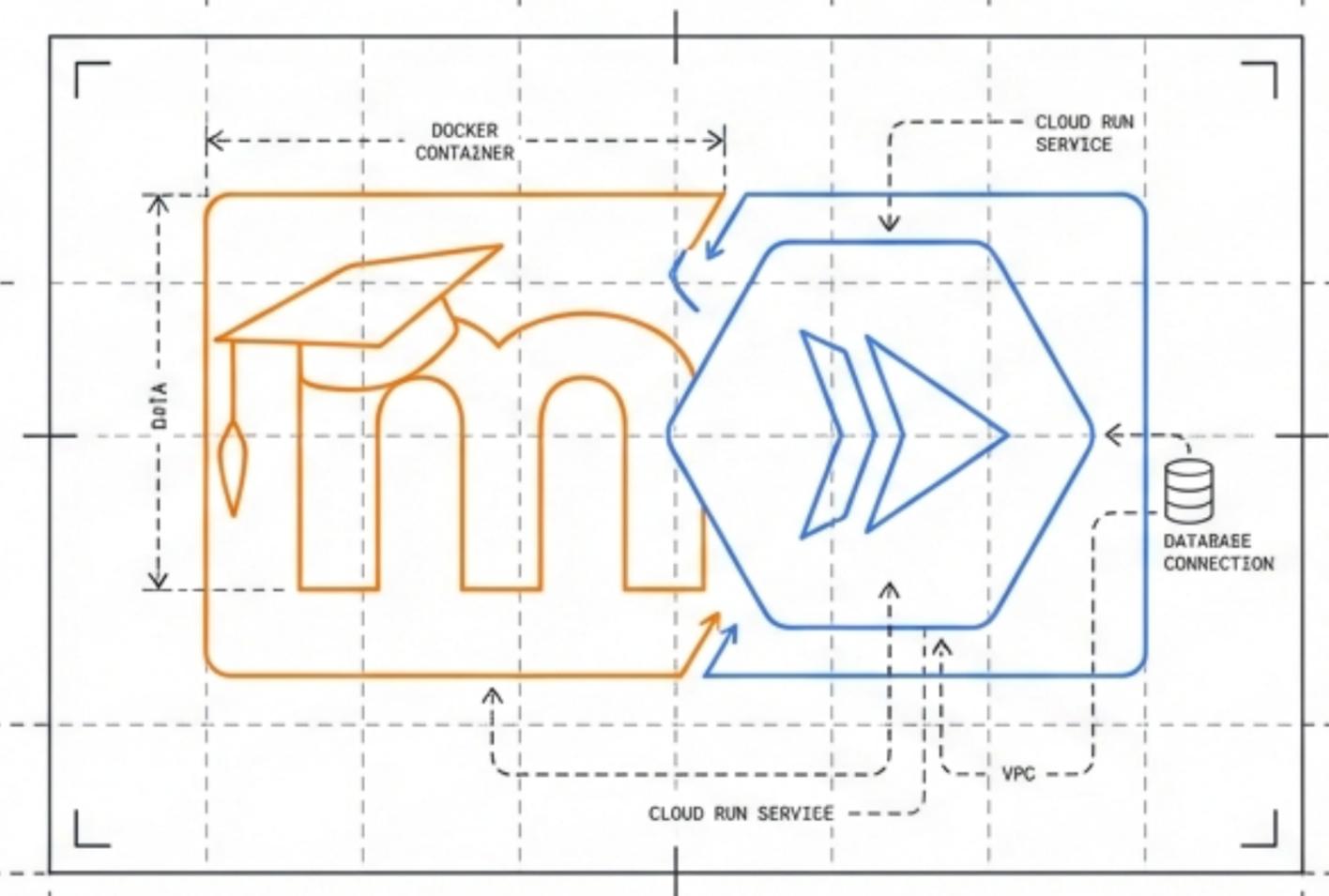


Modernizing Moodle on Google Cloud

A Serverless, Containerized Architecture