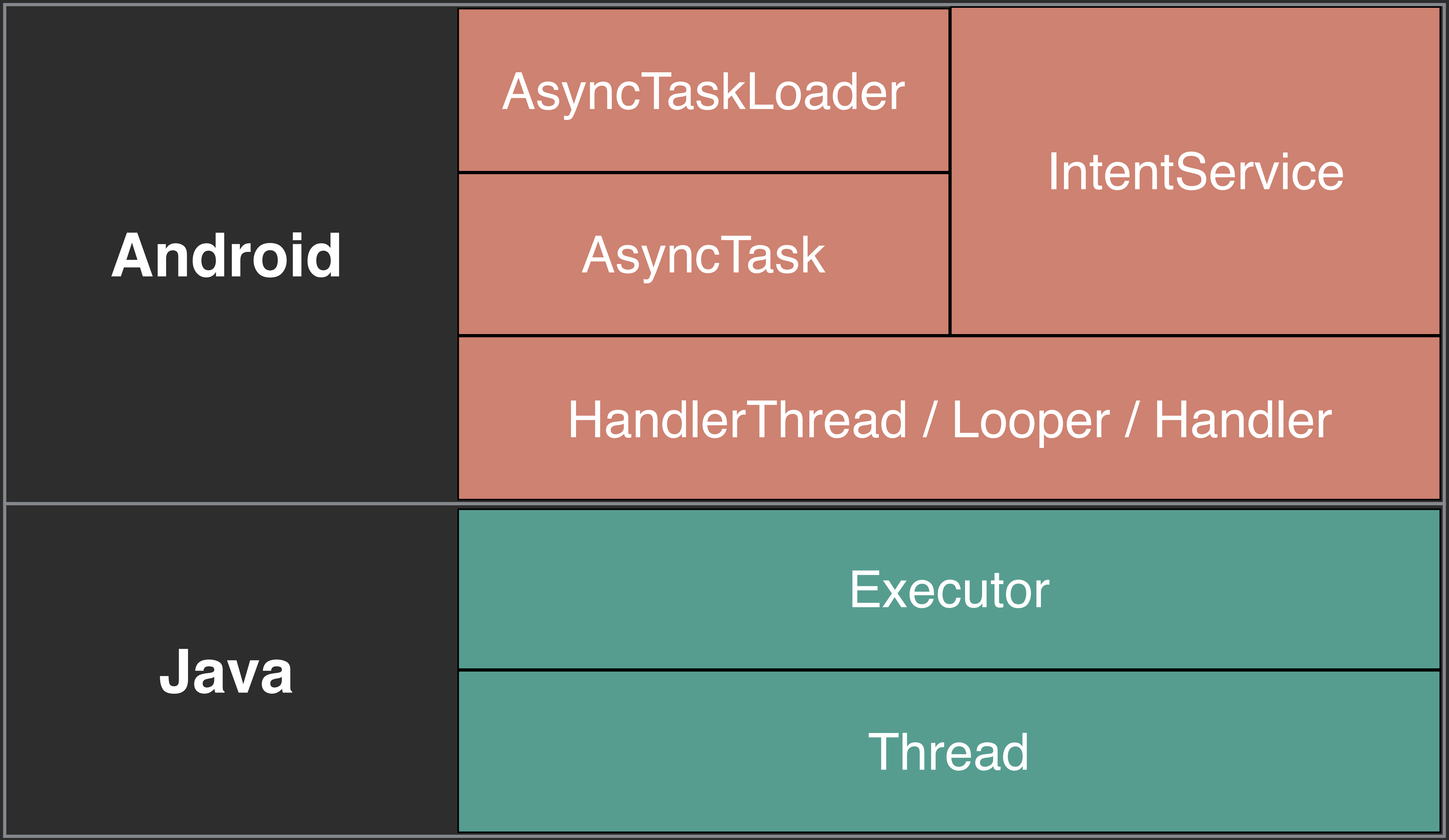
RxJava and Retrolambda

Making Android development more FUNctional

Async Programming

Standard Async Classes



Android

AsyncTaskLoader

AsyncTask

IntentService

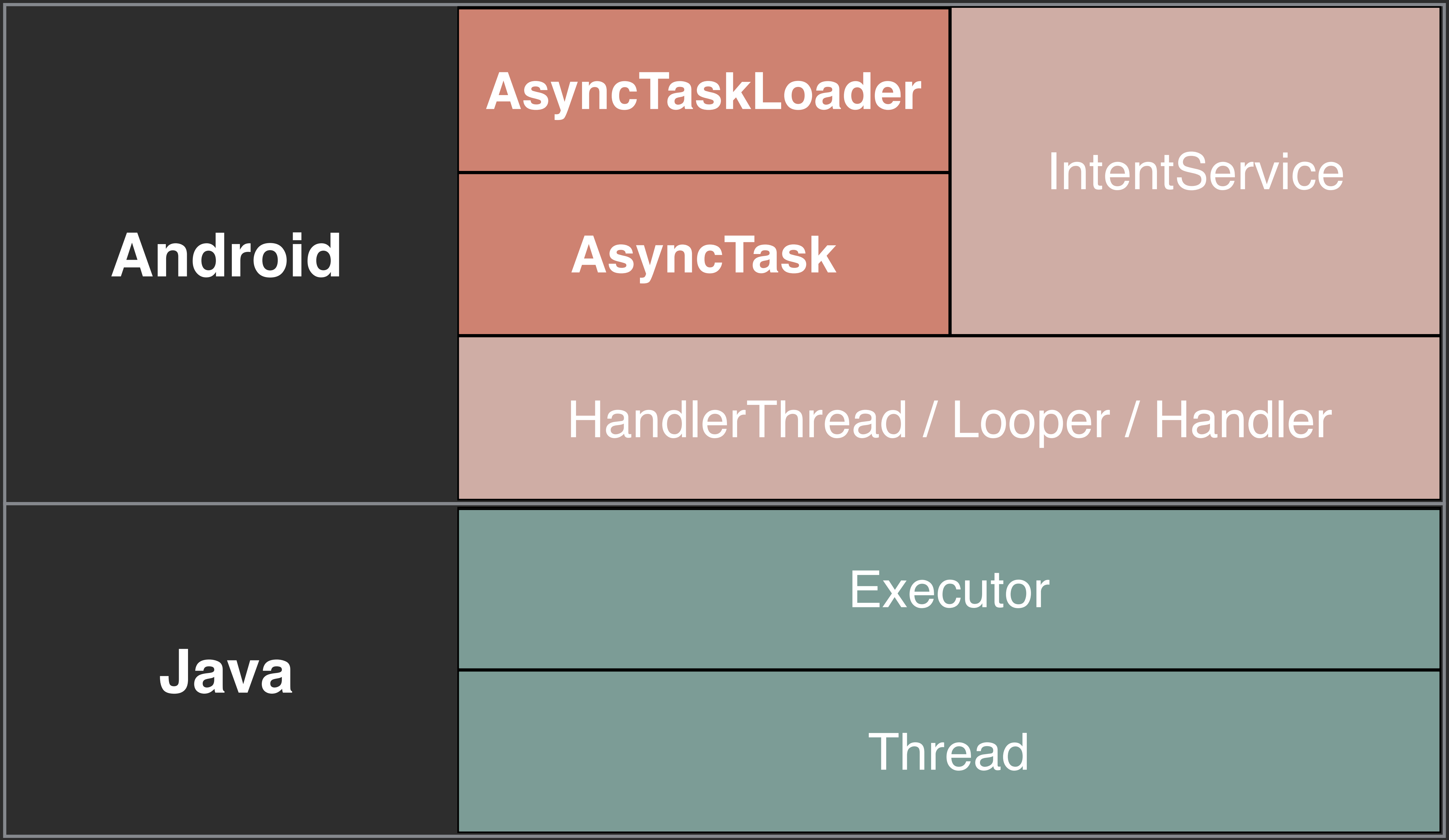
HandlerThread / Looper / Handler

Java

Executor

Thread

Standard Async Classes



Android

AsyncTaskLoader

AsyncTask

IntentService

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Java

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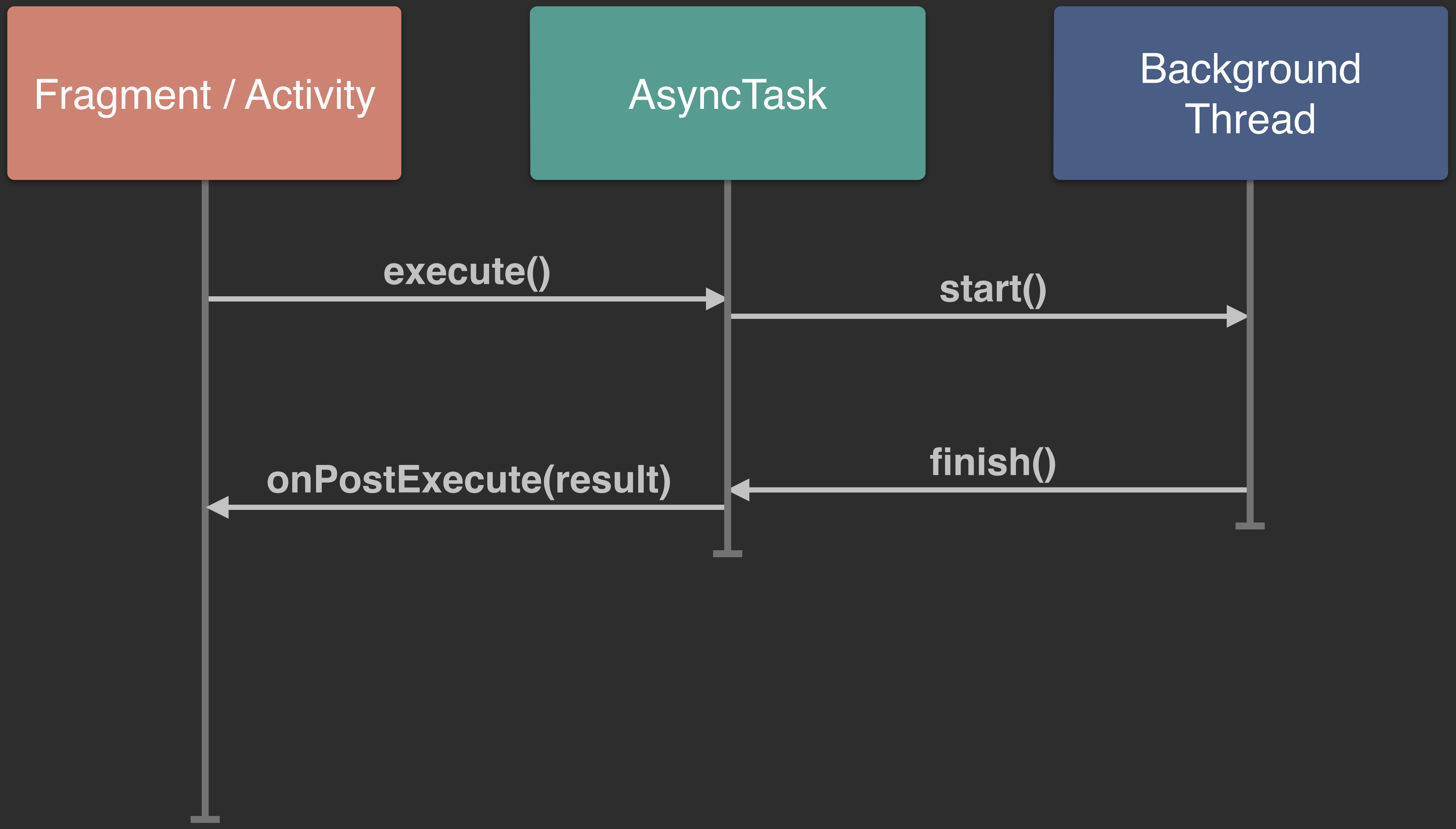
Thread

AsyncTask

Looks easy



Fragment / Activity

AsyncTask

Background Thread

execute()

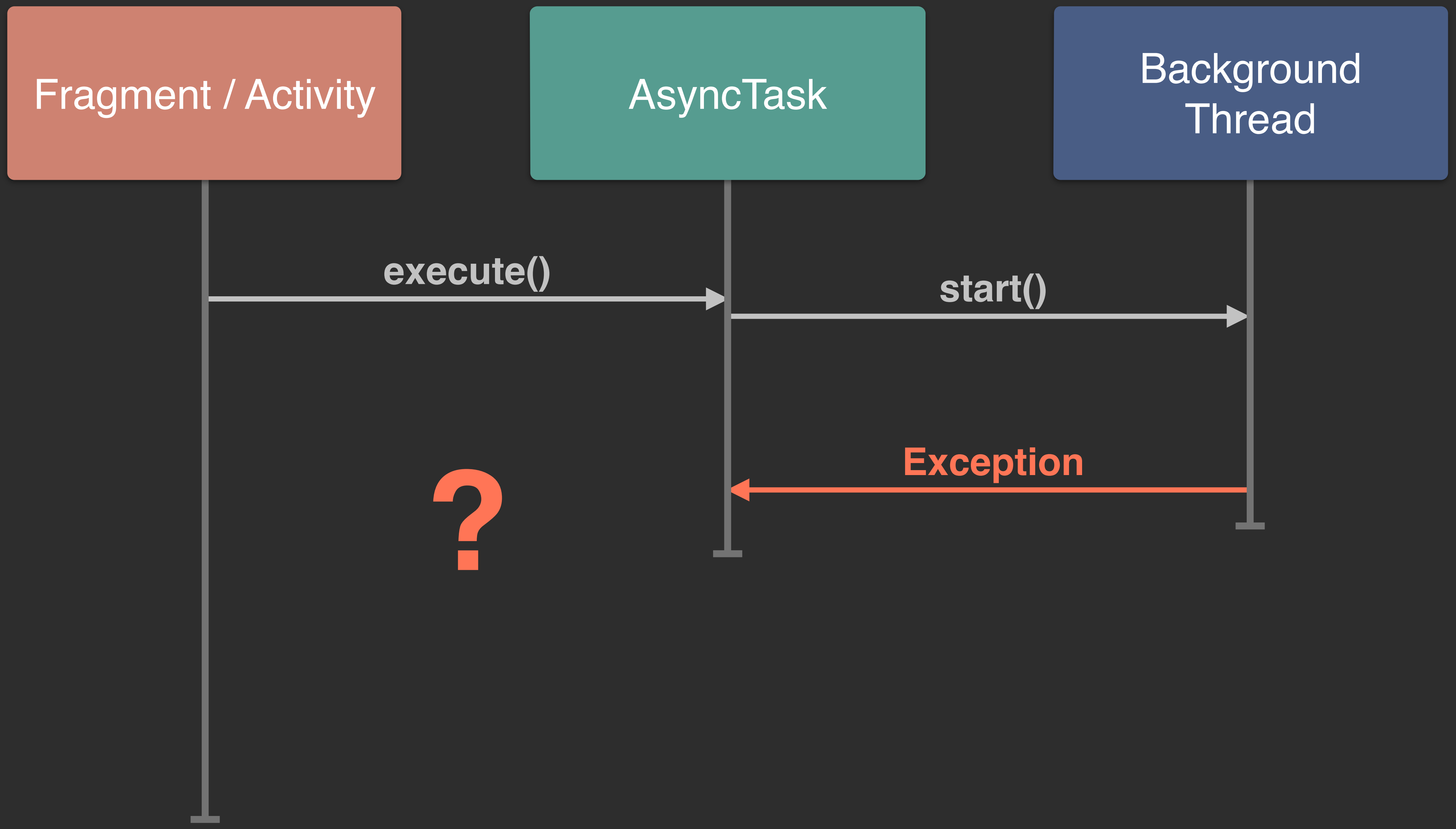
start()

finish()

onPostExecute(result)

