Technical Architecture & Security

Open Source Security Bastion

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Richard Ben Aleya

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1. Architecture Overview

The Vauban architecture adopts a hybrid model combining Axum (Tokio-based), Diesel, and Askama for the web interface and REST API, with Rust microservices for performance-critical and security-critical components. This approach allows us to benefit from Rust rapid development while ensuring maximum security and performance for connection processing.

1.1 Guiding Principles

- **Defense in Depth:** Multiple independent security layers
- **Zero Trust:** Authentication and authorization at every level
- **Least Privilege:** Minimum access required for each component
- **Fail Secure:** In case of error, the system denies access by default
- **Total Auditability:** All actions are tracked and timestamped

2. Technology Stack

2.1 Frontend & API Layer (Rust)

Component	Technology
Framework	Axum (Tokio-based) + Diesel + Askama
API	Axum (Tokio-based) + Diesel
Authentication	Argon2, JWT, totp-rs, oauth2, openidconnect, samael
Frontend	HTMX + Alpine.js (lightweight, progressive)
WebSocket	Axum (Tokio-based)
Cache	Valkey (sessions, cache, pub/sub)

2.2 Rust Services Layer

Component	Technology
Async Runtime	Tokio
SSH Proxy	russh (thrussh fork)
RDP Proxy	IronRDP
Serialization	serde + MessagePack/CBOR
gRPC	tonic (with mTLS)
Crypto	ring, rustls (TLS 1.3 only)

2.3 Infrastructure

Component	Technology
Database	PostgreSQL 18 (with encryption)
Message Queue	RobustMQ (persistence)
Secrets	HashiCorp Vault
Internal PKI	step-ca (Smallstep)
Sandbox	Capsicum
Logs/Metrics	OpenTelemetry → Loki/Prometheus

3. Microservices Architecture

The architecture is divided into 7 main services, each with a unique responsibility and clearly defined interfaces.

3.1 Services Overview

Service	Lang.	Responsibilities
vauban-web	Rust	• User interface (admin & users) • REST/GraphQL API • Web session management • Real-time dashboard
vauban-auth	Rust	• Authentication (MFA, SSO) • LDAP/AD/OIDC integration • JWT token management • Connection audit

Service	Lang.	Responsibilities
vauban-rbac	Rust	• RBAC engine (Casbin) • Policy evaluation • Authorization cache • Decision API (PDP)
vauban-proxy-ssh	Rust	• Transparent SSH proxy • Session recording • Key injection • Command filtering
vauban-proxy-rdp	Rust	• RDP proxy (NLA support) • Video session capture • Credential injection • Watermarking
vauban-vault	Rust	• Secret management • Automatic rotation • HSM integration • SSH keys/certificates
vauban-audit	Rust	• Log collection • Secure storage (WORM) • Search and replay • Real-time alerts

4. Inter-Service Security

Communication between services follows the Zero Trust model with mandatory mutual authentication.

4.1 mTLS (Mutual TLS)

- Each service has its own X.509 certificate issued by the internal PKI (step-ca)
- TLS 1.3 only with modern cipher suites (AEAD)
- Automatic certificate rotation (lifetime: 24h)
- OCSP/CRL verification for immediate revocation

4.2 Communication Protocols

Type	Protocol	Usage
Synchronous	gRPC + mTLS	RBAC calls, auth verification, vault queries
Asynchronous	RobustMQ	Audit events, notifications, session events
Streaming	Bidirectional gRPC	Session recording, live monitoring

4.3 Service Mesh Pattern

Each Rust service integrates a lightweight sidecar implementing:

- **Circuit Breaker:** failure isolation (via tower-rs)
- **Rate Limiting:** protection against abuse
- **Retry with backoff:** resilience to transient errors
- **Distributed tracing:** request correlation (OpenTelemetry)

4.4 Service Authentication

In addition to mTLS, each request includes a SPIFFE (Secure Production Identity Framework for Everyone) token enabling fine-grained service identification.

5. Data Model

5.1 Main Entities (PostgreSQL)

Entity	Description
User	Users with MFA, preferences, connection history
Group	User groups (mapped from LDAP/AD)
Asset	Target servers/equipment (SSH, RDP, VNC)
Credential	Stored credentials (Vault reference, never in plaintext)
Policy	RBAC rules (Casbin format)
Session	Active and historical sessions with metadata
AuditLog	Immutable logs with cryptographic signature

5.2 Data Separation

- **PostgreSQL:** relational data (users, policies, metadata)
- **Vault:** secrets (passwords, SSH keys, certificates)
- **Object Storage (S3/MinIO):** session recordings
- **Valkey:** cache, web sessions, ephemeral data

6. Authentication Flow

6.1 User Authentication (Web UI)

- User accesses the Rust web interface
- Login/password entry (or SSO via OIDC/SAML)
- MFA challenge (TOTP)
- Signed JWT creation (claims: user_id, groups, permissions)
- Refresh token stored in database, access token in HttpOnly cookie

6.2 Asset Connection (SSH)

- User selects a server in the interface
- vauban-web queries vauban-rbac (gRPC) to verify authorization

- If authorized, ephemeral session token creation
- WebSocket client connects to vauban-proxy-ssh
- Proxy retrieves credentials from vauban-vault
- SSH connection established to the asset
- Bidirectional streaming + recording to vauban-audit

6.3 Just-In-Time Access

The system implements an approval workflow for sensitive access:

- Access request with justification
- Notification to approvers (email, other means)
- Temporary policy creation (configurable TTL)
- Automatic revocation on expiration

7. Implementation Roadmap

Phase 1: Foundations (Q1 2026)

- Monorepo setup (Cargo workspaces)
- PKI infrastructure (step-ca) and Vault
- vauban-auth: basic authentication + MFA
- vauban-rbac: Casbin engine with simple policies
- CI/CD with security tests (SAST, dependency audit)

