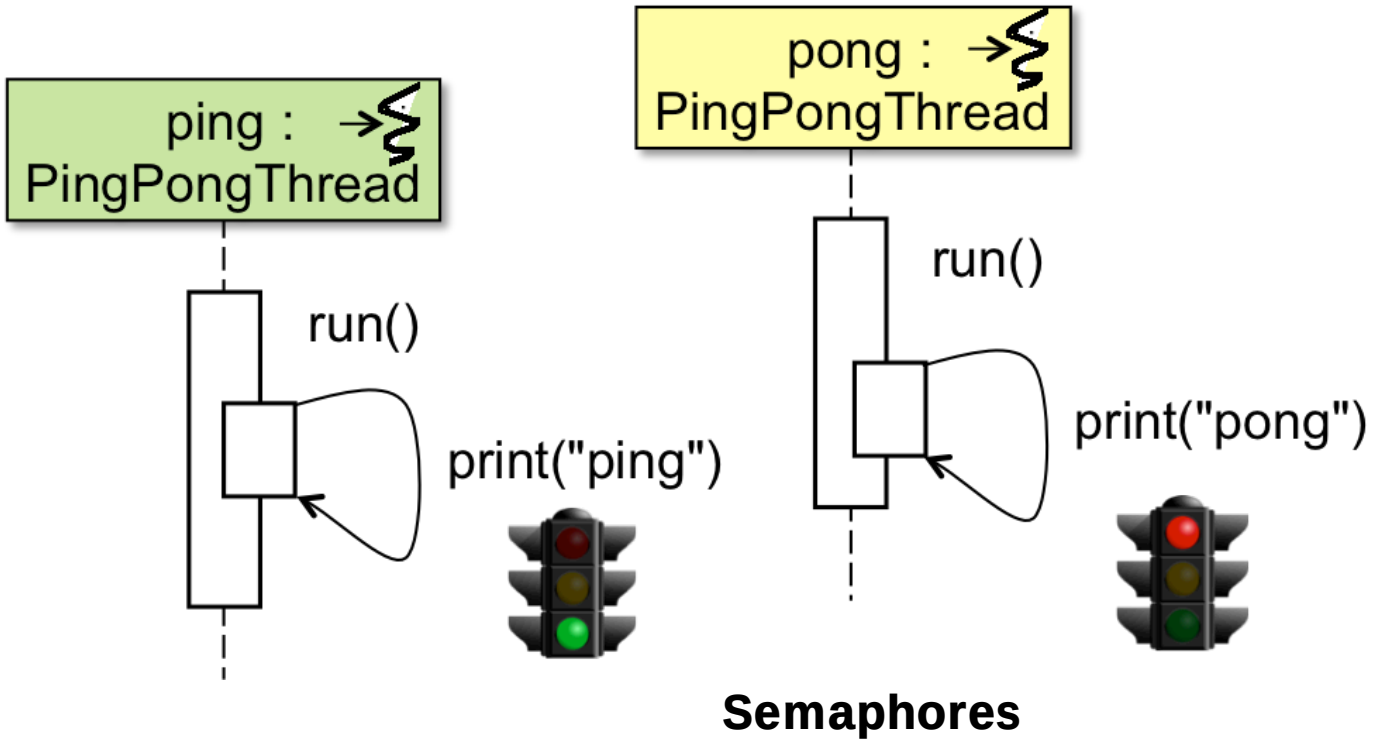

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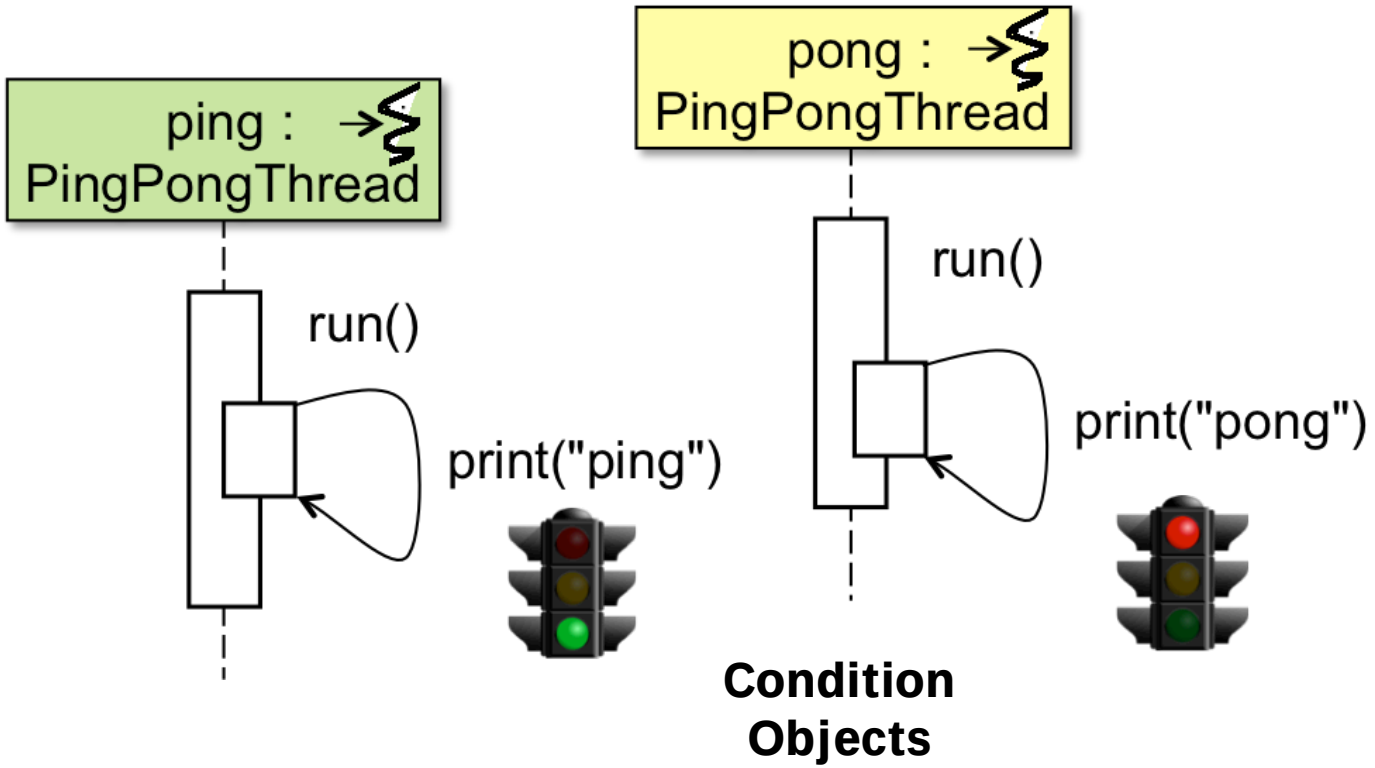

