
aws
SUMMIT

Run your robots in the cloud 🤖

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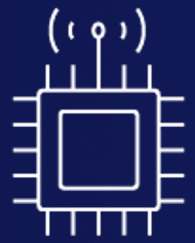
Amazon Web Services

What defines a robot?

Sense



Compute

Act

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

Robotics is key to digital transformation

By 2023, it's estimated that mobile autonomous robots will emerge as the standard for logistic and fulfillment processes

By 2030, 70% of all mobile material handling equipment will be autonomous

Source: IDTechEx

- Logistics
- Healthcare
- Retail
- Construction
- Consumer home
- Energy and utilities
- Oil and gas
- Agriculture

Business drivers for automated operations

Scale

Customer experience

Standardization

Cost improvement

Robotics industry trends

Open-source software and hardware

Intelligent robotics through AI/ML

Connected products

Robot-as-a-service (RaaS)

Cloud is an enabler

What makes robotics development hard?

Build

- Multi-domain expertise is required to build robots
- Iterative development is required to get it right

Test

- There is limited robot hardware and restricted access to physical environments
- Scaling to create multiple scenarios in the physical world is hard

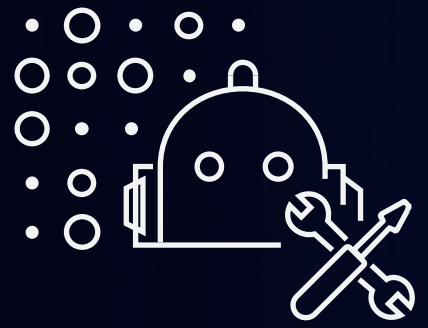
Deploy and manage

- Deployment and updates need to be managed
- Setting up a secure communication layer between the robot and external systems is difficult

Role of the cloud

AWS ROBOTICS MAKES IT EASY TO BUILD, TEST, AND MANAGE ROBOTICS APPLICATIONS

Build



Cloud-based IDE

Test

Simulation

Manage

Fleet management

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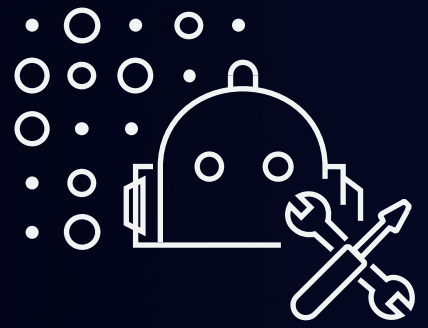

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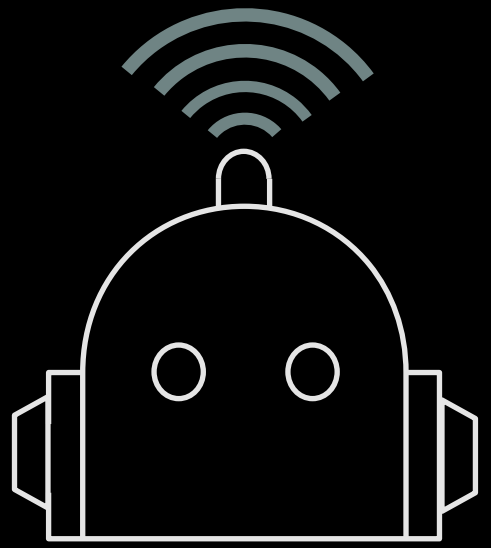
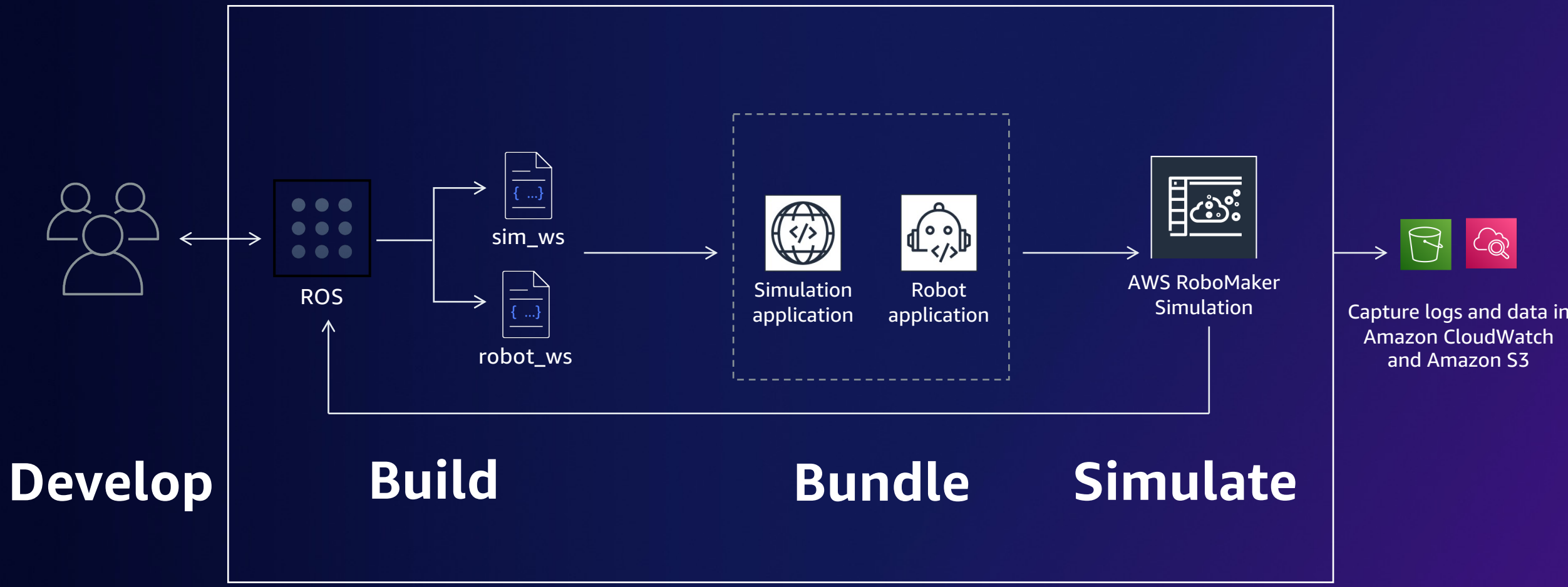
Introducing AWS RoboMaker

