Actors or Not

Async Event Architectures

demonware

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Background

- 10 years in the industry
- ~1 year at Demonware/Activision, 5 years at Bench Accounting
- Mostly web, back-end, platform, infrastructure and data things
- @sap1ens / sap1ens.com
- Talk to me about data pipelines, stream processing and the Premier League ;-)

Two stories

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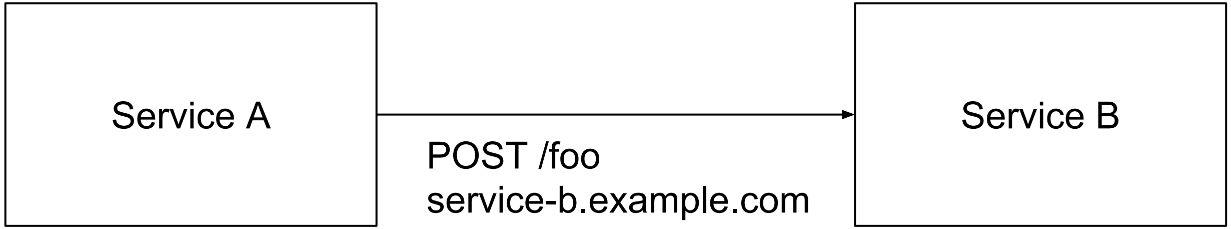
Bench

Context: sync vs async communication



“Easy” way – HTTP (RPC) API

Context: sync vs async communication

- **Destination** – where to send request?
    - Service discovery
    - Tight coupling
- **Time** – expect reply right away?
- **Failure** – always expect success?
    - Retries
    - Back-pressure
    - Circuit breakers

You cannot make synchronous requests over the network behave like local ones

Context: async communication styles

- **Point-to-Point Channel**
  - One sender
  - One receiver
- **Publish-Subscribe Channel (Broadcast)**
  - One publisher
  - <u>Multiple</u> subscribers

Context: Events vs Commands

- **Event**
    - Simply a notification that something happened in the past
- **Command**
    - Request to invoke some functionality (“RPC over messaging”)

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CALL OF DUTY
WWII

Demonware by the numbers

- 469+ million gamers
- 3.2+ million concurrent online gamers
- 100+ games
- 300,000 requests per second at peak
- Average query response time of <.02 second
- 630,000+ metrics a minute
- 132 billion+ API calls per month

Demonware Back-end Services

- Core game services including:
  - Auth
  - Matchmaking
  - Leaderboards
  - Marketplace
  - Loot & Rewards
  - Storage
  - Etc.
- **Erlang** for networking layer, **Python** for application layer
- Still have a big application monolith, but slowly migrating to independent services (**SOA**)

