
AWS
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ROB201

How to test and train your robots with AWS RoboMaker

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iRobot

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Agenda

Robotics development lifecycle

Simulation benefits

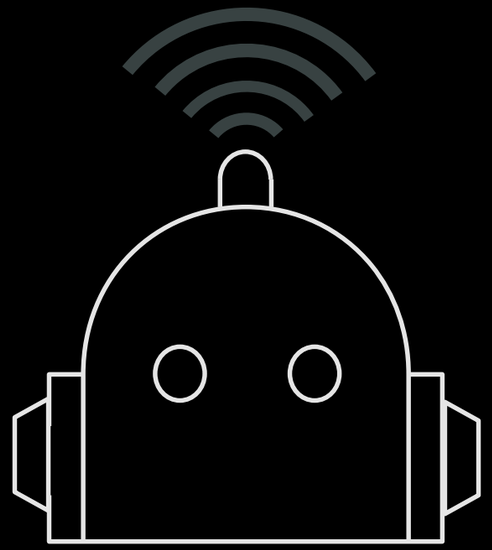
Introduction to AWS RoboMaker simulation

Deep dive into simulation use cases

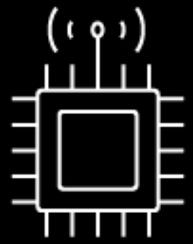


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What defines a robot?



