Elegant reactive streams with coroutines

Claim

Reactive streams are **hard to implement** and **error prone** as a result of the **poor concurrency primitives** provided by the JVM.

Part 1: Theory

Hard to implement

Backpressure

```
import ...

/**
 * Maps the values of the source publisher one-on-one via a mapper function.
 *
 * @param <T> the source value type
 * @param <R> the result value type
 *
 * @see <a href="https://github.com/reactor/reactive-streams-commons">Reactive-Streams-Commons</a>
 */
final class FluxMap<T, R> extends FluxOperator<T, R> {

    final Function<? super T, ? extends R> mapper;

    /**
     * Constructs a FluxMap instance with the given source and mapper.
     *
     * @param source the source Publisher instance
     * @param mapper the mapper function
     *
     * @throws NullPointerException if either {@code source} or {@code mapper} is null.
     */
    FluxMap(Flux<? extends T> source,
            Function<? super T, ? extends R> mapper) {
        super(source);
        this.mapper = Objects.requireNonNull(mapper,  message: "mapper");
    }

    @Override
    /unchecked/
    public void subscribe(CoreSubscriber<? super R> actual) {
        if (actual instanceof Fuseable.ConditionalSubscriber) {
            Fuseable.ConditionalSubscriber<? super R> cs =
                    (Fuseable.ConditionalSubscriber<? super R>) actual;
            source.subscribe(new MapConditionalSubscriber<>(cs, mapper));
            return;
        }
        source.subscribe(new MapSubscriber<>(actual, mapper));
    }
```

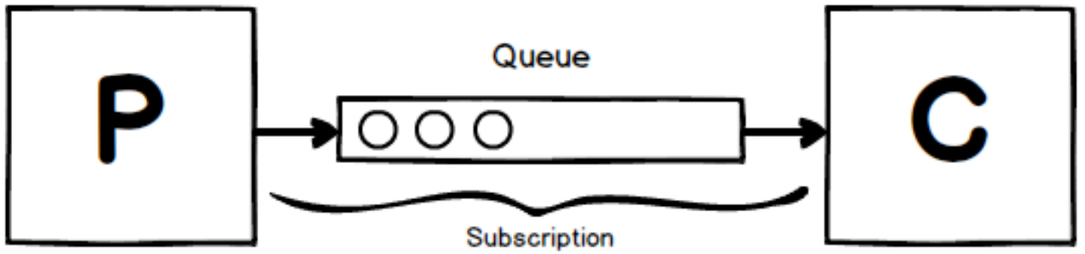
Error prone[1]

[1] https://medium.com/jeroen-rosenberg/10-pitfalls-in-reactive-programming-de5fe042dfc6

