How to build an Event-Sourcing system Ho using Akka with EKS

ScalaMatsuri 2019

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Chatwork

Who am I

- Chatwork Tech-Lead
- github/j5ik2o
  - scala-ddd-base
  - scala-ddd-base-akka-http.g8
  - reactive-redis
  - reactive-memcached
- 翻訳レビュー
  - エリックエヴァンスのドメイン駆動設計
  - Akka実践バイブル

Agenda

1. Event Sourcing with Akka
2. Deployment to EKS

- https://github.com/j5ik2o/thread-weaver

AkkaでのES実装。EMSへのデプロイなどを話します。動作するソースコードはGithubにあります

Akka with Event Sourcing

Event Sourcing

- The latest state is derived by the events
- For example, transactions such as the e-commerce are sourced on events. This is nothing special.
- An event sequence represents an immutable history.
    - The transaction makes the following unique corrections. Events are never modified or deleted.
    - The order #0001 is canceled at the #0700, and the corrected data is registered at the slip #0701.

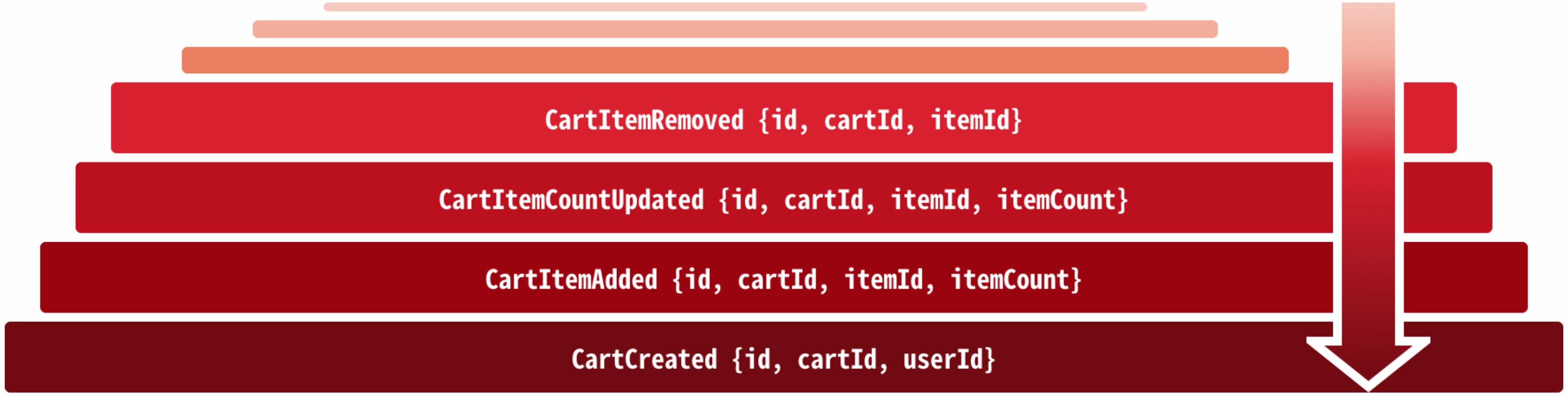
Slip Number	Product	Price	Quantity	Slip Number For Correction	Remarks
0001	A0123	5,000	10	0700	data before modification
0700	A0123	5,000	-10	0001	data for cancellation
0701	A0123	4,000	20		corrected data

状態はイベントから導出可能。取引はドメインイベントのよい例。イベントは列は不変な歴史を示す

Domain Events

- Events that occurred in the past
- Domain Events are events that domain experts is interested in
- Generally, Domain Events is expressed as a verb in past tense
  - CustomerRelocated
  - CargoShipped

- Events and commands are similar, but different languages are handled by humans
  - Command may be rejected
  - Indicates that the event has already occurred


CartItemRemoved {id, cartId, itemId}
CartItemCountUpdated {id, cartId, itemId, itemCount}
CartItemAdded {id, cartId, itemId, itemCount}
CartCreated {id, cartId, userId}

イベントをモデリングの主軸にするのがES。ドメインイベントは動詞の過去形で表現される

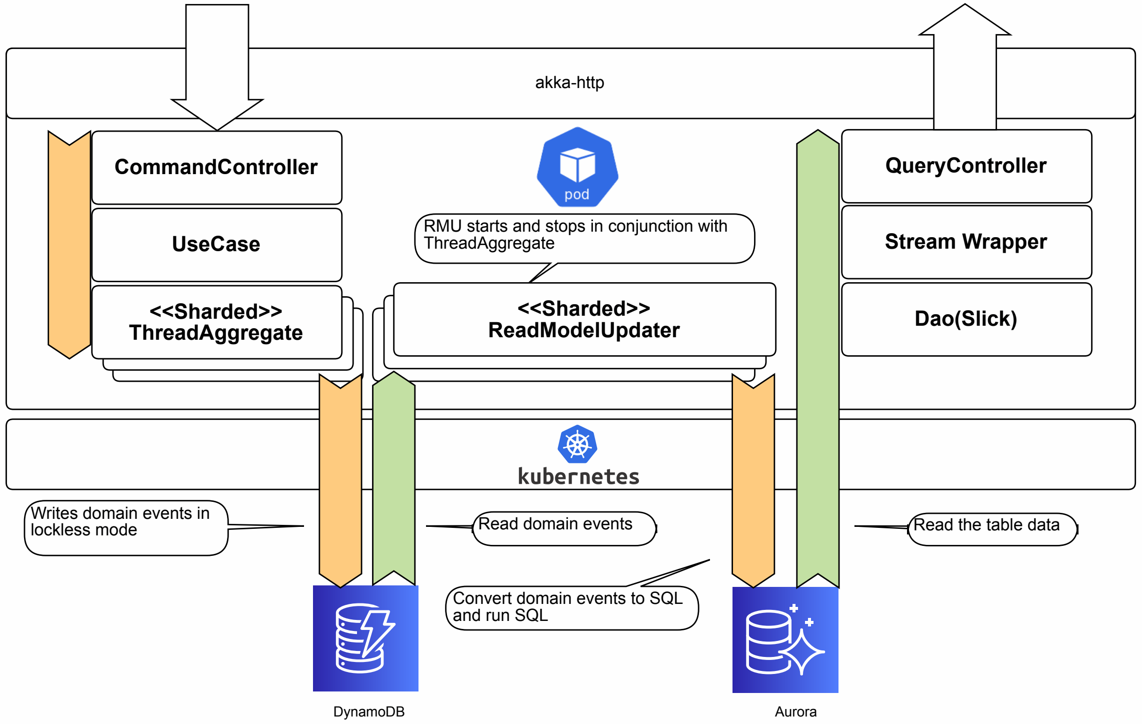
Consider thread-weaver
as an example of a simple chat application.