Sense



Compute

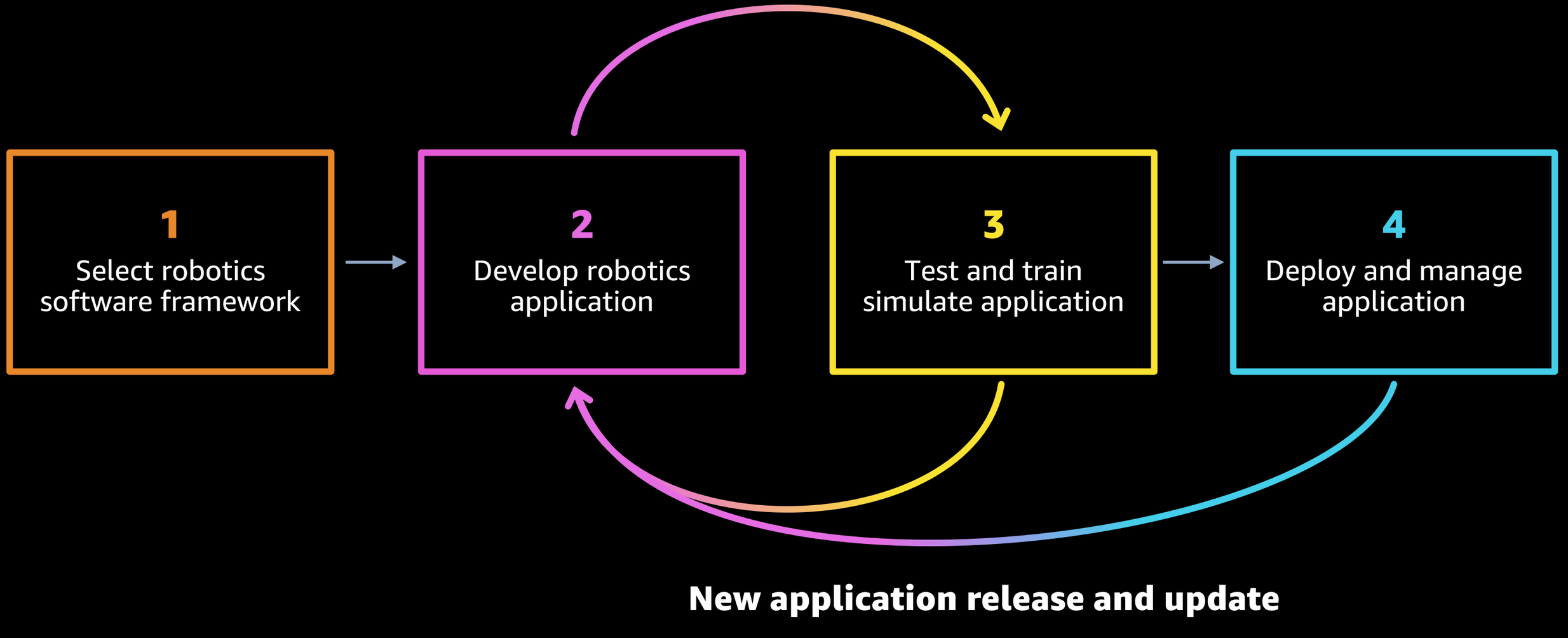


Act

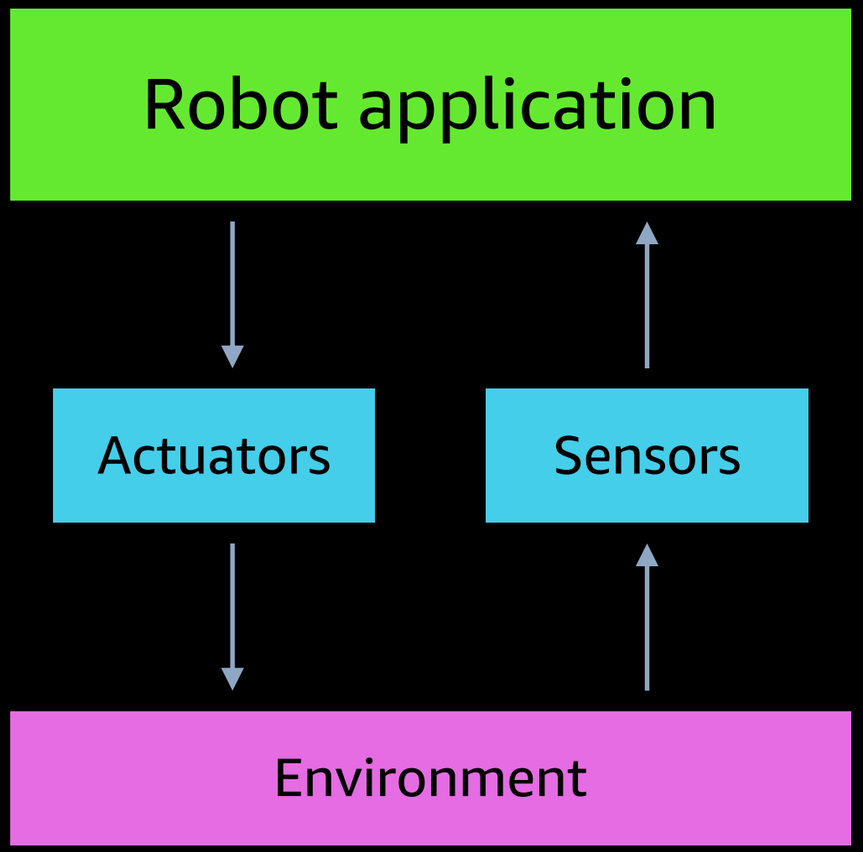


A robot is an autonomous machine that can sense its environment, that performs computations to make decisions, and that performs actions in the real world

Robotics development cycle



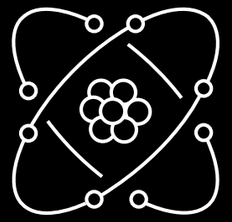
What makes robotics development hard?



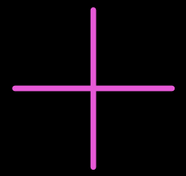
- Multi-domain expertise required to build robots
- Iterative development to get it right
- Limited robot hardware and restricted access to physical environments
- Deployment and updates need to be managed
- Scaling to create multiple scenarios in the physical world is hard

This is where simulation comes in

SIMULATION IS THE BEST POSSIBLE SUBSTITUTE FOR PHYSICAL ROBOTS

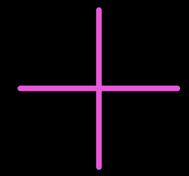


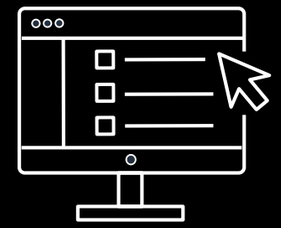
Physics



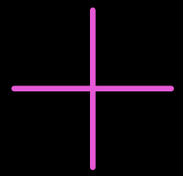


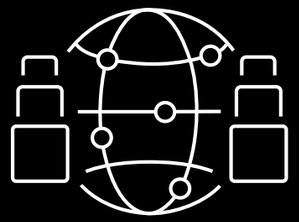
Sensors



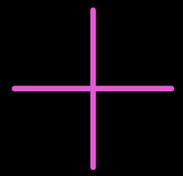


GUI





Interfaces

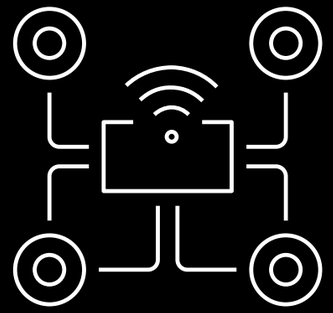




Cloud

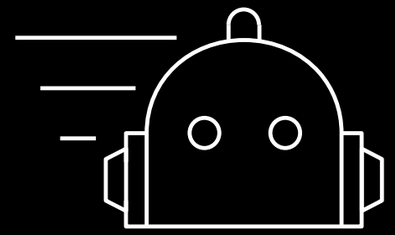
Robotics simulation use cases

Testing



Test robots more robustly with a multitude of testing scenarios

Training



Train machine learning models more rapidly by presenting the robot with a multitude of environmental scenarios