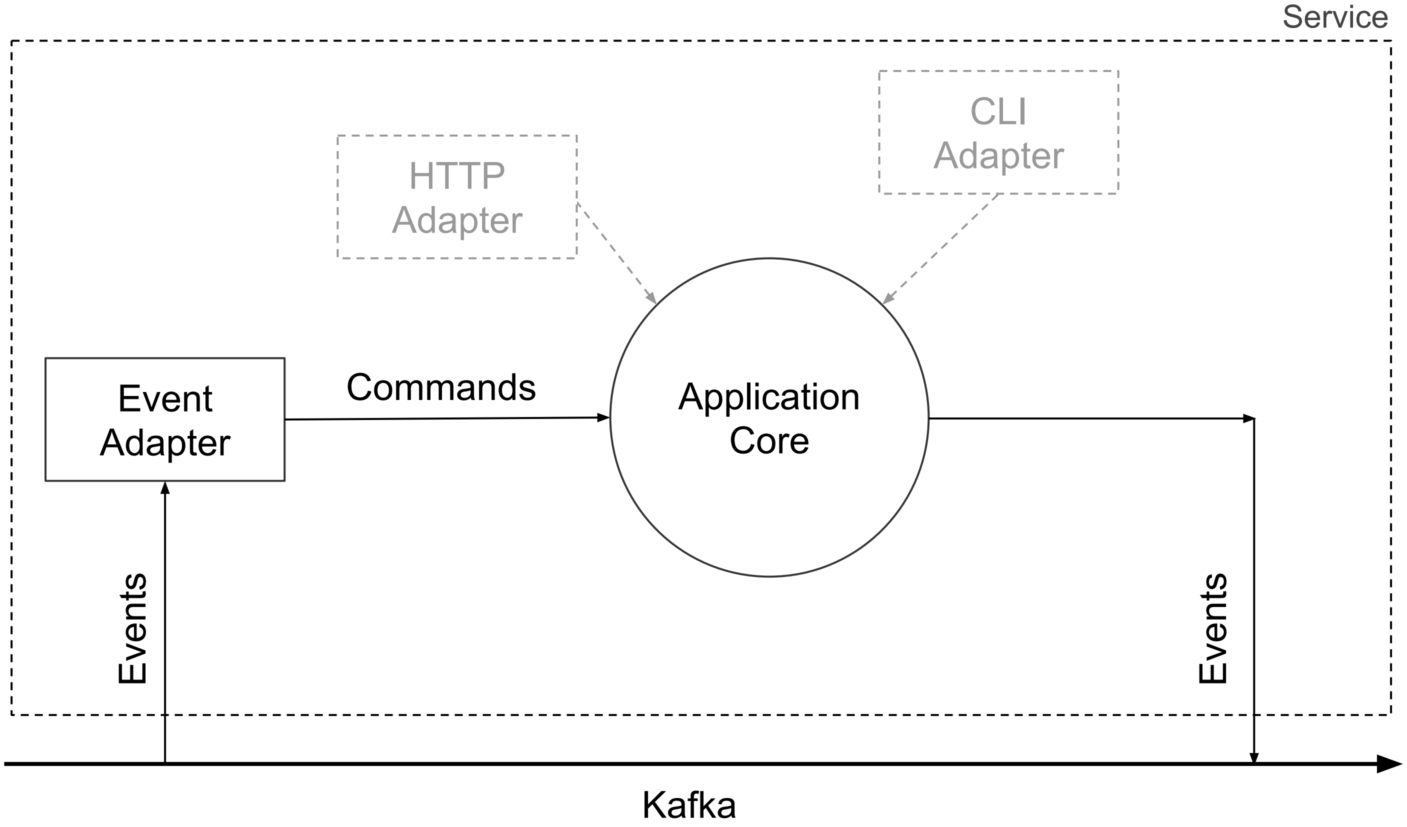
DW Services: Synchronous communication

- Lots of synchronous **request/response** communication between the monolith and the services using:
  - **HTTP**
  - **RPC**
- The requesting process:
  - conceptually **knows which service it wants to call into**
  - is **aware of the action that it is requesting**, and its effects
  - generally **needs to be notified of the request's completion** and any associated information before proceeding with its business logic

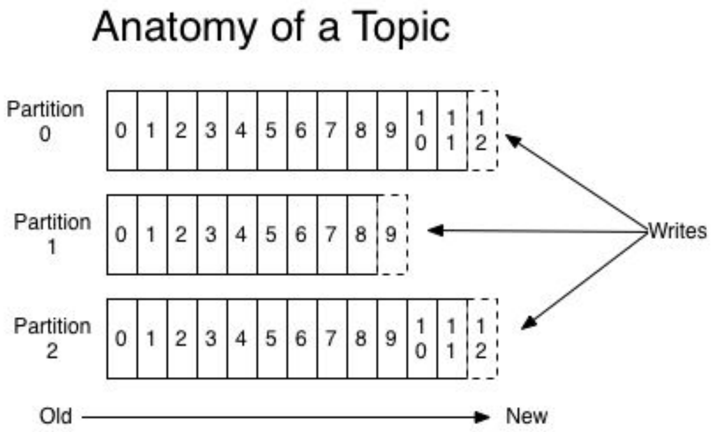
DW Services: Asynchronous communication*

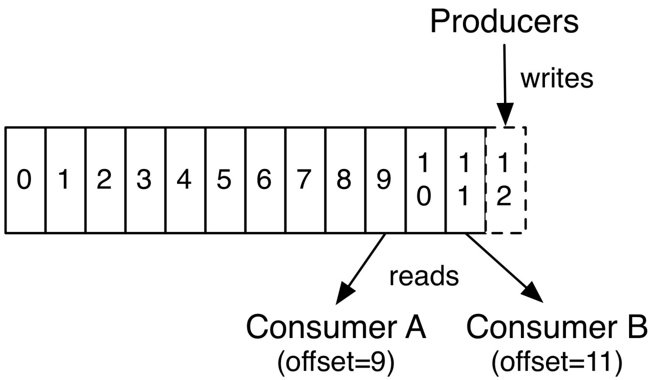
- Using **Domain Events**
- Communication model assumes the following:
  - The event may need to be handled by **zero or more service processes**, each with different use cases; the process that generates the event does not need to be aware of them
  - The process that generates the **event does not need to be aware of what actions will be triggered**, and what their effects might be
  - The process that generates the **event does not need to be notified of the handlers' completion** before proceeding with its business logic
- Seamless integration with the Data Pipeline / Warehouse

Domain Driven Design

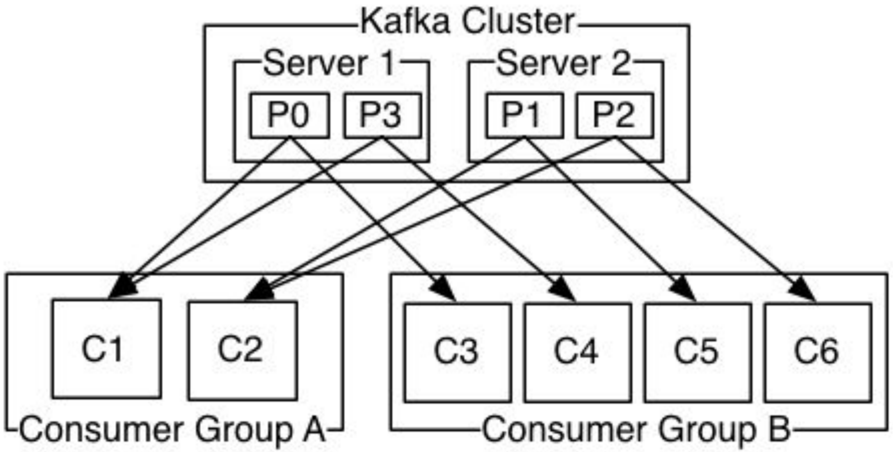


Kafka


Anatomy of a Topic
Partition 0
0 1 2 3 4 5 6 7 8 9 10 11 12
Partition 1
0 1 2 3 4 5 6 7 8 9
Partition 2
0 1 2 3 4 5 6 7 8 9 10 11 12
Writes
Old
New


