Using AWS Resilience Hub To Monitor Cloud Architectures

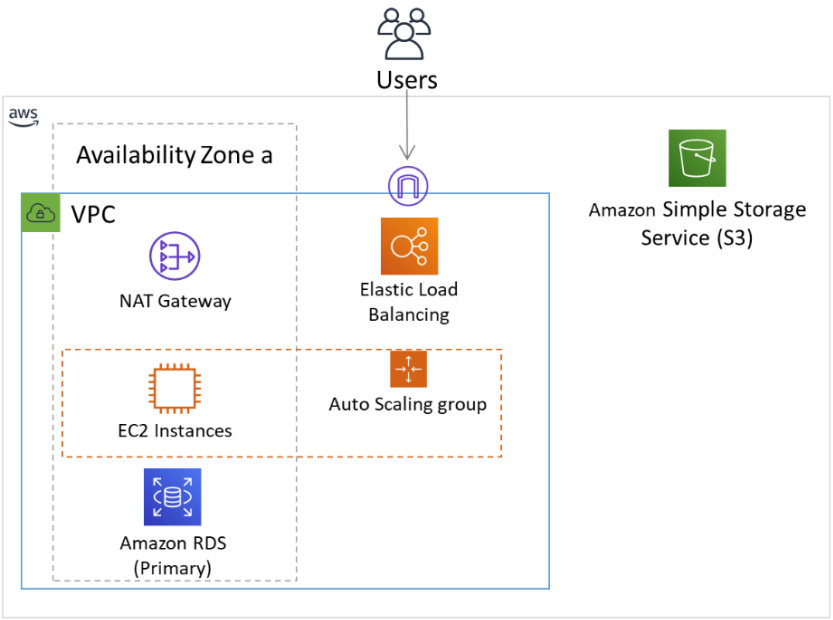
By Gerald Blackmon 08/26/2022

The objective of this lab is to deploy a workload and use AWS Resilience Hub to measure its resiliency. You will learn to use recommendations provided by Resilience Hub to make improvements to the workload and ensure it meets the resiliency targets you are looking for. You will also perform Chaos testing on the workload using AWS Fault Injection Simulator (FIS) to measure the effectiveness of workload improvements by intentionally inducing failure and seeing how the workload responds. By the end of the lab you should have an understanding of how Resilience Hub can be used to measure and improve your application resilience.

1. Deploy the workload.
2. Add and assess application using AWS Resilience Hub.
3. Resiliency findings and recommendations.
4. Operational recommendations.
5. Chaos testing with AWS Fault Injection Simulator.

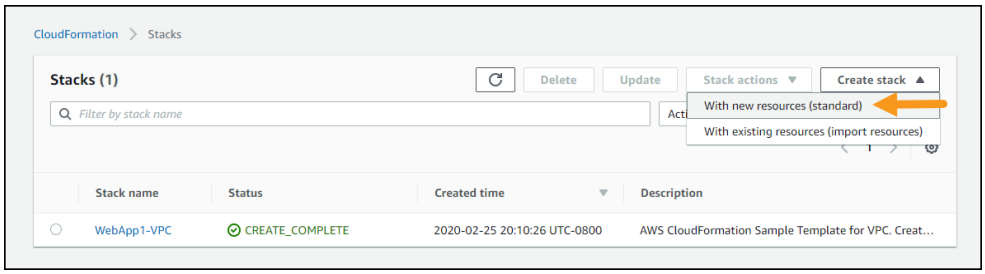
Wordpress Web application architecture

The architecture diagram below shows an overview of the WordPress application infrastructure we will deploy in phase 1. It is a 3-tier architecture consisting of an application load balancer, an autoscaled fleet of EC2 instances, and an RDS database in a single Availability Zone (AZ). The EC2 instances have outbound connectivity through a NAT Gateway and static assets for the application are stored in an S3 bucket.



Deploy The Template

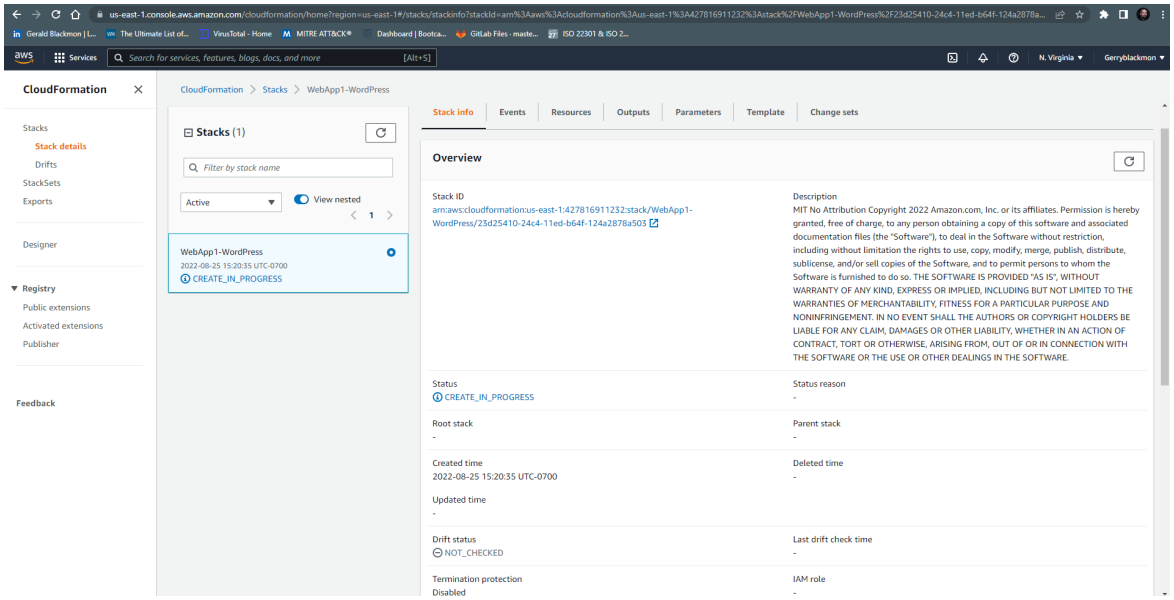
1. Select **us-east-1** for the region.
2. Download the wordpress_singleaz.yaml CloudFormation template to your local machine.
3. Navigate to the CloudFormation console and click **Create Stack** > **With new resources (standard)**.



4. For **Prepare template** select **Template is ready**, and select **Upload a template file** under **Template source**. Choose the CloudFormation template that you downloaded at the beginning of this section and click **Next**.
5. Enter **WebApp1-WordPress** for the **Stack name**.

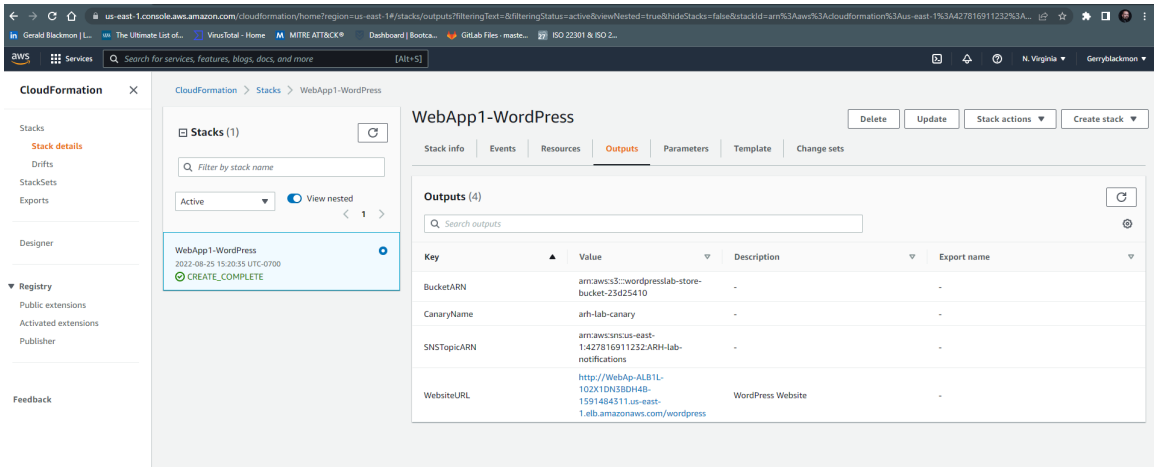
Deployed URL:
http://WebAp-ALB1L-102X1DN3BDH4B-1591484311.us-east-1.elb.amazonaws.com/wordpress

Stack ID

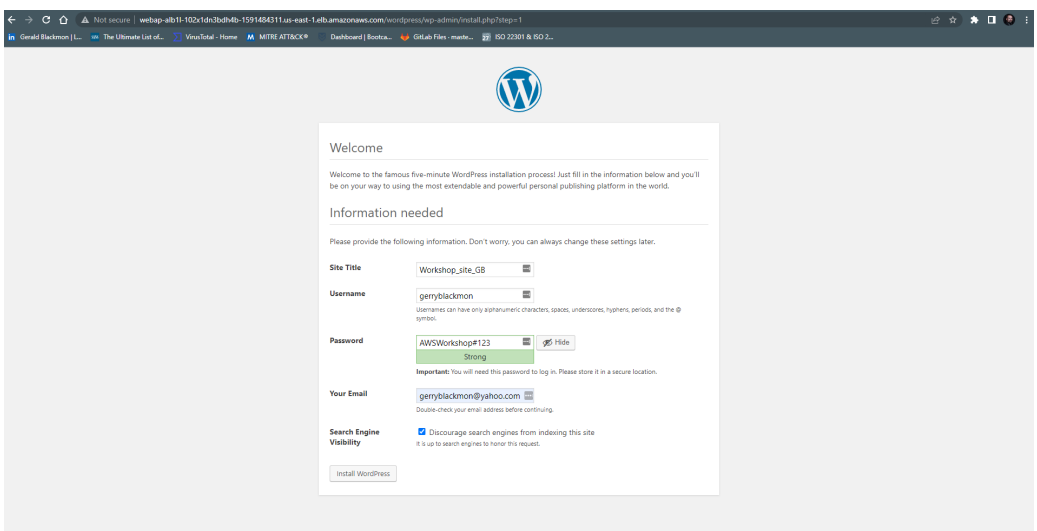


Outputs

BucketARN	arn:aws:s3:::wordpreslab-store-bucket-23d25410	-	-
CanaryName	arh-lab-canary	-	-
SNSTopicARN	arn:aws:sns:us-east-1:427816911232:ARH-lab-notifications	-	-
WebsiteURL	http://WebAp-ALB1L-102X1DN3BDH4B-1591484311.us-east-1.elb.amazonaws.com/wordpress		



Wordpress site credentials



We selected the policy from a suggested policy bank in AWS. The policy selected was for a **Mission Critical Application**. This gave us the Application RTO & RPO as well as the Infrastructure RTO & RPO

Step 2: Identify resources

Edit

Resources (9) Info

AWS Resilience Hub will assess the listed resources, unless you choose to exclude them.