System requirements

- API server accepts commands and queries from API clients
- Create a thread to start the chat
- Only members can post to threads
- Only text messages posted to threads
- Omit authentication and authorization for convenience

システム要件。API鯖を作る。チャットはスレッドを生成しメンバーとして投稿することで始められる

System Configuration

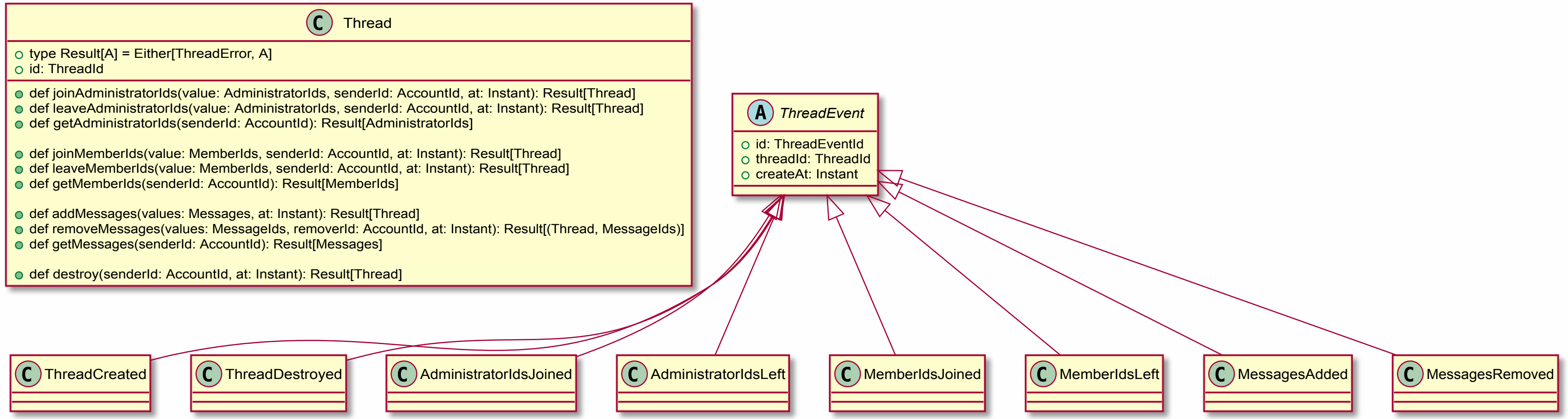

akka-http
CommandController
UseCase
<<Sharded>> ThreadAggregate
pod
RMU starts and stops in conjunction with ThreadAggregate
<<Sharded>> ReadModelUpdater
QueryController
Stream Wrapper
Dao(Slick)
kubernetes
Writes domain events in lockless mode
Read domain events
Convert domain events to SQL and run SQL
Read the table data
DynamoDB
Aurora

- Split the application into the command stack and the query stack
- The command is sent to (clustered sharding) aggregate actor
- The aggregate actor stores(appends) domain events in storage when it accepts a command
- RMU(cluster sharding) starts up in conjunction with the aggregation actor and reads the domain events for the appropriate aggregate ID immediately after startup, executes the SQL, and creates the Read-Model
- Query using DAO to load and return the lead model
- Deploy the api-server as a kubernetes pod

Command stack side

Domain Objects

- Account
  - Account information identifying the user of the system
- Thread
  - Indicates a place to exchange Messages
- Message
  - A hearsay written in some language
- Administrator
  - Administrator of the Thread
- Member
  - Users of the Thread



```
Thread
type Result[A] = Either[ThreadError, A]
id: ThreadId
def joinAdministratorIds(value: AdministratorIds, senderId: AccountId, at: Instant): Result[Thread]
def leaveAdministratorIds(value: AdministratorIds, senderId: AccountId, at: Instant): Result[Thread]
def getAdministratorIds(senderId: AccountId): Result[AdministratorIds]

def joinMemberIds(value: MemberIds, senderId: AccountId, at: Instant): Result[Thread]
def leaveMemberIds(value: MemberIds, senderId: AccountId, at: Instant): Result[Thread]
def getMemberIds(senderId: AccountId): Result[MemberIds]

def addMessages(values: Messages, at: Instant): Result[Thread]
def removeMessages(values: MessageIds, removerId: AccountId, at: Instant): Result[(Thread, MessageIds)]
def getMessages(senderId: AccountId): Result[Messages]

def destroy(senderId: AccountId, at: Instant): Result[Thread]
```

```
ThreadEvent
id: ThreadEventId
threadId: ThreadId
createAt: Instant
```

Commands/Domain Events

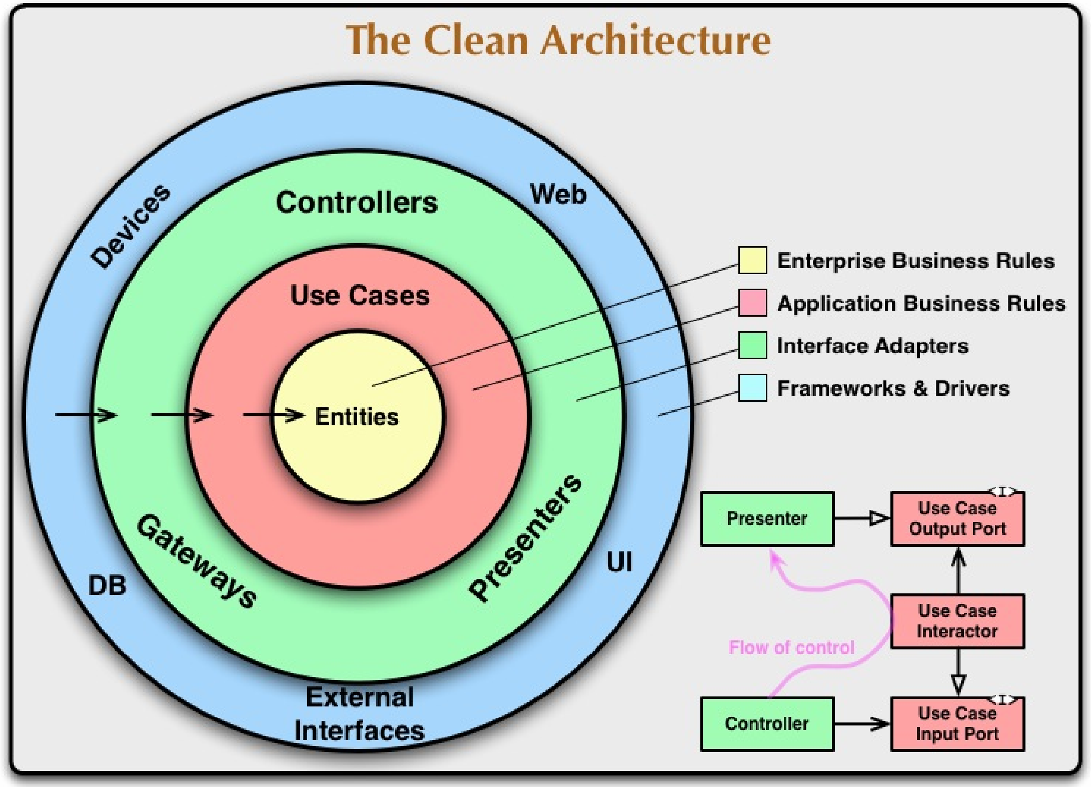
ThreadEvent sub types

- Create/Destroy Thread
    - ThreadCreated
    - ThreadDestroyed
- Join/Leave AdministratorIds
    - AdministratorIdsJoined
    - AdministratorIdsLeft
- Join/Leave MemberIds
    - MemberIdsJoined
    - MemberIdsLeft
- Add/Remove Messages
    - MessagesAdded
    - MessagesRemoved

コマンドとドメインイベント。コマンドが受理されるとドメインイベントが生成される

Layered architecture

- Clean Architecture
- Common
  - interface-adaptors
  - infrastructure
- Command side
  - use-cases
  - domain
- Query side
  - data access streams
  - data access objects