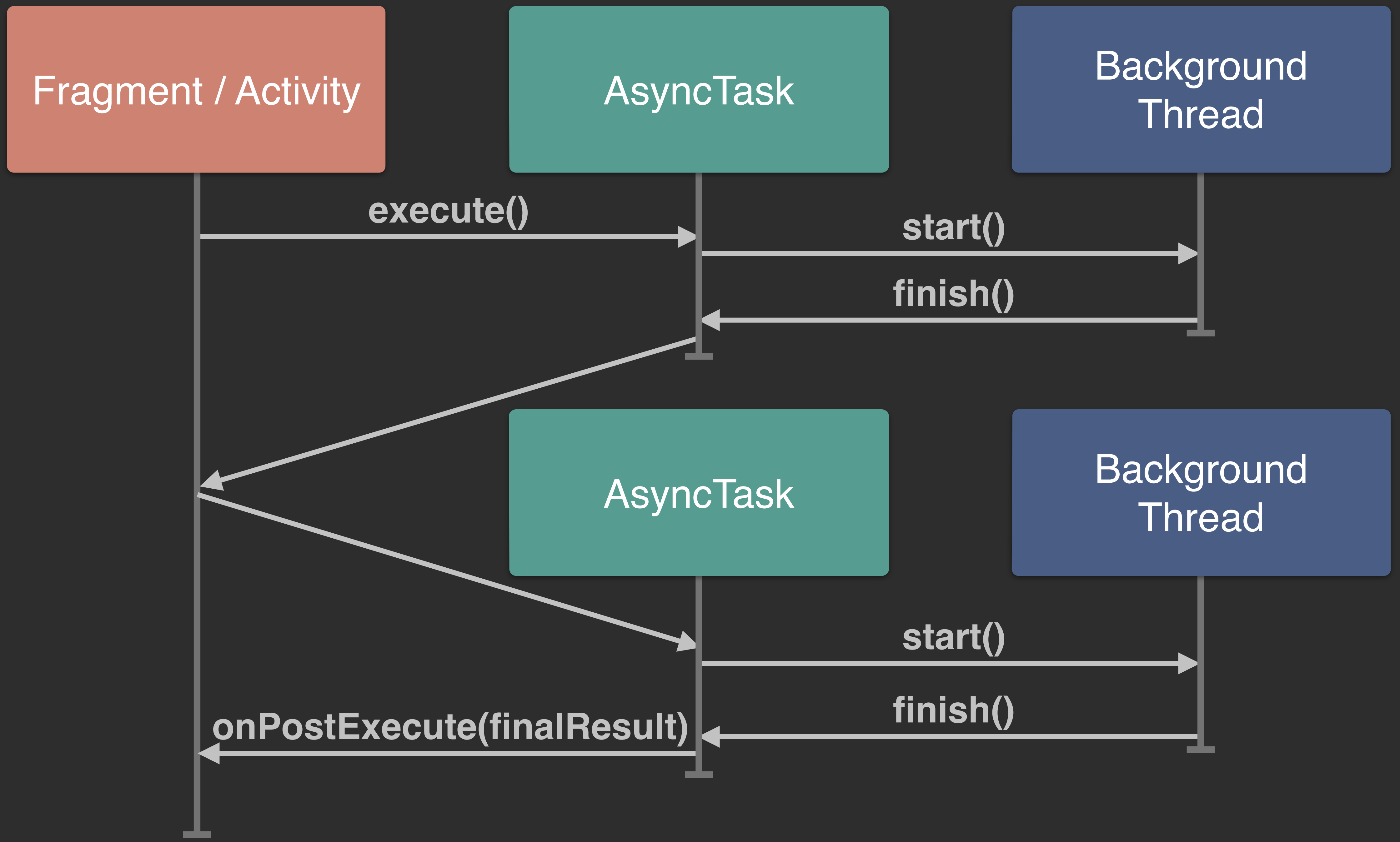
AsyncTask

No exception handling

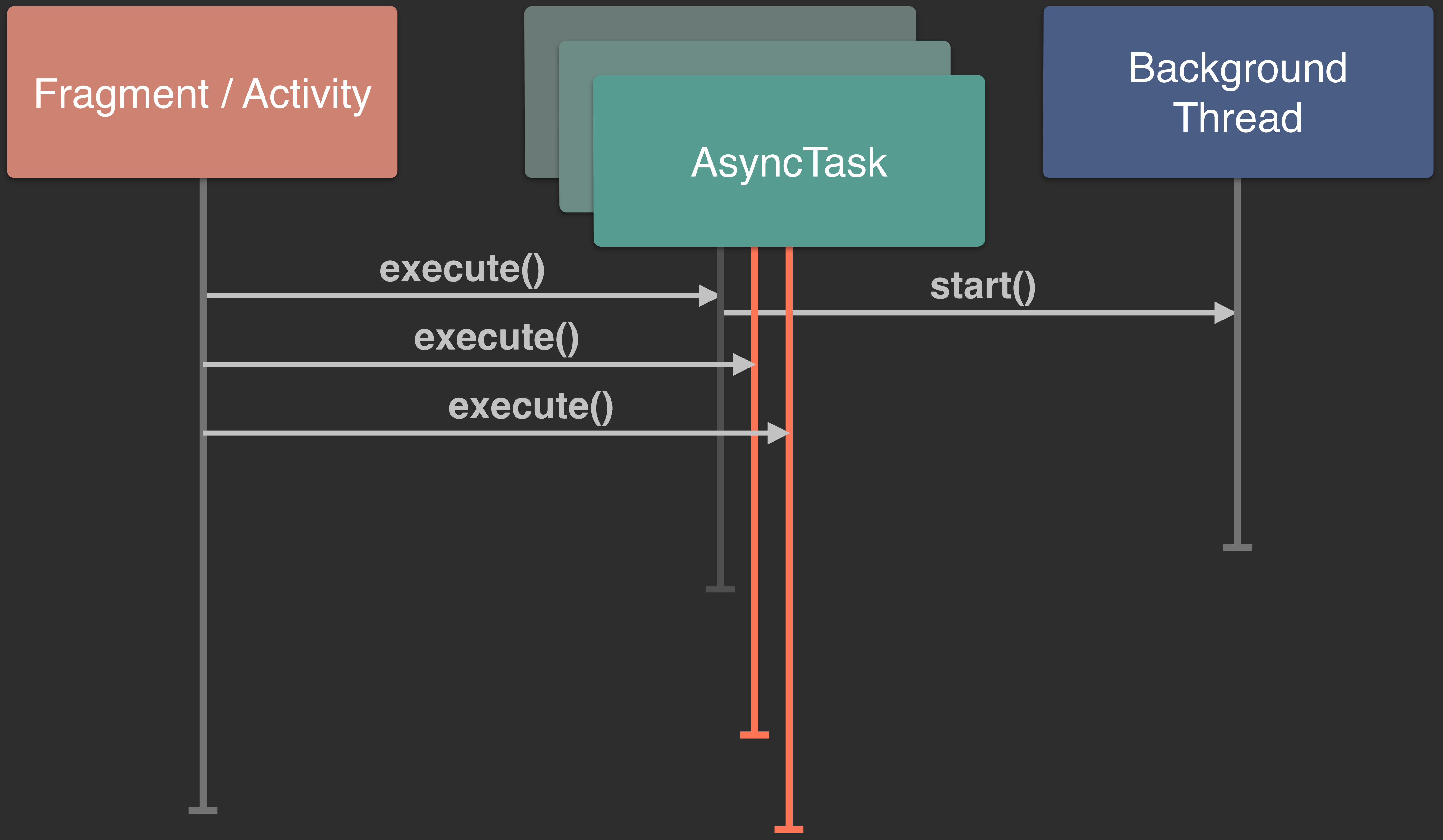


AsyncTask

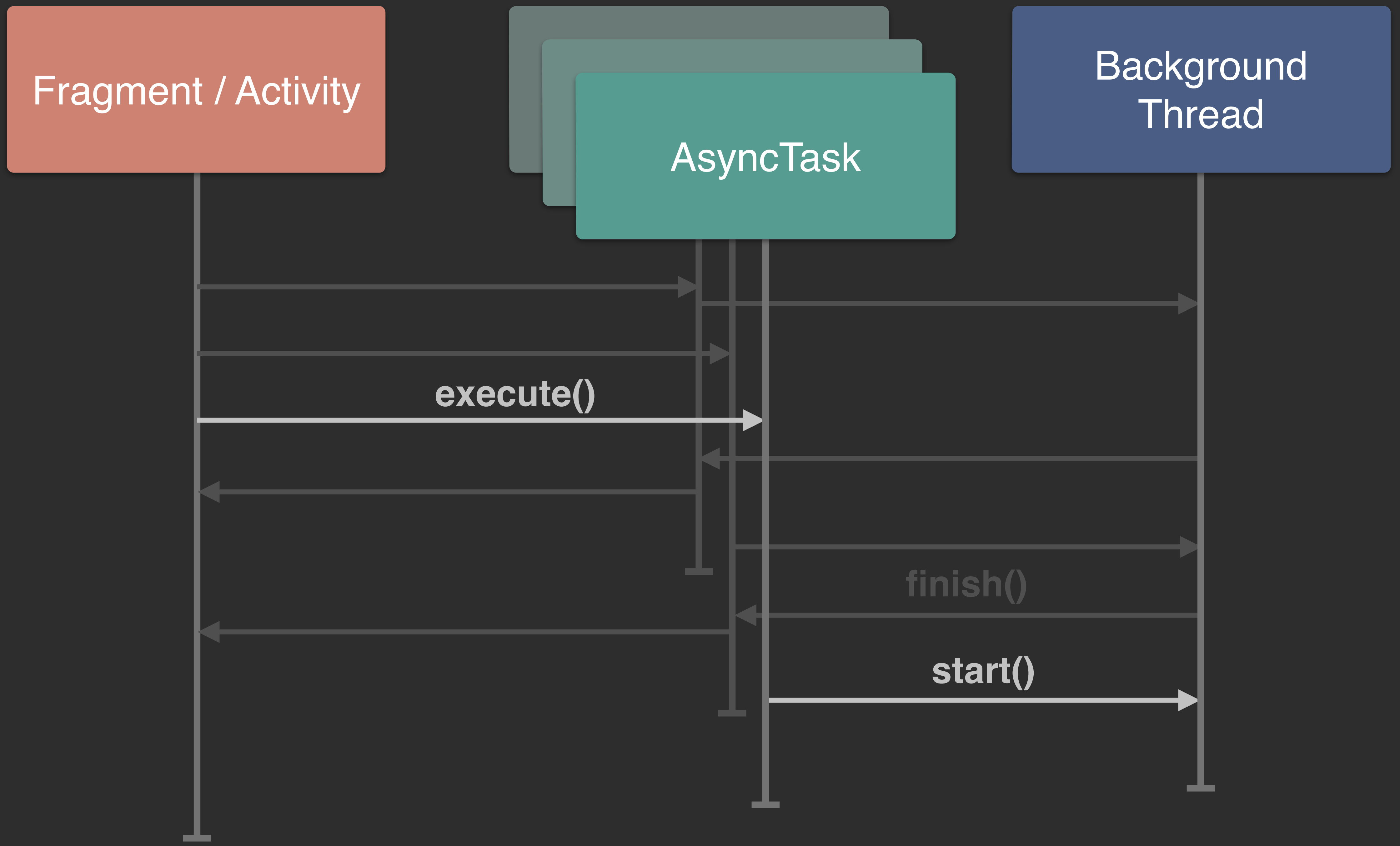
Chaining tasks



AsyncTask Serialized thread processing

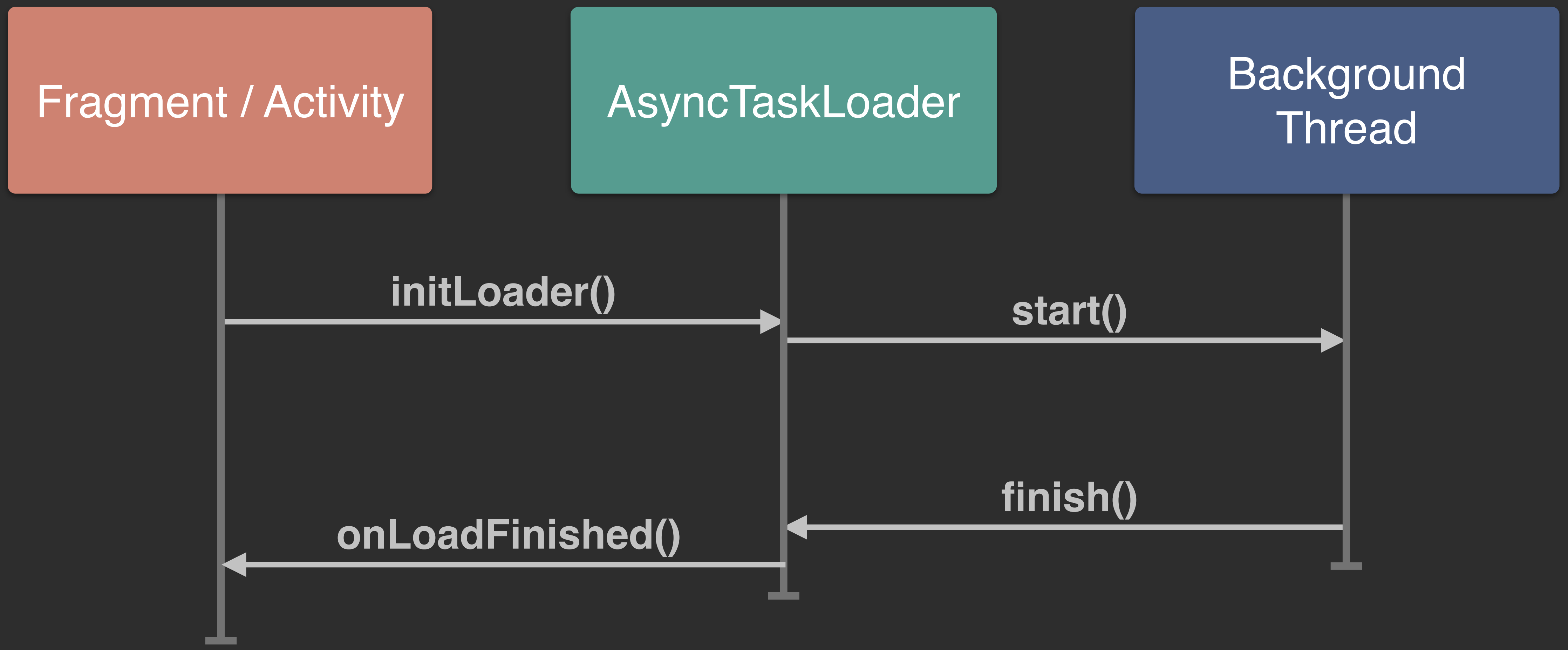


AsyncTask Serialized thread processing



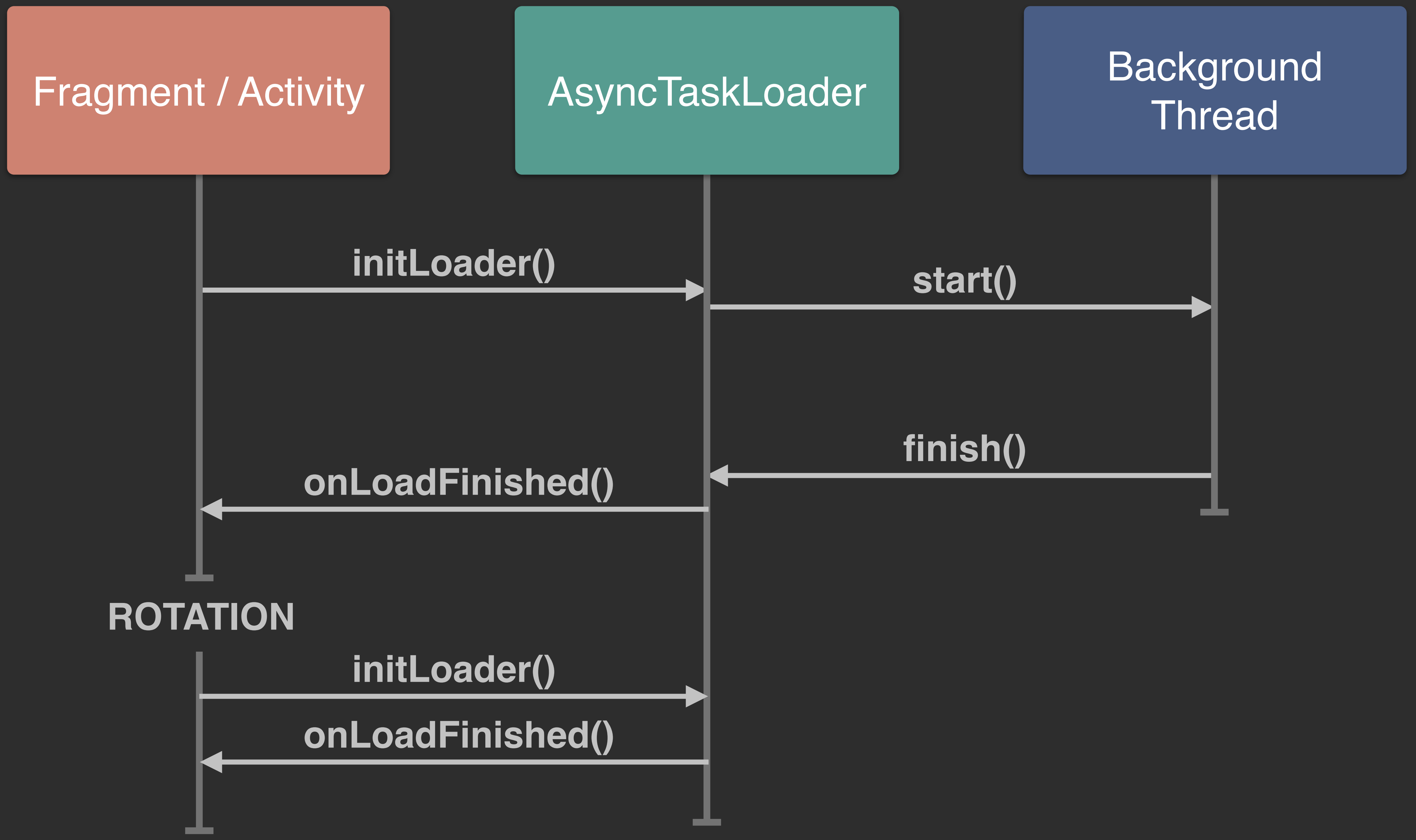
Loader

Caching



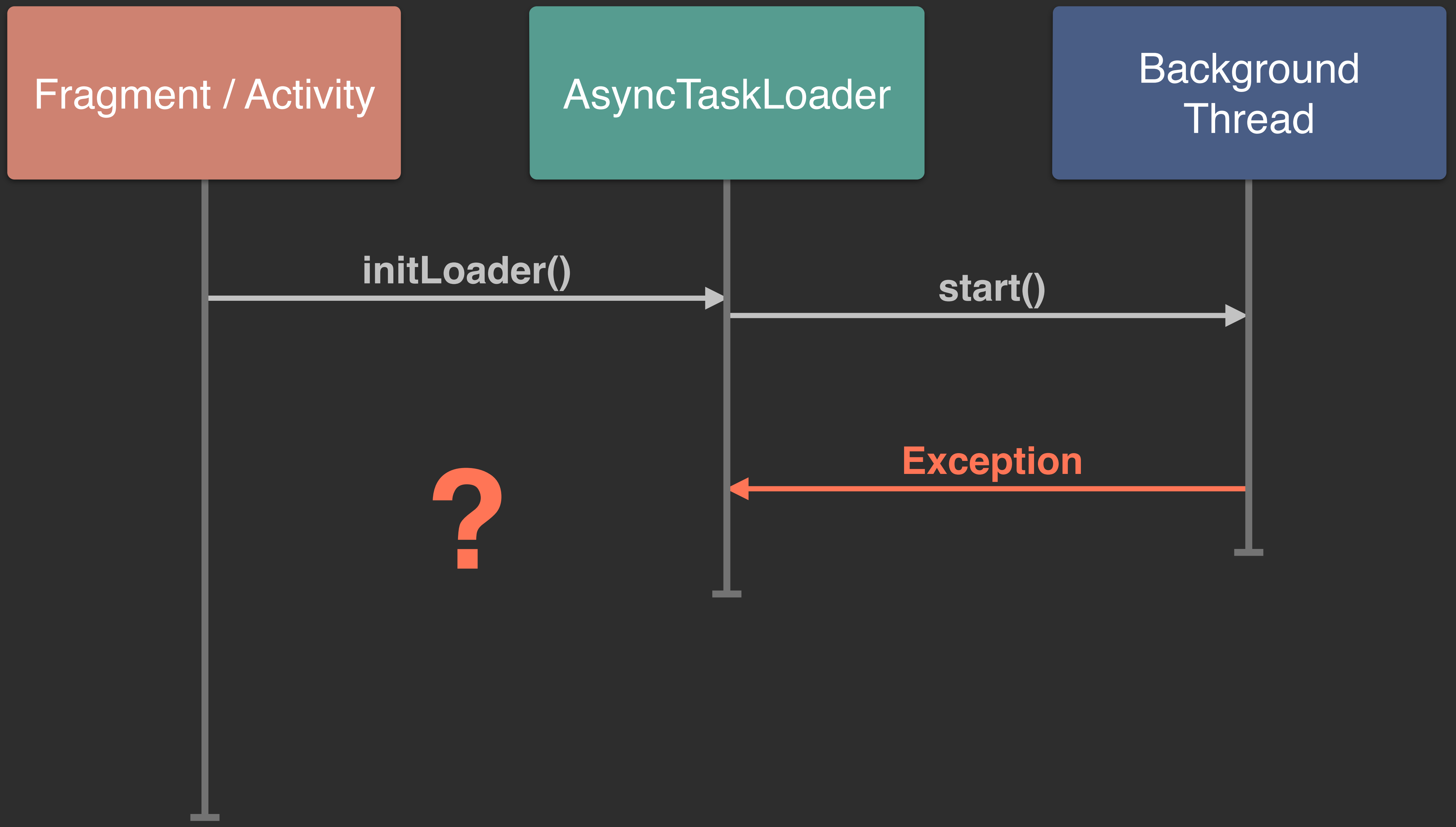
Loader

Caching



Loader

Exceptions



Fragment / Activity

AsyncTaskLoader

Background Thread

initLoader()

start()

Exception

?

Alternative: RxJava

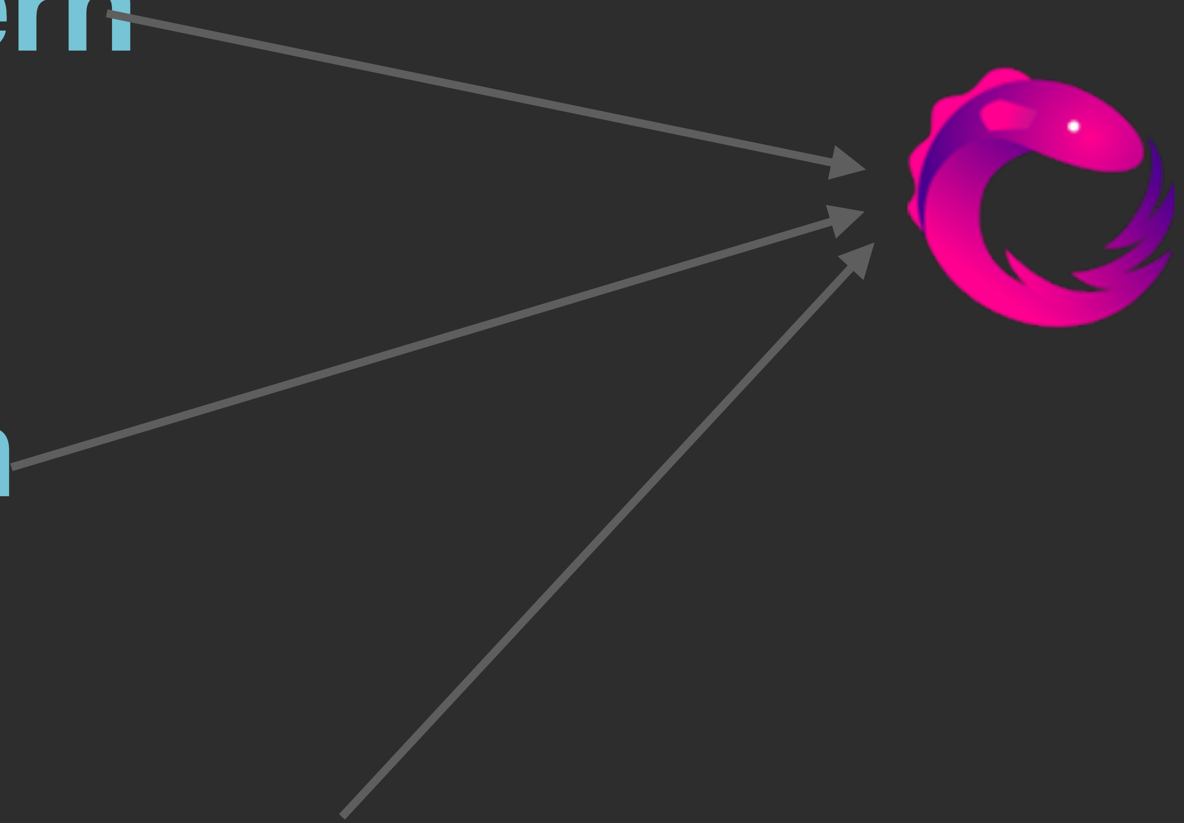
Functional Reactive Programming