Find resources

1

Any resource type

Logical ID	Resource type	Component name	Physical ID	Status
ALB1LoadBalancer	AWS::ElasticLoa...	networkingappcom...	arn:aws:elasticlo...	Included
CanaryBucket	AWS::S3::Bucket	storageappcompon...	arh-lab-canary-...	Included
RDSDBInstance1	AWS::RDS::DBIns...	databaseappcompo...	webapp1-wordp...	Included
S3BucketStore	AWS::S3::Bucket	storageappcompon...	wordpresslab-st...	Included
Web1InstanceA...	AWS::AutoScalin...	computeappcompo...	Webapp	Included
vpcnatgw	AWS::EC2::NatG...	networkingappcom...	nat-0cc1f981a3...	Included
DB1KMSKey	AWS::KMS::Key	-	343a6b5b-9c54...	Not supported
SNSTopic	AWS::SNS::Topic	-	arn:aws:sns:us-e...	Not supported
DB1Secret	AWS::SecretsMa...	-	arn:aws:secrets...	Not supported

Resiliency policy

Policy name
ARH-lab

Description
-

Tier
Mission critical

Customer Application RTO and RPO Info

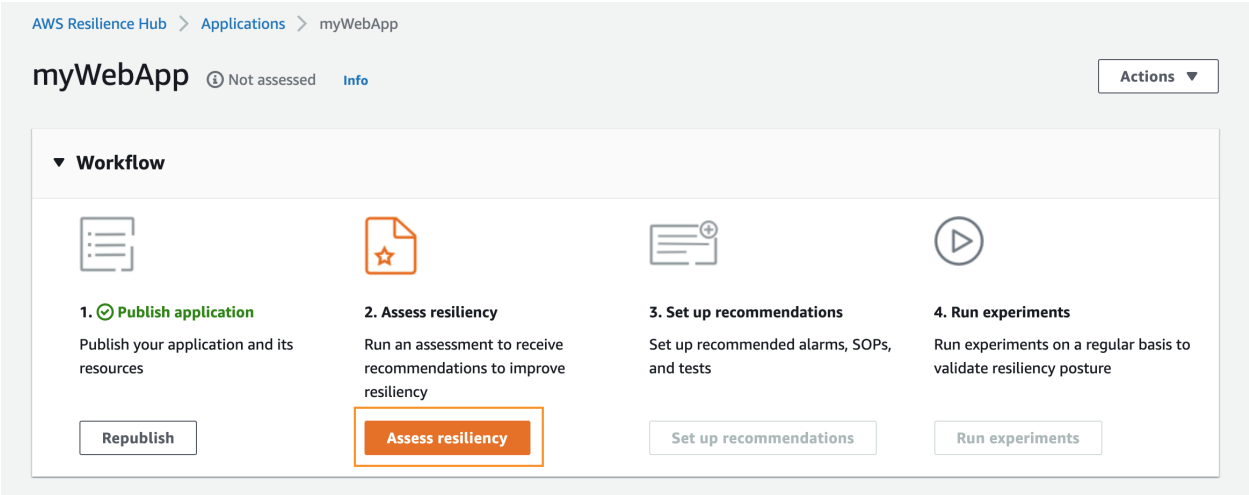
Type	RTO	RPO
Application	1h	15m

Cloud Infrastructure RTO and RPO Info

Type	RTO	RPO
Infrastructure	5m	5m
Availability Zone	5m	5m
Region	-	-

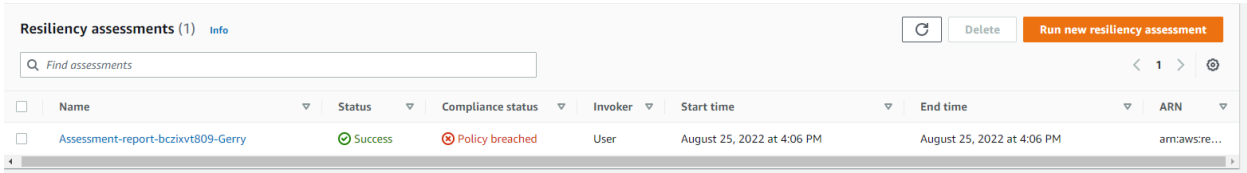
Assess Workload Resiliency

Once the application has been published, we take note of the workflow described by Resilience Hub for the application.



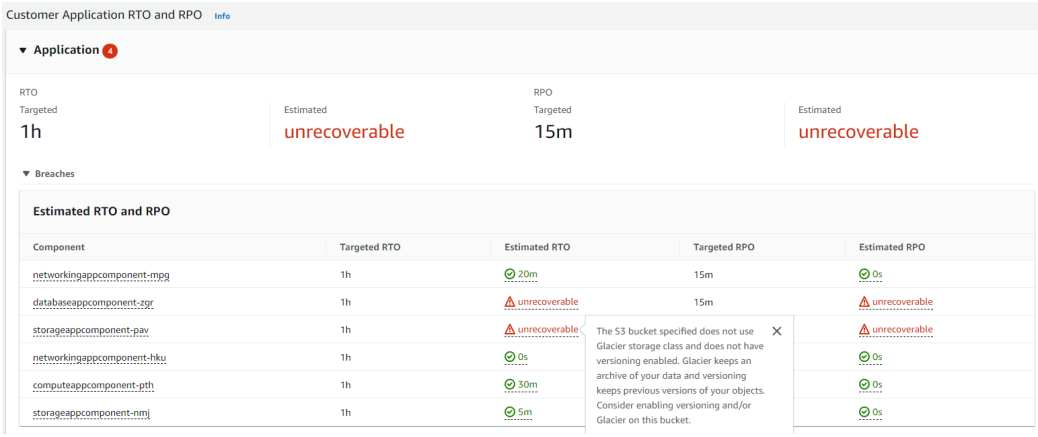
1. Click **Assess resiliency**, enter a report name and then **run**. Resilience Hub now assesses the resiliency posture of our application and compares it to the targets that were defined when we created the Resiliency policy.
2. The **Assessments** tab should then auto select, you may see the status go to **Pending** briefly before going to **Success**.
3. After the assessment is complete and the status has changed to **Success**, look at the **Compliance status** for the report.

After completing the assessment Resilience Hub has determined that our resiliency targets cannot be met with the current architecture. This means that if an incident were to occur, our application will not be able to recover **within the RTO and RPO** defined in the policy used for the assessment.



Results

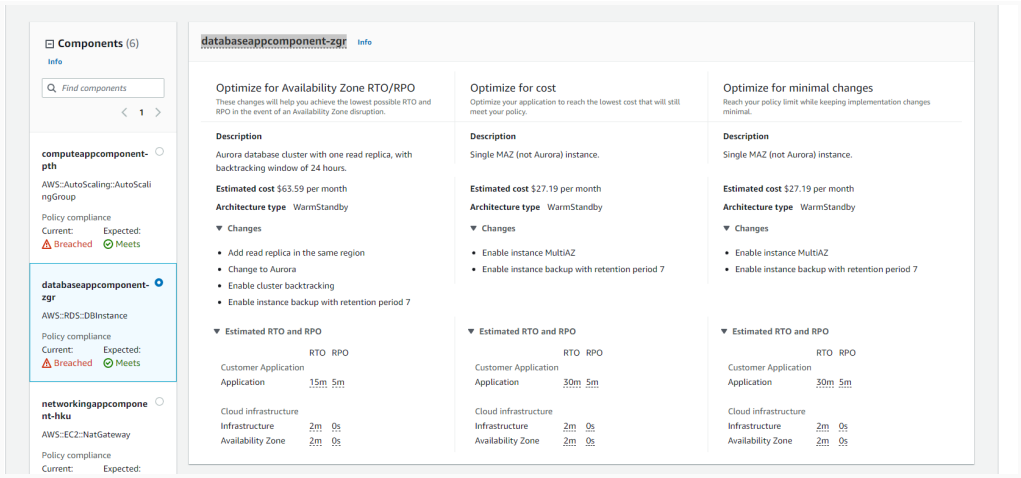
1. Click on the Assessment report to expand more details about the policy breach.
2. In the **Results** tab we are able to see a few things as a summary and specifically, what has caused the breach and what the Estimated RTO/RPO is for each Disruption type. (1 example of the results shown below)



Resiliency recommendations

In addition to assessing your application's resiliency, Resilience Hub also provides guidance on how improvements can be made to architecture in order to satisfy the RTO/RPO requirements defined in the resilience policy that we created.