Projects structure

プロジェクト構造。レイヤー間の依存はサブプロジェクトで強制します。依存には契約と実装の二つの種類があります

Domain objects with actors

- Actors that fulfill all the functions are undesirable
- Follow object-oriented principles to build a hierarchy of actors with a single responsibility

Thread

```
trait Thread {

  def isAdministratorId(accountId: AccountId): Boolean
  def isMemberId(accountId: AccountId): Boolean

  def joinAdministratorIds(value: AdministratorIds, senderId: AccountId, at: Instant): Result[Thread]
  def leaveAdministratorIds(value: AdministratorIds, senderId: AccountId, at: Instant): Result[Thread]
  def getAdministratorIds(senderId: AccountId): Result[AdministratorIds]

  def joinMemberIds(value: MemberIds, senderId: AccountId, at: Instant): Result[Thread]
  def leaveMemberIds(value: MemberIds, senderId: AccountId, at: Instant): Result[Thread]
  def getMemberIds(senderId: AccountId): Result[MemberIds]

  def addMessages(values: Messages, at: Instant): Result[Thread]
  def removeMessages(values: MessageIds, removerId: AccountId, at: Instant): Result[(Thread, MessageIds)]
  def getMessages(senderId: AccountId): Result[Messages]

  def destroy(senderId: AccountId, at: Instant): Result[Thread]
}
```

ドメインオブジェクトのひとつであるThread。ユビキタス言語を反映したメソッドを持ちます

ThreadAggregate

```scala
class ThreadAggregate(id: ThreadId,
  subscribers: Seq[ActorRef]) extends Actor {
  // add messages handler
  private def commandAddMessages(thread: Thread): Receive = {
    case AddMessages(requestId, threadId,
      messages, createAt, reply) if threadId == id =>
      thread.addMessages(messages, createAt) match {
        case Left(exception) =>
          if (reply)
            sender() ! AddMessagesFailed(ULID(), requestId,
              threadId, exception.getMessage, createAt)
        case Right(newThread) =>
          if (reply)
            sender() ! AddMessagesSucceeded(ULID(), requestId,
              threadId, messages.toMessageIds, createAt)
          context.become(onCreated(newThread))
      }
  }

  override def receive: Receive = { /*...*/ }
}
```

- Actors that support transactional integrity
- The boundary of the data update is the same as the boundary the aggregates has.
- For example, when an actor receives the CreateThead command, a Thread state is generated internally
- Then Messages are also added to the Thread when the AddMessages command is receives
- If the other commands defined in the protocol are received by the Actor, the Actor will have corresponding side effects.

ドメインオブジェクトを集約するアクターを実装。集約は強い整合性をサポートする

ThreadAggreateSpec

```
val threadId        = ThreadId()
val threadRef       = newThreadRef(threadId)
val now             = Instant.now
val administratorId = AccountId()
val title           = ThreadTitle("test")

threadRef ! CreateThread(ULID(), threadId, administratorId,
  None, title, None, AdministratorIds(administratorId),
  MemberIds.empty, now, reply = false)

val messages = Messages(TextMessage(MessageId(), None,
  ToAccountIds.empty, Text("ABC"), memberId, now, now))
threadRef ! AddMessages(ULID(), threadId, messages,
  now, reply = true)

expectMsgType[AddMessagesResponse] match {
 case f: AddMessagesFailed =>
   fail(f.message)
 case s: AddMessagesSucceeded =>
   s.threadId shouldBe threadId
   s.createAt shouldBe now
}
```

- Verify that add messages and create a thread by using Test Kit

PersistentThreadAggregate(1/2)

```
object PersistentThreadAggregate {
  def props(id: ThreadId, subscribers: Seq[ActorRef]): Props =
      ...
}

class PersistentThreadAggregate(id: ThreadId,
  subscribers: Seq[ActorRef],
  propsF: (ThreadId, Seq[ActorRef]) => Props)
    extends PersistentActor with ActorLogging {

  override def supervisorStrategy: SupervisorStrategy =
    OneForOneStrategy() { case _: Throwable => Stop }

  private val childRef =
    context.actorOf(propsF(id, subscribers),
      name = ThreadAggregate.name(id))
  context.watch(childRef)

  // persistenceIdえ is the partition keでもスレッドIDに対応するf persi

  override def receiveRecover: Receive = {
    case e: ThreadCommonProtocol.Event with ToCommandRequest =>
      childRef ! e.toCommandRequest
    case RecoveryCompleted =>
      log.debug("recovery completed")
  }
```

- Actors that add the persistence function to ThreadAggregate
- Domain behavior is provided by child actors
- The recover process sends commands generated from events to child actors.

メッセージパッシングを使ってテストを実装します

PersistentThreadAggregate(2/2)

```
  override def receiveCommand: Receive = {
    case Terminated(c) if c == childRef =>
      context.stop(self)
    case m: CommandRequest with ToEvent =>
      childRef ! m
      context.become(sending(sender(), m.toEvent))
    case m =>
      childRef forward m
  }

  private def sending(replyTo: ActorRef,
    event: ThreadCommonProtocol.Event): Receive = {
    case s: CommandSuccessResponse => persist(event) { _ =>
        replyTo ! s
        unstashAll()
        context.unbecome()
      }
    case f: CommandFailureResponse =>
      replyTo ! f
      unstashAll()
      context.unbecome()
    case _ =>
      stash()
  }
}
```

- Delegate to child actors when receiving commands. Persists only on success
- message processing is suspended until a command response is returned

PersitentThreadAggregateSpec

```scala
// Create id = 1 of Thread actor
threadRef1 ! CreateThread(ULID(), threadId, administratorId, None, title, None,
  AdministratorIds(administratorId), MemberIds.empty, now, reply = false)
val messages = Messages(TextMessage(MessageId(), None,
  ToAccountIds.empty, Text("ABC"), memberId, now, now))
threadRef1 ! AddMessages(ULID(), threadId, messages, now, reply = false)

//Stop id = 1 of Thread actor
killActors(threadRef)

// Recover id = 1 of Thread actor
val threadRef2 = system.actorOf(PersistentThreadAggregate.props(threadId, Seq.empty))

// Check if it is in the previous state
threadRef2 ! GetMessages(ULID(), threadId, memberId, now)
expectMsgType[GetMessagesResponse] match {
  case f: GetMessagesFailed =>
    fail(f.message)
  case s: GetMessagesSucceeded =>
    s.threadId shouldBe threadId
    s.createAt shouldBe now
    s.messages shouldBe messages
}
```

- a test that intentionally stops and restarts the persistence actor
- Replayed state after reboot

FYI: akka-persistence plugin

- Different plugins for different databases
  - Akka Persistence journal and snapshot plugins
- Default corresponds to LevelDB
- recommended on AWS is DynamoDB. There are the following plugins, but I recommend my plugin:P
  - https://github.com/j5ik2o/akka-persistence-dynamodb
  - https://github.com/akka/akka-persistence-dynamodb

