

Elfege Arthur Leylavergne

Solution Architect | Senior Software Engineer | Ph.D. Logic & Epistemology

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PROFILE

I architect systems that anticipate and resolve complexity. With 15 years studying logic and epistemology, I approach distributed systems as evolving structures with internal tensions — not static designs. Combined with hands-on engineering since 2000, I design solutions that anticipate failure modes before they occur, reduce complex problems to their essential structure, and integrate contradictory data sources into unified outputs. My work centers on translating ambiguous requirements into scalable, production-grade architectures — bridging the gap between stakeholder intent and technical execution.

CORE COMPETENCIES

Solution Architecture:	System design, requirements analysis, cross-team technical leadership, stakeholder communication, distributed system design, integration architecture, defense-in-depth design
Languages:	Python, JavaScript/ES6, TypeScript, C++, Groovy, Bash (preferred for systems automation & infrastructure), SQL
Data & Streaming:	Apache Flink, Apache Kafka, PyFlink, AVRO serialization, XML parsing, real-time stream processing
Front-End:	React 19, Next.js 15, TypeScript, MUI, Tailwind CSS, Kendo UI, Leaflet/GeoServer, ECharts, TanStack
Back-End:	React Query, Socket.io, jQuery, Jinja2, HTML5, CSS3
DevOps & Cloud:	Flask, FastAPI, Gunicorn, Node.js/Express, PostgreSQL, PostgREST, Flyway, RESTful API design, database schema design, stored procedures, trigger functions
Async & Concurrency:	Docker (Compose, Swarm), CI/CD, GitHub Actions, AWS (ECR, EC2, S3, Secrets Manager, SSO), Linux administration, systemd, log rotation
Security:	Python asyncio, aiohttp, APScheduler, multiprocessing, multithreading, event-driven architecture
Networking:	NIST (SP 800-160/800-37/800-47), AES-256-CBC/PBKDF2, Fernet/OpenSSL, Bcrypt, JWT/CSRF, SSH, TLS 1.2, VPN, Docker network isolation
Hardware Integration:	TCP/IP, ICMP, SMTP, SNMP, NTCIP, RTSP, RTMP, SRT, SRTP, SFTP, MQTT, WebRTC, WHEP/WHIP, HLS, STUN/TURN, ONVIF, CORS, firewall configuration
Spoken Languages:	LiDAR/TEMS sensors, Bosch RCP+, ONVIF, SNMP relay controllers, FFmpeg
	English (native), French (native), Spanish (intermediate), Portuguese (intermediate), Academic Ancient Greek, Latin

EXPERIENCE

Senior Software Engineer — Mindhop Inc., White Plains, NY | 2023 – Present

Over Height Vehicle Detection — Real-Time Safety System for NYSDOT

Single-handedly architected and delivered production-grade edge-computing safety system — real-time over-height vehicle detection via integrated LiDAR, VCA cameras, and automated traffic control. Owned full stack from application architecture to field hardware configuration.

- Architected fault-isolated multi-process system (5 data processors + Flask app) in single Docker container with 7-layer watchdog architecture; achieved 120+ days continuous uptime.
- Implemented VCA streaming optimization: 18 duplicate detections to 1 optimal output via confidence plateau detection, maintaining ~100MB memory footprint.
- Designed dual-sensor correlation: LiDAR (TCP, millimeter-accurate) + VCA (RTSP classification) with 5-second deduplication and UUID-based video matching.
- Built MQTT/WebSocket distribution for TMC dashboards; AVRO pipeline integration with Apache NiFi.
- Created Express.js admin server in isolated container with SSH proxy for secure TMC remote management.
- Developed automated field installer handling encryption, hardware integration (LiDAR, PTZ, SNMP relays), and system service configuration.
- Engineered PostgreSQL batch operations (100/batch) with 6-day automated retention under 24/7 write loads.

DMS Control API — Highway Dynamic Message Sign Command & Control

Sole architect and developer of a production command & control API for Dynamic Message Signs across multiple state DOT deployments. Reverse-engineered NTCIP 1203 protocol from MIB specifications and IRIS open-source reference to build a vendor-agnostic driver framework — no SDK access provided.

- Designed driver-based architecture with factory/registry pattern: manufacturer-specific SNMP drivers (Daktronics VFC-3000, generic NTCIP), 4-gate request router, 3-tier quirk resolution (device override > model template > defaults).
- Implemented full NTCIP 1203 message lifecycle: MULTI markup validation, CRC computation, message activation sequences, readback verification, and scheduled message management via APScheduler.
- Built interactive API dashboard with live endpoint testing, Mermaid-based architecture diagrams, and field-level contextual help across 15+ endpoints.
- Delivered 31 end-to-end tests, Kafka event streaming integration, and MIB-driven capabilities discovery — all from protocol specs with zero vendor support.