1. Select the **Resiliency recommendations** tab and scroll down and select the **databaseappcomponent** component. Resilience Hub shows us some different options here that we can take to meet our resiliency needs. These changes have associated costs and Resilience Hub gives an **Estimated cost** & **Architecture type**. Below are the recommendations for our database component. An important aspect to note is the cost difference between optimizing for RTO/RPO and that of optimizing for cost and minimal changes.
2. An example provided below outlines the recommendations for **databaseappcomponent-zgr**

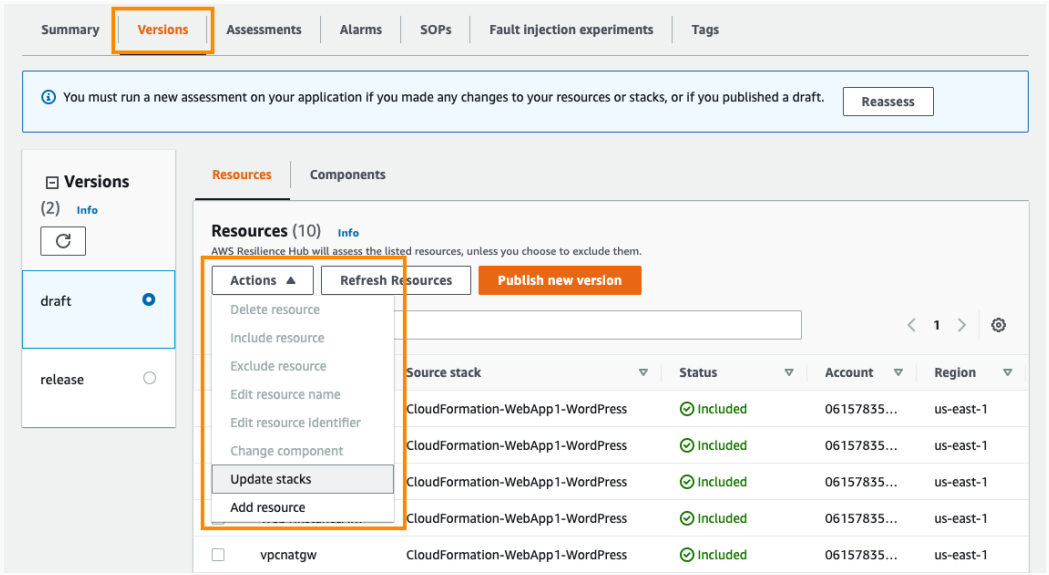


To implement the recommendations made by Resilience Hub, we will once again use AWS CloudFormation.

1. Download the wordpress_multiaz.yaml CloudFormation template, it already contains the necessary changes to implement the best practices outlined in the table above.
2. Navigate to the AWS CloudFormation console , select the stack for our workload - WebApp1-WordPress, and click Update.

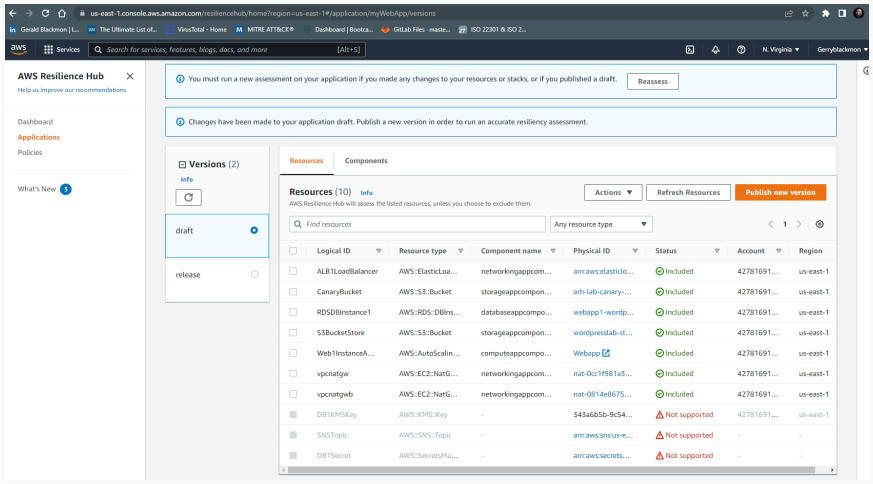
3. Under Prerequisite - Prepare template, choose Replace current template. Select Upload a template file under Specify template, provide the new template that you downloaded - wordpress_multiaz.yaml

1.
2. Once the update is complete, go back to the Resilience Hub dashboard for the application.
3. Select the Versions tab, click Actions and select Update stacks. Since we have made changes to our CloudFormation stack, we need to import the new resources that were created into the application on Resilience Hub.

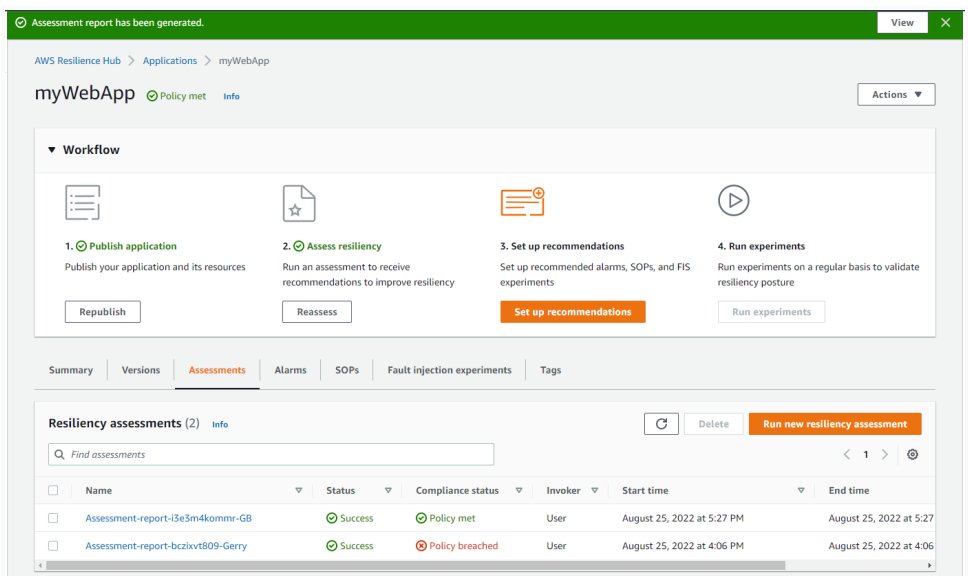


From the dropdown, select the WebApp1-WordPress stack and click Update. Resilience Hub will now pull in any new resources that may have been created as part of the CloudFormation stack update.

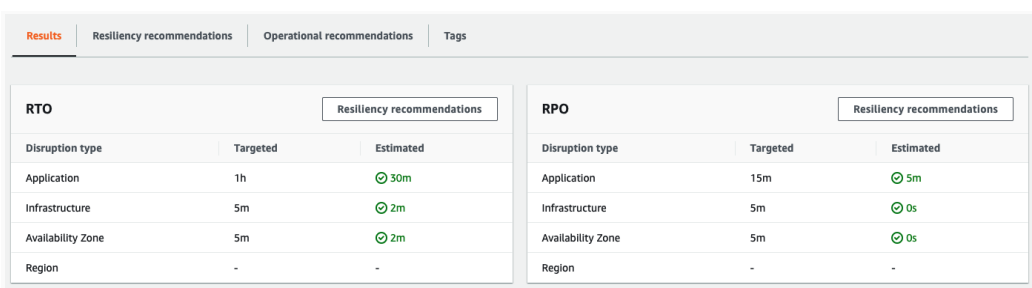
Now that the new resources have been imported, it is time to publish a new version of the application that reflects the updated architecture. Click on Publish new version and then Publish. The application has now been updated on Resilience Hub.



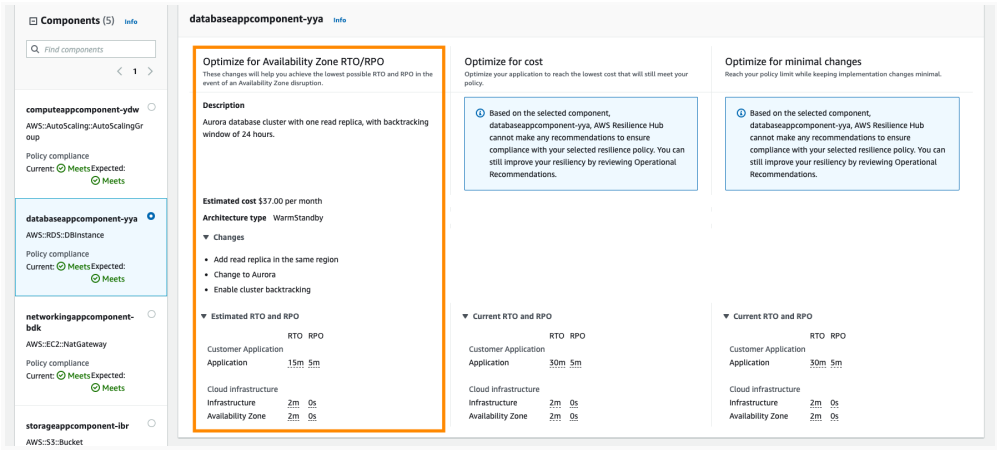
From the workflow section, select Reassess to run a new assessment of the application resiliency against our policy. The results are now “Policy met”



Click on the report to view additional details. The resiliency recommendations summary shows us the Targeted and Estimated RPO and RTO assessments against the different Disruption types.



