Testable Database Interaction

Sebastian Bergmann

- **Sebastian** since 1978
- **Computers** since 1990
- **PHP** since 1998
- **Open Source** since 1998
- **PHPUnit** since 2000
- **thePHP.cc** since 2009

thePHP.cc

sharing experience

Expectation Management

I will not cover techniques specific to Doctrine DBAL, Doctrine ORM, Eloquent, or similar standard solutions.

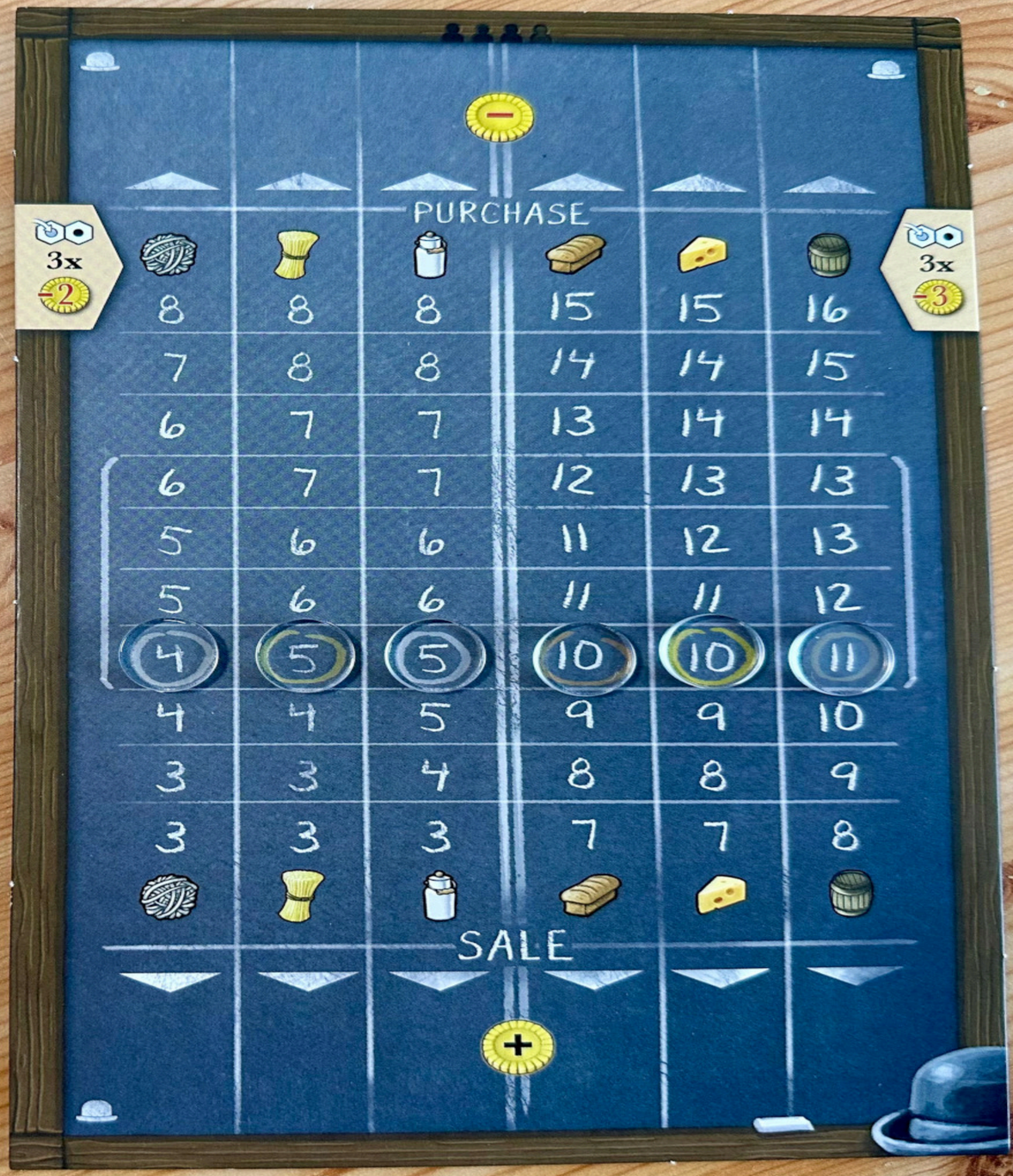
I will not cover optimisations such as running a relational database from a RAM disk, or using containerisation tricks to improve the performance of tests that interact with the database.

You will see **best practices** and **design patterns** in action for interacting with your database.

You will learn how to **implement testable database interaction** – and how to **test code that interacts with the database** without getting frustrated.

We focus on **concepts**, **best practices**, and **design patterns** rather than off-the-shelf frameworks and libraries.

Once you understand these, you can apply them to your preferred framework or library with confidence and ease.


