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Leveraging AWS IoT Core to deliver SepTrac™ Smart System for KSS

Executive Summary

For over 50 years, Koch Separation Solutions (KSS) has been an industry leader in separation technology. With an extensive portfolio of products and systems, KSS has worked with thousands of customers worldwide to bring them effective and reliable solutions across food & beverage, dairy, general industrial, and life science markets.

KSS's commitment to customers spans across R&D, piloting, large-scale implementation, and continued after-sales services. To further simplify operations, KSS developed the SepTrac™ Smart System, a cloud-based customer portal that captures system performance data in real time for remote monitoring and offers self-service options for quicker engagement.

KOCH™

SEPARATION SOLUTIONS

Koch Separation Solutions (KSS) is transforming the landscape of separations by developing and leveraging synergistic technology such as membrane filtration, ion exchange, evaporation, drying, and more. With over half a century worth of experience, KSS offers comprehensive solutions for the most challenging applications in food and beverage, life science, and general industrial markets. KSS works with customers around the world to recover high-value product, eliminate waste, reduce footprint, increase productivity, and lower costs.

Industry: General Industrial

Location: Wilmington, MA

Service: Lorem Ipsum

Website: kochseparation.com

Client's Key Challenges

KSS is a very mature engineering organization with over 50 years of experience in separation technology engineering complex hardware and embedded software solutions. With no experience in modern web application development, IoT and cloud technology, KSS turned to VividCloud to develop their SepTrac™ Smart System.

The KSS systems are implemented with rugged, industrial Programmable Logic Controllers (PLC) and SCADA control system and are not well suited to support a broad set of remote monitoring and management functions. Process engineers often monitor these systems onsite.

The client wished to evolve these systems into an IoT network and provide advanced product monitoring and up to date customer support as part of the company's digital transformation strategy.

VividCloud's Solution

The SepTrac™ Smart System links to any KSS system to gather live data, send notifications and alerts, store documentation and influent logs, and provide an easy point of access to our dedicated customer service teams.

Live Performance Data Dashboard and Charts

Remote system monitoring takes data collection and analytics to the next level. The SepTrac™ smart system offers an easy-to-use dashboard that is completely customizable depending on system type, application, operating mode (batch vs. continuous), and user preference. It eliminates the need to download and manipulate process data, a time-consuming effort that is seamlessly automated in the SepTrac program.
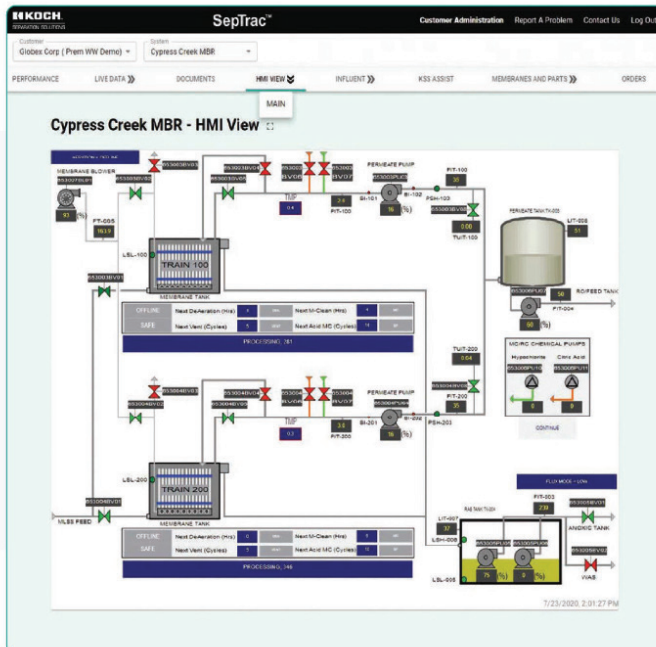

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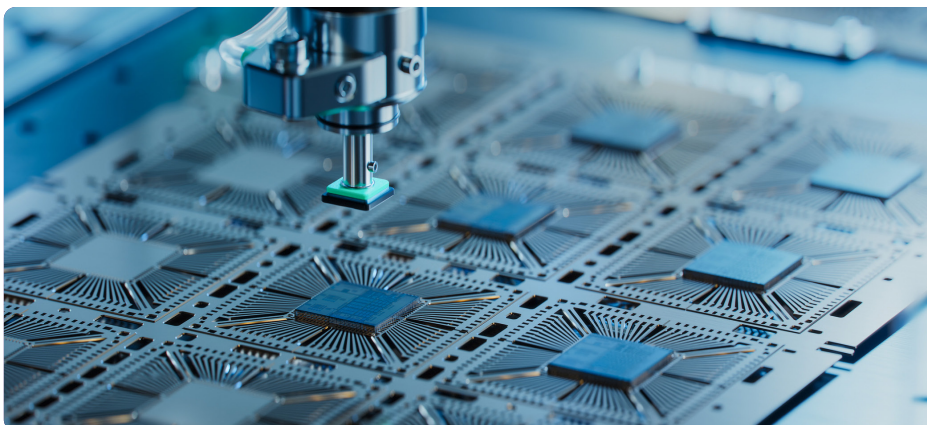
The performance dashboard can show complete system performance or be broken down into subsystems with the range of operational data being a few hours to a few months. Parameters captured in this dashboard include:

- Performance metrics (productivity, quality, etc.)