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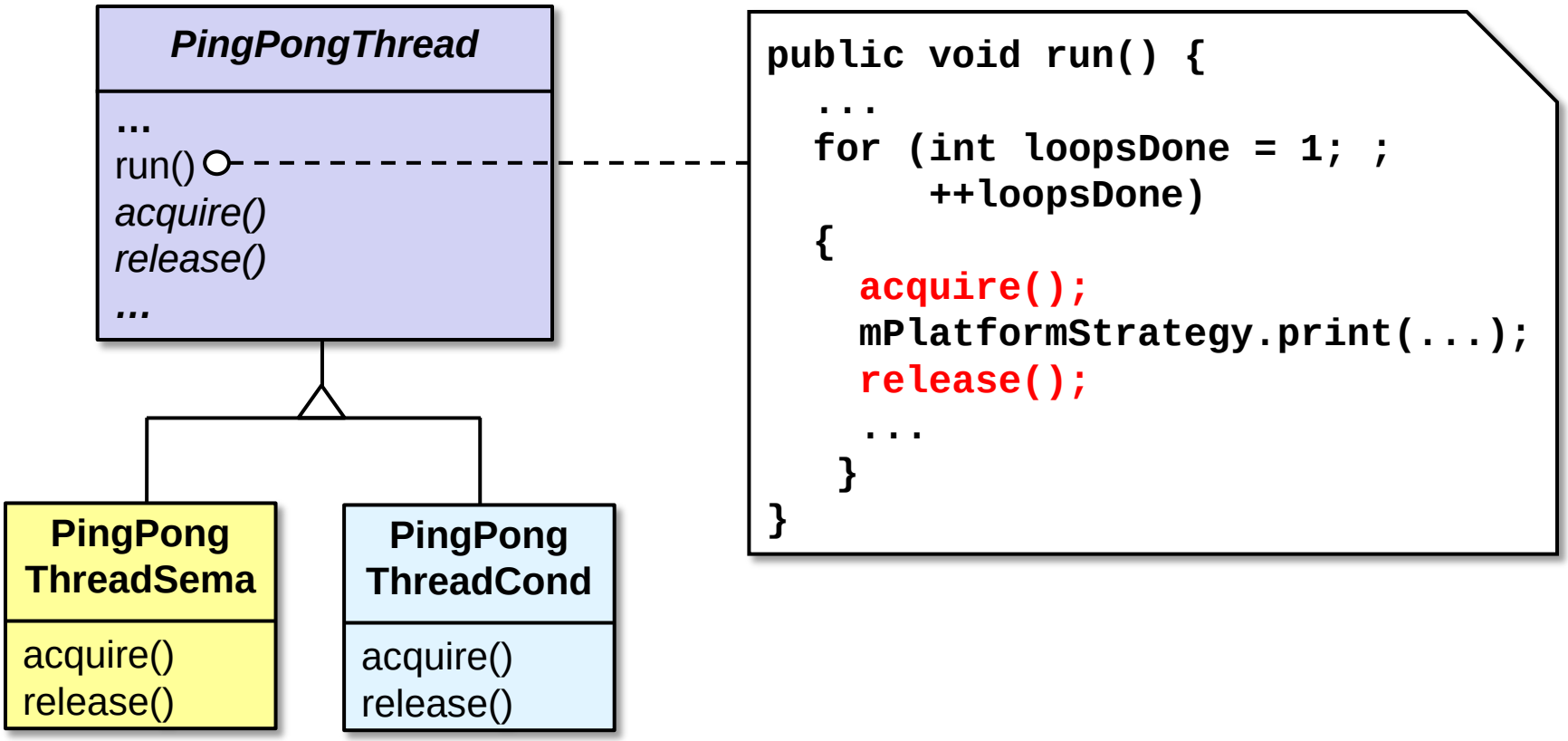
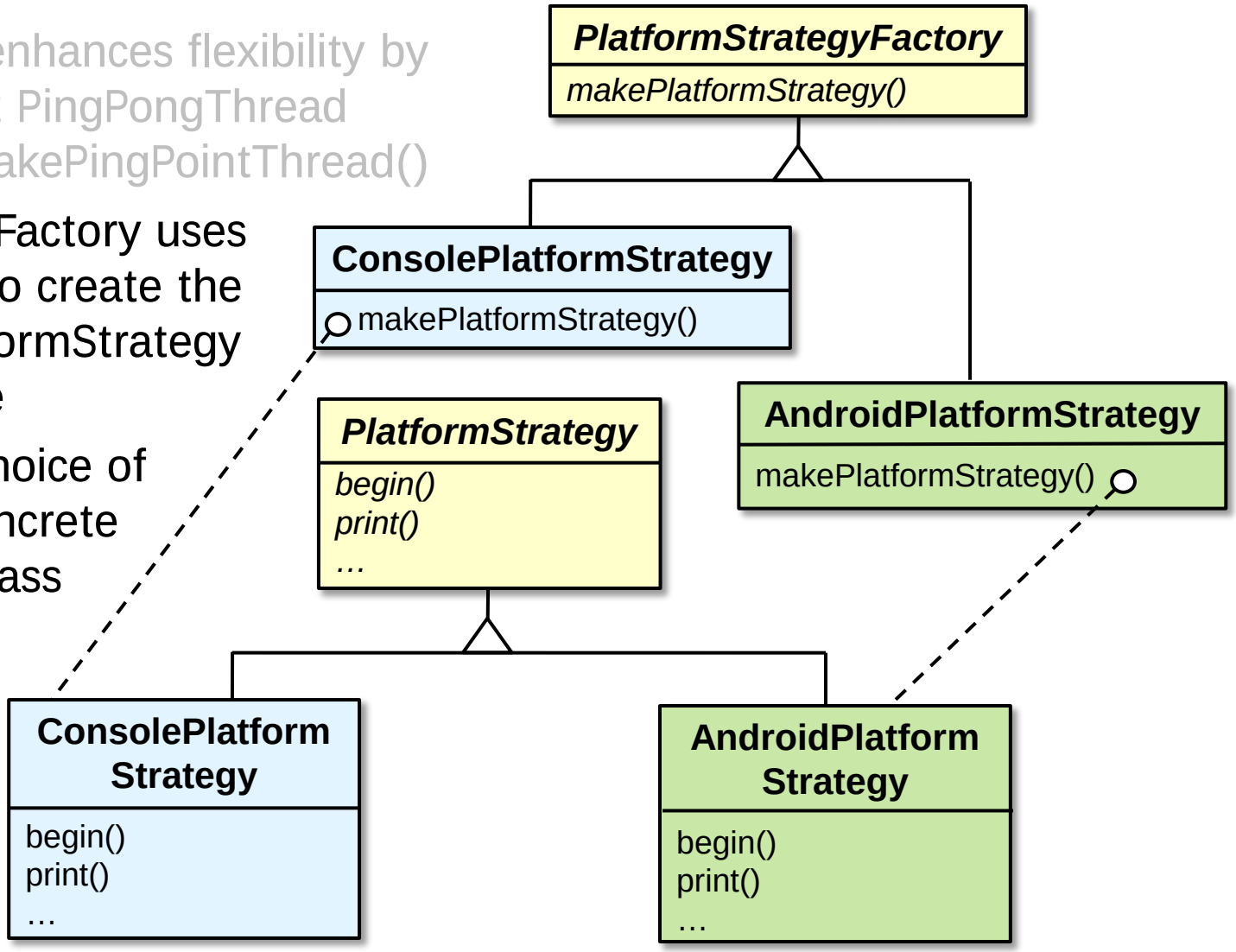