Producers
writes
0 1 2 3 4 5 6 7 8 9 10 11 12
reads
Consumer A
(offset=9)
Consumer B
(offset=11)

Kafka

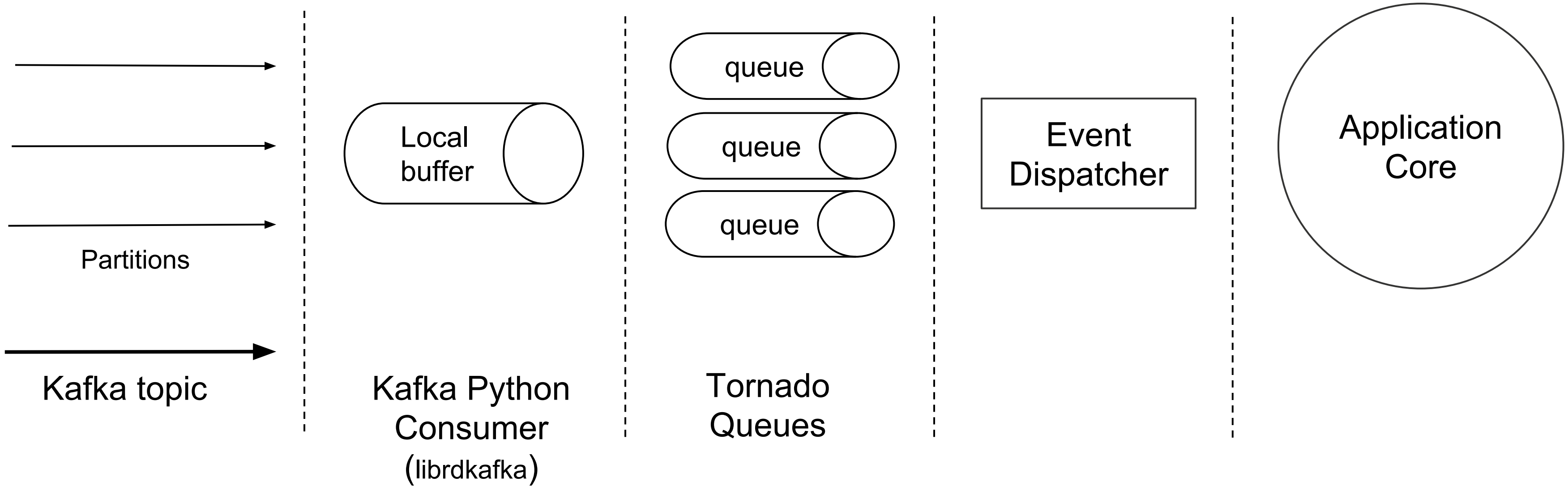


Publish-Subscribe OR **Point-to-Point** is a decision made by consumers

Kafka

- Service name is used as a topic name in Kafka
- Services have to explicitly subscribe to interested topics on startup (some extra filtering is also supported)
- All messages are typically partitioned by a user ID to preserve order

Event Dispatcher



Event Dispatcher

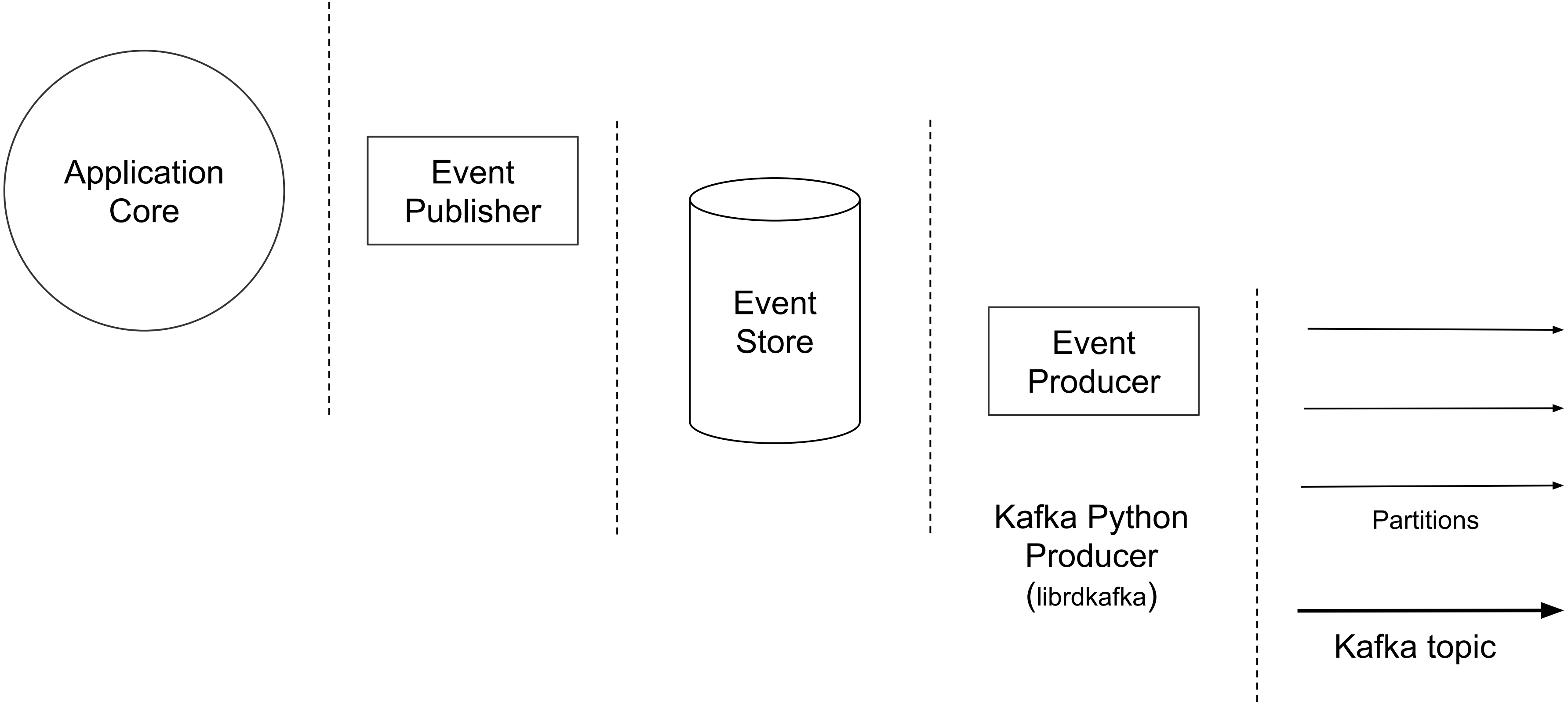
```python
@demonata.event.source(
    name='events_from_service_a'
)
class ServiceAEventsDispatcher(object):
    def __init__(self, my_app_service):
        self._app = my_app_service

    @demonata.event.schema(
        name='service.UserUpdated',
        ge_version='1.2.3',
        event_dto=UserUpdated
    )
    def on_user_updated(self, message, event):
        assert isinstance(message, DwPublishedEvent)
        # ...
```