Poor concurrency primitives

1. Threads
   - → Expensive!!!
2. Callbacks
   - → Backpressure

Why do we need backpressure?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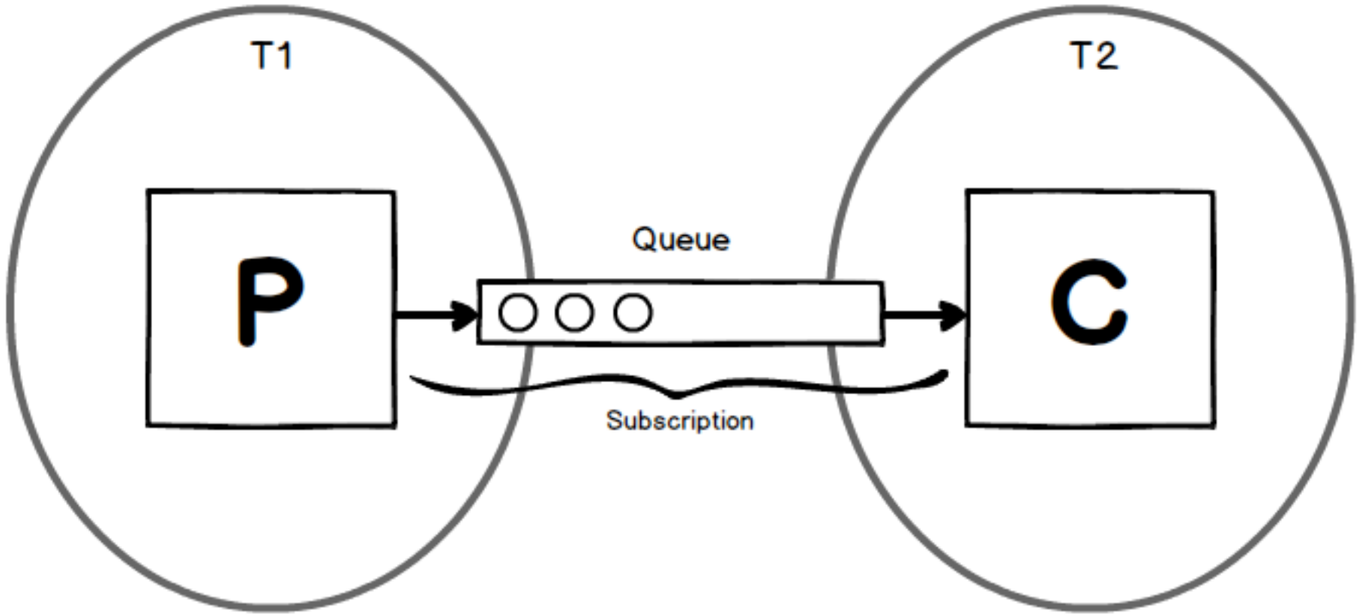
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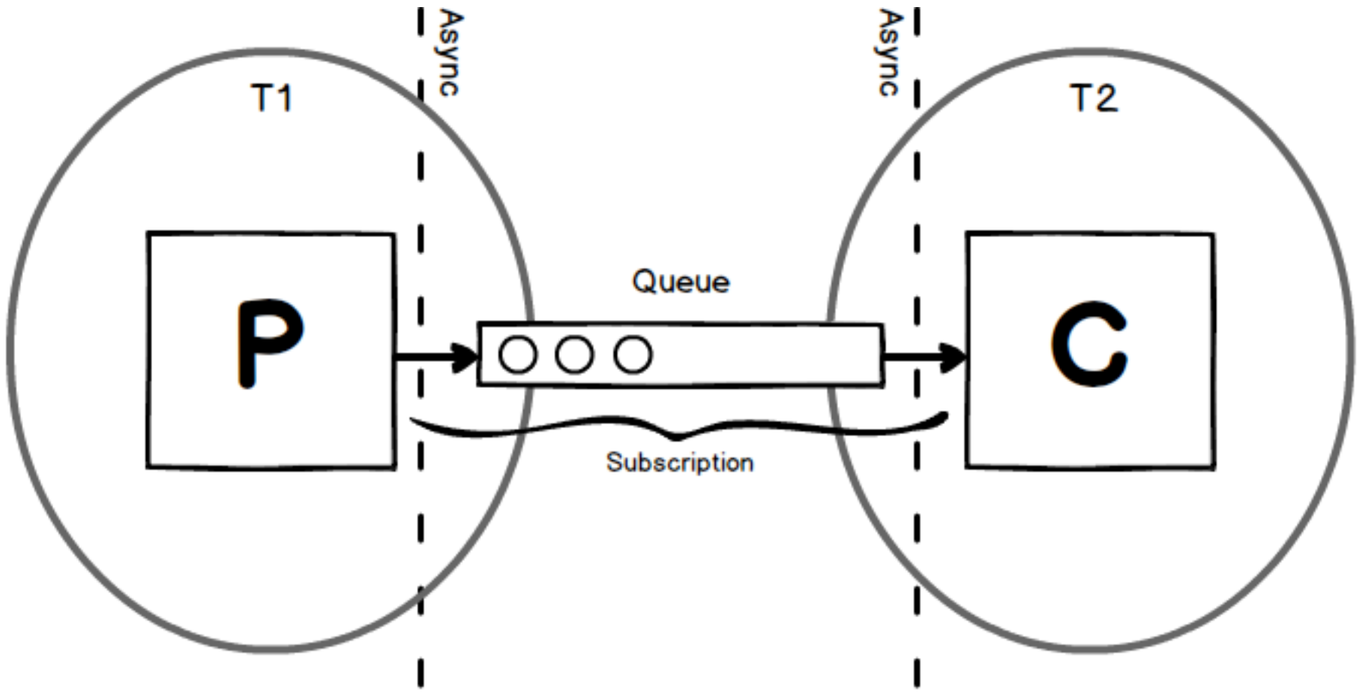
T1
Async
Async
T2
P
Queue
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Subscription

```
    // Asynchronous Producer
Flux.create(emitter -> {
            emitter.next("hello");
            // <- How do we suspend our thread here??? ->
            emitter.next("world");
        })
    // Thread boundary
    .publishOn(Schedulers.elastic())
    // Consumer
    .subscribe(System.out::println);
```

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```

What if there existed a **concurrency primitive** that allowed us to implement a queue on which operations **do not block.**

