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 deposits[1]

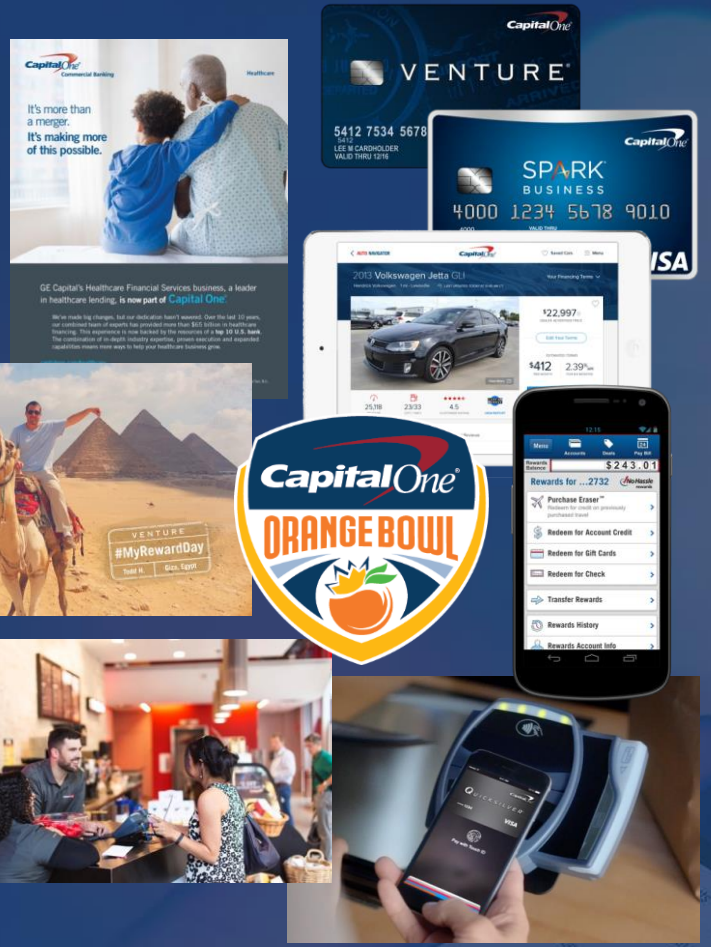
- 8th largest bank based on U.S. deposits[2]
- 6th largest retail depository institution in metro New York[3]
- Largest consumer and commercial banking institution headquartered in the Washington, DC region
- 3rd largest credit card issuer in the U.S.[4]
- The 3rd largest issuer of small business credit cards in the U.S.[5]
- The 3rd largest financial institution auto loan originator[6]
- Largest U.S. direct bank[7]

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

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

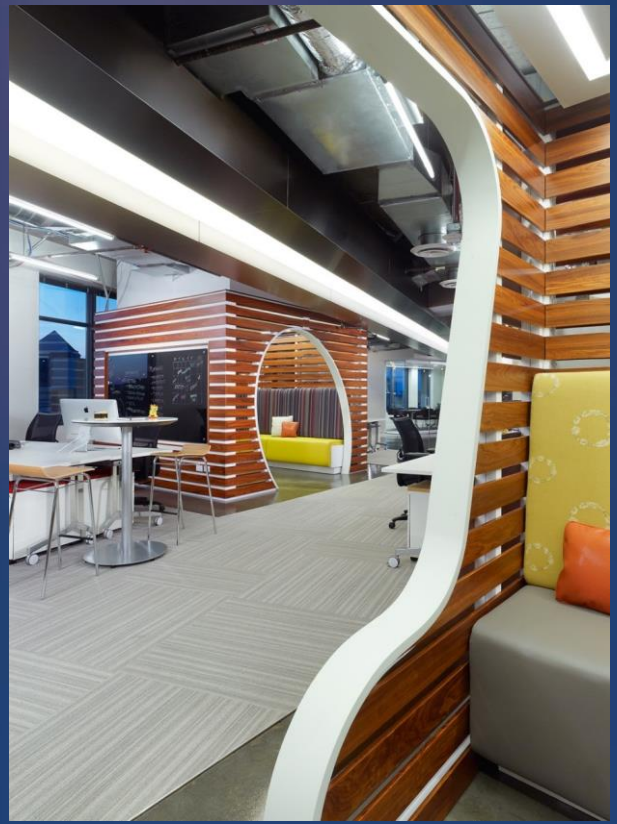
-A FORTUNE 500 Company - #112

- **-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

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.

Capital One

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

THE CIVIC 50

DEI BEST PLACES TO WORK 2016℠ 100% DISABILITY EQUALITY INDEX

Secretary of Defense Freedom AWARD 2014 Recipient

2016 NBIC BEST OF THE BEST CORPORATIONS FOR INCLUSION

BEST FOR VETS 2016 MILITARY TIMES EMPLOYERS

MILITARY FRIENDLY MF'16 TOP 100 EMPLOYER

MILITARY FRIENDLY MF'16 SPOUSE EMPLOYER

HUMAN RIGHTS CAMPAIGN BEST PLACES TO WORK 2016 for LGBT Equality 100% CORPORATE EQUALITY INDEX

InformationWeek ELITE 100 2016

Capital One

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

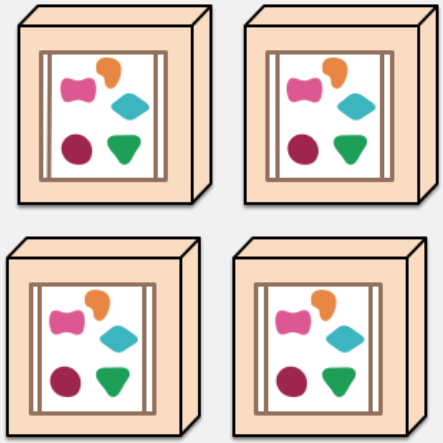
Having several microservices execute a business process creates some challenges

- 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

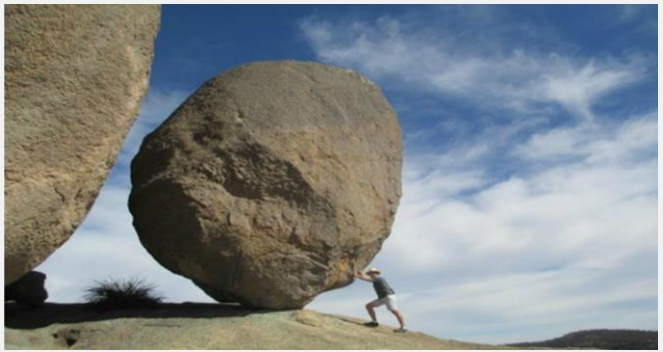
A monolithic application puts all its functionality into a single process...