PURCHASE
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SALE


PURCHASE
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SALE


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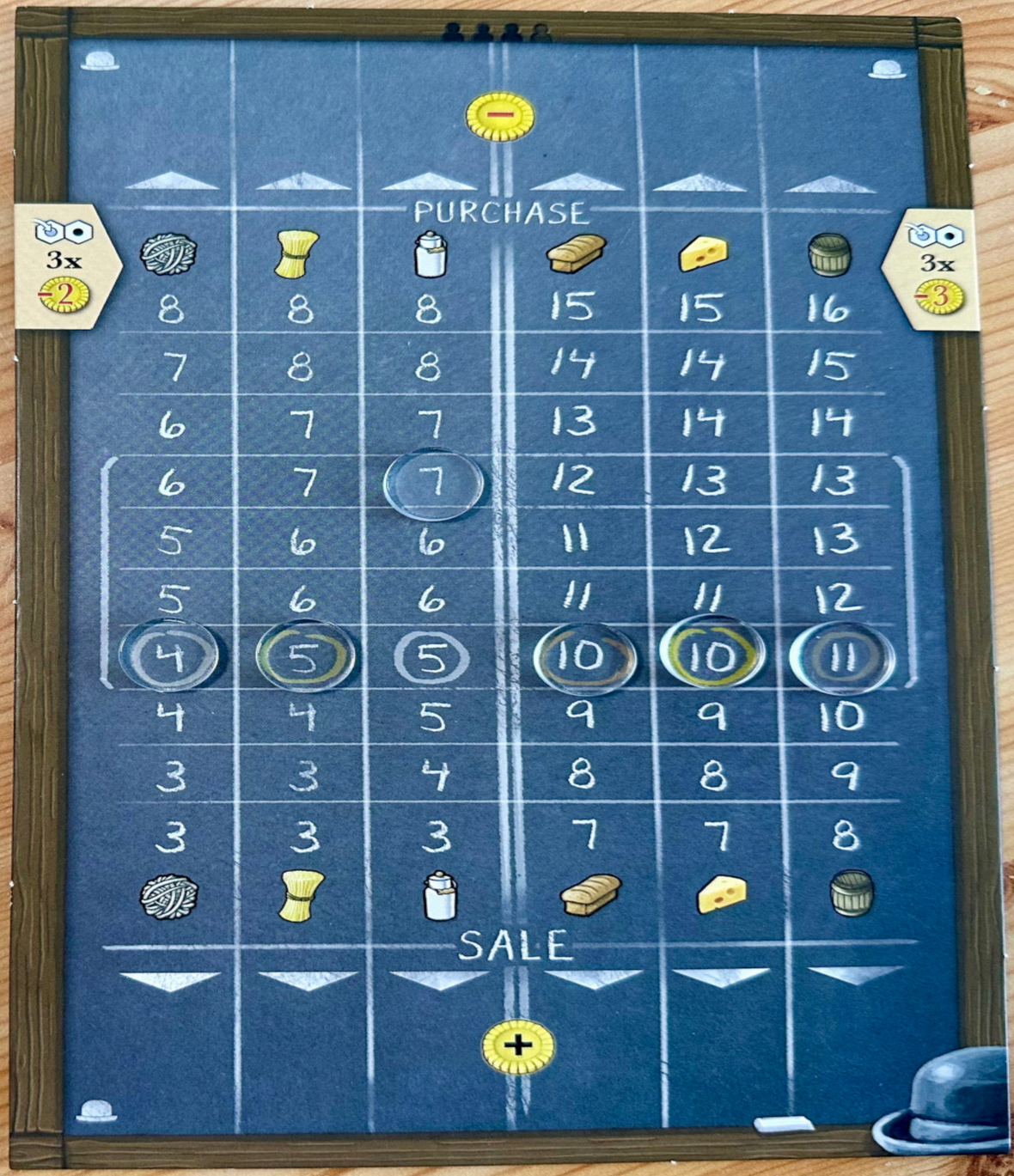
SALE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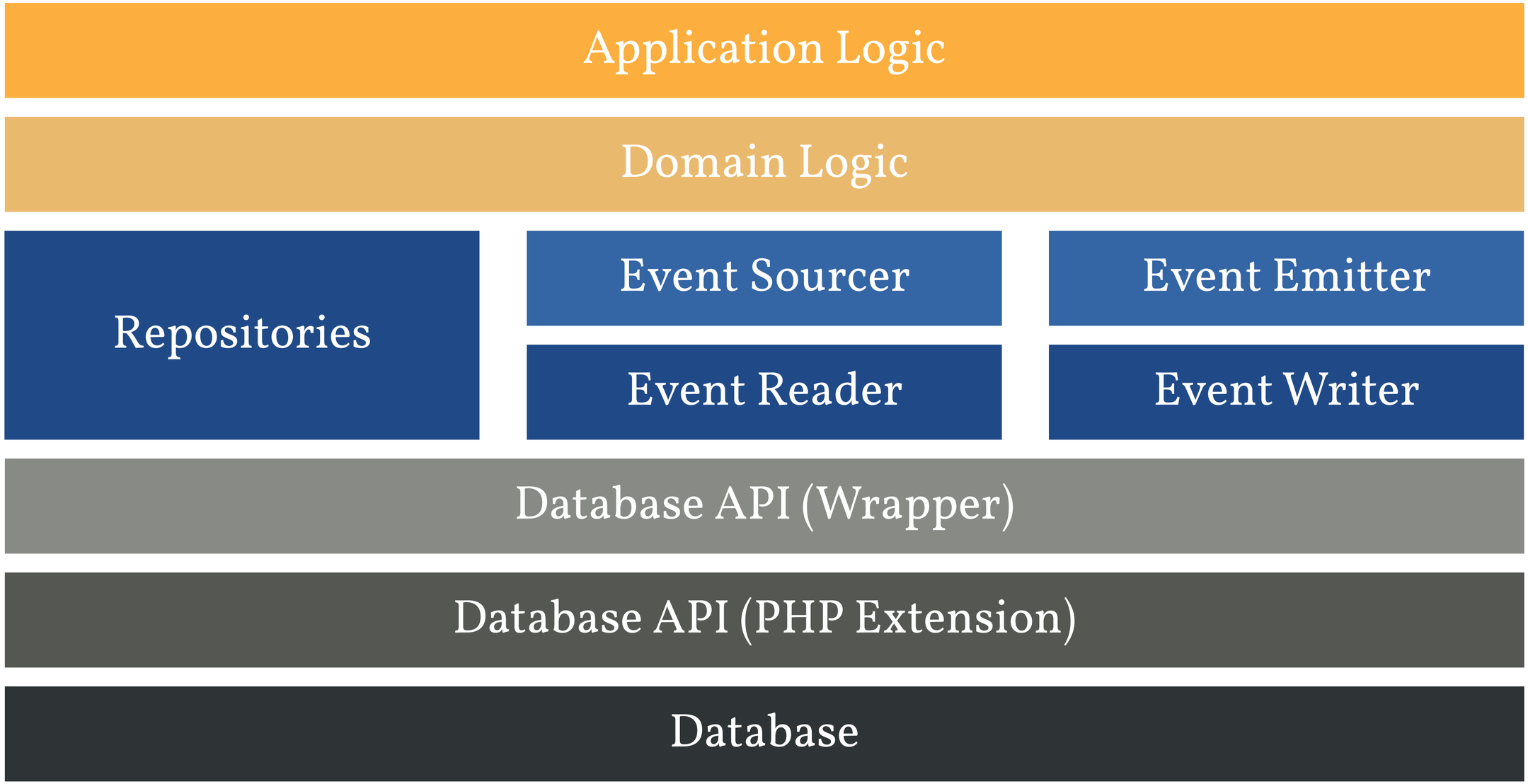
SALE


Application Logic
Domain Logic
Repositories
Event Sourcer
Event Emitter
Event Reader
Event Writer
Database API (Wrapper)
Database API (PHP Extension)
Database

```php
<?php declare(strict_types=1);
namespace example\framework\http;

final readonly class Kernel
{
    private PostRequestRouter $postRequestRouter;

    public function __construct(PostRequestRouter $postRequestRouter, /* ... */)
    {
        $this->getRequestRouter  = $getRequestRouter;
        $this->postRequestRouter = $postRequestRouter;
    }

    public function run(Request $request): Response
    {
        if ($request->isGetRequest()) { /* ... * / }

        if ($request->isPostRequest()) {
            $command = $this->postRequestRouter->route($request);

            return $command->execute();
        }

        // ...
    }
}
```

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```php
<?php declare(strict_types=1);
namespace example\framework\http;

final readonly class PostRequestRouter
{
    /** @var list<PostRequestRoute> */
    private array $routes;

    public function __construct(PostRequestRoute ...$routes)
    {
        $this->routes = $routes;
    }

    /** @throws RequestCannotBeRoutedException */
    public function route(PostRequest $request): Command
    {
        foreach ($this->routes as $route) {
            $command = $route->route($request);

            if ($command !== false) {
                return $command;
            }
        }

        throw new RequestCannotBeRoutedException;
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\caledonia\application;

use example\caledonia\domain\PurchaseGoodCommand as DomainCommand;
// ...

final readonly class PurchaseGoodRoute implements PostRequestRoute
{
    // properties, constructor

    public function route(PostRequest $request): false|PurchaseGoodCommand
    {
        if ($request->uri() !== '/purchase-good') {
            return false;
        }

        $data = json_decode($request->body(), true);

        return new PurchaseGoodCommand(
            $this->factory->createPurchaseGoodCommandProcessor(),
            new DomainCommand(
                Good::fromString($data['good']),
                (int) $data['amount'],
            ),
        );
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\caledonia\application;

use example\caledonia\domain\PurchaseGoodCommand as DomainCommand;
use example\framework\http\Command;
use example\framework\http\Response;

final readonly class PurchaseCommand implements Command
{
    private PurchaseGoodCommandProcessor $processor;
    private DomainCommand $command;

    public function __construct(PurchaseGoodCommandProcessor $processor, DomainCommand $command)
    {
        $this->processor = $processor;
        $this->command   = $command;
    }

    public function execute(): Response
    {
        $this->processor->process($this->command);

        return new Response;
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\caledonia\application;

use example\caledonia\domain\PurchaseGoodCommand;

final readonly class ProcessingPurchaseGoodCommandProcessor implements PurchaseGoodCommandProcessor
{
    // properties, constructor

    public function process(PurchaseGoodCommand $command): void
    {
        $market = $this->sourcer->source();