FYI: akka-persistence plugin

- akka plugin
  - is complex schema
  - doesn't support the query function.
  - doesn't support non-blocking I/O (by aws-sdk v2)

akka/akka-persistence-dynamodb

```
# PersistentRepr
PKey: par = <journalName>-P-<persistenceId>-<sequenceNr / 100>
SKey: num = <sequenceNr % 100>
pay = <payload>
idx = <atomic write batch index>
cnt = <atomic write batch max index>
# 高いシーケンス番号
PKey: par = <journalName>-SH-<persistenceId>-<(sequenceNr / 100)
   % sequenceShards>
SKey: num = 0
seq = <sequenceNr rounded down to nearest multiple of 100>
# 低シーケンス番号
PKey: par = <journalName>-SL-<persistenceId>-<(sequenceNr / 100)
   % sequenceShards>
SKey: num = 0
seq = <sequenceNr, not rounded>
```

j5ik2o/akka-persistence-dynamodb

```
# PrimaryIndex(for Writing)
PKey: pkey = ${PersistenceId}-${SequenceNumber % ShardCount}
SKey: sequence-nr = ${SequenceNumber}
# GSI:GetJournalRows(for Reading)
persistence-id = ${PersistenceId}
sequence-nr = ${SequenceNumber}
# GSI:TagsIndex(for Reading)
tags = ...
```

FYI: akka-persistence plugin

```
// build.sbt
libraryDependencies ++= Seq(
  // ...
  "com.typesafe.akka" %% "akka-persistence" % akkaVersion,
  "org.fusesource.leveldbjni" % "leveldbjni-all" % "1.8" % Test,
  "org.iq80.leveldb" % "leveldb" % "0.9" % Test,
  "com.github.j5ik2o" %% "akka-persistence-dynamodb" % "1.0.2",
  // ...
)
```

```
// application.conf
akka {
  persistence {
    journal {
      plugin = dynamo-db-journal
    }
    snapshot-store {
      plugin = dynamo-db-snapshot
    }
  }
}
```

akka-persistence pluginには様々なプラグインがある。AWSでのお勧めは私が作ったDynamoDBプラグイン

ThreadAggregates(Message Broker)

```
class ThreadAggregates(subscribers: Seq[ActorRef],
    propsF: (ThreadId, Seq[ActorRef]) => Props)
    extends Actor
    with ActorLogging
    with ChildActorLookup {
  override type ID             = ThreadId
  override type CommandRequest = ThreadProtocol.CommandMessage

  override def receive: Receive = forwardToActor

  override protected def childName(childId: ThreadId): String =
    childId.value.asString
  override protected def childProps(childId: ThreadId): Props =
    propsF(childId, subscribers)
  override protected def toChildId(commandRequest: CommandMessage): ThreadId =
    commandRequest.threadId
}
```

- The message broker that bundles multiple ThreadAggregates as child actors
- Most of the logic is in ChildActorLookup
- Resolve the actor name from ThreadId in the command message, and transfer the message to the corresponding child actor. If there is no child actor, generate an actor and then forward the message to the actor

ChildActorLookup

```scala
trait ChildActorLookup extends ActorLogging { this: Actor =>
  implicit def context: ActorContext
  type ID
  type CommandRequest

  protected def childName(childId: ID): String
  protected def childProps(childId: ID): Props
  protected def toChildId(commandRequest: CommandRequest): ID

  protected def forwardToActor: Actor.Receive = {
    case _cmd =>
      val cmd = _cmd.asInstanceOf[CommandRequest]
      context
        .child(childName(toChildId(cmd)))
        .fold(createAndForward(cmd, toChildId(cmd)))(forwardCommand(cmd))
  }

  protected def forwardCommand(cmd: CommandRequest)(childRef: ActorRef): Unit =
    childRef forward cmd

  protected def createAndForward(cmd: CommandRequest, childId: ID): Unit =
    createActor(childId) forward cmd

  protected def createActor(childId: ID): ActorRef =
    context.actorOf(childProps(childId), childName(childId))
}
```

- Create a child actor if none exists and forward the message
- forward the message to its child actors, if any

ShardedThreadAggregates (1/2)

```scala
object ShardedThreadAggregates {

  def props(subscribers: Seq[ActorRef],
    propsF: (ThreadId, Seq[ActorRef]) => Props): Props =
    Props(new ShardedThreadAggregates(subscribers, propsF))

  def name(id: ThreadId): String = id.value.asString

  val shardName = "threads"

  case object StopThread

 // function to extract an entity id
  val extractEntityId: ShardRegion.ExtractEntityId = {
    case cmd: CommandRequest => (cmd.threadId.value.asString, cmd)
  }

  // function to extract a shard id
  val extractShardId: ShardRegion.ExtractShardId = {
    case cmd: CommandRequest =>
      val mostSignificantBits  = cmd.threadId
        .value.mostSignificantBits  % 12
      val leastSignificantBits = cmd.threadId
        .value.leastSignificantBits % 12
      s"$mostSignificantBits:$leastSignificantBits"
  }

}
```

- Allow ThreadAggregates to be distributed across a cluster
- extractEntityId is the function to extract an entity id
- extractShardId is the function to extract a shard id

ShardedThreadAggregates (2/2)

```
class ShardedThreadAggregates(subscribers: Seq[ActorRef],
  propsF: (ThreadId, Seq[ActorRef]) => Props)
    extends ThreadAggregates(subscribers, propsF) {
  context.setReceiveTimeout(
    Settings(context.system).passivateTimeout)

  override def unhandled(message: Any): Unit = message match {
    case ReceiveTimeout =>
      log.debug("ReceiveTimeout")
      context.parent ! Passivate(stopMessage = StopThread)
    case StopThread =>
      log.debug("StopWallet")
      context.stop(self)
  }
}
```

- Inherit ThreadAggregates
- Then add an implementation to passivate ShardedThreadAggregates when occurred ReceiveTimeout

ShardedThreadAggregatesはThreadAggregatesを継承。一定時間を過ぎたらランタイムから退避させる設定を追加する

ShardedThreadAggregatesRegion

```scala
object ShardedThreadAggregatesRegion {

  def startClusterSharding(subscribers: Seq[ActorRef])
    (implicit system: ActorSystem): ActorRef =
    ClusterSharding(system).start(
      ShardedThreadAggregates.shardName,
      ShardedThreadAggregates.props(subscribers,
        PersistentThreadAggregate.props),
      ClusterShardingSettings(system),
      ShardedThreadAggregates.extractEntityId,
      ShardedThreadAggregates.extractShardId
    )

  def shardRegion(implicit system: ActorSystem): ActorRef =
    ClusterSharding(system)
      .shardRegion(ShardedThreadAggregates.shardName)
}
```

- The startClusterSharing method will start ClusterSharing with the specified settings
- The shardRegion method gets the ActorRef to the started ShardRegion.

MultiJVM Testing(by using sbt-multi-jvm)

```
"setup shared journal" in {
  Persistence(system)
  runOn(controller) { system.actorOf(Props[SharedLeveldbStore], "store") }
  enterBarrier("persistence-started")
  runOn(node1, node2) {
    system.actorSelection(node(controller) / "user" / "store") ! Identify(None)
    val sharedStore = expectMsgType[ActorIdentity].ref.get
    SharedLeveldbJournal.setStore(sharedStore, system)
  }
  enterBarrier("setup shared journal")
}
"join cluster" in within(15 seconds) {
  join(node1, node1) { ShardedThreadAggregatesRegion.startClusterSharding(Seq.empty) }
  join(node2, node1) { ShardedThreadAggregatesRegion.startClusterSharding(Seq.empty) }
  enterBarrier("join cluster")
}
"createThread" in { runOn(node1) {
    val accountId = AccountId(); val threadId  = ThreadId(); val title = ThreadTitle("test")
    val threadRef = ShardedThreadAggregatesRegion.shardRegion
    threadRef ! CreateThread(ULID(), threadId, accountId, None, title, None, AdministratorIds(accountId),
      MemberIds.empty, Instant.now, reply = true)
    expectMsgType[CreateThreadSucceeded](file:///Users/j5ik2o/Sources/thread-weaver/slide/10 seconds).threadId shouldBe threadId
  }
  enterBarrier("create thread")
}
```

cluster-sharding with persistence

- Actors with state in on-memory are distributed across the cluster
- Domain events that occur are saved in partitioned storage by aggregate ID