Phase 2: SSH Proxy (Q2 2026)

- vauban-proxy-ssh: basic connection
- Integration with vauban-vault for keys
- Session recording (asciinema format)
- Web interface with xterm.js terminal

Phase 3: Audit & Monitoring (Q3 2026)

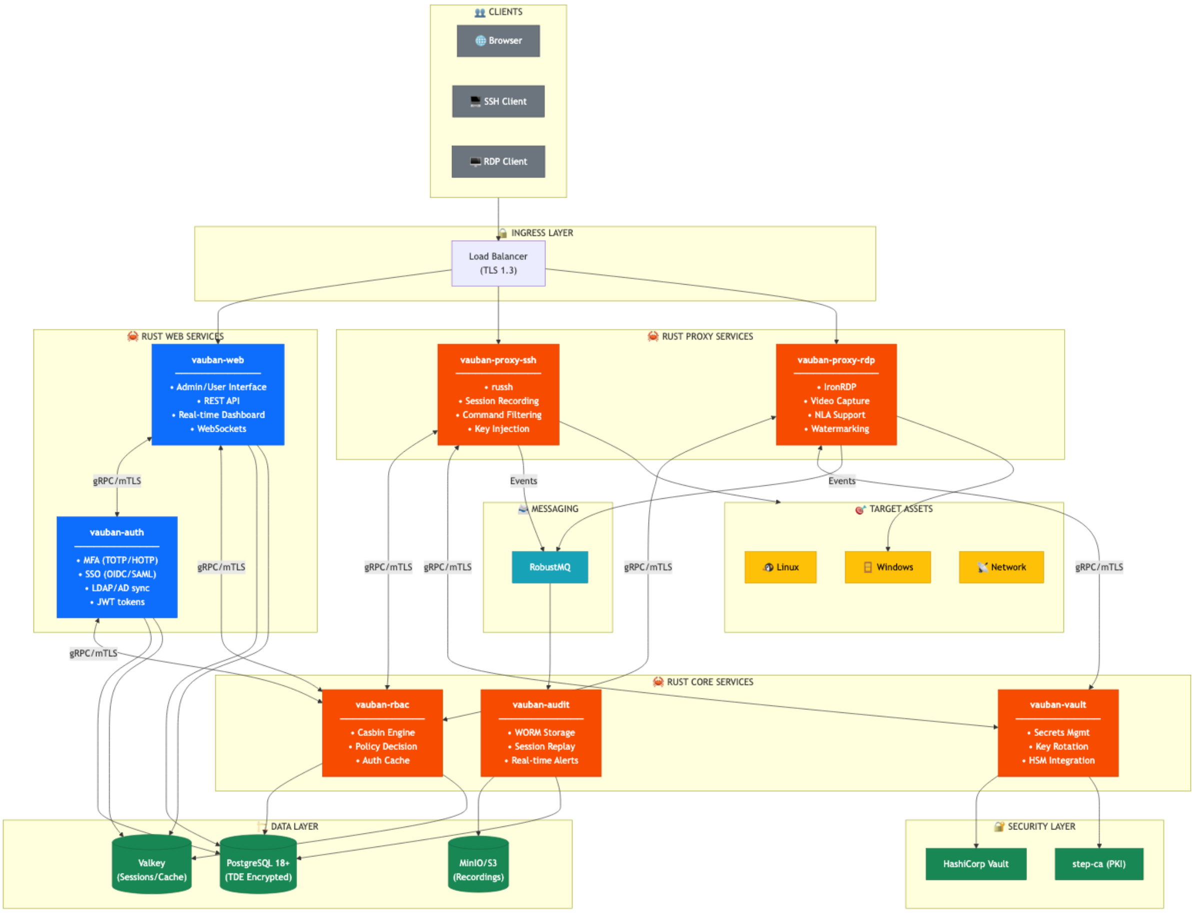
- vauban-audit: WORM collection and storage
- Real-time dashboard (WebSockets)
- Session replay
- Alerts and notifications

Phase 4: RDP & Enterprise (Q4 2026)

- vauban-proxy-rdp with IronRDP
- LDAP/Active Directory integration
- SSO (OIDC/SAML)
- Documentation and deployment guides

Appendix: Architecture Diagram

Vauban - Microservices Architecture


CLIENTS
Browser
SSH Client
RDP Client
INGRESS LAYER
Load Balancer
(TLS 1.3)
RUST WEB SERVICES
vauban-web
• Admin/User Interface
• REST API
• Real-time Dashboard
• WebSockets
gRPC/mTLS
vauban-auth
• MFA (TOTP/HOTP)
• SSO (OIDC/SAML)
• LDAP/AD sync
• JWT tokens
gRPC/mTLS
RUST PROXY SERVICES
vauban-proxy-ssh
• russh
• Session Recording
• Command Filtering
• Key Injection
vauban-proxy-rdp
• IronRDP
• Video Capture
• NLA Support
• Watermarking
Events
Events
MESSAGING
RobustMQ
TARGET ASSETS
Linux
Windows
Network
gRPC/mTLS
gRPC/mTLS
gRPC/mTLS
gRPC/mTLS
gRPC/mTLS
RUST CORE SERVICES
vauban-rbac
• Casbin Engine
• Policy Decision
• Auth Cache
vauban-audit
• WORM Storage
• Session Replay
• Real-time Alerts
vauban-vault
• Secrets Mgmt
• Key Rotation
• HSM Integration
DATA LAYER
Valkey
(Sessions/Cache)
PostgreSQL 18+
(TDE Encrypted)
MinIO/S3
(Recordings)
SECURITY LAYER
HashiCorp Vault
step-ca (PKI)