

COMP 4651 - Cloud Computing

Human Relations & Customer Relationship Management System

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CONTENTS

I	Motivation	1
II	Specification	1
II-A	Problem Analysis	1
II-B	Project Scope & Requirement Formalisation	1
III	Design	2
III-A	Load Balancing	2
III-B	Security & Authentication	2
III-C	Compute	2
III-D	Architecture	2

I. MOTIVATION

In our increasingly globalised world, the scope and demands of businesses have drastically evolved, and the necessity for infrastructure to support these new demands is evident. With the ubiquity of the internet even small businesses are likely to have customers – and with the rise of remote work, possibly even employees – in countries other than their own.

This entails a multitude of issues when managing employees and customer relations which we propose a cloud-based human resources customer relationship management (HR CRM) solution is well-suited to solve.

II. SPECIFICATION

A. Problem Analysis

Our solution is tailored to address challenges frequently encountered by multinational corporations, with requirements naturally stemming from the legislative and operational constraints they face. To meet these demands, the software must ensure global accessibility at all times while securely managing sensitive data, such as payslips, paid leave records, and employee details. This gives rise to the following key requirements:

- 24 hour availability during the work week to cover all time zones

- Security measures for file storage
- Regulated access for employees only; minimising employee access to what is strictly necessary

Additionally, the system should provide a smooth experience for its users, meaning user experience features, such as a Single Sign-On (SSO) system, are important.

For a complete solution, further consideration could also be given to product development within the company. For example, a pre-production pipeline and environment could be integrated, allowing developers to internally validate new software functionality, testers to ensure these features match requirements and work as expected, and these changes to be deployed to the production environment. However, this will be omitted from the scope of the project.

B. Project Scope & Requirement Formalisation

In the interest of relevance to the module, and feasibility given the time frame for development, a decision to focus on the high availability, high redundancy, and security aspects of the cloud CRM solution was made.

This focus includes key elements such as inbound traffic filtering, HTTPS access to the web app, and the implementation of internal AWS service communications protocols in TLS 1.2.

Additionally, the aim is to also implement SSO login support using the SAMLv2 protocol.

We have based our assumptions on the typical scale of multinational corporations, which generally employ over 60,000 employees worldwide (Minbaeva and Navrbjerg 2011, p. 104). Consequently, our system is designed to meet the following development requirements:

- Secure communication via HTTPS and a firewall
- Defenses against Distributed Denial of Service (DDOS) attacks
- TLS 1.2 protocol for internal communication between AWS services

- 24-hour-a-day availability from all regions during the work week
- SSO in SAMLv2 for system security and user convenience
- Capacity to support 60,000 concurrent
- SFTP communication with third-party tools

We can also consider the storage system to be somewhat coherent and consistent of a HR CRM model. Considering that there's multiple data types to store per person, we can assume a NoSQL system under a key-value database, where the key would be the employee's unique ID and the value would be the rest (name, address, salary, number of paid leaves remaining, timezone...)†

III. DESIGN

A. Load Balancing

To ensure the [requirements](#) for availability and redundancy are met, deploying multiple instances of the app alone is insufficient.

To address network load distribution, the methods discussed by Patil (2022) are implemented; utilizing the *Elastic Load Balancer (ELB)* module in AWS, network traffic is distributed across multiple Availability Zones (AZs) within a specific region. Additionally, incorporating the *Route 53* DNS module is critical for managing load balancing across regions. This ensures that, in scenarios where a particular region becomes overloaded, traffic can be rerouted to alternative regions to maintain optimal performance and reliability.

For example, if servers in North America (e.g., those located in Canada and the USA) experience high load or downtime, users accessing the application from this region could be redirected to servers in Europe or South America. This approach enhances system reliability and ensures uninterrupted service delivery.

B. Security & Authentication

In addition to the aforementioned AWS modules, user identification and authentication must be addressed; as highlighted by Ismailov (2024), *Amazon Cognito* emerges as a suitable solution, providing secure and scalable Customer Identity and Access Management (CIAM) for employees. Crucially for the application, it supports SAML, along with a range of other authentication protocols.

Furthermore, in order to facilitate HTTPS connectivity, between the open Internet and the application, and TLS 1.2 secured inter-service commu-

nication *AWS Certificate Manager (ACM)* is employed. This allows for use to seamlessly handle SSL and TLS certificate handling for the deployed application instances.

