



Using BPM Suite in a Reactive Architecture with Microservices, Docker, and Amazon ECS

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Capital One at a glance

-A leading diversified bank with \$357.0 billion in assets, \$245.6 billion in loans and \$236.8 billion in deposits¹

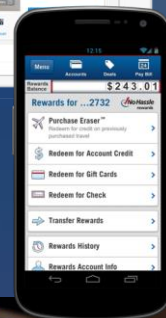
- 8th largest bank based on U.S. deposits²
- 6th largest retail depository institution in metro New York³
- Largest consumer and commercial banking institution headquartered in the Washington, DC region
- 3rd largest credit card issuer in the U.S.⁴
- The 3rd largest issuer of small business credit cards in the U.S.⁵
- The 3rd largest financial institution auto loan originator⁶
- Largest U.S. direct bank⁷

-Major operations in 15 U.S. cities, Canada, U.K.

-More than 65 million customer accounts and 45,000 associates

-A FORTUNE 500 Company - #112

- -Numerous recent awards including:
- Ranked #17 on Fortune Magazine's list of "100 Best Companies to Work For"
- Best Places to Work for LGBT Equality by *Human Rights Campaign*
- Received J.D. Power & Associates Call Center Certification
- Aon Hewitt's Top Companies for Leaders
- Named to *Working Mother's* 100 Best Companies list & Best Companies for Hourly Workers
- Ranked #10 on *Military Times'* 2016 "Best for Vets"
- Recipient of the Secretary of Defense Employer Support Freedom Award



1) Source: Company reported data as of Q4'16

2) Source: FDIC, Domestic deposits ranking as of Q4'16

3) Source: FDIC, June 2016, deposits capped at \$1B per branch

4) Source: Company-reported domestic credit card outstandings, Q4'16.

5) Source: The Nilson Report, Issue 1089, June 2016

6) Note: Financial institutions includes banks & specialty finance lenders, Source: AutoCount, 2016 originations

7) Source: Regulatory filings, company reports as of Q4'16

We have transformed the company into a top 10 bank



- 2016 – Acquires Critical Stack and Paribus
- 2015 – Acquires GE Capital's Healthcare Financial Services, Level Money and Monsoon
- 2014 – Acquires Adaptive Path, a digital design leader and AmeriCommerce, an online e-commerce company
- 2013 – Acquires Beech Street Capital, an originator, underwriter and servicer of multifamily commercial real estate loans
- 2012 – Acquires ING DIRECT, HSBC US Card portfolio
- 2010 – Enters into card partnerships with Kohl's and Sony in the US and Hudson's Bay Company and Delta in Canada
- 2009 – Acquires Chevy Chase Bank in the Washington, DC area
- 2006 – Acquires North Fork Bank, one of the largest banks in the New York metro area
- 2005 – Acquires Hibernia National Bank, #1 bank in Louisiana
- 2002 – Launches its Small Business credit card
- 2000 – Introduces slogan, "What's in your wallet?"
- 1998 – Enters Auto Finance Market
- 1996 – Expands into Canada and the U.K.
- 1995 – Spins off from Signet Bank
- 1994 – Initial Public Offering (IPO)

Capital One's Technology Transformation

Focus on tech
innovation,
data-driven
solutions and
diverse thinking

We hire great technology talent and arm them with the cutting-edge technologies needed to innovate.



Our company is being publicly recognized

- *Fortune's* 2017 100 Best Companies to Work For #17
- Named one of *Fortune's* 2016 World's Most Admired Companies
- Civic 50 list as one of America's most community-minded companies
- Top 100 Military-Friendly Employers" and "Top 25 Military-Friendly Spouse Employers" by G.I. Jobs
- Ranked #10 on *Military Times'* 2016 "Best for Vets"
- America's Top Corporations for Women's Business Enterprises by Women's Business Enterprise National Council (WBENC)
- Women Enterprise USA's "2016 WE USA Corporations of the Year"
- National Business Inclusion Consortium "Best of the Best: Top 30 Corporations for Inclusion"
- Awarded the Secretary of Defense Employer Support *Freedom Award*
- 2017 "Top Companies for Executive Women" by the National Association for Female Executives (NAFE)
- Capital One placed #9 on *Training Magazine's* Training Top 125
- Information Week Elite 100 #1 for Business Technology Innovators
- "Top Workplace" Richmond, Washington D.C., Chicago, Wilmington, Minnesota, Tampa
- Best Places to Work for LGBT Equality by *Human Rights Campaign*
- Dave Thomas Foundation for Adoption – 100 Best Adoption-Friendly Workplaces
- 2016 top-scoring company and Best Place to Work by the AAPD USBLN Disability Equality Index