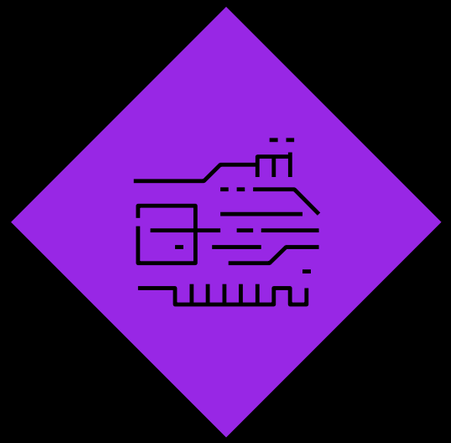
Benefits of testing and training in simulation

FASTER TIME TO MARKET, INCREASED FEATURE RELEASE VELOCITY, FEWER SOFTWARE DEFECTS

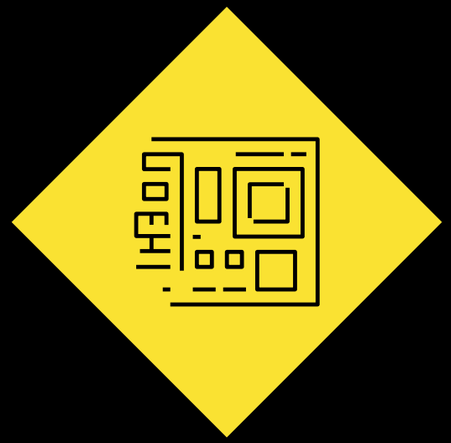


- Safety
- Repeatability
- Speed
- Expanded test coverage
- Reduced costs

Common blockers to using simulation



Infrastructure required to run simulations



Integrating application management and control systems



Consistency across development teams



Difficulty setting up automation

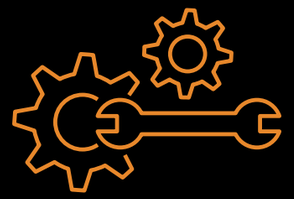


Creation of 3D model assets – world and robot definitions
(Unified Robot Description Format, or URDF)

AWS RoboMaker simulation

FULLY MANAGED INFRASTRUCTURE FOR ROBOTICS SIMULATION

Fully managed



Managed robotics and simulation software stack frees up engineering resources

Highly scalable



Concurrent simulations at cloud scale via a single API call

Cost-effective



Pay-as-you-go pricing at per-CPU and per-minute granularity

Automatic 3D world generation



Automatic generation of virtual simulation worlds with randomization

AWS RoboMaker WorldForge

AUTOMATICALLY GENERATE ONE OR MORE RESIDENTIAL SIMULATION WORLDS WITHIN MINUTES



- Out-of-the-box 3D assets and world templates
- Generate a world within minutes
- $1.5 per generated world versus thousands of dollars
- Concurrent world generation up to hundreds of worlds
- Fully integrated with AWS RoboMaker simulation run
- Tag worlds at creation time

Simulation use cases using AWS RoboMaker



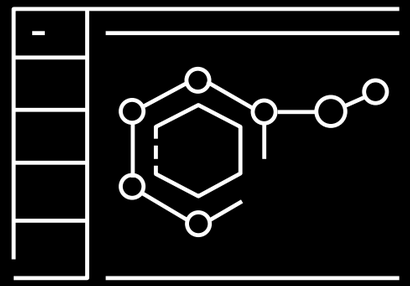
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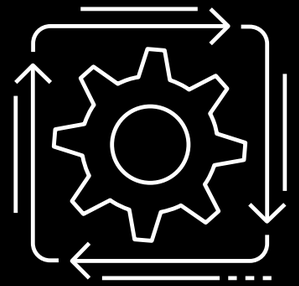
Simulation use cases using AWS RoboMaker

1. Automated regression testing (CI / CD) using simulation
2. Multi-robot simulation
3. Reinforcement learning
4. Sandbox

