2DT902 : Project : Group 2

link to document on gdrive

Report

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Persistence

Requirements TODO

QAS 1 : Data Availability

TODO Description

Source: Unexpected power outage.

Stimulus: The system is restarted after an unexpected power outage.

Artifact: Web-server.

Environment: System has just recovered from an unexpected shutdown.

Response: The system should restore all the data exactly as it was before the outage, with no data loss or corruption.

Response Measure: All data is accessible and system is fully operational within x minutes.

QAS 2 : Data Integrity

TODO Description

Source: An Employee.

Stimulus: An employee updates the price of a product in the inventory.

Artifact: Web-server.

Environment: System is fully operational.

Response: The system ensures that the price update is reflected across all orders, reports, and inventory views. The old price is archived (logs).

Response Measure: The update is applied across the system within 2 seconds (MySQL/PostgresSQL).

QAS 3 : System Maintenance

TODO Description

Source: System Administrator.

Stimulus: Administrator initiates a system upgrade during off-peak hours.

Artifact: Database and web-server.

Environment: System is partially operational (only administrator access is allowed).

Response: The system should allow data migration, backup, or configuration changes with minimal downtime, while ensuring no data loss.

Response Measure: Maintenance tasks are completed and system is back online within 15 minutes.

Solutions

QAS 1 : Data Availability

Alternative 1 : Database Replication with Automatic Failover

Pros:

- Ensures high availability and rapid recovery.
- Protects against hardware failures by distributing data copies.

Cons:

- Additional server costs for replication.
- May require complex setup and monitoring.

Alternative 2 : Regular Backups with Manual Recovery

Pros:

- Lower cost than replication.
- Simpler to implement and manage.

Cons:

- Longer recovery time in case of an outage.
- Risk of some data loss between backup intervals.

****Our choice:**

TODO Motivation Alternative 1, as high availability is critical for minimizing downtime in an online store environment.**

QAS 2 : Data Integrity

Alternative 1 : Database Transactions with Versioning

Pros:

- Ensures atomicity and prevents data corruption during updates.
- Maintains history for rollback or auditing.

Cons:

- Higher storage requirements due to versioning.
- Potentially slower for frequent updates.

Alternative 2 : Event Sourcing for Data Changes

Pros:

- Allows rollback and auditing by preserving events.
- Effective for tracking data changes over time.

Cons:

- Adds complexity in data retrieval.
- More challenging to query current state.

****Our choice:**

TODO Motivation Alternative 1, as database transactions with versioning provide a reliable and simpler solution for ensuring data integrity across the system.**

QAS 3 : System Maintenance

Alternative 1 : Rolling Updates

Pros:

- Minimizes downtime by updating components sequentially.
- Allows system to remain accessible to users during updates.

Cons:

- Requires support for backward-compatible updates.
- More complex deployment process.

Alternative 2 : Scheduled Downtime for Maintenance

Pros:

- Easier to implement with fewer compatibility concerns.
- Lower infrastructure demands as it doesn’t require redundant setups.

Cons:

- System is completely inaccessible during updates.
- Might impact user experience if not scheduled during low traffic.

****Our choice:**

TODO Motivation Alternative 1, to ensure maximum uptime for users and avoid disrupting the shopping experience.**

Security Components

Authentication component

Responsibilities:

- Manages user login, logout, and session handling.

Provides:

- Secure access control for employees and customers.

Requires:

- Secure storage for user credentials, preferably with encryption.

Choice of technology/software:

OAuth 2.0 or OpenID Connect.

Access Control Component

Responsibilities:

- Defines and enforces permissions for different user roles.

Provides:

- Role-based access management for employee actions and customer data.

Requires:

- Integration with the Authentication Component and database for user roles.

Choice of technology/software:

Role-based access control (RBAC) using Access Control Lists (ACLs).

Logging

Requirements TODO

QAS 1 : System Error

TODO Description

Source: System (hardware or software failure).

Stimulus: A system error occurs (database connection failure or server crash).

Artifact: Error logs stored in a centralized logging service (e.g., ELK stack, Cloud logging).

Environment: The system encounters an error while processing requests.

Response: The system logs the error, including a description of the affected service, the severity level and the time-stamp. Alerts may be sent to administrators.

Response Measure: The error is logged instantly, and the administrators are notified for immediate troubleshooting.