We adopted a microservices approach to modernizing our legacy vendor product platform

Legacy Platform is very key in the overall marketing and decisioning flow

- Served well for several years but it is running on unsupported hardware and product version getting out of support very soon
- Has several business rules in the proprietary platform
- Several integration touch points
- But has excellent features for auditing and traceability

Adopting a microservices based approach gave us several advantages

- We can break the problem into small pieces and have dedicated teams solve each piece
- Gives us great agility to respond to change in business intent
- Create a clear sense of ownership for delivery and support for each microservices

We need to solve for auditability, traceability and inherent orchestration a monolithic application provides

Having several microservices execute a business process creates some challenges

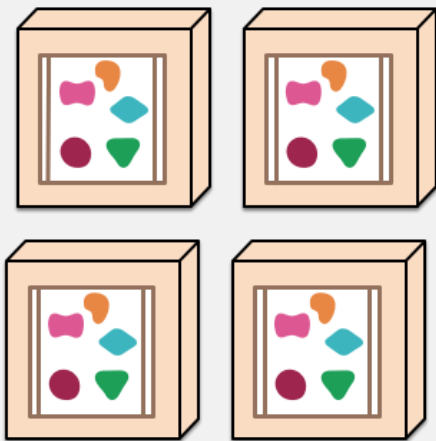
- There is no single entity that provides end to end visibility
- Lack of an easy way to orchestrate across the microservices to control the process flow
- Auditability – when a particular microservice executed in response to what trigger
- Challenging to support in production environment as we won't know where the process stopped and to be able restart from the point of failure

Challenges of a monolithic application

A monolithic application puts all its functionality into a single process...



... and scales by replicating the monolith on multiple servers



**This illustration is from <http://martinfowler.com/articles/microservices.html>*



**can have
many
dependencies**



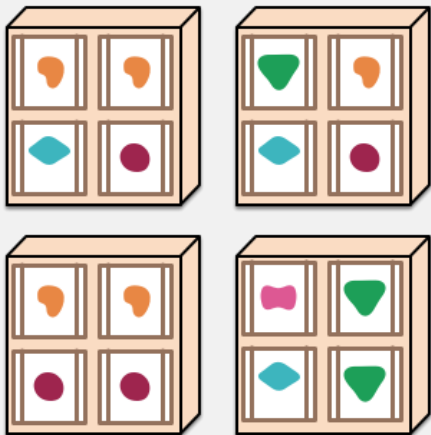
**can be
challenging
to make a
change**

Microservices and their key benefits

A microservices architecture puts each element of functionality into a separate service...



... and scales by distributing these services across servers, replicating as needed.



MICROSERVICES ARE:



SMALL

A microservice is very targeted in functionality and scope. Its codebase is relatively small and manageable.



LOOSELY COUPLED

Passing messages between services via an appropriate protocol, microservices decouple resources from the underlying technologies.



CONTINUOUSLY DEPLOYED

Microservices require good DevOps process, automation, acceptance testing and tooling.



DISPOSABLE

The systems microservices are in may be long-lived, but the microservices themselves may be short-lived.

"Organizations often want to frequently roll out updates, even multiple times a day. Consequently, it's **no longer adequate to develop simple, monolithic web applications** that serve up HTML to desktop browsers."

Chris Richardson, microservices.io

**This illustration is from <http://martinfowler.com/articles/microservices.html>*

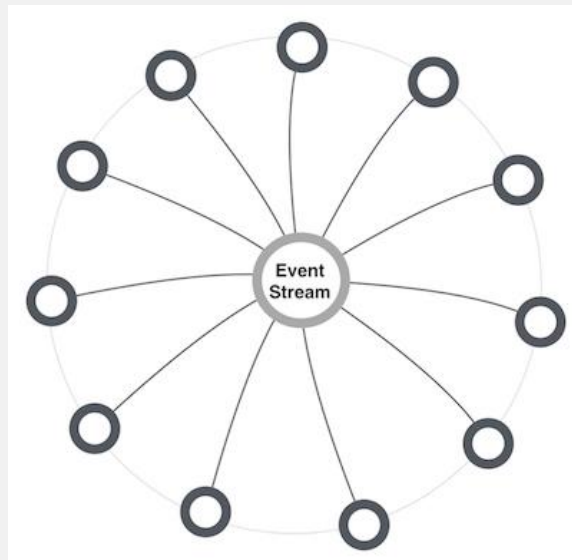
A reactive architecture leverages asynchronous messaging between microservices