Reactive Extensions

- Created by Erik Meijer at Microsoft
- Ported to Java by Netflix
- It’s everywhere
  - .NET, Java, Groovy, Scala, JS, Cocoa, etc.

Rx Concepts

- **Observer Pattern**
  - Reactive
- **Iterator Pattern**
  - Collections
- **Functional Programming**
  - Transformations



Reactive Programming

Not Reactive

Imperative

```
x = 2;
y = 3;
sum = x + y;
// sum == 5
```

Not Reactive

Imperative

```
x = 2;
y = 3;
sum = x + y;
// sum == 5

x = 4;
// sum == ?
```

Not Reactive

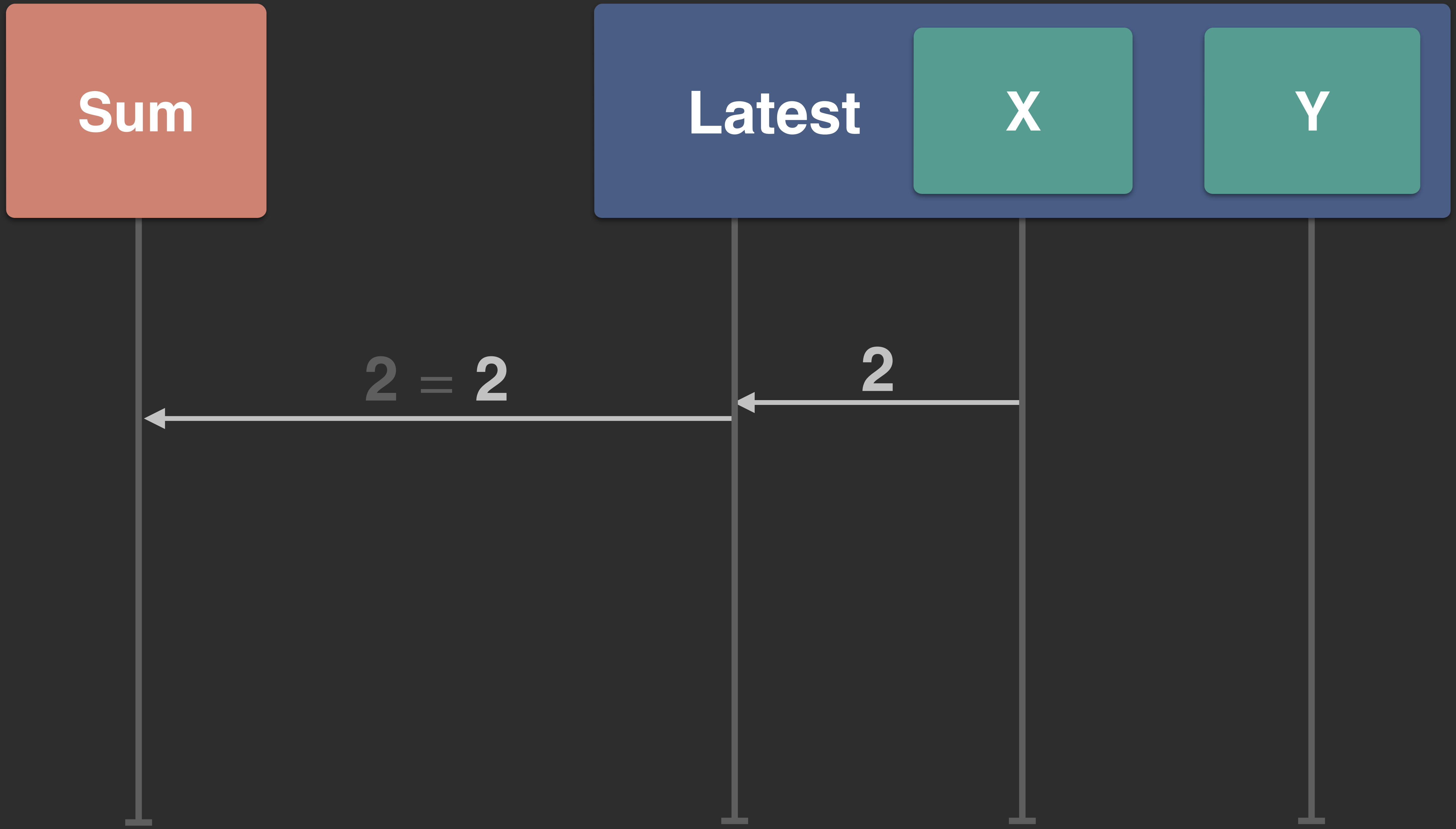
Imperative

```
x = 2;
y = 3;
sum = x + y;
// sum == 5

x = 4;
// sum == still 5 of course
```