C. Compute

In terms of performance, supporting 60,000 concurrent users requires a relatively powerful *Elastic Cloud Computing (EC2)* instance specification. However, since multiple instances will be deployed to ensure high availability and address potential bottlenecks, the specifications of each instance can be reduced to handle approximately 30% of the load – equivalent to 18,000 concurrent users per instance.

Network bandwidth must also be considered as it is critical for ensuring reliable, low-latency data transfer. Based on EC2 specifications (AWS 2024), the most suitable option for this use case is a compute-optimized instance type. This configuration is ideal as storage requirements are handled externally, making the storage-optimized instance type unnecessarily redundant. Additionally, a general-purpose instance type could be considered for the web app, given that the app functions as an interface hence not requiring as much expensive compute power.

Among the compute-optimized options, the *c8g.4xlarge* instance is particularly appropriate, offering 16 vCPUs, 32 GiB of RAM, and up to 15 Gbps of network bandwidth. This configuration balances performance and scalability, aligning well with the application's requirements.

D. Architecture

To achieve high availability and redundancy for the application, a multi-tiered architectural approach is adopted, leveraging key AWS services to ensure scalability, reliability, and security. The core components and their roles are as follows:

- **Global Deployment of EC2 Instances:** At least one *EC2* instance is deployed on each continent. Within each region, Cross Availability Zone replication is enabled using *Amazon Elastic Disaster Recovery (AWS DRS)* to safeguard against regional failures.
- **Regional Elastic Load Balancers (ELBs):** Each region employs an *Elastic Load Balancer (ELB)* to distribute incoming network traffic evenly across its local EC2 instances and their replicas. This ensures a balanced workload within the region.

- **Global Traffic Management with Route 53:** *Route 53* DNS routing distributes traffic across all globally deployed instances. When a region becomes overloaded or experiences downtime, *Route 53* automatically redirects users to alternative regions, maintaining seamless access.
- **Secure Communication with AWS Certificate Manager (ACM):** *ACM* is deployed in each region to manage SSL certificates for HTTPS access and TLS certificates for internal communication between AWS services, both within and across regions.
- **Enhanced Security Measures:** *AWS WAF* and *AWS Shield* are integrated to protect against DDoS attacks and other security threats. These services are applied globally across all AWS resources.

For user authentication, *Amazon Cognito* plays a central role. User pools are region-specific, therefore a centralized *Amazon Cognito* instance can be set up in the region hosting the organization's main IT infrastructure or headquarters, providing Single Sign-On (SSO) with SAMLv2 for all globally deployed instances. This centralized approach simplifies identity management and maintains secure access across the system. Additionally, by hosting the *cognito* instance by the headquarters it is likely to minimise the sign-on latency for the largest proportion of employees.

Data storage follows a similar centralized model. A NoSQL key-value database using *Amazon DynamoDB* is employed to store sensitive employee data. Consolidating storage in a single region minimizes the risks associated with duplicating sensitive data across multiple regions. For added reliability, the storage hub can be replicated in a secondary region to provide disaster recovery and redundancy. Considering the legislative repercussions of this decision, is far outside the scope of the project.

To facilitate communication between distributed components, asynchronous messaging is implemented via *AWS AppSync* or *Amazon Simple Notification Service (SNS)*. This pub-sub model ensures reliable message delivery without risking data duplication, supporting fault-tolerant operations across regions.

This architectural strategy centralizes critical resources like authentication and storage while maintaining regional compute and traffic management capabilities. Such a setup ensures scalability, fault tolerance, and operational efficiency across the global infrastructure.

Figure 1 provides a visual overview of the system's architecture, summarizing the components and their interactions to ensure high availability, redundancy, and security.

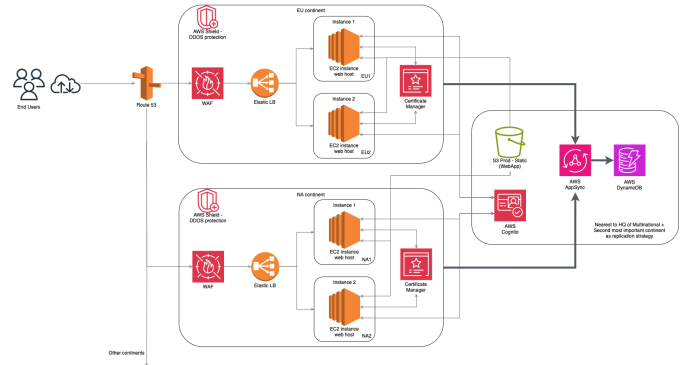


Fig. 1. Architecture proposal

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