**Pilot Pay Engine (FOP) Modernization Project at United Airlines**

**Overview:** United Airlines undertook a strategic initiative to modernize its Pilot Pay Engine (FOP), a critical system responsible for processing pilot compensation. The legacy platform faced challenges including outdated technology, scalability limitations, security vulnerabilities, and compliance risks—particularly in handling Personal Identifiable Information (PII) and Protected Health Information (PHI) with a mandated seven-year retention period.

To address these issues, United Airlines migrated FOP to a cloud-native environment on AWS, leveraging services such as ECS Fargate, EMR, Route 53, ALB, RDS Aurora MySQL, MSK, and Secrets Manager. The system integrates with CFA and uCrew via MSK clusters, enforces Role-Based Access Control (RBAC) through Active Directory Groups, and supports Single Sign-On (SSO) authentication. High availability is ensured through an active-passive disaster recovery strategy with a 50-minute Recovery Time Objective (RTO) and a 24-hour Recovery Point Objective (RPO), using Route 53 Application Recovery Controller for regional failover.

This modernization effort significantly improved the efficiency, security, and scalability of the FOP application, ensuring compliance with regulatory requirements while enhancing operational resilience.

**Industry:** Aviation/Transportation.

**Domain:** Enterprise Architecture.

**Person Interviewed:** Shyam Sundhar Venkataraman, Enterprise Architect, Creospan/United Airlines.

**Project Objectives:**

* Migrate the Pilot Pay Engine from a legacy system to a modern, cloud-native environment on AWS.
* Improve scalability, reliability, and integration with other enterprise applications.
* Enhance security measures to ensure compliance with data privacy regulations.
* Calculate pilot pay and enable pilots to view pay registers and report discrepancies while allowing pay analysts to audit and adjust pay.
* Automate and streamline workflows to reduce manual effort and operational inefficiencies.
* Implement robust disaster recovery mechanisms.
* Establish granular Role-Based Access Control (RBAC) to improve access control and security.

**Challenges:**

* Limited scalability to handle growing demand.
* Inefficiencies due to manual workflows for ticket resolution.
* Unencrypted messaging poses security risks.
* Limited disaster recovery capabilities (no full cross-region support).
* Compliance challenges for regulatory and security standards.
* Operational inefficiencies in role management and access control.
* Ensuring secure data transmission and storage of PII/PHI data.

**Implementation Approach:** United Airlines adopted an agile approach to modernize the Pilot Pay Engine Application by utilizing AWS cloud services and a microservices architecture. Key implementation steps include:

* **Cloud Migration:** Re-platformed the application to AWS for improved performance and scalability.
* **Security Enhancements:** Integrated end-to-end encryption, enforced RBAC policies, and ensured regulatory compliance.
* **Observability & Logging:** Implemented monitoring tools for better system reliability and troubleshooting.
* **Disaster Recovery:** Established automated failover mechanisms for business continuity.

**Short-Term Architecture Recommendations:**

* **Kafka Queue Prioritization:** Configured YARN priority settings for faster processing of time sensitive data.
* **Optimized EMR Batch Jobs:** Enabled parallel execution to speed up processing, reduced data transfer overhead for better efficiency, and improved cluster independence.
* **Performance Fine Tuning:** Continuous monitoring and fine-tuning to sustain optimal performance.

**Expected Performance Gains:**

* Total reply processing time reduction from 46 hours and 4 minutes to 20-25 hours (50-55% improvement).
* Inter-cluster communication latency to go grom high 4 clusters to low 2 clusters, which is a reduction of 40-50% of inter-cluster transfer.
* Spark streaming processing time expected to go from 180 minutes average for batch to 90 to 120 minutes average, which is 30-40% faster.
* More balanced workload distribution leading to lower idle time and better scaling.
* Kafka topic processing latency improved by 40% due to direct topic-to-cluster routing.
* Pipeline complexity reduced with consolidated architecture, simplifying management and easier to monitor.
* Disaster recovery with a 50-minute Recovery to Objective (RTO) and 24-hour Recovery Point Objective (RPO) improved business continuity, while automated deployments and encryption enhanced security. The platform now supports 5,000 requests per minute, providing faster and more reliable payroll processing.