Device Status Monitoring System — Network Infrastructure Monitoring for UDOT

Architected production-grade network monitoring system for Utah DOT, tracking 2,400 devices across 750+ subnets on state fiber infrastructure.

- Achieved 90%+ cycle time reduction (54–60 min to 5–7 min) through device-type filtering and adaptive batching.
- Designed Python asyncio/aiohttp architecture with configurable worker pools (2,000 concurrent pings) preventing file descriptor exhaustion.
- Engineered APScheduler-based per-device-group scheduling with independent intervals (12/24/48 min cycles), 100% adherence.
- Integrated PostgREST streaming writes for real-time visibility; containerized via Docker Compose with AWS (ECR, Secrets Manager, SSO).
- Validated 120+ hours continuous operation, zero errors.

Real-Time Alert Routing System — Event Processing & Notification

Architected real-time alert processing system using Apache Flink and Kafka, dispatching personalized notifications via email, SMS, and WebSocket.

- Designed event-driven architecture processing complex trigger conditions across multiple event types.
- Integrated PostgreSQL with stored procedures for optimized operations; modular dispatch supporting SMTP and Twilio.
- Containerized with Docker Compose; implemented multiprocessing/multithreading for concurrency.

Video-Streaming Platform — Low-Latency DOT Camera Infrastructure

- Built core video-streaming platform: Flask + FFmpeg encoding/compression with WebRTC/HLS delivery.
- Implemented React monitoring interface for real-time stream health and metrics visualization.
- Automated deployment infrastructure via Bash scripting and CI/CD pipelines.

Front-End — DotStream React/Next.js Monorepo

Contributor to production Next.js 15 / React 19 / TypeScript monorepo (Turbo, pnpm workspaces) serving 15+ dashboard pages across multiple state DOT deployments.

- Integrated full OHVD real-time subsystem into the React platform: alert providers, WebSocket event streams, map panel hierarchies, and Kendo data grids.
- Contributed to migration from 5,000+ line vanilla JS monolith to modular React component architecture with Jest unit tests and Playwright E2E coverage.

Software Engineer — PowerYou AI, New York, NY | 2022

Inherited React.js and React Native codebase in critical state following abrupt departure of prior development team. Stabilized, debugged, and partially refactored both web and mobile applications.

- Implemented testing protocols and deployment workflows to establish reproducible release processes.
- Audited and restructured AWS environment: IAM policy hardening (least privilege), S3 backup procedures, EC2/Route53 configuration.
- Transitioned infrastructure from ad-hoc configuration to documented, maintainable state.

Professor, Researcher & Technology Integrator — Lycée Français of New York | 2007 - 2022

- **Technology Integrator (2012–2016):** Led technology modernization of a \$100M+ K-12 institution — now outcompetes many Manhattan for-profits on infrastructure maturity.
- Deployed and configured Palo Alto NGFW + Cisco switching infrastructure; implemented VLAN segmentation, firewall policy design, and network monitoring.
- Enforced data security as institutional priority: student data protection, access control, audit trails — muscle memory that carries into every system I build.
- Integrated Blackbaud SIS API with enrollment solutions; designed unified data schemas across administrative systems.
- Founded and directed Robotics program (2015–2022): C++ firmware, hands-on hardware curriculum.
- Founded Polysophia research collective (2009–2022): coordinated with Columbia University, Rockefeller University, Nassau Community College, TED-Ed (2014).

Open-Source Developer — Personal Projects & Community | 2012 - Present

Linux Infrastructure & Bash Automation — Personal Homelab

Self-built production-grade homelab on Dell PowerEdge R730xd (Proxmox VE), managed entirely via Bash automation. Bash is the primary tool for infrastructure operations — not a fallback, but the preferred layer of control.

- Administers Ubiquiti network stack (USW-Pro-48, UXG-Fiber gateway, 6x UAPs), SonicWall firewall, VLAN segmentation across 8 network zones.
- Built and maintains `~/ .bash_utils` — personal automation library: AWS SSO auth chains, SSH ProxyJump orchestration across 5 machines, PDF export pipeline, secret rotation, Docker lifecycle management.
- Runs 20+ self-hosted services (Proxmox VMs/LXC, NVR, Anamnesis, job tracker, Ollama inference) on isolated network segments.
- SSH ProxyJump chains: `office → server → app1 → dellserver` with per-host key management and `.ssh/config` templating.