QAS 2 : Data Modification

TODO Description

Source: Authorized user (admin or employee).

Stimulus: A user modifies critical data (product price or inventory details).

Artifact: Database/API.

Environment: The system is fully operational.

Response: The system logs the modification, capturing the user's identifier, the data before and after the change, the resource affected and the time-stamp.

Response Measure: Modifications are logged in real-time, ensuring an audit trail of changes to critical system data.

QAS 3 : Transaction

TODO Description

Source: User (customer).

Stimulus: The customer initiates a payment for an order (whether success/failure).

Artifact: Web Server (payment authorization/payment gateway).

Environment: The system is operational.

Response: The system logs the transaction details, including payment method, order number/id, time-stamp and the result (success/failure), along with any relevant error messages if the transaction fails.

Response Measure: The transaction is logged immediately after the attempt whether successful or failed, and stored securely for audit and monitoring purposes.

Solutions

QAS 1 : System Error

Alternative 1 : Log errors locally with periodic batch uploads to centralized storage

Pros:

- Reduces immediate strain on network and server resources during high load.
- Allows for error data to persist locally in case of temporary network outages.

Cons:

- Potential delay in error visibility, slowing response time for admins.
- Higher risk of data loss if local logs are compromised before upload.

Alternative 2 : Real-time error logging to a centralized monitoring and alert system

Pros:

- Immediate log capture and alert, enabling rapid troubleshooting.
- Allows for pattern detection (e.g., multiple errors in a short time) which can help prevent cascading failures.

Cons:

- Increased bandwidth and processing resources for real-time logging, especially during high-error periods.
- Potential risk if centralized logging becomes unavailable during critical failures.

****Our choice:**

TODO Motivation Real-time error logging to a centralized monitoring and alert system for better response times and visibility into system health.**

QAS 2 : Data Modification

Alternative 1 : Log modifications in a dedicated audit log database

Pros:

- Provides structured, searchable records for efficient audit tracking.
- Can be optimized for logging and retrieval without affecting main application performance.

Cons:

- Requires additional maintenance and storage costs for a separate audit database.
- Introduces some additional latency in the modification process.

Alternative 2 : In-line logging within the main database using triggers

Pros:

- No need for an additional database; simplifies data management.
- Logging is tied directly to the modification transaction, ensuring atomicity.

Cons:

- Potential performance degradation of main database operations.
- Can complicate database schema and require more careful backup strategies.

****Our choice:**

TODO Motivation Dedicated audit log database to minimize performance impact on the primary database and streamline compliance with data logging standards.**

QAS 3 : Transaction

Alternative 1 : Log all transactions in the main application server logs

Pros:

- Easier to implement with fewer moving parts.
- Maintains transaction data close to the application logic, simplifying troubleshooting.

Cons:

- Log file growth can be high, increasing storage costs.
- Parsing and analysis of logs can be less efficient compared to structured storage.

Alternative 2 : Use a specialized transaction log system or service (e.g., transaction log database or third-party payment logging)

Pros:

- Dedicated system for transaction data, optimized for retrieval and analysis.
- Provides secure, tamper-proof records which are essential for financial data.

Cons:

- Requires integration with external systems, which may add complexity.
- Additional costs for setup, maintenance, or third-party service fees.

****Our choice:**

TODO Motivation Specialized transaction log system to ensure secure and scalable logging, compliant with financial data handling requirements.**

Security components

Authentication Component

Responsibilities:

- Validates and manages user identities.
- Enforces access controls for different user roles (e.g., customer, admin).

Provides:

- Secure user login and logout.
- Session management to prevent unauthorized access.

Requires:

- Connection to user database for identity verification.
- Secure channel for credential transmission (e.g., SSL/TLS).

Choice of technology/software:

OAuth 2.0 for secure token-based authentication, possibly with an identity provider like Auth0 or Firebase Authentication.

Logging and Monitoring Component

Responsibilities:

- Captures, stores, and provides access to system logs and alerts.
- Ensures that logs are retained securely for auditing and troubleshooting.

Provides:

- Real-time monitoring and alerting for critical system errors.
- Log search and filtering to support issue diagnosis and resolution.

Requires:

- Access to all application components for log aggregation.
- Integration with alerting and notification systems for administrator alerts.

Choice of technology/software:

ELK Stack (Elasticsearch, Logstash, Kibana) or CloudWatch for real-time logging and monitoring.