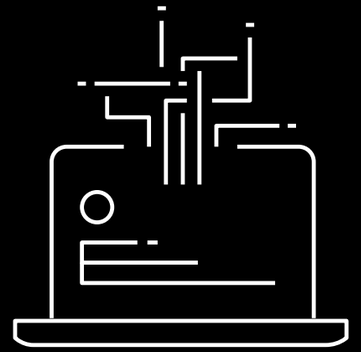
1. Automated CI / CD for robotics development



AWS RoboMaker enables testing in simulation to support CI / CD use cases for robotics development

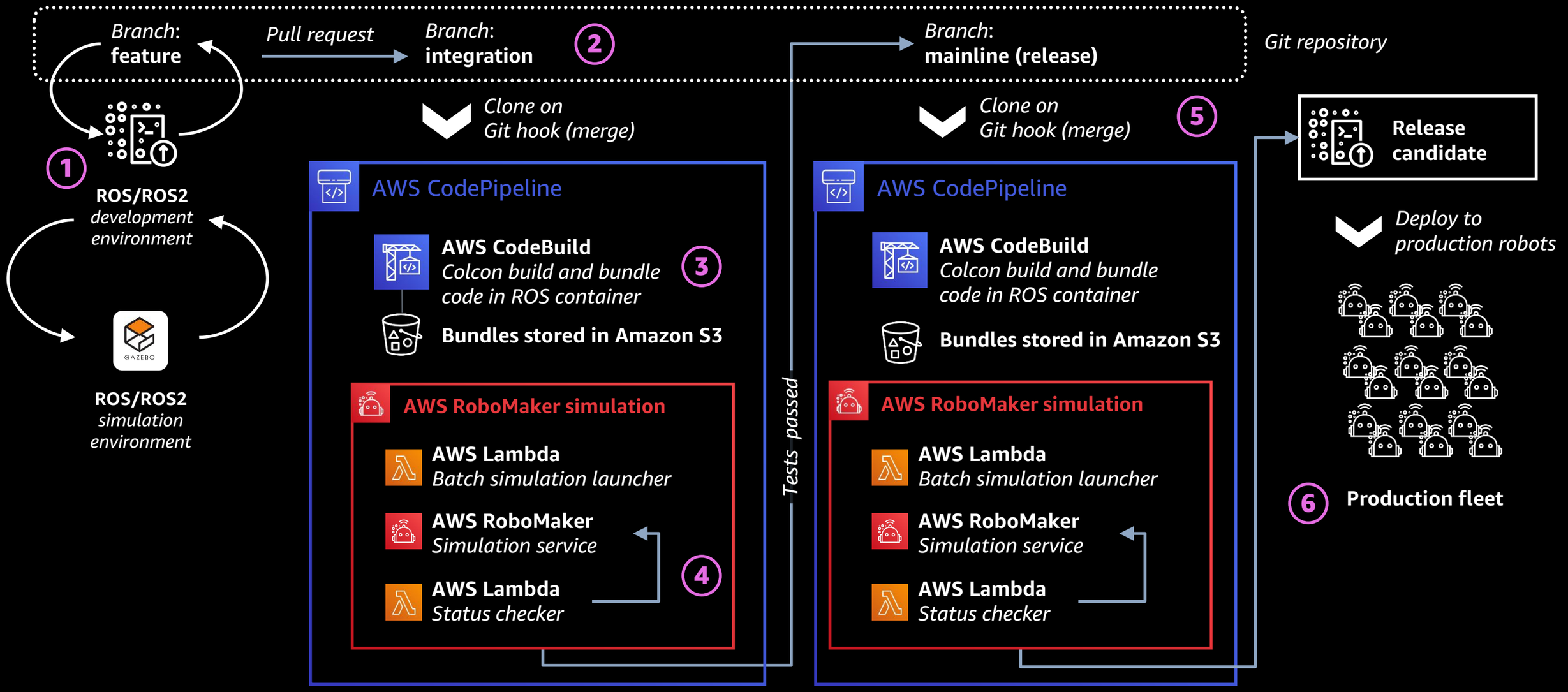


Automated continuous integration tests prevent integration issues caused by developers working in silos



Automated continuous delivery enables you to get new features and updates to customers on a regular basis