Publishing Events

The following reliability modes are supported:

- **Fire and forget**, relying on Kafka producer (acks = 0, 1, all)
- **At least once (guaranteed)**, using remote EventStore backed by a DB
- **At least once (intermediate)**, using local EventStore

Event Publisher



Publishing Events

```python
@demonata.coroutine
def handle_event_atomically(self, event_to_process):
    entity_key = self.determine_entity_key(event_to_process)
    entity = self.db.read(entity_key)

    some_data = yield self.perform_some_async_io_read()
    new_entity, new_event = self.apply_business_logic(
        entity, event_to_process, some_data
    )

    # single-shard MySQL transaction:
    with self.db.trans(shard_key=entity_key):
        db.save(new_entity)
        self.publisher.publish(new_event)
        commit()
```

Event Framework in Demonware

- Decorator-driven consumers using callbacks
- Reliable producers
- Non-blocking IO using Tornado
- Apache Kafka as a transport

But still…

Can we do better?

Event Dispatcher

This is just a boilerplate

```
@demonata.event.source(
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class ServiceAEventsDispatcher(object):
    def __init__(self, my_app_service):
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    def on_user_updated(self, message, event):
        assert isinstance(message, DwPublishedEvent)
        # ...
```

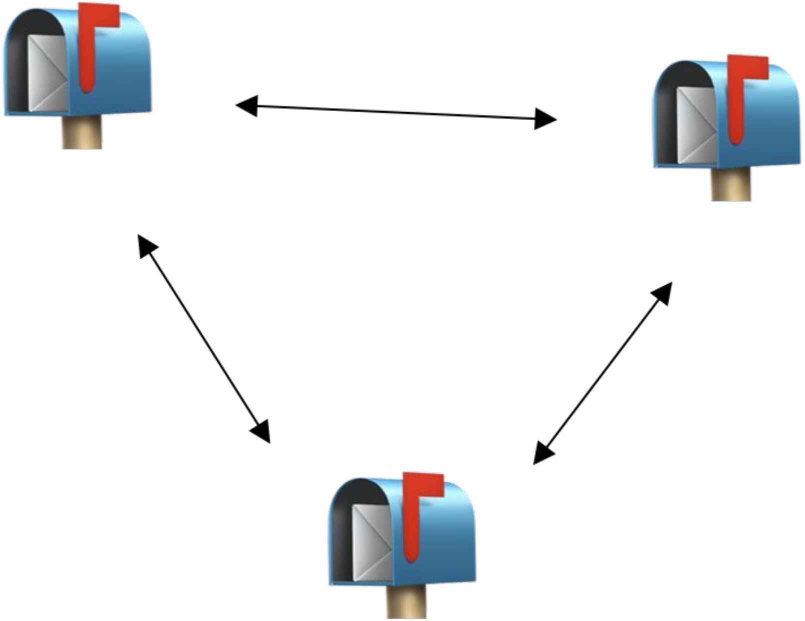
Callback that should pass an event to the actual application

Can we create producers and consumers that support message-passing natively?