        $oldPrice = $market->priceFor($command->good());

        $market = $market->purchase($command->good(), $command->amount());

        $this->emitter->goodPurchased($command->good(), $oldPrice, $command->amount());

        $newPrice = $market->priceFor($command->good());

        if (!$newPrice->equals($oldPrice)) {
            $this->emitter->priceChanged($command->good(), $oldPrice, $newPrice);
        }
    }
}
```

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```php
<?php declare(strict_types=1);
namespace example\caledonia\application;

// use statements

final readonly class MarketEventSourcer implements MarketSourcer
{
    // properties, constructor

    public function source(): Market
    {
        $market = Market::create();

        foreach ($this->reader->topic('market.good-purchased', 'market.good-sold') as $event) {
           if ($event instanceof GoodPurchasedEvent) {
                $market = $market->purchase($event->good(), $event->amount());

                continue;
            }

            $market = $market->sell($event->good(), $event->amount());
        }

        return $market;
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\framework\event;

use SebastianBergmann\MysqliWrapper\ReadingDatabaseConnection;

final readonly class DatabaseEventReader implements EventReader
{
    private ReadingDatabaseConnection $connection;
    private EventJsonMapper $mapper;

    public function __construct(ReadingDatabaseConnection $connection, EventJsonMapper $mapper)
    {
        $this->connection = $connection;
        $this->mapper     = $mapper;
    }

   public function topic(string ...$topics): EventCollection
    {
        $result = (new ReadEventsStatement($topics))->execute($this->connection);
        $events = [];

        foreach ($result as $row) {
            $events[] = $this->mapper->fromJson($row['payload']);
        }

        return EventCollection::fromArray($events);
    }
}
```

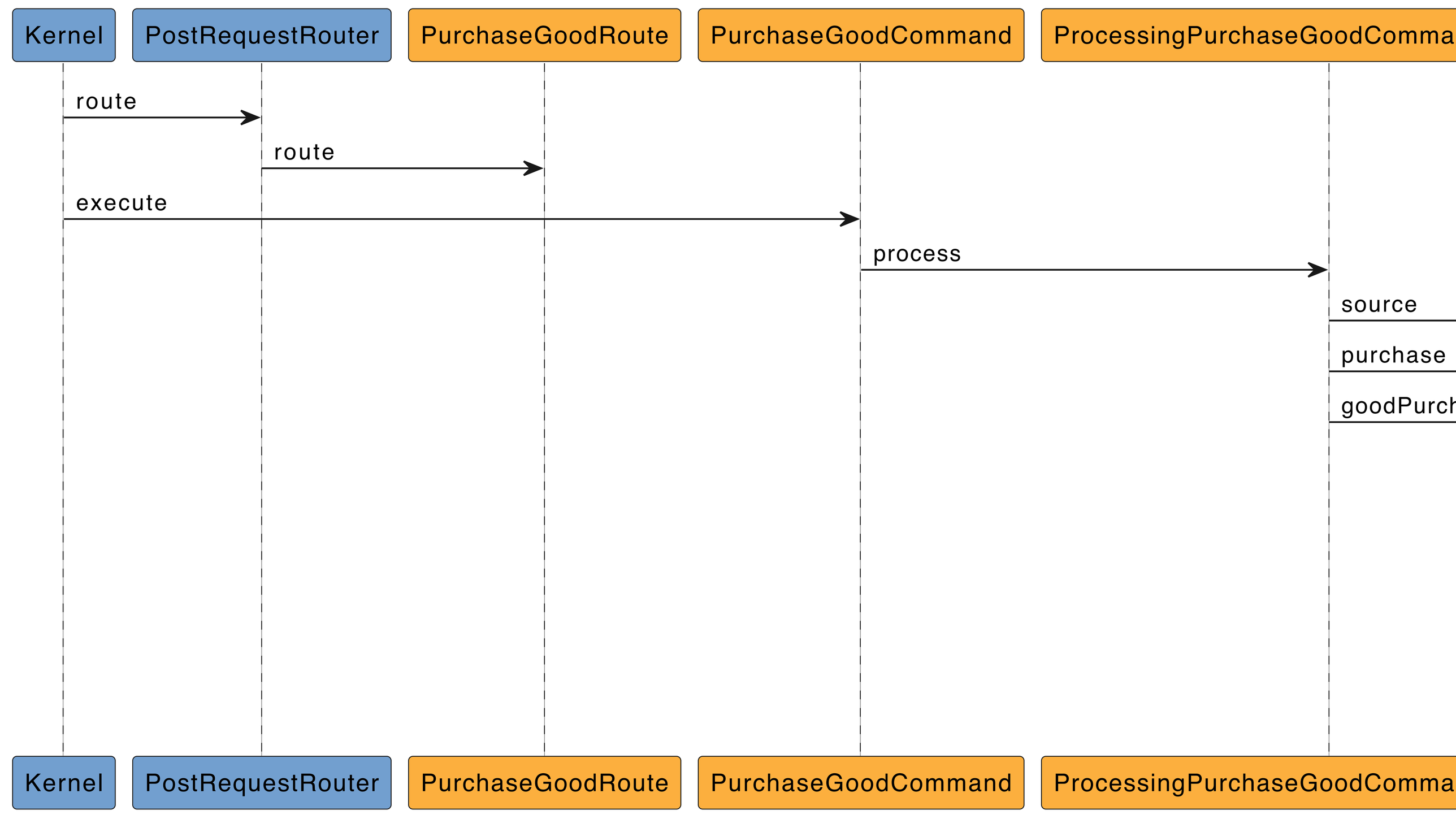
```php
<?php declare(strict_types=1);
namespace example\framework\event;

// use statements

final readonly class ReadEventsStatement implements ReadStatement
{
    // properties, constructor

    /** @return list<array{payload: non-empty-string}> */
    public function execute(ReadingDatabaseConnection $connection): array
    {
        return $connection->query(
            sprintf(
                'SELECT payload
                   FROM event
                  WHERE topic IN (%s)
                  ORDER BY id;',
                implode(
                    ', ',
                    array_fill(0, count($this->topics), '?'),
                ),
            ),
            ...$this->topics,
        );
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\framework\event;

use SebastianBergmann\MysqliWrapper\WritingDatabaseConnection;

final readonly class DatabaseEventWriter implements EventWriter
{
    private WritingDatabaseConnection $connection;
    private EventJsonMapper $mapper;

    public function __construct(WritingDatabaseConnection $connection, EventJsonMapper $mapper)
    {
        $this->connection = $connection;
        $this->mapper     = $mapper;
    }

    /** @throws CannotMapEventException */
    public function write(Event $event): void
    {
        $statement = new WriteEventStatement(
            $event->id()->asString(),
            $event->topic(),
            $this->mapper->toJson($event),
        );

        $statement->execute($this->connection);
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\framework\event;

use SebastianBergmann\MysqliWrapper\WriteStatement;
use SebastianBergmann\MysqliWrapper\WritingDatabaseConnection;

final readonly class WriteEventStatement implements WriteStatement
{
    // properties, constructor

    public function execute(WritingDatabaseConnection $connection): void
    {
        $connection->execute(
            'INSERT INTO event
                        (event_id, topic, payload)
                VALUES (?, ?, ?);',
            $this->id,
            $this->topic,
            $this->payload,
        );
    }
}
```

```php
<?php declare(strict_types=1);
namespace SebastianBergmann\MysqliWrapper;

interface ReadingDatabaseConnection
{
    /**
     * @param non-empty-string $sql
     *
     * @return list<array<non-empty-string, float|int|string>>
     */
    public function query(string $sql, float|int|string ...$parameters): array;
}



interface ReadStatement
{
    /**
     * @return list<array<non-empty-string, float|int|string>>
     */
    public function execute(ReadingDatabaseConnection $connection): array;
}
```

```php
<?php declare(strict_types=1);
namespace SebastianBergmann\MysqliWrapper;

interface WritingDatabaseConnection
{
    /**
     * @param non-empty-string $sql
     */
    public function execute(string $sql, float|int|string ...$parameters): true;
}



interface WriteStatement
{
    public function execute(WritingDatabaseConnection $connection): void;
}
```