**Short Term Cost Savings from Optimized Architecture:**

* **EC2 Cost Reduction:** $15,844/month (4 clusters) to $7,922/month (2 clusters), saving $95,064 annually.
* **Storage Cost Reduction (EBS):** from $1,200/month for 4 EMR clusters to $600/month, for the 2 optimized clusters saving $7,200 annually.
* **EMR Cost Savings:** the current 4 EMR clusters cost $17,044/month, the optimized 2 clusters cost $8,522/month which is a cost savings of $8,522 per month or an annual saving of $102,264/year.

**Medium-Term Architecture Recommendations:**

* **Move Rules to IBM ODM:** Simplifies business rule management and accelerates decision-making.
* **Transition to Real-Time Processing:** Shifts from batch processing to real-time processing using Kafka and AWS EMR.
* **Implement Machine Learning Architecture:** Introduces predictive corrections to reduce manual interventions, improve accuracy, and faster data corrections.

**Key Users & Stakeholders:**

* **Pilots (17,500+):** View pay registers and report discrepancies.
* **Pay Analysts:** Audit and adjust compensation discrepancies.
* **Administrators & DevOps Teams:** Manage system administration, deployments, and database performance.
* **Integration Systems:** CFA (payroll data processing) and uCrew (crew scheduling and payroll integration).
* **Stakeholders:** United Airlines management, finance, security, and compliance teams ensuring operational and regulatory adherence.

**Technology Stack:**

* **AWS Services:** ECS Fargate, EMR, Route53, ALB, RDS Aurora MySQL, S3, MSK, Secrets Manager, Parameter Store.
* **Integration:** Connects to CFA’s MSK Cluster for data consumption and publishes pay exceptions to on-prem CFA Confluent Kafka Cluster.
* **Security:** Uses KMS for data encryption, TLS 1.2 for RDS communications.
* **Monitoring:** Uses Datadog/Dynatrace for application monitoring and log management.
* **Authentication:** Employee Single-Sign-On (SSO authentication) via OAM and Active Directory.
* **Authorization:** Role-Based Access Control (RBAC) with specific roles defined.
* **DR Strategy:** Active-Passive approach with Route 53 Application Recovery Controller for regional failover.
* **Deployment Environments:** Development, QA, Stage/Pre-Prod, Production.
* **CI/CD:** Uses Harness for seamless deployments and pipeline management.
* **Code Ownership:** Developed internally with source code owned by United.

**Project Timeline:**

* **Q1 2025:** Implement short-term recommendations.
* **Q2 2025:** Fine-tune to further optimize.
* **Q3 2025:** Transition to real-time stream processing, move business logic to ODM, and ML architecture.

**Team Composition:** The projects involved multiple stakeholders from United Airlines, Creospan, and external vendors:

* **Enterprise Architecture Team (United Airlines):**
* Managing Director: Ninos Gabriel.
* Director of Architecture: Krishna Srinivasan.
* Principal Enterprise Architects: Jenny Zhou, Raj Thomas, Harold D’Souza.
* **Creospan Team:**
* Shyam Sundhar Venkataraman (Enterprise Architect).
* Ron Smith (Enterprise Architect).
* Kevin Dooley (Enterprise Architect).
* **External Vendor:** Infosys (Enterprise Architect).
* **Vendor Collaboration:** Creospan team members (Shyam Sundhar Venkataraman, Kevin Dooley, and Ron Smith), one Infosys enterprise architect, and additional vendors in portfolio teams.
* **Other Vendors:** Kforce, TCS
* **Other Contributors:** Scrum Masters, Engineers, Developers.

**Conclusion:** The modernization of United Airlines’ Pilot Pay Engine Application (FOP) successfully addresses the challenges of scalability, security, and compliance while improving efficiency in processing pilot compensation. By leveraging AWS cloud-native technologies, the system now supports faster, more reliable payroll processing, integrates seamlessly with CFA and uCrew systems, and ensures compliance with stringent regulatory requirements.  Additionally, performance optimizations have significantly reduced processing times and operational costs, reinforcing business continuity through automated disaster recovery mechanisms.

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