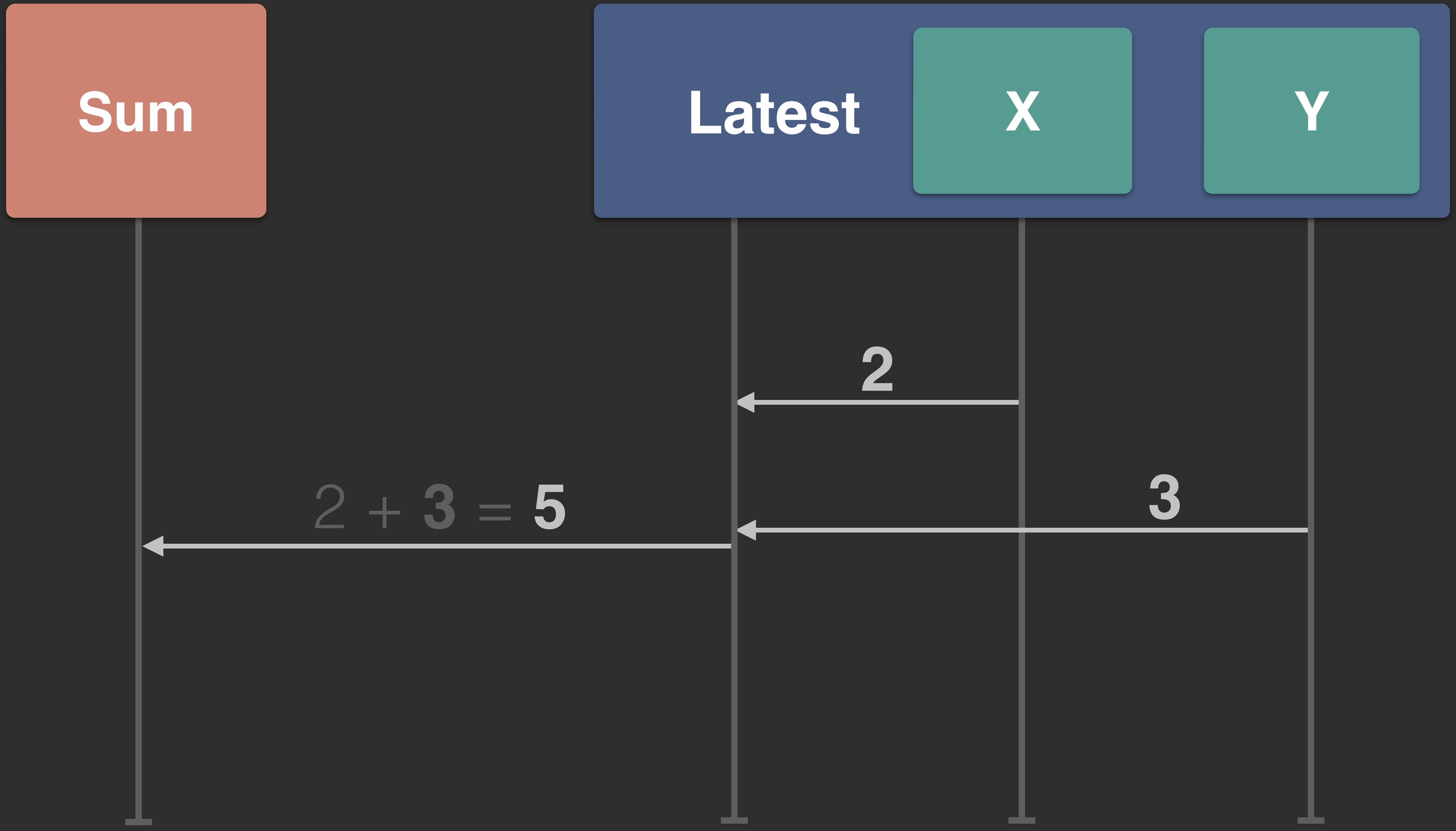
Reactive

Similar to a spreadsheet



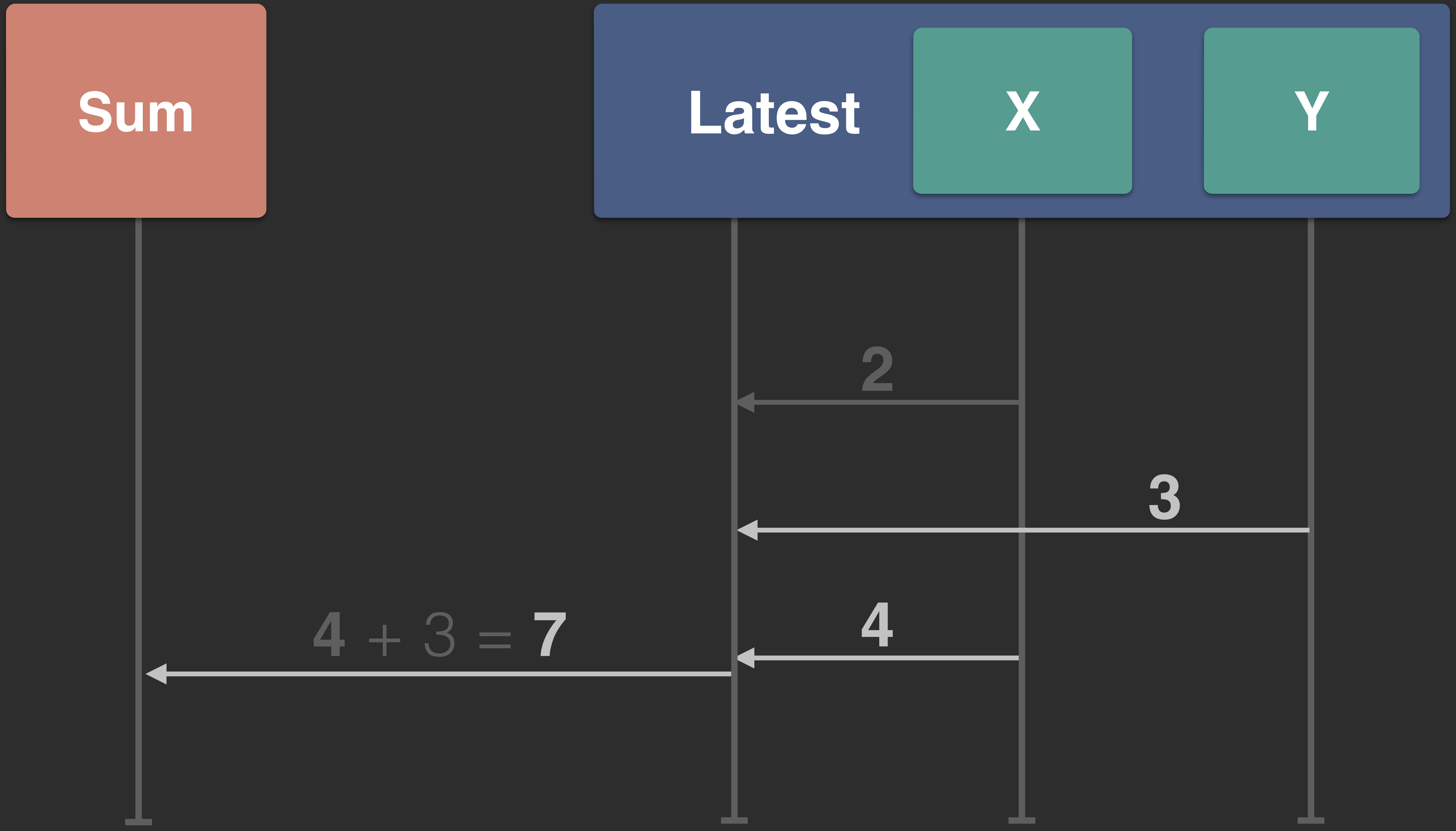
Reactive

Similar to a spreadsheet



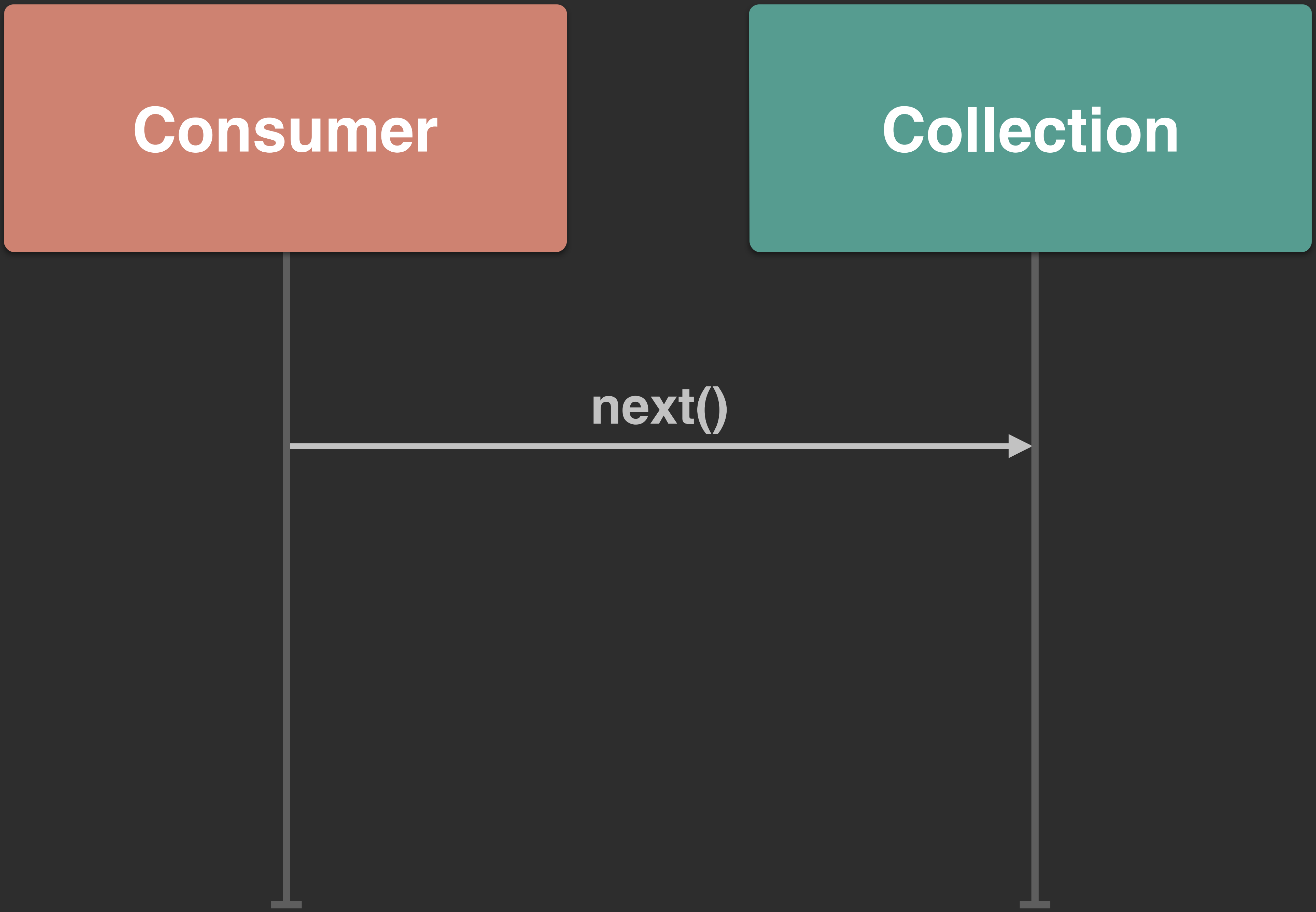
Reactive

Similar to a spreadsheet



Iterable

Pulls from producer
Blocks consumer thread



Iterable

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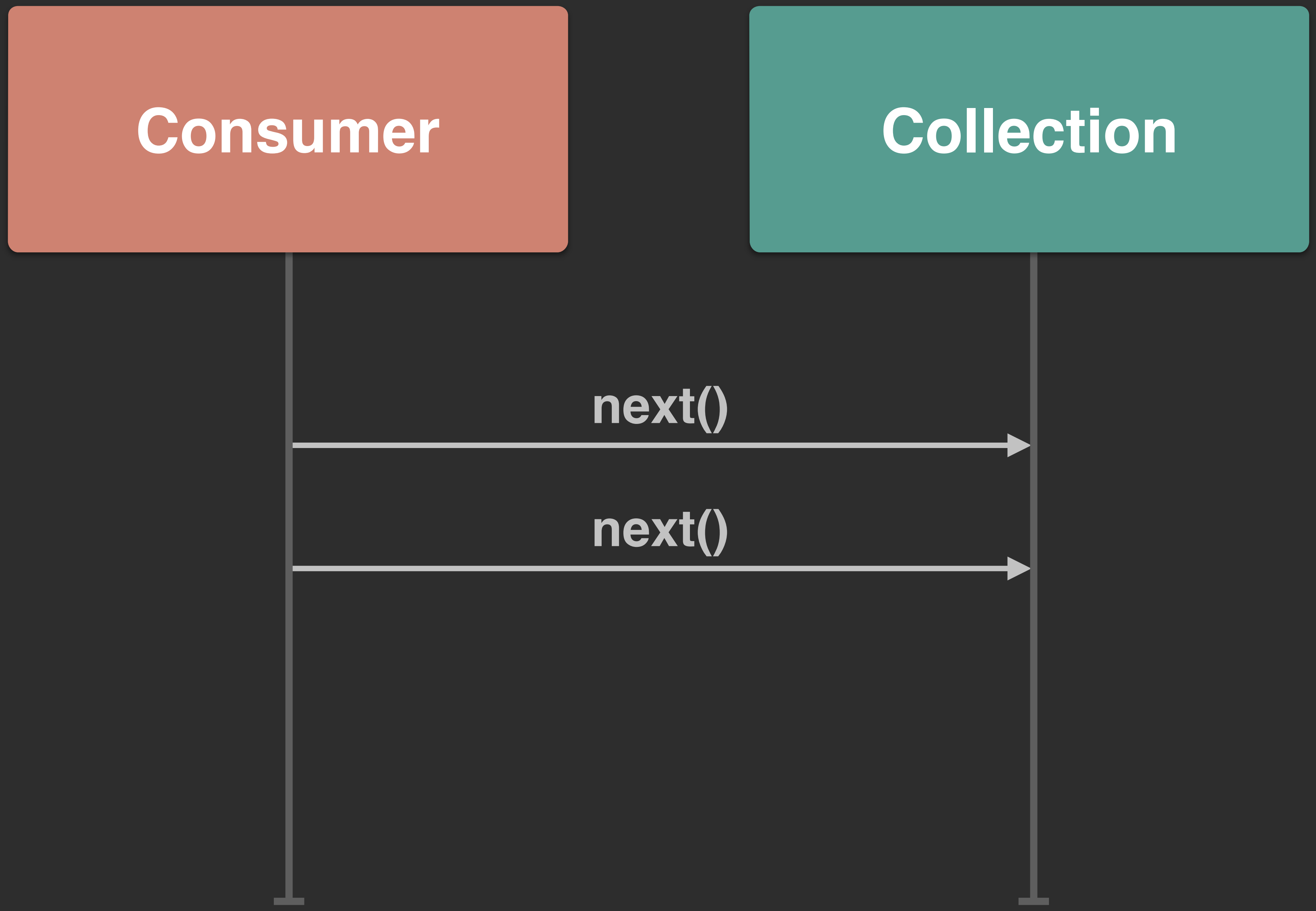

