

Practical event sourcing with EventFlow

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<https://github.com/rasmus>

Me?

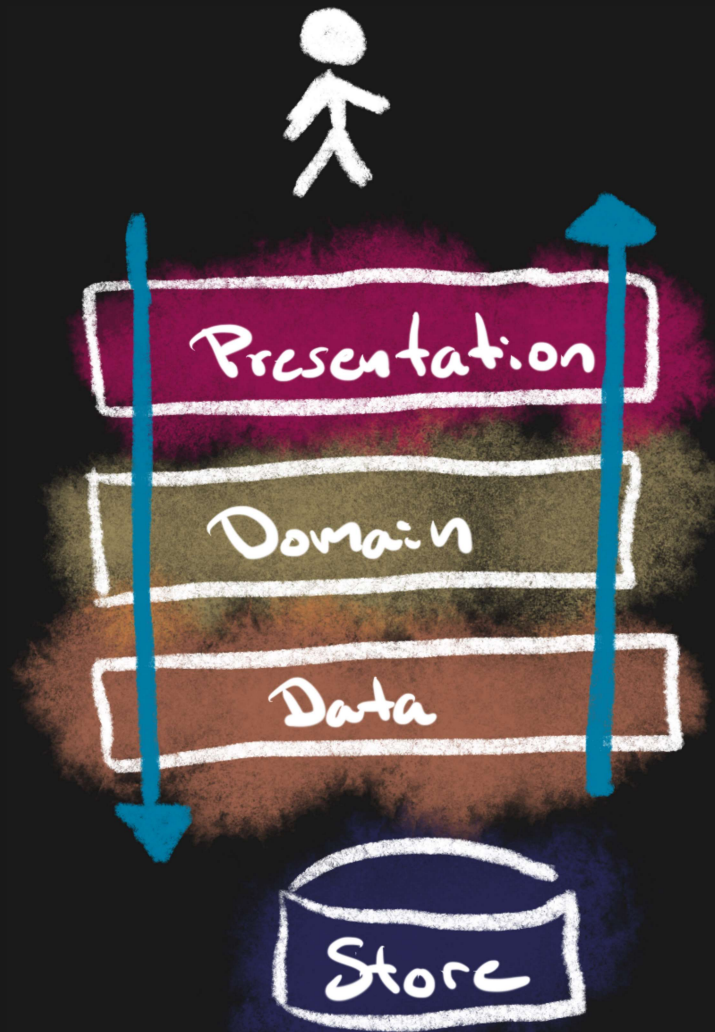
- eBay/Schibsted at DBA, Bilbasen and Bilinfo
 - Backend developer
 - DevOps engineer
 - Infrastructure architect
 - SiteOps and on-call
- Working as SRE at Schibsted Data & Tech
 - Support companies with ~100 k8s clusters
- Created EventFlow, an open source project
- First time doing a public talk 🤖

This talk

- Brief introduction to event sourcing
- See how to get started with event sourcing
- Convince you not to use event sourcing
- ... then talk about when use it

Introduction to event sourcing

Traditional service



Traditional data store

ID	FullName	Age
1	rasmus mikkelsen	21

- ID is a unique key

Traditional data store

- CRUD: Create, read, update, delete
- Stores current state
- Audit is stored separate (for critical systems)
- Awesome support in languages and ORMs

CRUD data stores

```
{  
  "id": 1,  
  "fullName": "rasmus",  
  "age": 21  
}
```

```
{  
  "id": 1,  
  "fullName": "rasmus",  
  "age": 25 // age edited again  
}
```


Event sourcing

- Stores changes as individual objects
- Append only
- Current state is sum of all changes applied in order
- Implementations often custom made
- Design is often a result of infrastructure preference

Event sourcing

ID	Version	Event	Data
1	1	Created	fullName: rasmus m age: 21
1	2	NewAge	age: 23
1	3	NewAge	age: 25

- **ID** and **Version** form an unique key
- **Version** specifies the order of events

Event sourcing

```
{
  "id": 1,
  "version": 1,
  "type": "Created",
  "meta" : {
    "ip": "147.29.150.82",
    "via": "browser"
  },
  "event:" {
    "fullName": "rasmus mikkelsen",
    "age": 21
  }
}
```

- Events have two components, data and metadata

Event sourcing

```
{  
  "id": 1,  
  "version": 2,  
  "type": "NewAge",  
  "meta" : {  
    "ip": "147.29.150.82",  
    "via": "browser"  
  },  
  "event": {  
    "age": 23  
  }  
}
```

Event sourcing

```
{  
  "id": 1,  
  "version": 3,  
  "type": "NewAge",  
  "meta" : {  
    "ip": "103.228.53.155",  
    "via": "mobile-api"  
  },  
  "event": {  
    "age": 25  
  }  
}
```

Event sourcing key points

- Current state is the sum of *all* events, you need to apply every single one in order
- **ID** and **Version** form a unique key
- Events are stored in an append only model
- Events are immutable - never ever, ever change them
- Event often relates to some business/user action
- Provides an excellent audit trail



EventFlow

- Created in 2015
- MIT licensed
- Written .NET/C#
 - Concepts are similar to other frameworks and languages

General event sourcing concepts

- **Command:** represents a request to change the system
- **Aggregate:** an entity, or group of entities, that are viewed as a single unit and updated together
- **(Aggregate) event:** represents something that has happened, thus cannot be changed