Automated regression testing using simulations in AWS RoboMaker



Case study: How iRobot uses AWS RoboMaker



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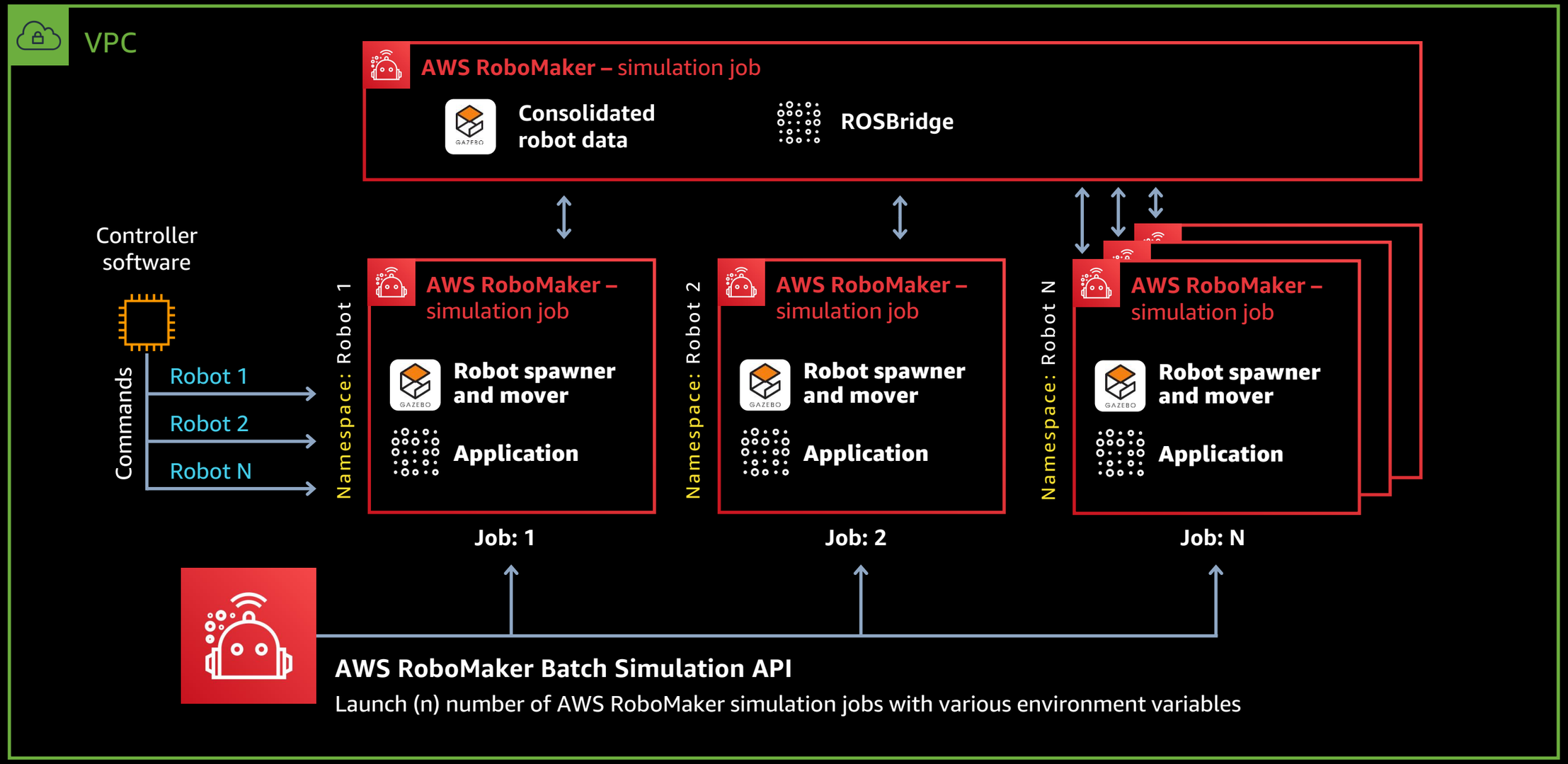
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2. Fleet simulation with multiple robots

- Verify robot navigation in the same environment
- Collect data from multiple robots running at the same time
- Use ML to train robots to react to other robots
- Develop algorithms that use state data from other robots