Cloud-based simulation service that enables robotics developers to run, scale, and automate simulation without managing any infrastructure





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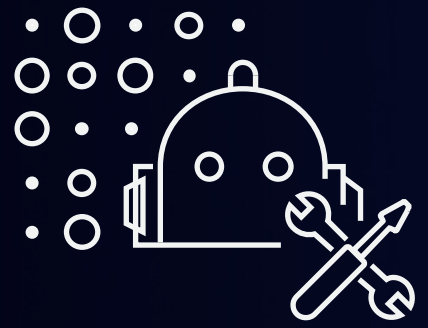

Cloud-based IDE

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Simulation makes robotics application developments easier and faster

Replicate realistic scenarios

Re-create edge cases and unsafe conditions to test for unexpected behaviors

Expand test coverage

Run many scenarios that cover the majority of situations your robot would encounter

Accelerate development velocity

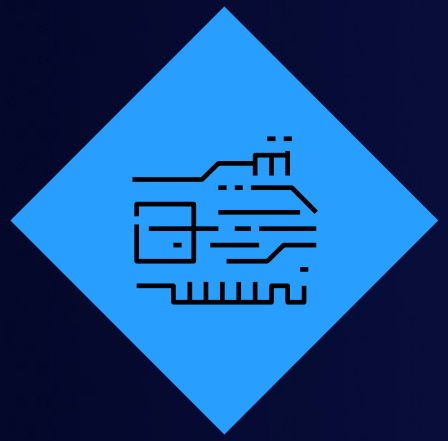
Run tests faster than real time for certain scenarios

Benefits of testing and training in simulation

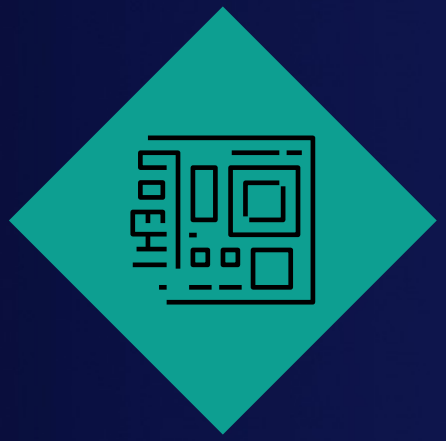
FASTER TIME TO MARKET, INCREASED FEATURE RELEASE VELOCITY, AND FEWER SOFTWARE DEFECTS IN PRODUCTION

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

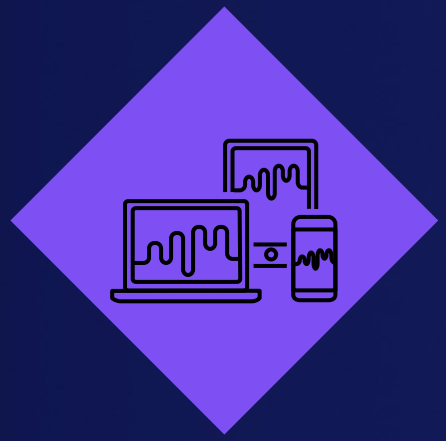
Common blockers to using simulation



Infrastructure required to run simulations



Integrating application management and control systems



Consistency across development teams

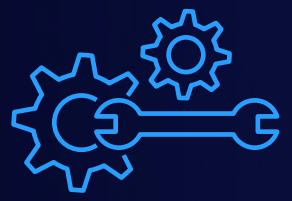
Difficulty setting up automation

Creation of 3D model assets – worlds and robot definitions (Universal Robot Description Format – URDF)