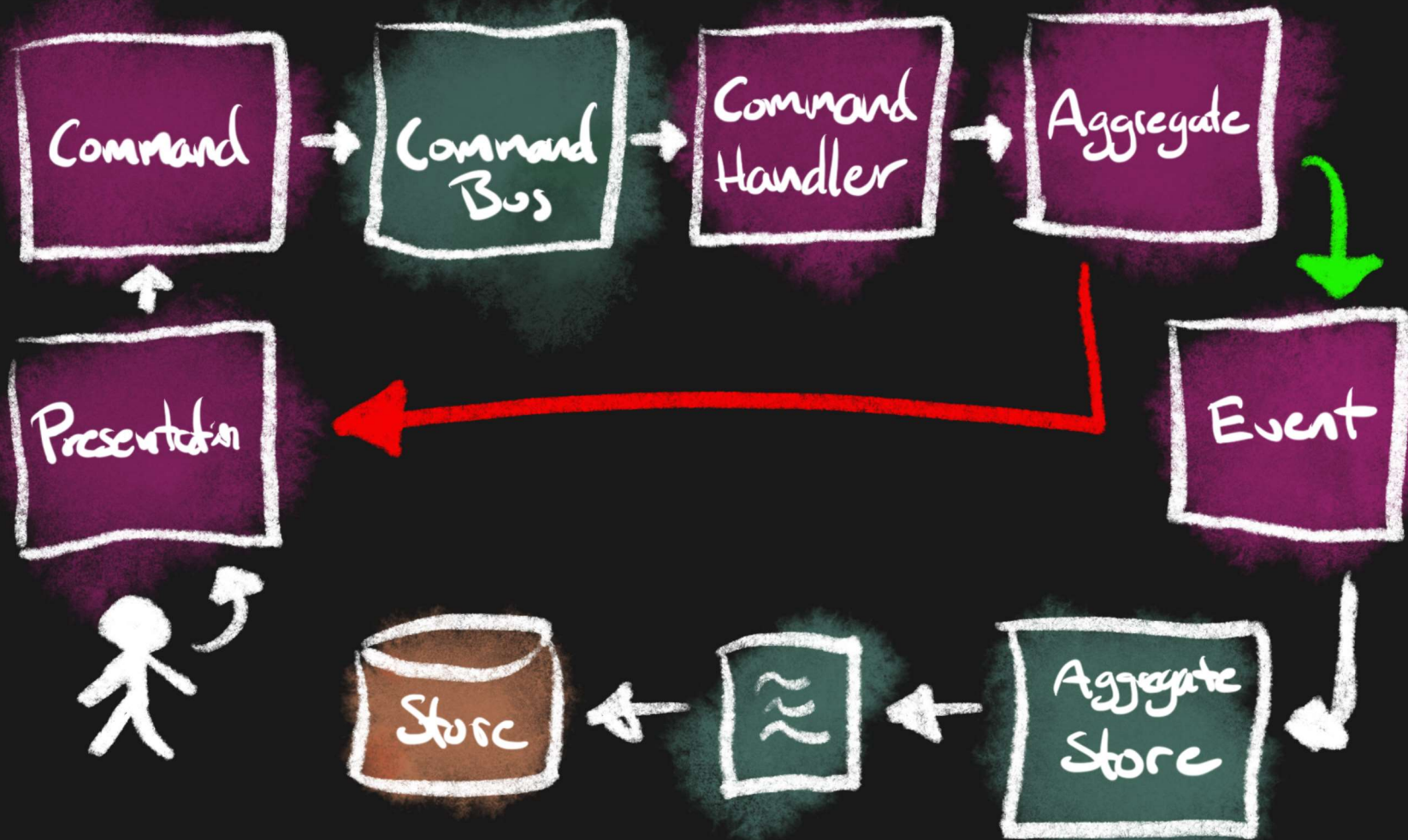
Will be illustrated shortly

Additional EventFlow concepts

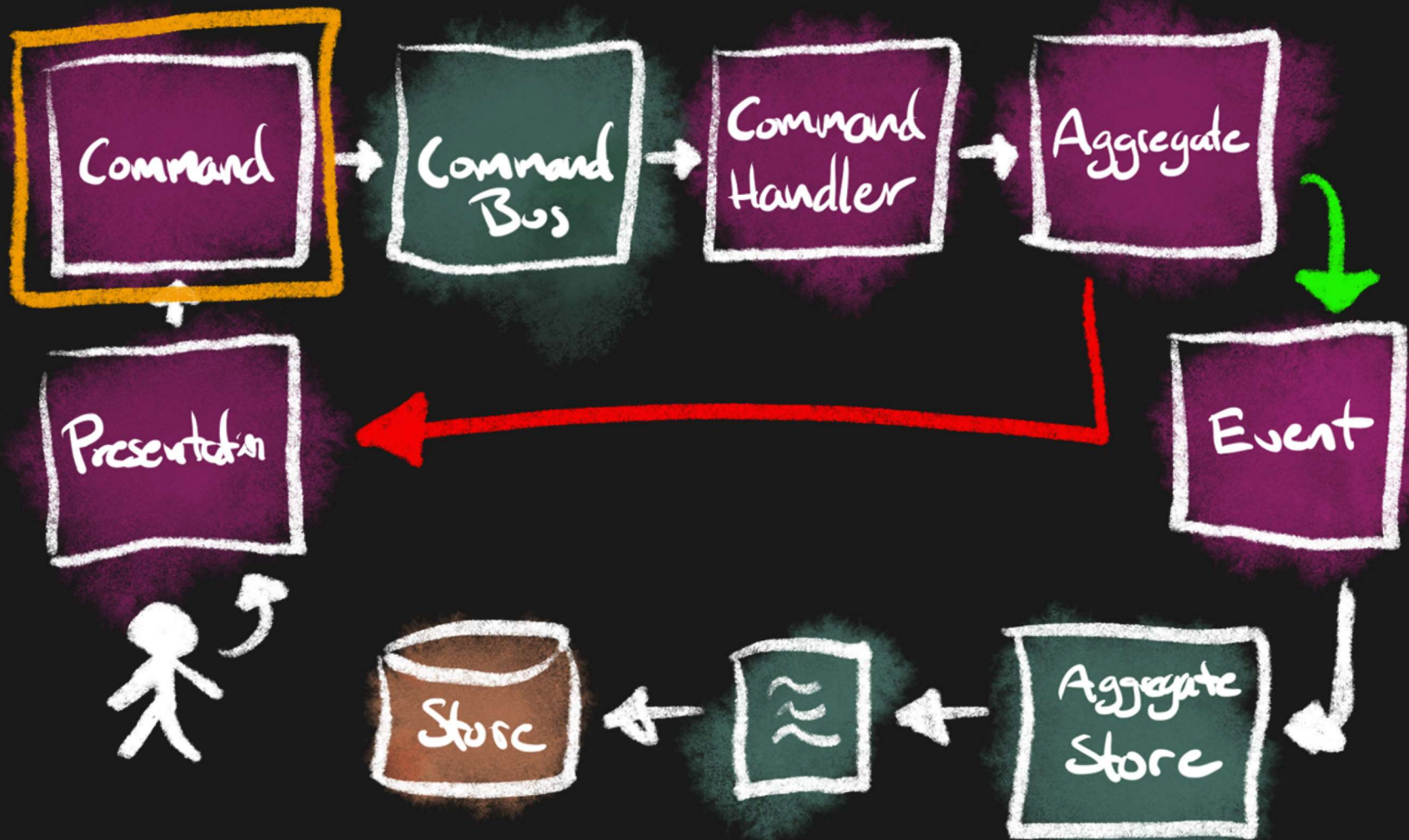
- **Command handler:** Maps a specific command to an aggregate
- **Domain event:** Wraps the aggregate event and metadata

Will be illustrated next slide

Overview of EventFlow concepts



Command



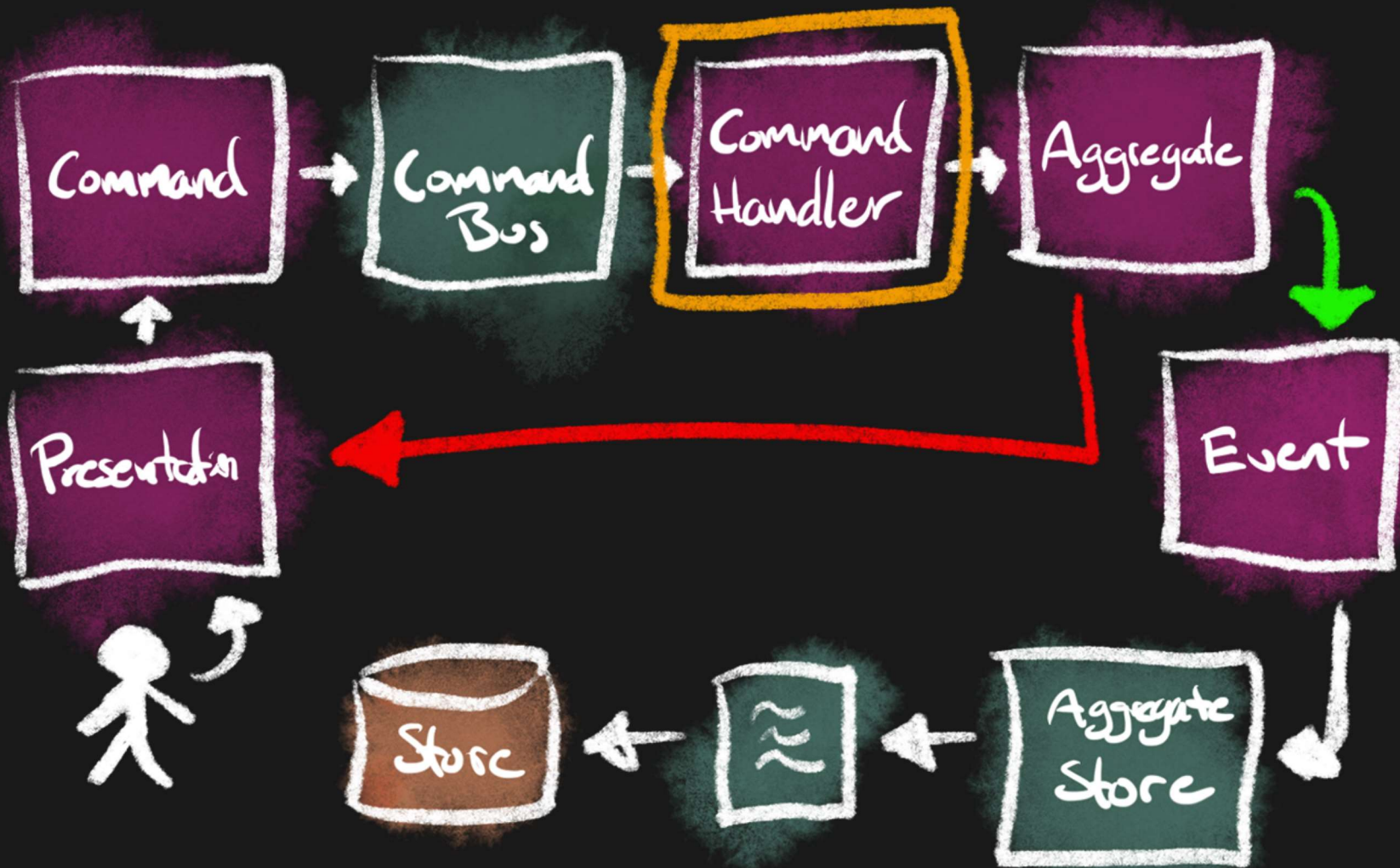
Command

```
public class CreateUserCommand : Command<UserAggregate, UserId>
{
    public string FullName { get; }
    public int Age { get; }

    public CreateUserCommand(
        UserId aggregateId,
        string fullName, int age)
        : base(aggregateId)
    {
        FullName = fullName;
        Age = age;
    }
}
```