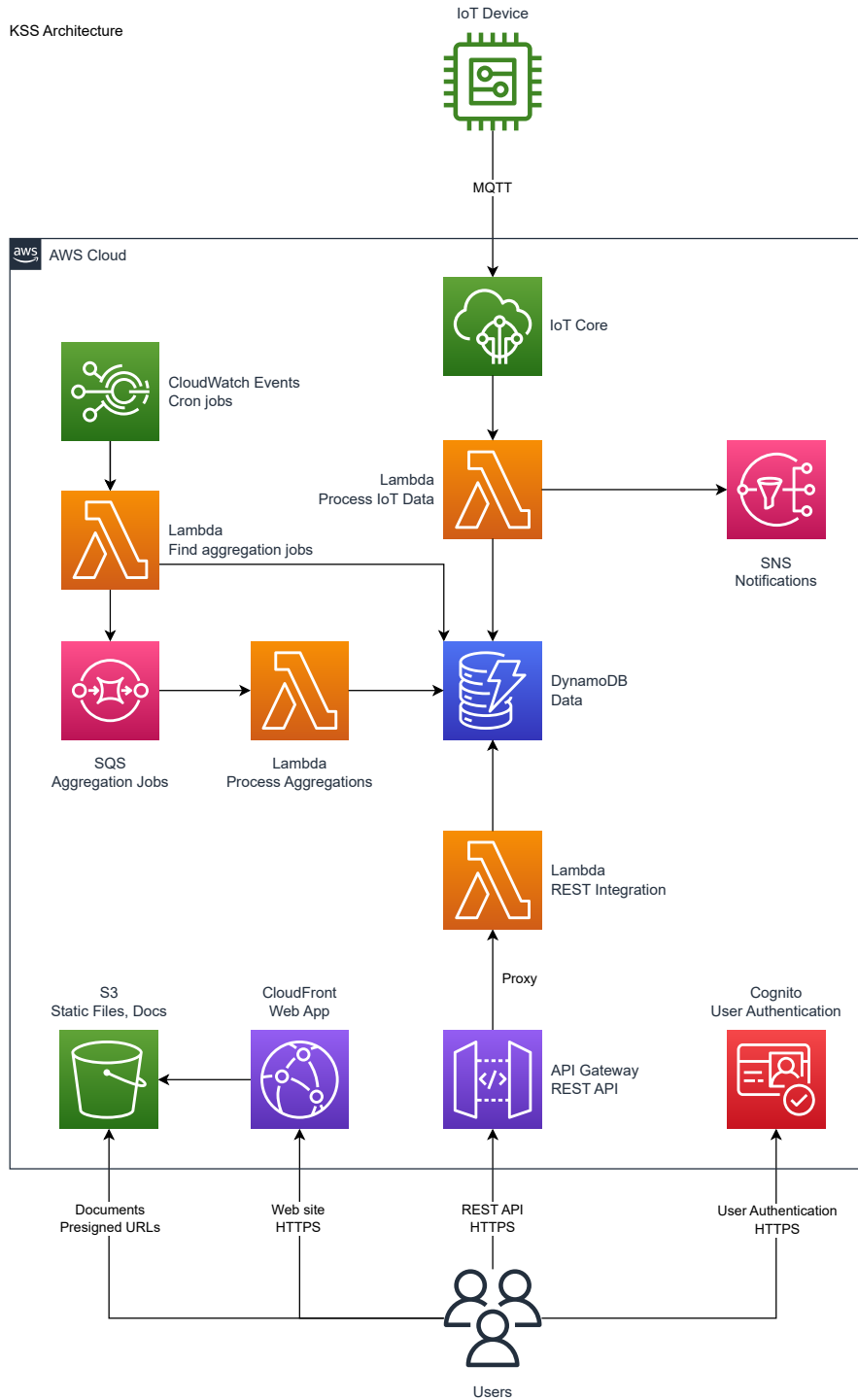- Operating conditions (pressure, flow, temperature, etc.)

HMI View

With the SepTrac™ Smart System, the Human-Machine Interface (HMI) is built directly into the program and is updated several times per minute, eliminating the need for third-party software. Operators can easily and remotely monitor the process and check in on pump and valve configurations, tank levels, and flow conditions.