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



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

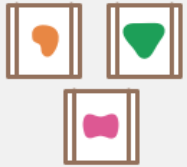
can have many dependencies



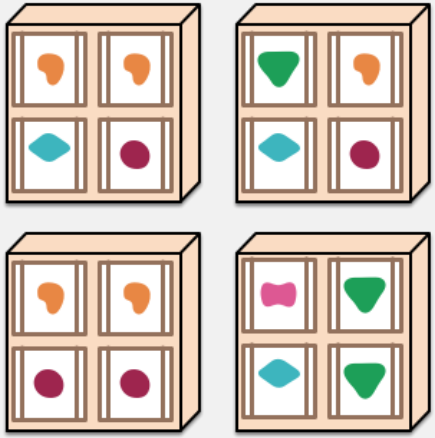
can be challenging to make a change

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.



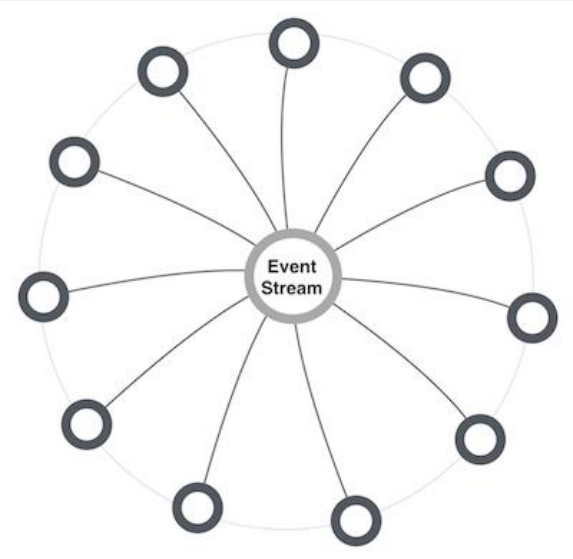
*This illustration is from http://martinfowler.com/articles/microservices.html

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

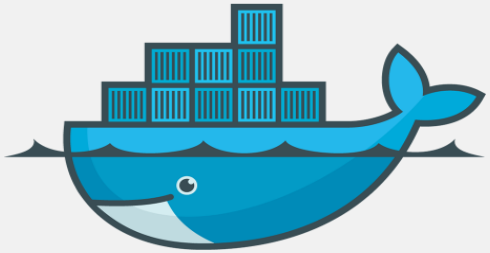
Reactive :



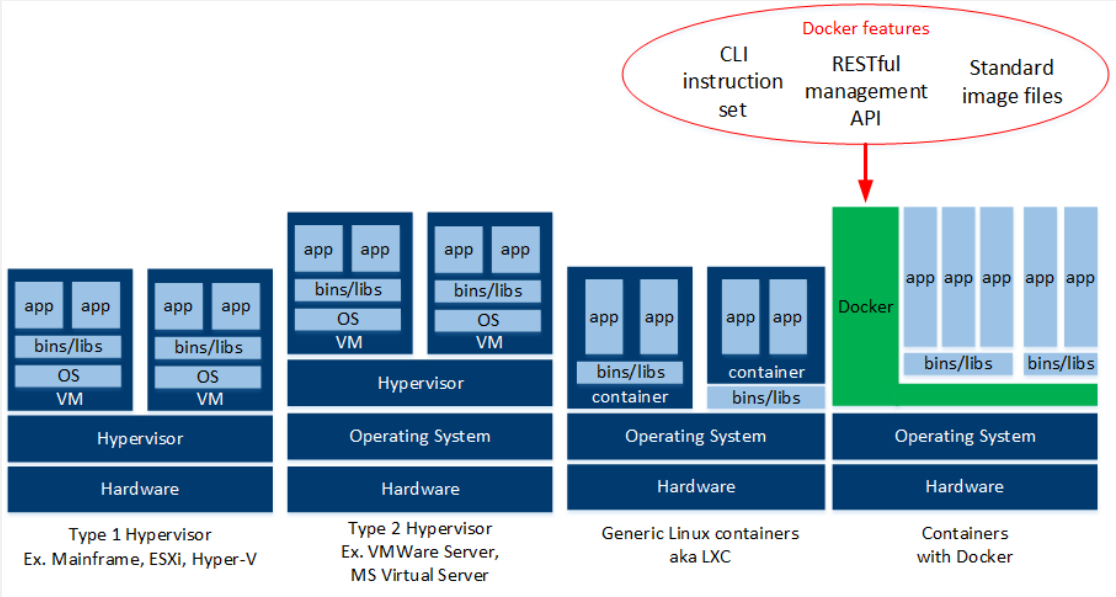
+ Async enables faster processing time
+ Decoupling makes it easier to change
+ Extensible
- Async programming is a mind shift; flow is decentralized

Example of a Reactive Architecture....