Job Application Tracker — Full-Stack AI-Assisted Workflow System

Designed and built a full-stack application tracking system integrating AI generation, browser automation, and email parsing — a real engineering problem solved with production-grade architecture.

- FastAPI async backend, Next.js 15 / React / TypeScript frontend, PostgreSQL, Docker Compose; modular API with 15+ endpoints.
- Chrome Extension (Manifest V3) integrates with ATS platforms via Chrome Debugger Protocol (Input .dispatchKeyEvent) — required reverse-engineering react-select component internals that block all synthetic DOM events.
- Nightly APScheduler pipeline: SSH to remote machine, parses Thunderbird mbox for LinkedIn/CareerBuilder alert emails, extracts job postings, deduplicates against DB.
- Claude CLI integration: AI-generated cover letters, cached fit assessments, Anamnesis episodic memory for cross-session learning.
- Event dedup system: URL-hashed form interaction tracking with confirmation guards — prevents duplicate submissions.

Anamnesis — Vector-Based Episodic Memory for AI Instances

Designed and built a semantic memory system enabling AI instances to retain and retrieve contextual knowledge across sessions — grounded in epistemological theory of episodic memory.

- Architected FastAPI async backend with MongoDB Atlas Local native \$vectorSearch (HNSW, 1024-dimensional embeddings) — zero cloud dependency.
- Built multi-model embedding pipeline (sentence-transformers) with automatic re-embedding on model change, checkpoint-based resumption, and JSONL bulk ingestion.
- Implemented cross-instance coordination: file crawler auto-ingests from handoff buffers, project histories, and CLAUDE.md files across networked machines.
- Integrated streaming chat with memory injection — semantic search before each turn, session persistence with rename history, three LLM backends (Ollama, Claude CLI, Claude API).

MOBIUS.NVR — Multi-Vendor Video Surveillance Platform

Unified NVR managing 17+ IP cameras across 4 vendors and growing (Python/Flask/Docker), with ONVIF/WebRTC/MediaMTX streaming at 200ms latency and Neolink bridging for non-ONVIF devices.

IoT & Home Automation — Custom Firmware, Robotics & Infrastructure

- Reverse-engineered iRobot Roomba 980 WiFi protocol (HTTPS/JSON API/Node.js) — first SmartThings/Hubitat integration, subsequently forked and extended by community developers.
- Thermostat Manager (Groovy): multi-device HVAC automation with narrow-AI learning features. Dashboard interface (JavaScript/HTML) for real-time IoT device control.
- **KOBRA robot** (ESP32): custom-built autonomous platform — dual motor+encoder closed-loop control, WiFi webserver, 3-DOF arm control, magnetic docking system; two full hardware generations.
- **MEBO robot** (ATmega2560 + ESP32/ESP8266): commercial toy reverse-engineered and extended across multiple iterations — custom motor driver, WebSocket interface, virtual joystick frontend, full firmware replacement.
- 6+ motorized **window actuators** deployed across apartment (A4988 stepper, H-bridge DC, and linear actuator variants) — each with custom C++ firmware + matching Groovy Hubitat driver.
- **Door intercom automation:** NodeMCU monitors analog voltage on LCD power line to detect doorbell ring; state machine drives TALK + DOOR relay sequence automatically — no hardware modification required.
- IR blaster network: split AC units (3 bedrooms + living room), Apple TV, Samsung TV — protocol-decoded and replayed via ESP8266 over MQTT.
- Environmental sensor network: motion (6 rooms), humidity, leak, water level, bed occupancy, gas sensors — all custom firmware on ST_Anything-adapted architecture with matching Groovy Hubitat drivers.

IT Administrator & Operations Manager — Teleperformance, Strasbourg, France | 1999 – 2001

- Migrated server infrastructure from Novell NetWare to Windows NT with LDAP/IIS; upgraded network from IPX/SPX to TCP/IP (500% throughput increase).
- Migrated data systems from dBASE/flat files to MySQL RDBMS with web-based reporting.
- Managed 20+ person team; achieved 20% productivity increase and 10% profit increase.

EDUCATION

Springboard Software Engineering Curriculum (800+ hours), Calif. BPPE — Certification 2023

Ph.D., Université de Nantes — Logic & Epistemology | Summa Cum Laude | Published thesis (ISBN 978-989-20-3141-5)

Master's, Université de Grenoble Alpes | ENS Lyon — Logic, Epistemology, Sciences of Languages & Philosophy | Magna Cum Laude

Bachelor's, Université de Strasbourg — Philosophy (completed while employed full-time at Teleperformance)

INTERESTS

Robotics, home automation (integrated systems with hundreds of DIY IoT devices), philosophy, martial arts (Karate, Wing Chun), swimming.