CreateThreadUseCaseUntypeImpl

```scala
class CreateThreadUseCaseUntypeImpl(
    threadAggregates: ThreadActorRefOfCommandUntypeRef, parallelism: Int = 1, timeout: Timeout = 3 seconds
)(implicit system: ActorSystem) extends CreateThreadUseCase {
  override def execute: Flow[UCreateThread, UCreateThreadResponse, NotUsed] =
    Flow[UCreateThread].mapAsync(parallelism) { request =>
      implicit val to: Timeout                      = timeout
      implicit val scheduler: Scheduler             = system.scheduler
      implicit val ec: ExecutionContextExecutor = system.dispatcher
      (threadAggregates ? CreateThread(
        ULID(), request.threadId, request.creatorId, None, request.title, request.remarks,
        request.administratorIds, request.memberIds, request.createAt, reply = true
      )).mapTo[CreateThreadResponse].map {
        case s: CreateThreadSucceeded =>
          UCreateThreadSucceeded(s.id, s.requestId, s.threadId, s.createAt)
        case f: CreateThreadFailed =>
          UCreateThreadFailed(f.id, f.requestId, f.threadId, f.message, f.createAt)
      }
    }
}
```

ユースケースクラスの実装例。アクターをラップしストリームに結合できるように

ThreadCommandControllerImpl

```
trait ThreadCommandControllerImpl
  extends ThreadCommandController
  with ThreadValidateDirectives {
  private val createThreadUseCase = bind[CreateThreadUseCase]
  private val createThreadPresenter = bind[CreateThreadPresenter]

  override private[controller] def createThread: Route =
    path("threads" / "create") {
      post {
        extractMaterializer { implicit mat =>
          entity(as[CreateThreadRequestJson]) { json =>
            validateJsonRequest(json).apply { commandRequest =>
              val responseFuture = Source.single(commandRequest)
                .via(createThreadUseCase.execute)
                .via(createThreadPresenter.response)
                .runWith(Sink.head)
              onSuccess(responseFuture) { response =>
                complete(response)
              }
            }
          }
        }
      }
    }
```

- Command side controller
- The thread creation root composes several directives and calls a use case
- The request JSON returns a command if validation passes. Pass the command to the use-case and execute it
- The presenter will convert the use-case result to Response JSON

コマンド側のコントローラ。バリデーションとユースケースの実行とプレゼンターの実行を行う

Read Model Updater side

FYI: akka-typed

- The message type received by the message handler was Any, but akka-typed allows the Message type to be specified
- There is basically no compatibility, so there are many things to remember. Let's get used to it now

```scala
object PingPong extends App {

  trait Message
  case class Ping(reply: ActorRef[Message]) extends Message
  case object Pong                          extends Message

  def receiver: Behavior[Message] =
    Behaviors.setup[Message] { ctx =>
      Behaviors.receiveMessagePartial[Message] {
        case Ping(replyTo) =>
          ctx.log.info("ping")
          replyTo ! Pong
          Behaviors.same
      }
    }

  def main: Behavior[Message] = Behaviors.setup { ctx =>
    val receiverRef = ctx.spawn(receiver, name = "receiver")
    receiverRef ! Ping(ctx.self)
    Behaviors.receiveMessagePartial[Message] {
      case Pong =>
        ctx.log.info("pong")
        receiverRef ! Ping(ctx.self)
        Behaviors.same
    }
  }

  ActorSystem(main, "ping-pong")

}
```

受け取るメッセージ型を指定できるようになった。APIには互換性がない

Read Model Updater(1/3)

- Starts the Read Model Updater (RMU) for each aggregation ID
- Sharding to allow multiple RMUs to boot on a single node
- Starting and stopping the RMU is triggered by events on the aggregate actor. It actually does message translation with AggregateToRMU.

Read Model Updater(2/3)

```scala
private def projectionSource(sqlBatchSize: Long, threadId: ThreadId)
  (implicit ec: ExecutionContext): Source[Vector[Unit], NotUsed] = {
  Source
    .fromFuture(
      db.run(getSequenceNrAction(threadId)).map(_.getOrElse(0L))
    ).log("lastSequenceNr").flatMapConcat { lastSequenceNr =>
      readJournal
        .eventsByPersistenceId(threadId.value.asString,
          lastSequenceNr + 1, Long.MaxValue)
    }.log("ee").via(sqlActionFlow(threadId))
    .batch(sqlBatchSize, ArrayBuffer(_))(_ :+ _).mapAsync(1) { sqlActions =>
      db.run(DBIO.sequence(sqlActions.result.toVector))
    }.withAttributes(logLevels)
}
```

- RMU does not end stream processing - persistenceId also gets the latest sequence number corresponding to the thread ID
- read events from readJournal since thread ID and last sequence number
- sqlActionFlow converts events to SQL
- Finally, run the SQL in batches (Read model not denormalized to be flexible to query patterns)

Read Model Updater(2/2)

```scala
class ThreadReadModelUpdater(
    val readJournal: ReadJournalType,
    val profile: JdbcProfile, val db: JdbcProfile#Backend#Database
) extends ThreadComponent with ThreadMessageComponent ... {
  import profile.api._

  def behavior(sqlBatchSize: Long = 10,
    backoffSettings: Option[BackoffSettings] = None): Behavior[CommandRequest] =
    Behaviors.setup[CommandRequest] { ctx =>
      Behaviors.receiveMessagePartial[CommandRequest] {
        case s: Start =>
          ctx.child(s.threadId.value.asString) match {
            case None =>
              ctx.spawn(
                projectionBehavior(sqlBatchSize, backoffSettings, s.threadId),
                name = s"RMU-${s.threadId.value.asString}"
              ) ! s
            case _ =>
              ctx.log.warning(
                "RMU already has started: threadId = {}", s.threadId.value.asString)
          }
          Behaviors.same
      }
    }
    // ...
}
```

- RMU starts stream processing when it receives a Start message.
- Stream processing is performed as a task on a child actor

ShardedThreadReadModelUpdater(1/3)

```scala
class ShardedThreadReadModelUpdater(
    val readJournal: ReadJournalType,
    val profile: JdbcProfile,
    val db: JdbcProfile#Backend#Database
) {
  val TypeKey: EntityTypeKey[CommandRequest] = EntityTypeKey[CommandRequest](file:///Users/j5ik2o/Sources/thread-weaver/slide/"threads

  def initEntityActor(
      clusterSharding: ClusterSharding,
      receiveTimeout: FiniteDuration
  ): ActorRef[ShardingEnvelope[CommandRequest]] =
    clusterSharding.init(
      Entity(typeKey = TypeKey, createBehavior = behavior(receiveTimeout)).withStopMessage(Stop)
    )
// ...
```