Docker

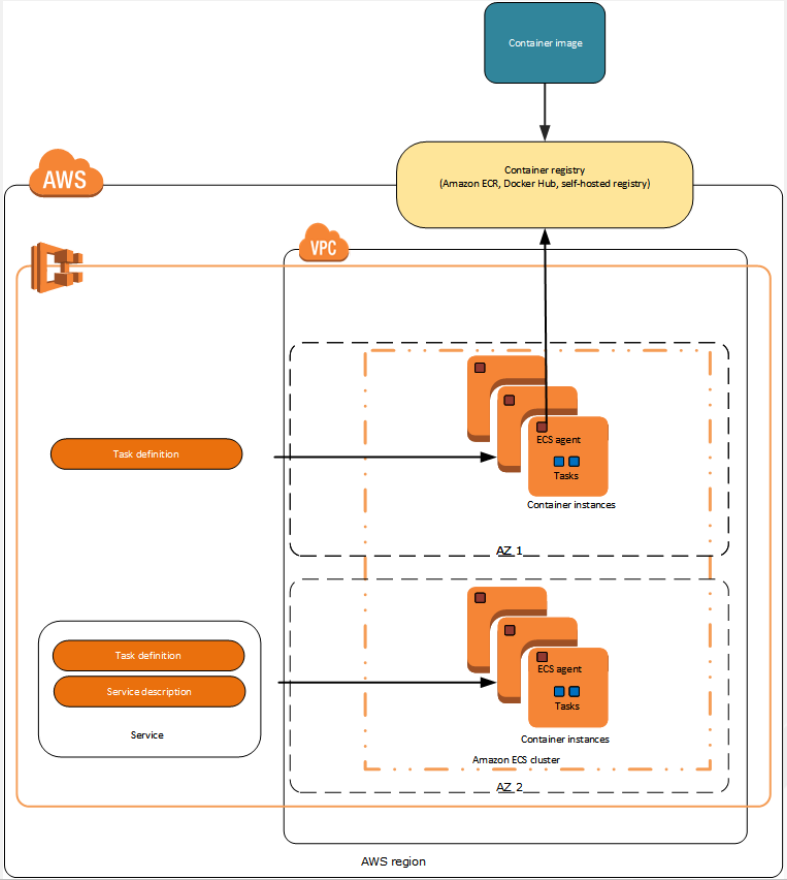


- Docker is a container technology built to enable DevOps methodologies and make it easy to package software, along with all its dependencies, so the same code can be shipped *with no alteration* to staging, production, the cloud, or anywhere else it needs to run.



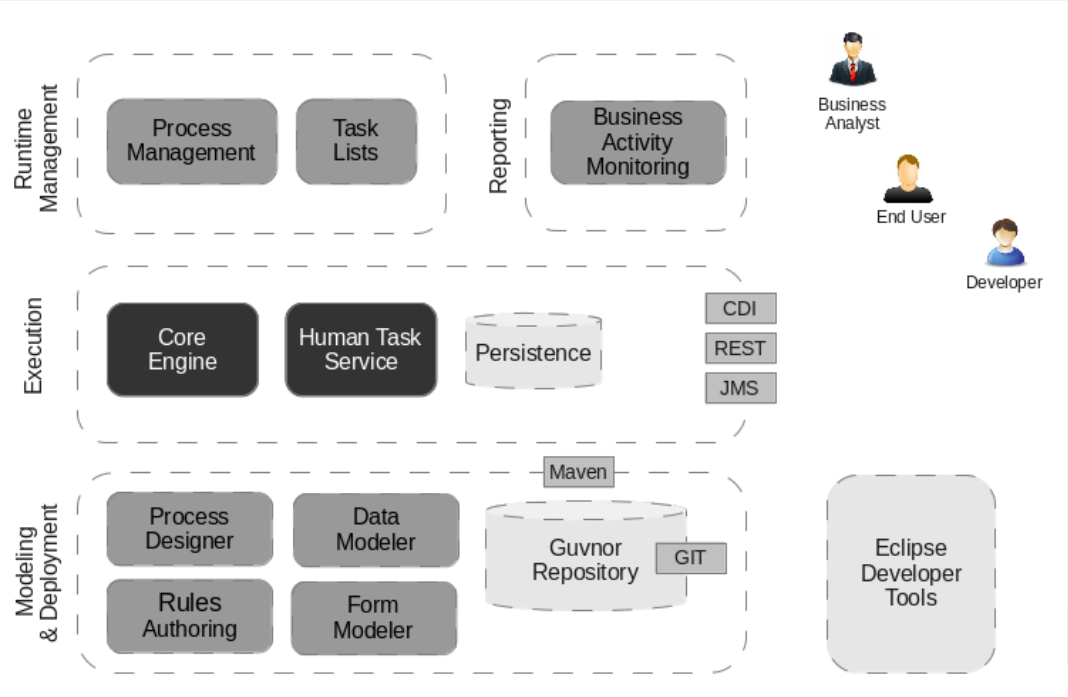
Amazon EC2 Container Service (ECS)

- 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

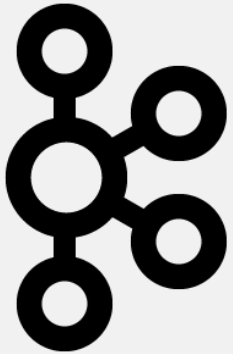


RedHat Business Process Management (BPM) Suite

- 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

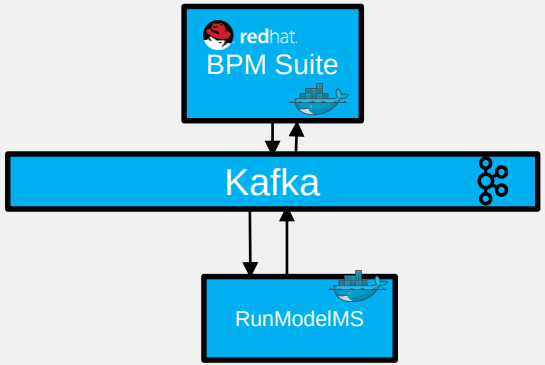


- Used in conjunction with Zookeeper
- Runs as a cluster
- Records are stored in categories called topics
- Provides 4 core APIs: Producer, Consumer, Streams and Connector
- Supports both publish-subscribe and queuing through a consumer group concept
- Very Fast and has very high throughput – many use 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