Kernel
PostRequestRouter
PurchaseGoodRoute
PurchaseGoodCommand
ProcessingPurchaseGoodComma
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execute
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source
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Kernel
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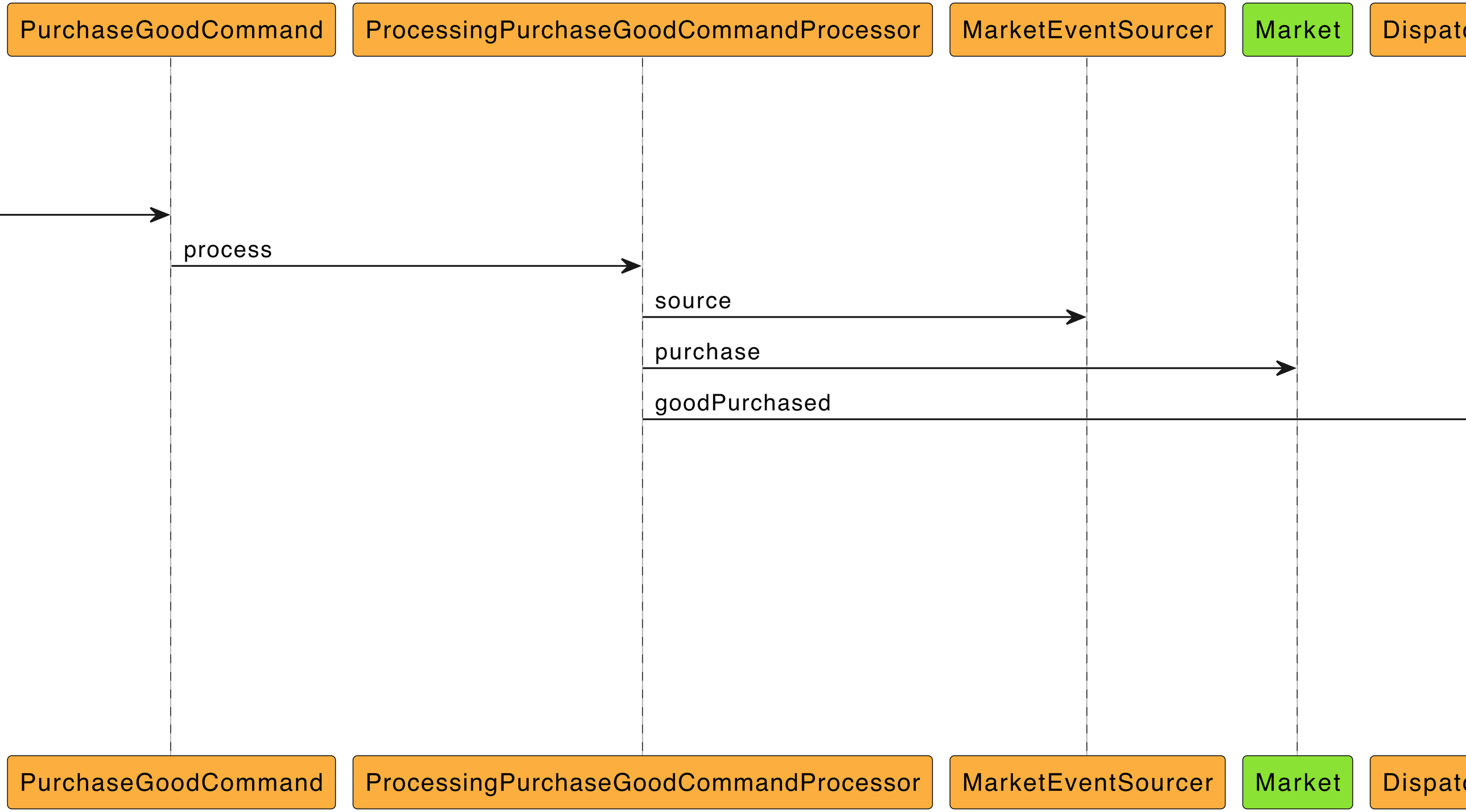
PurchaseGoodCommand
ProcessingPurchaseGoodCommandProcessor
MarketEventSourcer
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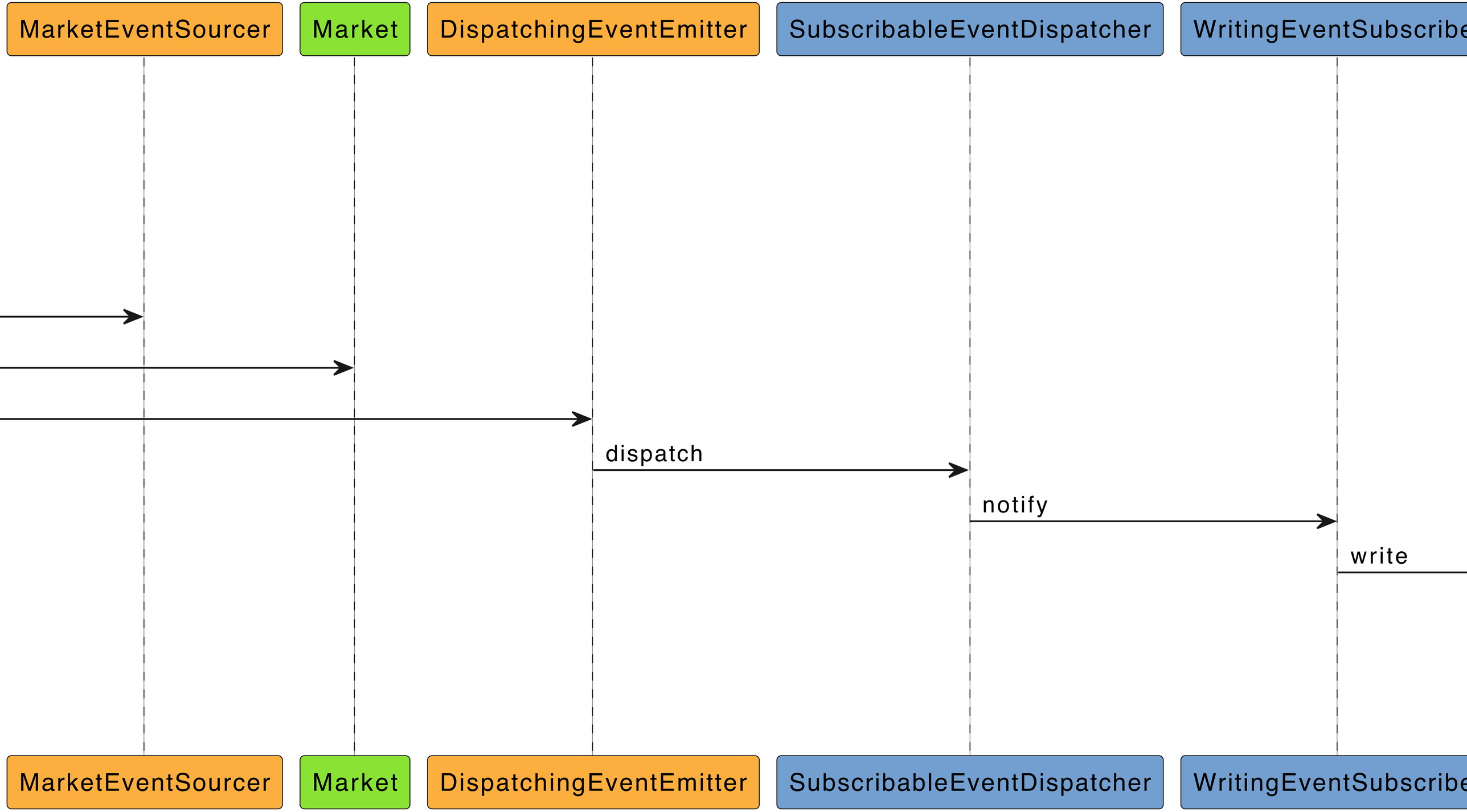
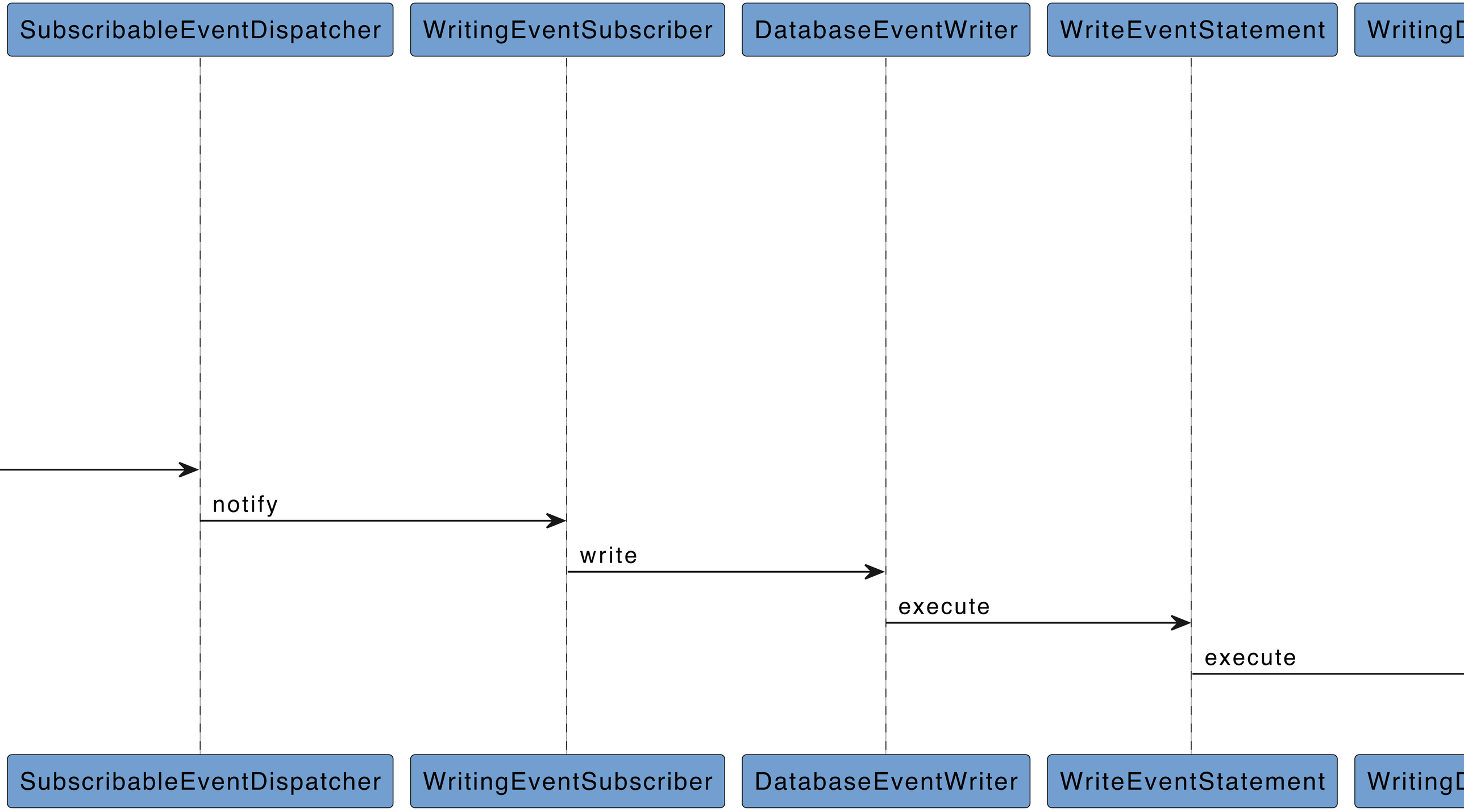