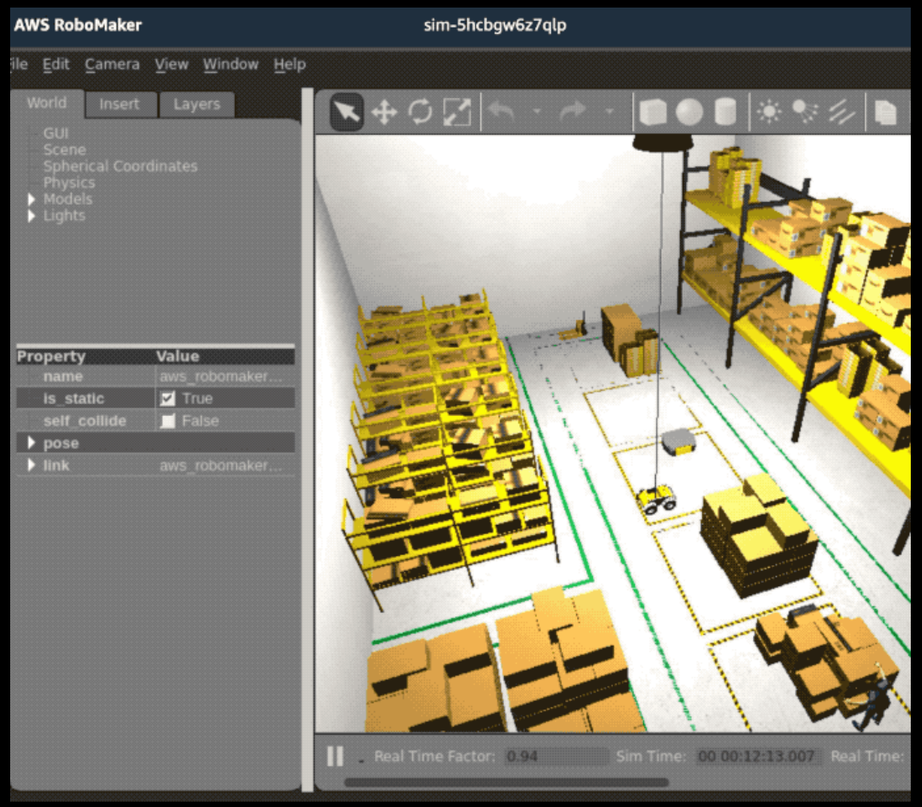
Multi-robot simulation with AWS RoboMaker

LAUNCH MULTIPLE ROBOTS THAT INTERACT WITH EACH OTHER IN SIMULATION



Multi-robot case study

Bastian SOLUTIONS



Usage

› Simulation of multiple robots in a fleet to test multi-robot navigation and orchestration

Results

› Simulations that support a fleet of robots to test inter-robot interaction

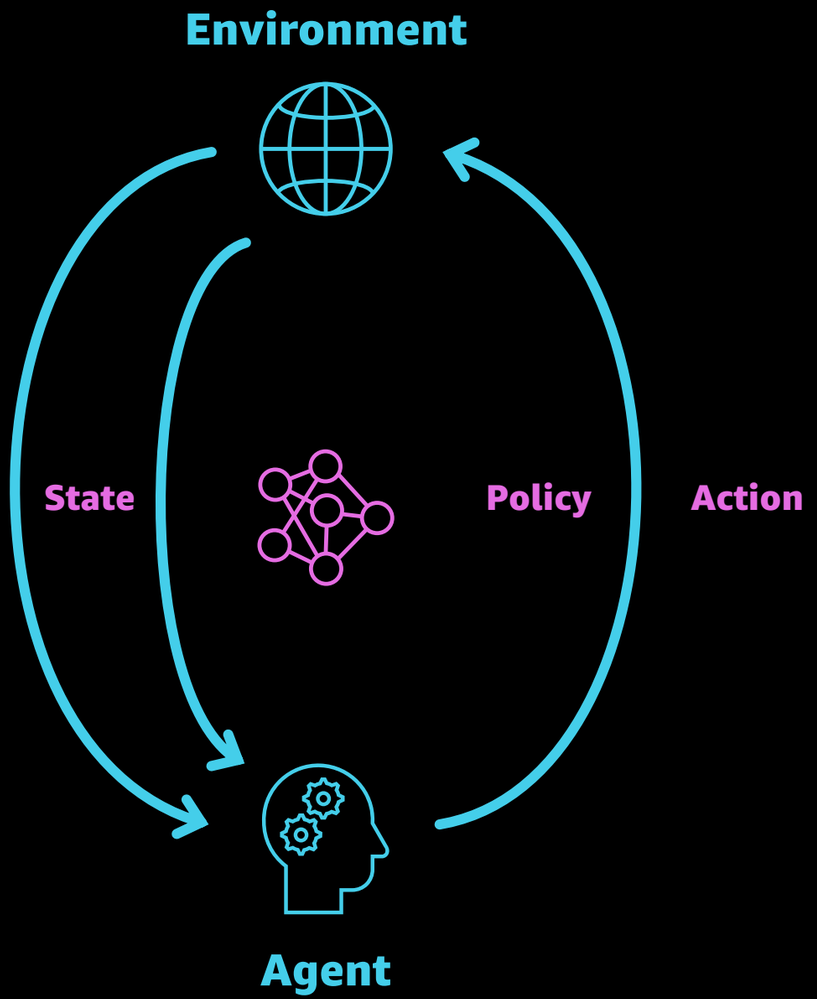
› Gazebo simulations with 35+ robots in a fleet, which was not possible with physical robots

3. Reinforcement learning

WHY USE REINFORCEMENT LEARNING (RL)?