http://kafka.apache.org/documentation.html

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

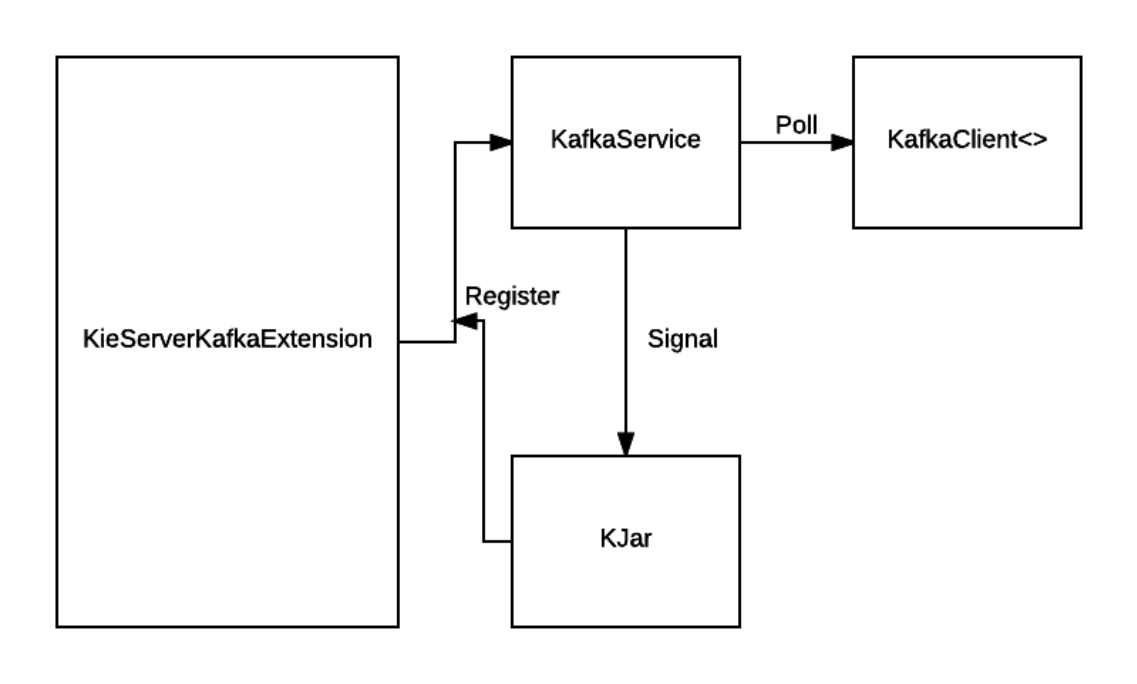
kie-server extension

So we’re going to add one more

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