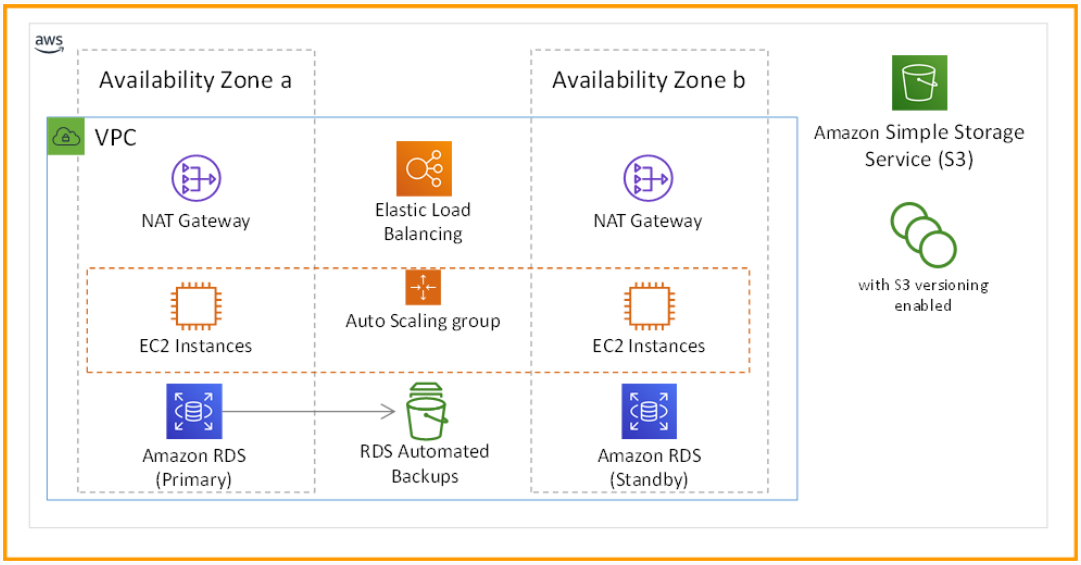
Next check the Resiliency recommendations, four out of five components state that AWS Resilience Hub has no further recommendations for this component. This is for **Computeapp**, Networkingapp & both the Storageapp components. The **databaseapp** component does still show us a potential resiliency improvement based around switching to using Aurora and backtracking.



However, the architecture that we have currently deployed still *Meets* the criteria we have setup in our Resiliency policy within Resilience Hub.

Final Architecture

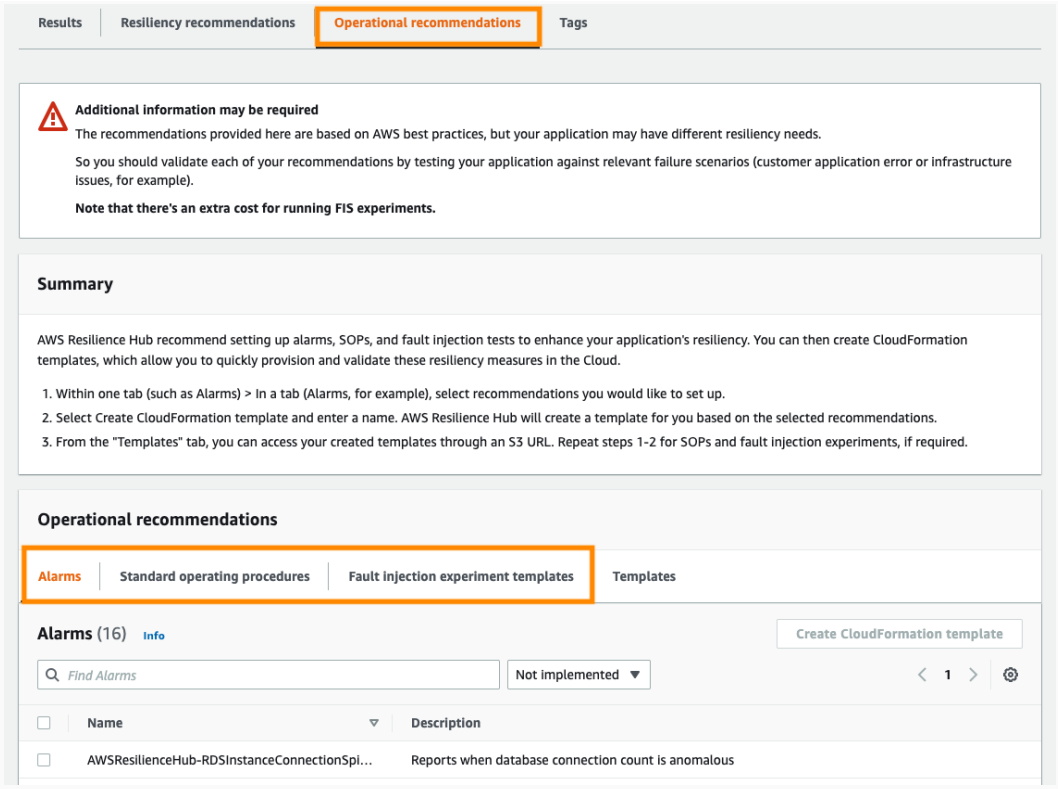
In phase 2, we implement the recommendations provided by Resilience Hub results in this final architecture. The changes are exactly as described in the table above.



Operational recommendations

In addition to resiliency recommendations, Resilience Hub also provides guidance on how to improve operations. Operational recommendations contain recommendations to set up alarms, Standard Operating Procedures (SOPs), AWS Fault Injection Simulator experiments, and AWS CloudFormation tests (learn more here). In this section, we will review the operational recommendations provided by Resilience Hub and see how they can be implemented for the application.

1. Navigate to the AWS Resilience Hub console .
2. Select the application that was created as part of this workshop, click on the Assessments tab and open the most recent assessment report.
3. Select the Operational recommendations tab. Resilience Hub provides 3 types of operational guidance:
    - Alarms - are used to monitor the health of your application and alert you if a specified metric reaches a threshold that you've configured.
    - SOPs - is a prescriptive set of steps designed to efficiently recover your application in the event of an outage or alarm.
    - Fault injection experiment templates - are designed to stress-test your application's resilience by simulating outages to your AWS resources.



In the following sections, we will implement the Alarms and Fault injection experiment templates recommendations. Implementing SOPs is a similar process but is outside the scope of this lab. Learn more about implementing SOPs.

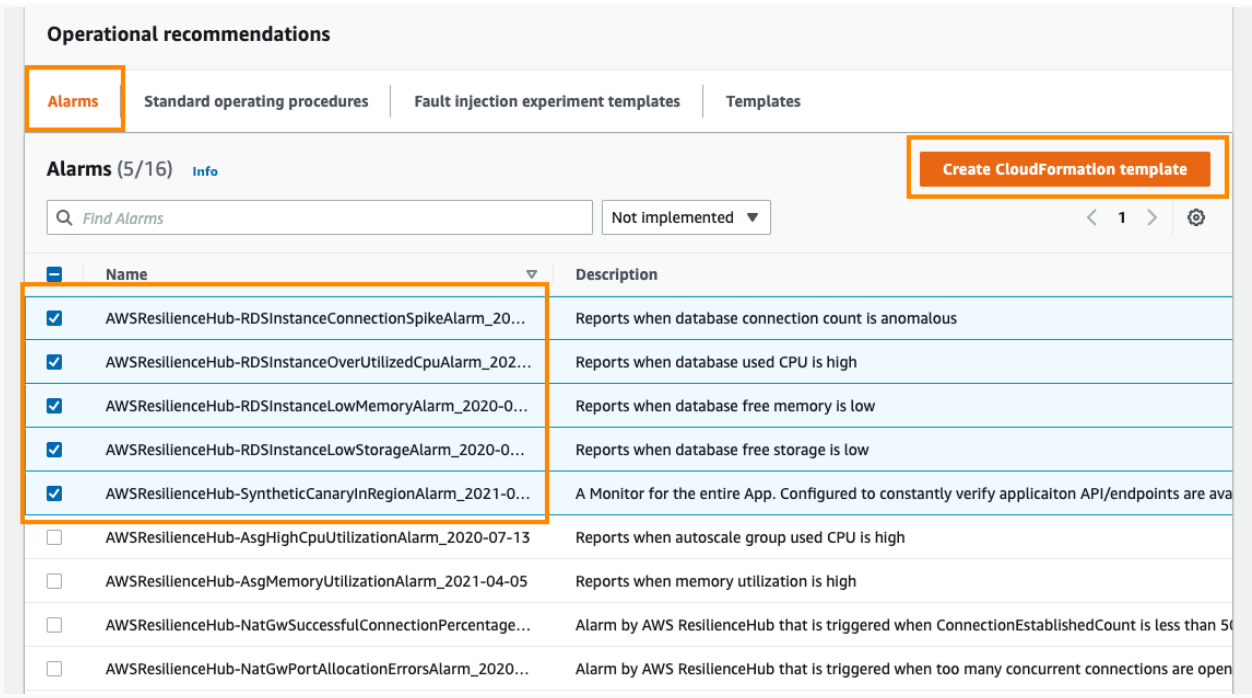
Alarms

Select the Alarms tab to see a list of alarms that Resilience Hub recommends.