- Value object that represents an action to take

Command handler

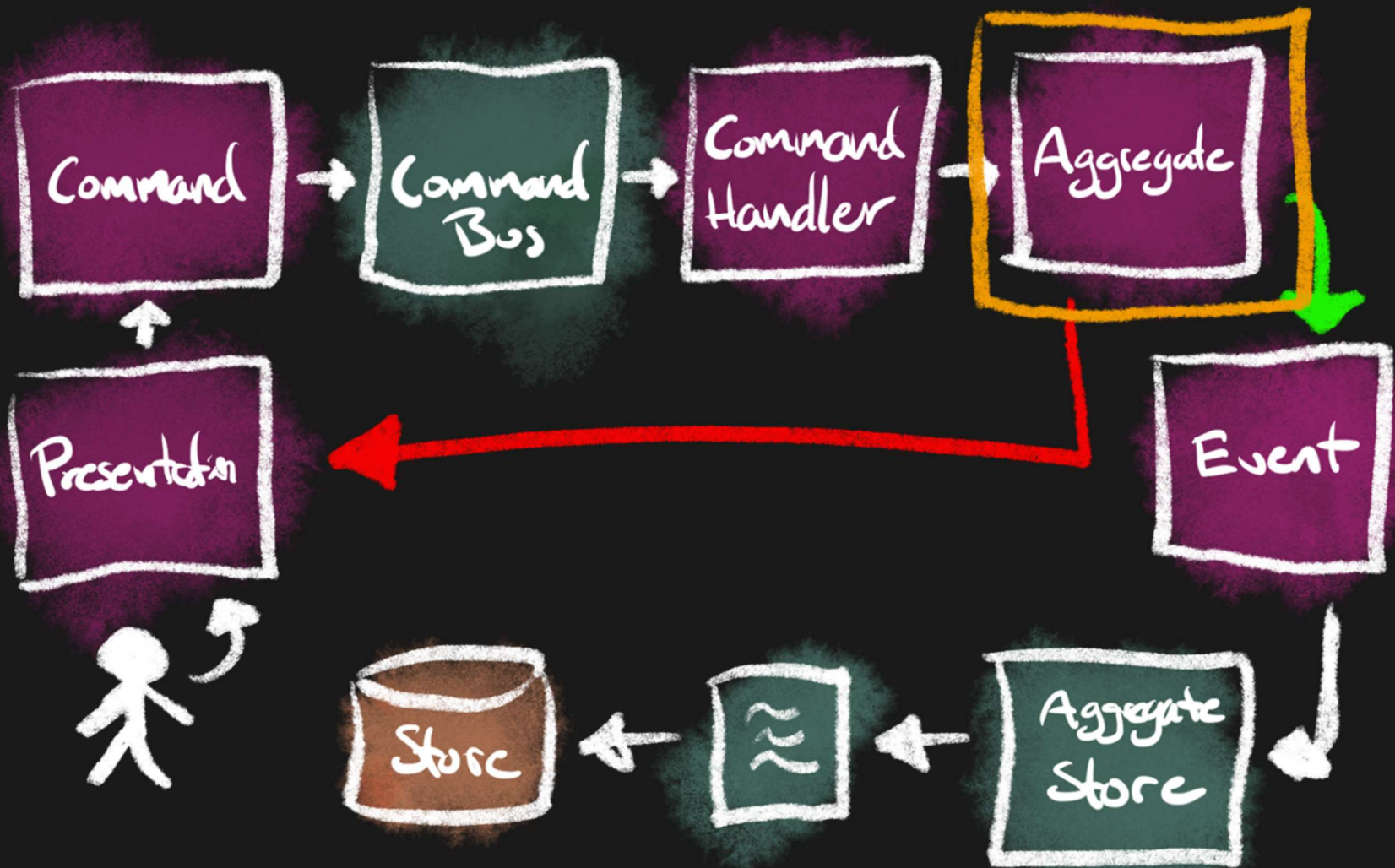


Command handler

```
public class CreateUserCommandHandler :  
    ICommandHandler<UserAggregate, UserId,  
        IExecutionResult, CreateUserCommand>  
{  
    public Task<IExecutionResult> ExecuteCommandAsync(  
        UserAggregate aggregate,  
        CreateUserCommand command,  
        CancellationToken cancellationToken)  
    {  
        var result = aggregate.Create(  
            command.FullName, command.Age);  
        return Task.FromResult(result);  
    }  
}
```

- 1-to-1 relation to a specific command
- Defines how to apply a command to the aggregate

Aggregate



Aggregate

```
public class UserId : Identity<UserId>
{
    public UserId(string value) : base(value) {}
}
```

```
public class UserAggregate : AggregateRoot<UserAggregate, UserId>
{
    // Public to do easy/lazy testing
    public string? FullName { get; private set; }
    public int? Age { get; private set; }

    public UserAggregate(UserId id) : base(id) { }

    // We'll fill in the rest later
}
```