- No existing training dataset required
- Adaptive to any environment scenario
- Allow iterative training with human inputs





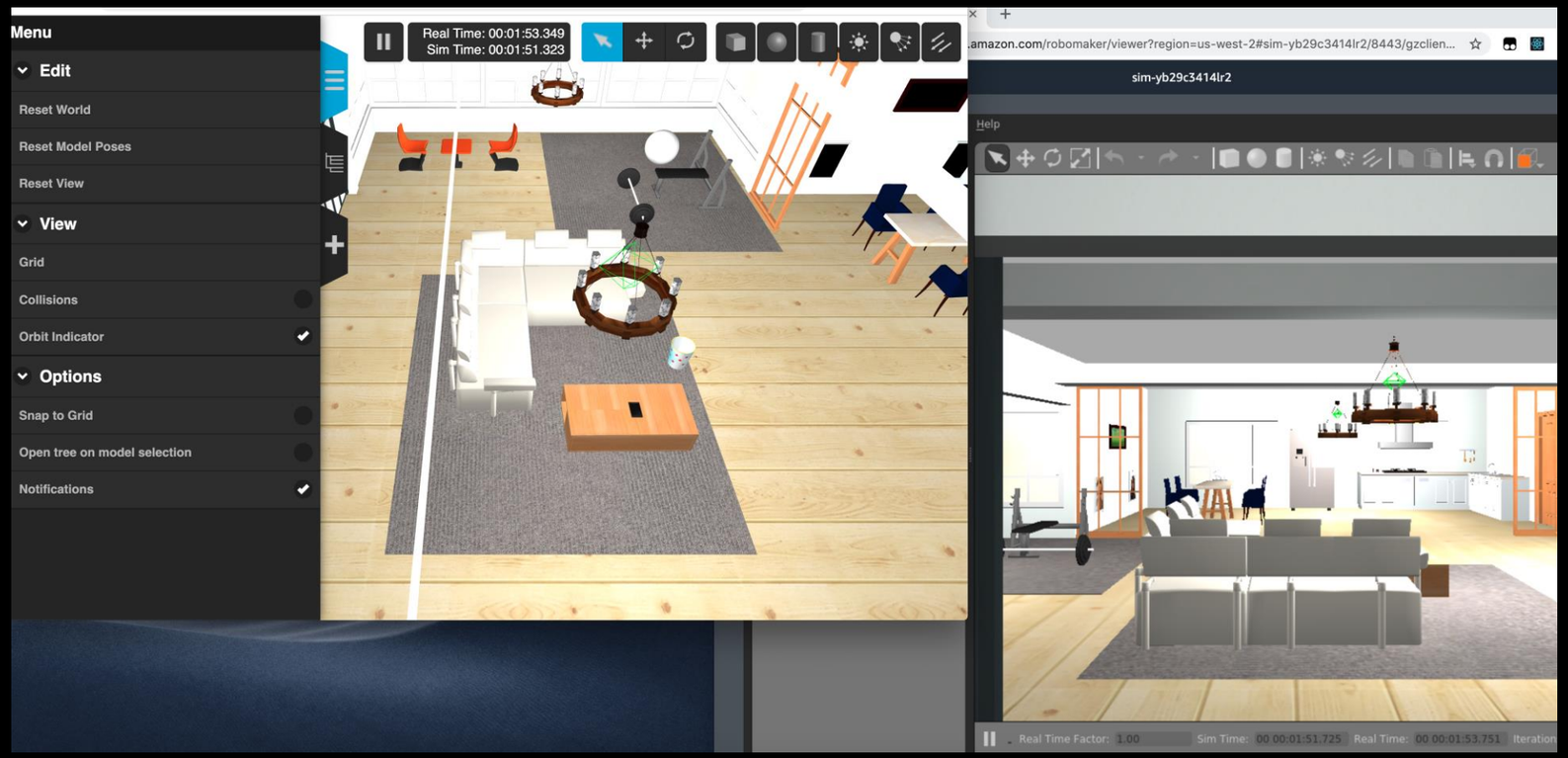


Reinforcement learning for AWS DeepRacer

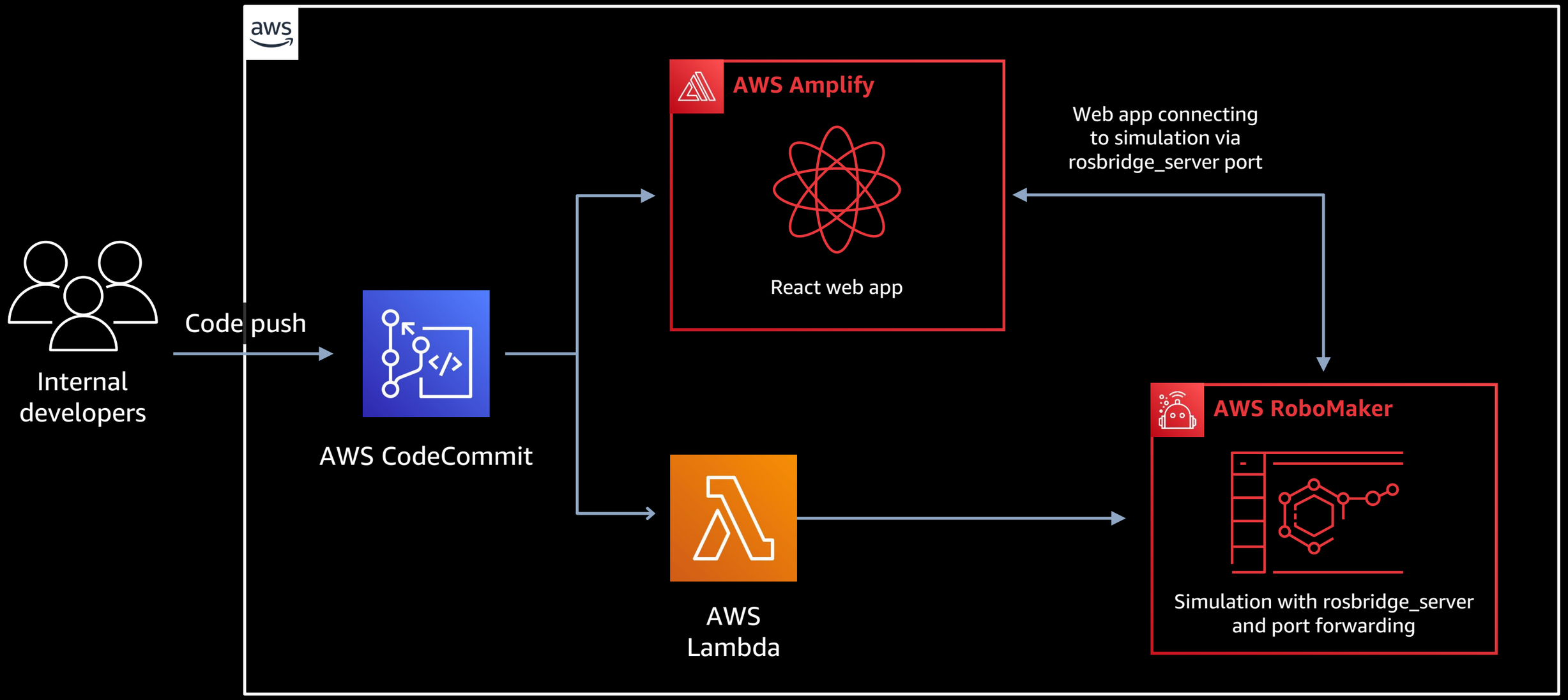
4. Testing non-robotic apps in simulation

SANDBOX

- Build and test client-facing web applications, Android/iOS apps, central fleet managers, etc.
- Easy setup with AWS RoboMaker simulation run – Gazebo simulation in the loop
- Visualize using AWS RoboMaker GUI tools



Sandbox architecture with AWS RoboMaker



AWS RoboMaker use cases

Milvus implemented an AWS RoboMaker simulation CI pipeline and can now easily test robots in different environments, resulting in a huge quality improvement



AWS RoboMaker simulation enabled Jetbrain to cost-effectively expand and speed up robotics development without sacrificing code quality or safety



AWS RoboMaker helps Cheetah enable their customers to build applications for Cheetah robots and test them in simulation before deploying to robotics hardware



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