

# Case Study: EC2 Auto-Recovery System with Predictive Failure Detection

## Document Information

- **Solution Name:** EC2 Auto-Recovery System with Predictive Failure Detection
  - **Version:** 1.0
  - **Date:** November 2024
  - **Category:** Infrastructure Automation, DevOps, Monitoring & Observability
  - **AWS Services:** Lambda, EventBridge, CloudWatch, DynamoDB, SSM, SNS
  - **Company:** Before You Solutions LLC
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## Executive Summary

This case study explains how Before You Solutions LLC developed and deployed a fully serverless EC2 Auto-Recovery System capable of automatically detecting, predicting, and recovering EC2 failures without manual intervention.

The solution uses real-time monitoring, CloudWatch metric analytics, predictive failure detection, and AWS Systems Manager to restore EC2 health in minutes. It reduces operational burden, improves reliability, and provides a complete audit trail of recovery events.

## Key Results:

- **Intelligent zero-touch recovery** for EC2 workloads
  - **Proactive 7-day metric analysis** for early failure detection
  - **Fully automated recovery pipeline** with no manual intervention
  - **Multi-channel alerting** via SNS, Slack, and Teams
  - **Structured audit trail** stored in DynamoDB
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## Business Challenge

Organizations running production services on EC2 commonly face:

- **Reactive alerts** only after failures occur
- **Manual troubleshooting**, causing extended downtime
- **No predictive signal** before instance degradation
- **Inconsistent recovery actions** across teams

- **Missing audit history** required for compliance
- **Overworked on-call staff** handling EC2 failures manually

These challenges become harder as infrastructure grows.

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## Solution Overview

The EC2 Auto-Recovery System is a serverless, event-driven automation solution that:

1. Monitors EC2 health, CloudWatch metrics, and application-level checks
2. Predicts failures using statistical analysis of 7-day metric history
3. Automatically executes the optimal recovery workflow
4. Sends alerts to Slack, SNS, and Teams
5. Logs every action to DynamoDB for compliance and analysis

## Why This Solution Is Unique

- **Predictive engine** detects anomalies before outages
  - **Multi-strategy auto-recovery** (restart, failover, EBS repair, SSM restart)
  - **Completely serverless** → no infrastructure to manage
  - **Event-driven orchestration** ensures fast response and minimal latency
  - **Tag-based activation** (AutoRecovery=enabled) makes adoption easy
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## Architecture

### 🔗 Architecture Diagram:

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/docs/architecture-diagram.png>

This solution follows an AWS-native serverless design, combining CloudWatch, EventBridge, Lambda, DynamoDB, and SSM to create a self-healing EC2 management system.

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## Implementation

### Deployment Workflow

1. **Infrastructure Setup via Terraform**
  - EventBridge rules

- 4 Lambda functions
- 3 DynamoDB tables
- SSM automation documents

## 2. Lambda Deployment

- Packaged using Docker for dependency layers
- Deployed using Terraform modules

## 3. EventBridge Configuration

- Predictive monitoring (hourly)
- Real-time EC2 status event triggers
- Recovery trigger events

## 4. Notification Setup

- Slack Webhook integration
- Optional Teams Webhook
- Optional SNS Topic

## 5. Instance Activation

Tag EC2 instances with:

AutoRecovery=enabled

## 6. Operational Scripts

See commands:

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/commands.md>

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## Results and Benefits

### Quantitative

- **Automatic recovery** of EC2 failures
- **MTTR reduced to minutes**
- **Failure prediction 24–72 hours early**
- **Avoided unnecessary replacement of instances**
- **Complete compliance-ready audit records**

### Qualitative

- Stronger uptime and reliability
  - Standardized recovery processes
  - Lower operational burden
  - Predictive insights into infrastructure health
  - Scales automatically for any EC2 fleet size
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## Technical Details

### Predictive Failure Detection Engine

Analyzes:

- CPU Steal Time
- I/O Wait
- Memory saturation
- Disk usage and queue depth
- ENA/network drops
- EC2 status-check patterns

Outputs confidence levels:

- **High (0–24 hours)**
- **Medium (24–72 hours)**
- **Low (72+ hours)**

### Recovery Actions Implemented

- Safe Restart
- Same-AZ Host Migration
- Cross-AZ Failover
- EBS Volume Repair
- SSM App-Level Restart
- Instance Quarantine

## Security

- IAM least-privilege roles

- DynamoDB encryption
  - CloudWatch structured JSON logs
  - Optional VPC Endpoint support
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## Documentation & References

### 🔗 Primary Documentation (README)

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/README.md>

### 🔗 Command Reference

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/commands.md>

### 🔗 Implementation Challenges

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/challenges.md>

### 🔗 Architecture Diagram

<https://github.com/Sumanth12-afk/ec2-auto-recovery-system/blob/main/docs/architecture-diagram.png>

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## Conclusion

The EC2 Auto-Recovery System by **Before You Solutions LLC** demonstrates how AWS serverless architecture can deliver predictive, intelligent, and completely automated recovery for EC2 workloads.

It improves uptime, reduces operational burden, and provides the foundation for highly resilient infrastructure without any manual intervention or added infrastructure cost.

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## Contact Information

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