Actors

- Communicate with **asynchronous messages** instead of method invocations
- Manage their **own state**
- When responding to a message, can:
  - Create other (child) actors
  - Send messages to other actors
  - Stop (child) actors or themselves

Actors



Actors: Erlang

```erlang
loop() ->
  receive
    {From, Msg} ->
      io:format("received ~p~n", [Msg]),

      From ! "got it";
  end.
```

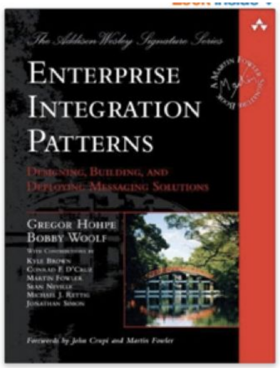
Actors: Akka

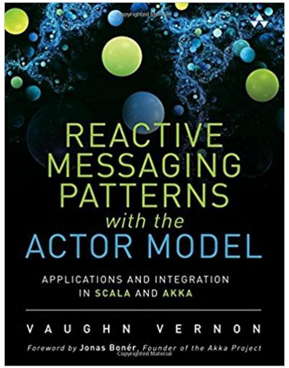
```scala
class MyActor extends Actor with ActorLogging {
  def receive = {
    case msg => {
      log.info(s"received $msg")

      sender() ! "got it"
    }
  }
}
```

Actor-to-Actor communication

- **Asynchronous** and **non-blocking message-passing**
- Doesn’t mean senders must wait indefinitely – timeouts can be used
- Location transparency
- Enterprise Integration Patterns!


The Addison-Wesley Signature Series
Enterprise Integration Patterns
Designing, Building, and Deploying Messaging Solutions
Gregor Hohpe
Bobby Woolf
Forewords by John Crupi and Martin Fowler


Reactive Messaging Patterns with the Actor Model
Applications and Integration in Scala and Akka
Vaughn Vernon
Foreword by Jonas Bonér, Founder of the Akka Project

Bench

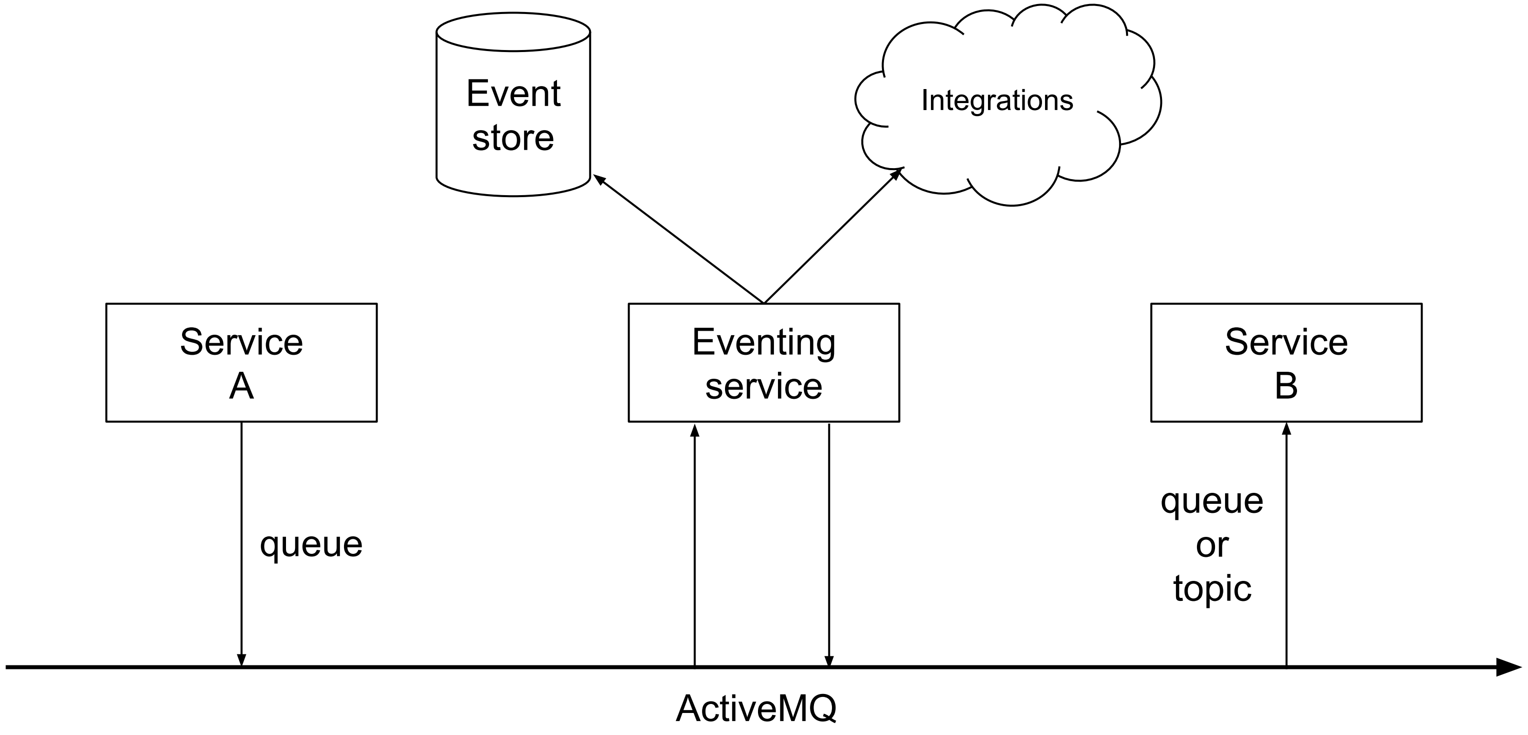
Bench Accounting Online Services

- Classic SAAS application used by the customers and internal bookkeepers:
  - Double-entry bookkeeping with sophisticated reconciliation engine and reporting [no external software]
  - Receipt collection and OCR
  - Integrations with banks, statement providers, Stripe, Shopify, etc.
- Enterprise **Java** monolith transitioning to **Scala** microservices (with **Akka**)
- Legacy event-based system built for notifications