Add method to mutate aggregate

```
public class UserAggregate : AggregateRoot<UserAggregate, User>
{
    // ...

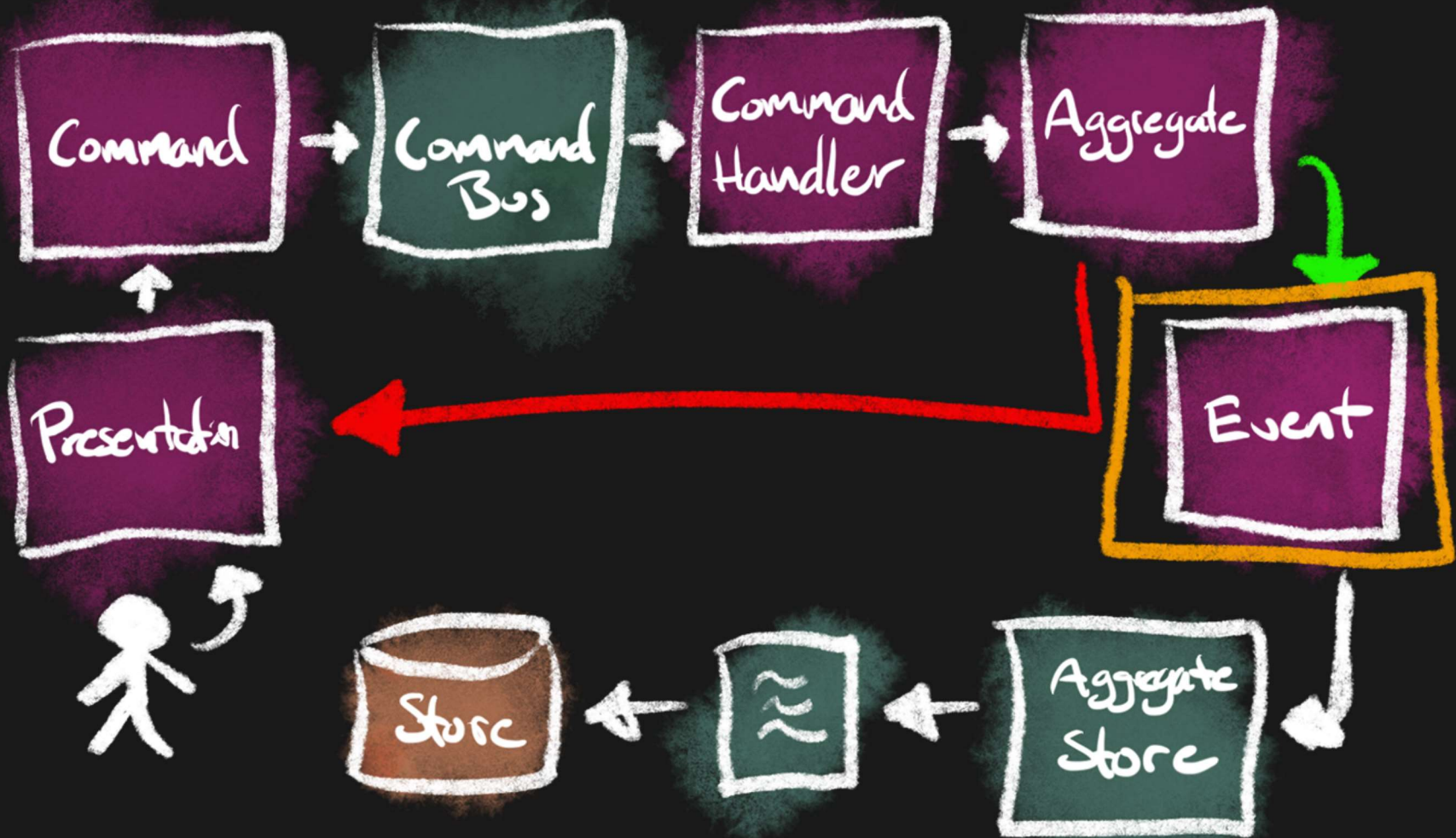
    public IExecutionResult Create(string fullName, int age)
    {
        if (age < 13)
            return ExecutionResult.Failed("Too young");

        Emit(new CreatedEvent(fullName, age), GetMetadata());

        return ExecutionResult.Success();
    }
}
```

- Can **Emit** zero or or more
- **Zero** represents "no change"

Command



Event for user creation

```
[EventVersion("Created", 1)]  
public class CreatedEvent : AggregateEvent<UserAggregate, User>  
{  
    public string FullName { get; }  
    public int Age { get; }  
  
    public CreatedEvent(  
        string fullName,  
        int age)  
    {  
        FullName = fullName;  
        Age = age;  
    }  
}
```

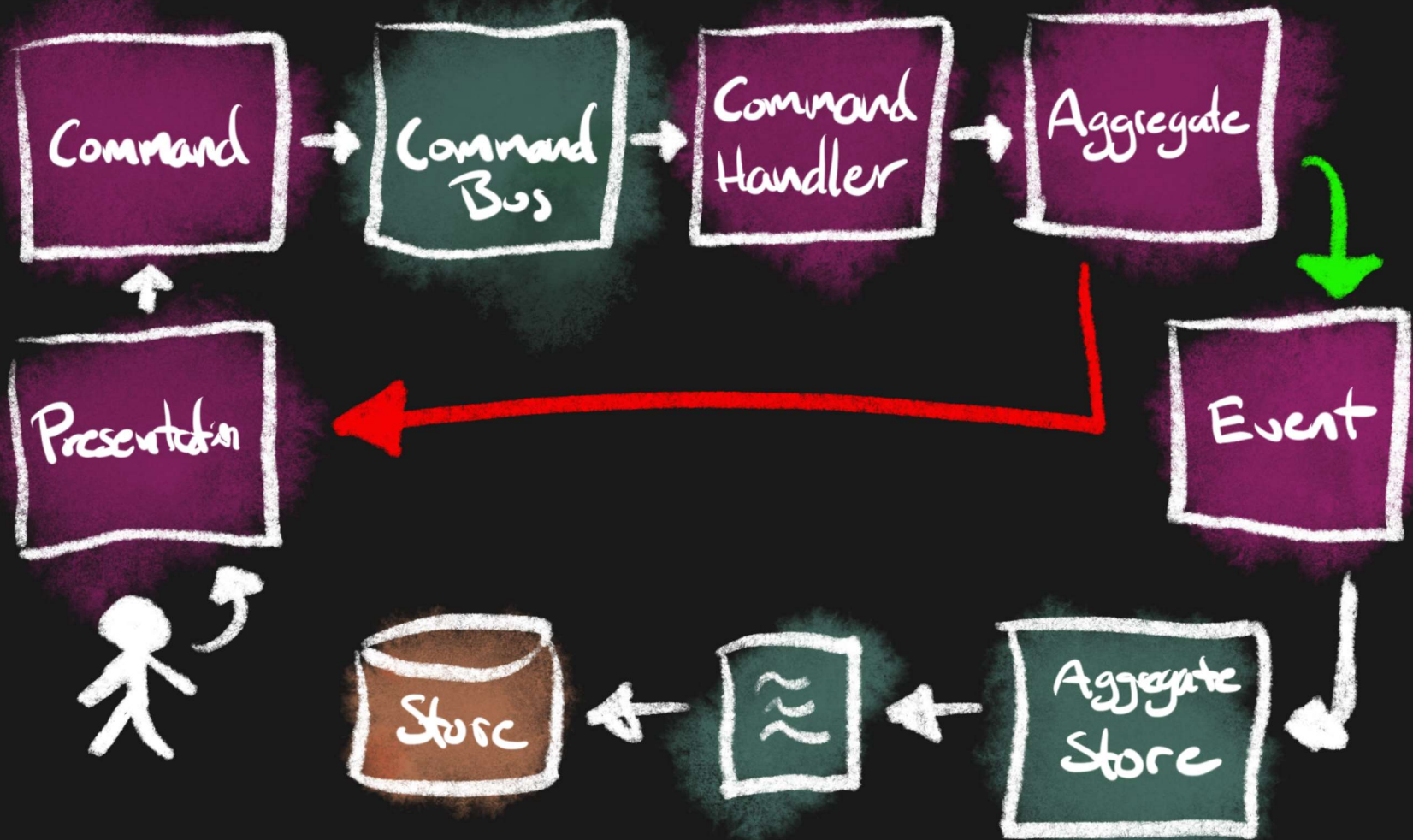
The **Apply** method

```
public class UserAggregate : AggregateRoot<UserAggregate, User>
{
    // ...

    public void Apply(CreatedEvent e)
    {
        FullName = e.FullName;
        Age = e.Age;
    }
}
```