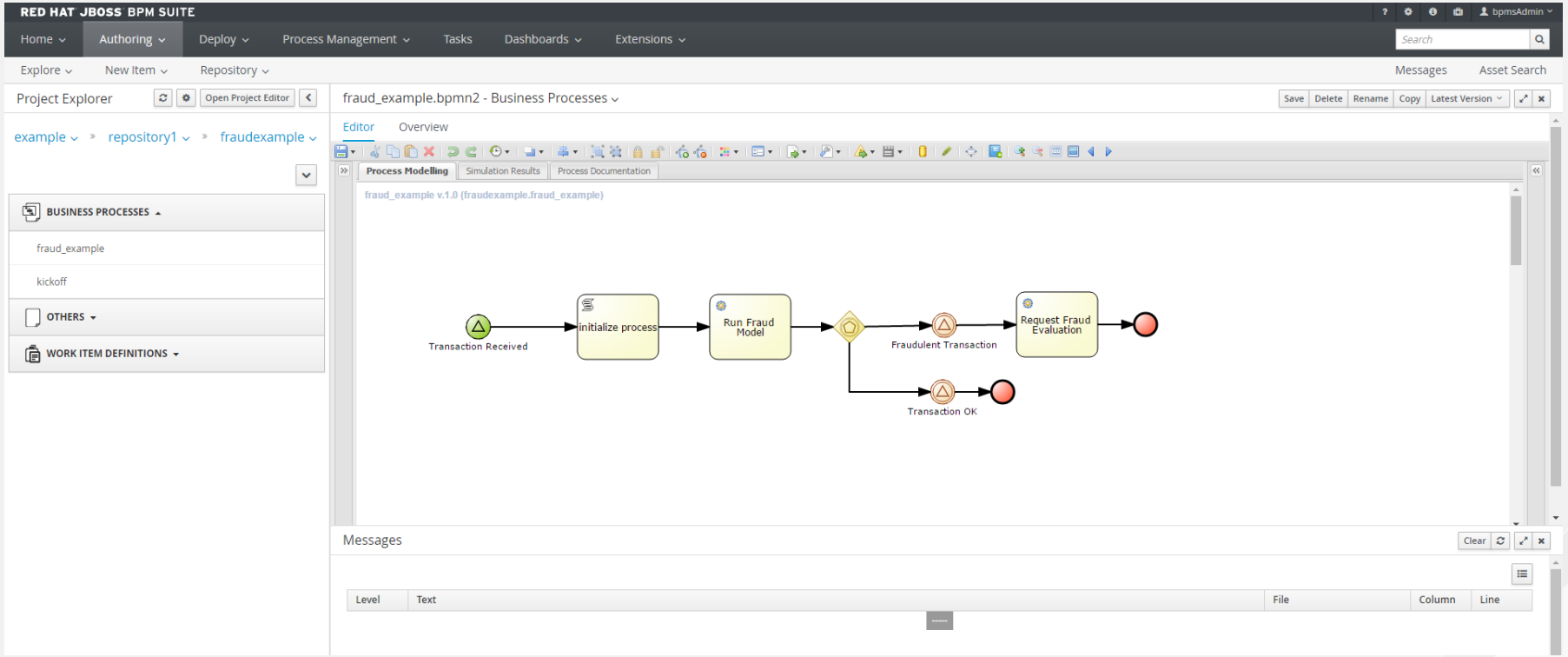
Kafka Integration

architecture

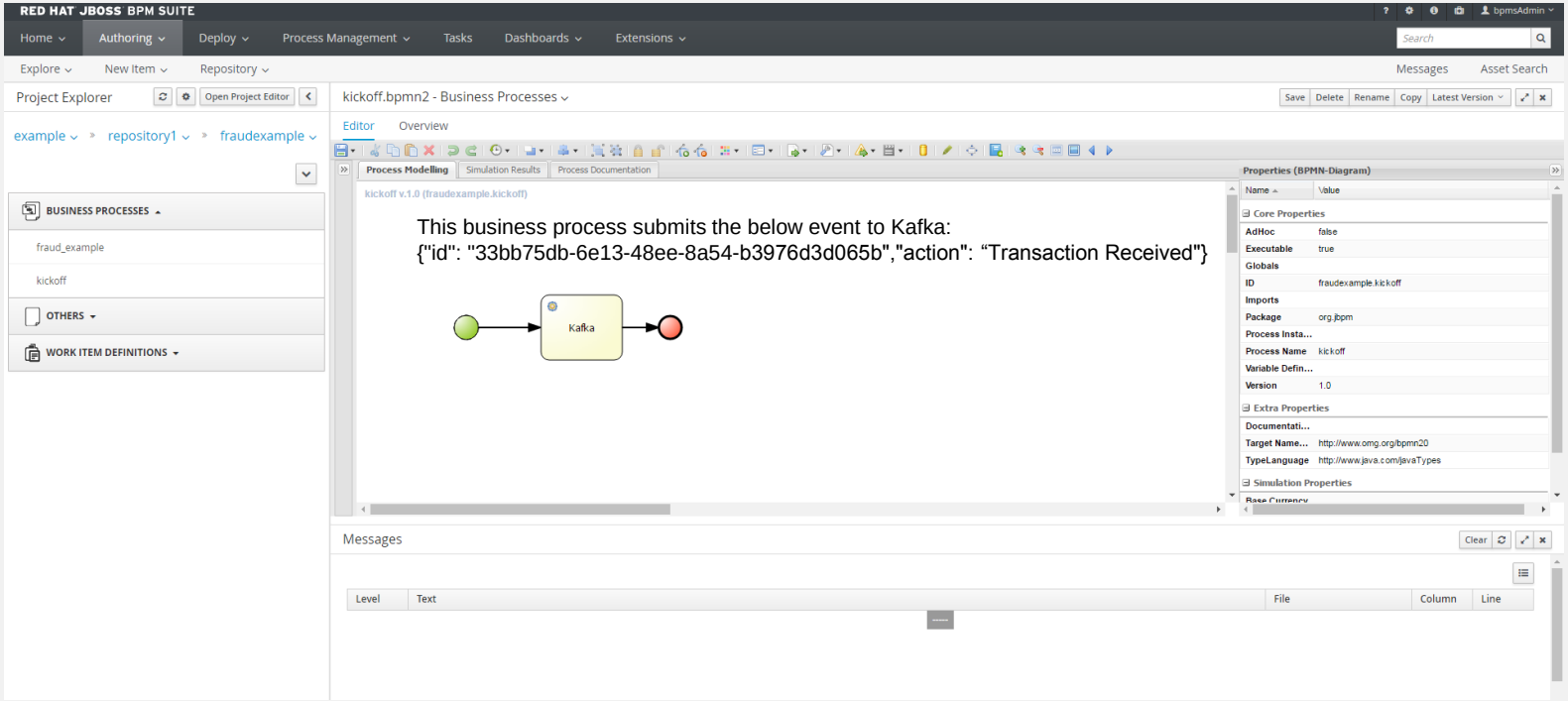


DEMO!

Fraudulent Transaction Use Case



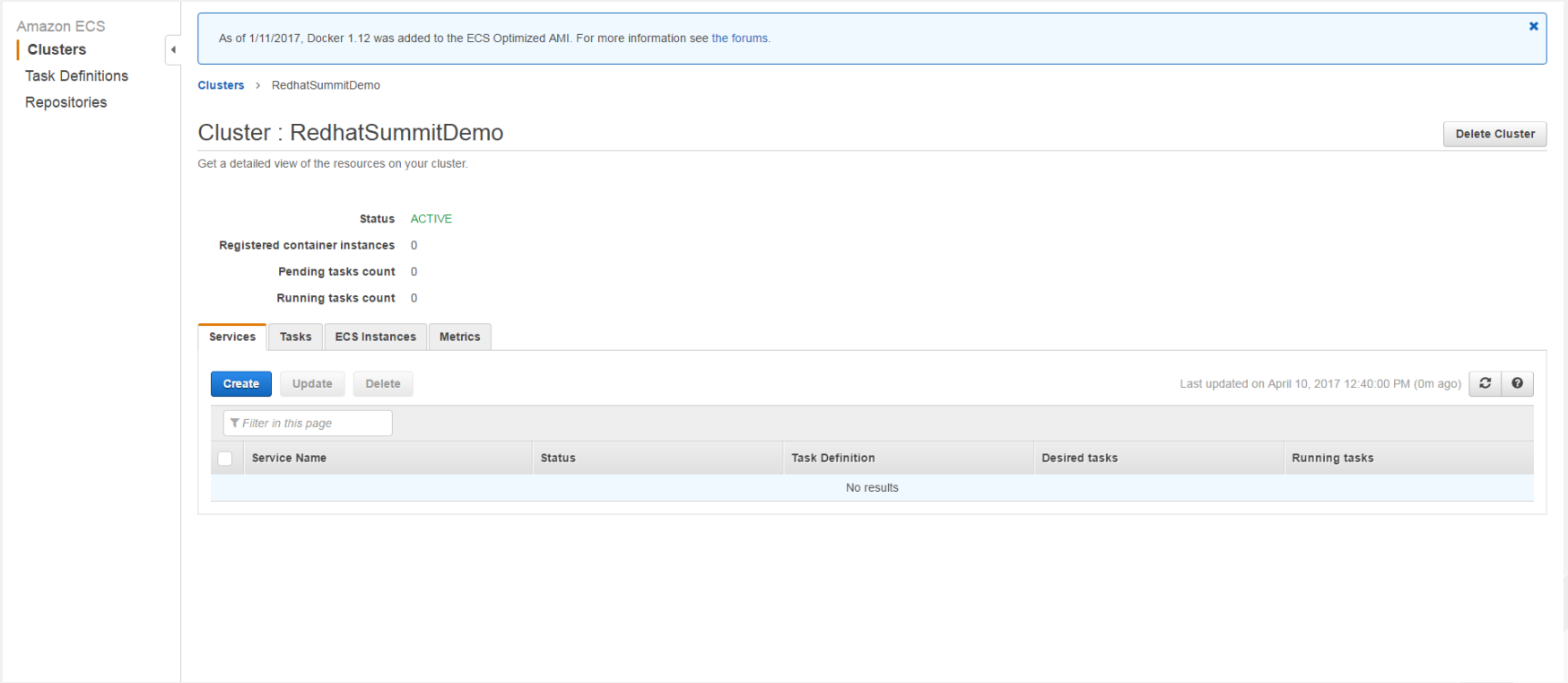
A business process to simulate the transaction