Orchestration:



- + Provides tight control for sequential processing
- Tightly coupled
- Can be blocking
- Central shared orchestrator instance is single point of failure

Reactive :



- + Async enables faster processing time
- + Decoupling makes it easier to change
- + Extensible
- Async programming is a mind shift; flow is decentralized

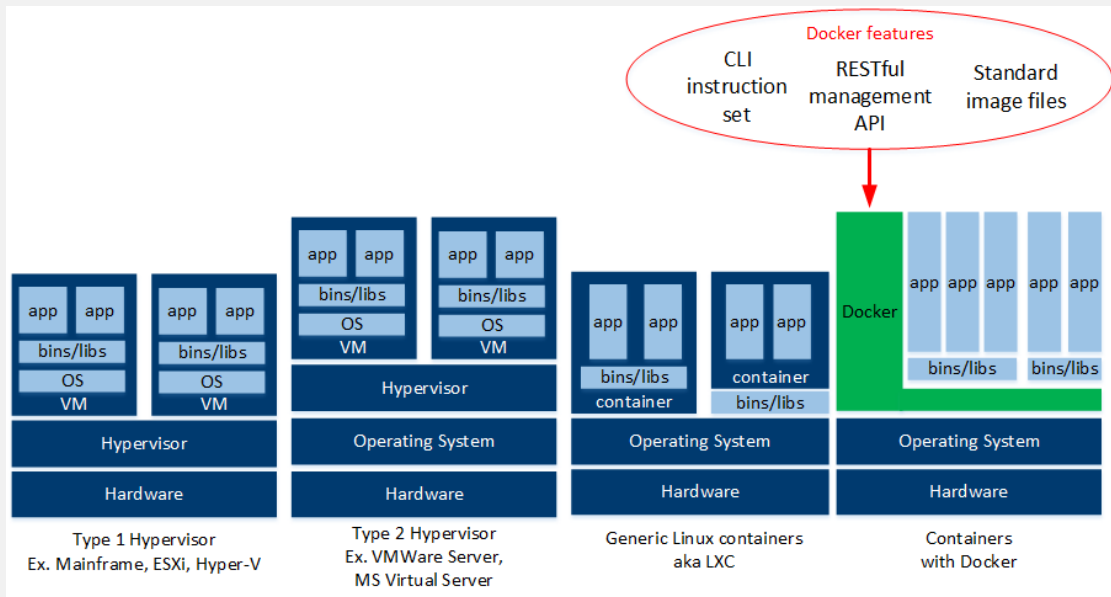
Example of a Reactive Architecture....