- Responsible to updating current in-memory state
- Executed on
 - ... every **Emit**
 - ... every time the aggregate is loaded
- One **Apply** for every event type

Overview again



... and in code

```
// Create initial input
var (userId, fullName, age) = (UserId.New, "rasmus mikkelsen",

// Send command via command bus
var command = new CreateUserCommand(userId, fullName, age);
var executionResult = await _commandBus.PublishAsync(command);
// executionResult.IsSuccess == true;

// Fetch aggregate directly
var userAggregate = await _aggregateStore.LoadAsync<UserAggregate>(
    userId);

// userAggregate.FullName == "rasmus mikkelsen";
// userAggregate.Age == 21;
```

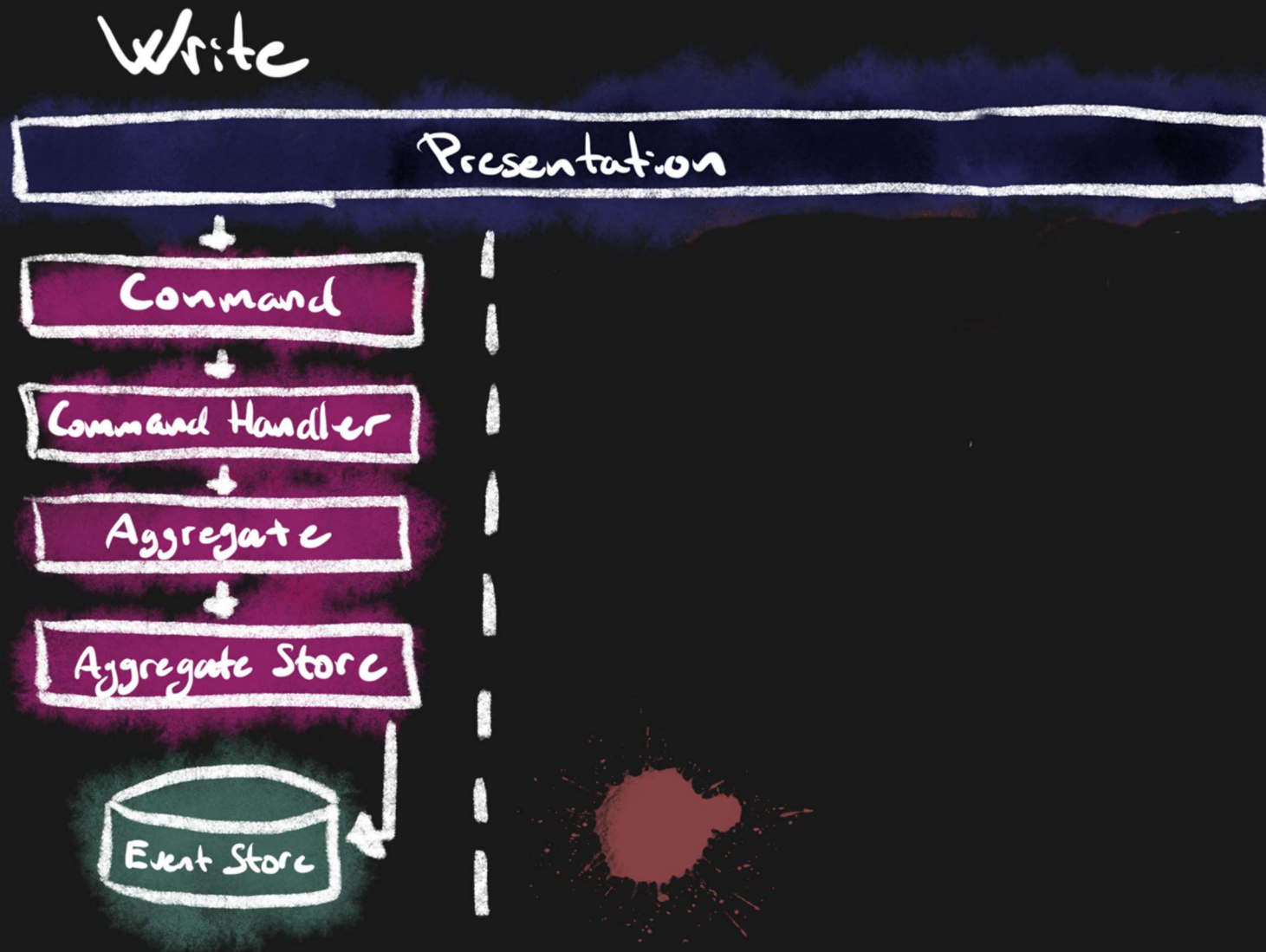
All good, but what about reads?

- We *could* just load the aggregate 🤔
- ... but *really* slow if enumerating aggregates
- ... want to query by something else than ID
- We need something else