via the RAD Platform

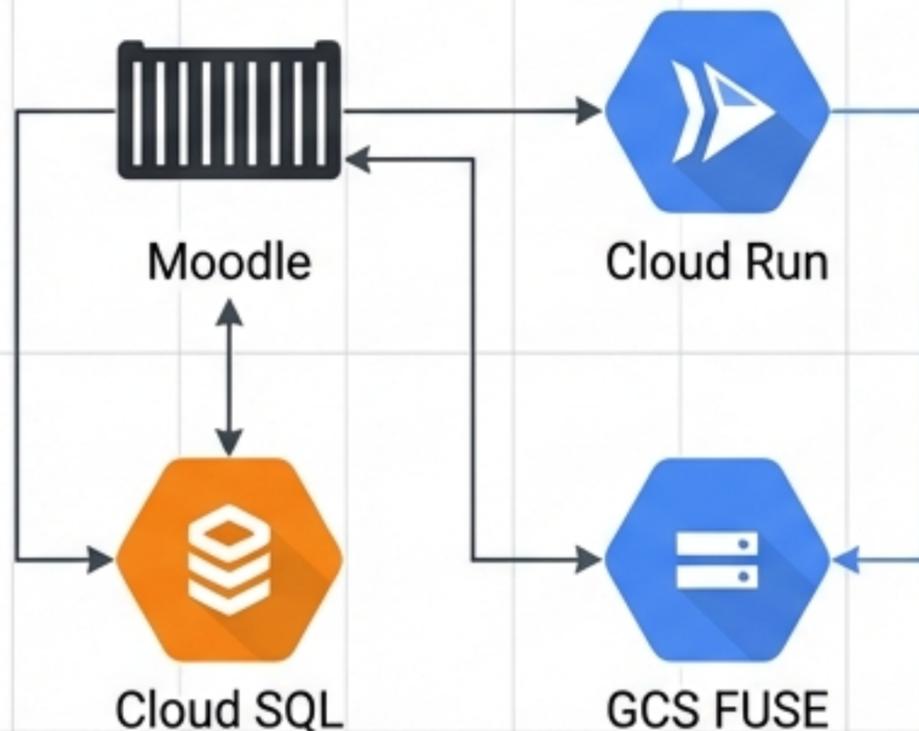
Architectural Deep Dive & Configuration Specification



