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Agile Digital Transformation Using Elastic Infrastructure on AWS Cloud

Grant Delivery System Modernization (GDSM) for
California Student Aid Commission (CSAC)

ABSTRACT

California Students Aid Commission (CSAC) celebrated successful production rollout of Grant Delivery System Modernization (GDSM) Project Phase 1, which includes the iterative release of WebGrants for Students and Chafee applications on their new modern platform in just 8 months.

The rapid agile iterative modernization is enabled by modern digital solution architecture using open source technologies, open standards, and elastic infrastructure on Amazon Web Services (AWS) Cloud.

THE ORGANIZATION

California Students Aid Commission (CSAC) is the foremost state agency responsible for administering approximately $3 billion dollars in financial aid programs for about 600,000 students attending public and private universities, colleges, and vocational schools in California. The Commission provides financial aid policy analysis and leadership, in partnership with California's colleges, universities, financial institutions, and financial aid associations while serving its mission of making education beyond high school financially accessible to all Californians.

xFusion Technologies partnered with CSAC to provide solution and infrastructure architecture, DevOps automation, and solution implementation services for the GDSM project.

CHALLENGES WITH LEGACY GRANT DELIVERY SYSTEM (GDS)

The existing Grant Delivery System (GDS) was developed over 30 years ago and has serious maintainability, performance, and scalability issues. Some of these issues are caused by unmaintainable technical architecture that can't cope up with changes in business requirements, business rules buried in the program code, manual labor-intensive business processes, data integrity and accuracy of the program outcome issues, data and business functions in silos, and challenges with audit, error and exception management and traceability.

The legacy GDS application and database were hosted in the on-premises servers with maximum server capacity to support peak load that normally occurs only few months per year. This resulted in higher upfront capital investment. The application maintenance and operations mostly relied on manual processes with hardly any automations that resulted in lengthy build and deployment cycles in various SDLC environments. Also, the monolithic legacy applications needed much longer cycle time to complete analysis, implementation and testing of changes. Security and Privacy of the sensitive data (PII, FTI) was also a critical risk.

SOLUTION: GRANT DELIVERY SYSTEM MODERNIZATION (GDSM)

The GDSM project initiative presented an opportunity to replace the legacy GDS with a new GDS on a modern technology platform that will improve the agility, maintainability, flexibility, performance and adaptability of the end-to-end Grant Delivery business processes, while addressing current business challenges and opportunities.

Key Architectural Agility Enablers

- Microservice Oriented Architecture (MOA)
- Container Based Virtualization
- Elastic Cloud Infrastructure on Amazon Web Services (AWS)
- Security and Privacy of Sensitive Data, API and System
- Automated DevOps

Iterative Modernization for Rapid Delivery of Business Values to the Users

The GDSM project used Scaled Agile Framework (SAFe) for the iterative modernization of the legacy Grant Delivery System. The WebGrants for Students and CHAFEE application were developed and deployed to production in just 8 months. The second phase of the project focused on modernizing the business functions for the High Schools, Colleges and Universities and CSAC staff. The applications have successfully handled 10,107 student registrations and an average daily traffic of 7000+ student logins since December 2019 go-live date.

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Business Driven Modern Open Source and Open Standards Based Technology Platform and Accelerators for Speed, Flexibility and Agility

Iteration 1 – Student Interface Go-Live on Dec 2019
❑ Iteration 1 Go Live: WebGrants for Students, Chafee
❑ Iteration 1 Completion Time: 8 Months
❑ Initial Project Cost: $30M+
❑ Number of Student Users: 1.6M
❑ Number of High School, College and University Users: 25,000
❑ Multi-Channel Application Access through PC Browser and Smart Mobile Devices
❑ New Students Registration Since Go-Live: 253,832
❑ Avg. Number of User Login: 7000 Users/Day
❑ Infrastructure as a Service (IaaS): AWS Cloud
❑ User Centric and API, DevOps and Security (ADS) First Approach
❑ SaFE Agile Methodology
❑ Modern Open Source IdAM Platform to Support Over 4 Million Users

The modern GDS platform is a Cloud-Enabled, Container based Microservices Solution Platform Powered by Open Source Technologies and Open Standards. Our DevOps solution enabled rapid delivery of business services to the users through the automated CI/CD pipeline. We adopted User Centric and Responsive Design approach to bring the desired User Experience for the end users. All the SDLC environments are established on AWS using Kubernetes cluster. WSO2 API Gateway is used for secure and centralized access to the Microservices APIs that ensures scalability, performance, and redundancy.