AWS RoboMaker simulation

FULLY MANAGED INFRASTRUCTURE FOR ROBOTICS SIMULATION

Fully managed



Managed robotics and simulation software stack frees up engineering resources

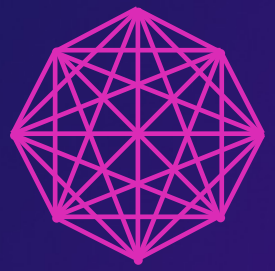
Highly scalable

Concurrent simulations at cloud scale via a single API call

Cost effective

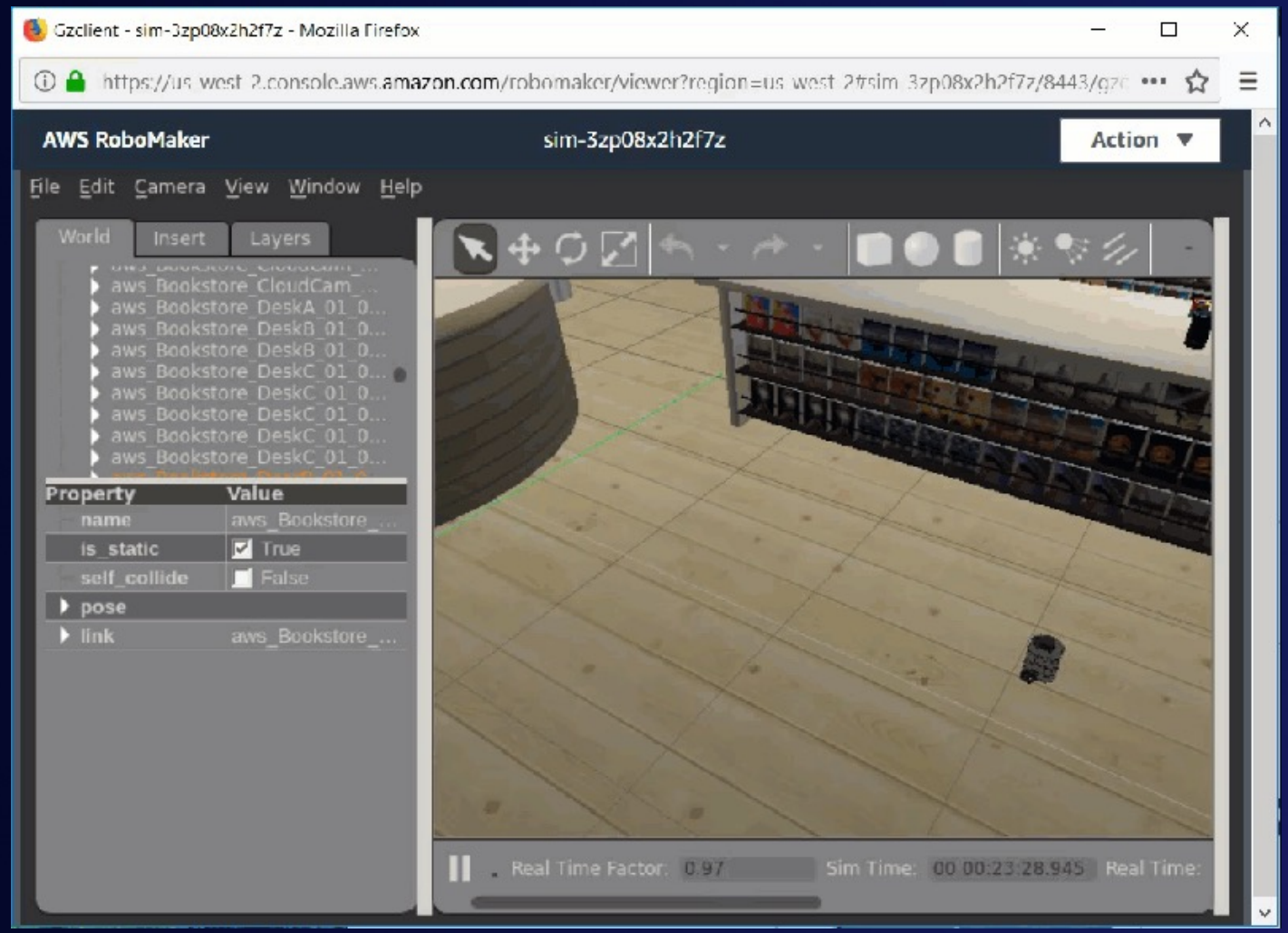
Pay-as-you-go pricing at per-CPU and per-minute granularity