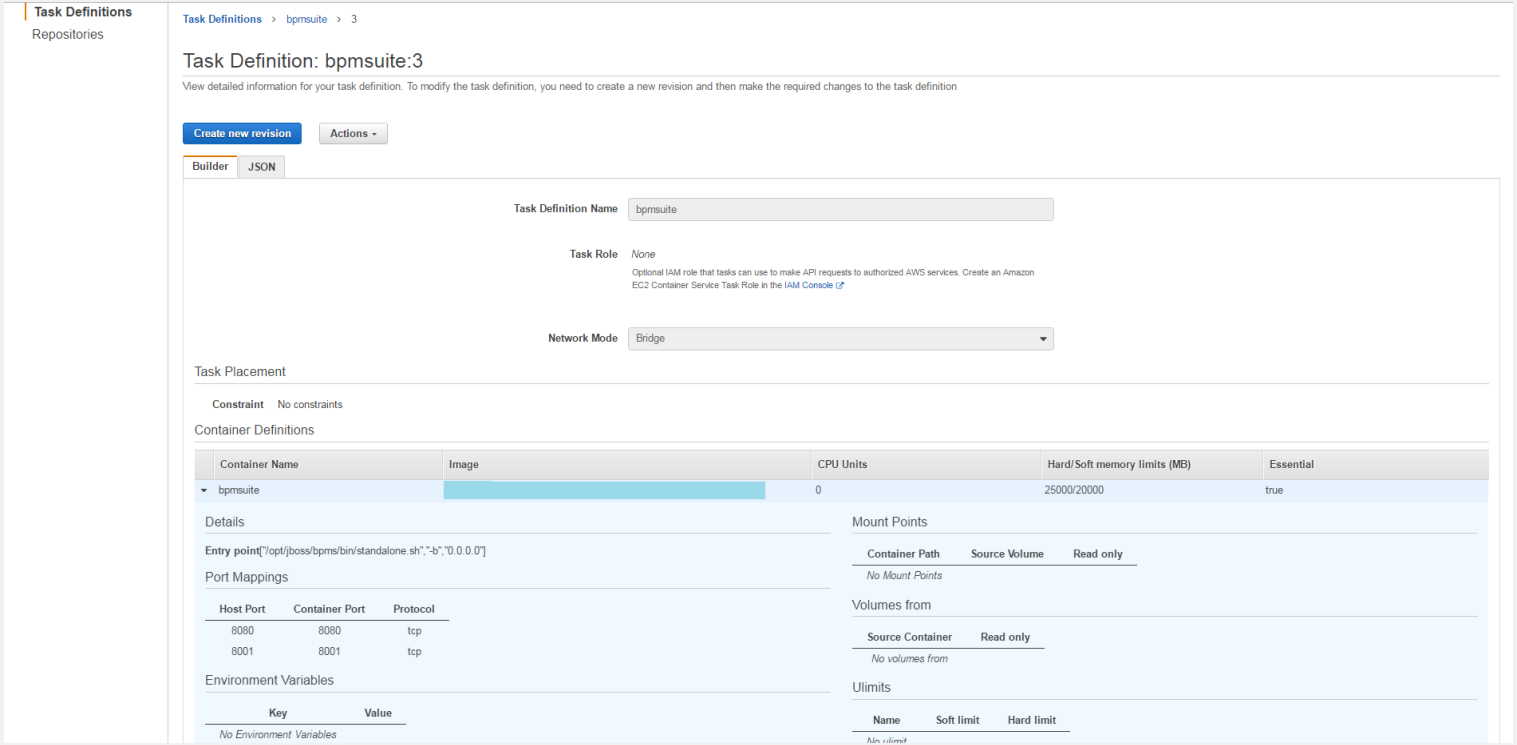
ECS setup

- Create cluster
- Create task definitions
- Create service

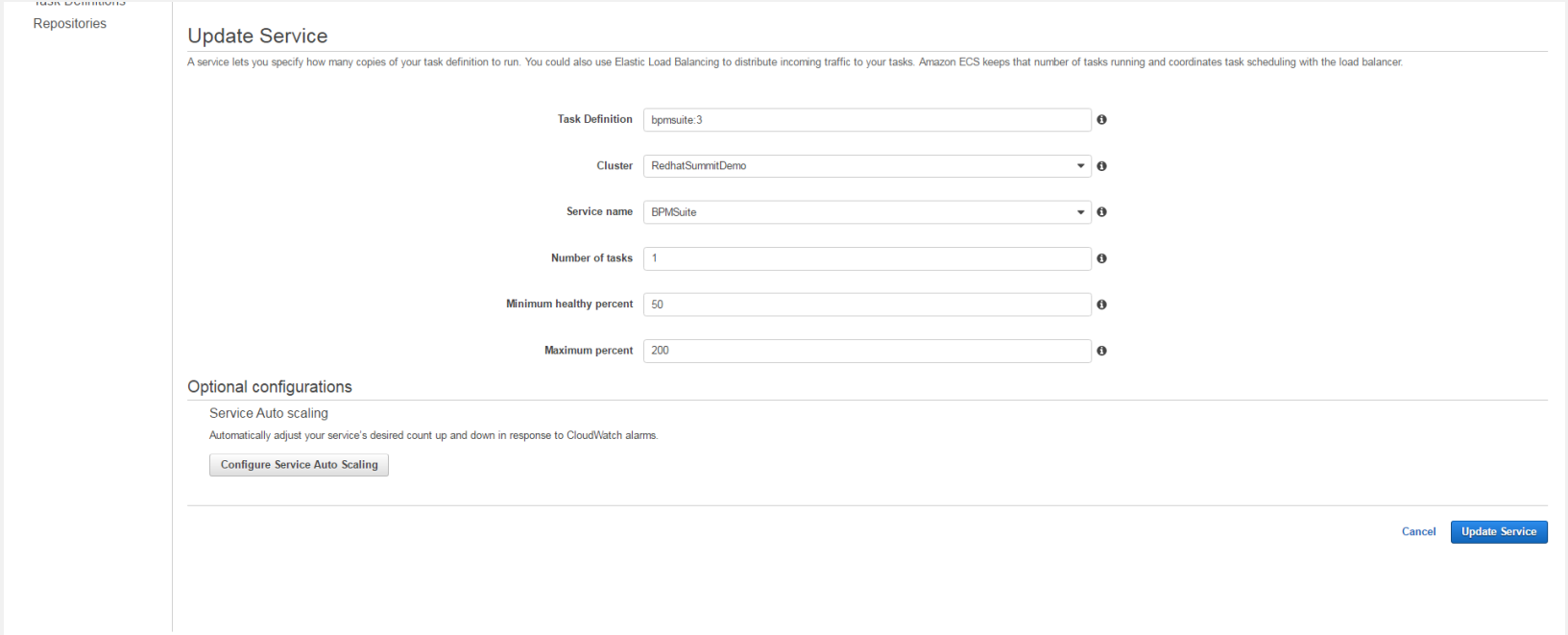
Create Cluster



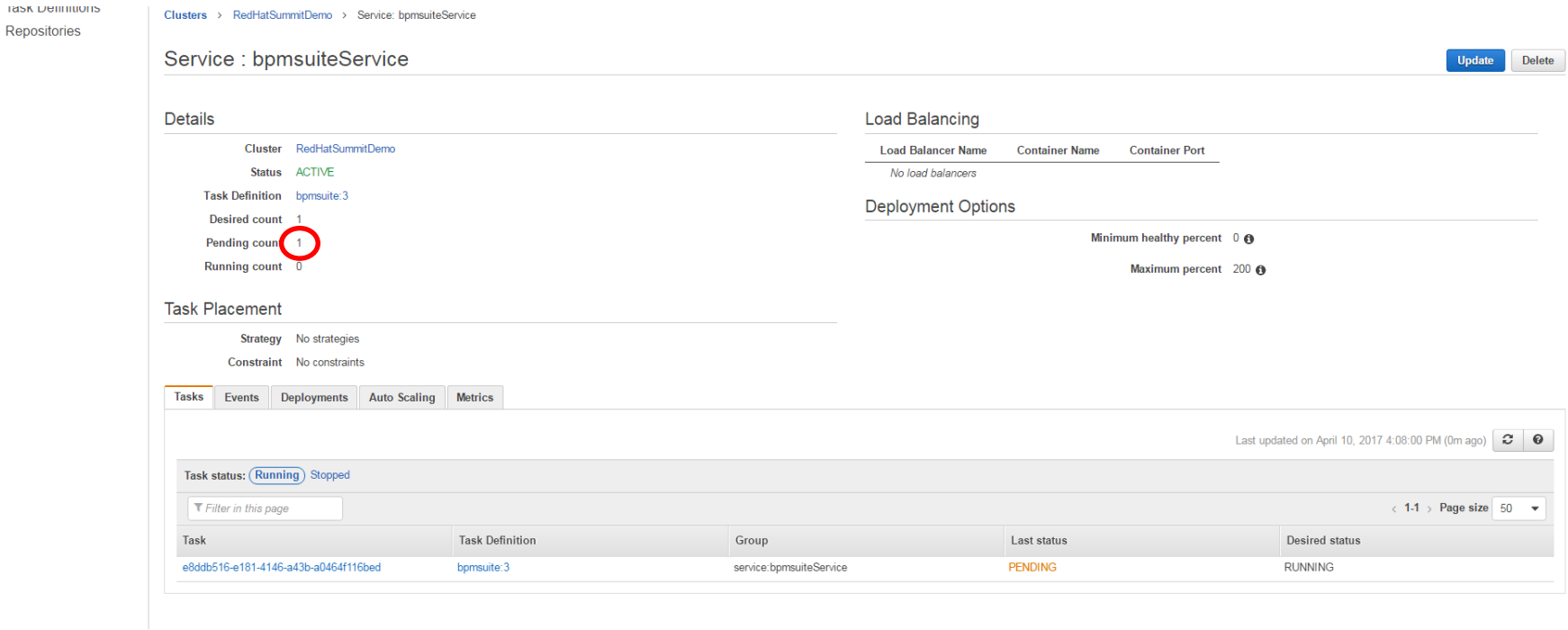
Create Task Definitions