Docker

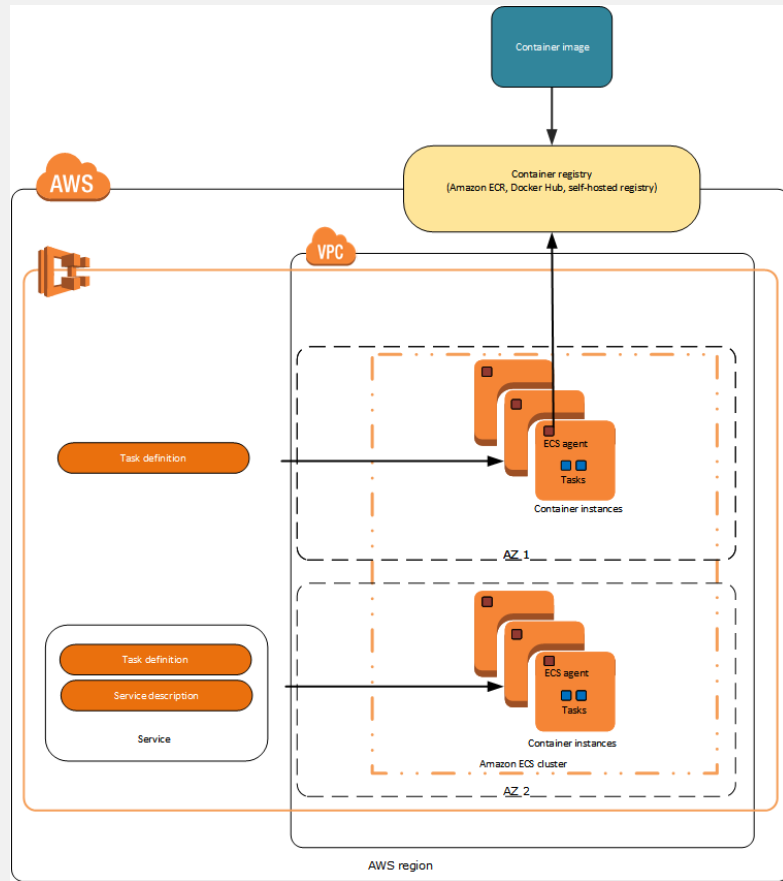


- Docker is a container technology built to enable DevOps methodologies and make it easy to package software, along with all its dependencies, so the same code can be shipped *with no alteration* to staging, production, the cloud, or anywhere else it needs to run.



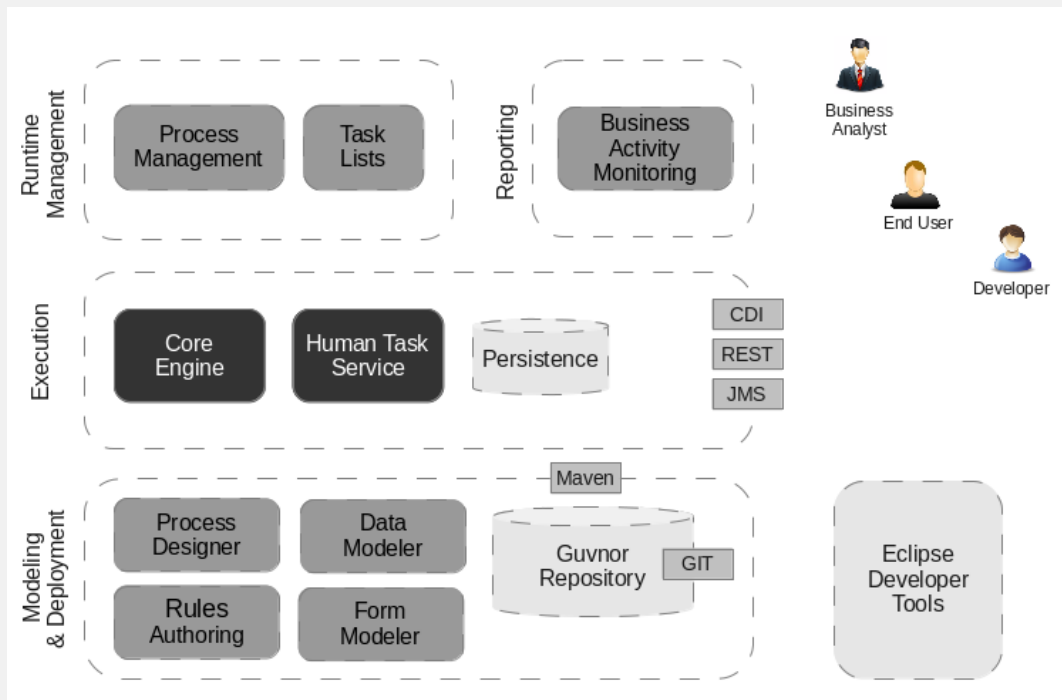
Amazon EC2 Container Service (ECS)

- highly scalable, fast, container management service
- makes it easy to run, stop, and manage Docker containers on a cluster of EC2 instances
- can schedule the placement of containers across your cluster based on your resource needs, isolation policies, and availability requirements
- eliminates the need to operate your own cluster management and configuration management systems or worry about scaling your management infrastructure



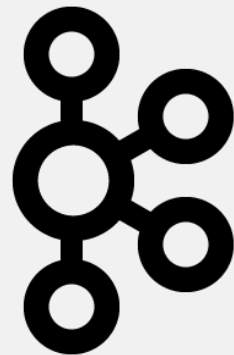
RedHat Business Process Management (BPM) Suite