Key Emphasis on the Security and Privacy (S&P) of the Data and System

Risk Based Security and Privacy Framework (NIST/FIPS) was used to plan, assess, design, implement and test the security controls to protect the PII and FTI data. We have implemented Identity and Access Management solution using Open Source WSO2 Identity Management platform for self-service user registration workflows, Multifactor Authentication,

The Modern GDS IdAM Solution supports over 4 million users. The Phase one has migrated over 1.6 million Users from the legacy system.

User ID/Password Reset, and Role Based Access Control (RBAC). We also used modern security controls such as Web Application Firewall (WAF), OAuth2, SAML etc. for data and API security.

MIGRATION TO ELASTIC CLOUD INFRASTRUCTURE ON AMAZON WEB SERVICES (AWS) – INFRASTRUCTURE AS A SERVICE (IAAS)

CSAC established end to end SDLC environments including Development, Testing, Staging, UAT and Production hosted in AWS cloud.

The modern GDS solution is implemented using Microservices-based architecture using Amazon Elastic Container Service (Amazon ECS) and Docker containers.

> GDSM achieved tremendous infrastructure agility using Microservices-based architecture, Amazon Elastic Container Service (Amazon ECS) and Docker Containers

By running modern GDS applications on Amazon ECS, the web applications benefit from the performance, scalability, reliability, and availability of the AWS. Additionally, the services get out-of-the-box integrations with AWS networking and security services, such as Application Load Balancers for load distribution of the web application and VPC for networking.

The GDSM solution utilizes AWS ECS and Auto-scaling service, that allows automatic scaling to support large traffic spikes. The team uses Amazon Elastic Container Service (Amazon ECS), AWS orchestration service, Amazon ECS for Docker containers to establish the capability to run and scale containerized GDS services on AWS. Amazon EC2 and Amazon ECS allows the application containers to scale dynamically and make any containers disposable. Any number of Docker containers can be integrated without any need for reconfiguration of the storage layer.

KEY TAKEAWAYS

High Availability & Fault Tolerance

Amazon Web Services are available in various geographic Regions and consist of multiple, isolated, and physically separate Availability zones (AZs) within a region, which provide easy access to redundant deployment locations. Regions and AZs help achieve greater fault tolerance by distributing the application geographically and help build multi-site solution. Placing EC2 instances in multiple AZs enables CSAC to protect the application from a single point of failure.

Rapid Agile Delivery

The modern GDS solution uses container based Microservice oriented architecture that allows CSAC to iteratively change, build and deploy smaller chunk of software rapidly.

Using automated container provisioning available from Amazon ECS has also allowed CSAC to reduce deployment times, increase update frequency, and improve developer satisfaction. When developers deploy a container, it is pushed to AWS container registry in a matter of minutes with no operational involvement. CSAC deploys application updates multiple times per day and expects the pace to pick up. Operations overhead has reduced now that developers can manage their deployments, which is icing on the cake. Amazon ECS rolling update service has made the deployment smooth with no downtime.

CSAC uses automated DevOps and CI/CD pipelines for continuous application deployment and delivery. This ensures a repeatable and automatable approach, reducing the possibility of inconsistencies or human errors that might occur when applying patches with direct management access (e.g. SSH/RDP) to instances.

Improved Operational Efficiency

Amazon ECS, Container as a Service (CaaS) model established using Containerized Microservices, combined with Auto Scaling groups have enabled rapid automated orchestration and deployment with little or no human intervention. CSAC can spin up a new container in a few seconds using Amazon ECS, instead of installing and configuring the database manually. This has dramatically improved the operational efficiency at CSAC.

End-point Security

After evaluating several security solutions, CSAC chose Amazon Web Services (AWS) and its web-application firewall, AWS WAF, because it provided the necessary level of security and scalability required for the modern GDS application. AWS WAF provides protection against HTTP flood, cross-site scripting, and SQL Injection. Another significant benefit to CSAC is AWS WAF's highly effective protection against known bad actors via "IP Blacklists," which uses an AWS Lambda function to check third-party IP-reputation lists—such as Spamhaus—for IP ranges to block. AWS WAF maintains the list of bad IP addresses and continually checks for them across the cloud. It is always up to date on protecting itself against IP offenders via Spamhaus, and offenders are automatically blocked.

Key Benefits

❑ Increased Solution Agility and Adoptability. ❑ Rapid Agile Delivery. ❑ Better System Performance, Availability and Stability.	❑ Better Operational Efficiency. ❑ Reduced Capital and Operational Expenses (CapEx/OpEx). ❑ Reduced Security Risk. ❑ Reduced Compliance Risks.

Maximized Investment on Business Value Creation!!