Iterable

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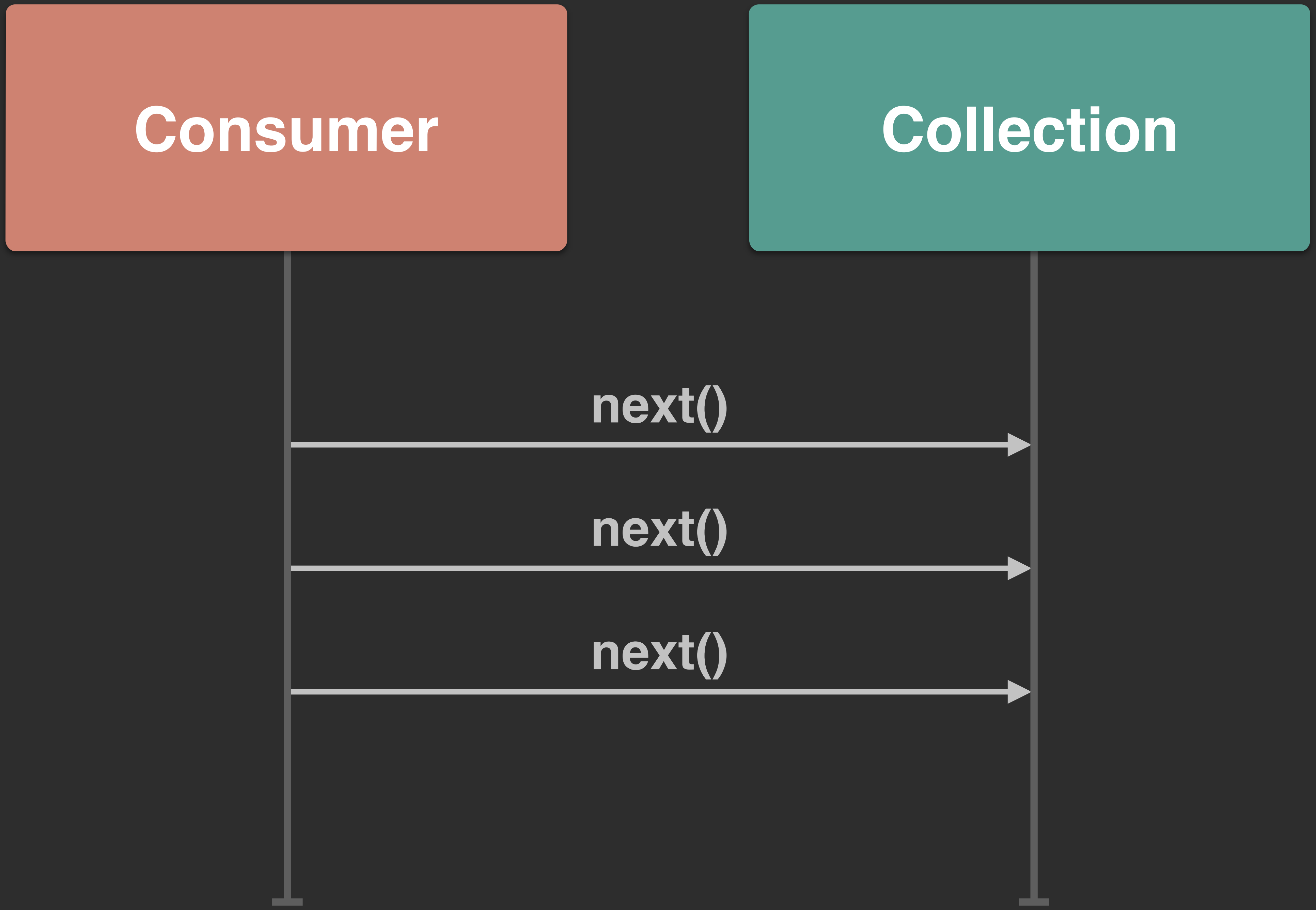

Iterable

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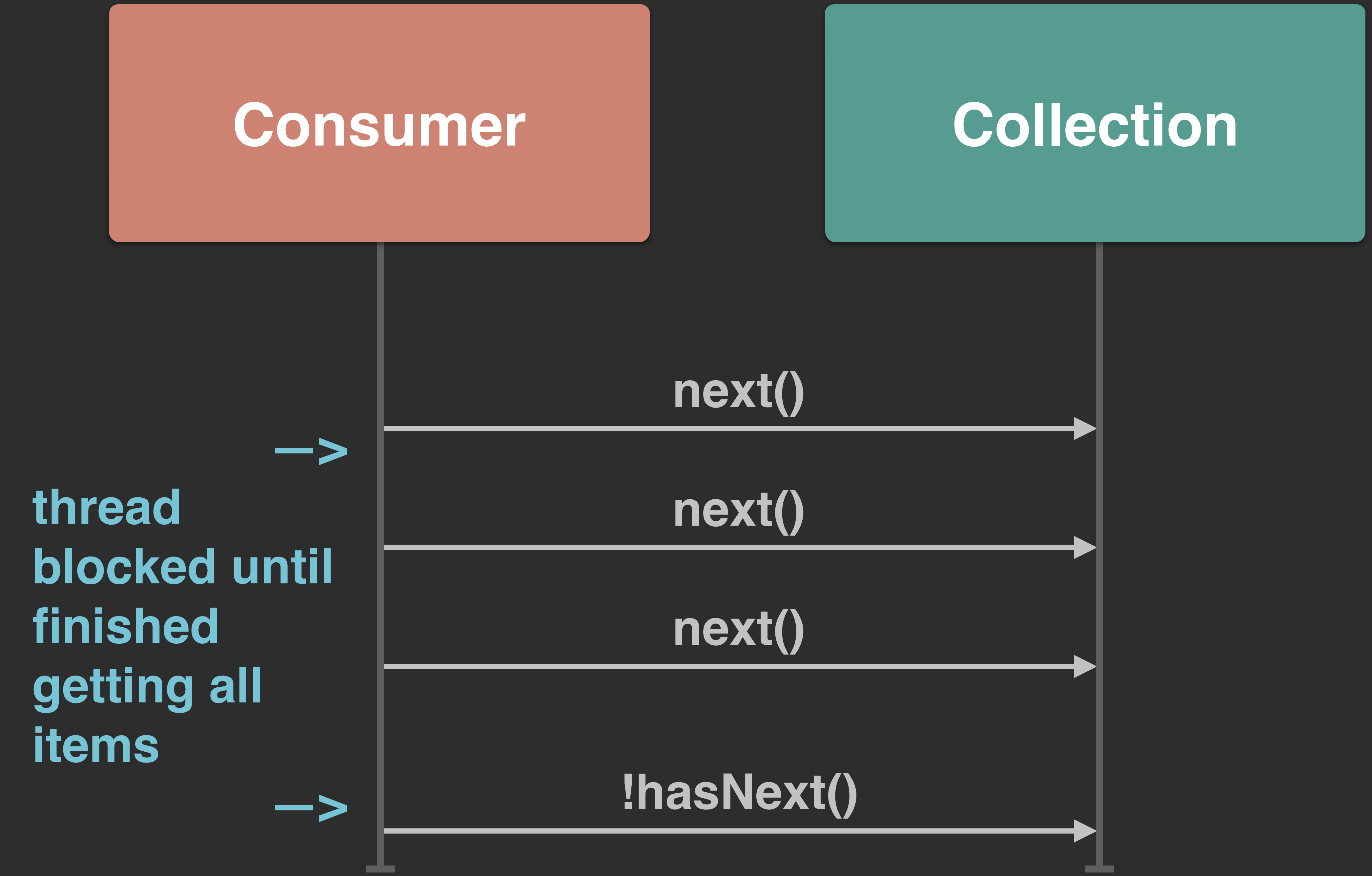
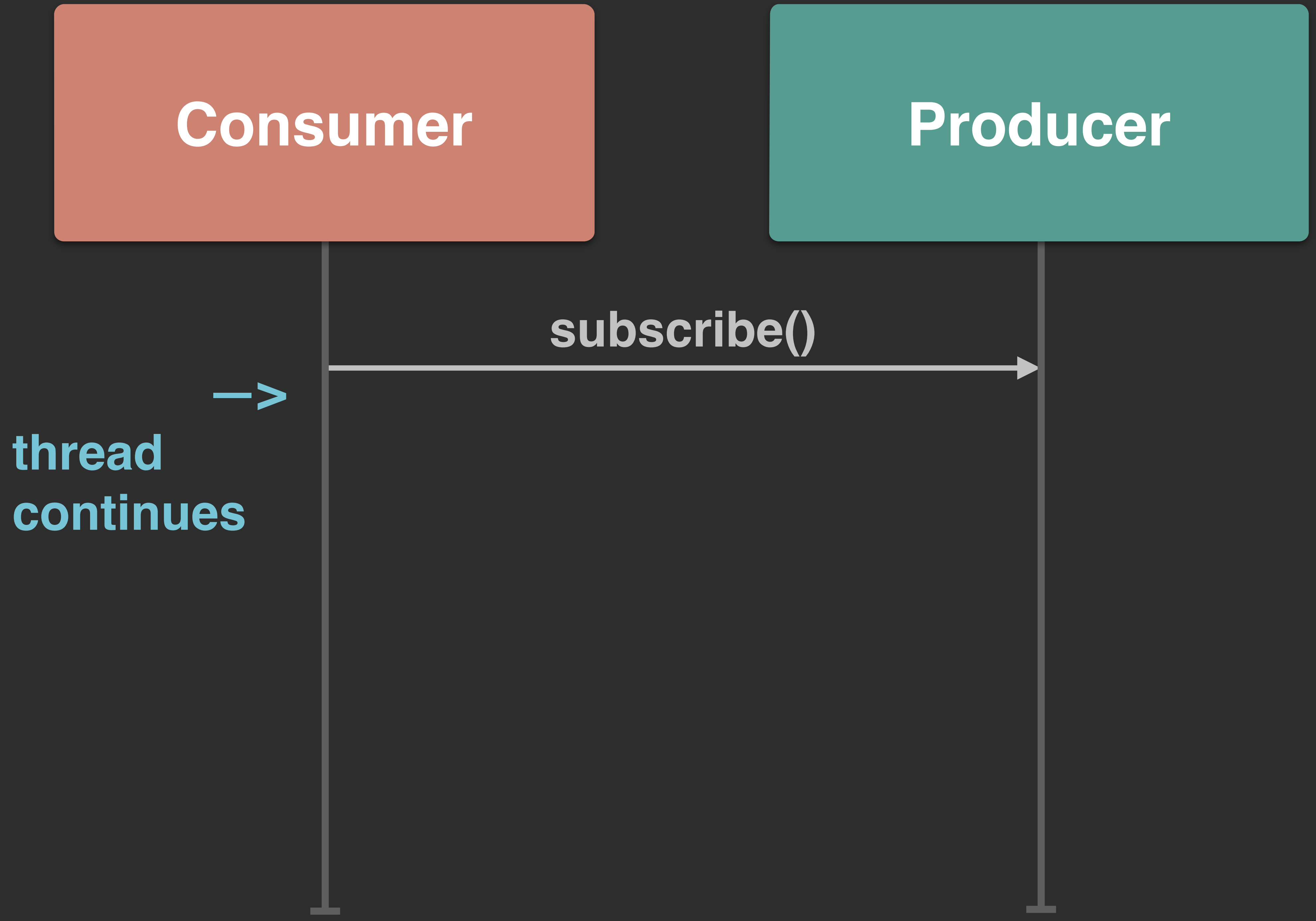