Channels

Channels

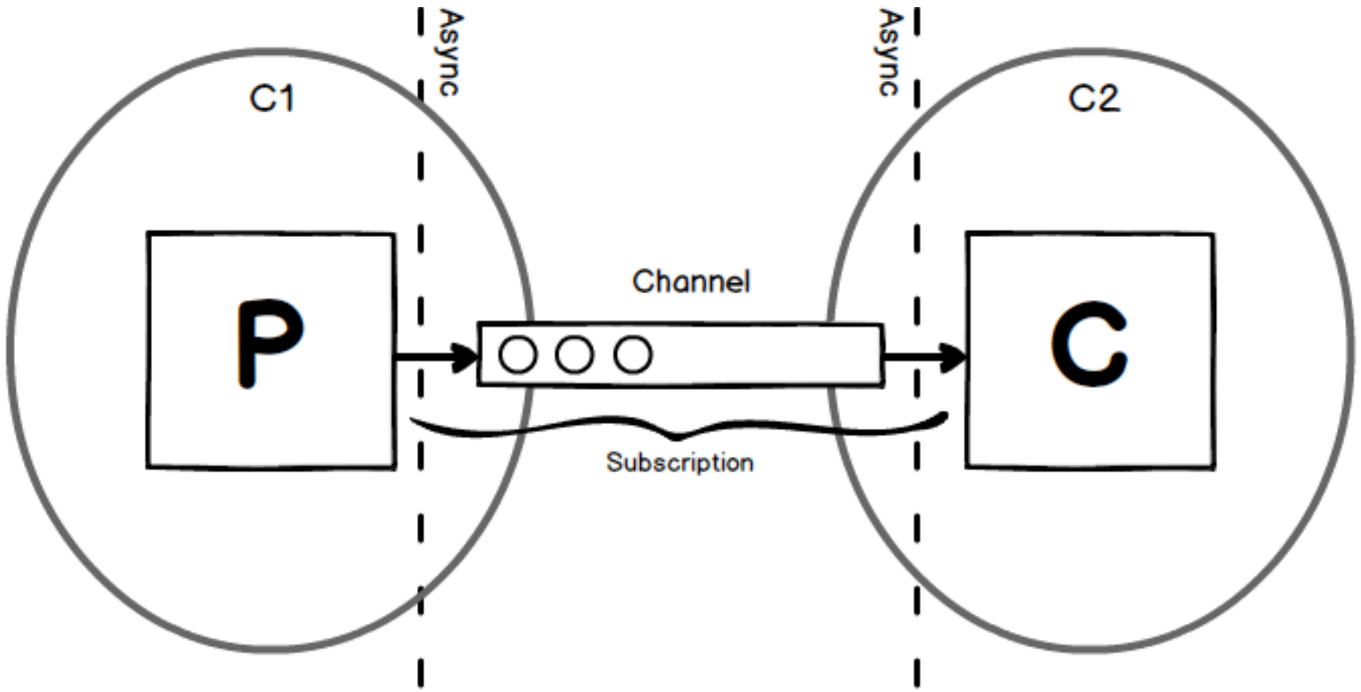
A Channel is conceptually similar to `BlockingQueue`. Where instead of a **blocking** `put` it has a **suspending** `send`, and instead of a **blocking** `take` it has a **suspending** `receive`.

What are we suspending here?

Coroutines

Coroutines are like **light-weight threads**, that allow us to *yield* and *re-enter* methods

```
suspend fun enterExit() {
    println("hello")
    delay(500) // suspend
    println("world") // re-enter
}
```