MarketEventSourcer
Market
DispatchingEventEmitter
SubscribableEventDispatcher
WritingEventSubscribe
dispatch
notify
write
MarketEventSourcer
Market
DispatchingEventEmitter
SubscribableEventDispatcher
WritingEventSubscribe


SubscribableEventDispatcher
WritingEventSubscriber
DatabaseEventWriter
WriteEventStatement
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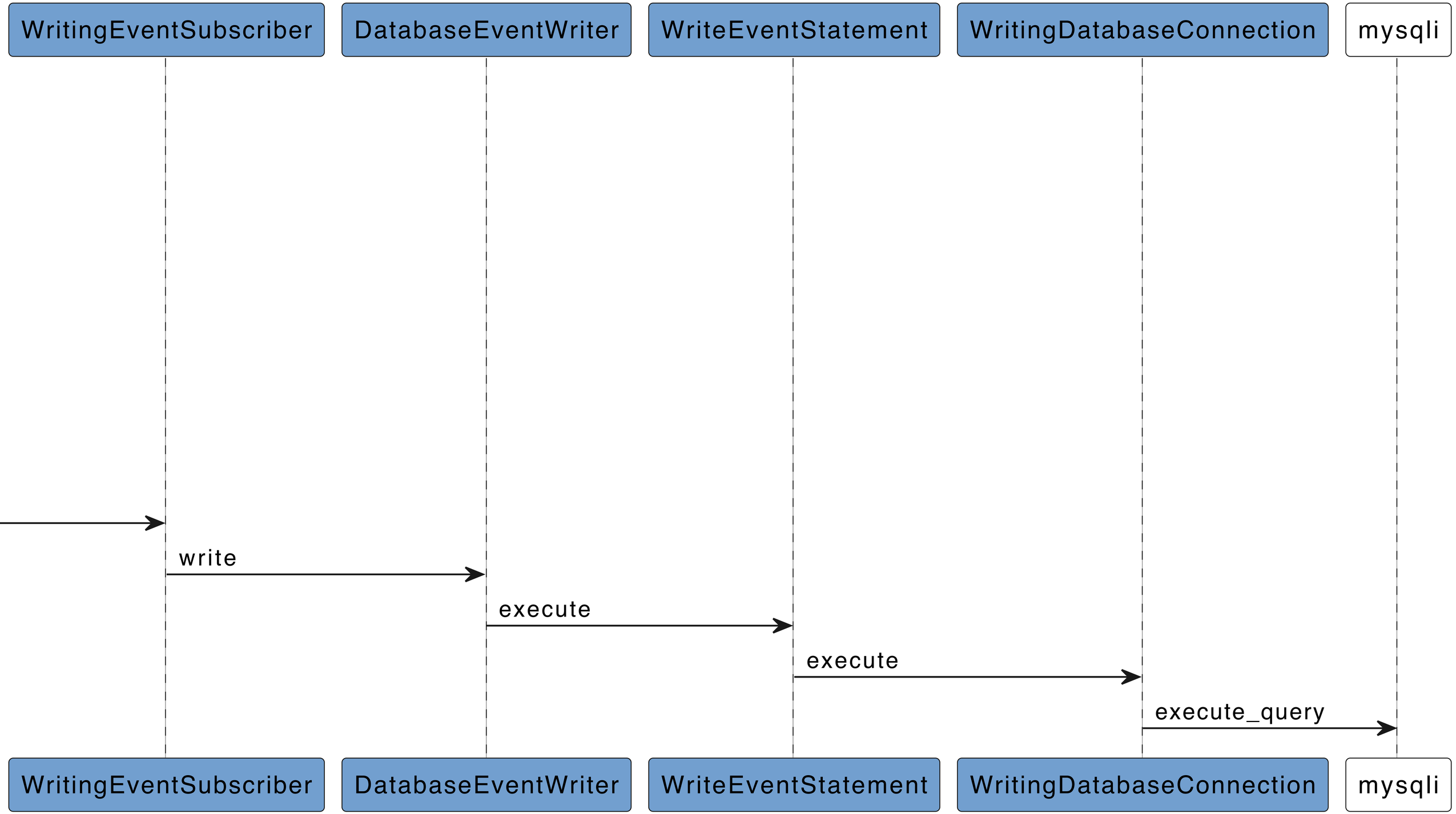
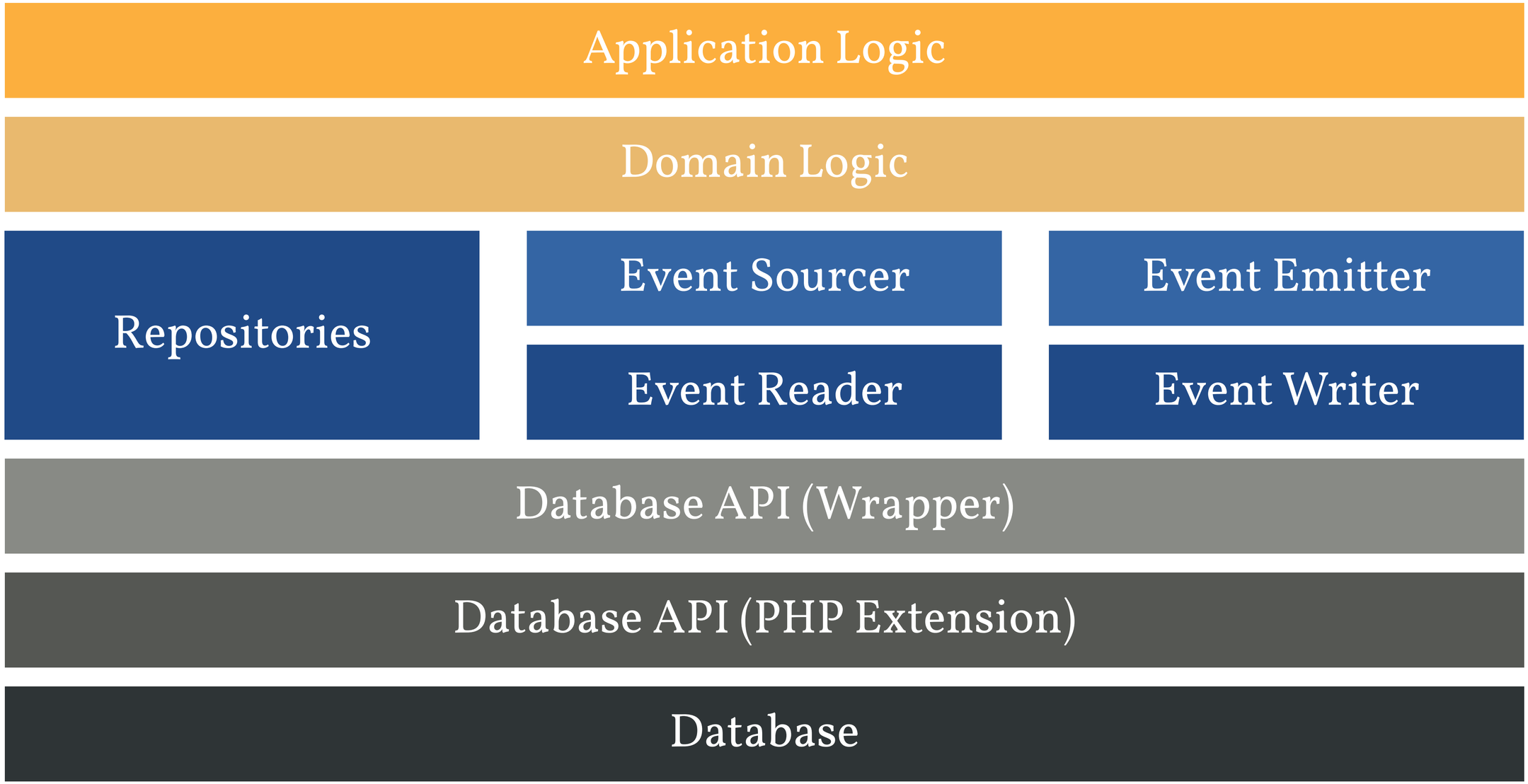
notify
write
execute
execute
SubscribableEventDispatcher
WritingEventSubscriber
DatabaseEventWriter
WriteEventStatement
WritingD