Security

Requirements TODO

QAS 1 : Unauthorized Access Attempt

TODO Description

Source: Unidentified User / User.

Stimulus: Attempts to access restricted resources, (employee dashboard).

Artifact: Access control systems (Authentication & Authorization).

Environment: The system is operational and user only has user-rights.

Response: System detects user-rights, denies the request, logs the attempt for security monitoring.

Response Measure: Unauthorized access is prevented 100% of the time, and an alert is sent to security with the IP-address of the attempt.

QAS 2 : Multiple Failed Login Attempts

TODO Description

Source: Unidentified User.

Stimulus: Multiple failed login attempts to an account.

Artifact: Login System (Authentication & Identification, account management, servers and logging).

Environment: The system is operational and functioning normally.

Response: After set amount of attempts blocks further login attempts, attempts are logged for security monitoring.

Response Measure: Locks the account, sends security alert to user email to be able to unlock account, this with a 100% prevention rate of unauthorized access to a users account.

QAS 3 : Denial of Service Protection

TODO Description

Source: Malicious actor(s).

Stimulus: X amount of requests per second, overloading the system (X >= 1000).

Artifact: Servers, traffic controller and logging.

Environment: The system is operational but slow (under a (D)DoS attack).

Response: System detects abnormal traffic patterns, limits requests and diverts the abnormal traffic to a backup server with limited resources.

Response Measure: System maintains 95% availability for regular users by limiting the abnormal traffic to 5% of the system's resources, logs attacks and notifies security and administrators within seconds of recognizing the attack.

Solutions

QAS 1 : Unauthorized Access Attempt

Alternative 1 : Role-Based Access Control (RBAC)

Pros:

- Simple to implement and understand.
- Limits access based on predefined roles, reducing risk of unauthorized access.

Cons:

- Lacks flexibility for dynamic access needs.
- Requires careful role management to avoid over-privileged access.

Alternative 2 : Multi-Factor Authentication (MFA) + Context-Based Access Control

Pros:

- Provides stronger access control by requiring a second factor.
- Context-based controls (such as IP location checks) can further limit unauthorized attempts.

Cons:

- More complex to implement, requiring additional hardware or software.
- Could inconvenience legitimate users, increasing login time.

****Our choice:**

TODO Motivation Multi-Factor Authentication + Context-Based Access Control to enhance security and ensure unauthorized access attempts are strictly managed.**

QAS 2 : Multiple Failed Login Attempts

Alternative 1 : Temporary Account Lockout

Pros:

- Limits brute-force attack success by locking out after a few failed attempts.
- Simple to implement with most authentication systems.

Cons:

- Could result in denial-of-access for legitimate users if they forget their credentials.
- Requires careful lockout time management to avoid frustrating users.

Alternative 2 : CAPTCHA Implementation after X Failed Attempts

Pros:

- Prevents automated brute-force attacks effectively.
- Allows users to attempt to log in without full lockout.

Cons:

- CAPTCHA may reduce user-friendliness.

- Limited impact on sophisticated attacks, especially if CAPTCHA is bypassable.

**Our choice:

TODO Motivation CAPTCHA after X failed attempts, followed by temporary lockout if necessary, to balance user experience and security.**

QAS 3 : Denial of Service Protection

Alternative 1 : Rate Limiting with Cloudflare / API Gateway

Pros:

- Easy to configure rate limits and monitor traffic patterns.
- Can scale automatically to handle legitimate high-traffic events.

Cons:

- Costs can increase with the level of usage and protection.
- Limited protection for complex (D)DoS attacks.

Alternative 2 : Load Balancer with Automated Traffic Analysis and Filtering

Pros:

- Allows real-time monitoring and redirection of abnormal traffic.
- Provides flexibility for adjusting resources to meet normal user demand.

Cons:

- Higher infrastructure costs.
- May require complex configuration and maintenance.

**Our choice:

TODO Motivation Load Balancer with automated traffic analysis to filter malicious traffic and maintain service availability during attacks.**

Security components

Authentication Component

Responsibilities:

- Verifies user identity before granting access.
- Implements RBAC and MFA to secure user sessions.

Provides:

- User authentication, login monitoring, and account management.

Requires:

- Integration with user management systems and logging services for security monitoring.