ShardedThreadReadModelUpdater(2/3)

```
// ...
  private def behavior(
      receiveTimeout: FiniteDuration, sqlBatchSize: Long = 10, backoffSettings: Option[BackoffSettings] = None
  ): EntityContext => Behavior[CommandRequest] = { entityContext =>
    Behaviors.setup[CommandRequest] { ctx =>
      // setting receive timeout
      ctx.setReceiveTimeout(receiveTimeout, Idle)
      val childRef = ctx.spawn(new ThreadReadModelUpdater(readJournal, profile, db).behavior(sqlBatchSize, backoffSettings),
        name = "threads-rmu")
      Behaviors.receiveMessagePartial {
        case Idle => entityContext.shard ! ClusterSharding.Passivate(ctx.self); Behaviors.same
        case Stop => Behaviors.stopped
        case msg => childRef ! msg; Behaviors.same
      }
    }
  }
// ...
```

ShardedThreadReadModelUpdater(3/3)

- MUST send the ShardingEnvelope to the ShardRegion. ShadedThreadReadModelUpdaterProxy converts CommandRequest into ShardingEnvelope and forwards it

```
class ShardedThreadReadModelUpdaterProxy(
    val readJournal: ReadJournalType, val profile: JdbcProfile, val db: JdbcProfile#Backend#Database
) {
  def behavior(clusterSharding: ClusterSharding, receiveTimeout: FiniteDuration): Behavior[CommandRequest] =
    Behaviors.setup[CommandRequest] { _ =>
      val actorRef =
        new ShardedThreadReadModelUpdater(readJournal, profile, db).initEntityActor(clusterSharding, receiveTimeout)
      Behaviors.receiveMessagePartial[CommandRequest] {
        case msg =>
          actorRef ! typed.ShardingEnvelope(msg.threadId.value.asString, msg)
          Behaviors.same
      }
    }
}
```

Interlocking of Aggreagte and RMU

```scala
object AggregateToRMU {

  def behavior(
      rmuRef: ActorRef[ThreadReadModelUpdaterProtocol.CommandRequest]
  ): Behavior[ThreadCommonProtocol.Message] =
    Behaviors.setup[ThreadCommonProtocol.Message] { ctx =>
      Behaviors.receiveMessagePartial[ThreadCommonProtocol.Message] {
        case s: Started =>
          ctx.log.debug(s"RMU ! $s")
          rmuRef ! ThreadReadModelUpdaterProtocol.Start(
            ULID(), s.threadId, Instant.now)
          Behaviors.same
        case s: Stopped =>
          ctx.log.debug(s"RMU ! $s")
          rmuRef ! ThreadReadModelUpdaterProtocol.Stop(
            ULID(), s.threadId, Instant.now)
          Behaviors.same
      }

    }

}
```

- These two actors are separated because they have different responsibilities, but start and stop work together
- Actually there is a problem with this method. If only the RMU stops due to a node failure, the RMU cannot recover until it receives the Start message again. The downside is that ThreadAggregate must periodically send heartbeat beads.

Improvement for RMU

- Another implementation pattern is to make the RMU a child actor of PersistentThreadAggregate.
- This method allows you to watch the RMU as a child actor so that it can be restarted if the RMU should stop.
- However, PersistentThreadAggregate is responsible for RMU responsibilities. Duplicate Responsibilities?

改善の余地がある。どちらのヒエラルキーがよいかは試してみてください

Query stack side

ThreadQueryControllerImpl

```
trait ThreadQueryControllerImpl
  extends ThreadQueryController
  with ThreadValidateDirectives {
  private val threadDas: ThreadDas = bind[ThreadDas]
  // ...
  override private[controller] def getThread: Route =
    path("threads" / Segment) { threadIdString => get {
      // ...
      parameter('account_id) { accountValue =>
        validateAccountId(accountValue) { accountId =>
          onSuccess(threadDas.getThreadByIdSource(accountId, threadId)
            .via(threadPresenter.response)
            .runWith(Sink.headOption[ThreadJson]).map(identity)) {
              case None =>
                reject(NotFoundRejection("thread is not found", None))
              case Some(response) =>
                complete(GetThreadResponseJson(response))
          }
        }
      }
    // ...
    }
  // ...
}
```

- The query side uses a stream wrapped Dao object instead of a use case.
- Same as command side except for this.

クエリサイドではユースケースではなくDaoをストリームでラップしたオブジェクトを利用

ThreadControllerSpec

```scala
val administratorId = ULID().asString
val entity = CreateThreadRequestJson(
    administratorId, None, "test",
    None, Seq(administratorId), Seq.empty,
    Instant.now.toEpochMilli
  ).toHttpEntity

Post(RouteNames.CreateThread, entity) ~>
  commandController.createThread ~> check {
  response.status shouldEqual StatusCodes.OK
  val responseJson = responseAs[CreateThreadResponseJson]
  responseJson.isSuccessful shouldBe true
  val threadId = responseJson.threadId.get

  eventually { // repeat util read
    Get(RouteNames.GetThread(threadId, administratorId)) ~>
      queryController.getThread ~> check {
      response.status shouldEqual StatusCodes.OK
      val responseJson = responseAs[GetThreadResponseJson]
      responseJson.isSuccessful shouldBe true
    }
  }
}
```

- a test where two controllers are connected.
- Verify threads are readable after they are created
- Works fine

二つのコントローラをつなげたテスト。スレッドを作成後にスレッドが読めるようになるかを検証

Bootstrap

- Start AkkaManagement and ClusterBootstrap, then start akka-http server

```scala
object Main extends App {
  // ...

  implicit val system: ActorSystem                           = ActorSystem("thread-weaver-api-server", config)
  implicit val materializer: ActorMaterializer               = ActorMaterializer()
  implicit val executionContext: ExecutionContextExecutor = system.dispatcher
  implicit val cluster                                       = Cluster(system)

  AkkaManagement(system).start()
  ClusterBootstrap(system).start()

  // ...

  val routes = session
      .build[Routes].root ~ /* ... */

  val bindingFuture = Http().bindAndHandle(routes, host, port).map { serverBinding =>
    system.log.info(s"Server online at ${serverBinding.localAddress}")
    serverBinding
  }

  // ...

}
```

FYI: Akka Cluster

- Cluster Specification
- Node
    - A logical member of a cluster. There could be multiple nodes on a physical machine. Defined by a hostname:port:uid tuple.
- Cluster
    - A set of nodes joined together through the membership service.
- leader
    - A single node in the cluster that acts as the leader. Managing cluster convergence and membership state transitions.
- Seed Nodes
    - The seed nodes are configured contact points for new nodes joining the cluster. When a new node is started it sends a message to all seed nodes and then sends a join command to the seed node that answers first.

Akka-Clusterの概念理解は公式ドキュメントを参照してください

FYI: Akka Management

- Akka Management is a suite of tools for operating Akka Clusters.
- modules
  - akka-management: HTTP management endpoints and health checks
  - akka-managment-cluster-http: Provides HTTP endpoints for cluster monitoring and management
  - akka-managment-cluster-bootstrap: Supports cluster bootstrapping by using akka-discovery
  - akka-discovery-kubernetes-api: Module for managing k8s pod as a cluster member

Akka-Clusterの運用をサポートするツール群がAkka Management

Example for akka.conf(1/2)

- Example configuration for Production

```
akka {
  cluster {
    seed-nodes = [] # seed-nodes are empty because managed by akka-management
    auto-down-unreachable-after = off
  }

  remote {
    log-remote-lifecycle-events = on
    netty.tcp {
      hostname = "127.0.0.1"
      hostname = ${?HOSTNAME}
      port = 2551
      port = ${?THREAD_WEAVER_REMOTE_PORT}
      bind-hostname = "0.0.0.0"
    }
  }
```

Example for akka.conf(2/2)