WritingEventSubscriber
DatabaseEventWriter
WriteEventStatement
WritingDatabaseConnection
mysqli
write
execute
execute
execute_query
WritingEventSubscriber
DatabaseEventWriter
WriteEventStatement
WritingDatabaseConnection
mysqli

```php
<?php declare(strict_types=1);
namespace example\framework\event;

// use statements

final class DatabaseEventWriterTest extends DatabaseTestCase
{
    public function testWritesEventToDatabase(): void
    {
        $this->emptyTable('event');

        $this->writer()->write($this->event());

        $this->assertTableEqualsCsvFile(
            __DIR__ . '/../../../expectation/event.csv',
            'event',
            $this->eventSchema(),
        );
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\framework\event;

// use statements

final class WriteEventStatementIntegrationTest extends DatabaseTestCase
{
    public function testWritesEventToDatabase(): void
    {
        $this->emptyTable('event');

        $statement = new WriteEventStatement(
            'b5578a2a-3188-470c-a2b7-3a249faed6fb',
            'the-topic',
            'payload',
        );

        $statement->execute($this->connectionForWritingEvents());

        $this->assertTableEqualsCsvFile(
            __DIR__ . '/../../../expectation/write_event.csv',
            'event',
            $this->eventSchema(),
        );
    }
}
```

```php
<?php declare(strict_types=1);
namespace example\framework\event;

// use statements

final class WriteEventStatementTest extends TestCase
{
    public function testExecutesStatementToWriteEvent(): void
    {
        $connection = $this->createMock(WritingDatabaseConnection::class);

        $connection
            ->expects($this->once())
            ->method('execute')
            ->with(
                'INSERT INTO event
                        (event_id, topic, payload)
                  VALUES (?, ?, ?);',
                'id',
                'topic',
                'payload',
            );

        $statement = new WriteEventStatement('id', 'topic', 'payload');

        $statement->execute($connection);
    }
}
```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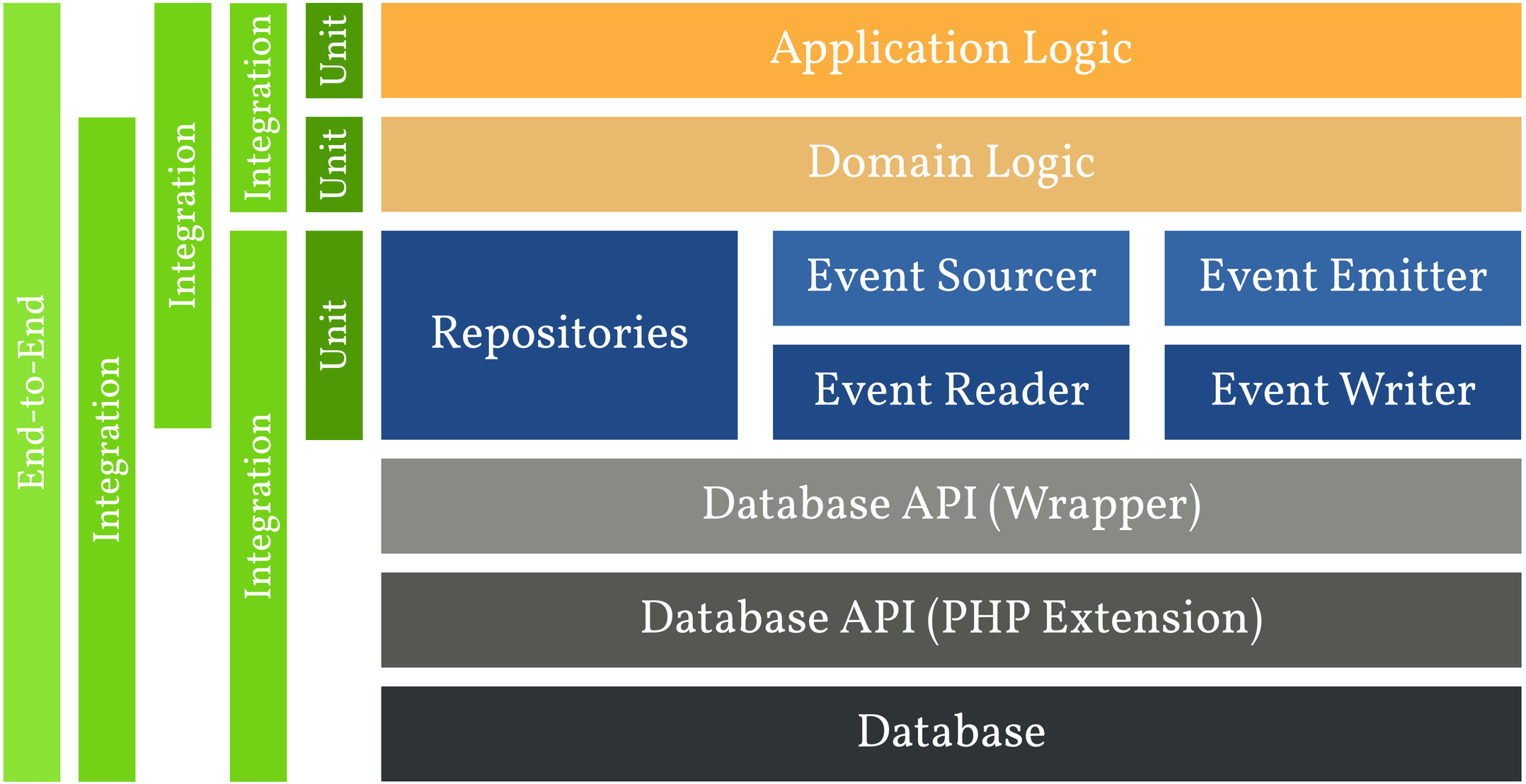
End-to-End
Integration
Integration
Integration
Unit
Unit
Unit
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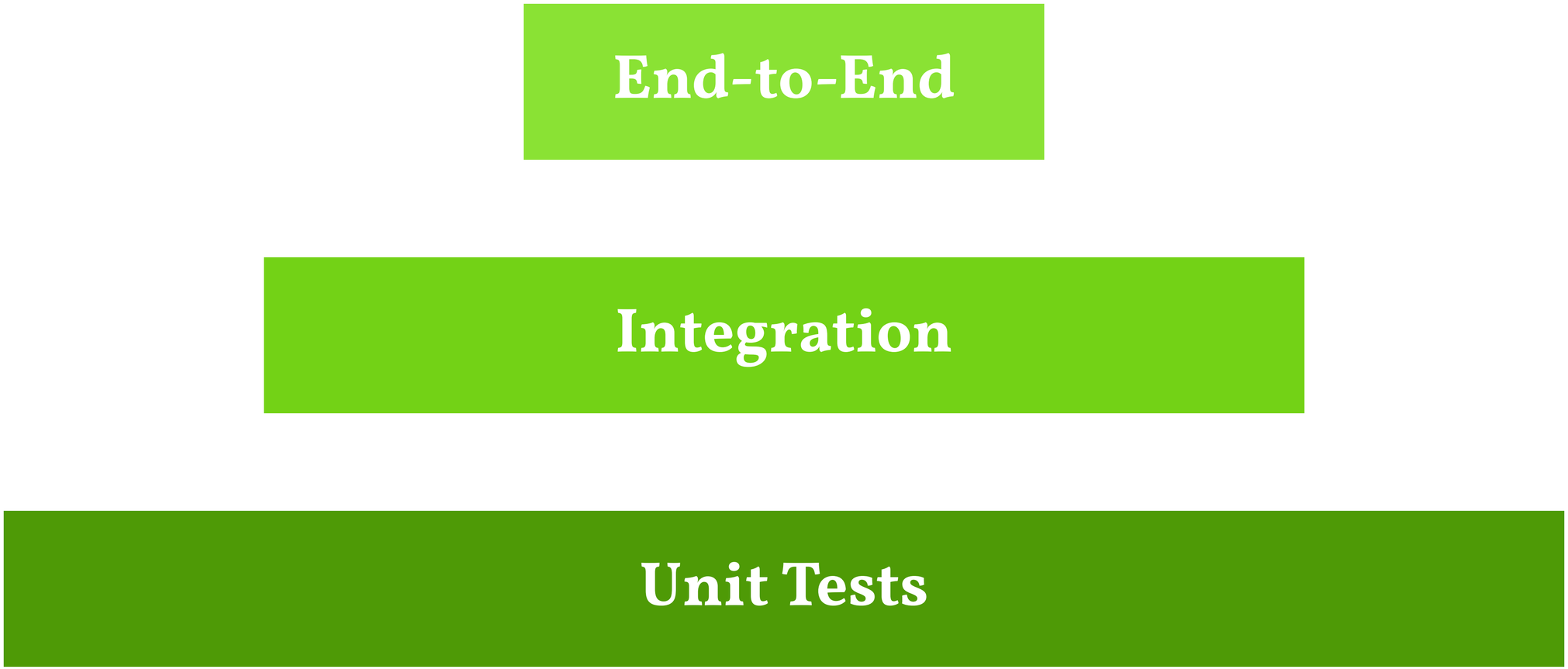
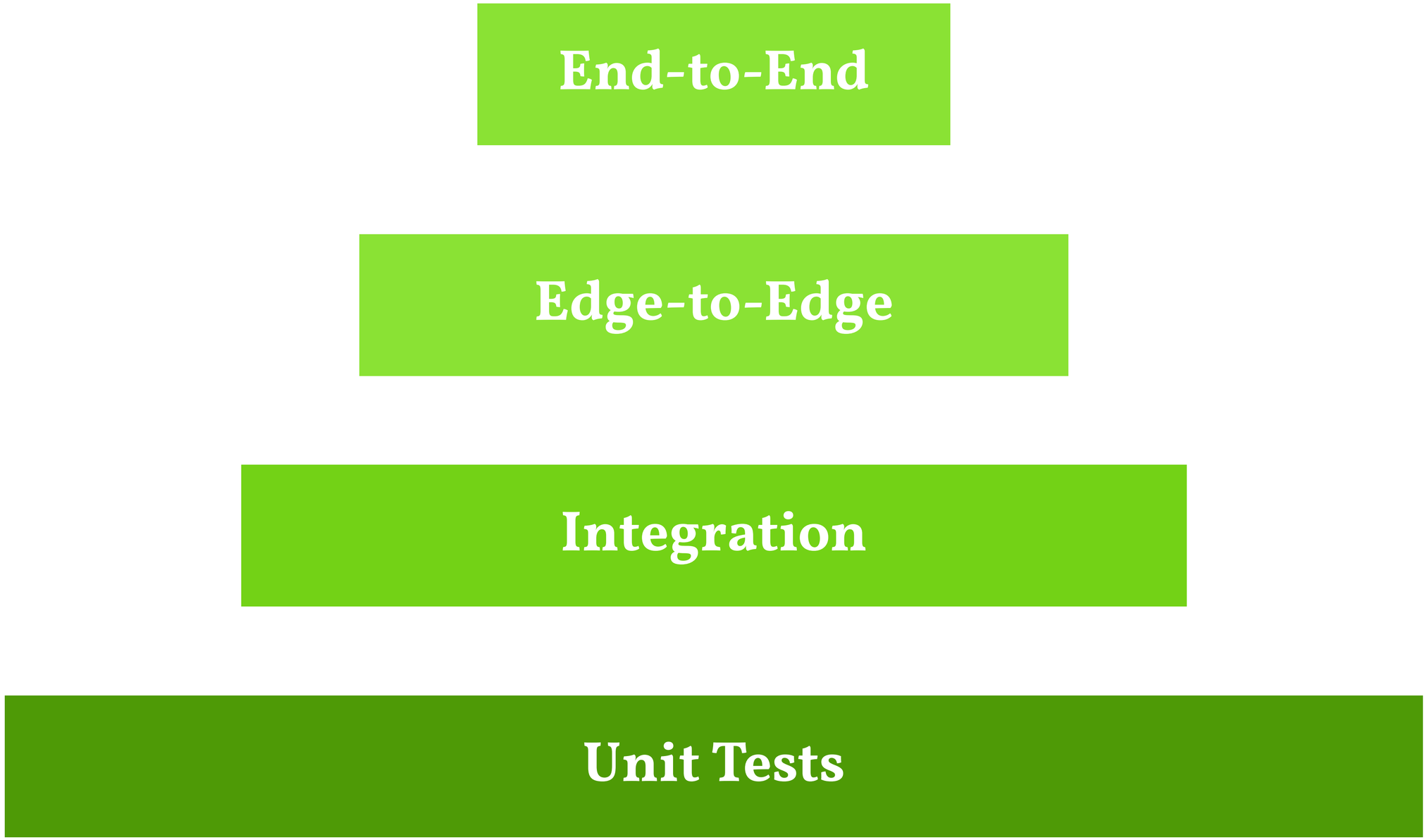