Supports new behavior & implementations without changing existing code

Applying the Factory Method Pattern

- *Factory Method* enhances flexibility by creating different PingPongThread subclasses via makePingPointThread()
- PlatformStrategyFactory uses *Factory Method* to create the appropriate PlatformStrategy subclass instance
  - It leaves the choice of the object's concrete type to a subclass



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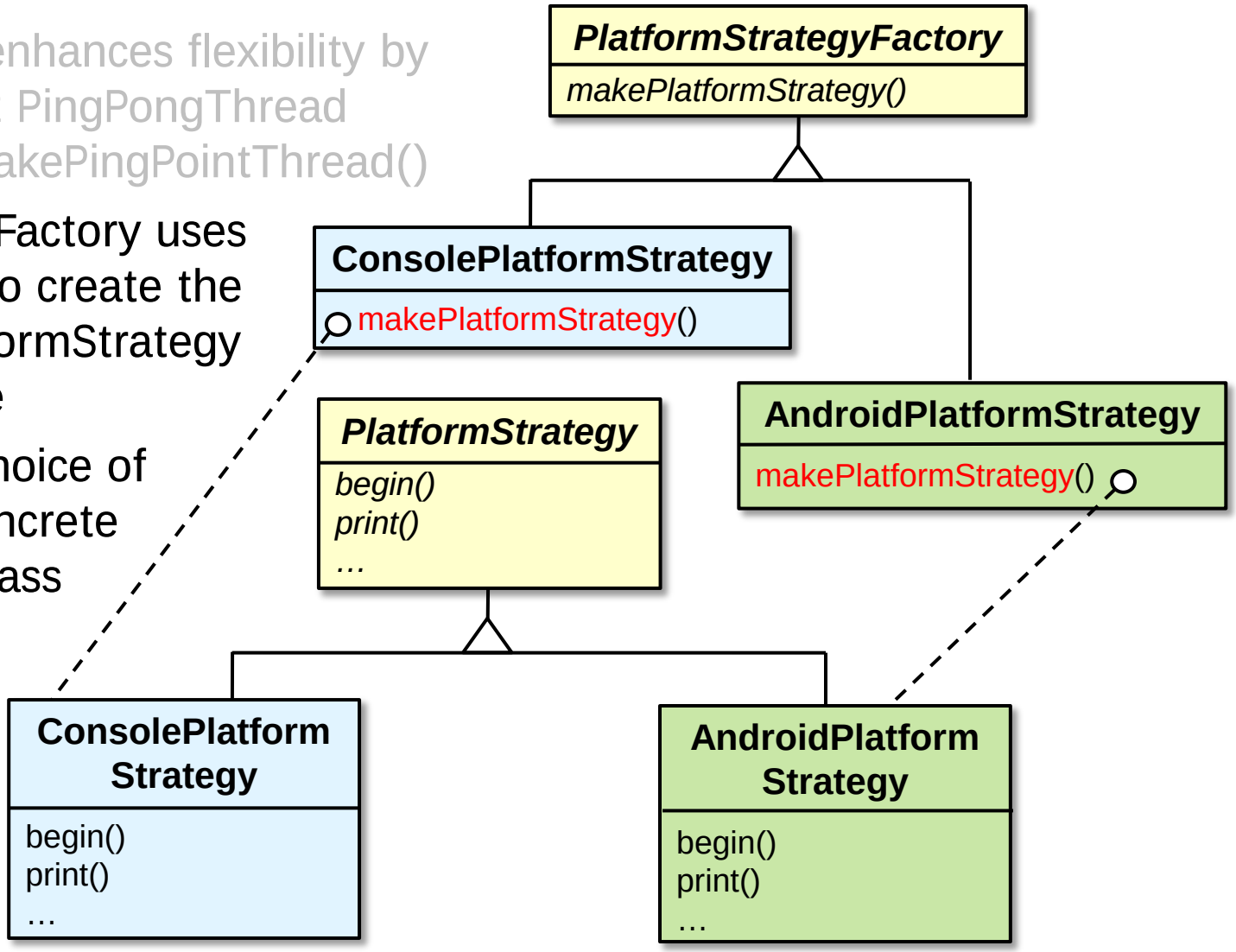