- Bridges Business and Technical resources together
- Leverages BPMN 2.0
- Natively integrated with Drools Rules
- Supports human workflow and system workflow
- Various APIs
- Java based and very Extensible
- BAM, Dashboards, Reports, Analytics



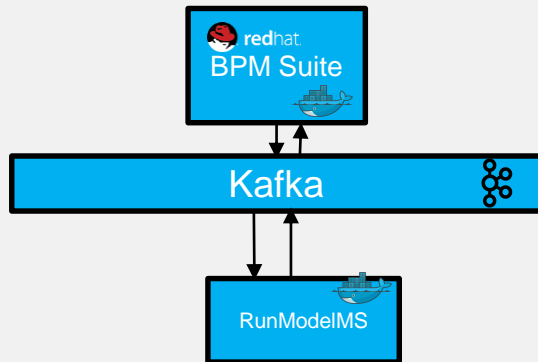
Kafka is a distributed streaming platform

- Used in conjunction with Zookeeper
- Runs as a cluster
- Records are stored in categories called topics
- Provides 4 core APIs: Producer, Consumer, Streams and Connector
- Supports both publish-subscribe and queuing through a consumer group concept
- Very Fast and has very high throughput – many use it for backpressure
- Can be used for message replay as the messages do not have destructive reads like traditional messaging technologies
- Guarantees order of messages within a partition, but not across partitions
- Very easy to get up and running



Combining all of these technologies & patterns together can create a powerful solution

- BPM Suite for coordinating a reactive workflow
- Leverage Kafka as the messaging mechanism between the microservices and BPM Suite
- Docker for microservice deployment
- ECS for docker container management



Kafka Integration

kie-server extension

KIE Server is built on a concept of extensions. All capabilities are implemented as extensions

- KIE Server extension
- Drools extension
- jBPM extension
- jBPM UI extension

Kafka Integration

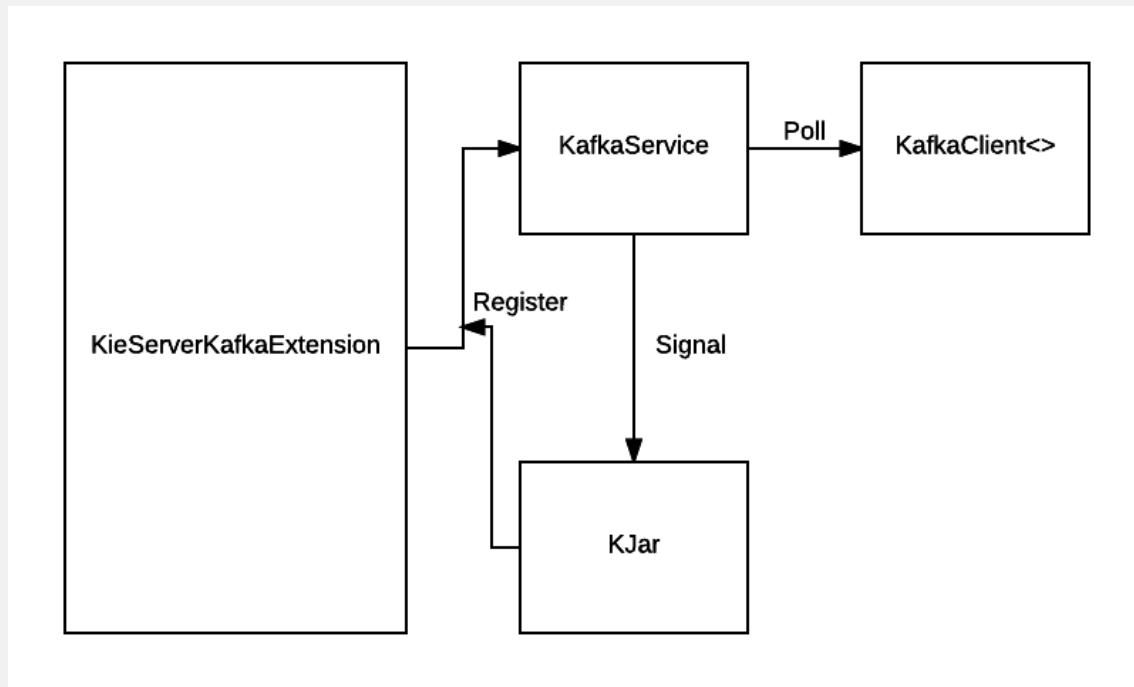
kie-server extension

So we're going to add one more

- KIE Server extension
- Drools extension
- jBPM extension
- jBPM UI extension
- **Kafka extension**