Observable

Reacts to producer
Does **not** block consumer



Observable

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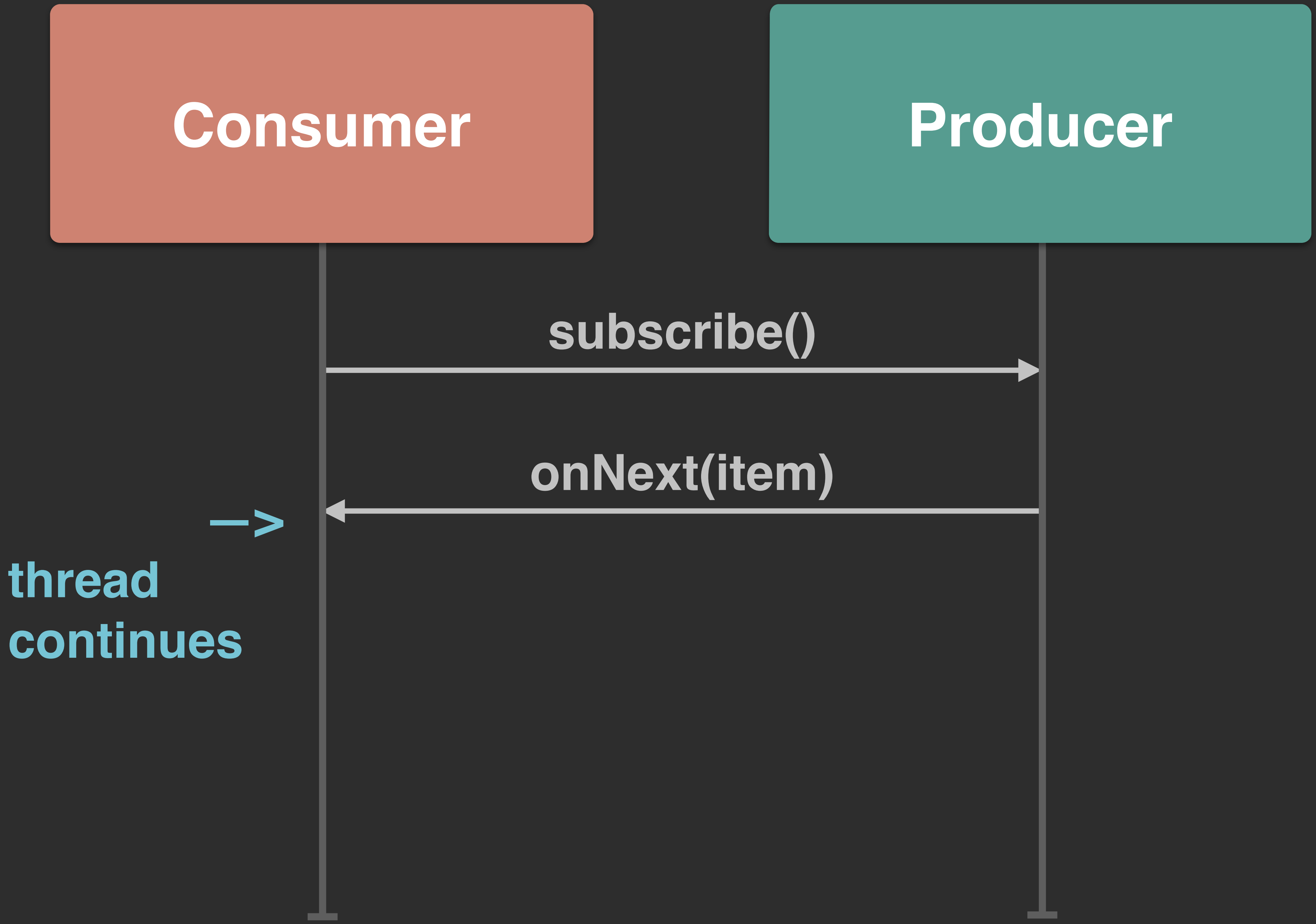
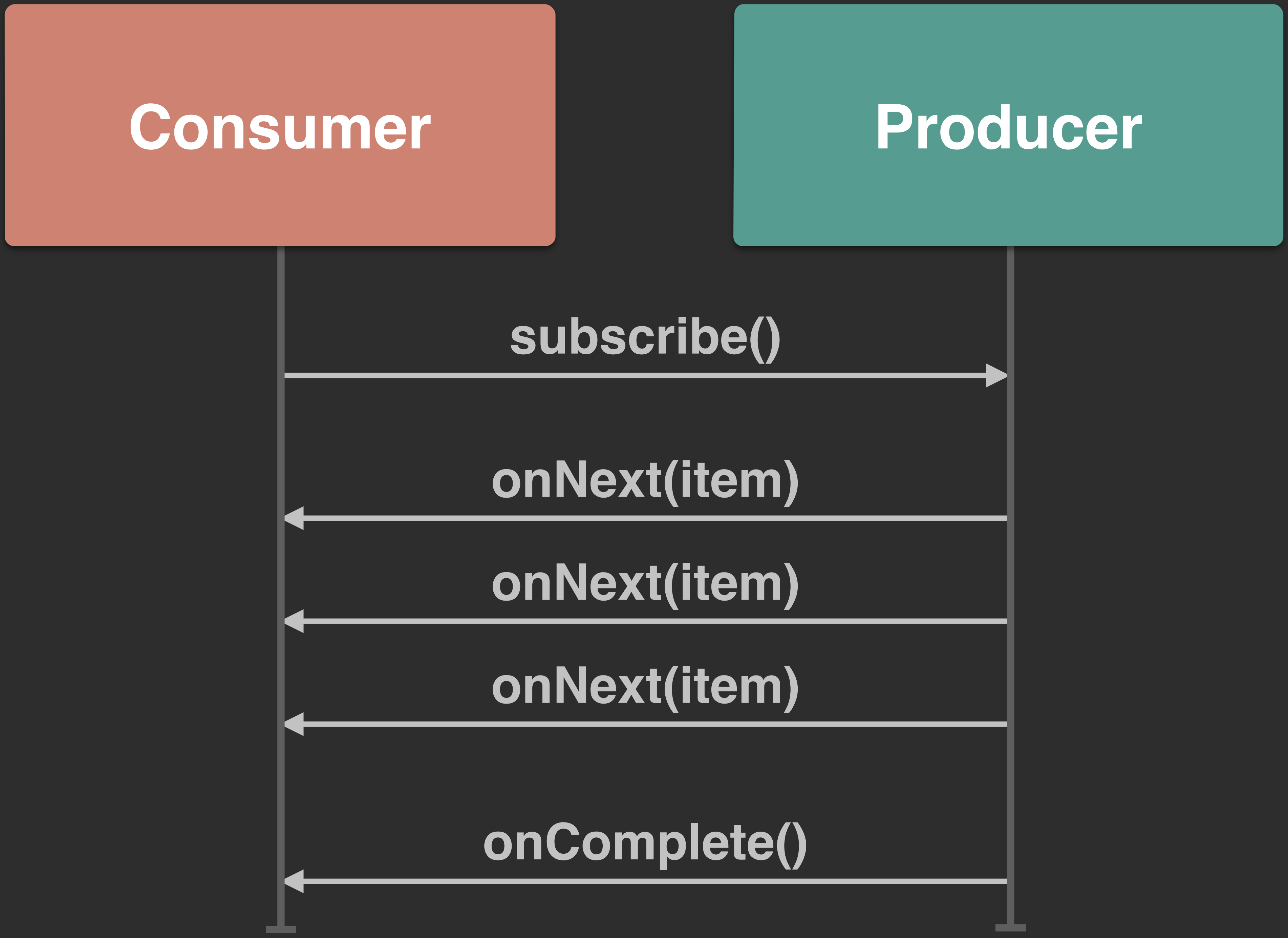
Does **not** block consumer



Observable

Reacts to producer
Does **not** block consumer



Functional Programming

Not Functional

Imperative

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = new int[integers.length];
for(int i = 0; i < integers.length; i++) {
    doubled[i] = integers[i] * 2;
}
```

Not Functional

Imperative

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = new int[integers.length];
for(int i = 0; i < integers.length; i++) {
    doubled[i] = integers[i] * 2;
}

filtered = new ArrayList<>();
for(int d : doubled) {
    if (d < 10) {
        filtered.add(d);
    }
}
```

Not Functional

Imperative

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = new int[integers.length];
for(int i = 0; i < integers.length; i++) {
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filtered = new ArrayList<>();
for(int d : doubled) {
    if (d < 10) {
        filtered.add(d);
    }
}
```

Functional

Apply to collections

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = integers.map(i -> i * 2);

filtered = doubled.filter(i -> i < 10);
```

Functional

Apply to collections

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = integers.map(i -> i * 2);

filtered = doubled.filter(i -> i < 10);
```

Functional

Apply to collections

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubled = integers.map(i -> i * 2);

filtered = doubled.filter(i -> i < 10);

sum = filtered.sum();

sorted = filtered.sort(Integer::compare);
```

Functional

Composing

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubledAndFilteredSum = integers.map(i -> i * 2)
                                .filter(i -> i < 10)
                                .sum();
```

Functional

Composing

```
integers = [0, 1, 2, 3, 4, 5, 6, 7, 9];

doubledAndFilteredSum = integers.map(i -> i * 2)
                                .filter(i -> i < 10)
                                .sum();
```

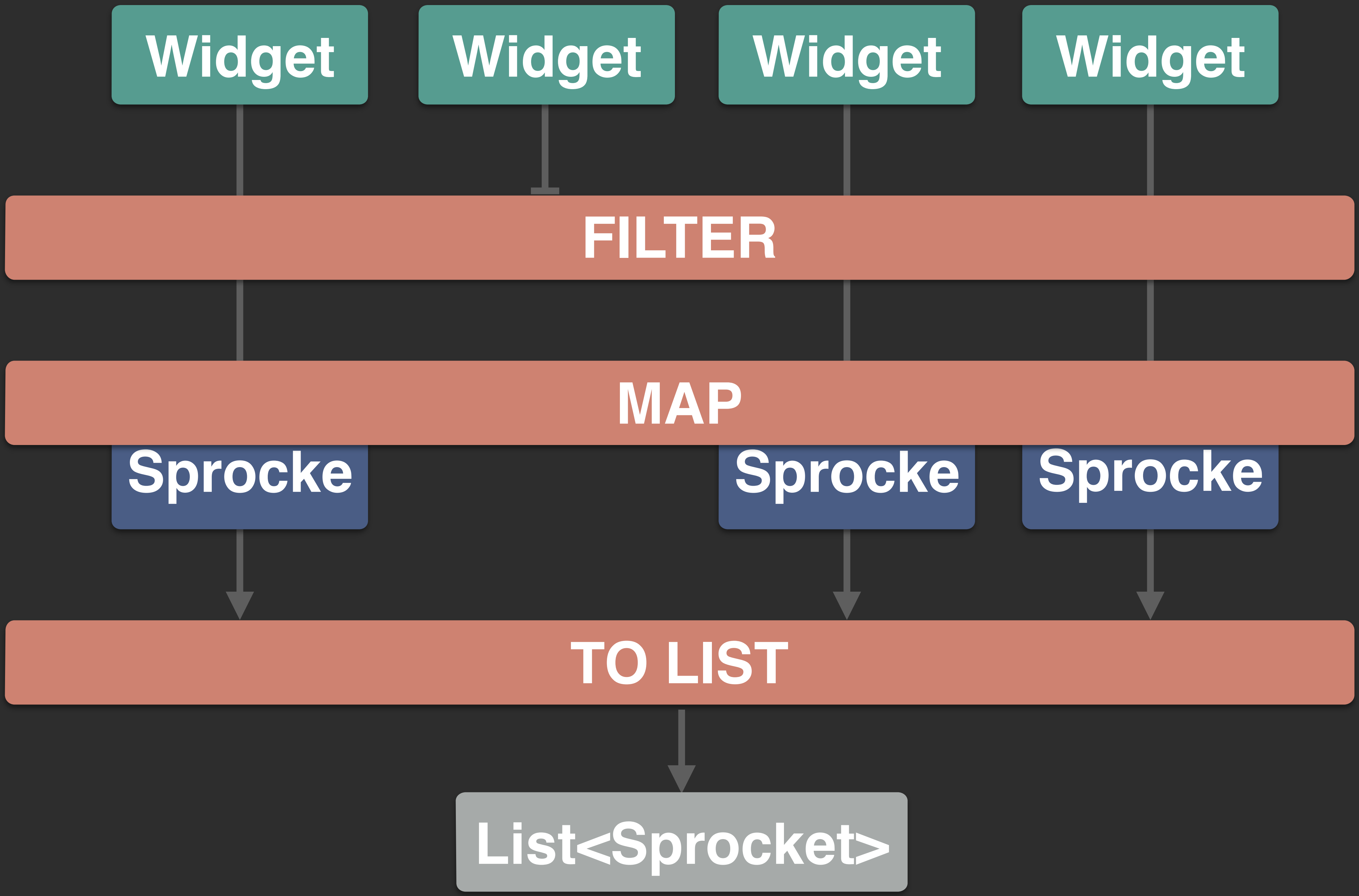
More expressive. Less error prone.

Functions Inputs, output, no side-effects

```
public static float fahrenheitFromKelvin(float kelvin) {
    return (kelvin - 273.15) * 1.80 + 32.00;
}
```

```
public static Customer customerFromJson(JSONObject customerJson) {
    Customer customer = new Customer();
    customer.setFirstName(customerJson.getString("firstName");
    customer.setFirstName(customerJson.getString("lastName");
    return customer;
}
```

Parallelism



Lambdas

Basically a one method class

```
button.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View button) {
        doSomething();
    }
});
```

Lambdas

Basically a one method class

```
button.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View button) {
        doSomething();
    }
});
```

Lambdas

Basically a one method class

```
button.setOnClickListener(new OnClickListener() {
    @Override
    public void onClick(View button) {
        doSomething();
    }
});
```

```
button.setOnClickListener(button -> doSomething());
```

Method References

```
.map(json -> new Customer(json))
```

```
.map(Customer::new)
```

Method References

```
.map(json -> new Customer(json))
```

```
.map(Customer::new)
```

Retrolambda

- Lambda syntax in Android projects
- Gradle plugin
- Converts Java 8 bytecode to Java 7
- Risk: Jack and Jill compiler

Functional + Reactive Programming

The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Web Service Example