Transforming the Monolith for the Cloud Era

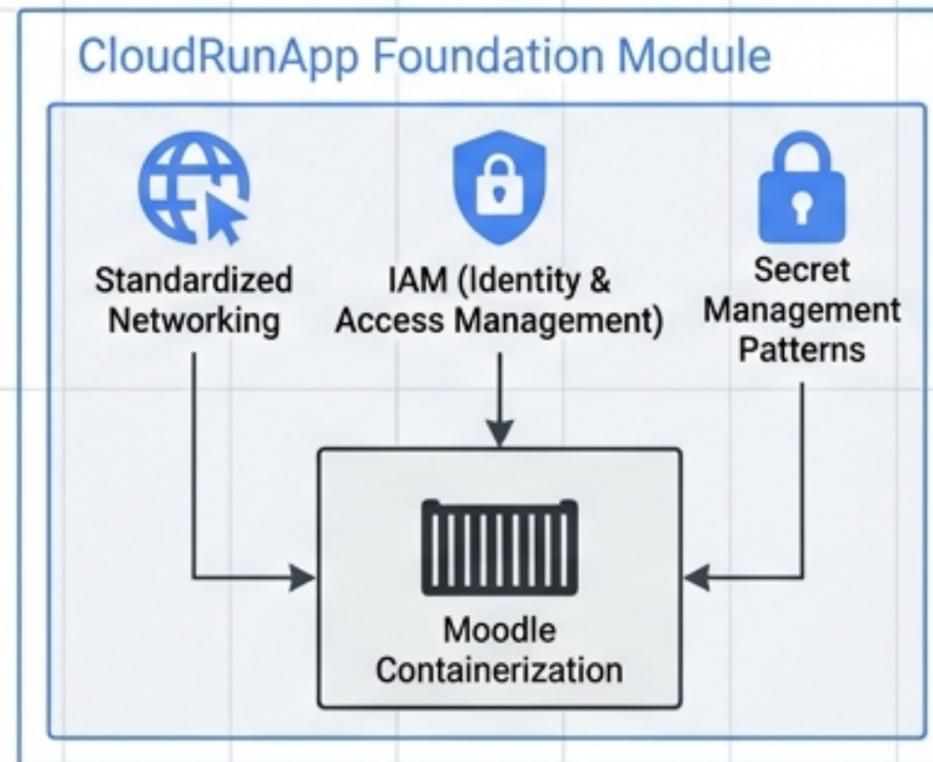
The Core Concept

A containerized Moodle deployment leveraging Cloud Run for serverless compute, Cloud SQL for state management, and GCS FUSE for shared file storage.



The Foundation

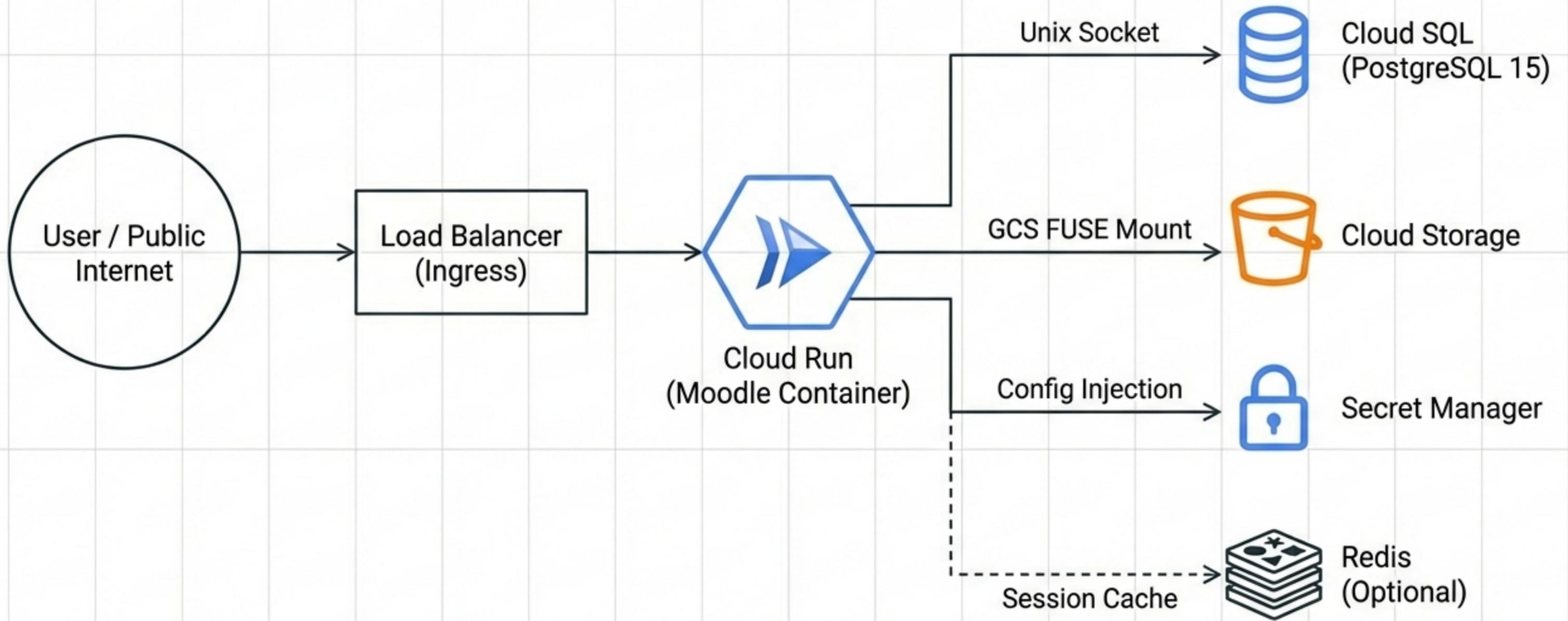
Wrapped by the 'CloudRunApp' foundation module, inheriting standardized networking, IAM, and secret management patterns automatically.