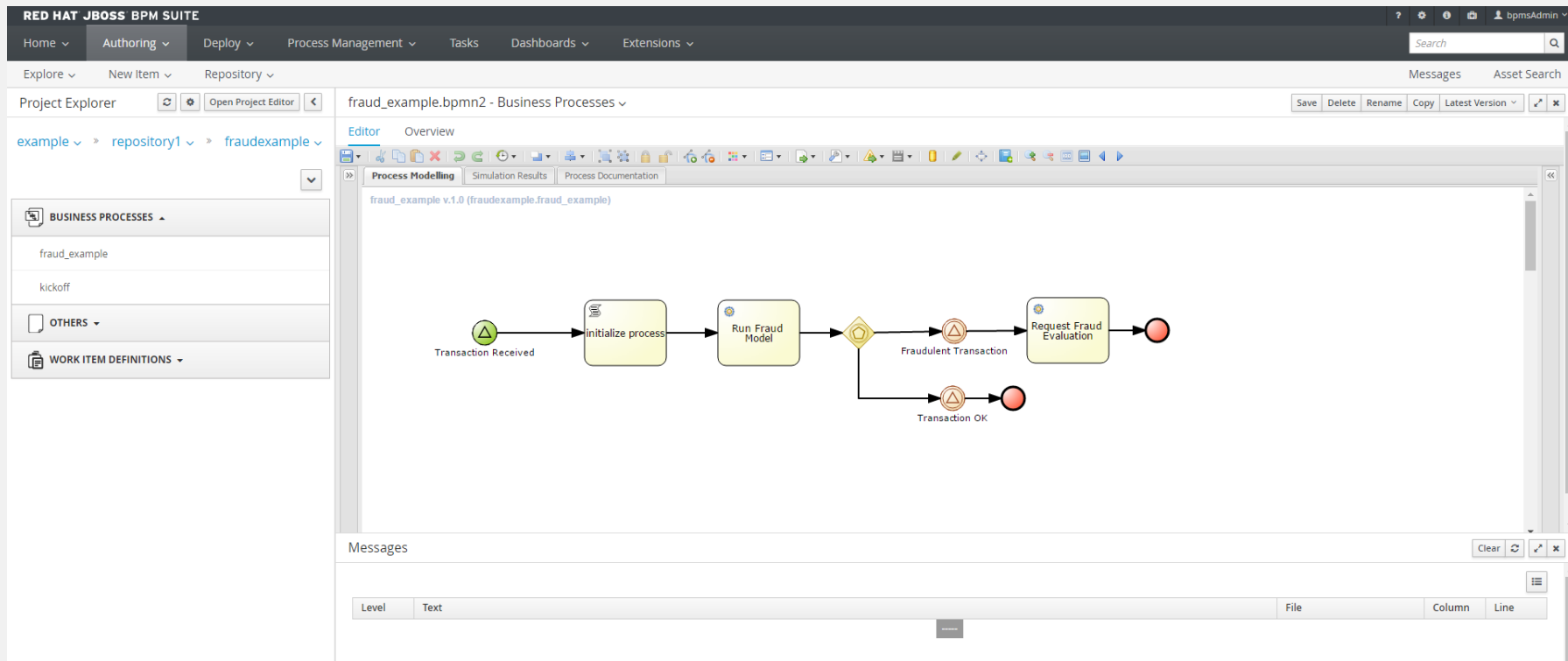
Kafka Integration

architecture



DEMO!

Fraudulent Transaction Use Case



A business process to simulate the transaction

The screenshot displays the Red Hat JBoss BPM Suite interface. The top navigation bar includes 'Home', 'Authoring', 'Deploy', 'Process Management', 'Tasks', 'Dashboards', and 'Extensions'. The left sidebar shows the 'Project Explorer' with a tree structure: 'example' > 'repository1' > 'fraudexample'. The main editor area is titled 'kickoff.bpmn2 - Business Processes' and shows a BPMN diagram for 'kickoff v.1.0 (fraudexample.kickoff)'. The diagram consists of a start event (green circle) connected to a task (yellow rounded rectangle labeled 'Kafka'), which is then connected to an end event (red circle). Above the diagram, the text reads: 'This business process submits the below event to Kafka: {\"id\": \"33bb75db-6e13-48ee-8a54-b3976d3d065b\", \"action\": \"Transaction Received\"}'. The right sidebar shows the 'Properties (BPMN-Diagram)' panel with a table of properties:

Name	Value
Core Properties	
AdHoc	false
Executable	true
Globals	
ID	fraudexample.kickoff
Imports	
Package	org.jboss
Process Inst...	
Process Name	kickoff
Variable Defn...	
Version	1.0
Extra Properties	
Documentat...	
Target Name...	http://www.omg.org/bpmn20
TypeLanguage	http://www.java.com/javaTypes
Simulation Properties	
Rate Currency	

At the bottom, there is a 'Messages' panel with a table structure: Level, Text, File, Column, Line.

ECS setup

- Create cluster
- Create task definitions
- Create service

Create Cluster

Amazon ECS

Clusters

Task Definitions

Repositories

As of 1/11/2017, Docker 1.12 was added to the ECS Optimized AMI. For more information see [the forums](#).

Clusters > RedhatSummitDemo

Cluster : RedhatSummitDemo

Get a detailed view of the resources on your cluster.

Status ACTIVE

Registered container instances 0

Pending tasks count 0

Running tasks count 0

ServicesTasksECS InstancesMetrics

CreateUpdateDelete

Last updated on April 10, 2017 12:40:00 PM (0m ago)

Filter in this page

<input type="checkbox"/>	Service Name	Status	Task Definition	Desired tasks	Running tasks
No results					

Create Task Definitions

Task Definitions
Repositories

Task Definitions > bpmsuite > 3

Task Definition: bpmsuite:3

View detailed information for your task definition. To modify the task definition, you need to create a new revision and then make the required changes to the task definition

Create new revision

Actions

Builder

JSON

Task Definition Name

bpmsuite

Task Role

None

Optional IAM role that tasks can use to make API requests to authorized AWS services. Create an Amazon EC2 Container Service Task Role in the IAM Console

Network Mode

Bridge

Task Placement

Constraint

No constraints

Container Definitions

Container Name	Image	CPU Units	Hard/Soft memory limits (MB)	Essential
bpmsuite		0	25000/20000	true

Details

Entry point["/opt/jboss/bpms/bin/standalone.sh","-b","0.0.0.0"]

Port Mappings

Host Port	Container Port	Protocol
8080	8080	tcp
8001	8001	tcp

Environment Variables

Key	Value
No Environment Variables	

Mount Points

Container Path	Source Volume	Read only
No Mount Points		

Volumes from

Source Container	Read only
No volumes from	

Ulimits

Name	Soft limit	Hard limit
No ulimit		

Create Service

Task Definitions
Repositories

Update Service

A service lets you specify how many copies of your task definition to run. You could also use Elastic Load Balancing to distribute incoming traffic to your tasks. Amazon ECS keeps that number of tasks running and coordinates task scheduling with the load balancer.

Task Definition

bpmsuite:3

Cluster

RedhatSummitDemo

Service name

BPMSuite

Number of tasks

1

Minimum healthy percent

50

Maximum percent

200

Optional configurations

Service Auto scaling

Automatically adjust your service's desired count up and down in response to CloudWatch alarms.

Configure Service Auto Scaling

Cancel

Update Service

ECS deploys the container to the ECS Cluster

task Definitions
Repositories

Clusters > RedHatSummitDemo > Service: bpmsuiteService

Service : bpmsuiteService

Update

Delete

Details

Cluster [RedHatSummitDemo](#)
Status **ACTIVE**
Task Definition [bpmsuite:3](#)
Desired count 1
Pending count **1**
Running count 0

Load Balancing

Load Balancer Name	Container Name	Container Port
--------------------	----------------	----------------

No load balancers

Deployment Options

Minimum healthy percent 0 ⓘ

Maximum percent 200 ⓘ

Task Placement

Strategy No strategies

Constraint No constraints

Tasks Events Deployments Auto Scaling Metrics

Last updated on April 10, 2017 4:08:00 PM (0m ago)



Task status: **Running** Stopped

Filter in this page

< 1-1 > Page size 50

Task	Task Definition	Group	Last status	Desired status
e8ddb516-e181-4146-a43b-a0464f116bed	bpmsuite:3	service:bpmsuiteService	PENDING	RUNNING

Task is deployed successfully

Amazon ECS

Clusters

Task Definitions

Repositories

As of 1/11/2017, Docker 1.12 was added to the ECS Optimized AMI. For more information see [the forums](#).