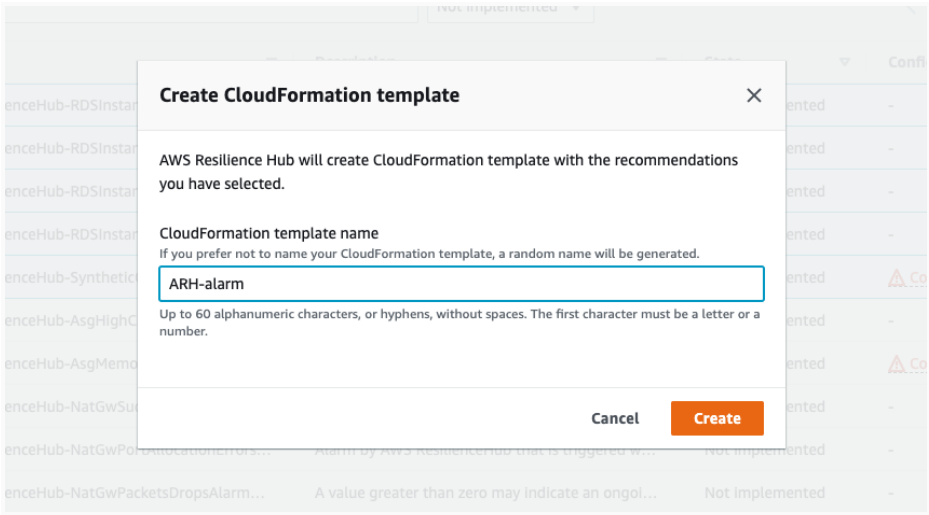
Some of the alarms such as AWSResilienceHub-SyntheticCanaryInRegionAlarm_2021-04-01 require additional configuration. You can find details on what the prerequisites are by clicking on Configuration for the alarms that need one.

For this lab, select the following synthetics canary and RDS alarms:

- AWSResilienceHub-SyntheticCanaryInRegionAlarm_2021-04-01
- AWSResilienceHub-RDSInstanceLowStorageAl
- AWSResilienceHub-RDSInstanceLowMemoryAlarm_2020-04-01
- AWSResilienceHub-RDSInstanceOverUtilizedCpuAlarm_2020-04-01
- AWSResilienceHub-RDSInstanceConnectionSpikeAlarm_2020-04-01

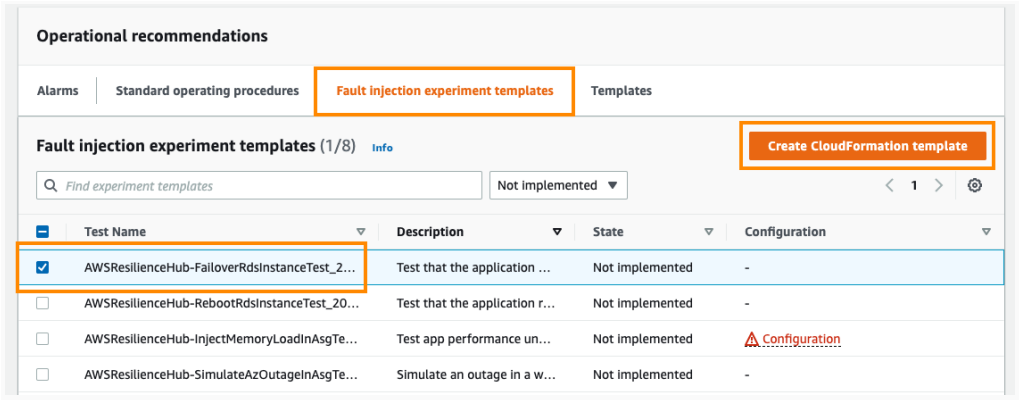


Resilience Hub makes it easy to implement these best practice alarms by providing CloudFormation templates. Click Create CloudFormation template, enter ARH-alarm for the template name and click Create. We will cover how to use these templates in a later section of the lab.

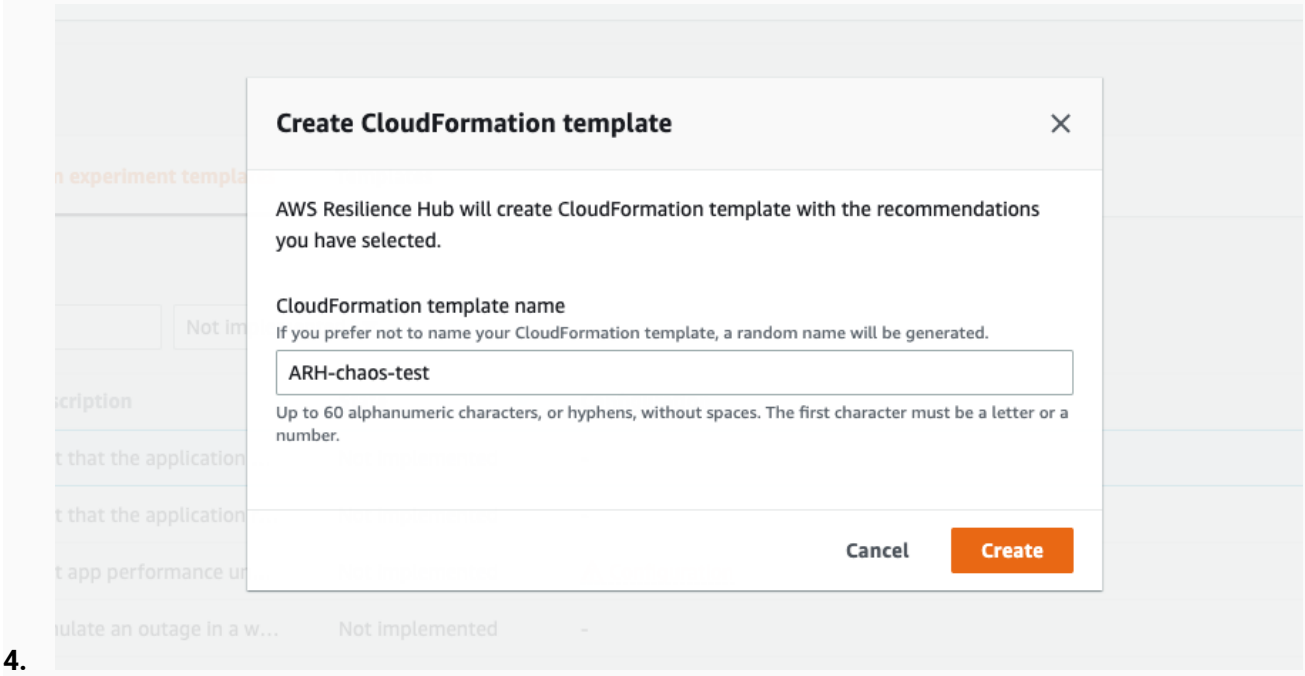


Fault injection experiment templates

1. Select the Fault injection experiment templates tab to see a list of fault injection experiments you can run on your application.
2. Some of the experiment templates such as AWSResilienceHub-InjectCpuLoadInAsgTest_2021-09-22 requires additional configuration. You can find details on what the prerequisites are by clicking on Configuration for the templates that need one.
3. For this lab, select the AWSResilienceHub-FailoverRdsInstanceTest_2020-04-01 experiment template. The Description for the experiment template provides information on what it does.



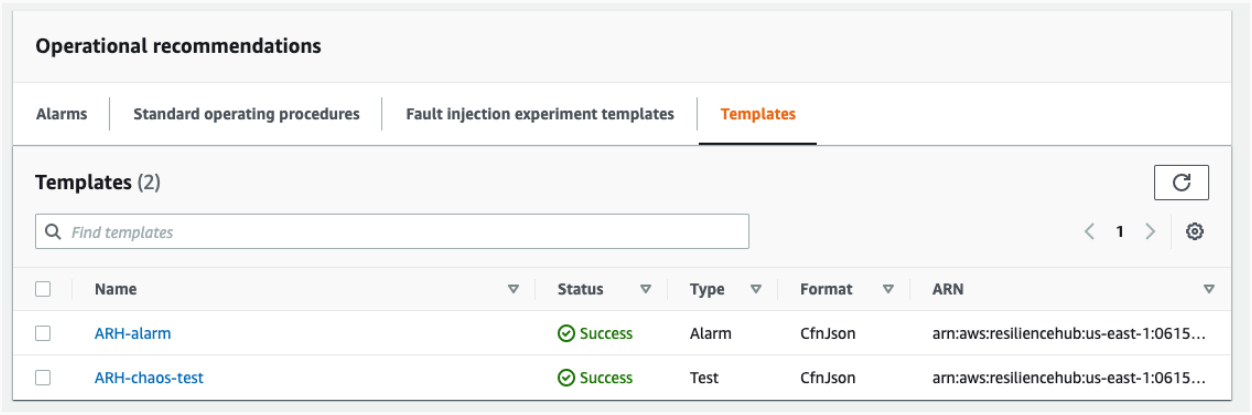
Click Create CloudFormation template and enter ARH-chaos-test for the template name.

4. 