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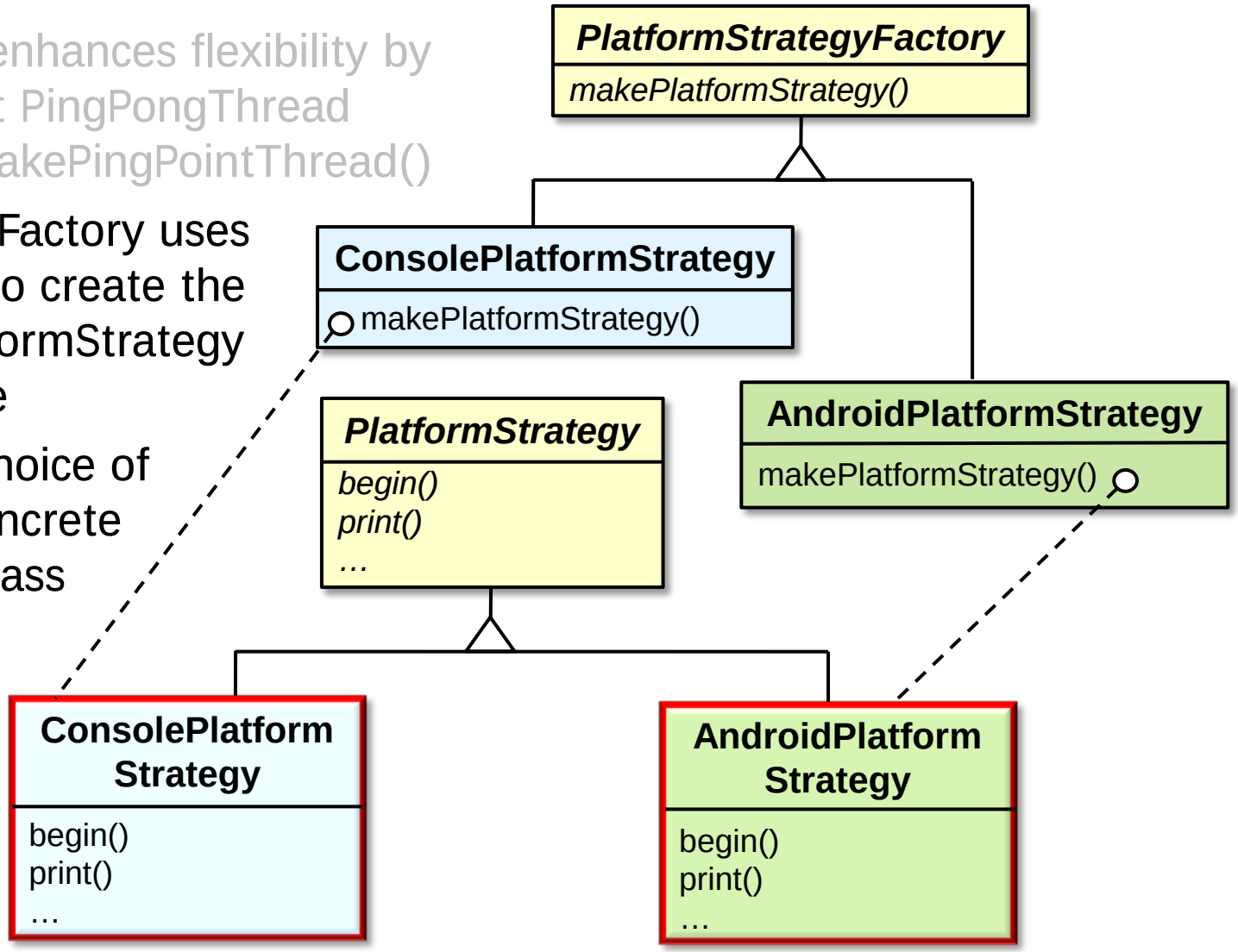

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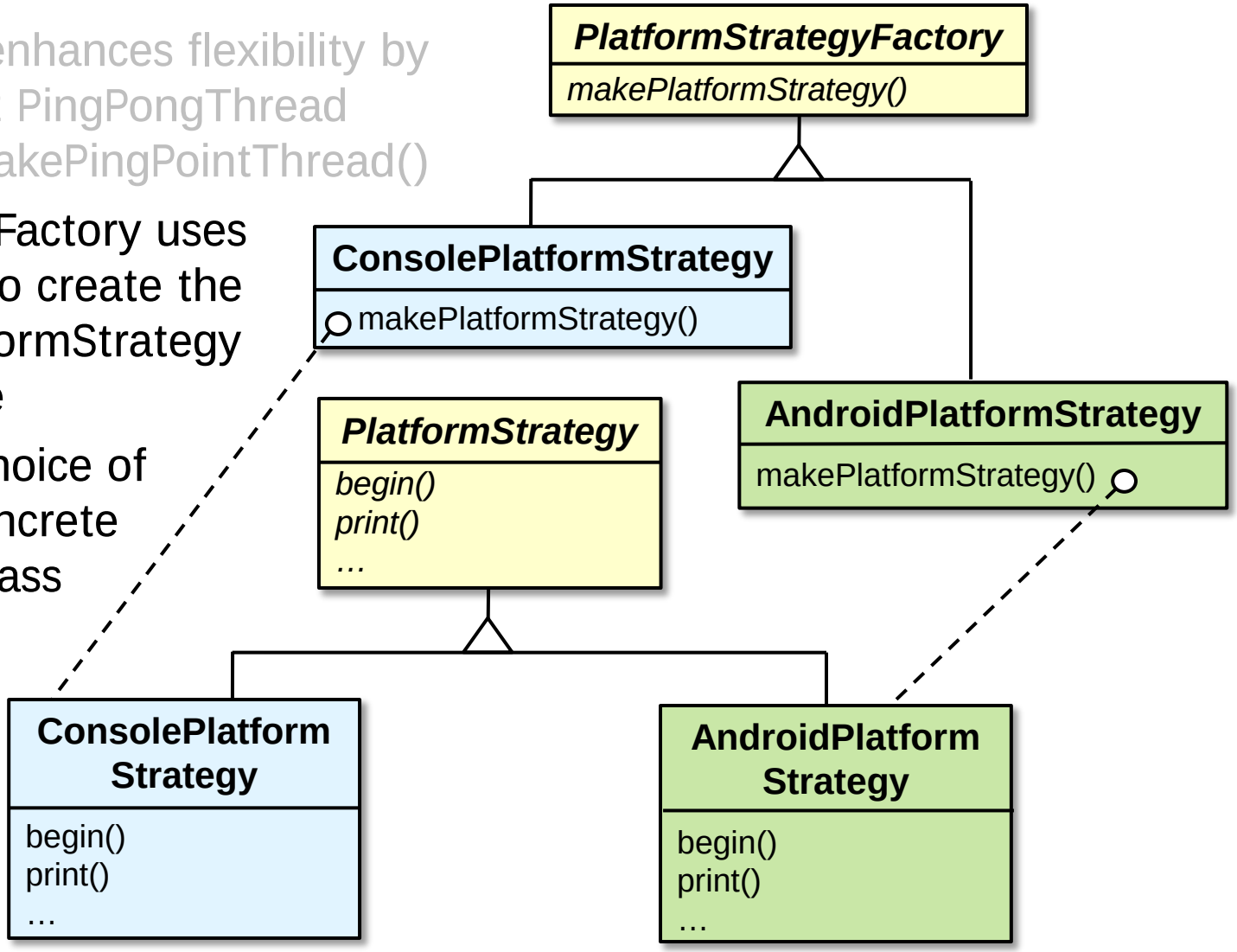
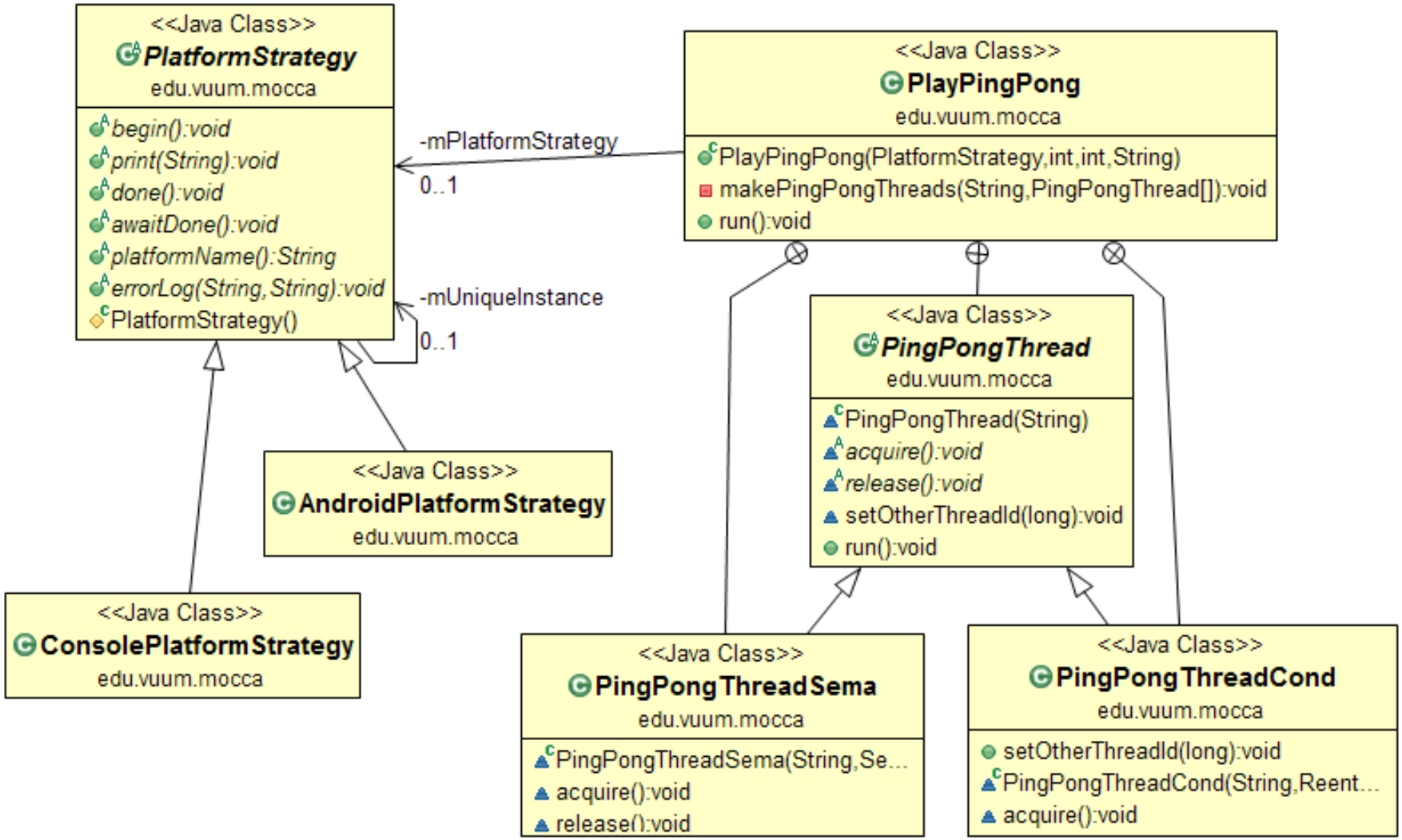