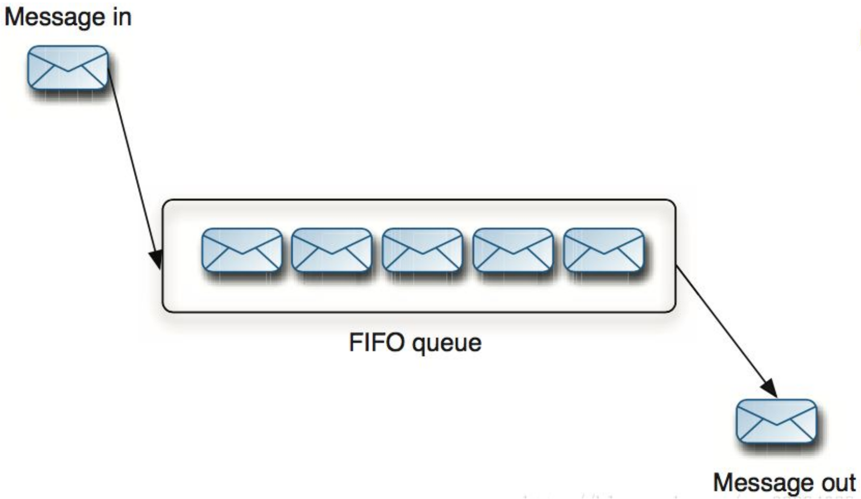
Bench Accounting Legacy Eventing

- Multiple issues:
    - Designed for a few specific use-cases, **schema is not extendable**
    - Wasn't built for **microservices**
    - Tight **coupling**
- New requirements:
    - Introduce **real-time** messaging (web & mobile)
    - Add a framework for producing and consuming **Domain Events** and **Commands** (both point-to-point and broadcasts)
    - Otherwise very similar to the Demonware's async communication model