Choice of technology/software:

OAuth 2.0 (for secure authorization), Google Authenticator (for MFA), and JWT (JSON Web Tokens for session management).

Traffic Controller Component

Responsibilities:

- Manages incoming traffic and mitigates DoS attacks by redirecting or rate-limiting requests.

Provides:

- Real-time traffic analysis and DoS protection, availability monitoring.

Requires:

- Connectivity with logging and alert systems, communication with backup server resources.

Choice of technology/software:

Cloudflare or AWS WAF for rate limiting, and HAProxy for load balancing.

Logging and Monitoring Component

Responsibilities:

- Records access attempts, monitors security events, and sends alerts for suspicious activities.

Provides:

- Log storage, access for security audits, real-time alerts.

Requires:

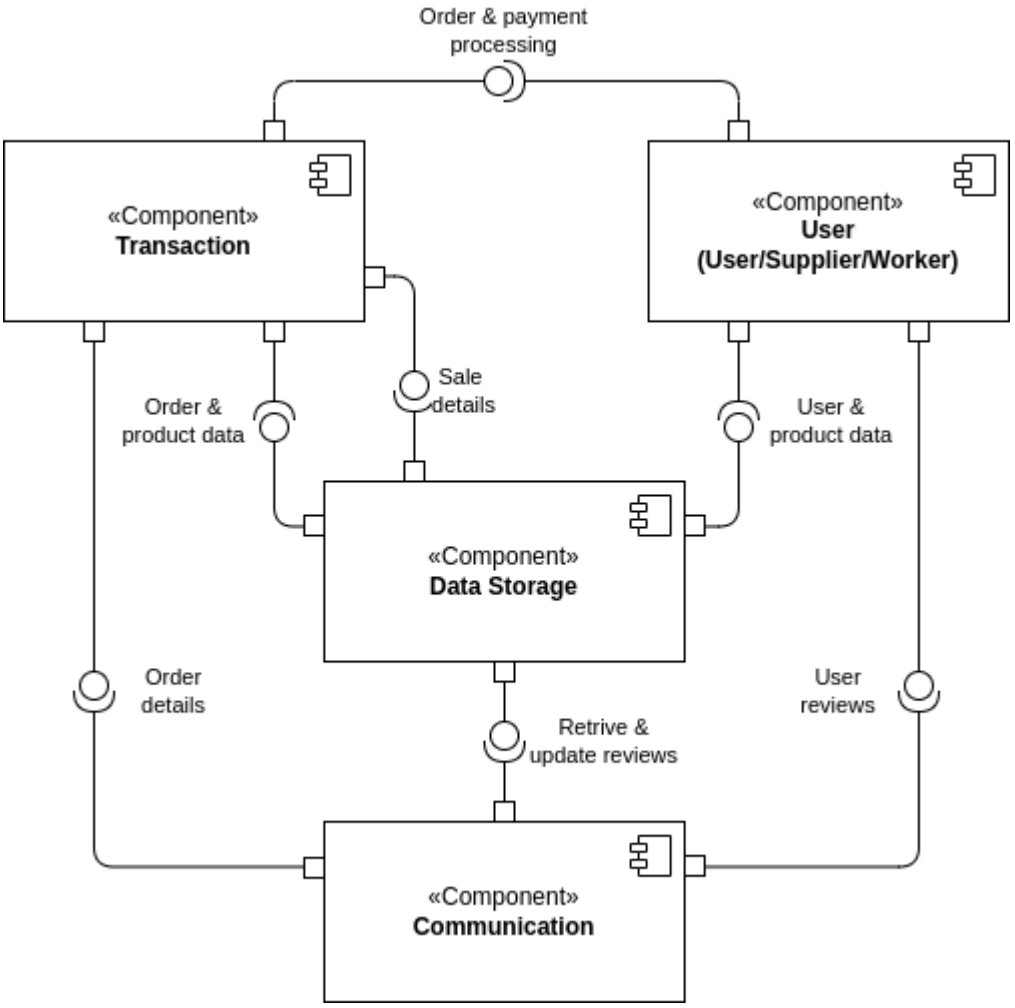
- Access to authentication and traffic controller logs, integration with notification services.