Factory Method also enhances systematic reuse & portability quality attributes

Summary

Summary

- The pattern-oriented framework supports a family of a concurrent ping-pong programs



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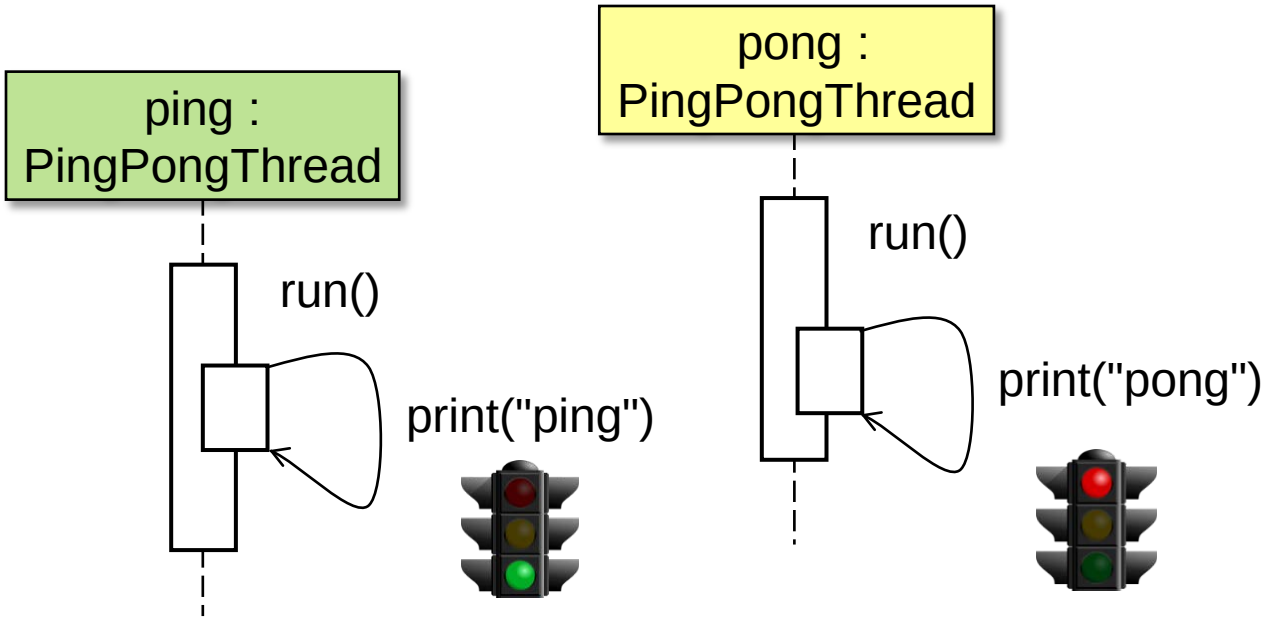
  - We'll customize it to correctly alternate printing "ping" & "pong" to output by using Java synchronizers