Clusters > RedHatSummitDemo

Cluster : RedHatSummitDemo

Delete Cluster

Get a detailed view of the resources on your cluster.

Status **ACTIVE**

Registered container instances 1

Pending tasks count 0

Running tasks count **1**

Services

Tasks

ECS Instances

Metrics

Create

Update

Delete

Last updated on April 10, 2017 4:14:51 PM (0m ago)



Filter in this page

< 1-1 >

<input type="checkbox"/>	Service Name	Status	Task Definition	Desired tasks	Running tasks
<input type="checkbox"/>	bpmsuiteService	ACTIVE	bpmsuite:3	1	1

Task is deployed successfully

Amazon ECS

Clusters

Task Definitions

Repositories

As of 1/11/2017, Docker 1.12 was added to the ECS Optimized AMI. For more information see the forums.

Clusters > RedHatSummitDemo

Cluster : RedHatSummitDemo

Get a detailed view of the resources on your cluster.

Status **ACTIVE**

Registered container instances 1

Pending tasks count 0

Running tasks count 1

ServicesTasksECS InstancesMetrics

Run new TaskStopStop All

Last updated on April 10, 2017 4:15:35 PM (0m ago)

Desired task status: RunningStopped

Filter in this page

	Task	Task Definition	Group	Container Instance	Last status	Desired status	Started By
<input type="checkbox"/>	e8ddb516-e181-4146-a43b-a0464f1...	bpmsuite:3	service:bpmsuiteService	8ff95df1-fbe8-4ce8-9199-6ab28d87...	RUNNING	RUNNING	ecs-svc/9223370545003061451

EC2 Container Instance is running

Amazon ECS

Clusters

Task Definitions

Repositories

As of 1/11/2017, Docker 1.12 was added to the ECS Optimized AMI. For more information see [the forums](#).

Clusters > RedHatSummitDemo

Cluster : RedHatSummitDemo

Delete Cluster

Get a detailed view of the resources on your cluster.

Status **ACTIVE**

Registered container instances 1

Pending tasks count 0

Running tasks count 1

Services

Tasks

ECS Instances

Metrics



Outdated ECS Agent

One or more container instances are not running the latest version of the Amazon ECS container agent. [Learn more](#)

Add additional ECS Instances using [Auto Scaling](#) or [Amazon EC2](#).

Actions

Last updated on April 10, 2017 4:17:12 PM (0m ago)



Status: **ALL** ACTIVE DRAINING

< 1-1 > Page size 50

Filter by attributes (click or press down arrow to view filter options)

<input type="checkbox"/>	Container Instance	EC2 Instance	Availability Zo...	Agent Connec...	Status	Running tasks...	CPU available	Memory availa...	Agent version	Docker version
<input type="checkbox"/>	8f95df1-fbe8-4ce8-9199-6...	i-036d77985d3c...	us-east-1a	true	ACTIVE	1	8192	11756	1.13.0	1.11.2

Lessons Learned of this approach

- Coordinator can be a single point of failure
 - Evaluate East/West deployment for active/active (application and database layers)
- Need a Unique ID (correlation ID) that goes across all microservices
- Apply this pattern where :
 - there are synchronous blocks of asynchronous processing
 - there is a need to see the overall all end to end business process at design time and run-time
 - there is a need to decouple as much as possible to eliminate dependencies

References

- Github repo for demo

<https://github.com/andy9876/ReactiveBPMDemo>

- Microservices: When to react vs. orchestrate

<https://developer.capitalone.com/blog-post/microservices-when-to-react-vs-orchestrate/>

<https://medium.com/capital-one-developers/microservices-when-to-react-vs-orchestrate-c6b18308a14c>

- Comparing and Contrasting Open Source BPM Products

<https://developer.capitalone.com/blog-post/contrasting-open-source-bpm-projects/>

<https://medium.com/capital-one-developers/comparing-and-contrasting-open-source-bpm-projects-196833f23391>

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The logo consists of a red speech bubble shape pointing downwards. Inside the bubble, the words "RED HAT" are in a smaller, white, sans-serif font, and "SUMMIT" is in a larger, bold, white, sans-serif font below it.

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