Automatic 3D world generation



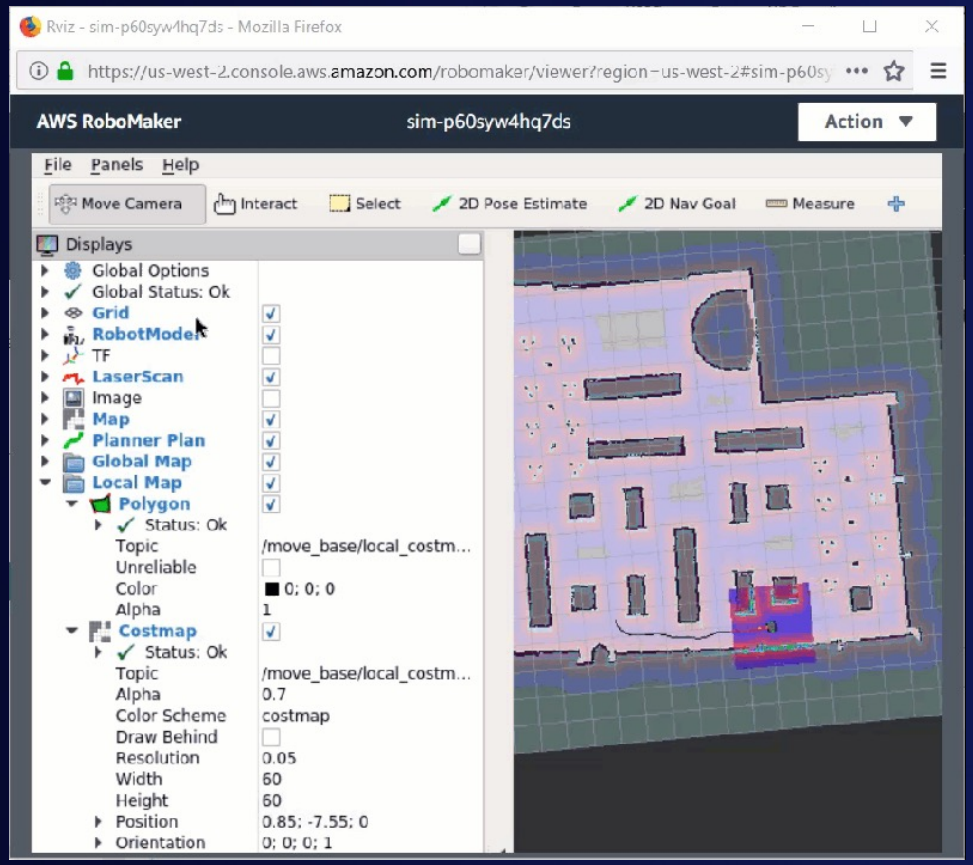
Automatic generation of virtual simulation worlds with randomization

Gazebo

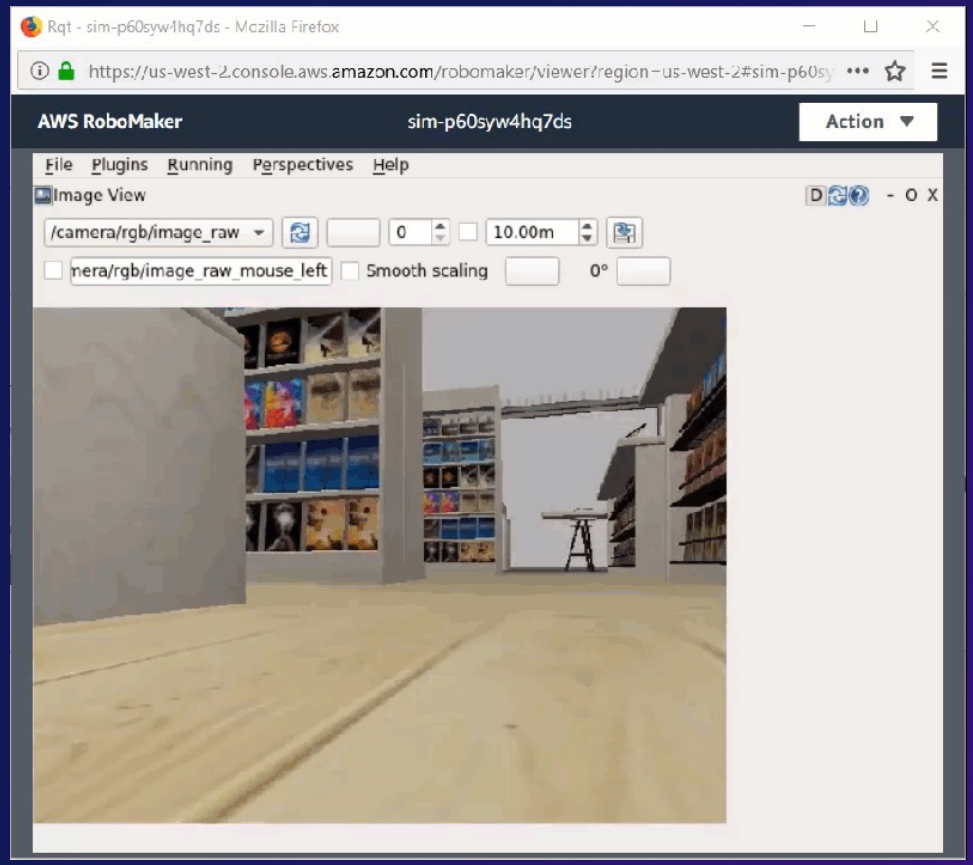


Simulation tool with robust physics engine, 3D graphics and programmatic interfaces

RViz



rqt suite



Visualization

GUI tools

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
- $1.50 per generated world versus thousands of dollars
- Concurrent world generation – up to hundreds of worlds
- Fully integrated with RoboMaker simulation run
- Tag worlds at creation time

Simulation use cases using AWS RoboMaker

Simulation use cases using AWS RoboMaker

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

Simulation use cases using AWS RoboMaker

1. Automated regression testing (CI/CD) using simulation
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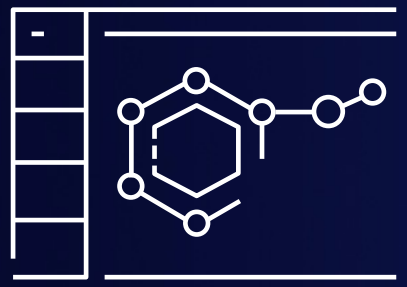
1. Automated CI/CD for robotics development