Choice of technology/software:

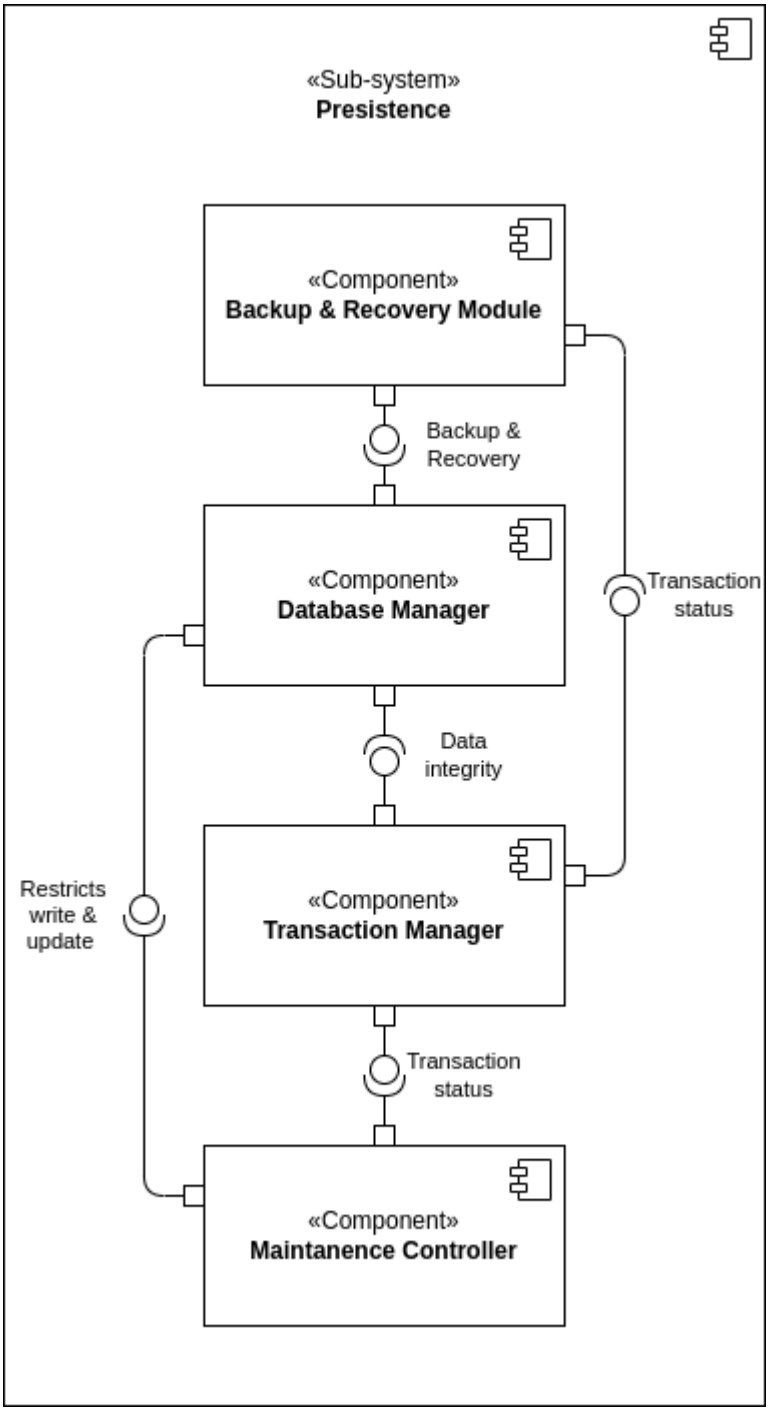
Elasticsearch and Kibana for logging and monitoring, with PagerDuty for alerting.