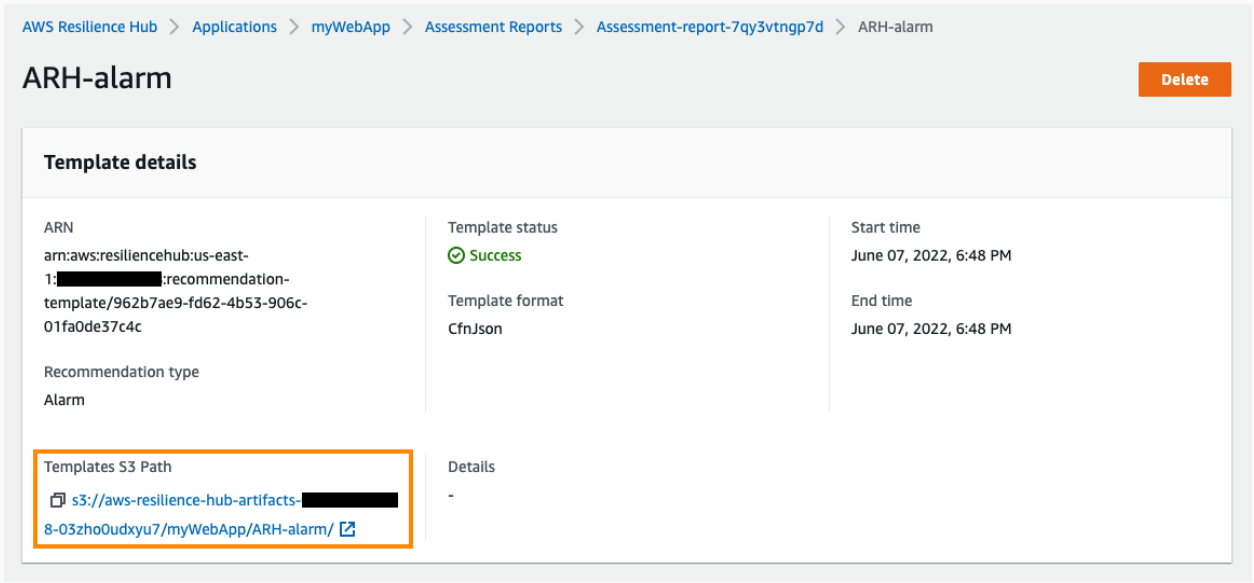
<u>CloudFormation templates</u>

In the previous sections, we selected the operational recommendations to implement from the list provided by Resilience Hub and generated CloudFormation templates for them. Now, we will deploy the templates generated by Resilience Hub and dive into the benefits that the application gains.

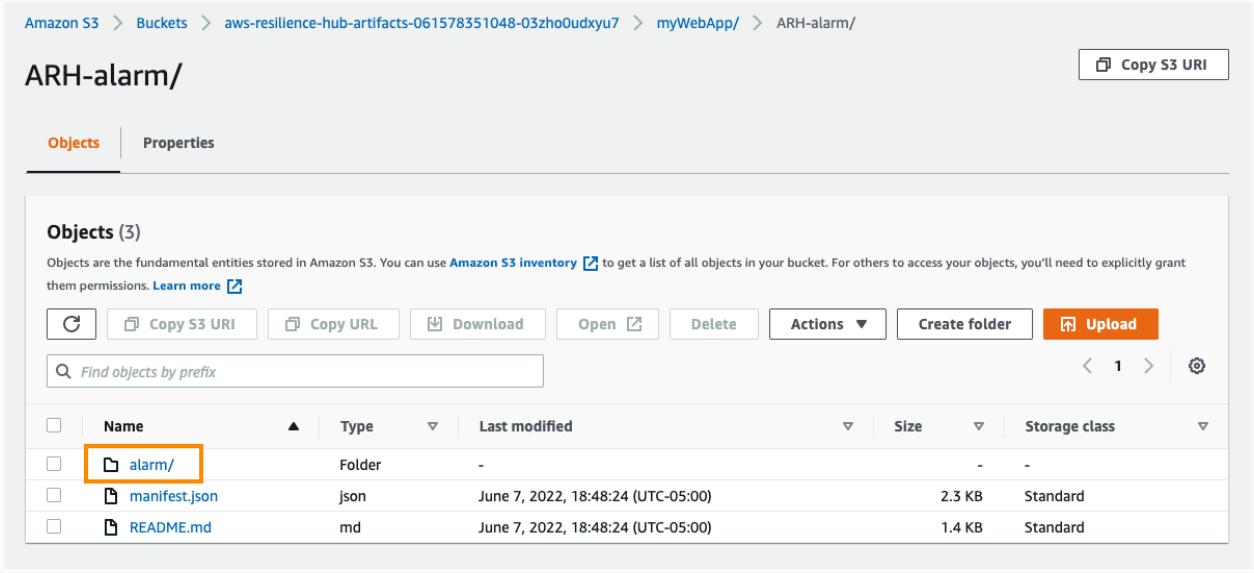
1. Under Operational recommendations, select the Templates tab. You will see a list of CloudFormation templates generated by Resilience Hub. Click on the ARH-alarm template.



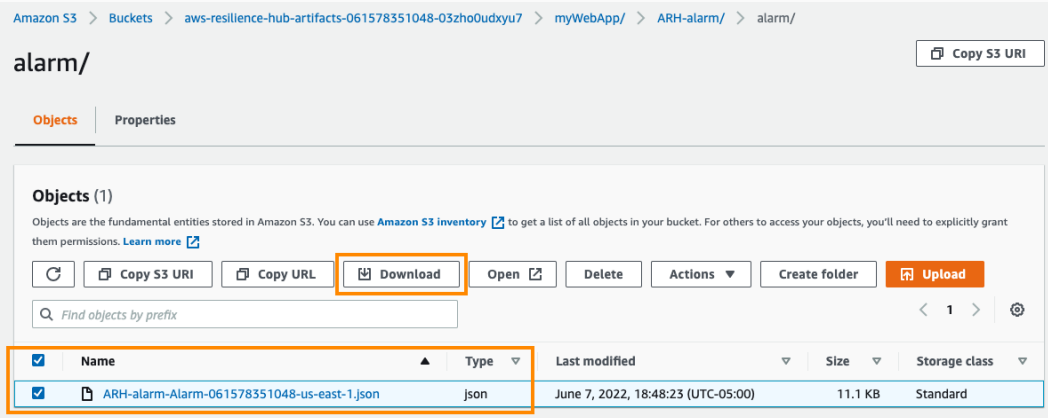
2. ARH stores the CloudFormation templates in Amazon Simple Storage Service (S3) for durability and ease of access. Click on the link under Templates S3 Path to navigate to the S3 location where the template is stored.



3. Depending on the type of recommendation the template was created for, you should see a folder named alarm, sop, or test. Since this is the ARH-alarm template, you should see a folder named alarm in the bucket.

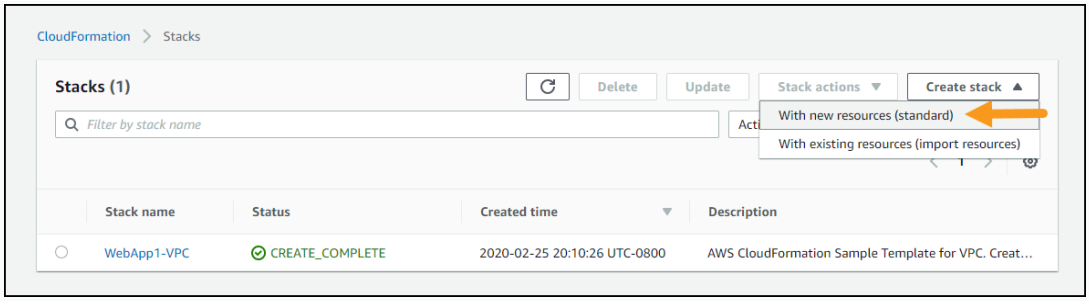


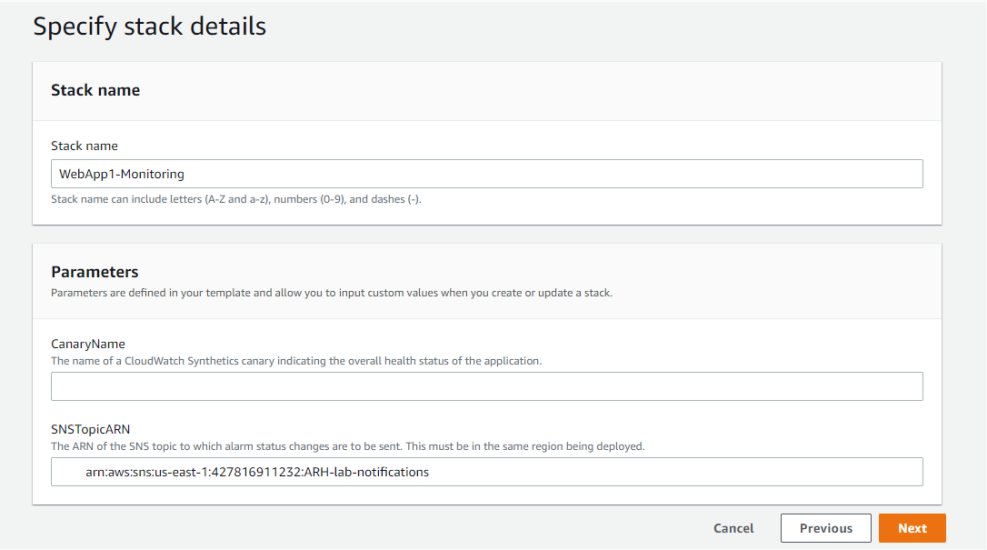
4. Navigate into the alarm folder and you will see the CloudFormation template (a JSON file).
5. Download the template file to your local machine by clicking Download.

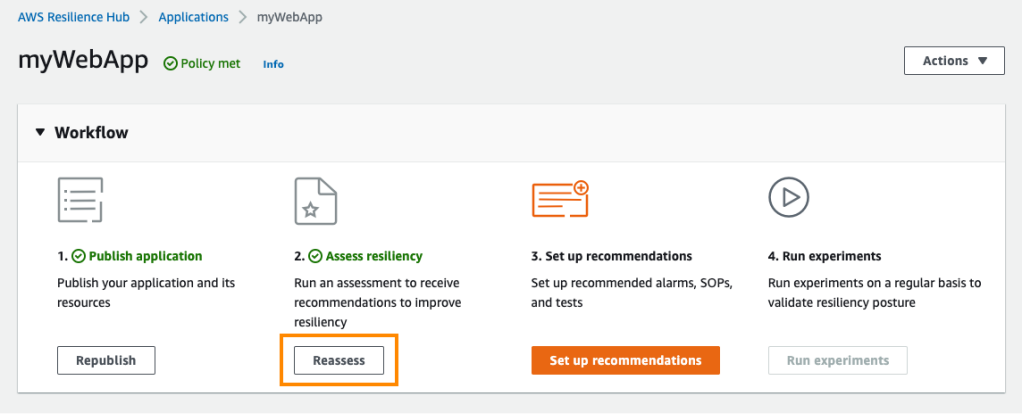
6. 