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

Git repository

Branch **feature**

Pull request

Branch **integration** 2

Branch **mainline (release)**

1

ROS/ROS2 development environment

ROS/ROS2 simulation environment

GAZEBO

Clone on git hook (merge)

AWS CodePipeline

AWS CodeBuild
Colcon build and bundle code in ROS container 3

Bundles stored in Amazon S3

AWS RoboMaker simulation

AWS Lambda
Batch simulation launcher

AWS RoboMaker
Simulation service

AWS Lambda
Status checker 4

Tests passed

Clone on git hook (merge) 5

AWS CodePipeline

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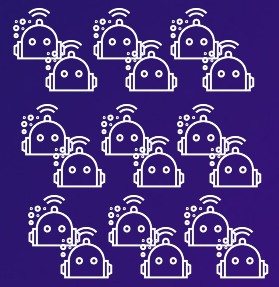
Release candidate

Deploy to production robots



6 **Production fleet**

iRobot

Need

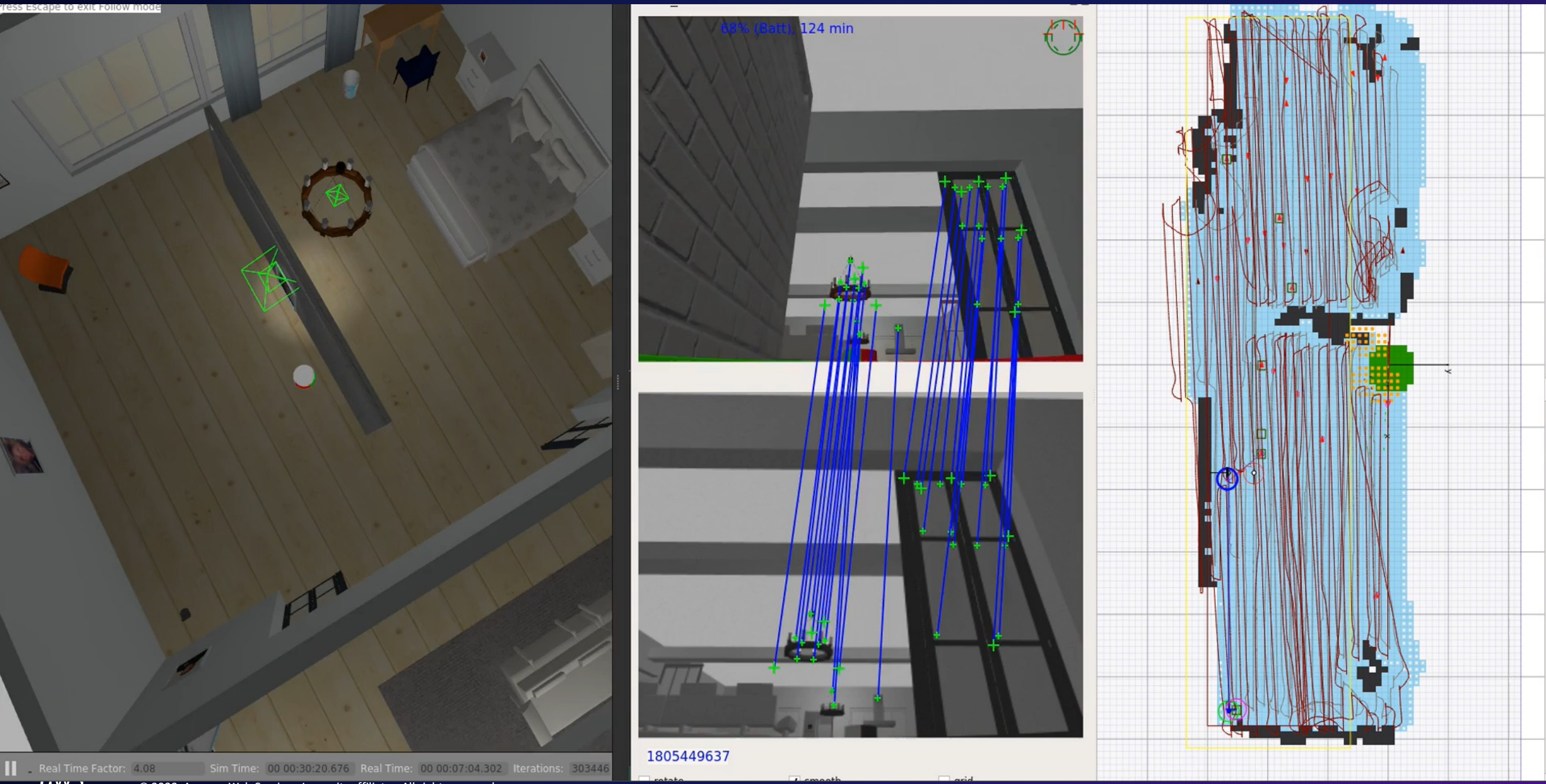
- Test coverage for different floor layouts
- Test coverage for different scenarios
- Improve code release speed

Challenges

- Costly and time consuming to test
- Limited test cases and coverage
- Late bug discovery