Key Value Propositions

- ✓ • Serverless: Scales to zero, gen2 execution environment.
- ✓ • Standardized: Pre-configured IAM and Security.
- ✓ • Persistent: Solves the stateful challenge via Cloud SQL SQL and Object Storage.

The Architectural Topology



The Compute Engine: Cloud Run



Execution Environment gen2

Scaling Configuration Min: 0 / Max: 5 Instances

Base Image ubuntu:24.04

Application Stack PHP 8.3 + Apache

Process Management Entrypoint: tini (Process 1)

Wrapper Logic cloudrun-entrypoint.sh
executing foreground.sh

Data Persistence Layer: Cloud SQL



Engine Specification

PostgreSQL 15. Standard, robust relational database engine.

Secure Connection

Utilizes Unix Socket integration. No public IP exposure required for database traffic.

Performance Tuning

Module automatically enables 'pg_trgm' extension. Critical for optimizing Moodle's specific search queries.

The Storage Paradigm Shift

Primary Storage (Active)



Mechanism: GCS FUSE

Mechanism: GCS FUSE

Mount Path: `' /gcs/moodle-data '`

Configuration: `' $CFG->dataroot '`
explicitly set in
`' moodle-config.php '`.

Access: Native Cloud Run
volume mount.

Secondary Storage (Legacy Support)



Filestore / NFS

Mechanism: Filestore NFS

Mount Path: `' /mnt '`

Status: Inactive by default.
Available only for legacy
plugin compatibility.