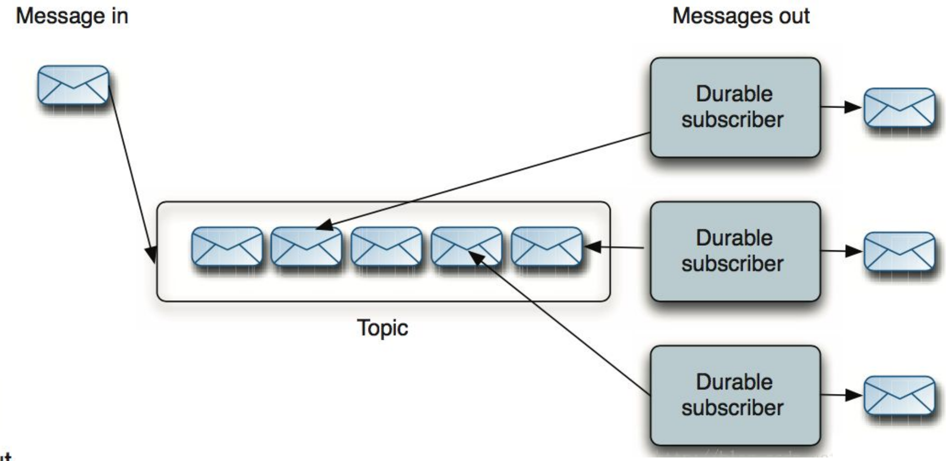
Bench Accounting Eventing System



ActiveMQ



Point-to-Point



Publish-Subscribe

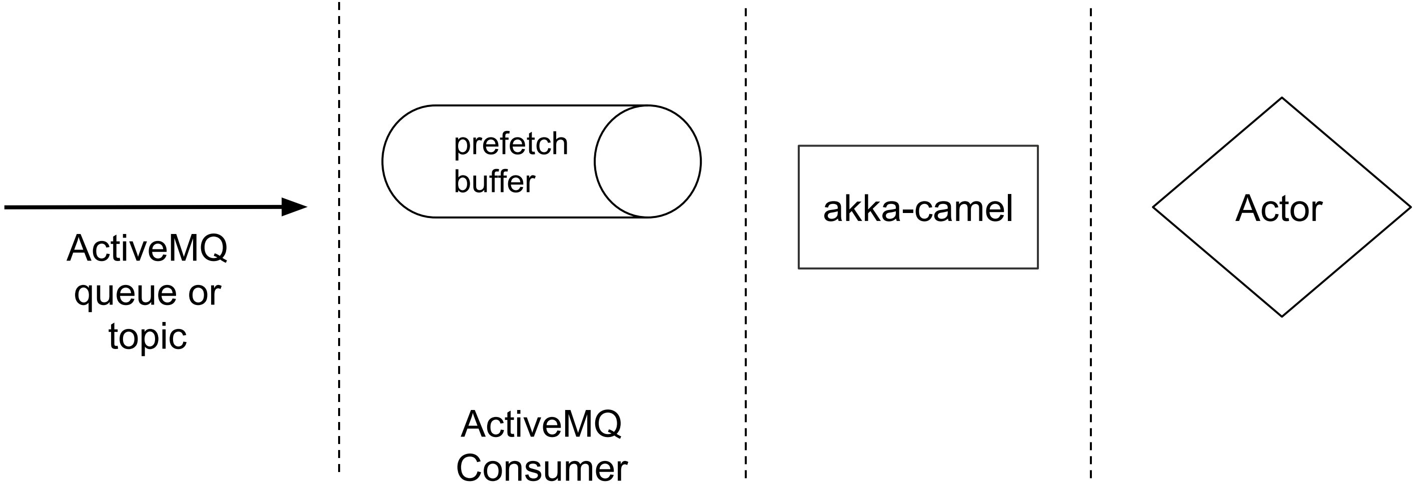
ActiveMQ

- Service name is used as a queue or topic name in ActiveMQ, but there is a also a topic for global events
- Services can subscribe to interested queues or topics any time a new actor is created
- Supports 3 modes of operations:
  - **Point-to-Point** channel using a queue (perfect for **Commands**)
  - **Publish-Subscribe** channel with guaranteed delivery using a Virtual topic
  - Global **Publish-Subscribe** channel with guaranteed delivery using a Virtual topic

Secret sauce: Apache Camel

- Integration framework that implements Enterprise Integration Patterns
- akka-camel is an official Akka library (now deprecated, Alpakka is a modern alternative)
- Can be used with any JVM language
- “The most unknown coolest library out there”: JM (c)

Event Listener



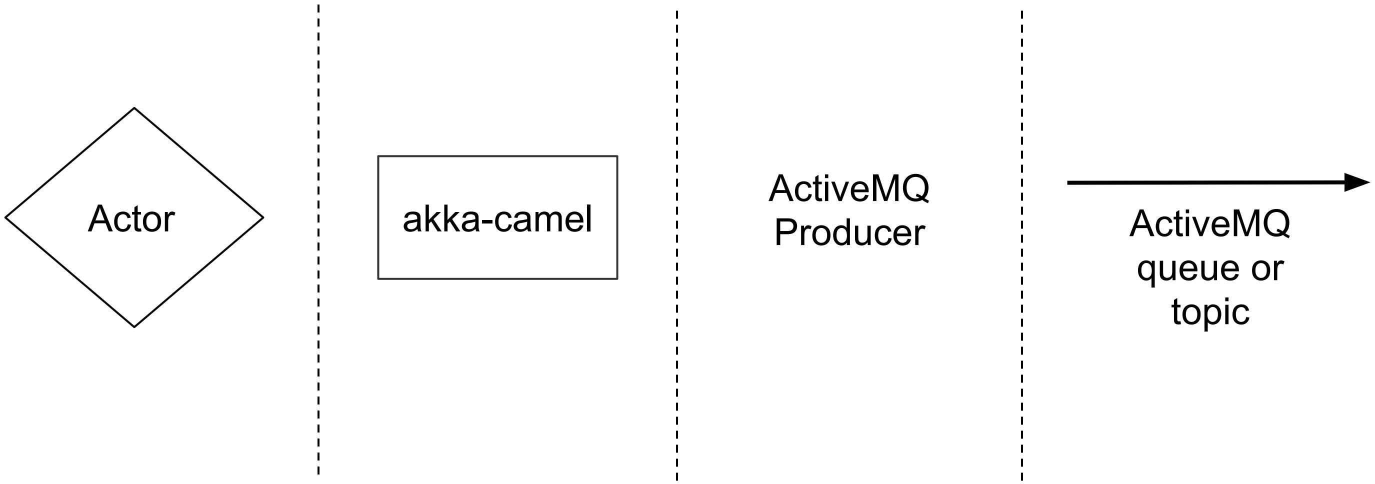
Event Listener

```
class CustomerService extends EventingConsumer {
  def endpointUri = "activemq:Consumer.CustomerService.VirtualTopic.events"

  def receive = {
    case e: CamelMessage if e.isEvent && e.name == “some.event.name” => {
      self ! DeleteAccount(e.clientId, sender())
    }

    case DeleteAccount(clientId, originalSender) => {
      // ...
    }
  }
}
```