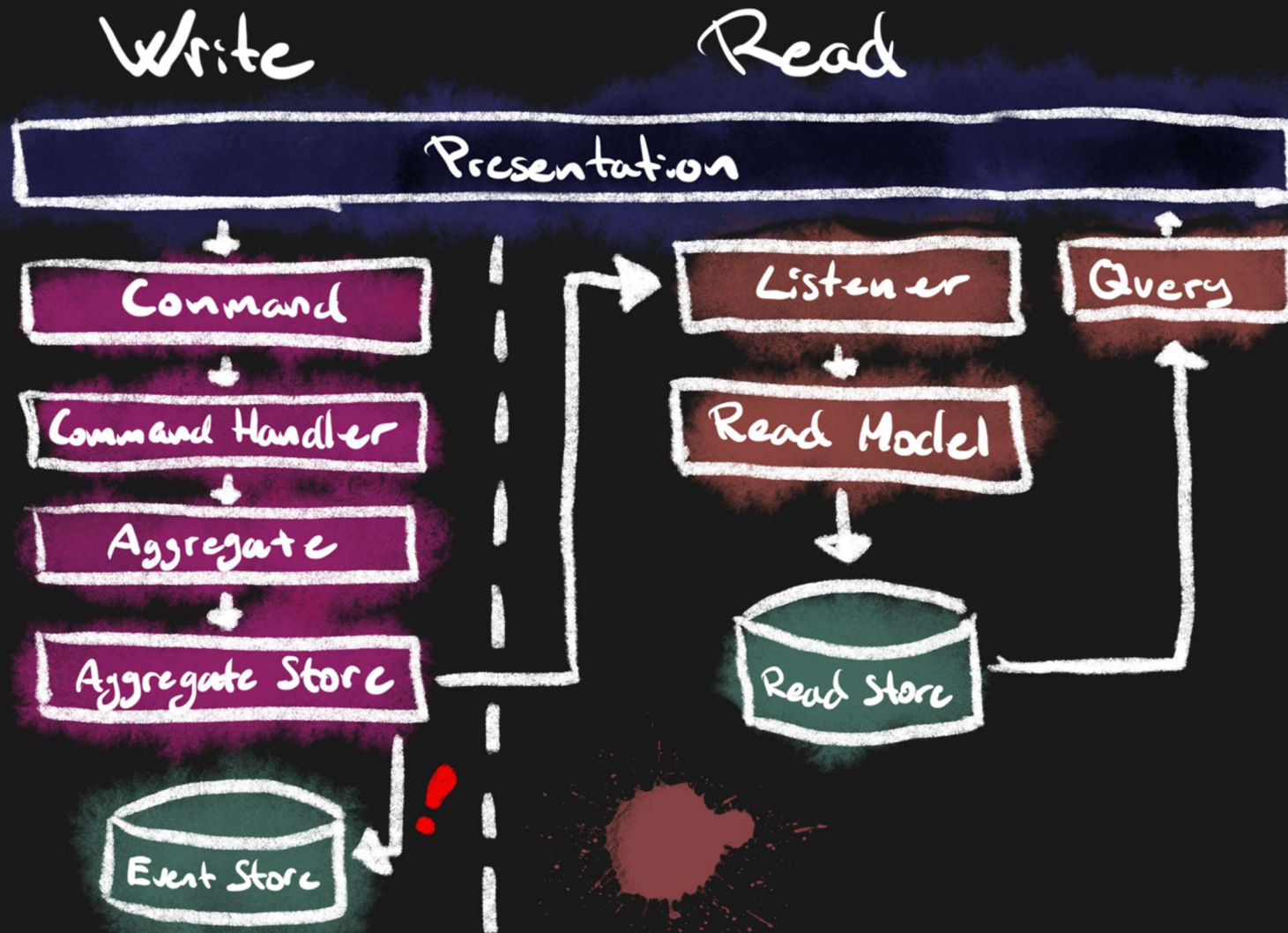
CQRS to the rescue 🦱

- **Command** and **Query Responsibility Segregation**
- Simply separate write and read operations
- Often to different types of datastores , e.g.
 - **Write:** MS SQL Server, PostgreSQL, ...
 - **Read:** Elasticsearch, Redis, ...
- Fits very nicely with event sourcing

Event sourcing + CQRS = ❤️



Event sourcing + CQRS = ❤️






Event listeners in EventFlow

```
public class UpdateReadModelWithCreatedUser :
    ISubscribeSynchronousTo<UserAggregate, UserId, CreatedEvent>
{
    public Task HandleAsync(
        IDomainEvent<UserAggregate, UserId, CreatedEvent> domainEv
        CancellationToken cancellationToken)
    {
        // Do awesome update of read model here \o/ ... the easy
        // solution is to simply read the aggregate and map it to
        // read model. Remember to take the version into account!

        return Task.CompletedTask;
    }
}
```

All done?

-  Optimized read models
-  Cool domain using event sourcing
-  ... need **FirstName** and **LastName**, not **FullName**

Problems

- Already live with millions of CreatedEvent
- Need v2 event with FirstName and LastName
- Not allowed to delete/change events
- Critical system, boss says "ZERO downtime!"

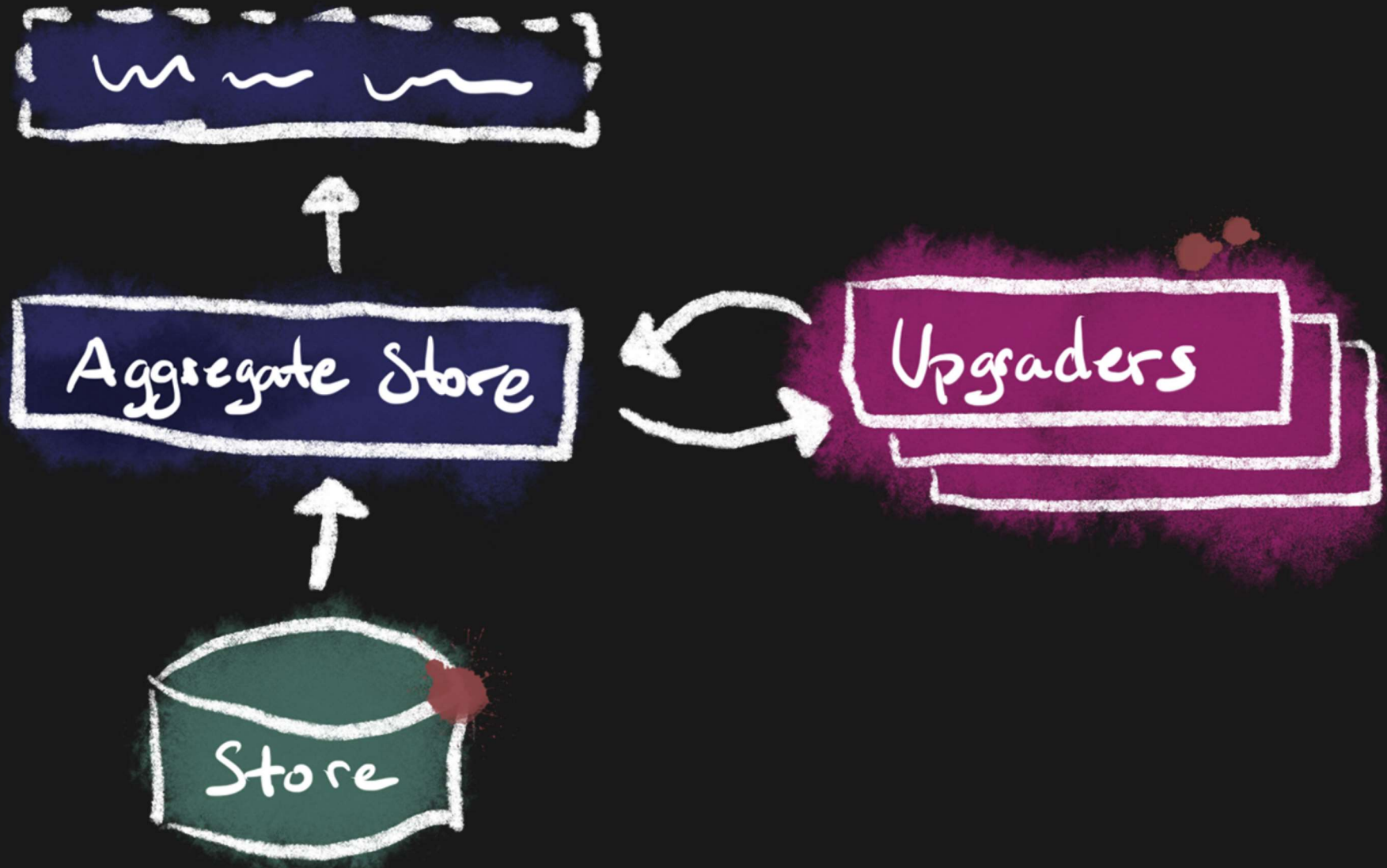
Upcast/upgrade events

... for when changes to the domain happen.

Upgraders in EventFlow

- Executed when events are **read**
- Can has as many as you like (performance)
- Keep them simple!
 - **v1** to **v2** upgrade
 - **v2** to **v3** upgrade
- Executed in alphabetical order

Upgraders in EventFlow



V2 event

```
[EventVersion("Created", 2)]  
public class CreatedEventV2 : AggregateEvent<UserAggregate, User>  
{  
    public string FirstName { get; }  
    public string LastName { get; }  
    public int Age { get; }  
  
    public CreatedEvent(  
        string firstName, string lastName, int age)  
    {  
        FullName = firstName; LastName = lastName; Age = age;  
    }  
}
```

Event upgrader in EventFlow

```
public class UserCreatedEventUpgrader : IEventUpgrader<UserAggregate, UserId>
{
    public IEnumerable<IDomainEvent<UserAggregate, UserId>> Upgrade(
        IDomainEvent<UserAggregate, UserId> domainEvent)
    {
        var createdEvent = domainEvent as IDomainEvent<UserAggregate, UserId, CreatedEvent>;
        if (createdEvent == null) {
            yield return domainEvent;
            yield return break;
        }

        var nameParts = createdEvent.FullName.Split(' ', StringSplitOptions.RemoveEmptyEntries);

        var createdEventV2 = _domainEventFactory.Upgrade<UserAggregate, UserId>(
            domainEvent,
            new CreatedEventV2(
                nameParts[0],
                nameParts[1],
                createdEvent.Age
            ));

        yield return createdEventV2;
    }
}
```