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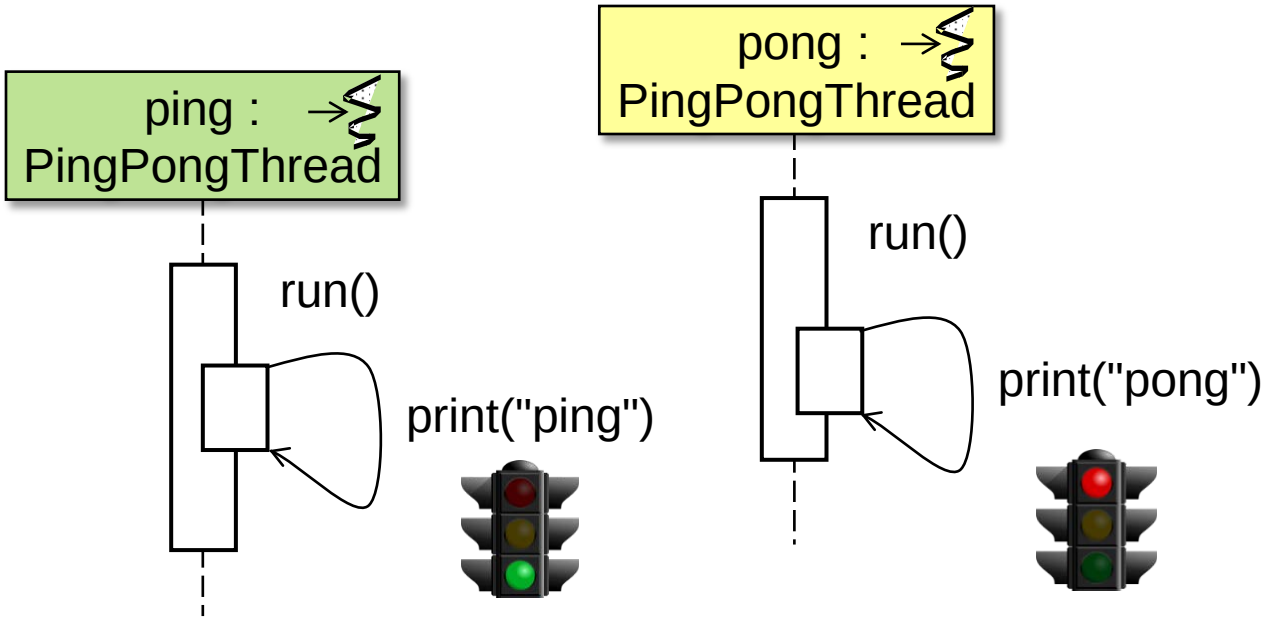

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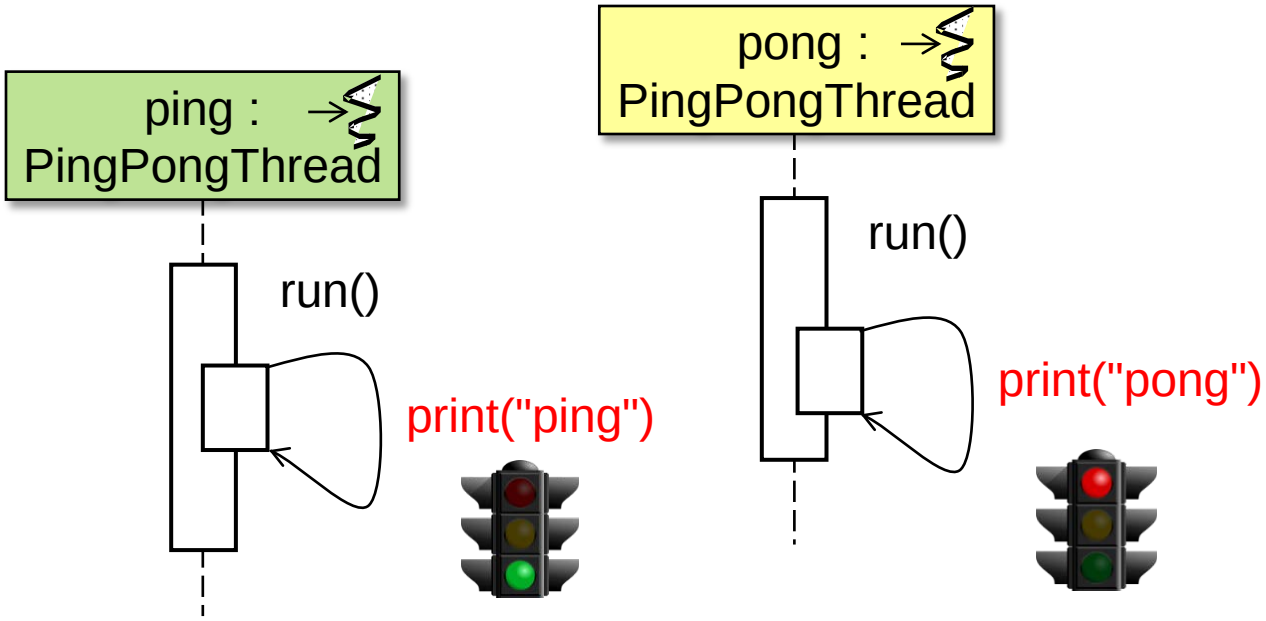
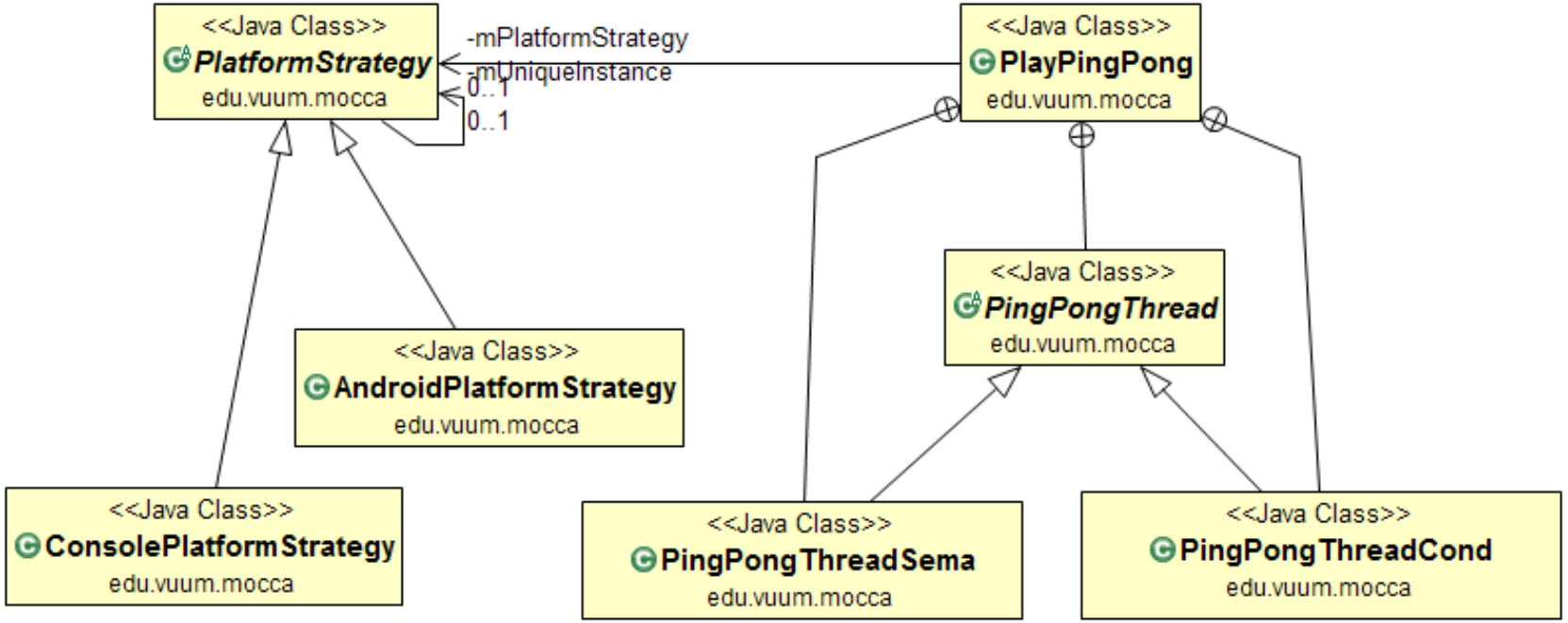



```
% java PlayPingPong
Ready...Set...Go!
Ping!(1)
Pong!(1)
Ping!(2)
Pong!(2)
Ping!(3)
Pong!(3)
Ping!(4)
Pong!(4)
Ping!(5)
Pong!(5)
Ping!(6)
Pong!(6)
Ping!(7)
Pong!(7)
Ping!(8)
Pong!(8)
Ping!(9)
Pong!(9)
Ping!(10)
Pong!(10)
Done!
```