7. Repeat steps 1-7 for the ARH-chaos-test template.

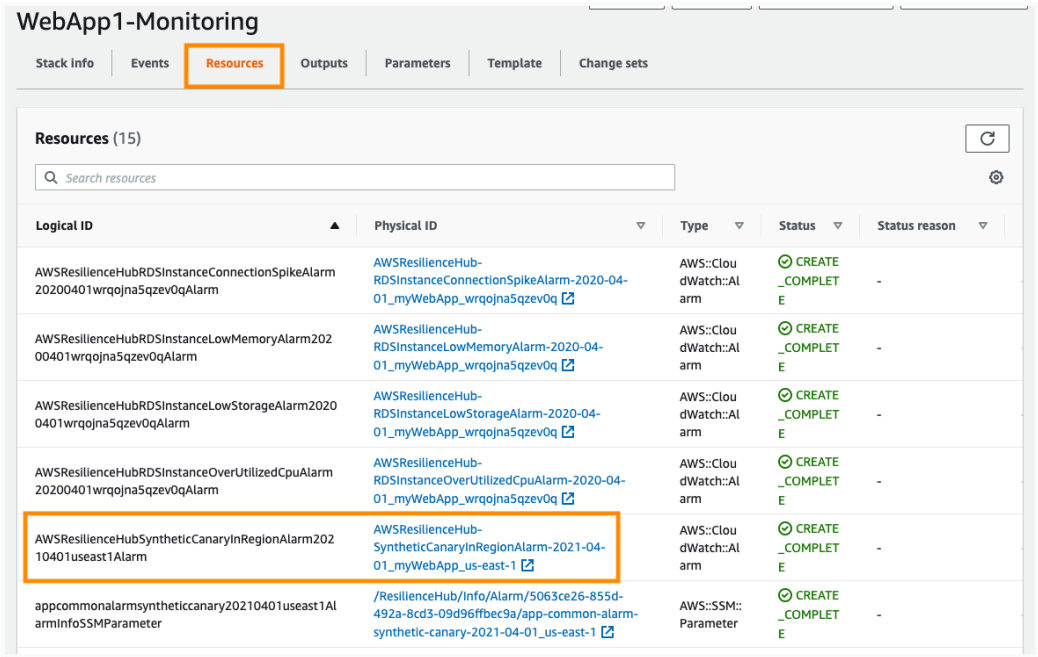
Once both templates have been downloaded, it is time to deploy them using CloudFormation.

1. Navigate to the CloudFormation console and click Create Stack > With new resources (standard).
2. 

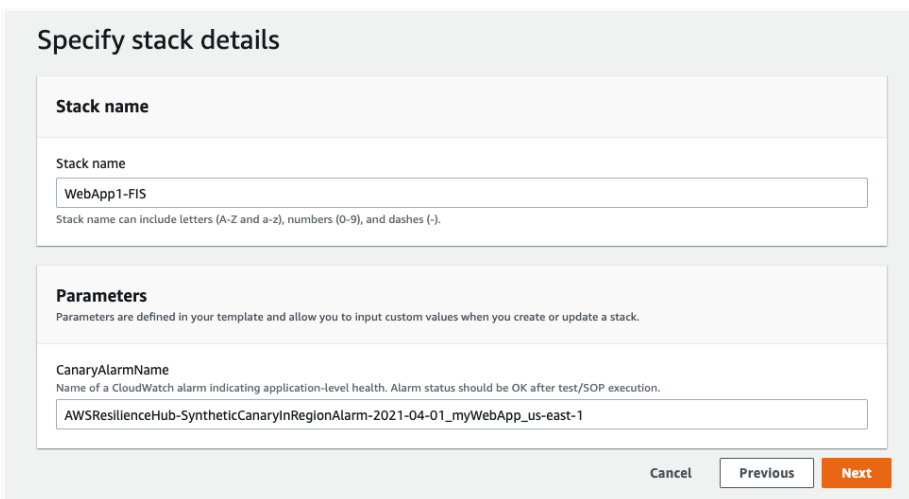
3. For Prepare template select Template is ready, and select Upload a template file under Template source. Select the ARH-alarm template that was downloaded in the previous section.
4. Enter WebApp1-Monitoring for the Stack name.
5. For the parameters, enter the value of the SNS Topic ARN and canary name obtained from the Outputs section of the WebApp1-WordPress stack.
6. 

7. Click Next till you get to the Review page and click Create stack.
8. Wait for CREATE_COMPLETE
9. Wait for the CloudFormation stack status to change to CREATE_COMPLETE before proceeding.
10. After the stack reaches CREATE_COMPLETE, navigate to the ARH console and select the application myWebApp.
11. Under Workflow, click Reassess to run a new assessment of the application.
12. 

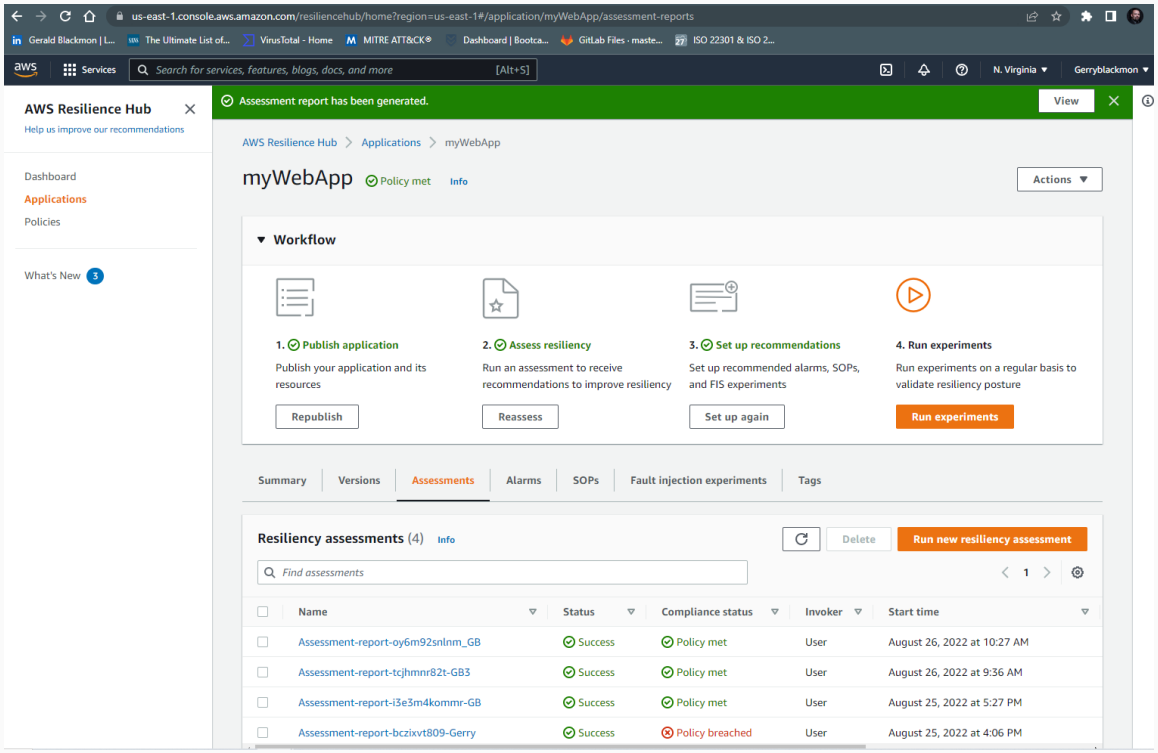
13. After the assessment is complete, consider: What changes would you expect you see in the Resilience Hub results? (hint: the architecture did not change, so we would *not* expect changes to the Resiliency recommendations.)
    - Click Applications on the left side
    - Click your application named myWebApp
    - Click the Summary tab to see the Resiliency Score. You should see that the Resiliency Score of the application has increased. This is because of the operational recommendations (creating alarms) that have been implemented.
14. Navigate back to the CloudFormation console and select the WebApp1-Monitoring stack. Click on the Resources tab and locate the logical ID AWSResilienceHubSyntheticCanaryInRegionAlarm20210401useast1Alarm. Copy the value of the corresponding phyiscal ID, this will be used as the parameter value for the chaos testing stack.



15. **Repeat steps 1-7 and create a CloudFormation stack using the ARH-chaos-test template downloaded in the previous section. Use WebApp1-FIS as the stack name and enter the physical ID of the canary alarm (obtained from the previous step) for the parameter CanaryAlarmName.**
16.