Updated aggregate

```
public class UserAggregate : AggregateRoot<UserAggregate, User>
{
    // Public to do easy/lazy testing
    public string? FirstName { get; private set; }
    public string? LastName { get; private set; }
    public int? Age { get; private set; }

    public UserAggregate(UserId id) : base(id) { }

    // We'll fill in the rest later
}
```

Updated aggregate **Apply** method

```
public class UserAggregate : AggregateRoot<UserAggregate, User>
{
    // ...

    // We delete the old Apply method for the old event

    public void Apply(CreatedEventV2 e)
    {
        FirstName = e.FirstName;
        LastName = e.LastName;
        Age = e.Age;
    }
}
```

Update aggregate mutate method

```
public class UserAggregate : AggregateRoot<UserAggregate, User>
{
    public IExecutionResult Create(
        string firstName, string lastName, int age)
    {
        if (age < 13)
            return ExecutionResult.Failed("Too young");

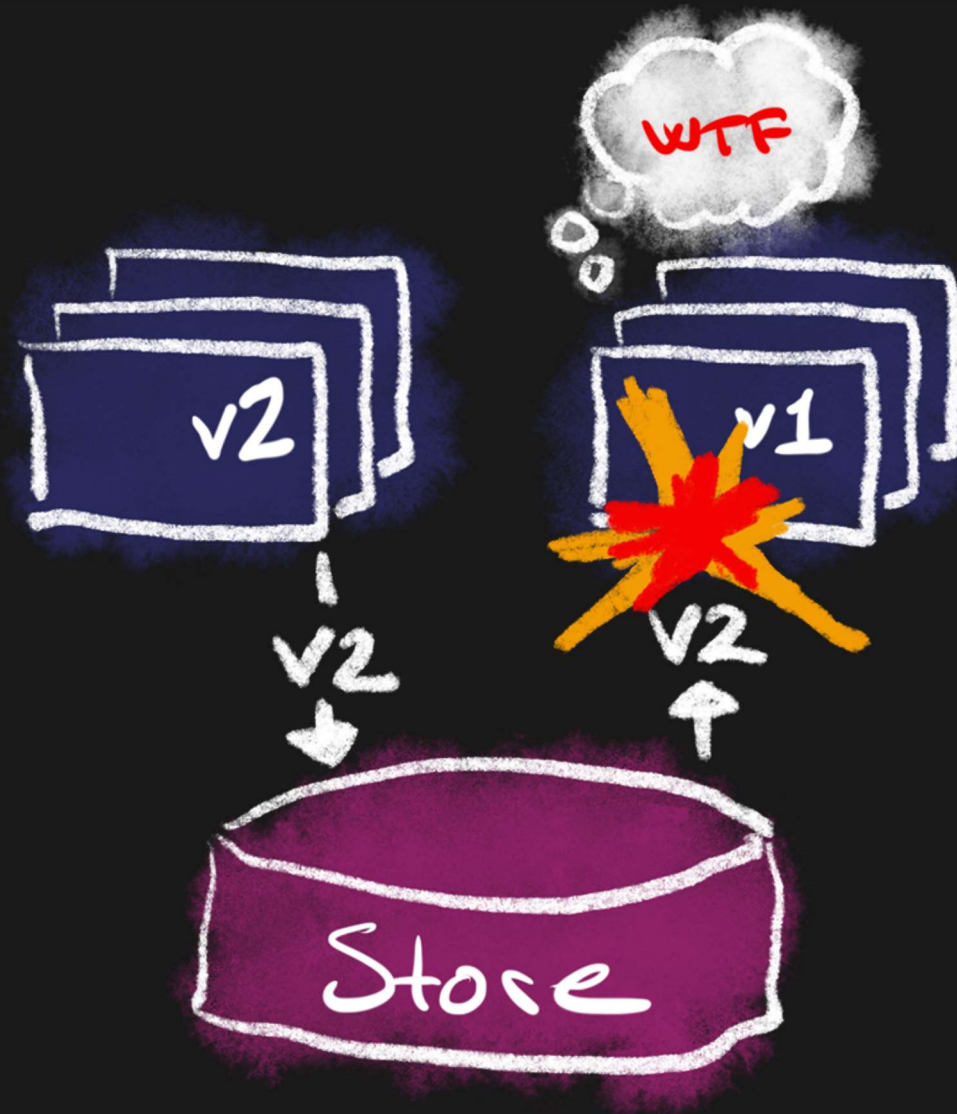
        Emit(new CreatedEventV2(firstName, lastName, age), GetMeta

        return ExecutionResult.Success();
    }
}
```

- ... and update the CreateUserCommand
- ... and update the CreateUserCommandHandler

Domain v2 go-live?

Domain v2 go-live 🤯



Updated domain **v2** go-live plan

- 🤔 multiple instances, **v1** and **v2** will both be live at the same doing rollout
- 1) Rollout **v1.1** that is able to **read** both **v1** and **v2**
- 2) Rollout **v2** that **writes** **v2** events, without **v1**
- Remember to keep old events, these are needed for reading and upgrading
- Success 🎉

Event sourcing, the bad parts

- A lot of ceremony. Any action requires a lot of code
- A lot of different ways to fill in the missing pieces
- Poor performance on writes, exceptionally bad with many events
- Too many concurrent updates can make a service useless
- Read models become eventually consistent, which adds complexity

Event sourcing, the good parts

- Fits very nicely with an event drive architecture
- Awesome together with CQRS, but that's just for reads
- Can provide an excellent link do user/domain actions
- Automatic retries for concurrent updates

Don't use event sourcing...

... it leads to pain and suffering... sometimes.

Don't use it in the wrong places

- Not in services with a *lot of* changes
- Not in high performance/concurrent writes
- Not in services with low importance

**Don't use it for *fun* at work,
unless doing an experiment or to learn**

- Don't force the decision to use event sourcing
- Don't enable every tool in the toolbox, start small
- Don't make simple domains overly complicated

Don't make first project too complicated

- If you are unsure of the domain, it can cause a lot of breaking changes, which requires a lot of work
- Don't use all the theories, initially agree how to do it
- Many opinions on how to do “proper” event sourcing. Agree on what to do (and not)
- Be conscious about how deep into the mythical DDD waters you want to go

Don't underestimate storage usage!!!

- Developers ❤️ 💪 ✨
- SiteOps 🤒 🤖 🙄
- Append only model
- Events are stored forever, by default
- Define when you archive and/or delete events
- Snapshot is your friend for long lived aggregates

Consider event souring if...