See earlier part on "Motivating Java Synchronization & Scheduling Mechanisms"

Summary

- The pattern-oriented framework supports a family of a concurrent ping-pong programs
- GoF patterns simplify the solution's portability, reusability, & extensibility



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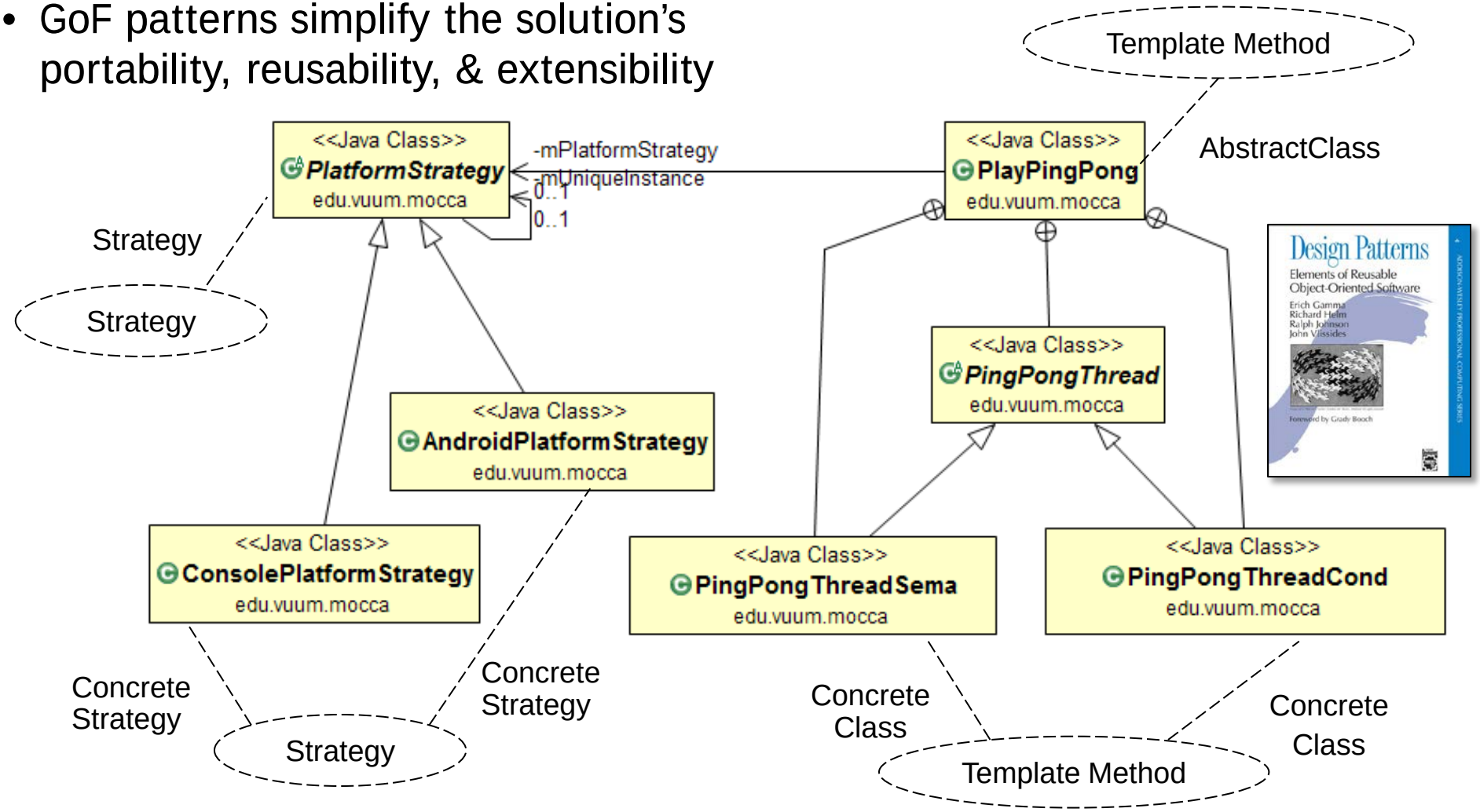