```
{
    customers: [
        {
            firstName: "Paul",
            lastName: "Cicero",
            isLocal: true
        },
        {
            firstName: "Tommy",
            lastName: "DeVito",
            isLocal: false
        },
        {
            firstName: "Billy",
            lastName: "Batts",
            isLocal: true
        }
    ]
}
```

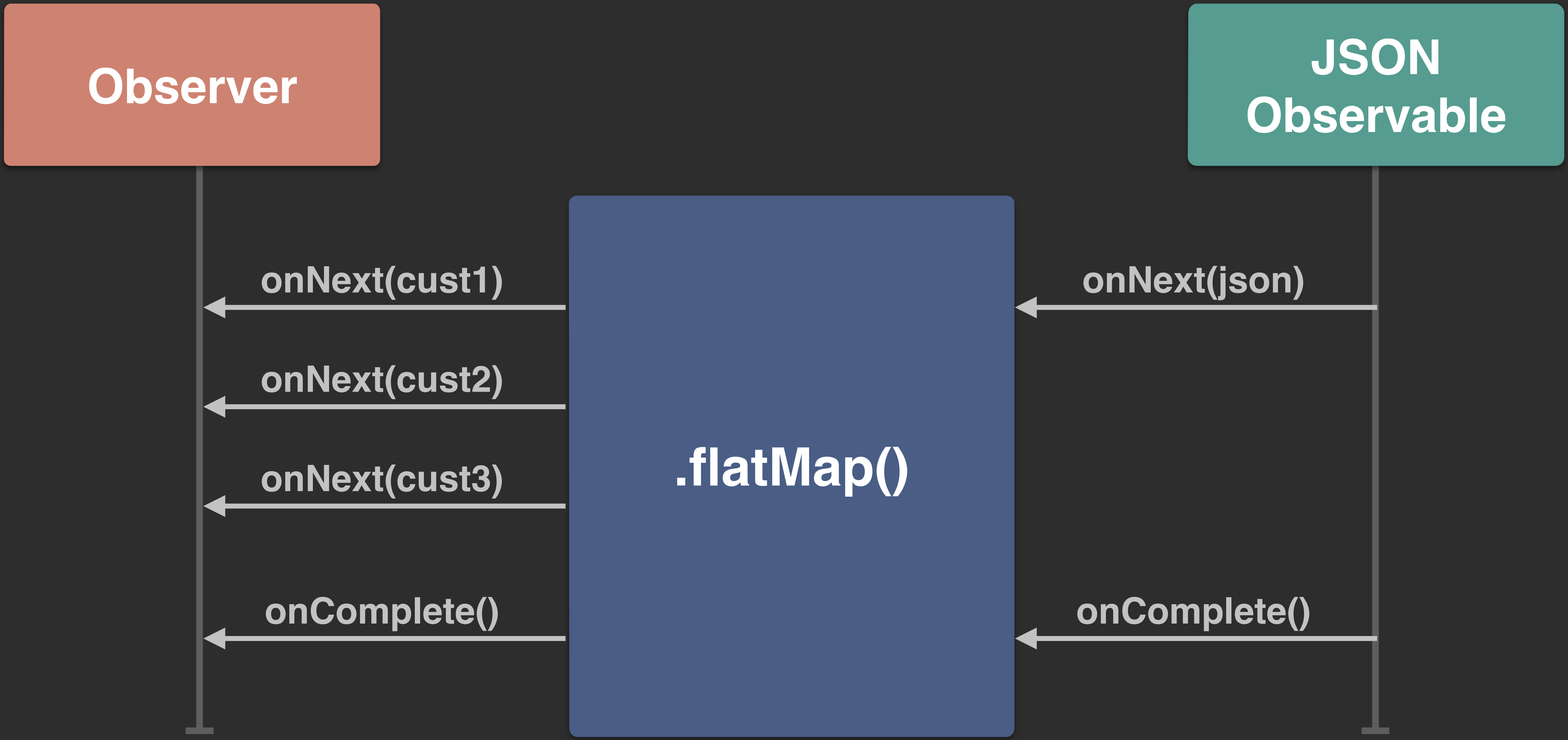
The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList))
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

FlatMap

Convert each item to Observable



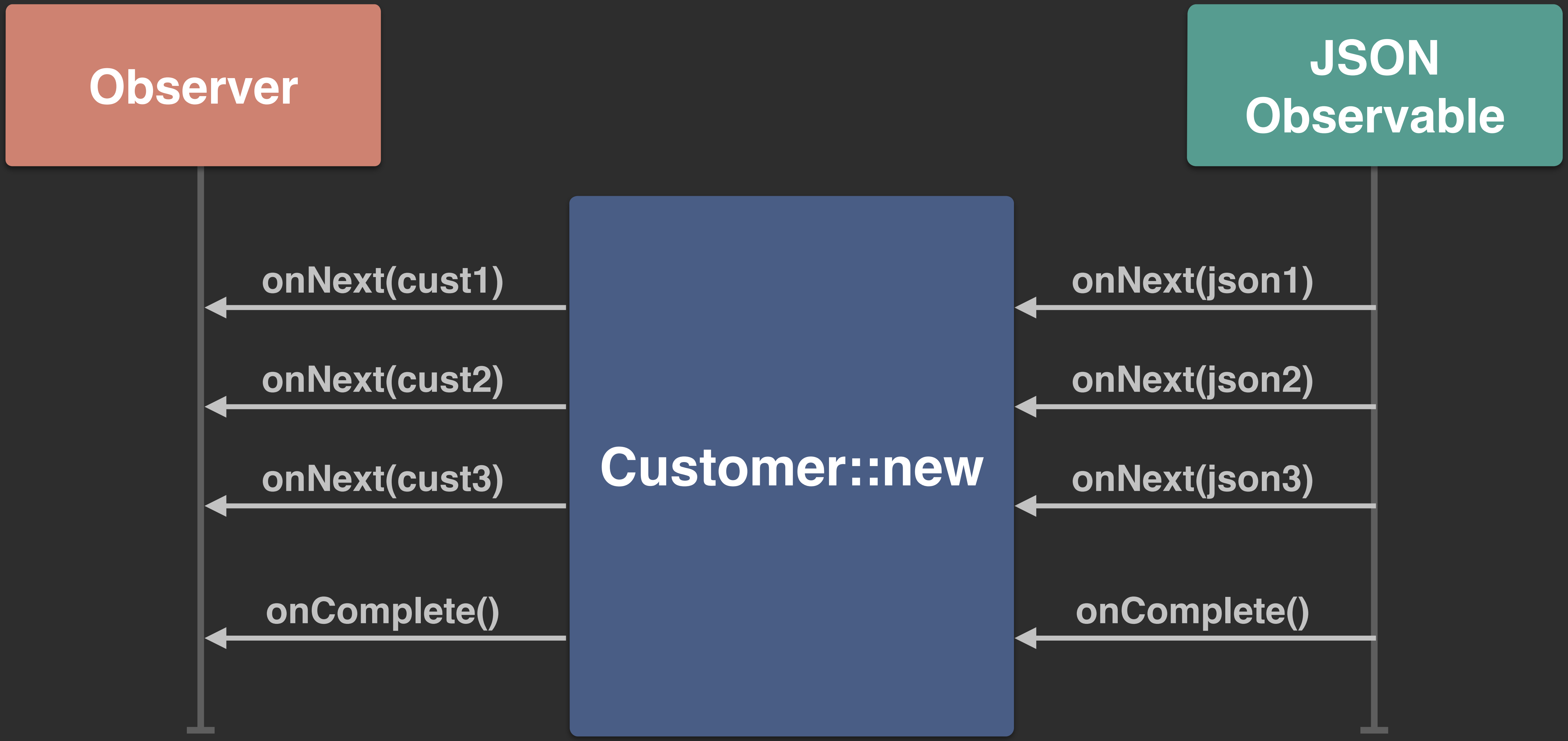
The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Map

Transform each item to another item



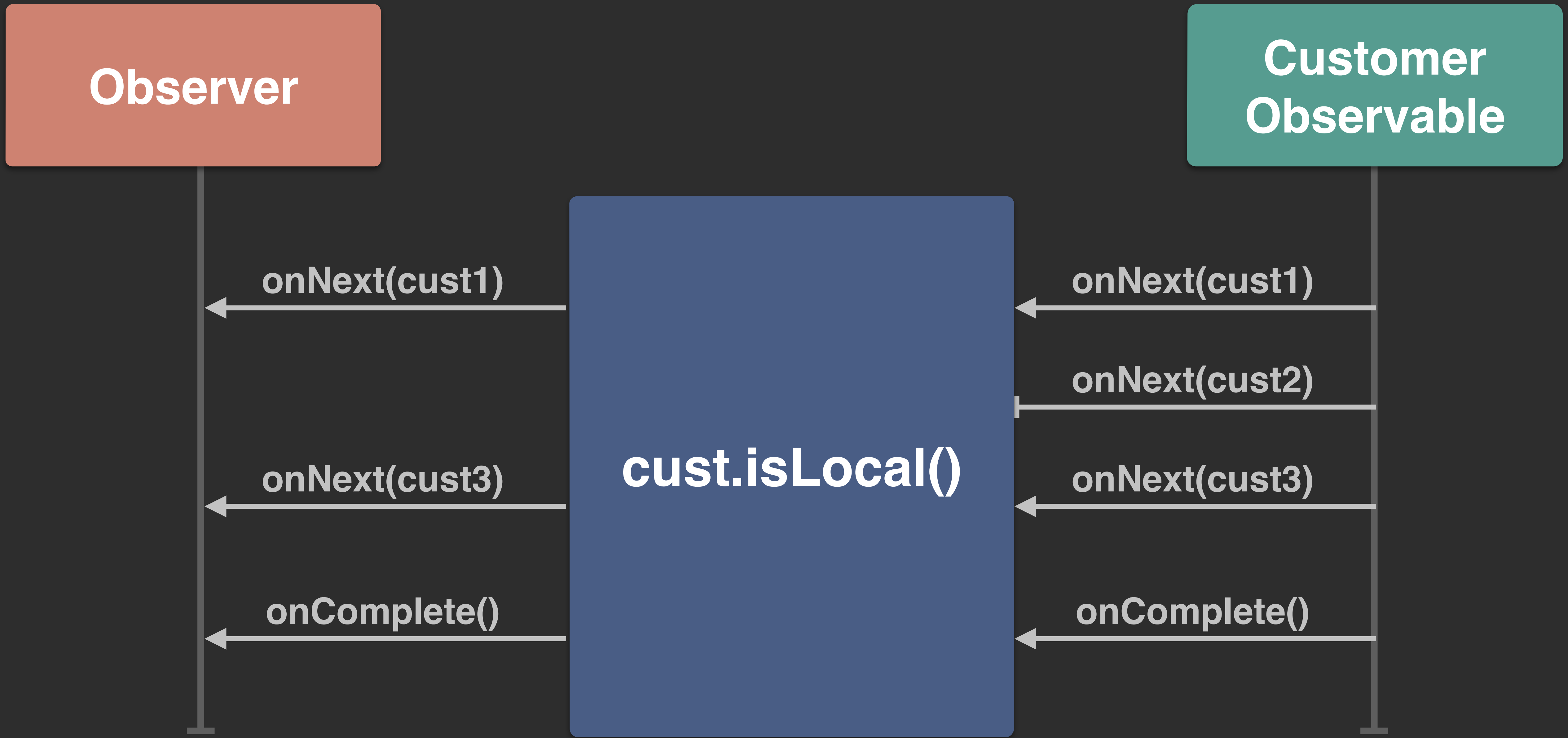
The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Filter

Select items that match criteria

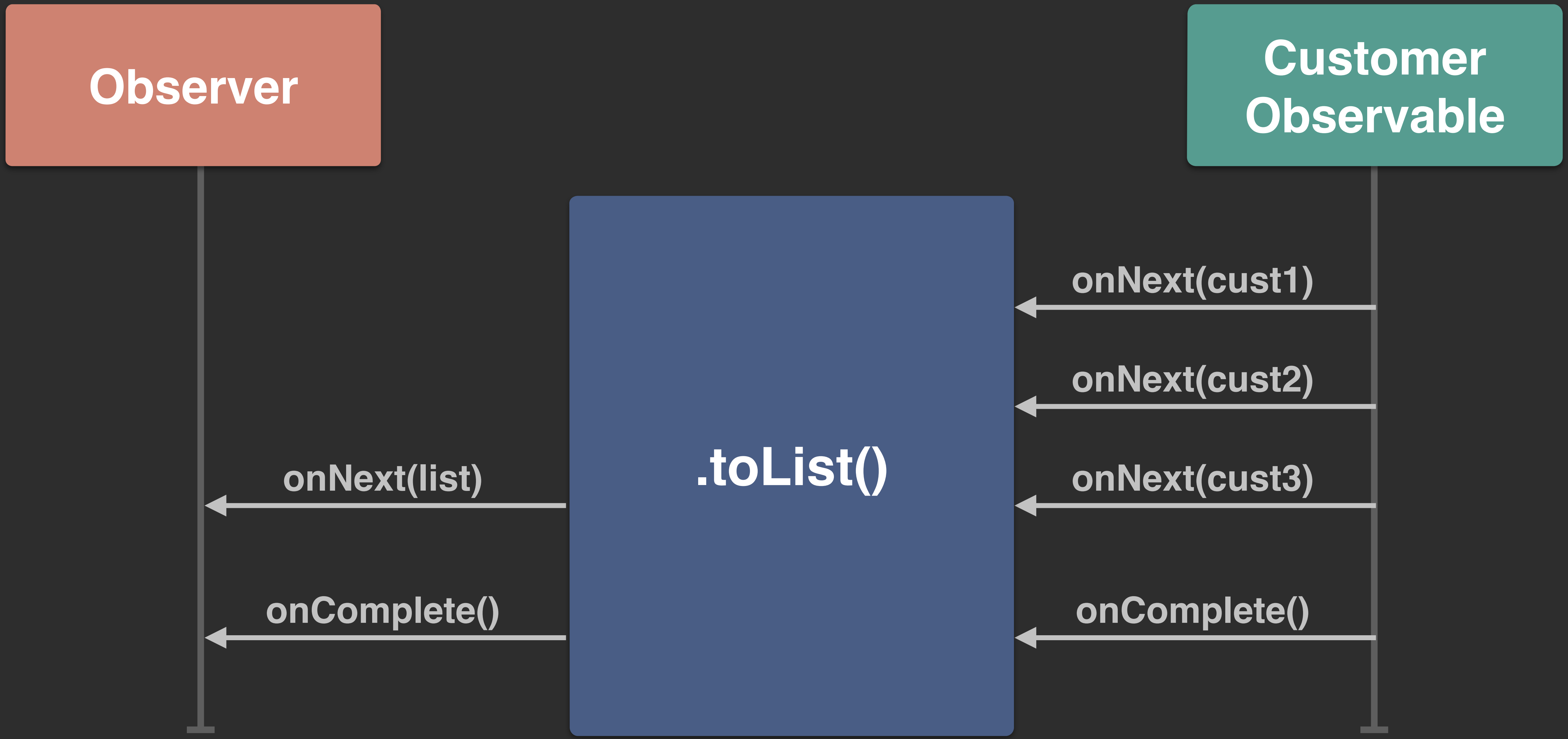


The Code

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Aggregate Operators



The Code

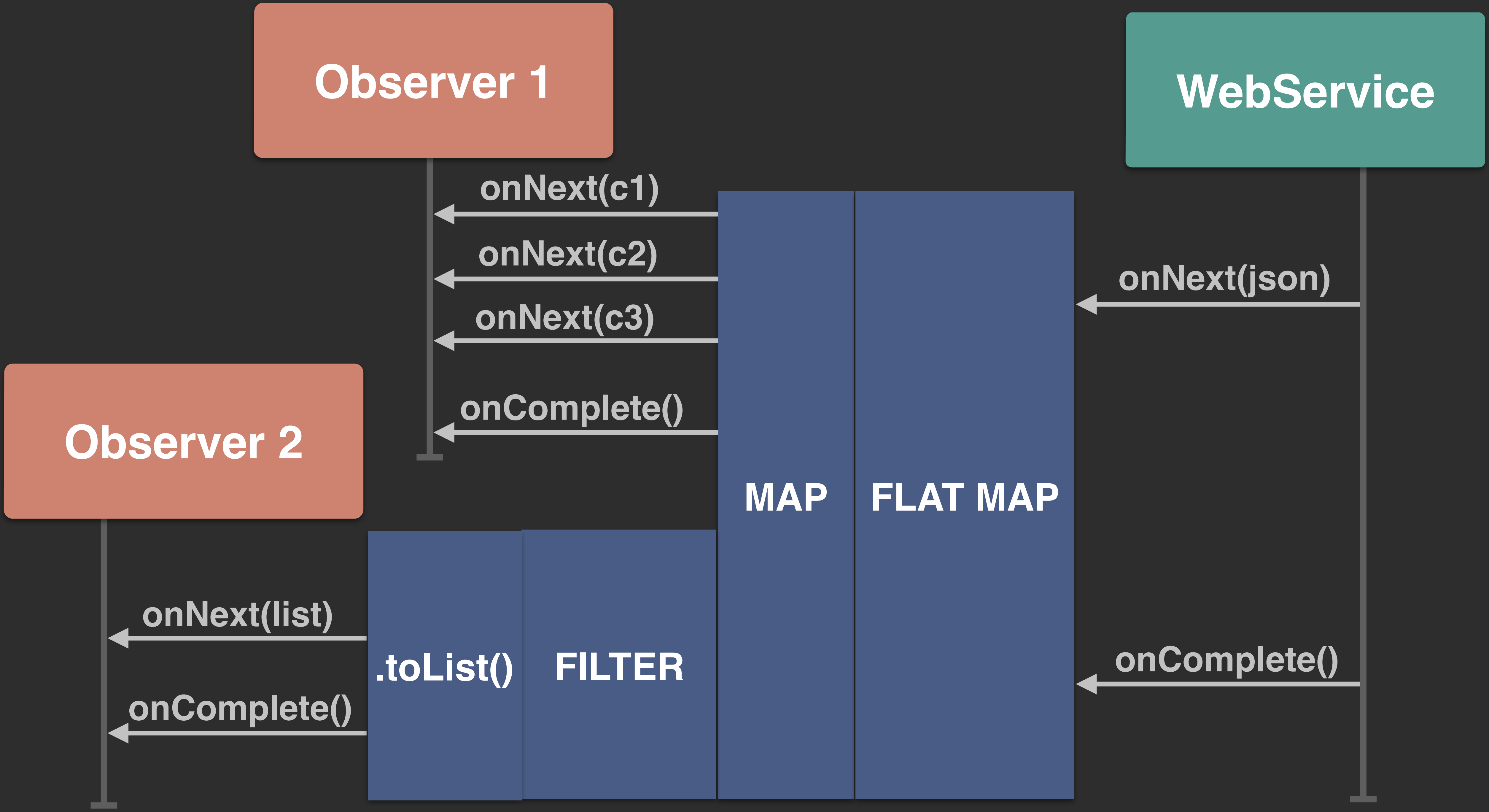
Declaration