Solution

- Large-scale and automated testing using AWS RoboMaker simulation



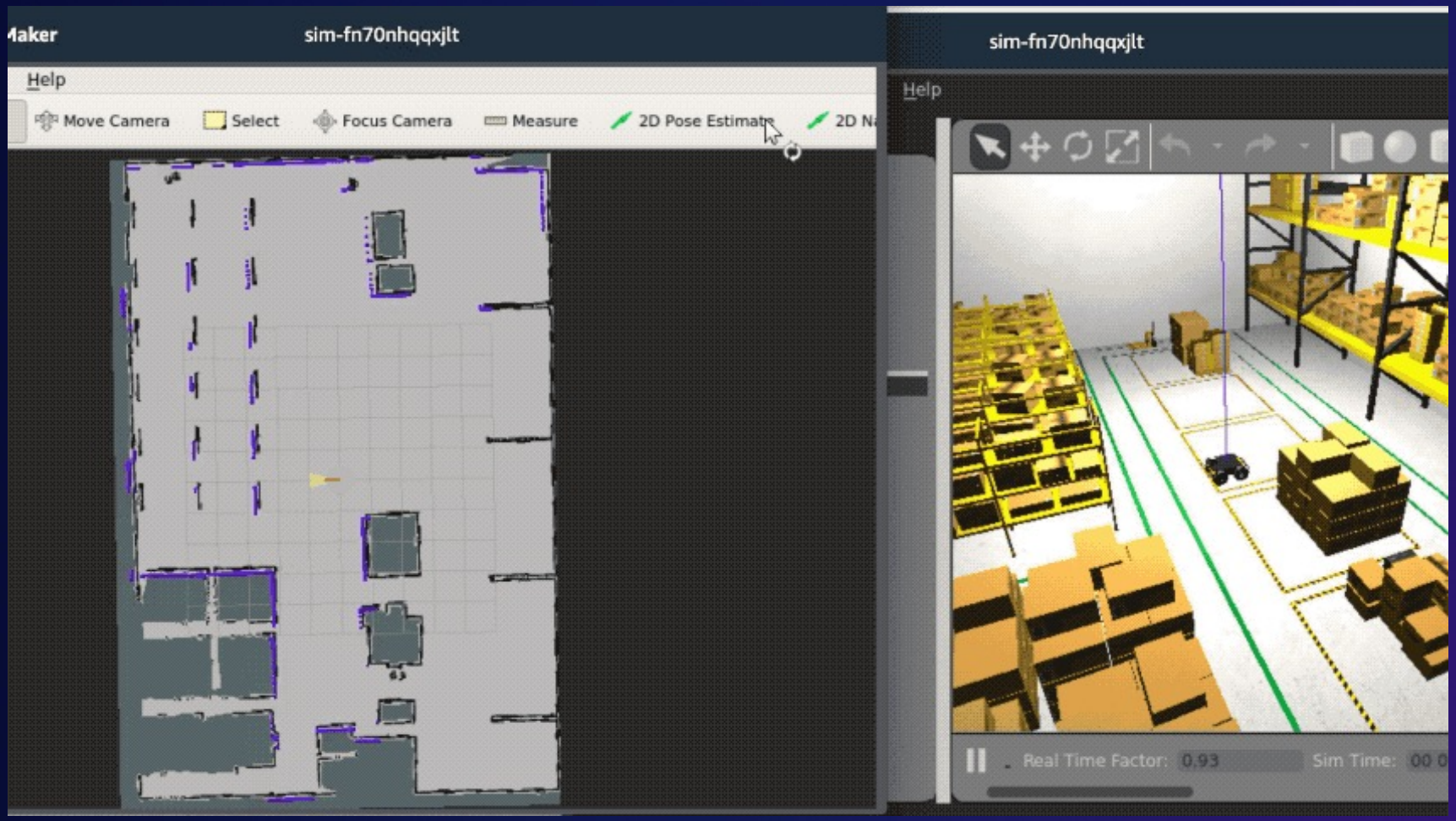
Customer success

iRobot

Results

- 5,000 tests per day (50x increase)
- 60 automated tests on each code commit
- Over 250,000 square feet cleaned per day
- 12 hours of robot runtime and 8,000 square feet cleaned on each code submission
- Validation across 5 different robots
- Much faster testing and release cycle (e.g., 1 hour versus 3 weeks for testing 70 robot-kidnap scenarios)