Event Sender

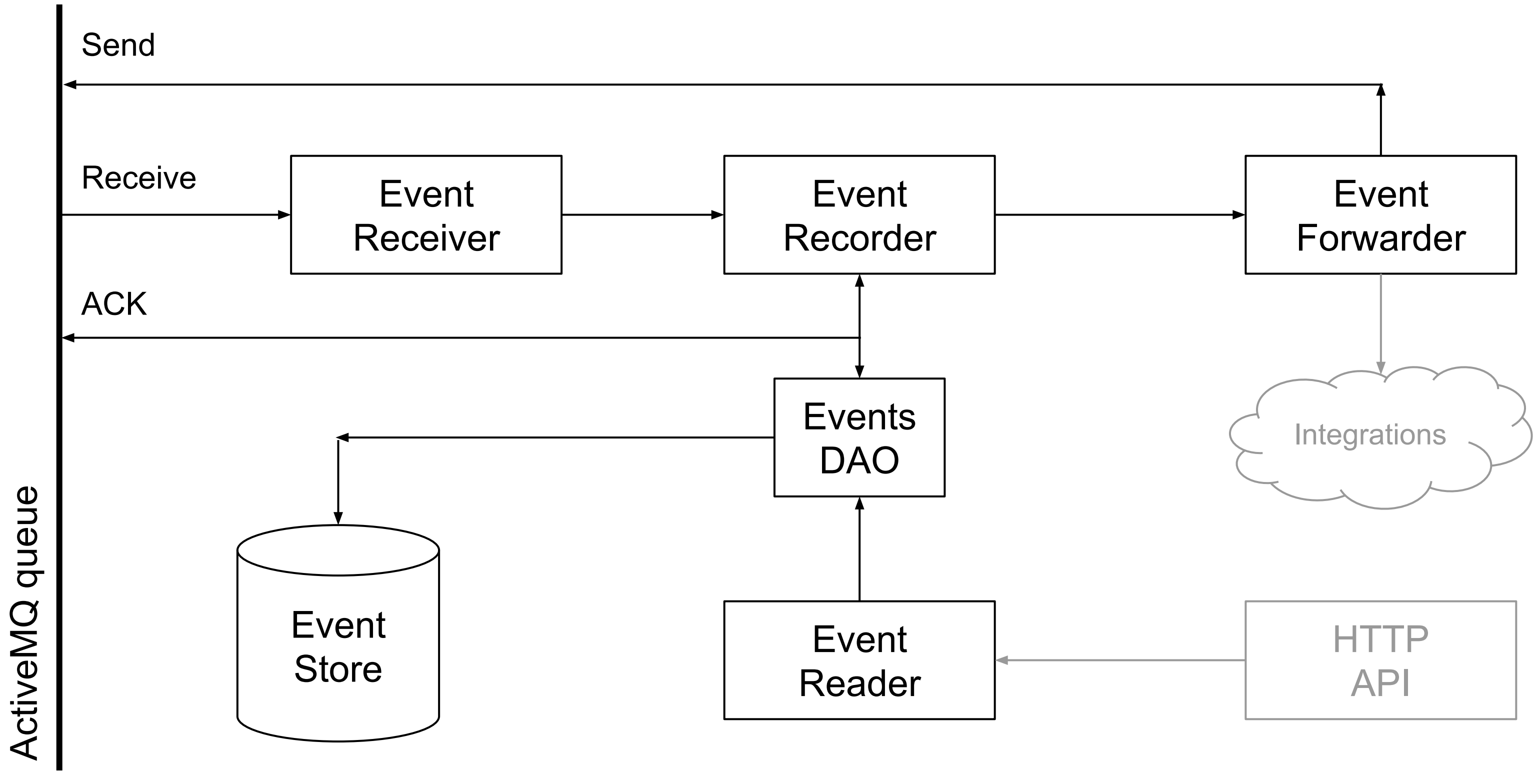


Event Sender

```
// Broadcast
EventingClient
  .buildSystemEvent (Event.BankError, userId, Component.ServiceA)
  .send(true)

// Direct
EventingClient
  .buildSystemEventWithAsset (Event.BankError, userId, Component.ServiceB)
  .buildUrlAsset("http://example.com")
  .sendDirect("reporting")
```

Eventing Service



Eventing Service

So, we do we need this “router” service?

- Routing is handled in one place
- Lightweight consumers and producers
- The same Event Store is used for all services

Event framework in Bench Accounting

- Actor-based consumers and producers using Apache Camel
- Producer with ACKs
- Non-blocking IO
- Apache ActiveMQ as a transport

Lessons learned

So, Actors

- Semantics is important! Natural message-passing in Actors is a huge advantage
- Asynchronous communication and location transparency by default makes it easy to move actors between service boundaries
- We could also talk about supervision hierarchies and “Let it crash” philosophy, excellent concurrency, networking features, etc... next time! You can start with basics

Recommendations

- Domain Driven Design and Enterprise Integration Patterns are great!
- Understand your Domain space and choose the concepts you need to support: Events, Commands, Documents or all of them
- Explicitly handle all possible failures. They will happen eventually
- Event Stores can be used for so many things! Tracing and debugging, auditing, data analytics, etc.
- Actors or not? It really depends. It’s possible to build asynchronous, non-blocking event frameworks in Java, Python, Node.js or a lot of the other languages, but actors are asynchronous and message-based by default

Recommendations

- Carefully choose the transport layer. Apache Kafka can handle an impressive scale, but many messaging features are missing / support just introduced
- Understand what you need to optimize: latency or throughput. You might need to introduce multiple channels with different characteristics
- Do you really need exactly-once semantics?
- Message formats and schemas are extremely important! Choose binary formats (Protobuf, Avro) AND/OR make sure to use a schema registry and design a schema evolution strategy
- Consider splitting your messages into an envelope (metadata) and a payload. Events and Commands could use the same envelope

Challenges

- We're too attached to the synchronous request/response paradigm. It's everywhere - in the libraries, frameworks, standards. It takes time to learn how to live in the asynchronous world
- High coupling will kill you. Routing is not a problem when you have a handful of services (producers/consumers), but things get really complicated with 10+ services. Try to avoid coupling by using Events as much as possible and stay away from Commands unless you really need them
- Managing a properly partitioned, replicated and monitored message broker cluster is still a non-trivial problem. Consider using managed services if your Ops resources are limited

Challenges

- It’s very straightforward to implement event-based communication for writes, but harder for reads. You’ll probably end up with some sort of DB denormalization, in-memory hash join tables, caching or all of the above
- When you have dozens of producers and consumer scattered across the service it becomes challenging to see the full picture. State and sequence diagrams can help with capturing business use-cases, distributed tracing becomes almost a must-have
- When things break you won’t notice them immediately without a proper monitoring and alerting. Considering covering all critical business use-cases first

That signup page...

Thanks

Davide Romani (Demonware)
Pavel Rodionov (Bench Accounting)

Questions?

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