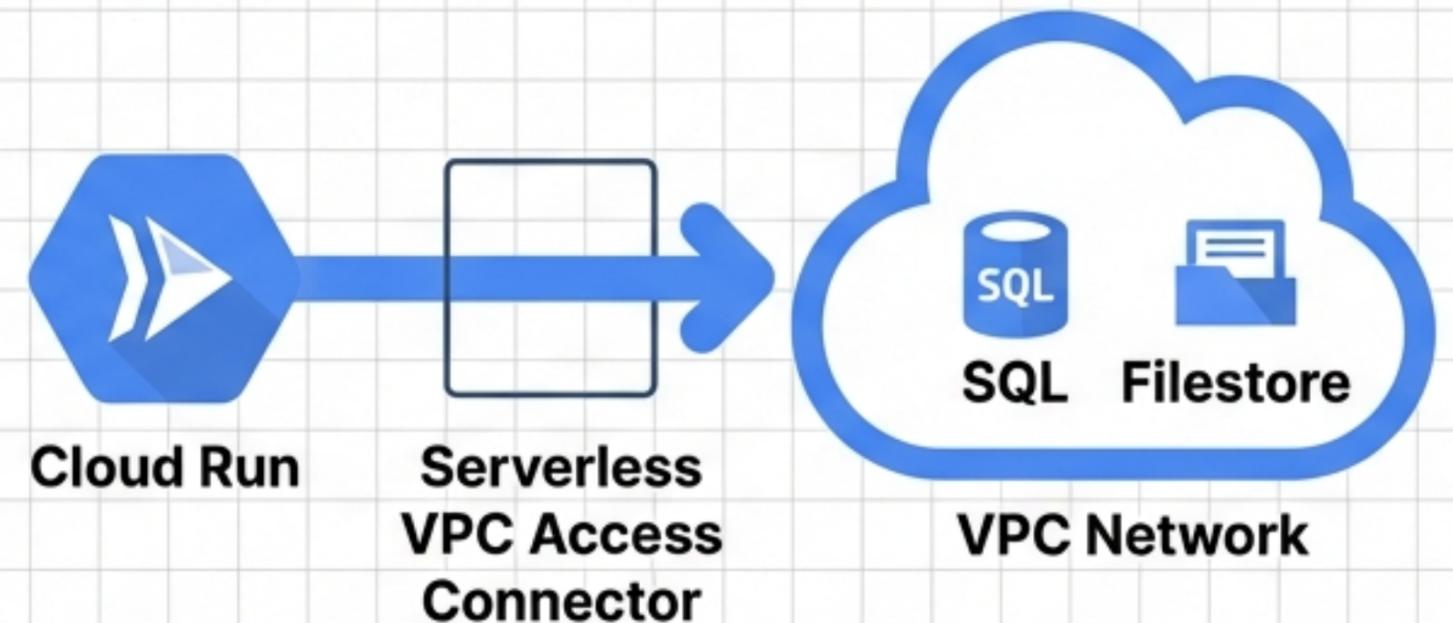
Traffic Flow and Network Isolation

Ingress (Incoming Traffic)



Mode: internal-and-cloud-load-balancing
Routing: Global HTTP(S) Load Balancer handles SSL termination.

Egress (Outgoing Traffic)



Mechanism: Serverless VPC Access.
Destination: Private IP ranges for Cloud SQL and Filestore.

Identity and Access Management

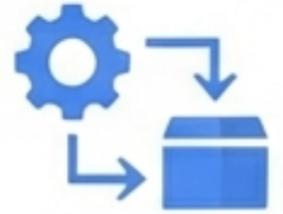
Runtime Identity (Cloud Run SA)



The application persona.

- roles/secretmanager.secretAccessor
- roles/storage.objectAdmin
- roles/storage.legacyBucketReader

Deployment Identity (Cloud Build SA)

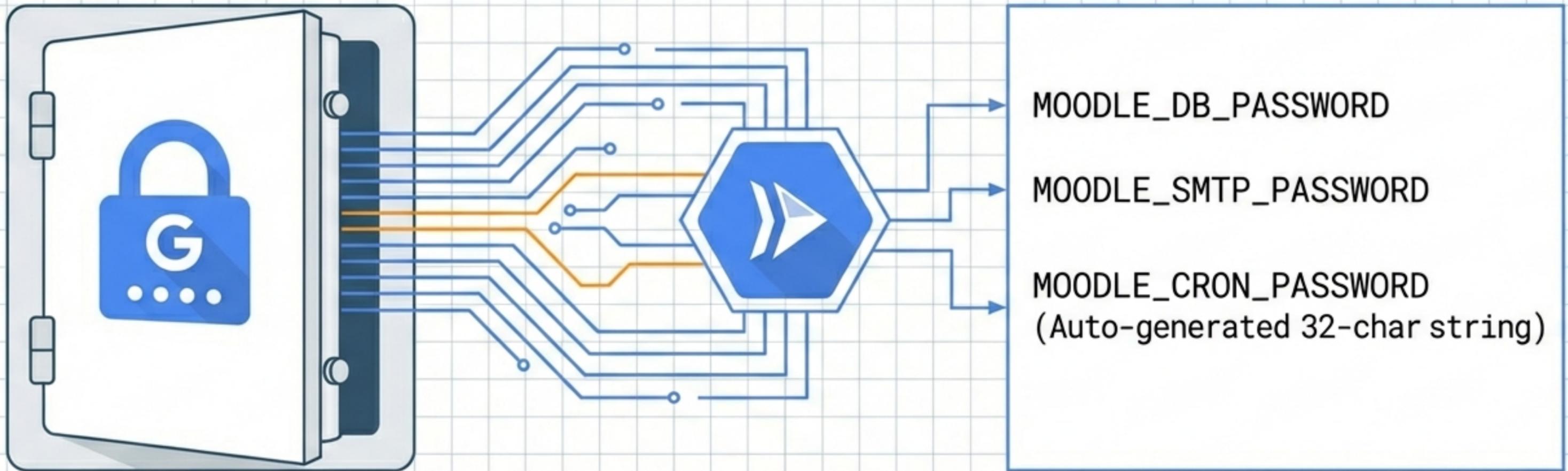


The CI/CD persona.