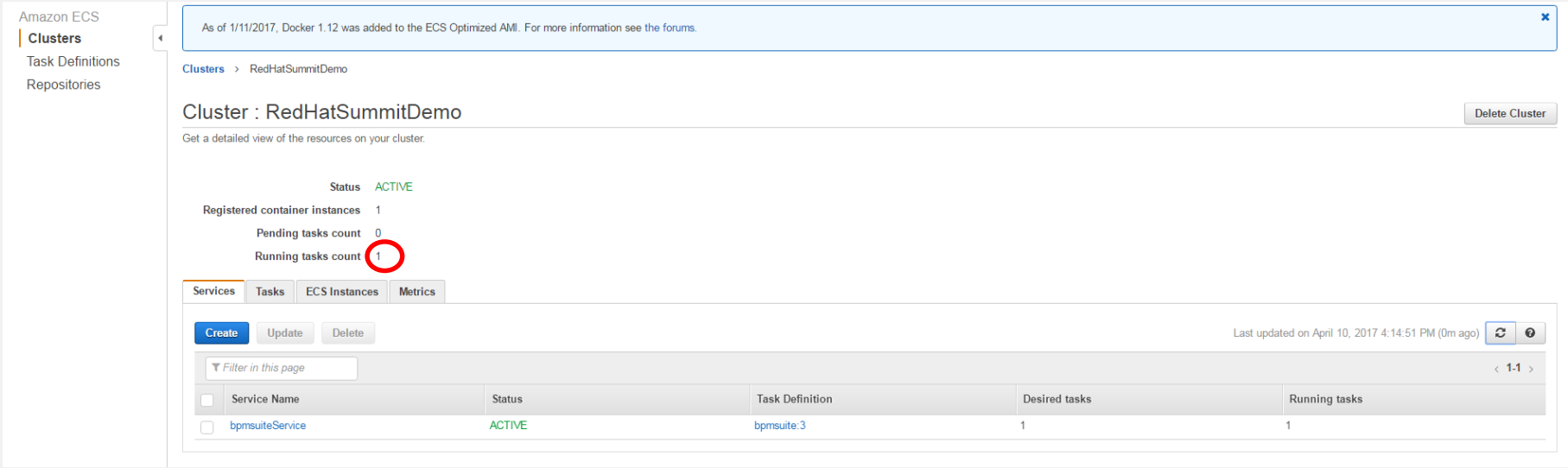
Create Service



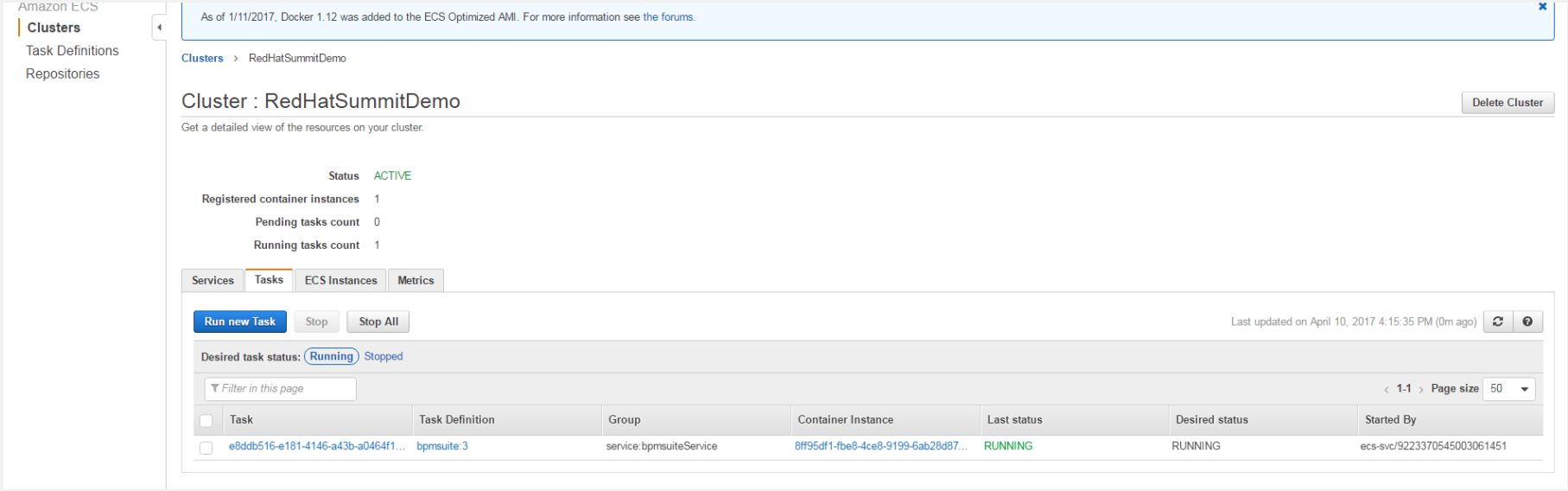
ECS deploys the container to the ECS Cluster



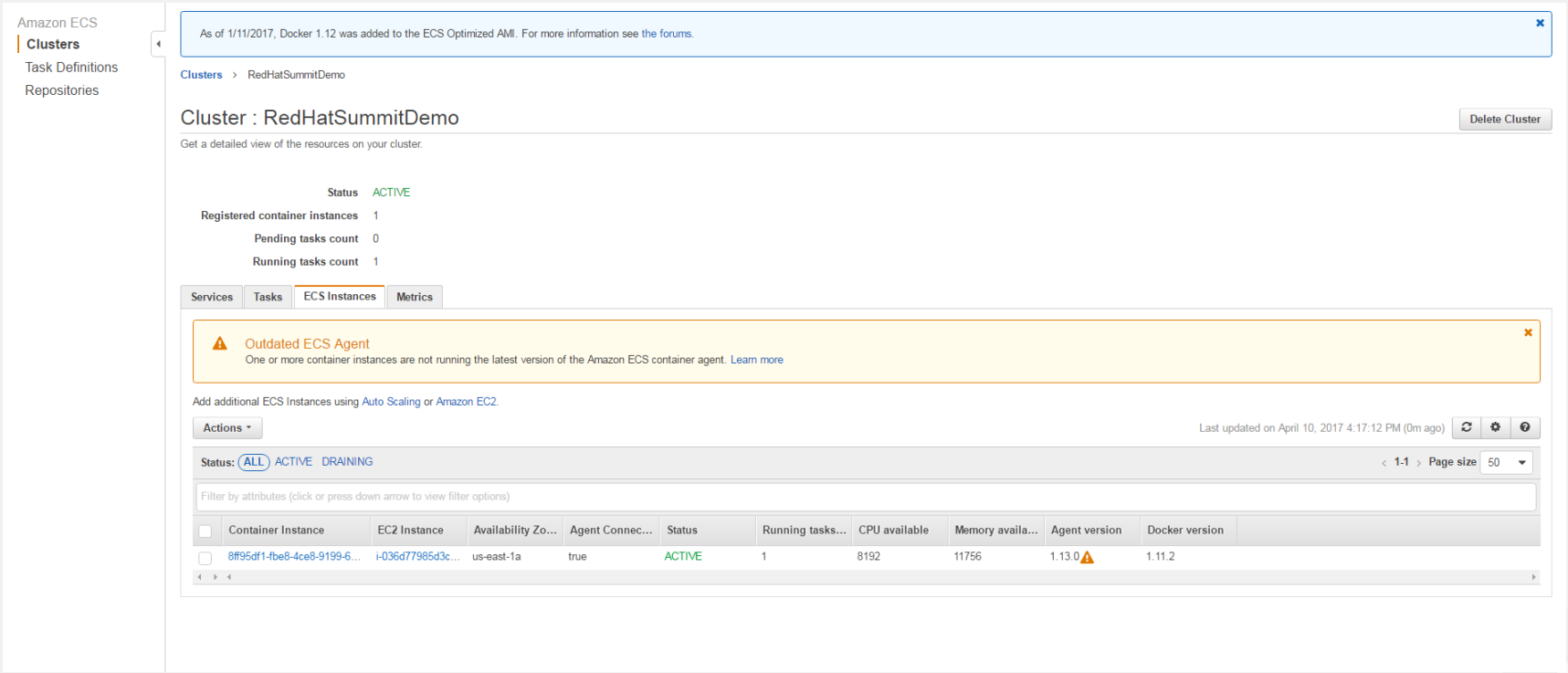
Task is deployed successfully



Task is deployed successfully



EC2 Container Instance is running



Lessons Learned of this approach

- Coordinator can be a single of 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

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