... you are absolutely sure

If auditing is important

- Very easy to document what happened
- View flow leading up to a complicated bug
- Reproduce bugs in tests by injecting events

If data recovery is important

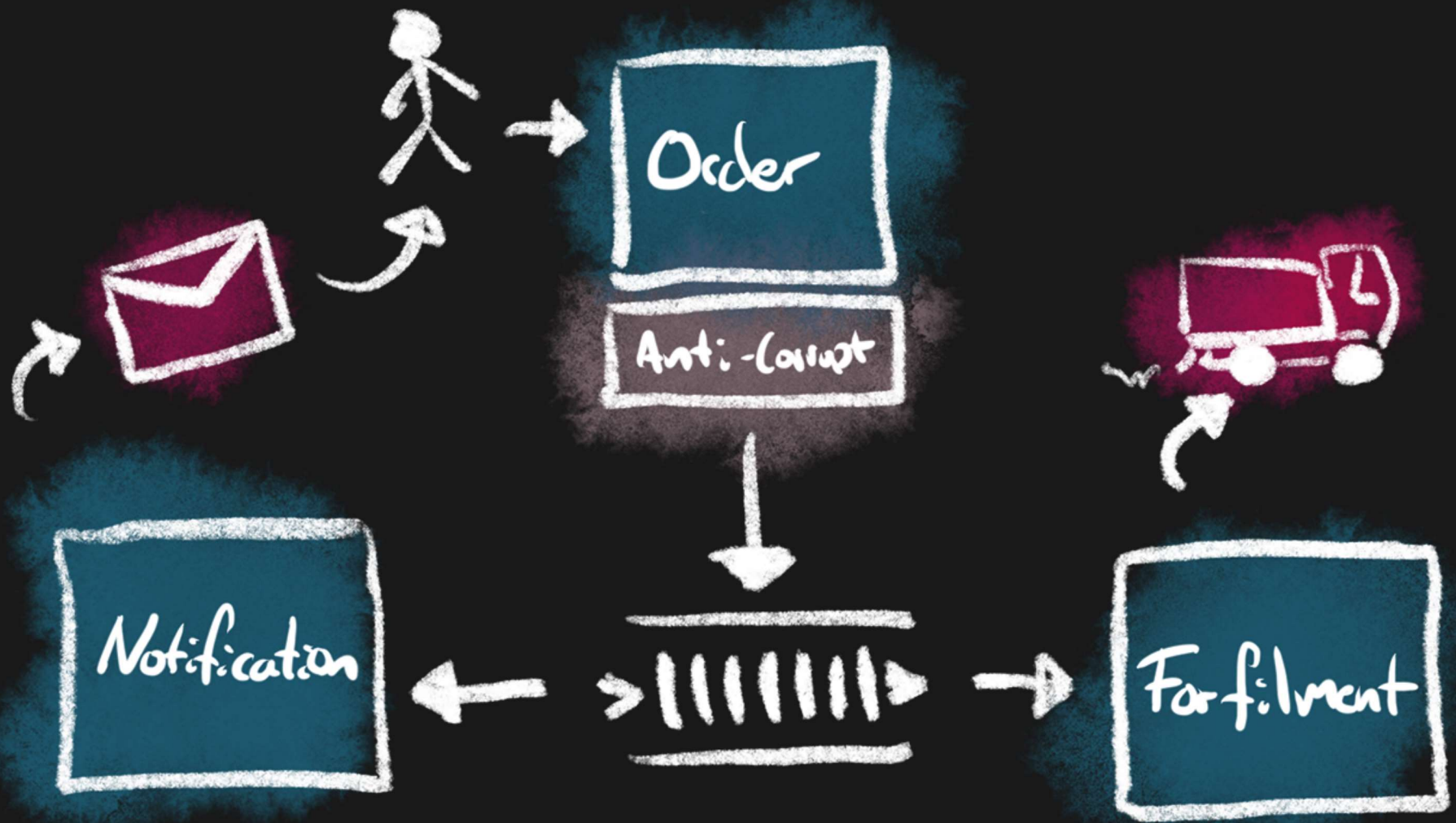
- An append only model, hard(er) to delete data
- Fix data corruption caused by bug
- Fix data corruption caused by wrongful/malicious edits
- Easy restore aggregates to a specific time
- In-place fix/skip/map of existing events

If it fits within your infrastructure

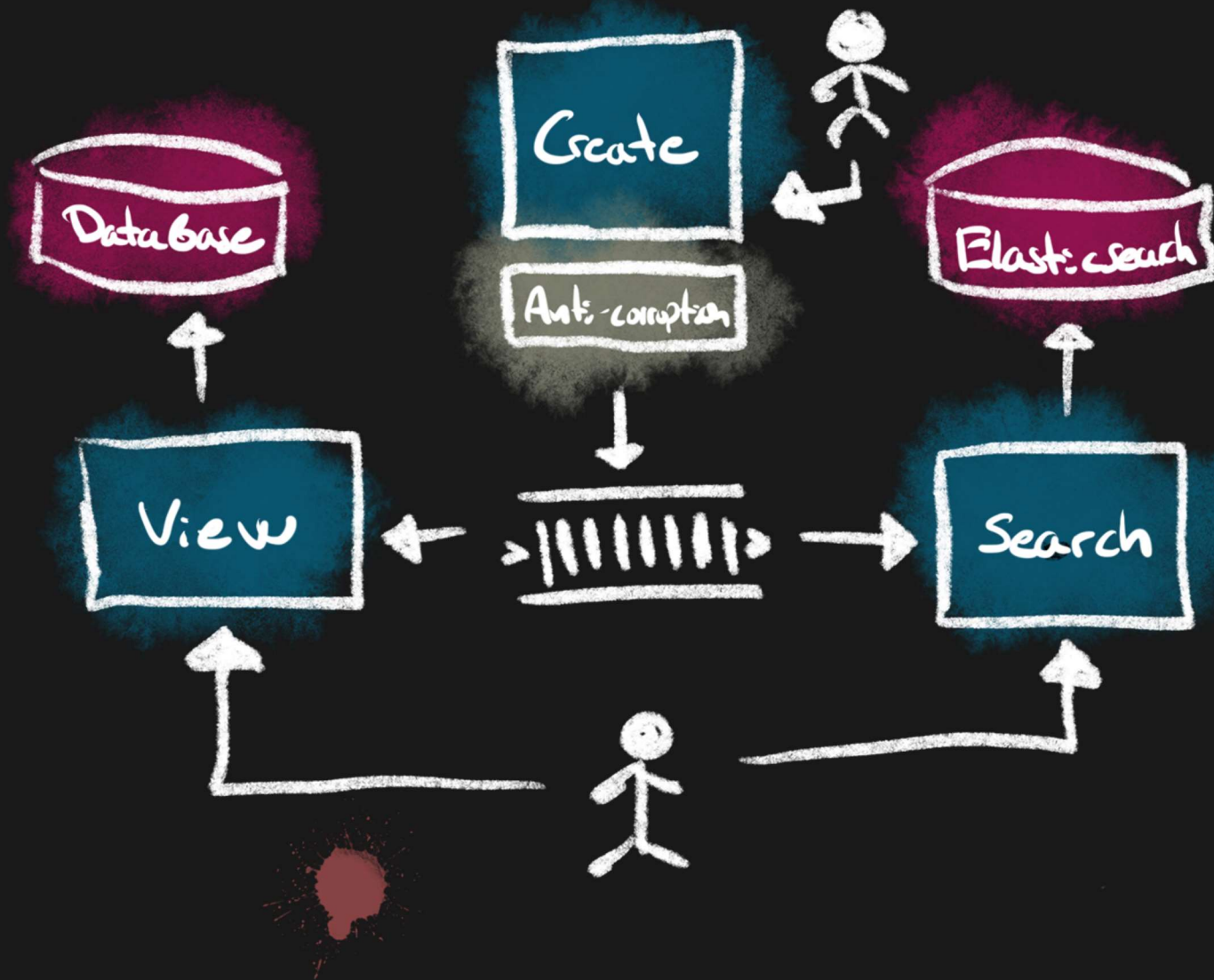
- Event driven (micro) service infrastructure
- ... remember to implement anti-corruption
- Supports an eventual consistent architecture

A few examples

Example - orders



Example - listings



Event sourcing

- Is an awesome piece of technology...
- ... but typically not the right one

Do you *really need*
event sourcing
for your next project?

Questions?

- Rasmus Mikkelsen
- <https://github.com/rasmus/>
- <https://docs.geteventflow.net/>