- roles/run.developer
- roles/iam.serviceAccountUser

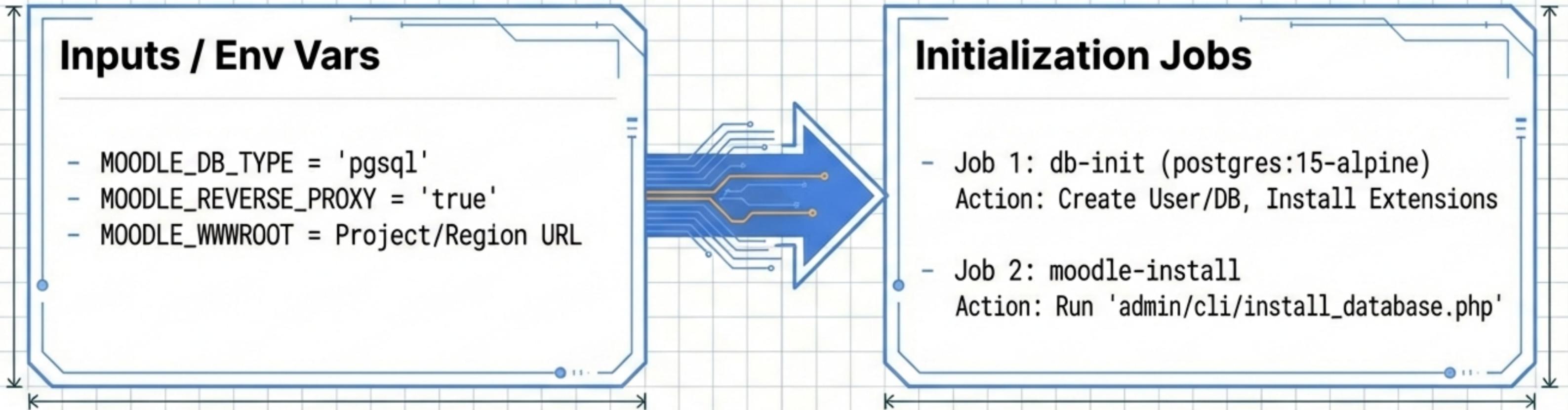
Secrets and Sensitive Data

Management Tool: Google Secret Manager



Infrastructure as Code Logic

moodle.tf Configuration Highlights



Runtime Optimization and PHP Config

gd

pgsql

intl

soap

xmlrpc

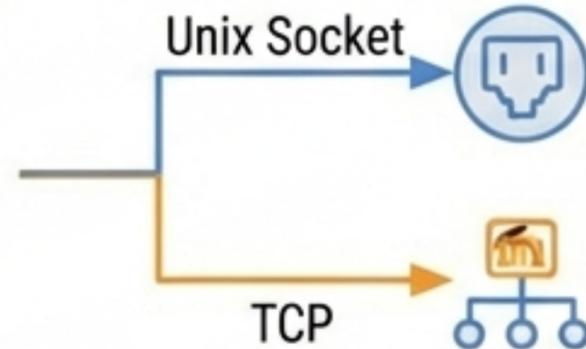
zip

mbstring

redis

Dynamic Host Detection

Scripts detect if DB_HOST starts with '/' to toggle between Unix Socket and TCP modes automatically.



Health Check Bypass

Problem: Moodle boot is heavy.

Health Check

Moodle Boot

Solution: Return '200 OK' immediately for 'GoogleHC' User-Agent to prevent boot loops.

GoogleHC User-Agent

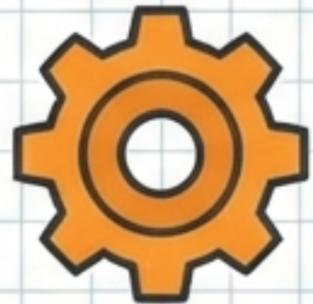
'200 OK'

Operational Features



Automated Cron

Cloud Scheduler triggers `/admin/cron.php` every minute using a secure, rotated password.