2. Fleet simulation with multiple robots



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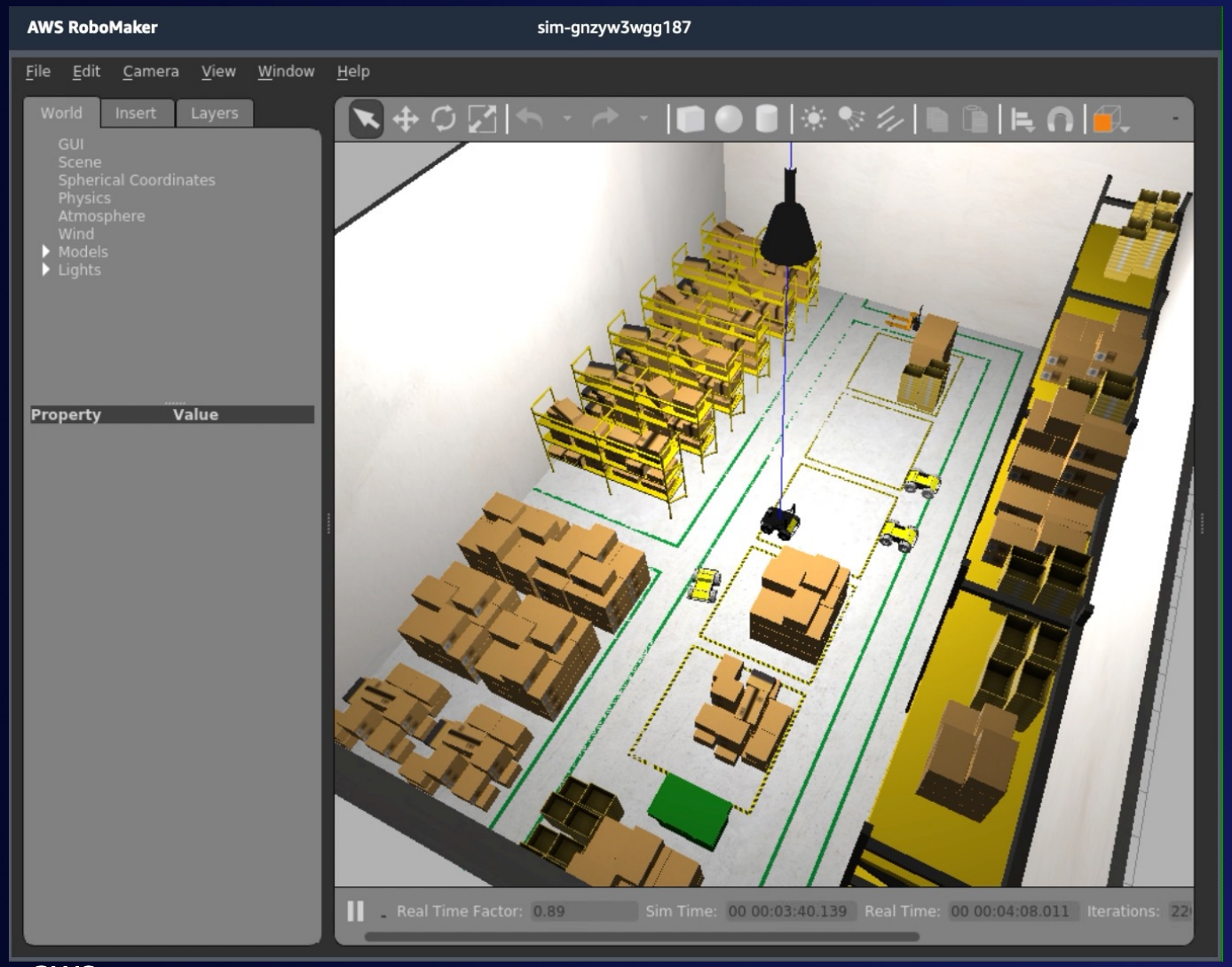
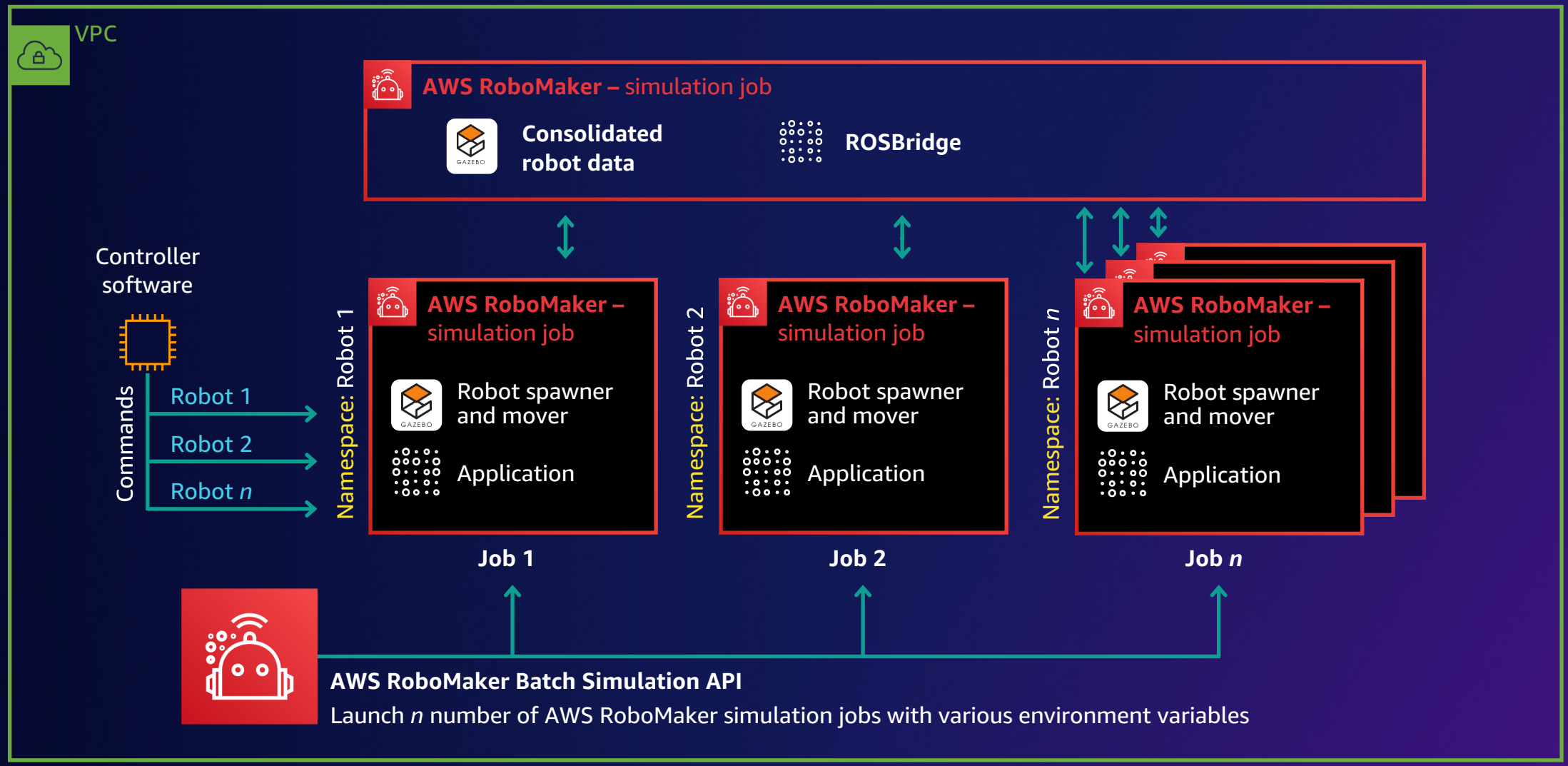