```
Observable<Customer> allCustomers =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json));



Observable<List<Customer>> localCustomerList =
      allCustomers.filter(c -> c.isLocal())
                  .toList();
```

Functional Pipelines



Subscribing

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Consume

```
localCustomerList.subscribe(
    list -> display(list),
    e -> handleError(e) <— error handling!
);
```

Subscribing

Declaration

```
Observable<List<Customer>> localCustomerList =
      webService.getCustomers()
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();
```

Consume

```
localCustomerList.subscribe(
    list -> display(list),
    e -> handleError(e)
);
```

or

```
localCustomerList.subscribe(
    this::display,
    this::handleError
);
```

RxAndroid

RxAndroid

- **AndroidSchedulers**
  - Observe on UI thread
- **AppObservable**
  - Protects against destroyed Fragment / Activity
- **LifecycleObservable**
  - Prevents leaking Fragment / Activity

Threading

```
localCustomerList.subscribe(
    this::display,
    this::handleError
);
```

Threading

Work in background thread pool

```
localCustomerList
    .subscribeOn(Schedulers.io())
    .observeOn(AndroidSchedulers.mainThread())
    .subscribe(
        this::display,
        this::handleError
    );
```

Threading

Handle on UI thread

```
localCustomerList
    .subscribeOn(Schedulers.io())
    .observeOn(AndroidSchedulers.mainThread())
    .subscribe(
        this::display,
        this::handleError
    );
```

Threads

```
localCustomerList
    .subscribeOn(Schedulers.io())
    .observeOn(AndroidSchedulers.mainThread())
    .subscribe(
        this::display,
        this::handleError
    );
```

AppObservable

```
AppObservable.bindFragment(this, localCustomerList)
    .subscribeOn(Schedulers.io())
~~    .observeOn(AndroidSchedulers.mainThread())~~
    .subscribe(
        this::display,
        this::handleError
    );
```

AppObservable

```
AppObservable.bindFragment(this, localCustomerList)
    .subscribeOn(Schedulers.io())
    .subscribe(
        this::display,
        this::handleError
    );
```

AppObservable

```
Observable<List> localCustomerList =
      webService.getCustomers() <— move inside here
                .flatMap(r -> Observable.from(r.customerList)
                .map(json -> new Customer(json))
                .filter(c -> c.isLocal())
                .toList();


AppObservable.bindFragment(this, localCustomerList)
~~    .subscribeOn(Schedulers.io())~~
    .subscribe(
        this::display,
        this::handleError
    );
```

AppObservable

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Observable<List> localCustomerList =
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```

AppObservable

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                .filter(c -> c.isLocal())
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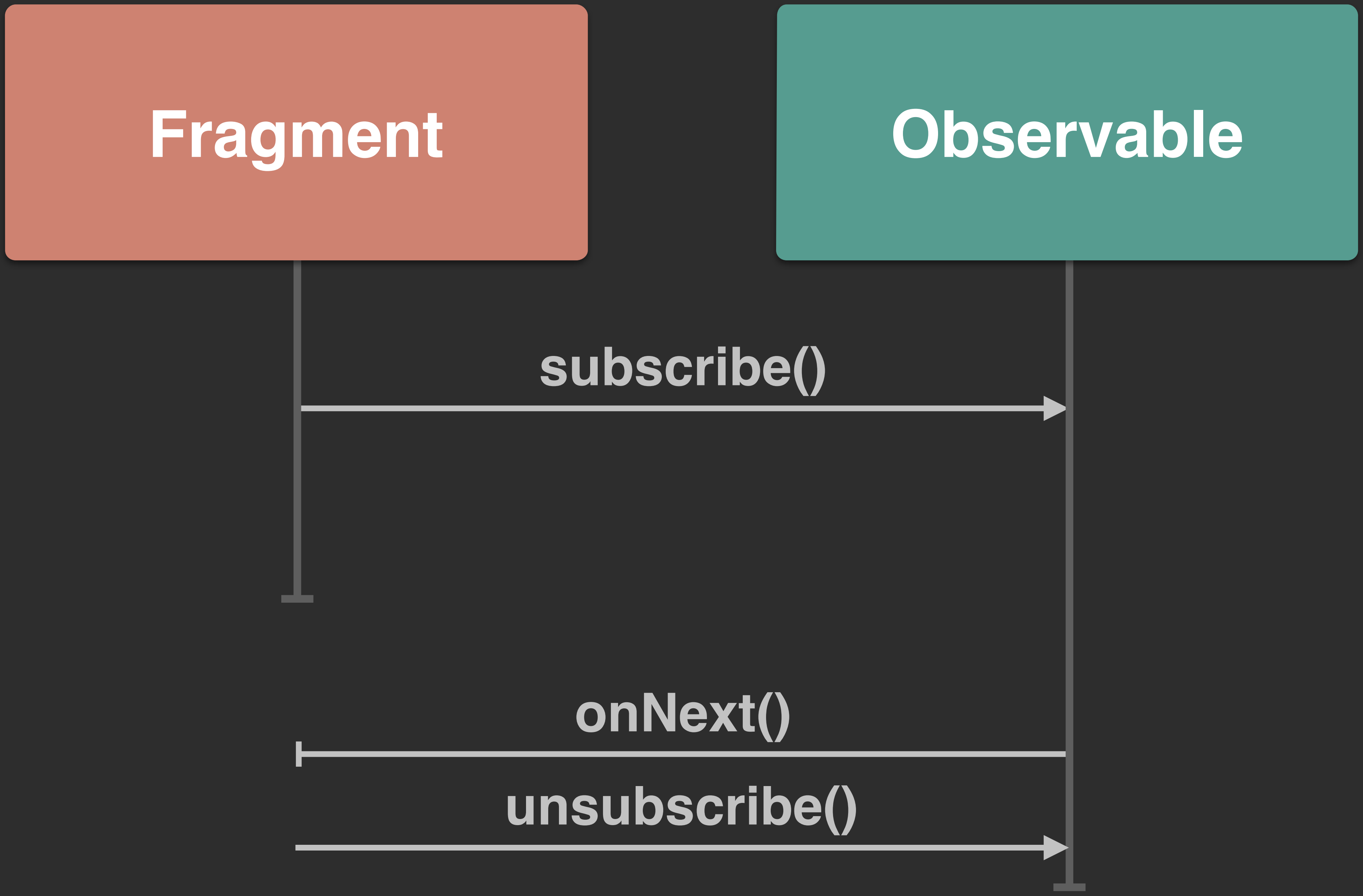
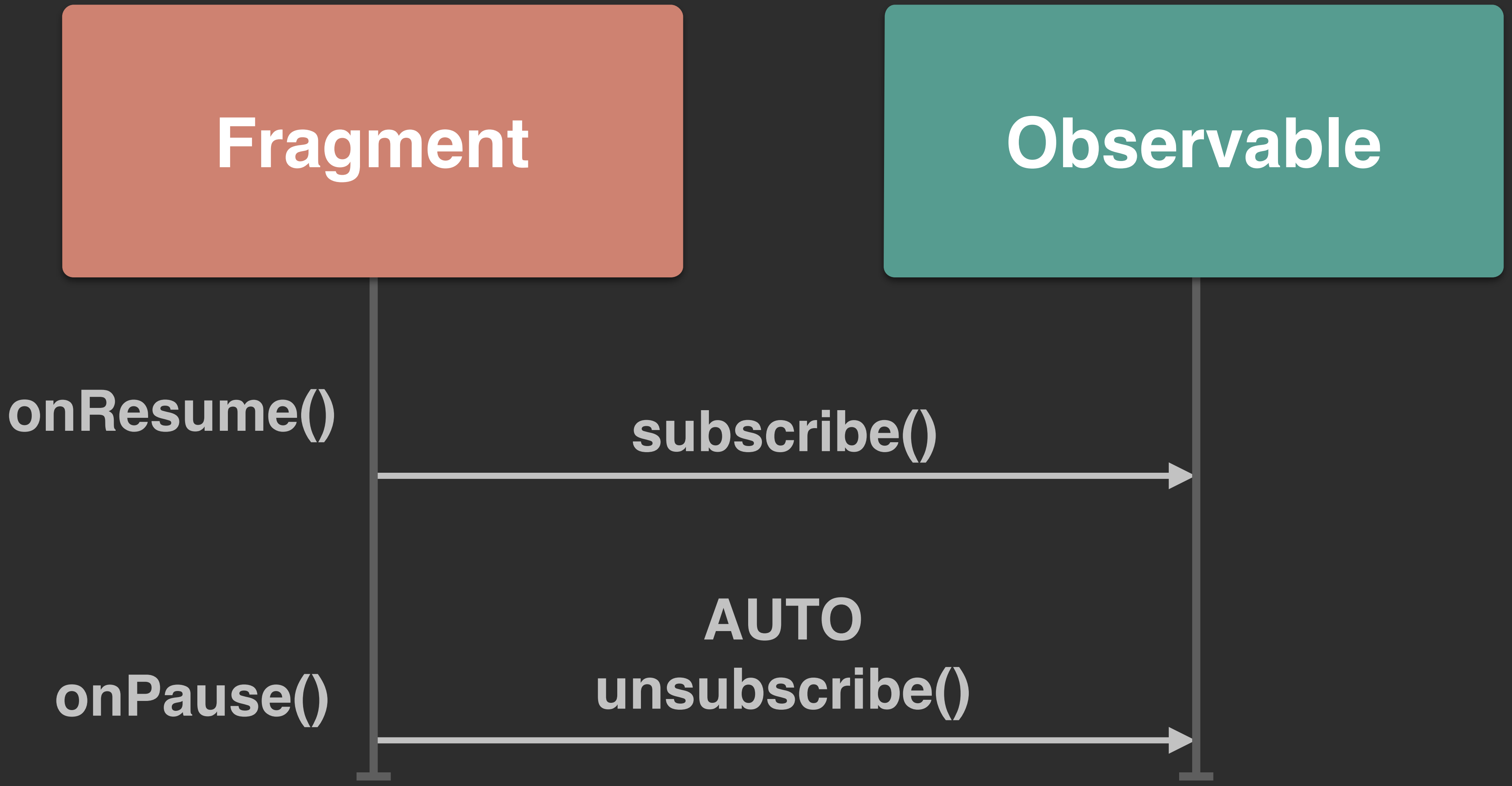
bindFragment(this, localCustomerList)
   .subscribe(
        this::display,
        this::handleError
    );
```

AppObservable

Safeguards



LifecycleObservable



Fragment

Observable

onResume()

subscribe()

onPause()

AUTO
unsubscribe()

More Power

Complex threading

```
public Observable<List<CityWeather>> getWeatherForLargeUsCapitals() {
    return cityDirectory.getUsCapitals()
        .flatMap(cityList -> Observable.from(cityList))
        .filter(city -> city.getPopulation() > 500,000)
        .flatMap(city -> weatherService.getCurrentWeather(city))
        .toSortedList((cw1,cw2) -> cw1.getName().compare(cw2.getName()));
}
```

Complex threading

```
public Observable<List<CityWeather>> getWeatherForLargeUsCapitals() {
    return cityDirectory.getUsCapitals()
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Complex threading

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Complex threading

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Complex threading

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Complex threading

```
public Observable<List<CityWeather>> getWeatherForLargeUsCapitals() {
    return cityDirectory.getUsCapitals()
        .flatMap(cityList -> Observable.from(cityList))
        .filter(city -> city.getPopulation() > 500,000)
        .flatMap(city -> weatherService.getCurrentWeather(city))
        .toSortedList((cw1,cw2) -> cw1.getName().compare(cw2.getName()));
}
```

Debouncing

```
temperatureChanges
    .debounce(2, SECONDS)
    .subscribe(WebService::save);
```

Debouncing

```
temperatureChanges
    .debounce(2, SECONDS)
    .subscribe(WebService::save);
```

```
WidgetObservable.text(searchBox)
    .debounce(500, MILLISECONDS)
    .flatMap(webService::search)
    .subscribe(this::displayResults);
```

Cache on rotation

```
public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    setRetainInstance(true);
    weatherObservable = weatherManager.getWeather().cache();
}

public void onViewCreated(...) {
    super.onViewCreated(...)
    weatherObservable.subscribe(this);
}
```

Why RxJava / RxAndroid?

- More robust interface than AsyncTask
- Easy to do complex threading
- Functional nature is more expressive

Why Retrolambda?

- Lambdas for Android
- Cleaner, simpler, more expressive
- Actually feels more functional