- Example configuration for akka-management and akka-discovery
- Configuration to find nodes from k8s pod information

```
discovery {
  method = kubernetes-api
  method = ${?THREAD_WEAVER_DISCOVERY_METHOD}
  kubernetes-api {
    pod-namespace = "thread-weaver"
    pod-namespace = ${?THREAD_WEAVER_K8S_NAMESPACE}
    pod-label-selector = "app=thread-weaver-api-server"
    pod-label-selector = ${?THREAD_WEAVER_K8S_SELECTOR}
    pod-port-name = "management"
    pod-port-name = ${?THREAD_WEAVER_K8S_MANAGEMENT_PORT}
  }
}
```

```
  management {
    http {
      hostname = "127.0.0.1"
      hostname = ${?HOSTNAME}
      port = 8558
      port = ${?THREAD_WEAVER_MANAGEMENT_PORT}
      bind-hostname = 0.0.0.0
      bind-port = 8558
    }
    cluster.bootstrap {
      contact-point-discovery {
        discovery-method = kubernetes-api
      }
    }
    contract-point {
      fallback-port = 8558
    }
  }
}
```

Deployment to EKS

FYI: Learn Kubernetes/EKS

- Kubernetes Documentation
- Amazon EKS
- Amazon EKS Workshop

build.sbt for deployment

project/plugins.sbt

```
addSbtPlugin("com.typesafe.sbt" % "sbt-native-packager" % "1.3.10")

addSbtPlugin("com.mintbeans" % "sbt-ecr" % "0.14.1")
```

build.sbt

- Configuration for Docker

```
lazy val dockerCommonSettings = Seq(
  dockerBaseImage := "adoptopenjdk/openjdk8:x86_64-alpine-jdk8u191-b12",
  maintainer in Docker := "Junichi Kato <j5ik2o@gmail.com>",
  dockerUpdateLatest := true,
  bashScriptExtraDefines ++= Seq(
    "addJava -Xms${JVM_HEAP_MIN:-1024m}",
    "addJava -Xmx${JVM_HEAP_MAX:-1024m}",
    "addJava -XX:MaxMetaspaceSize=${JVM_META_MAX:-512M}",
    "addJava ${JVM_GC_OPTIONS:--XX:+UseG1GC}",
    "addJava -Dconfig.resource=${CONFIG_RESOURCE:-application.conf}",
    "addJava -Dakka.remote.startup-timeout=60s"
  )
)
```

build.sbt

- Configuration for ECR

```
val ecrSettings = Seq(
  region in Ecr := Region.getRegion(Regions.AP_NORTHEAST_1),
  repositoryName in Ecr := "j5ik2o/thread-weaver-api-server",
  repositoryTags in Ecr ++= Seq(version.value),
  localDockerImage in Ecr := "j5ik2o/" + (packageName in Docker).value + ":" + (version in Docker).value,
  push in Ecr := ((push in Ecr) dependsOn (publishLocal in Docker, login in Ecr)).value
)
```

build.sbt

```
val `api-server` = (project in file("api-server"))
  .enablePlugins(AshScriptPlugin, JavaAgent, EcrPlugin)
  .settings(baseSettings)
  .settings(dockerCommonSettings)
  .settings(ecrSettings)
  .settings(
    name := "thread-weaver-api-server",
    dockerEntrypoint := Seq("/opt/docker/bin/thread-weaver-api-server"),
    dockerUsername := Some("j5ik2o"),
  // ...
    libraryDependencies ++= Seq(
      "com.github.scopt" %% "scopt" % "4.0.0-RC2",
      "net.logstash.logback" % "logstash-logback-encoder" % "4.11" excludeAll (/**/),
      "com.lightbend.akka.management" %% "akka-management" % akkaManagementVersion,
      "com.lightbend.akka.management" %% "akka-management-cluster-http" % akkaManagementVersion,
      "com.lightbend.akka.management" %% "akka-management-cluster-bootstrap" % akkaManagementVersion,
      "com.lightbend.akka.discovery" %% "akka-discovery-kubernetes-api" % akkaManagementVersion,
      "com.github.TanUkkii007" %% "akka-cluster-custom-downing" % "0.0.12",
      "com.github.everpeace" %% "healthchecks-core" % "0.4.0",
      "com.github.everpeace" %% "healthchecks-k8s-probes" % "0.4.0",
      "org.slf4j" % "jul-to-slf4j" % "1.7.26",
      "ch.qos.logback" % "logback-classic" % "1.2.3",
      "org.codehaus.janino" % "janino" % "3.0.6"
    )
```

Deployment to Local Cluster(minikube)

Deployment to Local Cluster(minikube)

- start minikube
- Helm Implementation
- Create namespaces and service accounts
- Deploy DB
- Create Schema
- Building an image for your application
- Deploy the image for the application

```
$ minikube start --vmdriver virtualbox \
  --kubernetes-version v1.12.8 --cpus 6 --memory 5000 --disk-size 30g
$ helm init
$ kubectl create namespace thread-weaver
$ kubectl create serviceaccount thread-weaver
$ helm install ./mysql --namespace thread-weaver \
    -f ./mysql/environments/${ENV_NAME}-values.yaml
$ helm install ./dynamodb --namespace thread-weaver \
    -f ./dynamodb/environments/${ENV_NAME}-values.yaml
$ sbt -Dmysql.host="$(minikube ip)" -Dmysql.port=30306 \
  'migrate-mysql/run'
$ DYNAMODB_HOST="$(minikube ip)" DYNAMODB_PORT=32000 \
  sbt 'migrate-dynamodb/run'
$ eval $(minikube docker-env)
$ sbt api-server/docker:publishLocal
$ helm install ./thread-weaver-api-server \
  --namespace thread-weaver \
  -f ./thread-weaver-api-server/environments/${ENV_NAME}-values.yaml
```

Helm charts

FYI: Helm

- Helm
  - Helm is 'The package manager for Kubernetes'
- Charts
  - Helm uses a packaging format called charts
- CLI
  - `helm init`
    - initialize Helm on both client and server(tiller)
  - `helm package`
    - package a chart directory into a chart archive
  - `helm install`
    - install a chart archive
  - `helm upgrade`
    - upgrade a release
  - `helm rollback`
    - roll back a release to a previous revision

HelmはKubernetesのためのパッケージマネージャ。パッケージ定義はChartと呼ぶ

deployment.yaml(1/2)

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: {{ template "name" . }}
spec:
  replicas: {{ .Values.replicaCount }}
  selector:
    matchLabels:
      app: {{ template "name" . }}
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 1
      maxUnavailable: 0
  template:
    metadata:
      labels:
        app: {{ template "name" . }}
    spec:
      containers:
      - image: "{{ .Values.image.repository }}:{{ .Values.image.tag }}"
        imagePullPolicy: {{.Values.image.pullPolicy}}
        name: {{ template "name" . }}
```

```yaml
env:
  - name: AWS_REGION
    value: "ap-northeast-1"
  - name: HOSTNAME
    valueFrom:
      fieldRef:
        apiVersion: v1
        fieldPath: status.podIP
  - name: ENV_NAME
    value: {{.Values.envName | quote}}
  - name: CONFIG_RESOURCE
    value: {{.Values.configResource | quote}}
  - name: JVM_HEAP_MIN
    value: {{.Values.jvmHeapMin | quote}}
  - name: JVM_HEAP_MAX
    value: {{.Values.jvmHeapMax | quote}}
  - name: JVM_META_MAX
    value: {{.Values.jvmMetaMax | quote}}
```

chartにはテンプレート化されたマニフェストファイルを使うことができる

deployment.yaml(2/2)