High Level Architecture and Deployment

It's useful to view the overall architecture of the SepTrac™ Smart System cloud platform:

KSS Architecture

IoT Device

MQTT

AWS Cloud

IoT Core

CloudWatch Events
Cron jobs

Lambda
Process IoT Data

SNS
Notifications

Lambda
Find aggregation jobs

DynamoDB
Data

SQS
Aggregation Jobs

Lambda
Process Aggregations

Lambda
REST Integration

Proxy

S3
Static Files, Docs

CloudFront
Web App

API Gateway
REST API

Cognito
User Authentication

Documents
Presigned URLs

Web site
HTTPS

REST API
HTTPS

User Authentication
HTTPS

Users

Results and Benefits

Equipment operators and plant managers get instant access to critical performance data and system information and are able to engage quickly and easily with KSS customer service and support teams. The cloud-based portal revolutionizes system operation and management through live data accessibility and predictive analysis. Designed by KSS process engineers and technology experts, the SepTrac™ Smart System creates ondemand access to decades of experience and expertise – anytime, anywhere.

IoT Gateway

A lightweight embedded software solution was developed for the IoT gateway device that resides within the end customer's industrial network. This software sends data from the filtration systems PLC through AWS IoT Core using the MQTT message protocol.

IoT Core and Serverless

The backend infrastructure was implemented as a serverless solution that utilizes IoT Core to manage the ingestion of data from the filtration systems andLambda functions for a variety of activities, such as processing the filtration data into DynamoDB, sending system alert notifications, and managing requests from users.

User Interface

The User Interface was developed as a Progressive Web Application using REACT, hosted on AWS S3, allowing a single code base to support a wide variety of platforms, including iOS, Android, Linux, Windows, and MacOS.

User Interface

It was realized early in the project that the frequency at which data was collected would overwhelm browser based graphing tools. A decision was made to aggregate the data at various time intervals (5 min, 15 min, 1 hour) to reduce the data points while keeping an accurate graphical representation of the data.

Two options were explored to solve the data aggregation challenge, SiteWise and DynamoDB.

SiteWise was eliminated as an option for a few reasons:

- SiteWise did not (at that time) allow backfilling data, and the client expressed a desire to import old data when onboarding a new system.

- SiteWise schemas were not an option as most systems had a unique set of measurements.

- The time series functions provided by SiteWise did not support the clients sampling preference, first data point in interval vs averages.

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A decision was made to develop a solution around DynamoDB to manage the data aggregation challenge. A few highlights of that solution:

- A CloudWatch event periodically triggers a Lambda process to determine which time periods need to be aggregated for each system.

- Time ranges are submitted as jobs to an SQS queue where they trigger another Lambda process to perform the actual aggregation.

- The aggregations are stored in a single table partitioned by the customer, system, interval size and then indexed by the interval timestamp with each measurement as a separate column. This allows easy querying for a time range of sampled data for a single system with projections for the measurements to be graphed.

- The partition keys fit into our multi-tenancy model that restricted access to a customer's items based on "dynamodb:LeadingKeys" conditions

DynamoDB's high performance for simple range queries and low cost have made it a great fit for use.

Multi-Tenancy

This SAAS application services to multiple customers. Data for many customers is stored in the same DynamoDB tables.

- "dynamodb:LeadingKeys" conditions are used in IAM roles to restrict a user's access to only their own customer's data.

- All tables use the customer ID as the leading part of the partition key.

- Separate IAM roles are created for each customer which allow access to the DynamoDB resources with "dynamodb:LeadingKeys" conditions that include their customer ID.

- Users are assigned to specific customer groups in Cognito.

- The Lambda functions that process the REST API requests assume the customer IAM role of the authenticated user when making DynamoDB queries.

There is high confidence that customer data cannot be viewed by a different customer.

Paving the Way for Machine Learning

Through the introduction of the SepTrac™ Smart System, KSS is primed to integrate advanced prescriptive software that will monitor and learn system performance trends to be able to predict upsets before they happen, ultimately reducing maintenance and downtime.

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AWS Services

The following services and capabilities of AWS are used in this solution:

- AWS Route 53 : DNS for public facing (i.e. the front-end web app)

- AWS DynamoDB : data store of the application

- AWS Lambda : processing of IoT messages, REST API requests, cron-based jobs

- AWS IoT Core : MQTT broker with topic rules for routing device data, secure communication with SSL certificates

- AWS S3 : private object storage and front-end website hosting through CloudFront

- AWS Cognito User Pools, Identity Pools : User authentication and authorization

- AWS SNS : email notifications for system alerts

- AWS SQS : Job queues for cron-based aggregations

- AWS CloudFront : Caching and delivery of front-end web app stored in S3

- AWS API Gateway : Proxy to Lambda for REST API requests

- AWS Cloudwatch : logs and periodic events for cron-based jobs

About VividCloud

VividCloud is a software development company focused on cloud and IoT. AWS is our cloud platform of choice, and we are an Advanced Tier APN Services Partner. We bring fully managed teams that free our client s from day to day oversight responsibilities.

VividCloud is based in Brunswick Maine, with 100% of our people onshore in the US.

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