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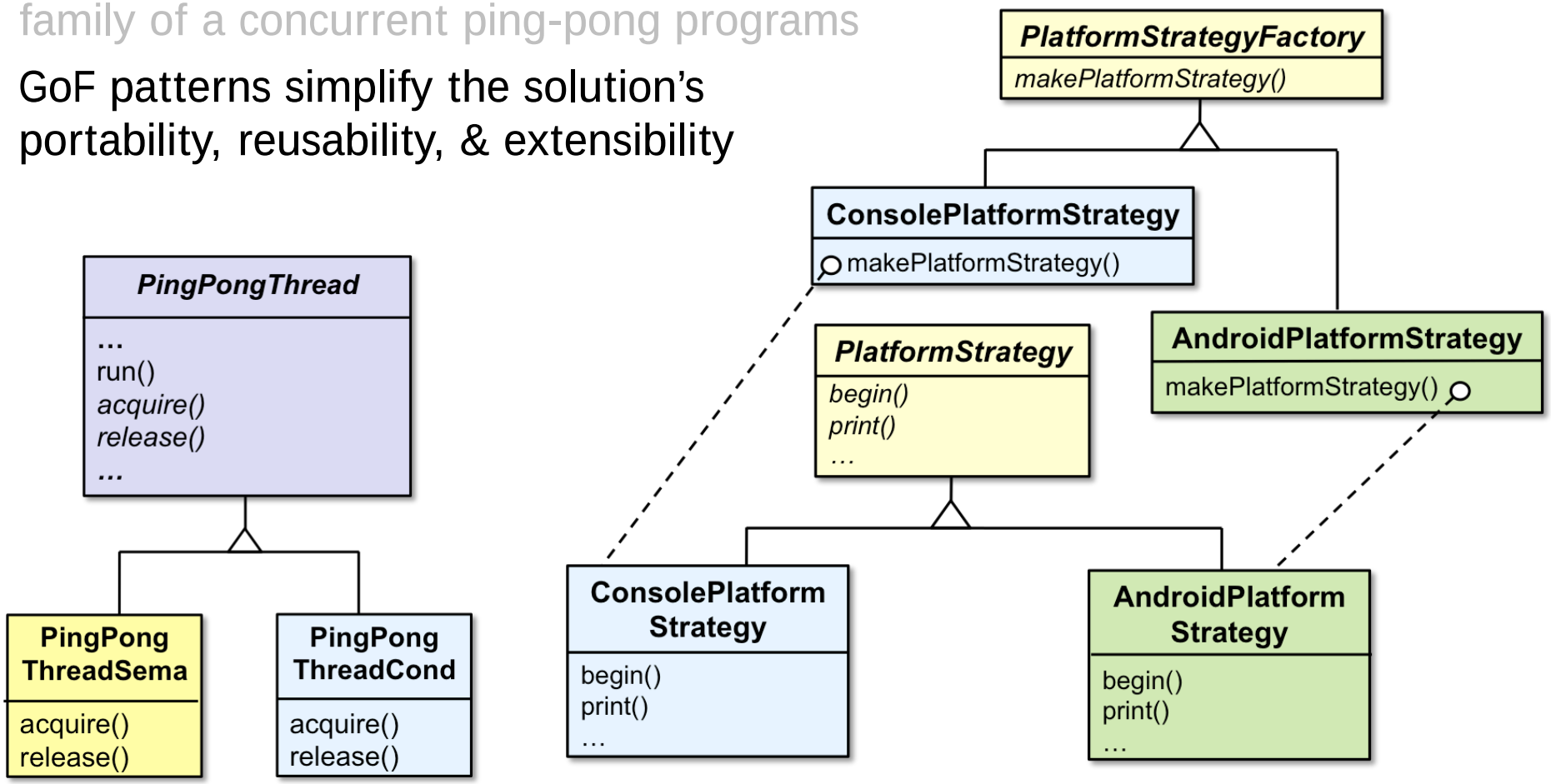

These patterns are broadly applicable to concurrent & non-concurrent software

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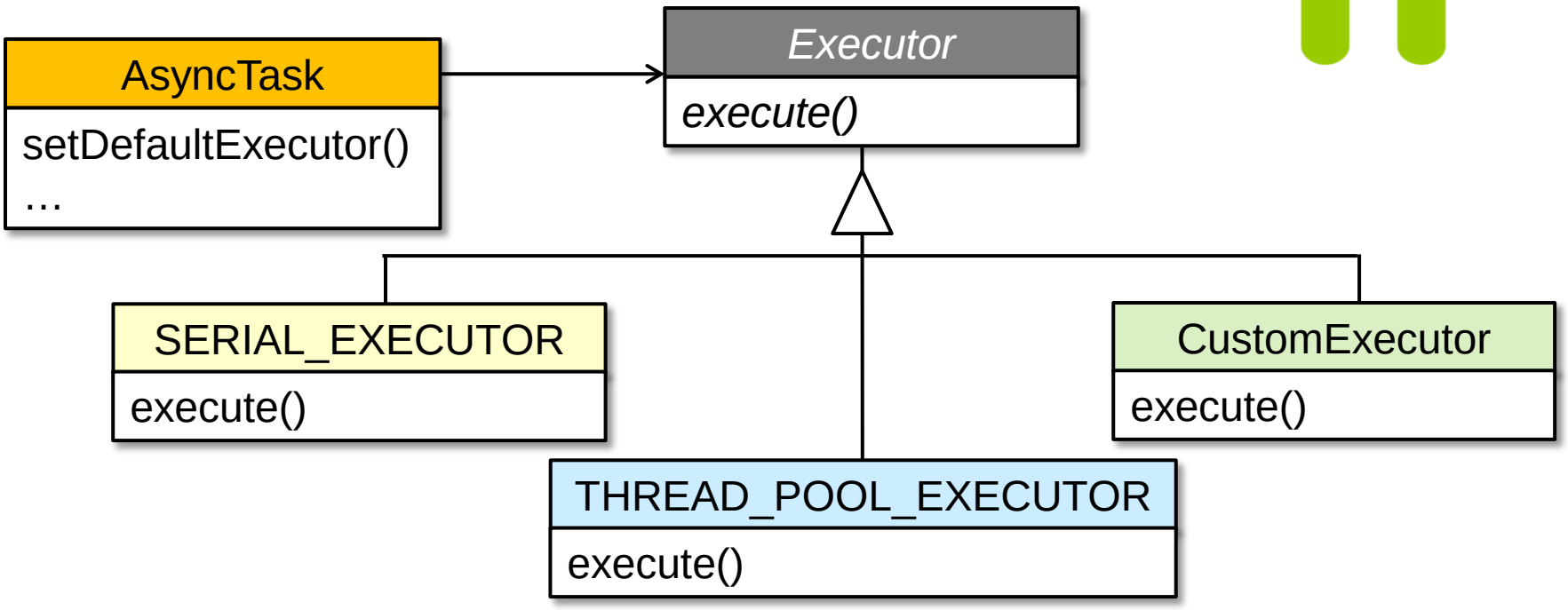

See upcoming module on "Android Concurrency Frameworks"

Summary

- The pattern-oriented framework supports a family of a concurrent ping-pong programs
- GoF patterns simplify the solution's portability, reusability, & extensibility
- We'll use this framework to port our solution to Android