After the stack has reached CREATE_COMPLETE, reassess the application on Resilience Hub and see if the Resiliency Score changes. Learn more about what the resiliency score is and how it is calculated



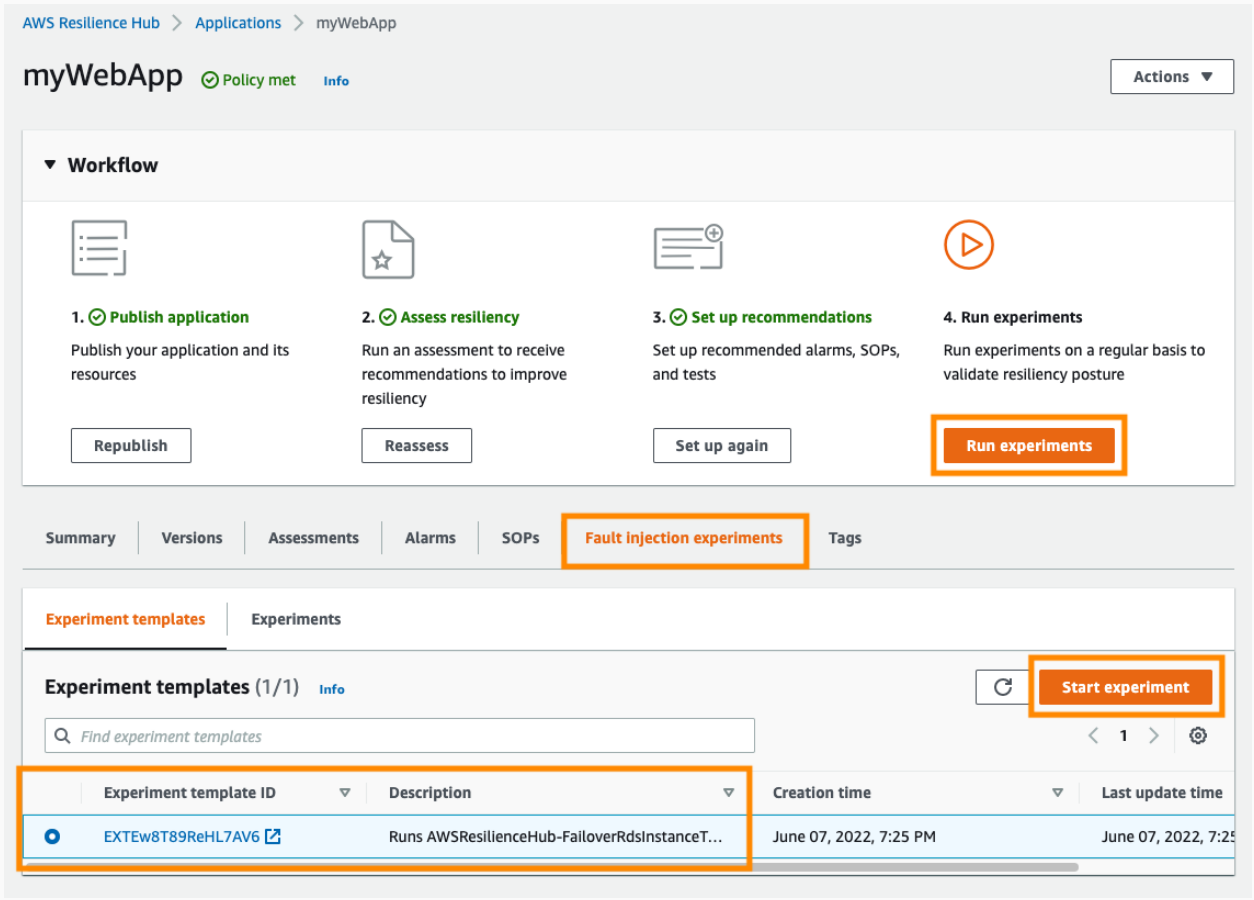
In the next section, we will run a series of tests to verify the resilience as well as the operational improvements made to the application.

Chaos testing with AWS Fault Injection Simulator

Chaos Engineering is the discipline of experimenting on a system (such as by injecting faults) in order to build confidence in the system's capability to withstand turbulent conditions in production. While Resilience Hub is a great way to understand your application's resiliency and make improvements, chaos testing will increase your confidence as you will be able to see your application's response to failures. In this section, we will inject faults into our application using AWS Fault Injection Simulator .

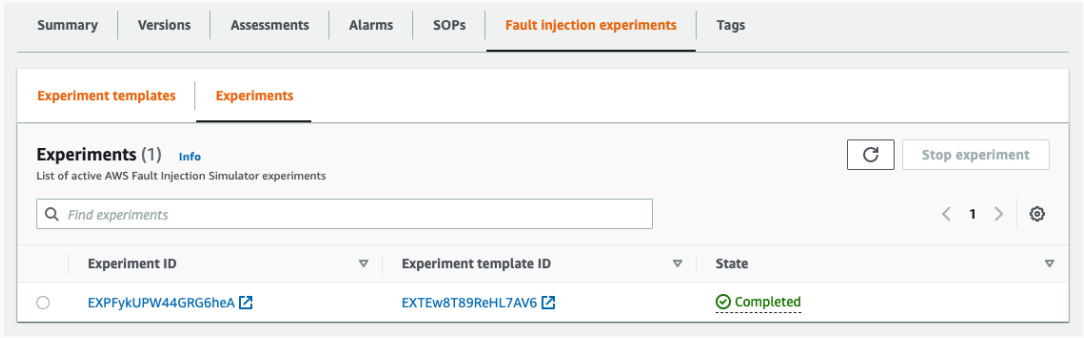
Fault injection

1. Navigate to the Resilience Hub console and select the application myWebApp.
2. Under Workflow, click Run experiments. This will take you to the Fault injection experiments tab where you will see the FIS experiment template that was created in the previous section.
3. Select the experiment template listed there (this was created in the previous section using CloudFormation) and read through the Description to understand what the experiment will be.
4. Click Start experiment and confirm you want to run this experiment.



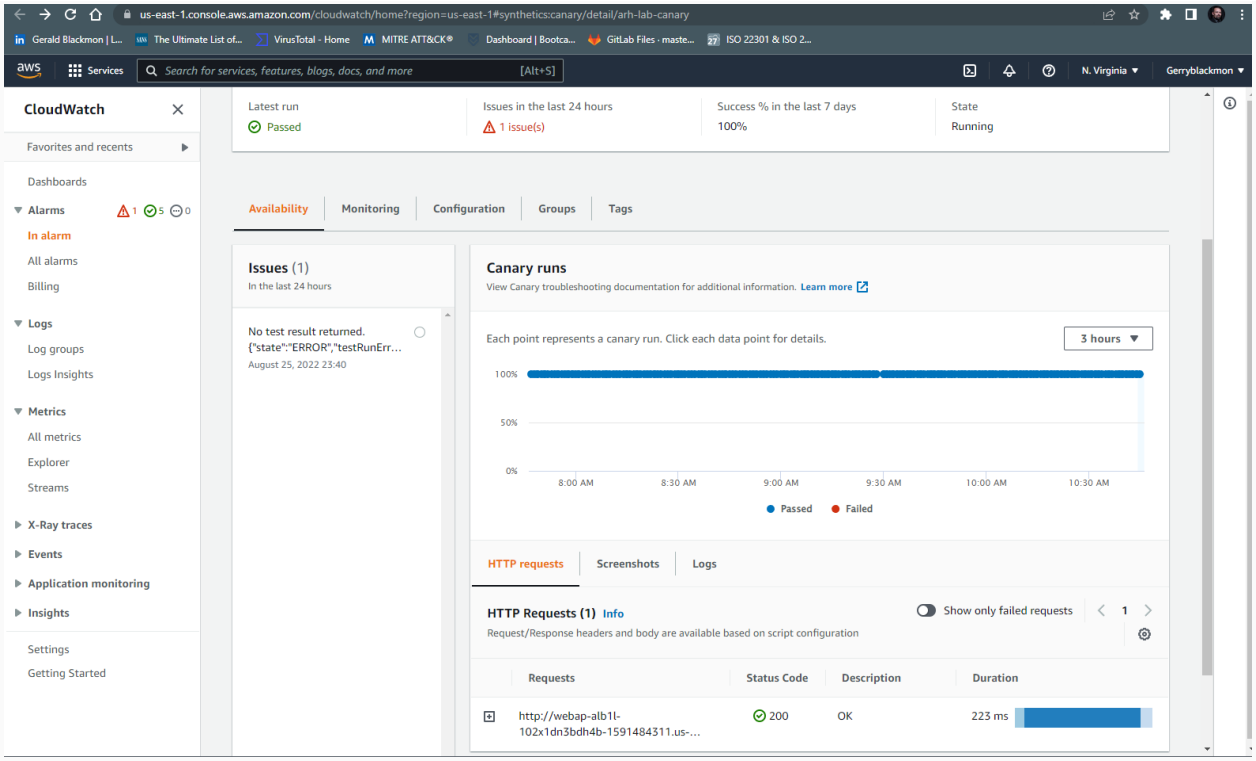
5. The Experiments tab should auto-select and you should see the experiment is Initiating. The State will change to Running after a few seconds and eventually reach Completed. The experiment we are running forces the RDS database to failover to the secondary instance by simulating an outage of the primary instance or Availability Zone. This is running the RebootDBInstance API call under hood and forcing the failover to simulate failure.
6. Navigate to the RDS console and select the database instance that was created as part of this workshop. You should see that the Status is Rebooting.

Wait for the experiment to reach Completed



Navigate to the CloudWatch Synthetics Canaries console. This is the Synthetics canary that has been monitoring our application endpoint by periodically sending it a request and verifying that it is reachable.

Observe the Canary runs data to see if there was an application outage when the FIS experiment was running. You might have to wait a few minutes for the graphs to be updated.



Conclusion

You should see that there was no application outage even when an RDS "outage" occurred and the primary database was no longer reachable. This is because we implemented the resiliency recommendation made by Resilience Hub and deployed the RDS instances across multiple AZs. With chaos testing completed and results verified, you can now be confident that your application can withstand the loss of the primary RDS database or Availability Zone.