Overview TODO

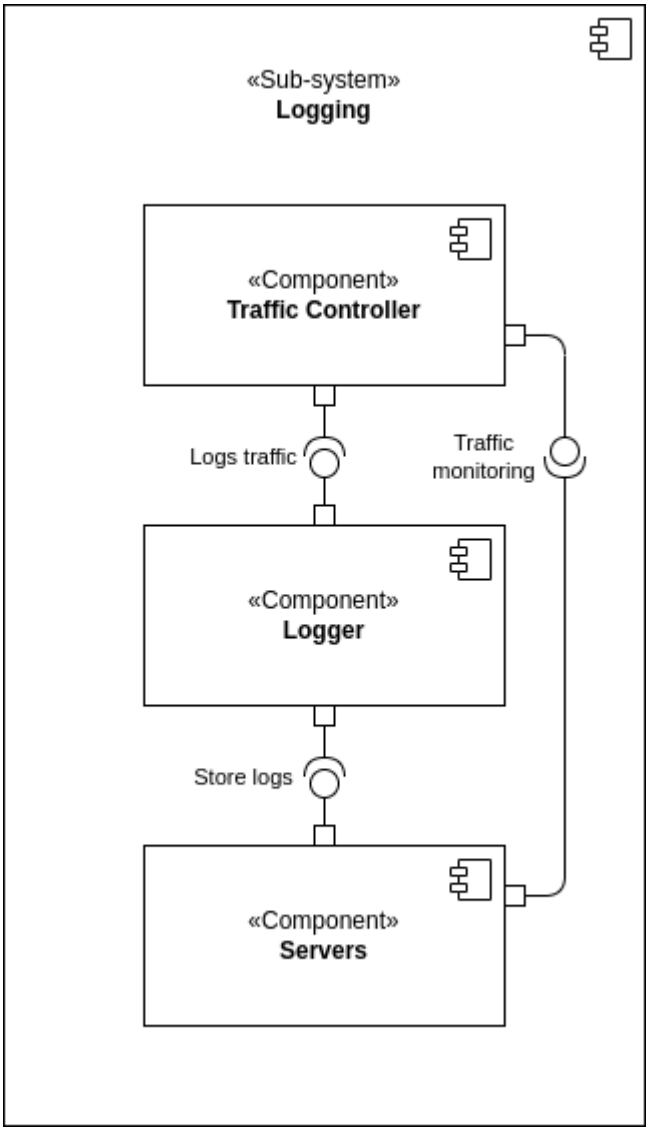
Images



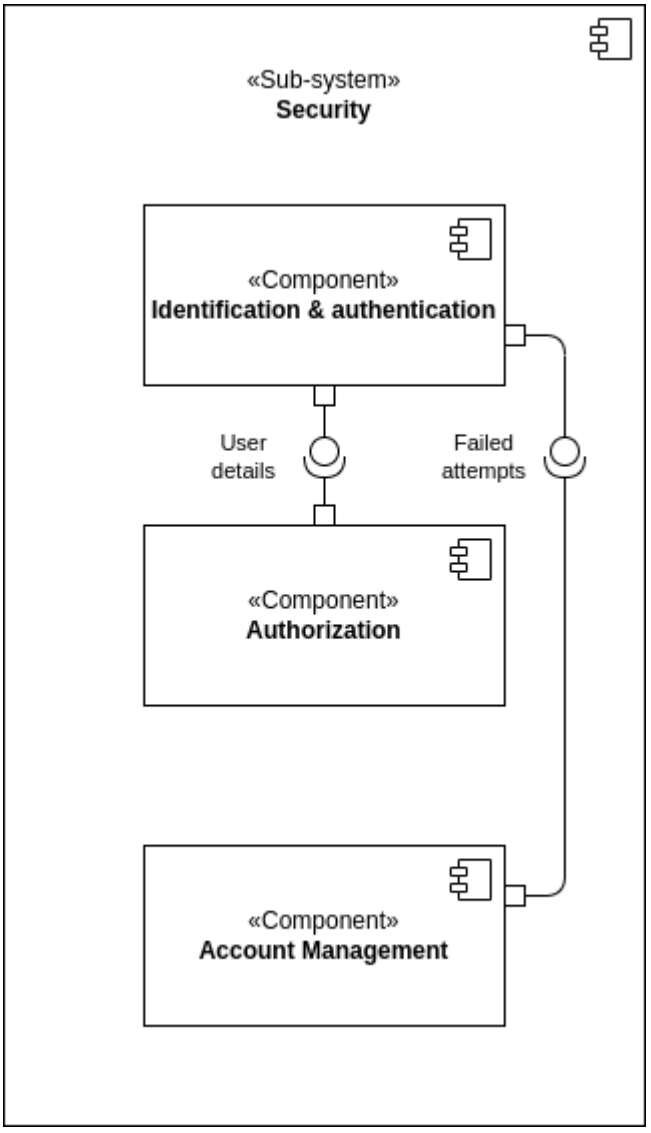
Decomposition diagram



Persistence sub-system

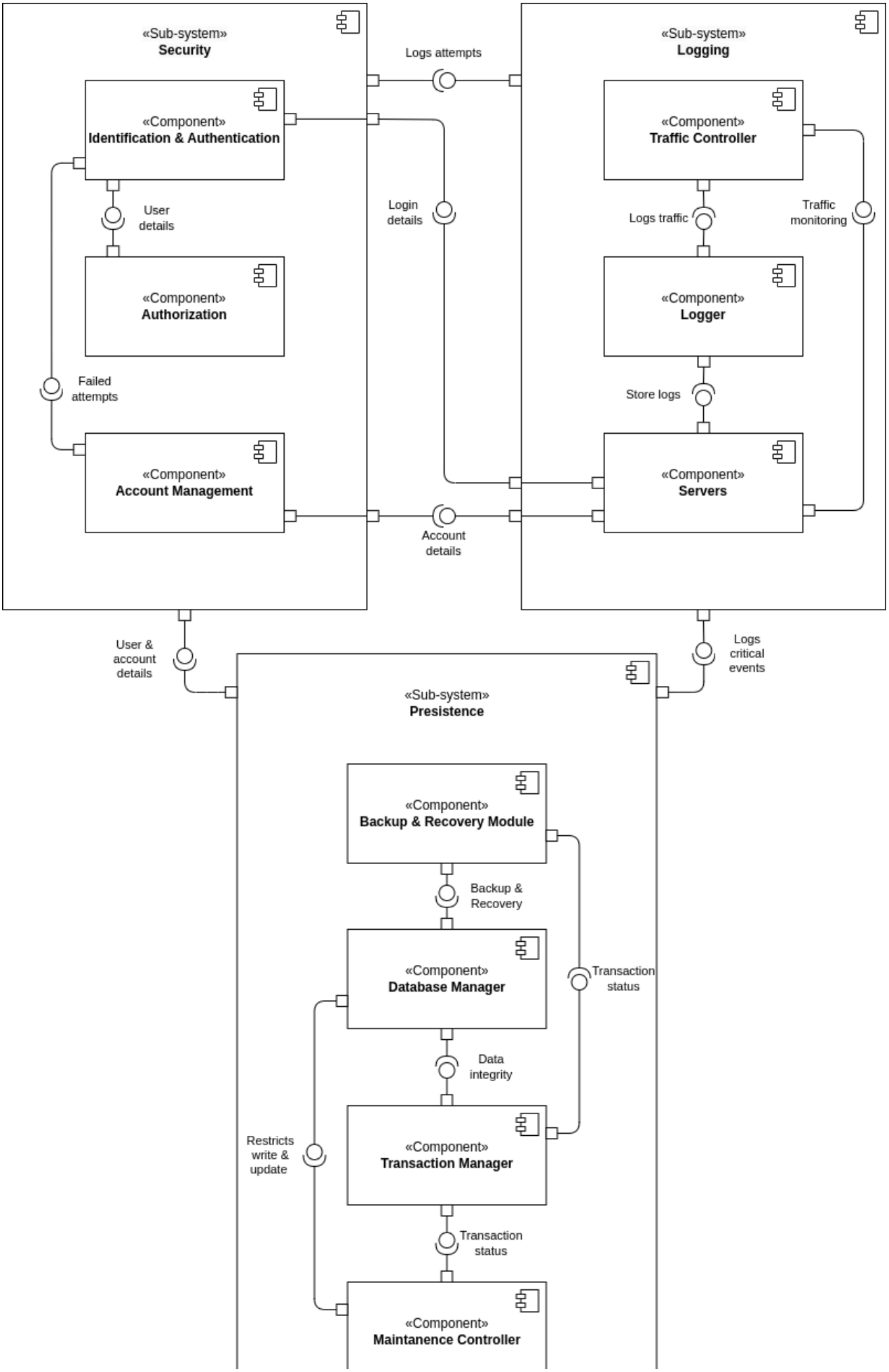


Logging sub-system



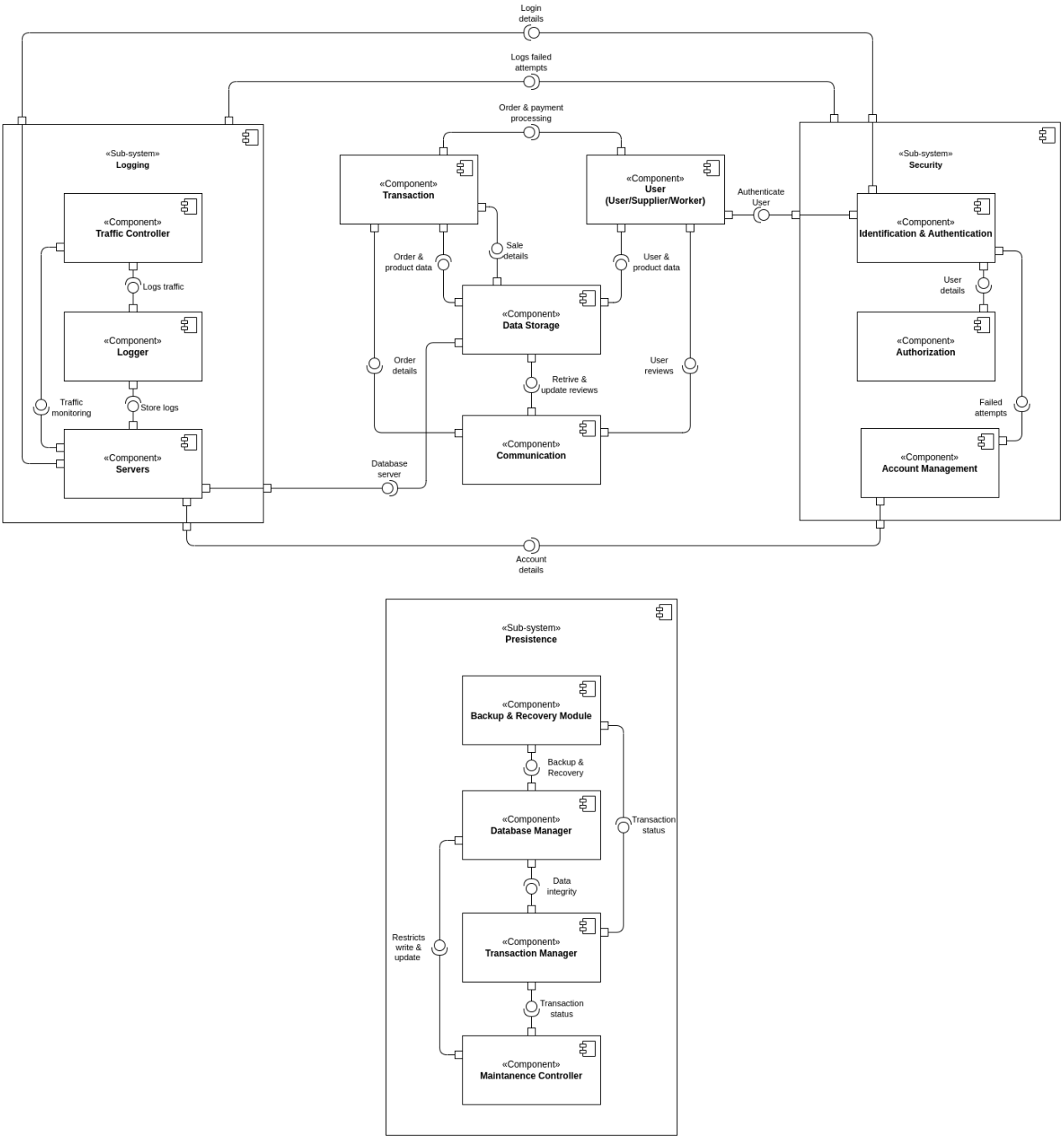
Security sub-system

Now the sub-systems will be connected to provide a "solution" that showcases how they will work together and dependent on each other.


«Sub-system»
Security
Logs attempts
«Sub-system»
Logging
«Component»
Identification & Authentication
«Component»
Traffic Controller
User
details
Login
details
Logs traffic
Traffic
monitoring
«Component»
Authorization
«Component»
Logger
Failed
attempts
Store logs
«Component»
Account Management
«Component»
Servers
Account
details
User &
account
details
Logs
critical
events
«Sub-system»
Presistence
«Component»
Backup & Recovery Module
Backup &
Recovery
«Component»
Database Manager
Transaction
status
Data
integrity
Restricts
write &
update
«Component»
Transaction Manager
Transaction
status
«Component»
Maintanence Controller

Connected sub-systems

Lastly the final component diagram including all the relations between components and sub-systems, including the decomposition diagram



Component diagram