```
        - name: THREAD_WEAVER_SLICK_URL
          value: {{.Values.db.url | quote}}
        - name: THREAD_WEAVER_SLICK_USER
          value: {{.Values.db.user | quote}}
        - name: THREAD_WEAVER_SLICK_PASSWORD
          valueFrom:
            secretKeyRef:
              name: thread-weaver-app-secrets
              key: mysql.password
        - name: THREAD_WEAVER_SLICK_MAX_POOL_SIZE
          value: {{.Values.db.maxPoolSize | quote}}
        - name: THREAD_WEAVER_SLICK_MIN_IDLE_SIZE
          value: {{.Values.db.minIdleSize | quote}}
      ports:
      - name: remoting
        containerPort: 2551
      - name: {{ .Values.service.name }}
        containerPort: {{ .Values.service.internalPort }}
      - name: management
        containerPort: 8558
```

```
      readinessProbe:
        tcpSocket:
          port: 18080
          initialDelaySeconds: 60
          periodSeconds: 30
      livenessProbe:
        tcpSocket:
          port: 18080
          initialDelaySeconds: 60
          periodSeconds: 30
```

- Describes the settings for starting the container, such as image name, tags, environment variables, and ports

イメージの名前やタグ、環境変数、ポートなどコンテナが起動するための設定を記述する

service.yaml

```yaml
apiVersion: v1
kind: Service
metadata:
  name: {{ template "name" . }}
  labels:
    app: {{ template "name" . }}
    chart: {{ .Chart.Name }}-{{ .Chart.Version | replace "+" "_" }}
    release: {{ .Release.Name }}
    heritage: {{ .Release.Service }}
spec:
  selector:
    app: {{ template "name" . }}
  type: {{ .Values.service.type }}
  ports:
    - protocol: TCP
      name: api
      port: 8080
      targetPort: api
    - protocol: TCP
      name: management
      port: 8558
      targetPort: management
```

- Build a Service of type LoadBalancer to make it externally accessible

外部からアクセス可能にするためにLoadBalancerタイプのServiceを構築しま

rbac.yaml

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: thread-weaver-api-server
rules:
- apiGroups: [""]
  resources: ["pods"]
  verbs: ["get", "watch", "list"]
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: thread-weaver-api-server
subjects:
  - kind: User
    name: system:serviceaccount:thread-weaver:default
roleRef:
  kind: Role
  name: thread-weaver-api-server
  apiGroup: rbac.authorization.k8s.io
```

Configure RBAC so that akka-discovery can find the nodes

akka-discoveryがノードを見つけられるようにRBACを設定します

Verification for Local Cluster

```
API_HOST=$(minikube ip)
API_PORT=$(kubectl get svc thread-weaver-api-server -n thread-weaver -ojsonpath="{.spec.ports[?(@.name==\"api\")].port}")

ACCOUNT_ID=01DB5QXD4NP0XQTV92K42B3XBF
ADMINISTRATOR_ID=01DB5QXD4NP0XQTV92K42B3XBF

THREAD_ID=$(curl -v -X POST "http://$API_HOST:$API_PORT/v1/threads/create" -H "accept: application/json" -H "Content-Type: applicatio
    -d "{\"accountId\":\"${ACCOUNT_ID}\",\"title\":\"string\",\"remarks\":\"string\",\"administratorIds\":[\"${ADMINISTRATOR_ID}\"],\"
echo "THREAD_ID=$THREAD_ID"
sleep 3
curl -v -X GET "http://$API_HOST:$API_PORT/v1/threads/${THREAD_ID}?account_id=${ACCOUNT_ID}" -H "accept: application/json"
```

Deployment to Production Cluster(EKS)

Build Kubernetes Cluster(EKS)

- Build the required components for the EKS cluster in advance
  - subnet
  - security group
  - ineternet-gw
  - eip
  - nat-gw
  - route table
  - ecr
- Build the database required by the application
  - rds(aurora)
  - dynamodb(with shema)

```
$ terraform plan
$ terraform apply
```

Build Kubernetes Cluster(EKS)

- Build an EKS cluster
  - eksctl

```
$ eksctl create cluster \
    --name ${CLUSTER_NAME} \
    --region ${AWS_REGION} \
      --nodes ${NODES} \
      --nodes-min ${NODES_MIN} \
      --nodes-max ${NODES_MAX} \
      --node-type ${INSTANCE_TYPE} \
      --full-ecr-access \
    --node-ami ${NODE_AMI} \
    --version ${K8S_VERSION} \
    --nodegroup-name ${NODE_GROUP_NAME} \
      --vpc-private-subnets=${SUBNET_PRIVATE1},${SUBNET_PRIVATE2},${SUBNET_PRIVATE3} \
      --vpc-public-subnets=${SUBNET_PUBLIC1},${SUBNET_PUBLIC2},${SUBNET_PUBLIC3}
```

- Initial Setup (RBAC settings, etc.)

```
tools/eks/helm $ kubectl apply -f ./rbac-config.yaml
$ helm init
$ kubectl create namespace thread-weaver
$ kubectl create serviceaccount thread-weaver
tools/deploy/eks $ kubectl apply -f secret.yaml
```

eksctlを使えば構築は簡単。ネームスペースなどの初期設定を行う

Deploy to Kubernetes Cluster(EKS)

- docker build & push to ecr

```
$ AWS_DEFUALT_PROFILE=xxxxx sbt api-server/ecr:push
```

- flyway migrate(should be implemented as k8s job)

```
$ docker run --rm -v $(pwd)/tools/flyway/src/test/resources/db-migration:/flyway/sql -v $(pwd):/flyway/conf boxfuse/flyway migrate
```

- deploy

```
$ helm install ./thread-weaver-api-server \
  --namespace thread-weaver \
  -f ./thread-weaver-api-server/environments/${ENV_NAME}-values.yaml
```

Verification for Kubernetes Cluster(EKS)

```
API_HOST=$(kubectl get svc thread-weaver-api-server -n thread-weaver -ojsonpath="{.status.loadBalancer.ingress[0].hostname}")
API_PORT=$(kubectl get svc thread-weaver-api-server -n thread-weaver -ojsonpath="{.spec.ports[?(@.name==\"api\")].port}")

ACCOUNT_ID=01DB5QXD4NP0XQTV92K42B3XBF
ADMINISTRATOR_ID=01DB5QXD4NP0XQTV92K42B3XBF

THREAD_ID=$(curl -v -X POST "http://$API_HOST:$API_PORT/v1/threads/create"
-H "accept: application/json" -H "Content-Type: application/json" \
-d "{\"accountId\":\"${ACCOUNT_ID}\", ... "memberIds\":[\"${ACCOUNT_ID}\"],\"createAt\":10000}" | jq -r .threadId)
echo "THREAD_ID=$THREAD_ID"
sleep 3
curl -v -X GET "http://$API_HOST:$API_PORT/v1/threads/${THREAD_ID}?account_id=${ACCOUNT_ID}" -H "accept: application/json"
```

Perspective to be considered for production operations

- Event Schema Evolution
  - Persistence - Schema Evolution
- Split-Brain Resolver
  - Split Brain Resolver
  - TanUkkii007/akka-cluster-custom-downing
- Distributed Tracing
  - kamon-io/Kamon
  - alevkhomich/akka-tracing

Summary

- T.B.D

一緒に働くエンジニアを募集しています！

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