C1
Async
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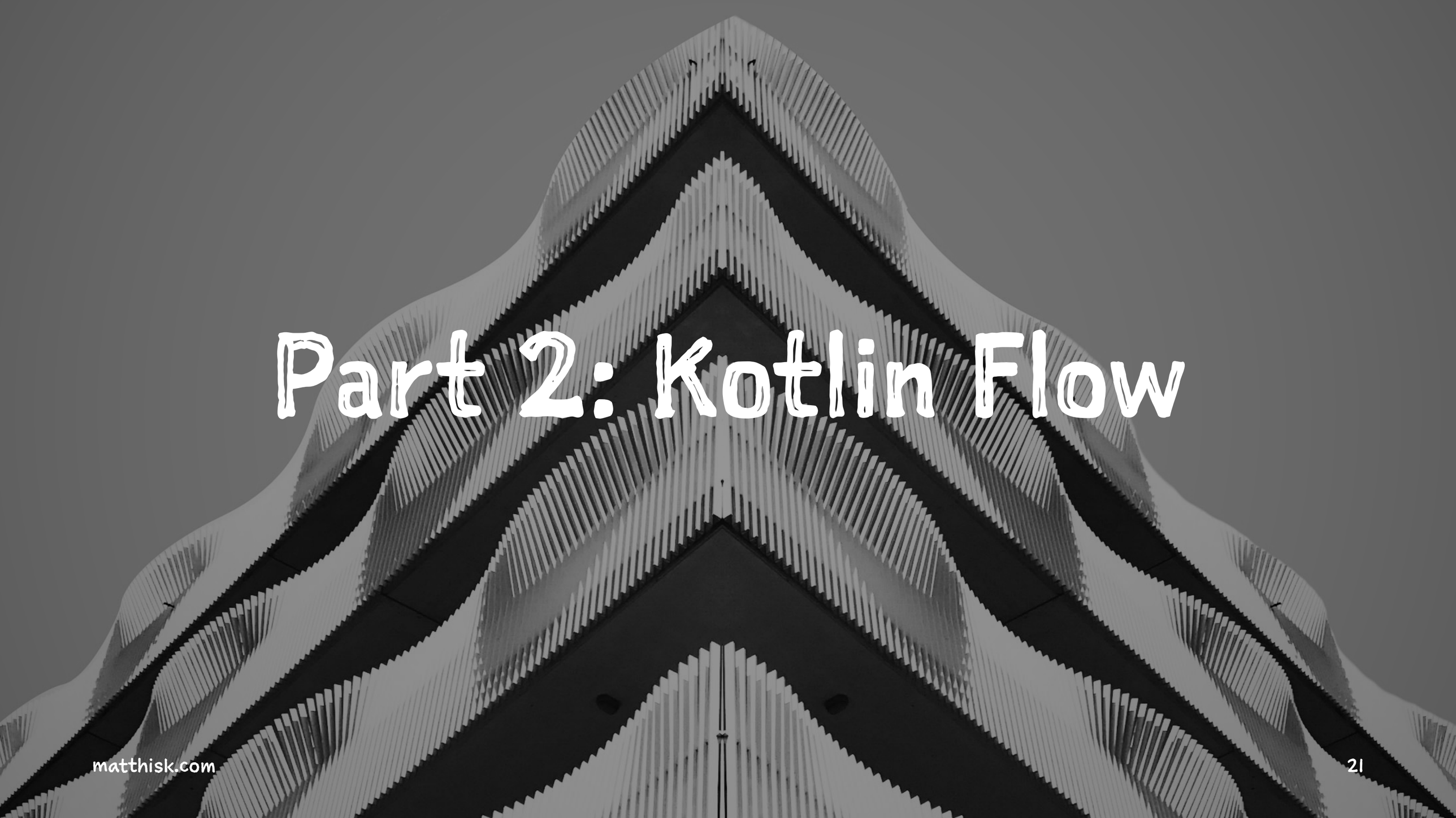

Part 2: Kotlin Flow

Kotlin Flow

```
interface Flow<out T> {
    suspend fun collect(collector: FlowCollector<T>)
}
```

Kotlin Flow

```
interface Flow<out T> {
    suspend fun collect(collector: FlowCollector<T>)
}

interface FlowCollector<in T> {
    suspend fun emit(value: T)
}
```

Creating a Flow

```
fun <T> flow(block: suspend FlowCollector<T>.() -> Unit): Flow<T>
```

Creating a Flow

```
fun <T> flow(block: suspend FlowCollector<T>.() -> Unit): Flow<T>

fun main() = flow {
    emit("hello")
    delay(100) // 🎉 Suspend the producer without blocking
    emit("world")
}
```

Creating a Flux

```
Flux.from(subscriber -> {
    subscriber.onSubscribe(new Subscription() {
        @Override
        public void request(long n) {
            // Send `n` items to `subscriber.onNext`
        }
    });
});
```

Using a Flow

```
    // Asynchronous Producer
flow {
    emit("hello")
    // <- How do we suspend our coroutine here??? ->
    emit("world")
}
    // Thread boundary
    .flowOn(Dispatchers.IO)
    // Consumer
    .collect { println(it) }
```

Using a Flow

```
    // Asynchronous Producer
flow {
    emit("hello")
    delay(100)
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    // Consumer
    .collect { println(it) }
```

Operators

```
fun <A, B> Flow<A>.map(transform: suspend (value: A) -> B) = flow {
    collect { emit(transform(it)) }
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Operators

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```
fun <A, B> Flow<A>.map(transform: suspend (value: A) -> B) = flow {
    collect { emit(transform(it)) }
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```

What have we learned

- Having to *account* for **backpressure** is **not** something inherent to async stream processing
- Poor concurrency primitives make for complexer application level code

References

- blocking threads suspending coroutines
- kotlin flows and coroutines
- simple design of kotlin flow
- cold flows hot channels