- Verify robot navigation in the same environment
- Collect data from multiple robots running at the same time
- Use ML to train robots to react to other robots
- Develop algorithms that use state data from other robots

Multi-robot simulation with AWS RoboMaker

LAUNCH MULTIPLE ROBOTS THAT INTERACT WITH EACH OTHER IN SIMULATION



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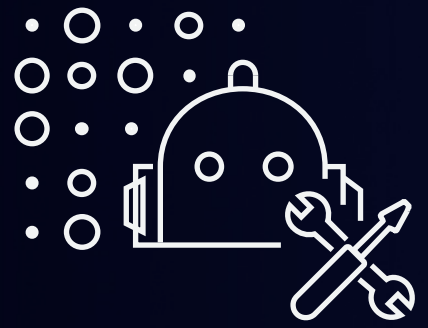

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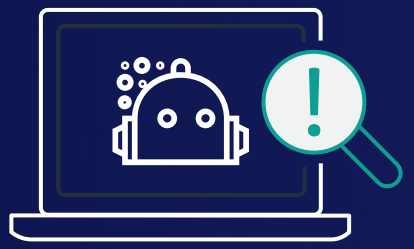
Challenges to robotics optimization

Connecting to different types of robots is challenging



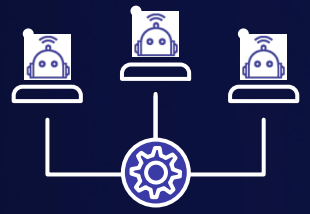
Deploying robotics requires complex software-integration work

Optimization applications are difficult to build and integrate

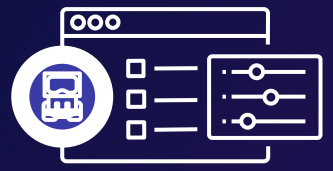
AWS IoT RoboRunner

BUILD APPLICATIONS THAT HELP ROBOTS WORK TOGETHER SEAMLESSLY

Enable robots from different vendors to work together

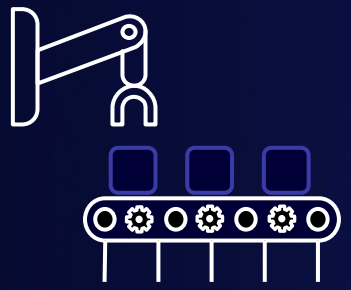


Connect robots and work management systems to a common infrastructure



Simplify building applications for optimizing robot fleets

AWS IoT RoboRunner use cases



Manufacturing and logistics process automation

Automated material handling

Robotics modernization

How AWS IoT RoboRunner works

Central data repositories

APIs to build robotics applications

Sample applications for orchestration use cases

Vendor integrations for easier deployment

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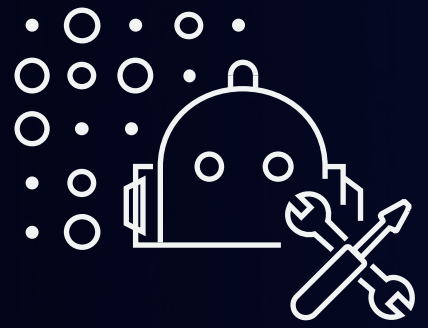

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Get started today!

Documentation and blogs

AWS Robotics blog: aws.amazon.com/blogs/robotics/

AWS RoboMaker Docs: docs.aws.amazon.com/robomaker/

Open-source assets

ROS1 and ROS2 tools, sample applications, cloud extensions, Gazebo simulation worlds, and more

https://github.com/aws-robotics

https://github.com/aws-samples

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Thank you!

Sohan Maheshwar

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