Auto-Installation

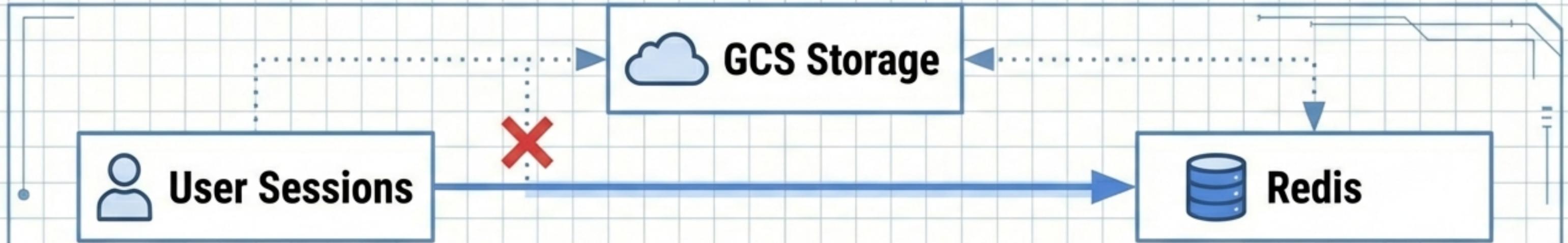
Self-installs on first boot via the `'moodle-install'` job if no database is detected.



PDF Annotation

`'ghostscript'` pre-installed to support Moodle's native assignment grading and annotation tools.

Performance Caching with Redis



Challenge

Challenge: GCS FUSE has higher latency for small, frequent I/O (like sessions).

Configuration: If 'redis_enabled' is true, '\$CFG->session_handler_class' switches to Redis driver.

Solution

Solution: Offload session management to Redis.

Result:

Stateless container, faster user experience.

Future Optimizations & Roadmap

Performance

- Implement **Google Cloud CDN** for static assets (`/theme/`, `/lib/javascript/`) to reduce container load.

Security

- Attach **Cloud Armor** (**WAF**) policies to Load Balancer.
- Enable **Identity-Aware Proxy (IAP)** for admin paths.

Reliability

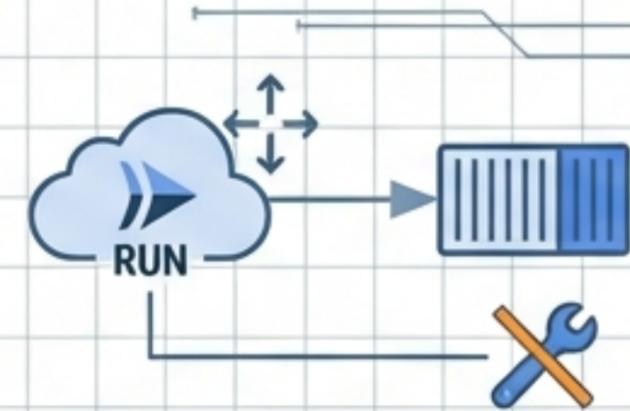
- Deploy **Read Replicas** for reporting-heavy instances.
- Enable **Object Versioning** on `'moodle-data'` bucket for backup resilience.

Architecture Summary



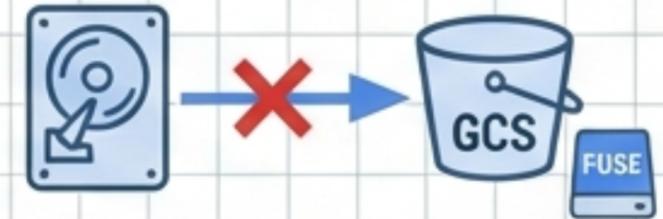
Serverless Compute

Cloud Run provides auto-scaling, managed infrastructure, and zero-maintenance patching.



Cloud-Native Storage

Transitioned from legacy NFS to scalable, cost-effective Object Storage (GCS) with FUSE.



Secure by Design

Pre-configured Identity (IAM), Secrets Management, and Private Networking (VPC Access) out of the box.