End-to-End
Integration
Unit Tests


End-to-End
Edge-to-Edge
Integration
Unit Tests

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For a class to be easy to unit-test, the class must have **explicit dependencies** that can easily be substituted and **clear responsibilities** that can easily be invoked and verified.

In software-engineering terms, that means that the code must be **loosely coupled** and **highly cohesive** - in other words, well-designed.

http://www.growing-object-oriented-software.com/

The **Single Responsibility Principle** states that each class (and method) should have exactly one responsibility.

https://thephp.cc/topics/solid

Queries [r]eturn a result and [are free of side effects].

Commands [c]hange the state of a system but do not return a value.

https://martinfowler.com/bliki/CommandQuerySeparation.html

A **Repository** mediates between the domain and data mapping layers, acting like an in-memory domain object collection.

https://martinfowler.com/eaaCatalog/repository.html

The **Data Mapper** is a layer of software that separates the in-memory objects from the database. Its responsibility is to transfer data between the two and also to isolate them from each other.

https://martinfowler.com/eaaCatalog/dataMapper.html

Event Sourcing ensures that all changes to application state are stored as a sequence of events. Not just can we query these events, we can also use the event log to reconstruct past states.

https://martinfowler.com/eaaDev/EventSourcing.html

```php
<?php declare(strict_types=1);
namespace example\caledonia\application;

// use statements

final class PurchaseGoodCommandProcessorTest extends EventTestCase
{
   public function testEmitsGoodPurchasedAndPriceChangedEvents(): void
    {
        $this->given(
            $this->goodPurchased(Good::Bread, Price::from(10), 1),
            $this->goodPurchased(Good::Bread, Price::from(11), 1),
        );

        $this->when(new PurchaseGoodCommand(Good::Bread, 1));

        $this->then(
            $this->goodPurchased(Good::Bread, Price::from(11), 1),
            $this->priceChanged(Good::Bread, Price::from(11), Price::from(12)),
        );
    }
}
```

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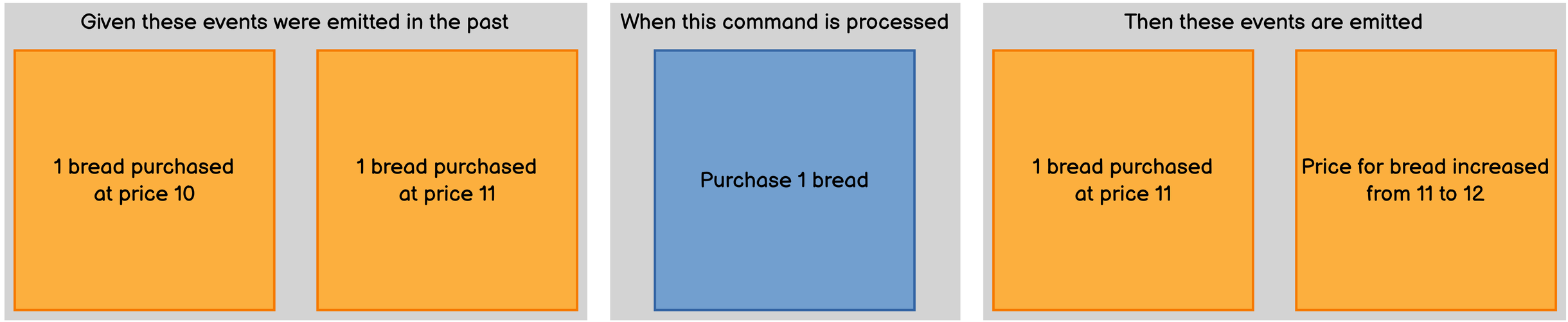
Given these events were emitted in the past
1 bread purchased at price 10
1 bread purchased at price 11
When this command is processed
Purchase 1 bread
Then these events are emitted
1 bread purchased at price 11
Price for bread increased from 11 to 12

Thank you!

https://thePHP.cc/

sebastian@thephp.cc

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